

**EFFECT OF INTERCROP AND WEED MANAGEMENT  
ON PRODUCTIVITY AND RESOURCE USE EFFICIENCY  
IN TURMERIC (*Curcuma domestica* Val.)**

**A thesis  
Submitted to the  
Assam Agricultural University**

**In partial fulfilment of the requirements for the Degree of  
DOCTOR OF PHILOSOPHY (AGRICULTURE)  
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*For*  
**THE FARMING COMMUNITY**

## ABSTRACT

A field experiment was conducted at the Instructional-Cum-Research (ICR) farm of Assam Agricultural University in 2013 and 2014 to study the “Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* Val.)” The treatments consisted of two planting methods of turmeric *viz.*, paired row 80/20 cm and paired row 70/30 cm; two intercropping systems with baby corn and greengram and three weed management practices *viz.*, non-chemical i.e. mulching along with four hand weeding at 35, 65, 95 and 140 days after planting (DAP), pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding at 35, 65, 95, 140 and 185 DAP and pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding at 35, 65, 95, 140 and 185 DAP along with one weedy check (control). Thus, twenty treatment combinations including four controls (sole crops) were laid out in a factorial randomized block design with three replications. The surface soil of the experimental site was acidic in reaction, sandy loam in texture, low in organic carbon, medium in available nitrogen, low in available phosphorus and medium in available potassium.

In the experimental field, *Eleusine indica* (L) Gaertn., *Digitaria setigera* Roth., *Panicum repens* L. among the grasses, *Cyperus iria* L. and *Fimbristylis aestivalis* (Retz.) Vahl. in the sedges and *Ageratum houstonianum* Mill., *Borreria articularis* (L.f.) Will, *Commelina diffusa* Burm.f., *Mimosa diplotricha* C. Wright and *Mimosa pudica* L. under broad leaved weed were predominant. The grasses and broad leaved weed constituted the major proportion of the weed flora at early stage and later stage, respectively.

Significant difference in total weed density and dry weight was recorded between the method of planting. The planting method 70/30 cm proved to be superior in less weed density, dry weight and higher weed control efficiency in both the years.

In regards to intercropping, significantly higher value of total weed density and dry weight was recorded in turmeric-greengram intercropping system and higher weed control efficiency was found in turmeric-baby corn intercropping system.

Among the weed management treatments imposed, significantly lower total weed density, dry weight and lower removal of NPK by weeds was observed in the

non-chemical weed management practice i.e. mulching along with four hand weeding over other practices during both the years. Weed control efficiency was also higher in the same weed management practice.

The paired row planting at 70/20 cm proved superior in terms of different growth and yield attributes of turmeric crop. Significantly higher fresh rhizome yield of 24.25 and 24.63 t ha<sup>-1</sup>, higher dry rhizome yield of 5.61 and 5.55 t ha<sup>-1</sup>, higher uptake of N, P and K were recorded under paired row 70/30 cm as compared to paired row planting of turmeric at spacing of 80/20 cm during both the years.

The corn yield with husk of intercrop baby corn were 6.58 and 6.54 t ha<sup>-1</sup> under paired row 70/30 cm in both the years which accounted for 57.11 and 56.82 per cent to the sole baby corn yield (11.52 and 11.58 t ha<sup>-1</sup>) as compared to 57.03 and 56.48 per cent in paired row 80/20 cm during first and second year, respectively.

Intercropping greengram in the intervening space of paired row 70/30 cm produced grain yield of 3.32 and 3.40 q ha<sup>-1</sup>, which constituted 27.71 and 28.24 per cent of the yield of sole greengram (11.98 and 12.04 q ha<sup>-1</sup>), as compared to 27.96 and 28.24 per cent under paired row 80/20 cm during both the years. Method of planting of turmeric did not affect significantly in yield of intercrop greengram.

The intercropping greengram had produced significantly higher value of growth and yield attributes and rhizome yield of turmeric as compared to intercropping baby corn.

Different weed management practices had significant effect on the base crop turmeric and intercrops baby corn and greengram. The non-chemical weed management practice by mulching along with four hand weeding at 35, 65, 95 and 140 DAP proved superior in respect of growth and yield attributes. It produced significantly higher fresh yield (32.05 and 32.42 t ha<sup>-1</sup>), dry rhizome yield (7.14 and 7.66 t ha<sup>-1</sup>) and nutrient uptake as compared to other treatment of weed management practices. The same weed management practice produced the intercropped baby corn yield of 8.17 t ha<sup>-1</sup> that accounted for 70.81 and 70.58 per cent to the yield of sole baby corn in both the years. As regard to intercrop greengram, the yields were 4.20 q ha<sup>-1</sup> and 4.28 q ha<sup>-1</sup> which accounted for 34.95 and 35.58 per cent to the yield of sole greengram during the two years. Curcumin content did not differ significantly due to different treatment imposed for planting system, intercropping and weed management.

Better resource use efficiency in regard to water, nutrient, light was observed in the 70/30 cm planting method, turmeric-greengram intercropping system and in the non chemical weed management practice.

As regard to cropping system as a whole, planting methods had significant effect on most of the characters studied. Paired row 70/30 cm proved superior in terms of turmeric equivalent yield and land equivalent ratio.

Intercropping baby corn had resulted significantly higher turmeric equivalent yield and greater land equivalent ratio in both the years.

The weed management practice with non-chemical method i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP produced significantly higher turmeric equivalent yield of  $6.75 \text{ t ha}^{-1}$  and  $6.78 \text{ t ha}^{-1}$  as compared to other management practices in both the years of experimentation.

The sole turmeric (weedfree) was found superior over the sole turmeric (recommended practice) in respect of fresh rhizome and dry rhizome yield in both the years. However, curcumin content did not differ in both the sole crop treatment.

Turmeric planting in paired row 70/30 cm and intercropping greengram in between paired rows with non-chemical weed management practice by mulching along with four hand weeding at 35, 65, 95 and 140 DAP proved superior in most of the attributes studied, followed by paired row 70/30 cm and intercropping baby corn with non-chemical weed management practice by mulching along with four hand weeding at 35, 65, 95 and 140 DAP. The later treatment combination ( $M_2I_1W_2$ ) was found superior in terms of turmeric equivalent yield, land equivalent ratio, net return ( $\text{R ha}^{-1}$  and  $(\text{R R}^{-1}$  invested), benefit: cost ratio and bioenergetics.

**ASSAM AGRICULTURAL UNIVERSITY**  
**FACULTY OF AGRICULTURE**

**CERTIFICATE – I**

This is to certify that the thesis entitled “**Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* Val.)**” submitted to the Faculty of Agriculture, Assam Agricultural University, Jorhat in partial fulfilment for the degree of **DOCTOR OF PHILOSOPHY (Agriculture)** in **AGRONOMY** is a record of research work carried out by **Shr. Dwijendra Mohan Barman** under my personal supervision and guidance.

All help received by him have been duly acknowledged.

No part of the thesis has been reproduced elsewhere for any degree.

Dated Jorhat  
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## CERTIFICATE – II

This is to certify that the thesis entitled “**Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* Val.)**” submitted by **Shr. Dwijendra Mohan Barman, Regd. No. 498 of 2012** Assam Agricultural University, Jorhat in partial fulfilment for the degree of **DOCTOR OF PHILOSOPHY (Agriculture)** in the discipline of **AGRONOMY** has been examined and approved by the Student’s Advisory Committee and the External Examiner, after viva-voce.

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*Dated: Jorhat*

*The 28<sup>th</sup> September, 2015*

*The Author*

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## ACRONYMS AND ABBREVIATION USED

a.i.	: active ingredient
a.c.	: acid equivalent
@	: at the rate
%	: per cent
°C	: Degree Celsius
B:C	: Benefit Cost Ratio
BLW	: Broad Leaved Weeds
CD	: Critical Difference
Cal cm <sup>2</sup> day <sup>-1</sup>	: Calories per centimetre square per day
CO <sub>2</sub>	: Carbon di oxide
cm	: Centimetre
CPWC	: Critical period of Weed Competition
CGR	: Crop Growth Rate
DAP	: Days After Planting
DMP	: Dry Matter Production
EC	: Emulsifiable Concentrate
Fig.	: Figure
<i>et al.</i>	: Co workers
g m <sup>-2</sup>	: gram per metre square
g	: gram
g ha <sup>-1</sup>	: gram per hectare
HI	: Harvest Index
HW	: Hand Weeding
i.e.	: that is
K	: Potassium
kg a.i. ha <sup>-1</sup>	: kilogram active ingredient per hectare
L	: litre
LAI	: Leaf Area Index
LAD	: Leaf Area Duration
m	: metre
M ha	: million hectare

m <sup>2</sup>	: metre square
ml	: milli litre
mg kg <sup>-1</sup>	: milligram per kilogram
MOP	: Muriate of Potash
MSL	: Mean Sea Level
Max.	: Maximum
Min.	: Minimum
N	: Nitrogen
Na	: Sodium
NaCl	: Sodium Chloride
NAR	: Net Assimilation Rate
No. M <sup>-2</sup>	: Number per metre square
No.	: Number
NS	: Non significant
P	: Phosphorus
PE	: pre-emergence
pH	: Negative logarithm of hydrogen ion concentration
PoE	: Post-emergence
RD	: Relative density
RH	: Relative Humidity
R	: Rupees
R ha <sup>-1</sup>	: Rupees per hectare
SEd	: Standard Error Deviation
Spp	: Species
Sqm	: square metre
SSP	: Single Super phosphate
t	: tonnes
t ha <sup>-1</sup>	: tonnes per hectare
UV	: Ultra violate
viz.,	: Namely
WCE	: Weed control Efficiency

# CHAPTER I

## INTRODUCTION

Spices are considered as high value and low volume commodities of commerce in the world trade. It occupies a significant stance in the agricultural commodity bucket of India. The country, known as “Land of Spices” is the largest producer, consumer and exporter of variety of quality spices in the world. Amongst the 52 items brought under the purview of Spices Board of India, turmeric, as spice, is one of the most important by virtue of its production, domestic consumption and export. The International Trade Centre, Geneva, has estimated an annual growth rate of 10 per cent in the world demand for this multi purposed usable spice.

Turmeric (*Curcuma domestica* Valetton Syn. *Curcuma longa* L.) is a rhizomatous herbaceous perennial plant, 60-200 cm tall with short stem and tufted leaves, belongs to the family Zingiberaceae under the order Scitaminae. It is a versatile and remunerative cash crop of the tropics, from which the turmeric of commerce (dried rhizomes) is obtained. The common English culinary name for the herb is ‘Indian Saffron’ and yellow root. The term turmeric is believed to have originated from the Latin word *terramerita*, which became *terre merite* in French connoting meritorious earth (Kathleen, 2004). The cured, dried and ground rhizomes provide turmeric powder, which is used as an important constituent of curry powders and natural food colorant. The value-added products of turmeric are curcuminoids, dehydrated turmeric powder, oil and oleoresin etc. Chemical constituents of various tissues of turmeric have been extensively investigated. Altogether 235 compounds, primarily phenolic compounds and terpenoids have been identified so far from the species. Curcuminoids (diarylheptanoids) and essential oils are major bioactive ingredients showing various bioactivities *in vitro* and *in vivo* bioassays (Li *et al.*, 2011). Curcumin is highly aromatic with a musky odour and a pungent bitter taste, insoluble in water but soluble in acetone and ethanol.

Indian turmeric is highly valued worldwide because of its high curcumin content. Curcumin is the major active, medicinally potent ingredient of turmeric. It is an important constituent for the biological activity of turmeric that varies from 2.8 to 10.9

per cent among the 120 cultivars or accessions of *Curcuma longa* grown in India (Ratnambal, 1986). The plant is a native of India or China or Indo-Malayan region and is now a commercial crop of tropics. It is extensively cultivated in India, followed by Bangladesh, Pakistan, China, Thailand, Cambodia, Malaysia, Indonesia and Philippines. India is the world's largest producer, consumer and exporter of turmeric. The world production of turmeric is 8.0 lakh tonnes in which India hold a share of approximately 75-80 per cent and consumes around 80 per cent of its own production. Turmeric occupies about 6 per cent of the total area under spices and condiments in the country. During 2012-13, the country produced 9.92 lakh tonnes of turmeric from an area of 1.95 lakh ha (Anonymous, 2013). During the period between April 2011 to January 2012, India exported 67,000 tonnes of turmeric valued at ₹6,438 million. The major importing countries are UAE, USA, Japan, Sri Lanka, UK, Iran, Singapore and South Africa and together it share 65 per cent of total turmeric export from India (Anonymous, 2012).

Among the turmeric growing states of India, Andhra Pradesh stands first with 47 per cent of total annual national production followed by Maharashtra, Tamil Nadu, Kerala, Karnataka, Orissa, Assam, Bihar and West Bengal. Assam occupies an area of 15.2 thousand ha with a production of 12.6 thousand tonnes and a productivity of 830 kg per hectare. It is interesting to note that in Assam the area increased markedly from 4,000 ha in 1970 to 12,000 ha in 2000, but the productivity remained near constant between 1979 and 1990. In the State, during 1990-1995, both area and productivity decreased. However, between 1995 and 2000, the area increased but the productivity increased marginally from 600 kg per hectare to 700 kg per hectare (Parthasarathy *et al.*, 2007). Recently, in some parts of Assam, turmeric is cultivated commercially and established as an economically viable crop. However, the productivity in the region is very low because of various reasons like, poor knowledge on cultivation technology and socio-economic conditions of the farming community etc. The climate and soil requirements that are available for the crop are not exclusively sufficient to realize potential yield. Hence, appropriate agronomic management practices and other related techniques should be searched out in order to enhance productivity and maximizing profit in a sustainable system. Improvement of crop cultivation technologies for local climatic and edaphic factors is important for successful production (Akamine, 1995).

Planting method is a soil management tool which affects plant growth and yield (Chattopadhyay *et al.*, 1993). Development of feasible, economically viable

and farmer acceptable intercropping system largely depends on the adaptation of right planting system and selection of compatible crops. The technique of paired row planting in inter-cropping system is one way of accommodating the whole population of the base crop and creating inter-spaces wide enough to accommodate one or two rows of intercrop.

Turmeric is a long duration crop. Hence, economically poor small and marginal farmers hardly can spare lands for cultivation of such a long temporal crop like, turmeric without getting an intermediate income. In general, farmers grow turmeric commercially, in this region, in marginal land as a subsistence crop rather than any commercial consideration. However, a good number of progressive farmers of few pockets, particularly from hill areas, grow turmeric in large scale for marketable purpose. Intensive cultivation in the form of inter-cropping to exploit growth resources in slow growing turmeric crop during initial stages is not an uncommon practice. But selection of high value, fast growing, and mutually cooperative, early maturing right component crop is of great concern. The farmers never grow the component crops in a definite planting geometry. The yield of component crops due to competition (Behera, 2008). Adoption of appropriate intercropping systems might increase the unit productivity through efficient utilization of production factors like space, water, nutrient, sunlight etc.

Weeds are a big constraint in crop production and they are responsible for heavy yield losses in almost all the crops grown in this region of the country. The peak growing season of turmeric is categorized by warm humid summer and fairly long rainy season which favours the outbreak of several flashes of weeds; thus become a major impediment to production system. Delayed emergence, slow initial growth and poor canopy development at early growth stage of turmeric provide an ideal environment for weeds to grow and compete with the crop. Turmeric fields are severely infested with many sub-tropical and tropical weed species. Weeds can harbour insects, disease and nematode pests that infect crops significantly. Proper weed management is very important in long duration crop like, turmeric because it is cost involving unavoidable affair. Non-availability of labour hinders the timely control of weeds. Herbicides can bridge this gap to a greater extent but chemical control of weeds in turmeric has limitations. It is because, besides its use as spices, turmeric is extensively used as medicines. The non-chemical methods are eco-friendly, hence, selection of such

appropriate and cost effective methods are very important. Straw mulch is another approach adopted by the farmers that conserves soil moisture and modifies soil temperature which benefit the crop, besides controlling weeds (Mahey *et al.*, 1986).

There are several varieties of turmeric distinguished by the name of localities in which they are grown. The North Eastern States of India have many good local turmeric varieties with the name of locality where they are grown. One such variety is *Lakadong* originating from Jayantia Hill of Meghalaya State with high yield and high curcumin content. The quality of turmeric is reported to get affected by the altitudinal differences and the ones grown on hills are found to be of better qualities. The curcumin content of turmeric differs in different place due to genetic and environment reasons.

Turmeric has great potential for vertical and horizontal expansion for production in the region. Ratnambal (1986) reported that farmers of Assam grow very good local varieties like, 'Nowgaon' (20% dry recovery), 'Hazo' (21% dry recovery), 'Barhola Jorhat' (25% dry recovery), 'Dadara Guwahati' (23.2% dry recovery), and 'Maran' (26% dry recovery). At present, productivity of turmeric in Assam is very low but this may be uplifted with improved infrastructure like, good marketing and storing facilities, irrigation, etc. along with awareness about the suitability of the crop (Parthasarathy, 2007).

Expansion of area as well as increased productivity of turmeric will help the country to achieve higher export earnings from turmeric in addition fulfilment of domestic requirement. Information work regarding the reasons for low productivity and premium return for turmeric growers in the region is not sufficient. Therefore, keeping the research bottle neck in view as well as to ensure some early income for the producers and higher productivity per day per unit area of turmeric in the region, an experiment had been planned to study the "Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* val.)" with the following objectives:

1. To study the effect of planting systems and weed management on growth, yield attributes and yields of component crops
2. To evaluate a suitable intercropping system with turmeric

3. To study weed dynamics, economic aspects and resource use efficiency under different weed management practices in turmeric based intercropping

## **CHAPTER II**

### **REVIEW OF LITERATURE**

A suitable crop cultivation technology benefiting the area specific climatic and edaphic conditions is imperative for successful crop production. Turmeric is a soil and climate sensitive crop. It is also highly responsive to agronomic management practices. It can be grown under diverse tropical conditions in altitudes ranging from sea level to 1500 m above mean sea level (Rema and Madan, 2001). It is adapted to an annual rainfall of 640 to 4290 mm. Moderate rainfall of 1500 mm at planting, fairly heavy and well-distributed rain during growing period and dry weather of about one month ahead of maturity is much suitable. The temperature range of 18.2-27.4°C is optimum (Kumar *et al.*, 2008).

The initial growth stages of turmeric encounter major competition with weeds for various growth resources. It is indeed important to understand the proper planting system to reduce weed interference and increase yield of crop. Keeping in view of importance of plant distance to get maximum yield by providing individual plant to best utilize resources in one hand and to create some space between pairs of base crop rows to accommodate an inter-crop but wide enough to minimize undue competition among plants of the base crop on the other, standardization of paired row spacing is essential.

Turmeric is a long duration crop and it takes about 8-10 months from the date of planting to harvest and therefore, the small farmers can hardly afford to grow it

as a sole crop. Hence, to encourage farmers for turmeric cultivation, the practice of intercropping is vital. As turmeric is a slow growing crop in its initial stage and takes 3-4 months to cover the inter-space, the space between turmeric rows can be efficiently utilized by growing some short duration high value crops which, in essence, can give farmers an intermediate income.

Weed infestation is one of the main reasons for low productivity of turmeric in our region because of high rainfall. Weeds have better adaptability because of hardiness, quick growing capacity and compete very efficiently with crops for growth resources. Hence, weeding is one of the most important, costly but unavoidable farm operations for successful crop production. But, very often farmers ignore weed control due to several reasons including involvement of high cost. Since, a sizable portion of agricultural work force is required on weeding operations, it was felt necessary to explore the alternative and suitable ways and means of crop management that might help in better weed management as well as enhance productivity. In order to get an efficient, economically viable and acceptable integrated weed management practice as well as suitable inter-crop and planting system, it was decided to evaluate a few methods of crop management in turmeric.

In this connection, an attempt has been made here to review the literature on planting system, suitable intercrops and integrated weed management practices in turmeric. Sivaraman (2012) revealed that there is a lack of published information on the agronomical aspects of turmeric in general and weather relationships in particular. Results of most of the systematic work on agronomical features of turmeric are available only from India. The status of scientific study on agronomical aspects of turmeric in other growing countries is scanty, except a few publications on cultivation of turmeric from Bangladesh. Studies on paired row planting system in turmeric and other long duration crop is not reported and hence, wherever the literature on turmeric is meagre, literature on other related crops was also reviewed.

## **2.1 Studies on planting system**

Designing and establishing a feasible and economically viable intercropping system largely depend on the adaptation of planting system and selection

of compatible crops as far as farmer's acceptability and sustainability of the system is concerned. Planting pattern very often require row arrangement to accommodate optimum plant population of base and inter-crops in intercropping system. Willey (1979) also opined beneficial effect of manipulating plant population and spatial arrangement in intercropping system. The practice of paired row planting in intercropping system is one way of maintaining the entire population of the base crop and creating interspaces amply adequate to accommodate one or two rows of intercrop. De and Singh (1979) reported that keeping the plant population of base crop constant

and altering row orientation for paired or trebled row planting offers more space for accommodating the companion crops.

Depending on cultivar, turmeric grows well under different spacing adopted for its above and underground development. Mohamed *et al.* (2014) reported that plant spacing of 25 cm was found to be better than wider or narrower spacing to increase yield as well as chemical constituents (total curcumin, total essential oil and total carbohydrate) of turmeric plant. Chattopadhyay *et al.* (1993) also observed that plant spacing of 30 cm x 20 cm gave significantly more fingers per plant in turmeric than plant spacing of 20 cm x 15 cm at Cooch Behar, West Bengal. Delayed germination, slow initial growth but luxuriant growth in later stage of turmeric is greatly affected by plant population per unit area. Influence of spacing on growth, yield and nutrient uptake in turmeric was also reported by Kandiannan and Chandaragiri (2008). Hossain *et al.* (2005) observed that largest shoot biomass and highest yield were obtained when turmeric was planted in two rows on the ridges with a 75 cm width followed by 100 cm width. They also observed that 30 cm triangular pattern gave highest yield followed by 30cm quadrate pattern. On the other hand, Kumar and Gill (2010) reported that planting of turmeric in 60 cm x 10 cm in ridges and 30 cm x 20 cm in flat bed gave higher yield than 60 cm x 15 cm in ridge and 30 cm x 30 cm in flat as well as 60 cm x 20 cm ridge and 30 cm x 40 cm in flat bed.

Palaniappan *et al.* (1975) reported, from several experiments conducted all over India, that paired row planting of sorghum gave similar yield as normal spaced planting. Similarly, Rathore *et al.* (2006) found that modified planting patterns *viz.*, row and furrow system, paired row system and paired row + intercrop (cowpea) system brought about a significant improvement in grain and stover yields of pearl millet over uniform row system.

Porwal *et al.* (2006) observed that planting methods and intercropping systems significantly affected the seed yield, castor-equivalent yield, net returns and benefit: cost ratio in castor based intercropping system. They opined that an intercropping of castor (paired row planting at 60/120 cm x 60 cm) with 3 rows of greengram was highly productive and beneficial, as it yielded maximum castor-equivalent yield (55.3 q ha<sup>-1</sup>), net returns (₹ 57,334 ha<sup>-1</sup>) and benefit: cost ratio (4.95). However, Rana *et al.* (2006) reported that maize paired row (40/80 cm) + 1 row mungbean recorded significantly higher plant height and yield attributes, *viz.*, cob

plant<sup>-1</sup>, cob length, grains cob<sup>-1</sup> and grain weight cob<sup>-1</sup>, compared to sole maize but were at par with maize paired row (40/80 cm) + 2 rows of mungbean.

Nedunchezhiyan (2007) observed that greater yam intercropped with maize, both in normal and paired row planting, resulted significantly higher yield over sole greater yam. He also noticed that maximum tuber equivalent yield was obtained from greater yam (normal planting) + maize followed by greater yam (paired row planting) + maize.

Brintha and Seran (2009) observed that 20/50 cm paired row planting of radish intercropped with three rows of vegetable amaranthus in between paired rows of radish is the most suitable planting system in sandy regosol of Srilanka. They revealed that the radish yield did not change significantly due to reduced inter row spacing in radish.

## **2.2 Studies on intercropping**

Intercropping can provide biological insurance in weather dependent agriculture and intermediate income in case of long duration base crop. It is one of the most promising options for diversification towards a sustainable agricultural production system. According to De and Singh (1979), intercropping (or mixed cropping) of two or more crops is an age old practice in India, especially under rainfed conditions. The practice aims to (1) insure against total crop failures under aberrant weather conditions or pest epidemics, (2) increase total productivity per unit land area, and (3) equitably and judiciously utilize land resources and farming inputs, including labour.

As compared to the sequential cropping and relay cropping, the practice of intercropping is known to increase the total productivity, because crops are able to utilize different resources at a time (Willey, 1979).

Research on intercropping has indicated how niche differences in crop species can lead to resource capture and conversion leading to increased biological efficiency and yield advantage (Shah *et al.* 2011). However, suitable assortment of crops and complimentary space arrangement play a vital role in accruing advantages under intercropping system.

### **2.2.1 Studies on suitable intercrops**

Delayed emergence, slow initial growth and wider row spacing in turmeric gives ample scope to grow suitable short duration high value crops which not

only act as smother crop, but will also give additional and intermediate income during cropping period of turmeric.

From earlier works on intercropping, it is evident that selection of companion crop depends on agro-climatic conditions of a particular zone, farmers' choices and market demand. Compatibility of crops in an intercropping system greatly influences the viability of the system. Choice of the component crops needs to be suitably manoeuvred to harvest the synergism among them towards efficient utilization of resource-base and to increase overall productivity (Anderson, 2005). Das *et al.* (1991) reported that intercropping reduced the yields of both the components in pigeonpea + groundnut intercropping system due to reduction in plant population and competitive effect. Groundnut equivalent and land equivalent remained unaffected due to intercropping. Maximum net return was obtained from uniform planting of sole pigeonpea. Pigeonpea: groundnut planting pattern of 1:2 gave the highest net return among the intercropping systems. On the contrary, Chatterjee and Mandal (1992) opined that intercropping provided substantial yield advantage over sole crop owing to temporal and spatial complementary and minimizing inter or intra-specific competition. In sandy loam soil of Kalyani (WB), turmeric intercropped with one row of a short duration crop such as maize, rice or greengram in 60 cm wide gap between turmeric rows, total economic production of the land increased even though turmeric yield were slightly reduced (Kundu and Chatterjee, 1982).

Sekar and Muthuswami (1985) reported that the highest net income was obtained from the combination of turmeric (main crop) + fenugreek (1<sup>st</sup> intercrop) + onion (2<sup>nd</sup> intercrop) followed by the combination of turmeric + beans + beet root. But Singh and Randhawa (1988) reported that intercropping turmeric with pigeonpea, maize or greengram reduced the availability of light to turmeric and the rhizome yield. However, net returns were higher under intercropping, compared with monoculture. On the contrary, Sivaraman and Palaniappan (1995) revealed that though intercropped turmeric grew tall and luxuriant in the shade provided by maize, the total DMP recorded was higher in sole cropping of turmeric. Similarly, significant decrease in turmeric rhizome yield due to maize intercropping was observed by Avilkumar and Reddy (2000). Similarly, Giri *et al.* (2006) found the highest seed-cotton yield from sole crop of cotton with recommended cultural practices for weed management which was significantly superior to intercropping cotton with blackgram/soybean/pigeonpea.

Akpan *et al.* (2013) in an experiment in south eastern Nigeria on intercropping Egusi (*Citrullus colosynthis* L.) with turmeric found that it is more productive and profitable to grow sole turmeric.

Mohanthy *et al.* (1991) evaluated the influence of intercrops on the yield of turmeric under rainfed conditions and they observed early germination and increased yield of turmeric as well as highest return per rupee investment (2.16) in turmeric + frenchbean combination. Similarly, in Turmeric-Maize-Onion inter-cropping system, the rapidly growing maize and onion could use the space between the slow growing turmeric crop with minimal effect on turmeric growth as reported by Sivaraman and Palaniappan (1995).

Behera *et al.* (2008) advocated that turmeric + pigeon pea (10:2) intercropping in replacement series may be recommended for maximizing productivity and profitability under organic environment of hilly and tribal dominated districts in Eastern Ghats, Orissa. Experiment conducted in Calicut showed that intercropping turmeric with greengram, maize, and pigeonpea regularly produced higher net returns than pure stands of turmeric and a LER of 1.56 was achieved with one row of pigeon pea planted with every four rows of turmeric (Anon., 2008).

In Ludhiana, though production of turmeric intercropped with greengram was reduced by 11 per cent than that of pure stand but higher turmeric equivalent yield was obtained by intercropping with greengram against intercropping with maize and pigeon pea. One of the important reasons of higher yield realization in turmeric-greengram intercropping was apparently due to the short plant height of greengram plants that prevented excessive shading of turmeric contrary to that caused by taller pigeon pea and maize plants (Anon., 2008). Nayak and Patra (2000) observed that groundnut + greengram intercropping system found to be more productive than sole groundnut, with yield advantage of 35 to 41 per cent.

Dass *et al.* (2008) revealed that among the different kinds of maize, baby corn is a speciality corn and provides a viable option for crop diversification and enhancing profitability particularly in peri-urban areas. It can easily fit in an intensive cropping system due to its short duration.



### **2.2.2 Effect of intercrops on quality of component crops**

Shah *et al.* (2011) opined that intercropping is one of the most promising options for diversification towards sustainable agricultural production system in India, and weed management in intercropping system demands concerted efforts to provide weed-free environment to both main and component crop for attaining higher productivity level.

### **2.3 Studies on weed in turmeric**

Weeds are considered as a major hinder among the production impeding factors of crop production. In the agro-ecosystems, favourable environmental conditions provided for obtaining maximum crop productivity are being exploited by the associated weeds. Apart from reduction in crop yield and production efficiency, weeds very often growing within and outside the field habitually provide shelter to insect pests and disease causing organisms of crops and act as alternate hosts. Turmeric crops are also vulnerable to various weeds in their different critical growth stages. India, though leads in production of turmeric with 75 per cent global production, its average productivity is quite low, mainly due to the competition offered by weeds which reduce yield by 30-75 per cent. Hence, experimental data based knowledge on different aspects generated by weeds is essential for successful turmeric cultivation by minimizing weed generated damage.

#### **2.3.1 Weed continuum in turmeric**

The extent of damage caused by weeds depends upon species, nature and population of weeds that prevail in a crop field. The season and cultivation practices adopted mainly determine the weed flora over a crop community. Perseverance of weeds in a locality is basically influenced by abiotic and biotic factors which affect their occurrence, abundance, degree and distribution. Frick and Thomas (1992) revealed that weed surveys provide weed biologists with the quantitative information on weed communities that is required in developing integrated weed-management strategies. Surveys provide baseline information for measuring and evaluating changes in the weed flora in the future.

Singh and Mahey (1991) reported that the major weed flora composition in the turmeric field included *Trianthema monogyna*, *Euphorbia hirta*, *Amaranthus viridis*, *Eleusine indica*, *Acrachene racemose*, *Cyperus rotundus* and *Digitaria sanguinalis*. Similarly, Avilkumar and Reddy (2000) observed weed species like *Amaranthus viridis*, *Commelina benghalensis*, *Cyperus rotundus*, *Cynodon dactylon*, *Celosia argentea*, *Digitaria marginata*, *Digitaria muricata*, *Euphorbia hirta*, *Eleusine indica* and *Panicum repens* as the major weeds in turmeric and maize intercropping system.

Gill *et al.* (2000) reported the dominance of weed species like *Digitaria ischamum*, *Cynodon dactylon*, *Cyperus rotundus*, *Eleusine aegypticum*, *Euphorbia hirta*, *Commelina benghalensis* and *Eragrostis pilosa* in turmeric.

The study by Mannikeri (2006) in Dharwad, Karnataka indicated that turmeric field was dominated by weed species *viz.*, *Cynodon dactylon*, *Digitaria marginata*, *Panicum repens*, *Parthenium hysterophorus*, *Amaranthus viridis*, *Mimosa pudica*, *Euphorbia hirta*, *Tridax procumbens* and *Cyperus rotundus*.

Barooah *et al.* (2010) reported that dominant weed flora in ginger of experimental field of Assam Agricultural University at Jorhat were *Cynodon dactylon* (L.) Pers., *Eleusine indica* (L) Gaertn., *Digitaria sanguinalis* (L) Scop., *Panicum australiaticum* Ohwi., *Axonopus campresus* (SW), *Cyperus rotundus* Linn., *Cyperus iria* L., *Fimbristylis miliaceae* Vahl., *Ageratum conizoides* Linn., *Alternanthera sessilis* L.Br., *Amaranthus spinosus* L., *Chenopodium album* Linn., *Oldenlandia diffusa* Roxb., *Melochia corcorifolia* Linn., *Scoparia dulcis* Linn., *Mimosa pudica* Linn., *Spilanthes paniculata* D.C. and *Commelina diffusa* Burm.f.

According to Manhas *et al.* (2011), *Cyperus rotundus*, *Cynodon dactylon*, *Eleusine aegyptiacum* and *Euphorbia hirta* were the dominant weed species of turmeric in Punjab. Ratnam *et al.* (2012) reported that the dominant weed flora, based on relative density, in turmeric field of Guntur, Andhra Pradesh were *Echinochloa colona*, *Dinebra retroflexa*, *Cynodon dactylon*, *Panicum repense*, *Leptochloa chinensis*, *Cyperus rotundus*, *Phyllanthus niruri*, *Celosia argentea*, *Chrozophora rotteleri*, *Cleome viscosa*, *Parthenium hysterophorus*, *Abutilon indicum*, *Digera arvensis*, *Trianthema portulacastrum*, *Euphorbia hirta*, *Corchorus acutangulus*, *Portulaca oleracea*, *Acalypha indica*, *Eclipta alba* and *Commelina benghalensis*.

The turmeric field of Himachal Pradesh were infested mainly by the weed species *Echinochloa colona*, *Digitaria sanguinalis*, *Panicum dichotomiflorum*, *Commelina bengalensis*, *Cyperus iria*, *Ageratum conyzoides*, *Polygonum* sp., *Physallis minima*, *Eragrotis* spp. and *Aeschynomene indica* (Suresh Kumar *et al.*, 2014).

Barla *et al.* (2015) observed that major weed flora in turmeric field of Ranchi were *Digitaria sanguinalis* (L.) (20%), *Cynodon dactylon* Pers. (10%), *Paspalum disticum* (5%), *Dactyloctenium aegyptium* (L.) (3.5%), *Eleusine indica* Gaerts. (2.5%), *Echinochloa colona* (L.) Link. (2%), *Ageratum conyzoides* L. (25%), *Stellaria media* (L.) Vallars (3%), *Heliotropium esculentum* (2%), *Spilanthes acmella* (8%), *Ludwigia parviflora* (2%), *Commelina nudifolia* (2%), *Tridax procumbens* (3%), *Cellosia argentea* L. (2%). *Cyperus rotundus* L. (7.5%) and *Kyllinga* spp. (2.5%).

### **2.3.2 Crop-weed competition**

Competition is the action of venturing to gain what another venture to gain at the same time. Weeds are the sole competitor of crops for the critical growth resources, both above and under the ground.

Under high weed infestation, the crop plants are unable to express their genetic potential due to tough weed competition for all the inputs like moisture, light, nutrient and space. The degree of crop-weed competition is ascertained by the weed species and their population, duration of infestation, type of crop, growth habit of crop plants and other biotic and abiotic factors. In general, weeds reduce 30-100 % crop yield by depleting nutrients, moisture, light and space; also by harbouring insect pests, nematodes and causal organism of diseases. In fact, without the insensitive interference by human, the weeds can easily wipe out the crop of interest from agricultural field in comparatively diminutive time.

#### **2.3.2.1 Critical period of crop-weed competition**

The critical period of crop-weed competition is defined as that short time span in the ontogeny of crop when weeding will result in the highest economic returns. The crop yield levels gained by managing the weed during this period should provide crop yields significantly close to those obtained by the full season weed free condition. Zimdahl (2004) concluded that the critical period has two components: (i) the length of time, weed control is required to prevent crop yield losses, and (ii) the length of time,

crops can tolerate weeds before resulting in yield losses. These components combined define the critical weed free period.

Swanton and Weise (1991), Hall *et al.* (1992) opined that the critical period of weed competition is an important consideration in respect of timely development of alternative weed management strategies. In the same tune, Knezevic *et al.* (2002) described the critical period of weed competition as a window in the crop growth cycle in which weeds must be controlled to prevent unacceptable yield losses.

Njoku *et al.* (2012) observed that the critical period of weed interference in turmeric is 8-12 weeks after planting. The weeds need to be removed during 70 to 160 days after planting of turmeric for higher yield indicating that it needed a longer period of weed free condition than other crops.

### **2.3.2.2 Effect of weed competition on growth and yield components**

There are many factors which affect on growth and yield components of crops. Crop-weed competition is always very severe when growth resources are limited and there is uncontrolled weed growth. This results in serious negative effect on growth and yield of crops.

#### **2.3.2.2.1 Growth components**

Mannikeri (2006) reported that weed free check plots in turmeric cultivation recorded highest plant height, maximum number of leaves per plant, number of tillers per plant, dry matter production, leaf area and LAI due to reduction in weed population. On the other hand, Kaur *et al.* (2008) observed that unweeded control recorded lesser leaf area index than all the herbicide treatments in turmeric.

Pre-emergence application of metribuzin @ 0.7 kg ha<sup>-1</sup> integrated with hand weeding at 45 and 75 DAP recorded significantly higher plant height, number of tillers per plant, leaf area index and dry matter production in turmeric than all other treatments employed (Sathiyavani and Prabhakaran, 2014).

#### **2.3.2.2.2 Yield components and yield**

In general, there is a hypothesis that for producing optimum yields the annual crops require a weedfree interval for the first 1/4 to 1/3 of their growing period. Longer duration of weed control usually does not give additional economic yield.

Krishnamurthi and Ayyaswami (2000) reported that yield losses of turmeric due to weeds vary from 30-70 per cent. Similarly, Ratnam *et al.* (2012) revealed that unweeded check reduced the rhizome yield by 80 per cent due to severe weed competition, particularly due to the presence of grasses and broad leaved weeds as weed competition could considerably lower the number of rhizome per plant and rhizome weight in turmeric. Kaur *et al.* (2008) observed that uncontrolled weed growth resulted in 64.9 per cent reduction in average rhizome yield of turmeric. They also found that paddy straw mulch @ 9 t ha<sup>-1</sup> combined with pre-emergence application metribuzin @ 0.7kg ha<sup>-1</sup> increased the rhizome yield by 20.5 per cent.

Babu (2008) reported that weed free check treatments registered higher cured rhizome yield (7.08 t ha<sup>-1</sup>) than all other treatments and it was followed by pendimethalin @ 1.5 kg ha<sup>-1</sup> (6.03 t ha<sup>-1</sup>) and 1.0 kg ha<sup>-1</sup> (5.74 t ha<sup>-1</sup>).

Hossain (2005) reported that early planting of turmeric during February and March resulted significantly higher yield than that of late planting after April; however, in early planting one additional weeding was necessary prior to emergence.

#### **2.3.2.2.3 Nutrient uptake by weeds**

In general, weed removes sizable quantity of soil nutrients and thereby the crop strives for essential nutrients. Kaur *et al.* (2008) observed that weeds in the unweeded control removed 103.5, 19.7 and 170.4 kg N, P, K ha<sup>-1</sup> in turmeric crop.

Pre-emergence application of metribuzin @ 0.7 kg ha<sup>-1</sup> + hand weeding at 45 and 75 DAP recorded significantly lower N, P and K removal by weeds in turmeric (Sathiyavani, 2014). Similarly, Tuti and Das (2011) reported in soybean that in weedy check, weeds removed higher quantity of N, P and K and the lowest removal of N, P and K by weeds was found in pre-emergence application of metribuzin at 0.5 kg ha<sup>-1</sup>.

#### **2.4 Integrated weed management methods**

Weeds are known to account for nearly one third of the yield losses due to various biotic stresses. Apart from causing huge reductions in crop yields, reduction in input efficiency, it involves major input cost for agriculture production system.

Weed management is a system approach whereby whole land use planning is done in advance to minimise the very invasion of weeds in aggressive forms and give crop plants a strong, competitive advantage over the weeds (Gupta, 2008).

Methods employed for minimising weeds from crop field have variable efficiency. Many workers in this line have suggested that integrated approach is the best as far as sustainability is concerned. A practical combination of good crop husbandry, herbicides, and other cultural, physical and mechanical methods can result effective weed management by enhancing crop competitiveness in a complex crop-weed interaction to augment crop productivity. Further, a strategic integrated weed management method to be accepted by the farmers must be agronomically feasible, economically viable and it should be under the farmer's manageable capability.

According to Singh and Singh (2014) the basic principles in ecological weed management primarily target on enhancement in crop competitiveness to minimize competitive pressure of weeds on the crop comprising integration of agronomic, genetic, mechanical, biological and chemical means of weed management that promote crop growth and development with less weed interference in a environmentally safe agro-ecosystem. Mahadevaiah *et al.* (2010) opined that integrating pre-emergence application of atrazine with inter-cultivation resulted in higher corn and green fodder yield and effective control of weeds in baby corn.

#### **2.4.1 Cultural methods**

The germination and initial growth of turmeric is very slow. Based on this fact, different types of mulches and short-duration fast growing intercrops have been tried by numerous researchers to protect the sprouts and also conserve moisture in one hand, and to reduce weed population before turmeric makes good growth on the other hand.

Murphy *et al.* (1996) reported that adjusting the ridge spacing and selecting the number of rows per ridge for a row crop are also important agronomic practices for reducing weed competition and increasing yield. On the contrary, Kaur and Singh (2006) reported that the weed density and dry weight under paired row planting of pearl millet were significantly higher as compared to regular planting at all the stages of crop. They opined that higher weed density under paired row planting might be due to more space between two paired rows which resulted in favourable environment in respect of light and space for germination and growth of weeds. Satyagopal *et al.* (2014) suggested that hand hoeing and weeding are necessary in turmeric at 60, 90, 120 and 150 days after planting in light soils which must be immediately followed by earthing up of the crop.

Kaur *et al.* (2008) opined that paddy straw mulch was beneficial for proper sprouting and establishment of turmeric rhizomes. Mohanty *et al.* (1991) observed that mulching with green leaves and straw applied just after planting controlled weeds and enhanced earliness in sprouting of turmeric. Another report by Gill *et al.* (1999) revealed that application of wheat straw mulch significantly improved growth and yield of turmeric by 46 and 44 per cent in Punjab during 1995 and 1996, respectively.

Considering medicinal value of turmeric and the environmental problems caused by herbicides, various agronomic practices have been evaluated for non-chemical weed control in turmeric. Mulching with straw or grasses at planting suppressed weed growth and improved turmeric yield; however, the yield differs with the mulching materials (Alam *et al.*, 2003; Verma and Sarnaik, 2006). Hossain (2005) reported that mulching suppressed weed growth and improved turmeric yield. He also indicated that though agronomic practices could not control the weeds completely, each individual agronomic practice obviously showed either significant or non significant positive effect on weed control and yield improvement without any additional cost.

Kaur and Singh (2006) observed that mulch application at 4 t ha<sup>-1</sup> decreased the weed density significantly as compared to mulch applied at 2 t ha<sup>-1</sup> in pearl millet. The reduction in weed density as well as dry matter of weeds under organic mulch treatments could be attributed to its smothering effect on weeds. Their results were in conformity with the findings of Kumar *et al.* (1995).

In baby corn, a thorough land preparation and irrigation up to field capacity for solarisation was found effective in suppressing weeds followed by one ploughing + harrowing and 40 mm of irrigation followed by hand weeding at 30 days was crucial (Thimmegouda *et al.*, 2007). Das *et al.* (2008) reported that in jute crop, weed control efficiency at 15 DAS was found to be highest under cultural management practices in Assam. Its value was the highest in the treatment of intercropping jute + red amaranthus followed by mulching with locally available cheap organic waste (wheat straw) @ 10 t ha<sup>-1</sup>.

Barooah *et al.* (2010) reported that integration of mulching (once after planting and once at 90 days after planting) with manual (hoeing at 40 days after planting and hand weeding at 90 days after planting) and mechanical measures (grubber

at 60 days after planting) recorded significantly higher yield, gross return and benefit: cost ratio in ginger.

Manhas *et al.* (2011) revealed that increase in the levels of paddy straw mulch from no mulch to 6.25 t ha<sup>-1</sup> and then to 9.38 t ha<sup>-1</sup> significantly decreased weed population and resulted in better growth parameters, yield attributes and mother, primary and secondary rhizome yield of turmeric.

Giri *et al.* (2006) reported that in cotton + blackgram intercropping system, the control of weeds by integrated weed management comprising pre-emergence application of either oxyfluorfen @ 0.10 kg ha<sup>-1</sup> or pendimethalin @ 0.75 kg ha<sup>-1</sup> each followed by hoeing (weeding) at 6 weeks after sowing proved more economical than the control of weeds by cultural methods of weed control, i.e. three hand-weeding and hoeing at 3, 6 and 9 weeks after sowing alone.

Saini *et al.* (2013) reported that in maize, intercropping of soybean along with either one mechanical weeding (20 DAS) or two mechanical weeding (20 and 40 DAS) could be the best options for non-chemical weed management.

Turmeric being a rainy season and widely spaced crop, it gets infested with variety of weeds and subject to heavy weed competition for growth resources and weed-crop interference through allelopathic effect. Intercropping system is recognized as a potential weed management practice in widely spaced crops. In an intercropping system, the weed suppression efficiency largely depends on the nature of the component crops.

Intercropping of winter maize with potato in additive series, significantly enhanced grain yield of winter maize. Inclusion of potato as an intercrop with winter maize reduced crop-weed competition in early stage due to smothering effects on weeds compared to sole winter maize and potato thereby increased the yield indices and finally the maize-equivalent yield of maize intercropping system (Kour *et al.* 2014).

#### **2.4.2 Physical methods**

The physical control of weeds is one of the oldest methods of weed control in agricultural field. Hand weeding or *spudding* is the most common and environment friendly method practised by farmer to control weeds and improve productivity.

#### **2.4.3 Chemical methods**

Conventional weed management practices are costly, un-available in time and exhaustive due to different back pulling reasons. Besides, such weed control practices are also often turned into uncertainty due to interference of rains. In this context, herbicides offer ample scope to bridge the gaps. As far as, the environment and health are concerned, herbicides are not aimed at substituting the traditional practices and they are only considered as additional production tools in crop production. Residual effect of chemicals is now of great concern. In order to reduce the risk of persistence of chemical residues, application of pre-emergence herbicides is gaining importance. Studies revealed that pre-emergence application of herbicides can facilitate to manage weeds in early growth stage of crop when crop canopy can hardly smother the weeds.

Baker and Terry (1991) opined that pre-emergence herbicide application can not only minimize crop-weed competition, but also can reduce work load during the peak labour demand period, avoiding at least one or two inter cultivation during the first 3 to 4 weeks of crop growth besides effecting control the weeds.

Jaiswal (1994) observed that, weed control efficiency of different herbicide treatments ranged from 40 to 91 per cent and highest WCE (91%) was recorded in pre-emergence application of metribuzin in potato. Pre-emergence application of herbicide can control 30 to 50 per cent of weeds (Guggari *et al.*, 1995). Bervadia *et al.* (1996) also reported that crop-weed competition can be minimized by pre-emergence application of herbicide which results in higher crop yield.

Kaur *et al.* (2008) observed that pre-emergence application of pendimethalin 1.0 kg, metribuzin 0.70 kg and atrazine 0.75 kg alone kept the weeds under check during the first 30 days in turmeric crop.

#### **2.4.3.1 Metribuzin**

Gill *et al.* (2000) observed that pre-emergence application of metribuzin 0.7 kg ha<sup>-1</sup> recorded higher rhizome yield in turmeric. According to them, highest percentage of increase in yield of turmeric over the control was achieved by 0.70 kg metribuzin ha<sup>-1</sup> followed by 1.0 kg diuron ha<sup>-1</sup> and the integrated control treatments of diuron, metribuzin and atrazine. Similarly, Jaiswal (1994) observed that weed control efficiency (WCE) of various herbicide treatments varied from 40 to 90 per cent and highest WCE (91%) was recorded in pre-emergence application of metribuzin in Potato.

Ajai *et al.* (2002) observed the influence of application of pendimethalin (1 kg ha<sup>-1</sup>) and oxyfluorfen (0.44 kg ha<sup>-1</sup>) which were followed by hand weeding at 80 days after sowing found 45 and 39 per cent more fresh rhizome yield, respectively as compared to other weed control treatments.

Kaur *et al.* (2008) reported that at Ludhiana, pendimethalin and metribuzin alone recorded effective control of *A. recemosa*, *E. crusgalli*, *E. aegyptiacum* and *D. sanguinalis*. However, poor and delayed sprouting of turmeric favoured the weeds at later stages, which increased the dry matter of weeds.

The paddy straw mulch was essential for proper sprouting and establishment of turmeric rhizomes (Kaur *et al.* 2008). They also observed that integrated use of paddy straw mulch @ 9 t ha<sup>-1</sup> with either of pendimethalin 1 kg ha<sup>-1</sup>, Metribuzin 0.70 kg ha<sup>-1</sup> or Atrazine 0.75 kg ha<sup>-1</sup> adjudged very effective for weed control and profitability in turmeric. Ratnam *et al.* (2012) reported that pre emergence application of Oxyfluorfen 0.25 kg ha<sup>-1</sup> followed by quizalofop-P ethyl @ 0.05 kg ha<sup>-1</sup> at 30 DAS supplemented with hand weeding at 60 and 90 DAS is effective and economical for weed management in turmeric. Sathiyavani and Prabhakaran (2014) revealed that pre-emergence application of metribuzin @ 0.7 kg ha<sup>-1</sup> at 3 DAP + hand weeding on 45 and 75 DAP in turmeric cultivation gave effective weed management and higher yield.

Effective and economic weed management in turmeric can be undertaken with integrated method of applying metribuzin at 0.7 kg ha<sup>-1</sup> along with straw mulch @ 10 t ha<sup>-1</sup> followed by one hand weeding (Jadhav and Pawar, 2014). Barla *et al.* (2015) found that metribuzin @ 0.7 kg ha<sup>-1</sup> followed by two hoeing could be the most productive and profitable among the different treatment methods of weed control in turmeric.

#### **2.4.3.2 Oxadiargyl**

Rajkhowa *et al.* (2005) reported that weed density at 30 DAT in rice did not vary under different formulations of oxadiargyl at varying rate of 70, 90 and 100 g ha<sup>-1</sup>. However, oxadiargyl at 100 g ha<sup>-1</sup> resulted in the lowest weed density at 60 DAT. Hasanuzzaman *et al.* (2009) opined that pre-emergence application of oxadiargyl at 190 ml ha<sup>-1</sup> + one hand weeding at 25 DAT recorded lesser weed density, dry weight and higher weed control efficiency and grain yield in rice. Deepthi and Subramanyam

(2010) reported that pre-emergence application of oxadiargyl at 75 g ha<sup>-1</sup> at 20 DAT was at par with hand weeding twice at 20 and 40 DAT in achieving higher grain yield in transplanted rice.

Yadav *et al.* (2010) inferred that application of oxadiargyl 50 g ha<sup>-1</sup> at 20 DAS + hand weeding (weed free) could be suitable for ensuring effective weed control and realizing higher seed and straw yield of cumin in semi-arid region.

Murthy *et al.* (2012) observed that pre-emergence application of oxadiargyl at 0.07 kg ha<sup>-1</sup> along with hand weeding at 40 DAS in aerobic rice could eliminate one hand weeding at 20 DAS and resulted highest grain yield. The superior performance of oxadiargyl could be attributed to the fact that it is a potent inhibitor of protox, deregulates the porphyrin pathway.

## **2.5 Effect of weed management practices on quality**

### **2.5.1 Soil health**

Soil health gets utmost importance in present day context of agriculture system. Over exploitation through intensive crop production and use of non-judicious agro-chemicals often cause severe deterioration of soil health. Soil microbial carbon (SMBC) is a very useful biological marker of soil health. It is the most sensitive one for assessing short-term changes in soil fertility and quality (Ladd *et al.*, 1994). According to Anderson and Domsch (1989), and Wardle (1992), SMBC encompasses only 1-4 per cent of total organic carbon. It is reported that high microbial biomass is an indicator of a healthy soil, because physical and chemical properties are shaped by biological activity; and biological activities are enhanced or limited by chemical and physical condition of soil (Gogoi *et al.*, 2010).

According to Perucci *et al.* (2000) and Vischetti *et al.* (2002), herbicides have the potential to variably affect soil organic matter dynamics, especially soil microbial biomass. It might be possible that the degraded products of the herbicide or herbicide metabolites more toxic than the herbicide itself, thereby interfering with the growth and activities of microbes. In response to herbicide application, soil microbial biomass may shrink (Wardle and Parkinson, 1990; Macur *et al.*, 2007), swell (Debnath *et al.*, 2002) or remain unchanged (Wardle and Parkinson, 1990; Lupwayi *et al.*, 2007).

Organic mulching directly supplies organic carbon inputs to soil, and has been used to effectively suppress weeds and reduce soil erosion in organic farming

systems (Bilalis *et al.*, 2003; Jordan, 2004). It is also helpful in conserving soil moisture and buffering drastic changes in soil temperature (Naeini and Cook, 2000) which can be of distinctive importance to give a favourable micro-climate for the growth of beneficial soil microbes. High microbial biomass and activity often lead to higher nutrient availability to crops (Zaman *et al.*, 1999; Tu *et al.*, 2003; Wang *et al.*, 2004) through enhancing both the microbial biomass turnover and the degradation of non-microbial organic materials. Richardson and Simpson (2011) indicated that soil microbial biomass (including saprotrophs and mycorrhizal fungi) played a central role in the cycling and availability of phosphorus in soils. Hence, enrichment in soil fertility can be correlated to soil microbial biomass.

Tu *et al.* (2005) reported that surface mulching by straw enhanced microbial biomass, its activity and potential nitrogen supply. Such effects of mulching may stem from improvements of soil carbon and water availability.

Bhuyan *et al.* (2013) observed that microbial biomass is affected by management practices, soil characteristics and environmental factors which vary during seasons. They also opined that seasonal variation had a greater impact on soil microbial biomass and labile carbon concentration than management techniques. However, the extent and magnitude of influence of herbicide application on soil biological properties, in general, and particularly of soil microbial biomass is scanty and very often conflicting (Vischetti *et al.*, 2002; Yang *et al.*, 2007).

### **2.5.2 Curcumin content of turmeric**

There is very little work done on the effect of planting patter, companion crops and weed management on turmeric quality. The distinctive yellow-orange curcuminoids (curcumin, demethoxy curcumin and bis-demethoxy curcumin) present in the turmeric rhizomes are the basic bioactive substances for its virtue. Variation in curcumin content of turmeric is the result of environment and genetic interaction. Kumar and Gill (2010) observed that effect of different plant densities (1,66,667; 1,11,111; 83,333 plants ha<sup>-1</sup>) on curcumin and oil content of turmeric was non-significant. However, highest value of curcumin and essential oil in *Curcuma domestica* was obtained when it was cultivated in 15 cm to 25 cm distance between plants (Mohamed *et al.*, 2014).

### **2.6 Resource use efficiency**

Increased efficiency of resources in any viable intercropping system is the distinguished advantage over sole crop. According to Willey and Lakhani (1976), intercropping is reported to be particularly beneficial when it involves two component crops which are of very different growth cycles and behaviour because this allows the greatest scope for making better temporal and spatial use of resources. The most common advantage of intercropping is to produce a higher yield from a given piece of land by achieving more efficient use of the available natural resources for crop growth that would otherwise not be utilized by each single crop grown alone (Lithourgidis *et al.*, 2011). Resource use efficiency and technical efficiency of turmeric, and inputs such as planting materials, nitrogen, potash, cost of harvesting and curing, machine hours, and irrigation have positive and significant influence on the yield of turmeric.

### **2.6.1 Water use efficiency**

Water is an indispensable resource for production of crops. Since major source of soil moisture loss is evapo-transpiration, its favourable regulation is essential to conserve and supply required amount of water to the crop plants. Doorenbos *et al.* (1979) defined water use efficiency (WUE) as a measure of the amount of dry matter produced per unit amount of evapo-transpiration. When soil water conditions are not limiting, water use efficiency differences between plants are insignificant as long as other conditions are favourable.

Rana *et al.* (2006) reported that maximum water-use efficiency was recorded under maize paired row (40/80 cm) + 2 rows of mungbean because of higher maize equivalent yield  $\text{ha}^{-1} \text{mm}^{-1}$  of water. They also observed that FYM + dust mulch + straw mulch treatment recorded highest water use efficiency in maize (paired row) – mungbean intercropping system. Singh and Rana (2006) observed that consumptive use was more with Indian mustard paired row (30/90 cm) + lentil (2 rows) intercropping system (299 mm) than with pure stand of Indian mustard (217 mm) and lentil 183 mm). Devi *et al.* (2014) reported that water use efficiency (WUE) in terms of yield of individual crops showed marked variation due to intercropping system. Intercropping of lentil with mustard at row ratios of 6:1 and 6:2 recorded higher WUE than sole lentil and mustard. This might be attributed due to proportionately higher grain yield of both the crops than the amount of water used for individual crop yield. Morris and Garrity

(1993) also opined that higher water use efficiency was obtained with the improved use of resource.

Kumar and Rana (2007) opined that water use efficiency in terms of pigeonpea-equivalent yield resulted mark variation due to cropping system. They found that Pigeonpea paired row + one row greengram system records higher water use efficiency than sole pigeonpea. According to them, this might be due to the grain yield of both the crops was proportionately higher than the amount of water used for biomass production. Rathore *et al.* (2006) reported that planting patterns resulted considerable variation in water-use efficiency in term of grain yield of pearl millet. Significantly higher water-use efficiency of pearl millet was recorded under paired row and paired row + intercropping system of planting. The paired row system of planting increased the WUE of pearl millet by 35 per cent over uniform system of planting.

### **2.6.2 Solar radiation use efficiency**

Solar radiation (intensity, quality, direction etc.), in general is a non lethal critical factor for crop production. It provides two essential needs of plants *viz.*, (i) light and (ii) thermal conditions. Depending upon the nature of the crops such as *heliophytes* and *sciophytes*, the dry matter production is affected due to congenial condition for solar radiation use efficiency.

Reddy *et al.* (1989) opined that spatial arrangement of intercrops is an important management practice that can improve radiation interception through a more complete ground cover. However, Keating and Carberry (1993) have suggested that increased radiation interception due to better ground cover of intercrops may be due to sub-optimal sole crop population densities used in comparisons. Two factors that affect yield in relation to incident radiation in an intercropping system are the total amount of radiation intercepted and the efficiency with which intercepted radiation is converted to dry matter.

Porwal *et al.* (2006) reported paired row planting of castor at 60/120 cm could intercept more solar radiation and utilize it more efficiently thereby improving its growth parameters, i.e. LER, LEC, and ultimately the seed yield. Intercropping combinations of high and low canopy crops is usually to improve radiation interception and hence yields of the shorter crops, but it requires that they be planted between sufficiently wide rows of the taller crop (Seran and Brintha, 2010).

### **2.6.3 Nutrient use efficiency**

Nutrient is one of the major production factors for agricultural crops. While nutrient exhausting crop like, turmeric is required to assort appropriately with inter-crops, much care is needed to maintain soil sustainability.

Turmeric being a long duration and high yielding crop, consumes greater amount of nutrients from the soil as well as from applied fertilizers for a prolonged period (Jagadeeswaran *et al.*, 2005). Therefore, nutrient use efficiency must be taken in consideration while inter-crops are accommodated in turmeric based inter-cropping system.

### **2.7 Plant population and planting geometry**

Optimum crop geometry is one of the important factors for higher yield, which influences by efficient utilization of underground resources and also harvesting as much as solar radiation and in turn better photosynthesis and congenial thermal environment for the crop. Plant population can have enormous effect on the final yield proportions of the component crops and on the yield levels (Deka, 1997).

### **2.8 Crop compatibility, yield advantage and stability**

The development of sustainable cropping systems using alternative cropping systems is one of several newer areas of specialized research that compare mixed-cropping practices with the current dominant sole-cropping ones (Jagatheeswaran and Walker, 2014). Therefore, in terms of land use efficiency, intercropping is regarded as more productive than sole cropping (Andrews and Kassam, 1976).

Devi *et al.* (2014) opined that crop compatibility is the most essential factor in a feasible intercropping system. Thus, the success of any intercropping system depends on the selection of crop species which competes for light, space, moisture and nutrients between them.

#### **2.8.1 Crop compatibility**

#### **2.8.2 Yield advantage and stability**

The land equivalent ratio (LER) has been developed for use in evaluating the yield advantage of intercropping systems. LER is defined as the area that a sole crop

has to occupy in order to produce the same amount as its component in the intercrop (Mead and Willey, 1980). The LER compares the yield of each part of the intercrop to the yield of that same species grown alone as a sole crop, thus the advantage of the combination of species or intercrop becomes obvious. Intercropping conferred yield advantages ranging from 15-60 per cent over sole cropping (Palaniappan, 1985).

## 2.9 Economics

Being a long duration and exhausting crop, turmeric involves high cost of cultivation expense. Intercropping turmeric with short duration high value cash crop could be useful to fetch intermediate income from the same piece of land.

### 2.9.1 Returns

Shankaraiah *et al.* (1987) noticed that turmeric + maize in 2:1 proportion gave significantly higher income continuously for three years and recorded maximum income of ₹19322.00 ha<sup>-1</sup>. This was followed by turmeric + chilli (2:1 proportion with ₹ 14, 778/- ha<sup>-1</sup>).

One additional weeding is required before turmeric emergence for February and March planting, and a similar and significantly higher yield is obtained with the February, March, and April plantings, compared with later planting (Hossain, 2005).

Behera *et al.* (2008) reported that sole turmeric under organic environment gave maximum gross return but turmeric + pigeonpea (10:2) in replacement series gave the maximum net return due to lower cost of cultivation as compared to sole turmeric.

Das *et al.* (2008) reported mulching with locally available cheap organic waste @10 t ha<sup>-1</sup> produced the second highest fibre yield, but recorded the highest net return and benefit: cost ratio in jute.

Kaur *et al.* (2008) observed that pre-emergence application of pendimethalin + straw mulch @ 9 t ha<sup>-1</sup> recorded higher net return (₹ 1,03,000/-) and B:C ratio (2.30) as compared to all other treatments in turmeric. Ratnam et al. (2012) reported that among the weed management treatments, the higher net return of ₹ 1,21,073 ha<sup>-1</sup> and B:C ratio of 0.61 was recorded with pre-emergence application of oxyfluorfen @ 0.25 kg ha<sup>-1</sup> followed by quizalofop ethyl @ 0.05 kg ha<sup>-1</sup> at 30 DAS supplemented with hand weeding at 60 and 90 DAS in turmeric. Jadhav and Pawar (2014) opined that pre-emergence application of metribuzin @ 0.70 kg ha<sup>-1</sup> along with straw mulch 10 t ha<sup>-1</sup> followed by one hand weeding recorded higher net return (₹ 1,44,630/-) and B:C ratio (1.47). Sathiyavani and Prabhakaran (2014) reported that pre-emergence

application of metribuzin @ 0.7 kg ha<sup>-1</sup> on 3 DAP + hand weeding on 45 and 75 DAP gave effective weed control, higher productivity and profitability in turmeric than that in other practices. Suresh Kumar *et al.* (2014) also observed similar result with metribuzin @ 0.7 kg + hand weeding in case of net profit per rupee investment in turmeric.

### **2.9.2 Bioenergetics of cropping system**

Bioenergetics denotes an approach to know the process of energy input and output involved in an agriculture system. In regard to cropping systems, it shows the relationship between the cultural energy input and output apart from monitoring solar energy utilization efficiency which is the key energy source of crop productivity.

Estimation of bioenergetics largely depends upon input and output of product for specific place and time. Pal *et al.* (1985), Deka (1990) and Deka (1997) revealed that energy input and output varied among different cropping system. Fluck (1979) suggested the measure of energetic with energy productivity by taking the ratio of the output to the energy input and it is specific for each agricultural product at a place and time. Determining energy efficiency for various crops and cropping system is important to evaluate the systems for best utilization of available energy (Thakare and Maji, 1983).

# CHAPTER III

## MATERIALS AND METHODS

The field experiments entitled “Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* Val.)” were carried out to study suitable inter-crop, crop establishment technique and integrated weed management practices in turmeric production under upland situation during 2013 and 2014 at the Instructional-cum-Research Farm (ICR Farm), Assam Agricultural University, Jorhat, PIN 785013. The details of the materials used and methods employed during the course of experimentation are presented in this chapter.

### 3.1 Geographical location of the experimental site

The experiments were conducted at the Instructional-cum-Research Farm of Assam Agricultural University located at Borbhetta, which is 4 km away from Jorhat town in the upper Brahmaputra Valley Zone of Assam. Geographically, Jorhat is located at 24°47'N latitude, 94°12'E longitude and at an altitude of 86.6 m above mean sea level.

### 3.2 Experimental site and soil

A site of upland situation was selected to conduct the experiment. Representative soil samples from a depth of 0-15 cm of the site were collected at random before the experiment was started for studying the initial physico-chemical properties. The results of the analysis and methods used are presented in Table 3.1.

The soil of the experimental site belongs to taxonomic order of inceptisol with sandy loam texture (Dutta and Karmakar, 1995). The surface soil, in both the years of experimentation was found acidic in reaction, low in organic carbon, medium in available nitrogen and potassium, and low in phosphorus.

**Table 3.1. Physico-chemical properties of surface soil at experimental site**

Particular(s)	Value(s) / class		Method adopted
	2013	2014	
<b>A. Physical properties</b>			
<b>I. Mechanical composition</b>			
Sand (%)	71.1	70.8	International Pipette Method (Khanna and Yadav, 1979)
Silt (%)	16.8	16.4	
Clay (%)	12.1	12.8	
Textural class	Sandy loam	Sandy loam	
<b>B. Chemical properties</b>			
Soil pH	4.71	5.06	Glass Electrode Method (Jackson, 1973)
Organic carbon (%)	0.45	0.49	Walkley and Black's Method (Piper, 1968)
Soil microbial carbon ( $\mu\text{g g}^{-1}$ of soil)	260.2	302.4	Chloroform Fumigation Incubation Method (Jenkinson and Powlson, 1976)
Available N ( $\text{kg ha}^{-1}$ )	360.0	369.4	Alkaline $\text{KMnO}_4$ Method (Subbiah and Asija, 1956)
Available $\text{P}_2\text{O}_5$ ( $\text{kg ha}^{-1}$ )	17.81	18.23	Bray's No.1 Method (Jackson, 1973)
Available $\text{K}_2\text{O}$ ( $\text{kg ha}^{-1}$ )	239.36	241.12	Flame Photometric Method (Jackson, 1973)

### 3.3 Cropping history of the experimental site

Rapeseed was grown in the experimental site in the preceding year (2012) of experimentation. Prior to 2012, the site was a fallow land for a few years.

### **3.4 Climate and weather**

The climatic condition of Jorhat as a whole is sub-tropical humid with warm summer and cold winter. The average annual rainfall of this tract is about 200 cm. Monsoon season, which normally sets in June extends up to September and withdraws in October. The data on weather parameters *viz.*, mean maximum and minimum temperature, mean relative humidity, cumulative rainfall, evaporation and bright sunshine hours, during the crop growth period are presented in Appendix I and II. The data of various climatic variables have also been depicted in this chapter in Fig. 3.1 and Fig. 3.2.

#### **3.4.1 Temperature**

The weekly mean maximum and minimum temperature from March to December during 2013 and 2014 are presented in Fig. 3.1 Fig. 3.2 and Appendix I and II. During the crop growth period of 2013, the mean maximum and minimum temperature were 30.6°C and 21.7°C, respectively. The highest average maximum temperature during the crop growth period of first year field experiment was recorded in June and that of lowest minimum temperature in December.

During the crop growth period of 2014, the mean maximum and minimum temperature were 31.2°C and 21.7°C, respectively. The highest average maximum temperature during the crop growth period of second year field experiment was recorded in July and that of lowest minimum temperature in December.

#### **3.4.2 Humidity**

During the crop growth period of 2013, average maximum relative humidity of 92.50 per cent was recorded at 0615 hrs and that of minimum relative humidity of 68.10 per cent was observed at 1315 hrs. During 2014, the mean values of maximum and minimum relative humidity at same standard time were 92.85 and 70.05 per cent, respectively (Fig. 3.1, Fig. 3.2 and Appendix I, II).

#### **3.4.3 Rainfall**

The total rainfall received during the crop growth period of 2013 was 1973.6 mm in 124 rainy days. There was no rainfall during first week after sowing of crops where as first rainfall was received on 10<sup>th</sup> day after sowing.

During the crop growth period of 2014, the total rainfall received was 1634 mm in 125 rainy days. There was no rainfall during first week after sowing of crop where as first rainfall received on 13<sup>th</sup> day after sowing.

Based on 30 years' rainfall data (Hussain and Deka, 2013), it can be surmised that rainfall in the crop growth period of 2013 was within the normal range but the same was below normal range in 2014.

**Fig. 3.1.**

**Fig. 3.2**

### **3.4.4 Evaporation**

The average evaporation during first and second year's crop growth period was 2.52 and 2.47 mm per day. The highest and lowest evaporation rate in the first year's experimentation was recorded in May and December, respectively whereas the same in case of second year experimentation was recorded in April and December.

### **3.4.5 Bright Sun Shine Hour (BSSH)**

A bright sun shine hour is important for rainy season crop as the sky use to remain cloudy in most of the time of crop growth period. The average bright sun shine hours during crop growth period of 2013 and 2014 was recorded as 5.33 and 5.15 hours, respectively.

## **3.5 Details of the Experiment**

The field experiment was laid out in a factorial randomised block design replicated thrice. Twenty treatments consisting combination of methods of paired row planting of turmeric, intercropping and weed management methods along with controls were allocated randomly. The process of randomisation was independently and separately followed in each replication (Fig. 3.3). The classified description of the treatment combinations with corresponding notation in order to facilitate their reference in the text are given in 3.5.2.

### **3.5.1 Experimental design and layout**

Design	: Factorial Randomised Block Design (FRBD)
Number of replication	: Three
Gross size of the plot	: $5\text{ m} \times 4\text{ m} = 20\text{ m}^2$
Treatment combination	: 20 (16 treatment combinations + 4 controls)
Total plots per replication	: 20 Nos.
Net area of the experiment	: $1200\text{ m}^2$
Gross area of the experiment	: $1645\text{ m}^2$

**Fig. 3.3**

### 3.5.2 Treatment details

Particulars of Treatments	Notation
<b>A.</b> Methods of paired row planting of turmeric (two numbers)	
80/20 cm spacing	M <sub>1</sub>
70/30 cm spacing	M <sub>2</sub>
<b>B.</b> Intercropping (two numbers)	
Baby Corn	I <sub>1</sub>
Greengram	I <sub>2</sub>
<b>C.</b> Weed management (four numbers)	
Weedy (Control)	W <sub>1</sub>
Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	W <sub>2</sub>
Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140, 185 DAP	W <sub>3</sub>
Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	W <sub>4</sub>
<b>D.</b> Controls (four numbers)	
Sole Turmeric (Recommended)	C <sub>1</sub>
Sole Baby corn	C <sub>2</sub>
Sole Greengram	C <sub>3</sub>
Sole Turmeric (Weed free)	C <sub>4</sub>

### 3.5.3 Crop Species and Varieties

#### i. Turmeric

##### Variety: *Lakadong*

*Lakadong* is a variety with high curcumin content, originated from the *Jayantia* hill of Meghalaya. Rhizome of *Lakadong* cultivar has unique orange red colour with curcumin content of approximately 8-8.7 per cent in its natural habitat. In Meghalaya, *Lakadong* is dominant variety and more than 50 per cent area is under this variety. All the North Eastern States by and large grow *Lakadong* variety of turmeric.

The crop matures in about 240-250 days and yields about 500-2000 gram fresh rhizome per plant amounting to approximately 20-30 tonnes yield per hectare. *Lakadong* is prone to leaf blotch attack.

## **ii. Baby Corn**

### **Variety: G 5414**

It is a popular variety released by Syngenta Seed Co. Ltd. It takes 49-55 days for first harvesting. Harvesting period extends to 5-6 days. Average number of cob per plant is 2-3. Yield with husk and without husk is 11.3-12.5 tonnes per hectare and 1.7-2.4 tonnes per hectare, respectively.

## **iii. Greengram**

### **Variety: Pratap (SG-1)**

The variety is the cross between ML-56 and PIMS 1 which was developed in 1993 at Regional Agricultural Research Station, Shillongani, Nagaon under Assam Agricultural University, Jorhat. *Pratap* is a medium tall variety. It matures in about 65-75 days and yields 10-14 quintal per hectare. It takes 65-70 days for first picking of pods. Grains are bold and light green in colour.

### **3.5.4 Herbicides used for study**

The properties of herbicides used in the experiment *viz.* metribuzin and oxadiargyl are given in the Appendix VI. The herbicides *viz.*, metribuzin and oxadiargyl were applied as pre-emergence on 3 DAP @ 500 gram per hectare and 90 gram per hectare, respectively with spray volume of 500 litre per hectare.

### **3.5.5 Cultivation details**

#### **3.5.5.1 Field preparation**

The field was ploughed twice by tractor drawn disc plough followed by ploughing once by cultivator and then levelled. Beds and channels were made manually by using spade. Ridges and furrows were made manually before planting and sowing. The layout of plots was done as per experimental design (Fig. 3.3).

#### **3.5.5.2 Manure and fertilizers application**

Farm yard manure @ 10 tonne per hectare was applied as basal during the time of bed preparation in equal quantity and spread uniformly over the beds. Lime

@ 0.5 tonne per hectare was applied one month before planting in first year of cultivation.

The recommended dose of 60:50:120 kg of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per hectare in the form of urea (46% N), single super phosphate (16% P<sub>2</sub>O<sub>5</sub>) and muriate of potash (60% K<sub>2</sub>O) were applied. The entire quantity of phosphorous was applied as basal before planting. Nitrogen and potash were applied in three equal splits at 65, 95 and 140 days after planting (DAP). Micro nutrients sprays containing zinc, boron and, sulphur were given at 140 and 185 DAP.

### **3.5.5.3 Rhizome, spacing and planting**

- i. Rhizome: Good quality rhizomes of *Lakadong* variety of turmeric were collected from certified turmeric grower of *Jayantia* hill district of Meghalaya in January, 2013 and treated with Carbendazim @ 2.5 gram per kilogram rhizome and shade dried before storage for the first year planting. The seed rhizome for the second year planting was used from the rhizome yield of first year trial.
- ii. A seed rate of 2000 kg turmeric rhizome (primary fingers) per hectare was used.
- iii. The spacing of 50 cm for row to row and 25 cm plant to plant in case of sole turmeric crop was followed. In case of paired row planting at 80/20 cm, the spacing between two paired rows was 80 cm, while the spacing between two rows of a paired planting was 20 cm. Similarly, in case of paired row planting at 70/30 cm, the spacing between two paired rows was 70 cm, while the spacing between two rows of a paired planting was 30 cm (Fig. 3.4 and Fig. 3.5). The plant to plant distance was same as that in sole crop. Thus, total plant population of turmeric in modified planting methods were same as that in sole crop of turmeric i.e. 80, 000 per hectare.

### **3.5.5.4 Mulching**

Mulching was done in two splits, one immediately after sowing of seed materials and second one at 65 DAP. Rice straw and rapeseed stover in equal quantity @ 4 tonne per hectare was used as mulch in first split as per treatment including control turmeric treatment.

The stover of baby corn and greengram (after harvest of intercrops) @ 10 tonne per hectare was applied as second split of mulching as per treatments including control treatment of turmeric.



**Fig. 3.4**

**Fig. 3.5**

### **3.5.5.5 Seeds of intercrop, spacing and sowing**

There were two intercrops viz., baby corn and greengram. The spacing taken up for sole baby corn was 60 cm × 20 cm and it was 30 cm × 10 cm for greengram. The seed rate for each of baby corn and greengram was 25 kilogram per hectare. Seeds of intercrops were sown on the same day as that of planting of turmeric rhizome.

### **3.5.5.6 Post planting care**

#### **3.5.5.6.1 Irrigation**

Life saving watering twice with rose-cane one after emergence of seedling and another at 20 DAS was given to the intercrops in both the years of cultivation.

#### **3.5.5.6.2 Weeding**

Hand weeding aided with hand blade (*Khurpi*) was done as per the treatment schedule.

#### **3.5.5.6.3 Earthing up**

Light earthing up was done at 95 DAP for the base crop of turmeric in intercropping as well as sole crop.

#### **3.5.5.6.4 Plant protection**

Need based plant protection measures were adopted in turmeric to manage pests and diseases as recommended by Spices Board of India, Cochin and Indian Institute of Spices Research, Calicut (2008) for turmeric, while in cases of greengram and maize, package of practices recommended by Assam Agricultural University were followed. The greengram crop was infested by collar rot disease for which Carbendazim @ 0.3% was sprayed. The turmeric crop was infested by Leaf blotch (*Taphrina maculans*) and Leaf spot (*Colletotichum capsici*). Both the diseases were managed by spraying two rounds of 1% Bordeaux mixture and three rounds Carbendazim 12% + Mancozeb 63% @ 0.2% , alternatively.

The infestation of shoot borer, *Dichorocis punctiferatis* (Pyraustidae, Lepidoptera) on turmeric causing ‘dead heart’, was controlled by spraying one round of Chloropyrifos @ 0.1%.

#### **3.5.5.6.5 Detasseling in baby corn**

Tassels were removed as and when they emerged to avoid pollination. If the silks get pollinated, the kernel would start developing within hours and the cob would become hard and unfit for baby corn purposes. Hence, detasseling is essential to get good quality baby corn (Prasanna *et al.*, 1995).

#### **3.5.5.6.6 Harvesting**

Harvesting of inter-crops *viz.*, baby corn and greengram were started on 60 and 65 DAS, respectively. Immediately after emergence of the silk, cobs were harvested with sheath (husk). It took 7 days to complete the harvest of baby corn from its first pick, while in greengram; it took 10 days to complete the harvest from its first pick. After harvest of cob of baby corn and pods of greengram, stalks were harvested and used as mulch in turmeric.

Normally the turmeric variety *Lakadong* requires 240-250 days for maturity but the experimental crop was harvested at 270 DAP as because the planting was advanced by a month to suit the time of sowing of inter-crops. Two weeks prior to harvest, stalks of each plant were bound individually for downward movement of curcumin from green leaves to rhizome. From each plot, rhizome was harvested immediately after drying of leaves. The stalks were cut close to ground level separately just before digging out of rhizomes. The rhizomes from each plot were harvested separately with the help of spade, cleaned and the yield was recorded.

### **3.6 Observation on weeds**

#### **3.6.1 Weed characters**

Weed characters were studied, the observations were recorded at 30, 60, 90, 120, 150 and 180 DAP.

#### **3.6.2 Weed flora of the experimental field**

The weed flora, of the unweeded control plots in species wise was recorded at 30, 60, 90, 120, 150 and 180 DAP.

#### **3.6.3 Weed density**

Density of individual weeds of grasses, sedges and broad leaved weeds in each plot was recorded by using quadrat (0.5 m x 0.5 m) and expressed as number

square metre (Burnside and Wick, 1965). The individual weed density was summed up to get total weed density.

### **3.6.4 Relative weed density**

Relative weed density of individual weed species and group wise were calculated by the method suggested by Kim and Moody (1983).

$$\text{Relative density (RD \%)} = \frac{\text{Absolute density of a given species (No. m}^{-2}\text{)}}{\text{Total absolute density of all species (No. m}^{-2}\text{)}} \times 100$$

### **3.6.5 Weed dry weight**

The individual weed species collected from each treatment from sampling area of the plot at different stages were air dried and then oven dried at  $65^{\circ} \pm 2^{\circ}\text{C}$  to obtain a constant weight and expressed as gram per square metre. The individual dry weights were summed to get total dry weight.

### **3.6.6 Weed control efficiency**

Weed control efficiency (WCE) was calculated as per the following procedure and expressed in percentage.

$$\text{WCE} = \frac{\text{WDC} - \text{WDT}}{\text{WDC}} \times 100$$

Where,

WDC = Weed dry weight in unweeded check plot ( $\text{g m}^{-2}$ )

WDT = Weed dry weight in treated plot ( $\text{g m}^{-2}$ )

### **3.7 Qualitative assessment through visual observations**

The qualitative assessment on weeds through visual observation was done to record the herbicidal effect on its germination, emergence and growth.

### **3.8 Bio-metrical observation**

Within the net plot area, five plants of each crop were selected at random and tagged for recording the biometric observations.

### **3.8.1 Turmeric**

#### **3.8.1.1 Growth parameters**

##### **3.8.1.1.1 Plant emergence count**

The plant emergence count was recorded at 60 DAP and thereafter at 15 days interval and continued up to 90 DAP. The data on plant population per square metre had been recorded.

##### **3.8.1.1.2 Plant height**

Plant height, in intercrops, was measured from the base of the plant to the tip of the longest leaf at harvest; while in turmeric, it was recorded at 95, 140, 185 and 256 DAP. The plant height is expressed in cm.

##### **3.8.1.1.3 Dry matter production**

Dry matter production (DMP) was estimated at harvest of the crop. Five plants were removed from the sample rows, air dried and then oven dried at  $80^{\circ} \pm 2^{\circ}\text{C}$  till a constant weight was recorded. Dry matter production was expressed in kilogram per hectare.

##### **3.8.1.1.4 Number of leaves per plant**

The total number of fully opened and functional leaves in a plant was recorded on 95, 140, 185 and 256 DAP and expressed as number of leaves per plant.

##### **3.8.1.1.5 Numbers of tillers per plant**

The number of tillers i.e. aerial shoots of turmeric plant emerged from the rhizome was counted on 95, 140, 185 and 256 DAP and expressed as number of tillers per plant.

#### **3.8.1.2 Physiological parameters**

##### **3.8.1.2.1 Leaf area index**

The total number of green leaves, length and breadth of the third leaf from the top of the tagged plants were measured in each plot in case of turmeric. The leaf area index was then worked out as suggested by Palaniswamy and Gomez (1974) using the formula as given below:

$$\text{LAI} = \frac{\text{L} \times \text{B} \times \text{K} \times \text{No. of green leaves per plant}}{\text{Spacing (cm}^2\text{)}}$$

Where,

L = Length of the third leaf from the top (cm)

B = Maximum breadth of the same leaf (cm)

K = Constant factor (0.6454)

### **3.8.1.3 Yield attributes**

Yield attributes of the intercrop and main crop were recorded at harvest with five randomly selected plants from the net plot area.

#### **3.8.1.3.1 Number of rhizome per plant**

The total numbers of mother, primary and secondary rhizomes produced by five randomly selected plants were recorded separately and their average value was expressed as number of mother, primary and secondary rhizomes per plant.

#### **3.8.1.3.2 Size of rhizomes**

Five rhizomes of each of mother, primary and secondary rhizomes were taken from the randomly selected five plants. Length and girth of mother, primary and secondary rhizomes were recorded and their average values were expressed in cm.

#### **3.8.1.3.3 Weight of rhizomes per plant**

Mother, primary and secondary rhizome were separated and weighed separately from each randomly selected five plants. Weight of each category rhizome was recorded and their average values were expressed in grams.

### **3.8.1.4 Yield**

#### **3.8.1.4.1 Fresh rhizome yield**

For ascertaining fresh rhizome yield, all the rhizomes were harvested separately and cleaned. The fresh rhizome yield from each net plot was calculated and expressed in tonne per hectare.

#### **3.8.1.4.2 Curing percentage (CP)**

Fresh (raw) turmeric yield was recorded by taking the weight of fresh rhizomes harvested from each net plot and was converted to yield per hectare. Fingers were separated from mother rhizomes and a sample of two kilogram of fresh rhizomes from each plot was boiled in a pan. The whole mass was boiled till the fingers became

soft and froth, dried under sun and their dry weight was recorded. Curing percentage was worked out by the following formula and expressed in percentage.

$$\text{Curing percentage} = \frac{\text{Dry weight of rhizome after curing (kg)}}{\text{Fresh weight of the rhizome (kg)}} \times 100$$

#### **3.8.1.4.3 Cured rhizome yield**

Cured rhizome yield was calculated by multiplying the fresh rhizome weight with mean curing percentage and expressed in tonne per hectare (Natarajan and Lewis, 1980).

#### **3.8.1.4.4 Stover yield**

The stover of each plot was dried well and their respective weights were recorded. The stover yield was expressed in tonne per hectare.

### **3.8.2 Baby corn**

#### **3.8.2.1 Growth parameters**

##### **3.8.2.1.1 Plant emergence count**

The plant emergence count was recorded at 7 days interval after sowing and continued up to 14 days. The data on plant population per square metre had been recorded.

##### **3.8.2.1.2 Plant height**

At harvest, five plants were selected randomly from each plot. Their height was measured from the soil surface to the highest tip of flag leaf with the help of a meter scale and average height was calculated. The height of plants is expressed in cm.

##### **3.8.2.1.3 Numbers of leaves per plant**

Numbers of green leaves from five plants randomly selected from each plot were counted and average number was calculated. The number of leaves is expressed as number of leaves per plant.

##### **3.8.2.1.4 Leaf Area Index**

Leaf length and maximum width of the third leaf from top of the main stem was measured. Total number of leaves in each plant was counted. The leaf area (LAI) was worked out using the formula suggested by McKee (1964).

$$\text{LAI} = \frac{L \times W \times N \times K}{\text{Unit land area (cm}^2\text{)}}$$

Where,

LAI = Leaf Area

L = Length of the third leaf from top (cm)

W = Maximum width of the blade (cm)

N = Number of leaves per plant

K = Constant factor 0.75 for maize (Elsahookie, 1985)

### **3.8.2.2 Yield attributes**

#### **3.8.2.2.1 Days to 50% Tasseling**

The total number of days taken for 50% tassel emergence in each plot was recorded.

#### **3.8.2.2.2 Days to 50% silking**

The total number of days taken for 50% silk emergence in each plot was recorded.

#### **3.8.2.2.3 Numbers of cobs per plant**

The numbers of cobs produced by five randomly selected baby corn plants were recorded and their average value was expressed as number of cobs per plant.

#### **3.8.2.2.4 Length of cobs with husk**

The length of five randomly selected cobs with husk from each tagged plant was measured and the average was worked out. It is expressed in cm.

#### **3.8.2.2.5 Weight of each cobs with husk**

Weights of five randomly selected cobs with husk from each tagged plant were taken and the mean value was worked out. It is expressed in gram.

#### **3.8.2.2.6 Length of cobs without husk**

The length of five randomly selected cobs without husk from each plot was measured and the average was worked out. It is expressed in centimetre.

### **3.8.2.3 Yield**

#### **3.8.2.3.1 Cob yield with husk**

The cobs with husk was harvested treatment-wise in net plot were weighed and expressed as tonne per hectare.

#### **3.8.2.3.2 Cob yield without husk**

The cobs of net plot after removing husk were weighed and expressed as tonne per hectare.

#### **3.8.2.3.3 Stover yield**

The stover of the each plot was dried well and their respective weights were recorded. The stover yield was expressed in tonne per hectare.

### **3.8.3 Greengram**

#### **3.8.3.1 Growth parameters**

##### **3.8.3.1.1 Plant emergence count**

The plant emergence count was recorded at 7 days interval after sowing and continued up to 14 days. The data on plant population per square metre was recorded.

##### **3.8.3.1.2 Number of branches per plant**

The numbers of branches of five greengram plants were counted before harvest and mean was worked out. It was expressed as numbers of branches plant<sup>-1</sup>.

##### **3.8.3.1.3 No. of leaves per plant**

The number of green and functional leaves from the five tagged plants was counted at flowering and average was worked out.

##### **3.8.3.1.4 Leaf Area Index**

The total number of green leaves, length and breadth of the third leaf from the top of tagged plants were measured in each plot. The leaf area index was then worked out as suggested by Palaniswami and Gomez (1974), using the formula given below:

$$LAI = \frac{L \times B \times K \times N}{\text{Spacing (cm}^2\text{)}}$$

Where, L = Length of the third leaf from top (cm)

B = Maximum breadth of the same leaf (cm)

N = Number of green leaves per plant

K = Constant factor (0.662)

### **3.8.3.2 Yield attributes**

#### **3.8.3.2.1 Numbers of pod per plant**

The number of pod from the five tagged plants was recorded and the mean value was worked out. It was expressed as pod per plant.

#### **3.8.3.2.2 Length of pod**

Five numbers of pods were collected and their lengths were measured and mean length of pods were calculated. It was expressed in cm.

#### **3.8.3.2.3 Grain per pod**

The seeds from five number collected pods were counted treatment wise and the mean was worked out. It was expressed as grain per pod.

### **3.8.3.3 Yield**

#### **3.8.3.3.1 Grain yield**

After threshing and winnowing, grains of each net plot were properly cleaned, sun dried and then weights were recorded. The yields were expressed in tonne per hectare.

#### **3.8.3.3.2 Stover yield**

The stover of the each net plot was well sun dried and respective weights were recorded. The stover yield was expressed in tonne per hectare.

#### **3.8.3.3.3 Test Weight**

Three samples each containing 1000 numbers of healthy seeds from each net plot were taken and the weight was recorded in grams. The mean value was then worked out and expressed in gram.

### 3.9 Chemical analysis

#### 3.9.1. Plant analysis

Plant samples were analysed at harvest to estimate nutrient content and nutrient uptake by the crop. Similarly, weed samples were analysed at crop to determine nutrient removal by weeds. The plant samples (rhizome / grain/ corn/ stover) collected at harvest for each plot were dried in oven at 60°C. Grinding of the stover and rhizome was done in an electric grinder while the grain / cob samples were crushed in pestle and mortar for chemical analysis of N, P and K content in percentage.

The methods followed in chemical analysis are given in the Table 3.2.

**Table 3.2. Methods used for chemical analysis of plant and weed samples for nutrient content**

Nutrient	Methods employed	Reference
Nitrogen	Kjeldahl method	Jackson, 1973
Phosphorus	Tri-acid digestion and Vanado-molybdate yellow colour method	Jackson, 1973
Potassium	Tri-acid digestion with flame photometry	Jackson, 1973

Total uptake of N, P and K was calculated for each treatment separately by using the following formula.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\% \text{ of nutrient concentration} \times \text{Dry weight (kg ha}^{-1}\text{)}}{100}$$

#### 3.9.2 Soil analysis

Soil samples were collected randomly from 0 to 15 cm depth from the experimental site prior to experimentation and analyzed for physical and chemical properties. At harvest of crop, soil samples collected from each plot at 0 to 15 cm depth and shade dried, ground and sieved through 2 mm diameter sieve and was used for estimation of available nitrogen, phosphorus, potassium, organic carbon and pH as per the method given in Table 3.1.

##### 3.9.2.1 Mechanical analysis

Mechanical analysis of the soil collected initial in the first year of experiment and at harvest of base crop was determined by International pipette method suggested by Piper (1966).

### **3.9.2.2 Soil moisture**

Soil moisture content (%) at one month intervals during the crop growth period was determined from 0-15 cm depth of soil. A representative two soil samples from each plot was taken by soil auger according to the depth mentioned above and brought to the laboratory to record their fresh weight. Then the samples were dried in oven at 105°C for 24 hours and the moisture content of each sample was determined gravimetrically. The per cent moisture content in soil was calculated out as follows:

$$\% \text{ Moisture} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 100$$

### **3.9.2.3 pH**

Soil pH of the experimental site was determined by glass electrode pH meter (Jackson, 1973) before and after lime application.

### **3.9.2.4 Organic carbon**

Soil organic carbon was estimated before planting and after harvest of crop by wet digestion method as suggested by Walkley and Black (1934) and expressed as percentage.

### **3.9.2.5 Soil microbial biomass carbon**

Soil microbial biomass carbon (SMBC) was estimated using chloroform fumigation incubation method as described by Jenkinson and Powlson (1976). In this method, collected soil samples (20 g in dry weight) from each treatment plot were fumigated with ethanol free chloroform vapour in sealed desiccators lined with moist filter paper for 24 hrs at 25°C. After fumigation, extraction was done with 0.5 M K<sub>2</sub>SO<sub>4</sub> (1:4 soil: solution ratio) for 1hr and the extracts stored at 4-5°C till further assay. Thus, the increase in organic carbon following the fumigation of soil samples was used to estimate the amount of carbon held in the soil microbial biomass. Control samples were also maintained with non-fumigated soil samples keeping in a desiccator lined with moist filter paper for 24 hrs at 25°C. The quantity of microbial biomass carbon thus calculated is expressed as microgram (µg) per gram of soil.

### **3.9.2.6 Available nitrogen**

The available nitrogen in initial soil was estimated in the first year of experiment and after the crop cycle by alkaline permanganate method as described by Subbiah and Asija (1956) and expressed as kilogram per hectare.

#### **3.9.2.7 Available phosphorus**

The soil available phosphorus was determined initially before starting the experiment in the first year of experimentation and after the crop cycle by Bray's I method (Jackson, 1973) and expressed as kilogram per hectare.

#### **3.9.2.8 Available potassium**

The available potassium was estimated in the initial soil sample in the first year of experiment and after the crop cycle by deploying neutral ammonium acetate extraction method using flame photometer as given by Jackson (1973) and expressed as kilogram per hectare.

### **3.9.3 Curcumin content of Turmeric**

Curcumin content of dried turmeric fingers was determined treatment-wise as per specification of American Spice Trade Association (ASTA).

## **3.10 Cropping system**

### **3.10.1 Turmeric equivalent yield**

The turmeric equivalent yield was calculated out by converting the yield of inter-crop into the yield of turmeric on the basis of price for product fixed by Assam Agricultural University, Jorhat and the following formula was used.

$$\text{Turmeric equivalent yield} = \frac{Y_a \times P_a}{P_b}$$

Where,

Y<sub>a</sub> = Yield of intercrop a

P<sub>a</sub> = Price of intercrop a

P<sub>b</sub> = Price of turmeric rhizome

### **3.10.2 Land equivalent ratio (LER)**

LER was calculated out by the following formula suggested by Willey (1979, 1979 a).

$$\text{LER} = \frac{Y_{\text{TI}}}{Y_{\text{TS}}} + \frac{Y_{\text{II}}}{Y_{\text{IS}}}$$

Where,  $Y_{\text{TI}}$  = Yield of turmeric when intercropped with crop B

$Y_{\text{TS}}$  = Yield of turmeric (base crop) in sole cropping

$Y_{\text{II}}$  = Yield of crop B when intercropped with turmeric

$Y_{\text{IS}}$  = Yield of crop B in sole cropping

### 3.10.3 Economics

Expenditure and total returns were worked out on hectare basis for each treatment by taking account of the cultural operations, labour wages and prices of product fixed by Assam Agricultural University and prevailing prices of other inputs as listed in Appendix VIII.

#### 3.10.3.1 Cost of cultivation

The total expenditure incurred from sowing to harvest including the field preparation was worked out and expressed as  $\text{R ha}^{-1}$ .

#### 3.10.3.2 Gross return

Gross return for each treatment was calculated as:

Gross return ( $\text{Rha}^{-1}$ ) = Value of rhizome/cob/grain + value of straw /  
stover of component crops

#### 3.10.3.3 Net return

Net return was calculated by subtracting the variable cost of cultivation from gross returns as detailed below and expressed as Rupees (R) per hectare.

Net return ( $\text{Rha}^{-1}$ ) = Gross return ( $\text{Rha}^{-1}$ ) – Cost of cultivation ( $\text{Rha}^{-1}$ )

#### 3.10.3.4 Monetary advantage

Monetary advantage was calculated out by the formula given by Willey (1979).

Monetary Advantage = Value of combined intercrops yield  $\times \frac{\text{LER} - 1}{\text{LER}}$

### 3.11 Bioenergetics

(a) Cultural energy use efficiency (CEUE)/ Output/ Input ratio)

$$\text{CEUE} = \frac{\text{Total energy output (Mcal) of crop / cropping system}}{\text{Total cultural energy (Mcal) input under that system}}$$

The total biomass from a system was used to calculate output / input ratio.

(b) Energy production ratio (EPR) for turmeric

$$\text{EPR} = \frac{\text{Turmeric equivalent yield (kg ha}^{-1}\text{)}}{\text{Cultural energy input (Mcal) ha}^{-1}}$$

### 3.12 Transformation

Data on weed count and dry weight showed high degree of variation. A linear relationship between the means and variance was observed and therefore, the data on weed count and dry weight was subjected to square root transformation after adding 0.5 to make analysis of variance valid as suggested by Bartlett (1947). The following formula was used to get transformed value.

$$\text{Transformed value} = \sqrt{(x + 0.5)}$$

### 3.13 Statistical Analysis

All the data pertaining to the present investigation wherever required were subjected to statistical analysis by Statistical Package for System Software (SPSS16). Analysis of variance (ANOVA) for factorial RBD was carried out to access the response of different treatments and treatment combinations on the parameters *viz.*, density and dry weight of weed, growth and yield attributes of crops, soil and plant nutrients and turmeric equivalent yield. The ANOVA was basically worked out to test the differences between mean of different factors for treatments and treatment combinations. In this experiment planting methods, intercropping and weed management were considered as main treatment factors. But in some cases, interaction effect also played an important role by showing significant relation. After analysis, the important statistical tools required for present study like standard error of differences (SEd) and critical difference (CD) at 5% probability level were calculated from ANOVA and presented in individual table. For comparing different level of observation, coefficient of variation (CV) was expressed in percentage and mentioned at the bottom of each table.

# CHAPTER IV

## RESULTS AND DISCUSSION

The results of the experiments conducted during the years 2013 and 2014 at the Instructional cum Research Farm, Assam Agricultural University, Jorhat to investigate the “Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* Val.)” are presented in this chapter. This chapter also embodies the discussion of the experimental findings obtained in field studies. The effect of methods of paired row planting, intercropping and weed management practices on base crop ‘turmeric’ and intercrops ‘baby corn/greengram’ were measured in terms of growth parameters, yield attributes, yields, land equivalent ratio, economics, monetary advantage and bioenergetics.

In this chapter, the effect of various factors, the interaction effects between two factors *viz.*, methods of paired row planting and intercropping; methods of paired row planting and weed management practices; intercropping and weed management practices and three factors interaction among methods of paired row planting, intercropping and weed management practices have been discussed wherever these were found significant. However, whenever interaction effect was significant, the effect of individual factors was least discussed.

### **4.1 Influence of weather on crop productivity and weed continuum**

Weather is a critical factor influencing the realization of potential yield of any crops grown in the cropping system. It is also a direct input to agriculture like other inputs such as land, labour, seeds, fertilizers, pesticides etc. While both sets of factors are crucial, measurable inputs are controllable, weather parameters are not. Wilson (1990) maintained that climatic factors of importance for crop production are precipitation and its mode of occurrence, humidity, temperature and wind (speed and direction), all of which directly affect evaporation and transpiration. Solar radiation has a linkage with evapo-transpiration and rainfall, which upshots soil temperature and control environmental resources, the crop yield and other categories of human activities

in the area. Crop-weather relationships being complex, it cannot always be expressed by linear relationship. However, linear relationship provides the first attempt at describing the dependence of crop yield on weather. The cultivation of spices including turmeric is governed by the prevalence of suitable climatic conditions occurring within a given region.

During the crop growth period of experimentation, the rainfall varied in respect of amount and distribution. In 2013, rainfall received during the crop growing period (March 6 to 3 December) was 1973.6 mm in 124 rainy days while, it was 1634 mm in 125 rainy days in the same period during 2014. Based on 30 years rainfall data of upper Brahmaputra valley zone of Assam as reported by Hussain and Deka (2013), it could be concluded that rainfall in the cropping period of 2013 was within normal range but it was below normal in 2014. However, distribution of rainfall was better during crop growth period of 2014 than that of 2013. The total evaporation during crop growth period of 2013 was also slightly higher (100.6 mm) than that of 2014 (98.7 mm).

The weekly average maximum and minimum temperature in 2014 were comparatively slightly higher than that in 2013. The range of maximum and minimum temperature during first year of experimentation was from 34.2°C to 12.1°C, while it was from 34.4°C to 13.3°C in the second year of experimentation. However, the observed range of maximum and minimum temperature was by and large within the optimum level during both the crop growing years.

The mean relative humidity recorded during morning and evening ranges varied between 97 per cent and 49 per cent in 2013 which was comparatively higher than that (96% and 46%) in 2014.

The bright sunshine hours varied between 8.9 to 1.8 and 9.6 to 1.3 hours during the crop growth period of 2013 and 2014, respectively. The sky was more cloudy in 2013 than that in 2014.

Sivaraman (2012) revealed that there is a lack of published information on the weather relationships with turmeric production. However, the weather condition that prevailed during the cropping period of the present study did not vary much from the weather condition required for the normal growth of turmeric.

#### **4.1.1 Crop productivity**

Turmeric grows well in tropical and subtropical climate. It needs a fairly long and warm growing season. The most conducive climatic conditions required for turmeric are a well distributed rainfall during growing season, ample sunshine and relatively warm temperatures. Turmeric grows better with the mean temperature of 20°C-30°C. Kandiannan (2002) reported that seed rhizomes planted in the field took about a month to produce new shoots. The weather during this period had no significant effect on yield, and it is probably significant only after emergence of the crop. However, a temperature range of 25°C to 35°C is optimum for sprouting of rhizome buds, and sprouting does not occur below 10°C or above 40°C. Seedling elongates well in the range between 25°C and 30°C, but do not thrive above 40°C (Ishimine *et al.*, 2004). The weather condition that prevailed during the cropping season had favourable impact on growth characters, yield attributing characters and yield of turmeric. Though, rainfall recorded during 2014 was much lower compared to 2013, fairly distributed rain in 2014 might have favoured better growth of crop plant than that of 2013. Evaporation and relative humidity was slightly higher in 2013 as compared to that in 2014. High humidity and rainfall intensity in 2013 favoured leaf blotch and leaf spot disease compared to 2014 and this might had affected in yield of turmeric in the first year.

Higher turmeric rhizome yield was realized in 2014 as compared to 2013 and this might be due to favourable weather conditions along with congenial soil environment prevailing during that cropping period. The ambient weather condition prevailing in the particular cropping period might have endorsed the growth through augmented photosynthetic activity that was reflected through high dry matter production, yield attributes and rhizome yield. Similar findings were also reported by Sathiyavani (2014) in turmeric crop while, Pramilarani and Reddy (2008) made such observation in soybean crop.

There was, for a long period, no rain before and after sowing of seeds and it adversely affected in germination of intercrops. However, favourable weather that prevailed in the later part of cropping period enhanced the growth of intercrops. High rainfall intensity at harvesting of greengram adversely affected its yield.

#### **4.1.2 Weed continuum**

Photosynthetic characteristics are reported to be highly correlated to the competitive ability of C<sub>3</sub> and C<sub>4</sub> species (Percy *et al.*, 1981). Most of the pre-dominant weeds of the present experimental fields were C<sub>4</sub> species. Dicots of C<sub>4</sub> species are

among the most noxious and aggressive among rainy season weeds in temperate and subtropical regions (Elmore and Paul, 1983). During both the years of experimentation, *Elusine indica* (L.) Gaertn., *Digitaria setigera* Roth., *Panicum repens* L., *Cyperus iria* L., *Fimbristylis aestivalis* (Retz.) Vahl., *Borreria articularis* (L.f.) Will, *Commelina diffusa* Burm.f., *Ageratum houstonianum* Mill, *Mimosa diplotricha* C Wright. and *Mimosa pudica* L. were the dominant weed flora which resulted significant yield loss in weedy check control and caused a lot of management problems in other treatments. The predominant incidence of these weed species in turmeric might be attributed to the ecological adaptation and dominance of the weed in sandy loam soils of upper Brahmaputra valley zone of Assam. The dominant occurrence of *Cynodon dactylon*, *Elusine indica*, *Digitaria sanguinalis*, *Panicum australiaticum*, *Axonopus campresus*, *Cyperus rotundus*, *Cyperus iria*, *Fimbristylis miliacea*, *Ageratum conizoides*, *Alternanthera sessilis*, *Amarathus spinosus*, *Chenopodium album*, *Oldenlendia diffusa*, *Melochia corcorifolia*, *Scoparia dulcis*, *Mimosa pudica*, *Spilanthus paniculata* and *Commelina diffusa* in ginger experimental field of Assam Agricultural University, Jorhat was reported by Barooah *et al.* (2010). Moreover, it was observed from the present study that existence in type and the intensity of weeds varied with the seasonal variations.

In 2013, the relative density of grasses was higher in initial growth stages of the crops but at later growth stages, broad leaved weeds dominated over other types. However, in 2014, both grasses and broad leaved weeds dominated equally in all the growth stages of turmeric. This result was in conformity with the findings of Bhuvanewari (2009) and Sathiyavani (2014) who reported that higher population of grass and broad leaved weed flora occurred due to high rainfall. Higher weed continuum recorded during both the years might be due to sufficient rainfall received during cropping period which resulted in advantageous field environment for weed growth.

## **4.2 Studies on weed characters**

### **4.2.1 Weed flora**

Weed flora of the experimental field consisted of six species of grasses, seven species of sedges and twelve species of broad leaved weeds (Table 4.1). Among the grassy weeds, *Elusine indica* (L.) Gaertn., *Digitaria setigera* Roth. and *Panicum repens* L. were the dominant ones. *Cyperus iria* L. and *Fimbristylis aestivalis* (Retz.)

Vahl dominated amongst sedges. The predominant among broad leaved weeds were *Ageratum houstonianum* Mill., *Commelina diffusa* Burm.f., *Borreria articularis* (L.f.) Will, *Mimosa pudica* L. and *Mimosa diplotricha* C Wright. The composition and competition by weeds is dynamic and varies with soil, climate, cropping system and management practices.

#### **4.2.2 Composition of weeds**

Weed composition in present studies are presented in Table 4.2(a), 4.2(b) and 4.2(c). During both the years of experimentation, grasses dominated in the initial growth stages *i.e.* up to 90 DAP which produced higher population and it was followed by broad leaved weeds and sedges. However, in later part of growth stages *viz.*, 120, 150 and 180 DAP; broad leaved weeds dominated the field followed by grassy weeds and sedges.

Relative density of grasses, between 30 and 180 DAP, was higher that ranged from 30.6 to 65.3 per cent and 33.7 to 62.1 per cent in 2013 and 2014, respectively followed by that of broad leaved weeds and sedges. The relative density of broad leaved weeds ranged from 34.7 to 49.2 and 37.9 to 47.3 per cent in 2013 and 2014, respectively while that of sedges ranged from 0 to 20.2 and 0 to 18.9 per cent in 2013 and 2014, respectively.

With regard to individual weed species, the relative density varied with time. The relative density of *Panicum repens* was the highest at 30 and 60 DAP among all the weed species during both the years of experimentation. The value recorded at 30 and 60 DAP were 36.4 and 19.6 per cent in 2013; 32.4 and 21.6 per cent in 2014, respectively. But at 90 DAP; *Digitaria setigera* recorded the highest relative density value of 25 and 24.7 per cent in 2013 and 2014, respectively. However, at 120 DAP, *Borreria articularis* and *Elusine indica* showed the highest value of relative density of 20.6 percent in 2013 and 15.7 per cent in 2014, respectively. At 150 and 180 DAP, *Borreria articularis* dominated over all other weed species with relative density of 20.6, 22.1 and 21.9 per cent in 2013 and 13.8, 18.2 and 17.3 per cent in 2014, respectively.

The variation of relative density of weed species with time might be due to ecological adaptation of the weeds in the region. Similar findings were reported by Dhawan *et al.* (2008).

#### **4.2.3 Density of grass weeds (Number per metre square)**

The data on density of total grass weeds at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.3(a), 4.3(b) and 4.3(c). The results showed that there was a significant variation in weed density for the planting methods, intercropping and weed management practices.

During both the years of experimentation, paired row planting 70/30 cm recorded significantly lower weed density compared to that in paired row planting 80/20 cm at all the growth stages barring 180 DAP. At 30 DAP, density of grass weeds recorded under 70/30 cm paired row planting was 5.8 and 5.7 in 2013 and 2014, respectively which was significantly lower than in paired row 80/20 cm (6.29 and 5.8). Similarly, at 60 DAP (6.7 and 6.5), 90 DAP (7.0 and 6.8), 120 DAP (5.9 and 5.9) and 150 DAP (2.3 and 2.3) significantly lower weed density were observed under 70/30 cm paired row planting method than that in 80/20 cm paired row planting method. Such a trend might be due to space available in between paired rows in the early stage.

In 2013, intercropping baby corn recorded significantly lower weed density at 30, 60, 90, 120, 150 and 180 DAP than that in intercropping greengram. However, in 2014, weed density between the two methods of planting did not vary significantly in all the growth stages except at 90 DAP. Suppression ability of baby corn might have resulted less density of grass weeds.

In regards to weed management practices, non-chemical method i.e. mulching with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed density in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. Weedy check control recorded significantly highest weed density at all the stages studied. Non-chemical method with continuous mulching and hand weeding helped in better control of the weeds.

In both the years, the control treatments i.e. sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) recorded significantly lower weed density at all the growth stages studied as compared to treatment mean. Kaur and Singh (2006) reported similar results in pearl millet.

The interaction effect among the factors was not significant.

#### **4.2.4 Density of sedges (Number per metre square)**

The data on density of total sedges at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.4(a), 4.4(b) and 4.4(c). The results showed that there was a

significant variation in weed density due to planting methods, intercropping and weed management practices.

During 2013, paired row planting 70/30 cm recorded significantly lower sedge weed density at 120 and 150 DAP as compared to that in paired row planting 80/20 cm while at 30, 60, 90 and 180 DAP, both the methods did not differ significantly. In 2014, paired row planting 70/30 cm recorded significantly lower sedge weed density only at 120 DAP as compared to that in paired row planting 80/20 cm while at 30, 60, 90, 150 and 180 DAP, both the methods did not differ significantly in regards of total sedge weed density.

In 2013, intercropping baby corn recorded significantly lower weed density at 120 and 180 DAP than that in intercropping greengram. However, in 2014, weed density at 60 and 180 DAP recorded under baby corn was significantly lower than that in greengram.

In regards to weed management practices, non-chemical method i.e. mulching with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed density in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. Weedy check control recorded significantly highest value at all the stages studied.

In 2013, the sole turmeric with recommended practice i.e. control treatment ( $C_1$ ) recorded significantly lower weed density at 90, 120, 150 and 180 DAP as compared to that in treatment mean. But, in 2014, the  $C_1$  recorded significantly lower weed density at all the growth stages studied except at 30 DAP.

The interaction effect among the factors was not significant.

#### **4.2.5 Density of broad leaved weeds (Number per metre square)**

The data on density of total broad leaved weeds at 30, 60, 90, 120, 150 and 180 DAP are incorporated in Table 4.5(a), 4.5(b) and 4.5(c). The results showed that there was a significant variation in broad leaved weed density for the planting methods, intercropping and weed management practices.

During 2013, paired row planting 70/30 cm recorded significantly lower density at 90, 120 and 150 DAP as compared to that in paired row planting 80/20 cm while at 30, 60 and 180 DAP, both the methods did not differ significantly in regards to density of sedges. In 2014, paired row planting 70/30 cm recorded significantly lower

weed density at all the stages except at 60 DAP as compared to that in paired row planting 80/20 cm.

In 2013, intercropping baby corn ( $I_1$ ) recorded significantly lower weed density at 30, 90, 120 and 150 DAP than that in greengram ( $I_2$ ). However, in 2014, weed density at 90, 120 and 180 DAP recorded under  $I_1$  was significantly lower than that in  $I_2$ .

In regards to weed management practices, non-chemical method i.e. mulching along with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest density of sedge in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. Weedy check control recorded significantly highest value at all the stages studied.

In both years, the sole turmeric with recommended practice and modified weed control practice i.e. control treatments ( $C_1$  and  $C_4$ ) recorded significantly lower weed density at all the stages as compared to that in treatment mean.

The interaction effect among the factors was not significant.

#### **4.2.6 Density of total weeds (Number per metre square)**

The data on density of total weeds at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.6(a), 4.6(b) and 4.6(c). The results showed that there was a significant variation in weed density due to planting methods, intercropping and weed management practices.

During both the years, paired row planting 70/30 cm recorded significantly lower total weed density at all stages than that in paired row planting 80/20 cm, except at 90 DAP in 2014 in which both of these were at par.

In 2013, intercropping baby corn ( $I_1$ ) recorded significantly lower weed density at 30, 60, 90 and 120 than that in greengram ( $I_2$ ). However, in 2014, weed density at 60, 120 and 180 DAP recorded under  $I_1$  was significantly lower than that in  $I_2$ .

In regards to weed management practices, non-chemical method i.e. mulching along with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed density in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as

compared to that in rest of the treatments. Weedy check control recorded significantly highest weed density at all the stages studied.

In both years, the sole turmeric with recommended practice and modified weed control practice i.e. control treatments (C<sub>1</sub> and C<sub>4</sub>) recorded significantly lower weed density at all the stages as compared to that in treatment mean.

The interaction effect among the factors was not significant.

#### **4.2.7 Dry weight of grass weeds (gram per metre square)**

The data on dry weight of total grass weeds at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.7(a), 4.7(b) and 4.7(c). The results showed that there was a significant variation in weed dry weight due to planting methods, intercropping and weed management practices.

During both the years of experimentation, paired row planting 70/30 cm recorded significantly lower weed dry weight compared to that in paired row planting 80/20 cm at all the growth stages barring 60 DAP. At 30 DAP, dry weight of grass weeds recorded under 70/30 cm paired row planting were 2.9 and 2.3 in 2013 and 2014, respectively which were significantly lower than in paired row 80/20 cm (3.0 and 2.3). Similarly at 90 DAP (8.9 and 6.4), 120 DAP (10.3 and 6.1), and 150 DAP (5.9 and 3.1) and 180 DAP (10.2 and 5.3) significantly lower dry weight was observed under 70/30 cm paired row planting method than that in 80/20 cm paired row planting method.

In 2013, intercropping baby corn recorded significantly lower dry weight of grass at all the growth stages. However, in 2014, dry weight under intercropping system did not vary significantly in all the growth stages except at 90 DAP.

In regards to weed management practices, non-chemical method i.e. mulching along with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed dry weight in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. This could be due to efficient control of weeds by mulching and subsequent hand weeding at different growth stages which suppressed weed population under this treatment. The highest weed dry weight at all the stages was recorded in weedy check.

In both the years, the sole turmeric with recommended practice and modified weed control practice i.e. control treatments viz., sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>)

recorded significantly lower weed dry weight at all the growth stages studied as compared to that in treatment mean.

There was no interaction among the factors in respect of dry weight of grass at any of the growth stages.

#### 4.2.8 Dry weight of sedges (gram per metre square)

The data on dry weight of total sedges at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.8(a), 4.8(b) and 4.8(c). The results showed that there was a significant variation in this parameter due to planting methods, intercropping and weed management practices.

During 2013, paired row planting 70/30 cm recorded significantly lower dry weight at 120 and 180 DAP as compared to that in paired row planting 80/20 cm while at 30, 60, 90 and 150 DAP, both the methods did not differ significantly in regards to dry weight of sedges. In 2014, paired row planting 70/30 cm recorded significantly lower weed dry weight at 120, 150 and 180 DAP as compared to that in paired row planting 80/20 cm while at 30, 60 and 90 DAP, both the methods did not differ significantly in regards to dry weight of sedges.

In 2013, intercropping baby corn ( $I_1$ ) recorded significantly lower total sedge dry weight at 90, 120 and 180 DAP than that in greengram ( $I_2$ ). But, in 2014, total weed dry weight at 90, 120, 150 and 180 DAP recorded under  $I_1$  was significantly lower than that in  $I_2$ .

In regards to weed management practices, non-chemical method i.e. mulching with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest sedge dry weight in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. This could be due significant reduction in weed population caused by mulching and subsequent hand weeding reduced weed population which eventually resulted in significant reduction of total dry matter production of weed under this treatment. Weedy check control recorded significantly highest sedge dry weight at all the stages studied.

In 2013, the sole turmeric with recommended practice ( $C_1$ ) recorded significantly lower weed dry weight at 90, 120 and 180 DAP as compared to that in treatment mean. However, in 2014, the  $C_1$  recorded significantly lower weed dry weight at 60, 90, 120 and 180 DAP as compared to treatment mean.

Different factors under investigation failed to show any interaction in context of sedge dry weight.

#### **4.2.9 Dry weight of broad leave weeds (gram per metre square)**

The data pertaining to dry weight of broad leaved weeds at 30, 60, 90, 120, 150 and 180 DAP are laid out in Table 4.9(a), 4.9(b) and 4.9(c). The results showed that there was a significant variation in dry weight of broad leaved weed due to planting methods, intercropping and weed management practices.

During 2013, paired row planting 70/30 cm registered significantly lower dry weight at all the growth stages, except 30 DAP, as compared to that in paired row planting 80/20 cm but in 2014, paired row planting 70/30 cm recorded significantly lower board leaved dry weight at all the stages as compared to that in paired row planting 80/20 cm.

In 2013, intercropping baby corn ( $I_1$ ) recorded significantly lower dry weight at 90, 120, 150 and 180 DAP than that in intercropping greengram ( $I_2$ ). However, in 2014, weed dry weight at all the growth stages recorded under  $I_1$  was significantly lower than that in  $I_2$ .

Among the weed management practices, non-chemical method i.e. mulching along with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest dry weight in all the growth stages i.e. 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. Weedy check control recorded significantly highest dry weight at all the growth stages studied.

In both years, the control treatment i.e. sole turmeric with recommended practice ( $C_1$ ) recorded significantly lower dry weight at all the growth stages, other than 60 DAP in 2014, as compared to that in treatment mean.

There was no interaction effect among the factors.

#### **4.2.10 Total dry weight of weeds (gram per metre square)**

The data on dry weight of total weeds at 30, 60, 90, 120, 150 and 180 DAP are furnished in Table 4.10(a), 4.10(b) and 4.10(c). The data revealed a significant variation in weed dry weight due to planting methods, intercropping and weed management practices.

During both the years, paired row planting 70/30 cm recorded significantly lower value of total weed dry weight at all stages than that in paired row planting 80/20 cm.

Intercropping baby corn recorded significantly lower value of total weed dry weight at all the growth stages except at 30 DAP than in intercropping greengram in both the years.

Further, perusal of the data in respect of weed management practices showed that non-chemical method i.e. mulching along with hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed dry weight in all the growth stages as compared to that in rest of the treatments. Weedy check control recorded significantly highest weed dry weight at all the stages studied. It is in conformity with the experimental results of Gill *et al.* (2000).

In both years, the control treatment i.e. sole turmeric with recommended practice (C<sub>1</sub>) recorded significantly lower weed dry weight at all the stages excluding 60 DAP of 2014, as compared to that in treatment mean.

The interaction effect among the factors was found not significant.

#### **4.2.11 Weed control efficiency**

The efficiency of treatments on control of weeds in terms of dry weight in comparison to control plot was worked out and presented in Table 4.11(a) and Table 4.11(b).

During both the years of experiment, the highest weed control efficiency at 30 and 60 DAP was obtained under the treatment combination of planting method 70/30 cm; baby corn; mulching along with four hand weeding at 35, 65, 95, 140 DAP (M<sub>2</sub>I<sub>1</sub>W<sub>2</sub>) followed by combination of planting method 80/20 cm; baby corn; mulching along with four hand weeding at 35, 65, 95, 140 DAP (M<sub>1</sub>I<sub>1</sub>W<sub>2</sub>). This might be due to better smothering effect of intercrop baby corn in the early growth stage. However, in later part of growth stages of observation *viz.*, at 90, 120 and 180 DAP higher weed control efficiency was recorded in the treatment 70/30 cm; greengram; mulching along with four hand weeding at 35, 65, 95 and 140 DAP (M<sub>2</sub>I<sub>2</sub>W<sub>2</sub>) followed by the treatment 70/30 cm; baby corn; mulching along with four hand weeding at 35, 65, 95 and 140 DAP (M<sub>2</sub>I<sub>1</sub>W<sub>2</sub>) in both the years. This is due to lower weed population and reduced dry matter production of weeds during later stage owing to greater crop canopy development and effective control of later emerged weeds through mulching and hand weeding which ultimately provided weeds free environment to turmeric crop. This finding is in conformity with Arvadiya (2012) who reported similar findings in sweet

corn. At 150 DAP; highest weed control efficiency (97%) was obtained in all the treatments imposed as because of hand weeding at 140 DAP which efficiently removed weeds.

### **4.3 Studies on plant characters**

#### **4.3.1 Turmeric**

##### **4.3.1.1 Growth characters**

###### **4.3.1.1.1 Plant population**

Data on plant population per square meter are presented in Table 4.12. In both the years, plant population was not affected significantly by planting methods and intercropping. This was due to the fact that the intercropping was done in an additive pattern and the intercrop was accommodated between the paired rows without reducing the normal population of base crop of turmeric. Plant population and spatial arrangement have enormous effect on the yield of base as well as component crops and finally the total yield. Deka (1997) opined that there may be greater flexibility of spatial arrangement as pairing of rows may have little effect on the yield of paired crop. Choices of crops which have to be grown in an intercropping system play a vital role in this regard.

Plant population, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching along with four hand weeding ( $W_2$ ) followed by that in pre-emergence application of metribuzin @  $500 \text{ g ha}^{-1}$  along with hand weeding at 35, 65, 95, 140, 185 DAP ( $W_3$ ). Weedy check control resulted significantly lowest population of turmeric in both the years of experimentation.

As turmeric rhizome takes one to two months from date of planting to germination and emergence with very slow canopy development at early growth stages; hence, timely weed management practice play an important role in emergence and establishment of crop which determines total plant population. Kaur *et al.* (2008) opined that paddy straw-mulch was beneficial for proper sprouting and establishment of turmeric rhizomes.

However, both the control treatments i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly higher plant population over that in treatment mean during 2013 and 2014. The value of treatment mean in regards to population was reduced due to the

effect of uncontrolled weed growth in weedy check treatment that recorded significantly lower plant population of turmeric

The interaction effect among the factors was not significant.

#### **4.3.1.1.2 Plant height**

Data on plant height at different growth stages are presented in Table 4.13(a) and 4.13(b). In both the years, plant height at 95 and 140 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm.

During 2013, plant height at 185 and 256 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm. In 2014, plant height at 256 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm. The closer spacing of the paired rows i.e. 20 cm might have enhanced the vertical growth of the plant than that of paired row spacing of 30 cm.

The intercropping recorded significant effect on plant height at 95, 140, 185 and 256 DAP in both the years, except at 140 DAP in 2014. Intercropping with greengram had resulted significantly higher plant height of turmeric than that of intercropping with baby corn. Both the intercropping was at par in 2014 in regard to the plant height of turmeric at 140 DAP. This might be due to the synergistic effect of leguminous intercrop greengram on turmeric, while on the other hand, baby corn being a highly exhaustive crop, might have exploited more soil resources thereby affecting the base crop.

Various weed management practices had significant effect on plant height at all the four growth stages viz., 95, 140, 185 and 256 DAP in both the years. Plant height at all the growth stages was highest for non-chemical weed control treatment i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) which was significantly superior to rest of the weed control treatment. This might be due to the fact that proper weed control in  $W_2$  has reduced the crop weed competition thereby facilitating better growth and development of the turmeric crops. Hossain (2005) reported that mulching with straw or grasses at planting suppressed weed growth and improved turmeric growth and yield.

However, both the control treatments i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly higher plant height, at all four growth stages, over that in

treatment mean during 2013 and 2014. The value of treatment mean, in regards to plant height, was reduced due to the effect of weedy check control that recorded significantly lower plant height of turmeric at all four growth stages studied.

The interaction effect among the factors was not significant.

Plant height (of pseudo stem) in turmeric is a single important morphological character for which selection for yield could be made (Nambiar, 1979). Correlation analysis of morphological traits indicated that tall plants having longer and broader leaves with higher number of suckers and tillers/plant would be an ideal plant type for higher rhizome yield (Roy *et al.*, 2011). However, the present study indicated that besides genotype, the planting method, companion intercrop and agronomic (weed management) practices also influenced the plant height in turmeric. Higher plant height resulted due to closer spacing produced narrower leaves.

#### **4.3.1.1.3 Number of tillers per plant**

The data on number of tillers per plant are presented in Table 4.14(a) and 4.14(b). Paired row 70/30 cm ( $M_2$ ) produced higher tillers per plant in all the four growth stages which was significant over that in paired row 80/20 cm ( $M_1$ ) in 2013. During 2014,  $M_2$  also recorded higher number of tiller but were statistically at par with that in  $M_1$ . This might be due to the fact that wider inter-row spacing i.e. 30 cm in paired row  $M_2$  (70/30 cm) reduces intra-plant competition thereby enhancing higher tillering than that in  $M_1$ .

Similarly, intercropping turmeric with greengram ( $I_2$ ) recorded significantly higher tillers per plant over that in baby corn ( $I_1$ ) in all the four growth stages during 2013. However, both  $I_1$  and  $I_2$  were statistically at par during 2014 at all the four growth stages except 140 DAP. The tiller per plant at 140 DAP, in 2014, were statistically higher in intercropping greengram over intercropping baby corn. This might be due to the synergistic effect of leguminous intercrop greengram on turmeric that enhances higher tillering in turmeric, while on the contrary, baby corn being a highly exhaustive crop, and might have exploited more soil resources thereby affecting the tillering of base crop.

The weed management practices significantly influenced the number of tillers of turmeric plant in both the years of experiment. During both the years, non-chemical weed management practices i.e. mulching along with four hand weeding at 35,

65, 95 and 140 DAP ( $W_2$ ) recorded the highest number of tillers per plant at all the four<sup>106</sup> growth stages under record which were significantly superior to that in all other practices studied. Proper weed management in  $W_2$  might have reduced the crop weed competition for nutrients, water and light thereby facilitating better growth and development of the turmeric crops leading to more tillers per plant. This result is in accordance with the findings of Hossain *et al.* (2005).

The control treatments i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) had recorded significantly higher tillers per plant than that in treatment mean in both the years. The value of treatment mean, in regards to tiller number, was less due to the effect of weedy check control that recorded significantly lower tiller number of turmeric at all four growth stages studied.

The interaction effect among the factors was not significant.

#### **4.3.1.1.4 Number of leaves per plant**

The data on number of leaves per plant are presented in Table 4.15(a) and 4.15(b). Paired row 70/30 cm ( $M_2$ ) produced higher number of leaves per plant at 95 DAP in 2013 which was statistically significant over that in paired row 80/20 cm ( $M_1$ ); however, in 2014 both were statistically at par. At 140 DAP,  $M_2$  recorded statistically higher number of leaves per plant over  $M_1$  during 2013 and 2014. In 2013,  $M_2$  recorded higher number of leaves per plant at 185 DAP which was statistically superior over  $M_1$ ; however in 2014, both were statistically at par in regards to number of leaves. At 256 DAP, both the planting methods were statistically at par in regard to this attribute in both the years.

This might be due to the fact that wider inter-row spacing i.e. 30 cm in paired row  $M_2$  (70/30 cm) reduced intra-plant competition which resulted significantly higher number of tillers thus resulting in increased number of leaves than that in  $M_1$ .

Intercropping greengram ( $I_2$ ) recorded higher number of leaves per plant at 95, 140 and 185 DAP which was significantly superior to intercropping baby corn ( $I_1$ ) during 2013 and 2014. At 256 DAP,  $I_2$  produced statistically higher number of leaves per plant over that in  $I_1$  during 2014; however both the intercropping was at par in 2013 in regard to number of leaves per plant.

The synergism between leguminous intercrop greengram and turmeric might have enhanced higher tillering in turmeric thus higher number of leaves per plant, while on the contrary, baby corn being a highly exhaustive crop, might have exploited more growth resources resulting less tillers of base crop and thereby reduced number of leaves per plant in turmeric.

Weed management practices had significant effect on number of leaves per plant in both the years. The highest number of leaves was achieved in non-chemical weed control treatment ( $W_2$ ) which was statistically superior to all other practices during 2013 and 2014. This finding is with conformity of experimental result of Sathiyavani (2014). Better weed management in  $W_2$  might have reduced the crop weed competition which enhanced the number of tillers per plant that eventually leads to significantly higher number of leaves in turmeric plant.

In both the years of experimentation, the controls  $C_1$  (sole turmeric with recommended practice) and  $C_4$  (sole turmeric with modified weed management practice) had recorded significantly higher leaves per plant than in treatment mean. The value of treatment mean, in regards to number of leaves, was less due to the effect of weedy check control that recorded significantly lower number of leaves per plant of turmeric at all four growth stages studied.

There was no significant interaction among the factors.

#### **4.3.1.1.5 Leaf area index**

The data on Leaf area index are presented in Table 4.16(a) and 4.16(b). Paired row 70/30 cm ( $M_2$ ) produced higher leaf area index (LAI) at all the stages during both the years which was statistically significant over that in paired row 80/20 cm ( $M_1$ ). The LAI values for paired row 70/30 cm were 2.4, 15.4, 23.3 and 11.5 at 95, 140, 185 and 256 DAP, respectively during 2013, while in second year the values were 2.4, 15.4, 23.1 and 11.4 at 95, 140, 185 and 256 DAP, respectively. This might be due to the fact that  $M_2$  recorded significantly higher number of leaves per plant than that in  $M_1$  which eventually reflected in superior LAI.

Intercropping greengram ( $I_2$ ) recorded higher leaf area index (LAI) at all the stages during both the years of experimentation which was statistically significant over that in intercropping baby corn ( $I_1$ ). At  $I_2$ , the LAI were 2.5, 15.1, 22.9 and 11.4 at 95, 140, 185 and 256 DAP, respectively during 2013, while in second year the values

were 2.5, 15.8, 22.9 and 11.4 at 95, 140, 185 and 256 DAP, respectively. This might be due to the fact that I<sub>2</sub> recorded significantly higher number of leaves per plant than that in I<sub>1</sub> which eventually leads to superior LAI. The synergistic effect of leguminous intercrop greengram on turmeric might have increased the number of leaves per plant in turmeric thus higher LAI, while on the contrary, baby corn being a highly exhaustive crop, might have exploited more soil resources resulting less number of leaves per plant of base crop and thereby reduced LAI in turmeric.

Weed management practices had significant effect on LAI in both the years. The highest value of LAI was achieved in non-chemical weed control treatment (W<sub>2</sub>) which was statistically superior to all other practices during 2013 and 2014. Better weed control in W<sub>2</sub> might have reduced the crop-weed competition causing higher number of leaves per plant that eventually lead to significantly higher value of LAI. Lower weed population resulted in higher plant growth was supported by Hashim *et al.* (2003) and Jan *et al.* (2004).

In both the years of experimentation, the sole turmeric with recommended practice (C<sub>1</sub>) and modified weed control practice (C<sub>4</sub>) recorded significantly higher LAI than in treatment mean. The value of treatment mean, in regards to LAI, was less due to the effect of weedy check control that recorded significantly lower LAI of turmeric at all four growth stages. In conformity with this, Kaur *et al.* (2008) reported that LAI was closely correlated with dry matter production and they proved to be good indicator of the competition from weed. The decrease in leaf area index towards harvesting time (256 DAP) was due to senescence towards maturity of the crop.

The interaction effect among the factors was found to be not significant.

#### **4.3.1.2 Yield attributing characters**

##### **4.3.1.2.1 Number of mother rhizome per plant**

The data pertaining to number of mother rhizome are presented in Table 4.17(a). In both the years, number of mother rhizome under paired row 70/30 cm (2.28 and 2.26) was statistically higher than that in paired row 80/30 cm (2.01 and 2.10). This might be attributed to statistically superior growth characters observed in paired row 70/30 cm method of planting.

The intercropping with different crops had no significant effect on number of mother rhizome during both the years of experimentation.

Various weed management practices had significant effect on number of mother rhizome in 2013 and 2014. Among the weed management treatments, W<sub>2</sub> i.e. non-chemical weed management (Straw mulching along with hand weeding at 35, 65, 95 and 140 DAP) produced significantly higher number of mother rhizome (2.59 and 2.59) that was followed by pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> and hand weeding at 35, 65, 95, 140, 185 DAP (2.32 and 2.43) in both the years. This could be due to significantly higher plant height, number of tillers and leaves and LAI in W<sub>2</sub> as compared to that of remaining treatments.

The number of mother rhizomes, during 2013 and 2014, observed in sole turmeric (control treatments) i.e. sole turmeric with recommended practice (4.1 and 3.4) and sole turmeric with modified weed management practice (4.5 and 3.7) was significantly higher over that in treatment mean (2.15 and 2.18). The value of treatment mean in regards to number of mother rhizome was reduced due to the affect of weedy check treatment that recorded significantly lowest number (1.45 and 1.37) of mother rhizome of turmeric. Paired row planting methods and intercropping also might have affected this.

The interaction effect among the factors was found to be not significant.

#### **4.3.1.2.2 Number of primary rhizome per plant**

Data on number of primary rhizomes are presented in Table 4.17(a). Paired row 70/30 cm (M<sub>2</sub>) planting method recorded significantly higher number (6.68) of primary rhizome that that in M<sub>1</sub> i.e. paired row 80/20 cm (6.03) in 2013, however both the methods were at par in 2014. This might be due to the fact that in 2013, the M<sub>2</sub> recorded significantly higher number of tillers, number of leaves and leaf area index than that in M<sub>1</sub>; however in 2014, number of primary rhizome did not vary between two planting methods as because the growth attributes like, plant height (at 185 DAP), number of leaves (at 95, 185 and 256 DAP) and number of tillers at all the stages were statistically at par between the two method.

Intercropping of greengram (I<sub>2</sub>) resulted significantly higher number of primary rhizome (6.68 and 6.85) of turmeric over that in intercropping of baby corn (6.03 and 6.47) in both the years. This could be ascribed to the fact that in both the

years,  $I_2$  recorded superior growth characters like, plant height, number of tillers, number leaves and LAI over that in intercropping baby corn.

Various weed management practices had significant effect on number of primary rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher number of primary rhizome per plant i.e. 9.37 and 9.53 in 2013 and 2014, respectively followed by that (6.05 and 5.53) in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> with five hand weeding ( $W_3$ ). Significantly lowest primary rhizome (4.26 and 4.86) was observed in  $W_1$  i.e. weedy check control. This might be due to superior growth characters like, plant population, plant height, number of tillers, number of leaves and LAI observed in  $W_2$  during both the years as compared to that in the remaining weed management treatments.

The number of primary rhizomes, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (9.9 and 9.7) and sole turmeric with modified weed control treatment (10.3 and 9.8) was significantly higher over that in treatment mean (6.3 and 6.6). The value of treatment mean, in regards to number of primary rhizome, was reduced due to the effect of weedy check control that recorded significantly lowest number (6.3 and 6.6) of primary rhizome of turmeric. Paired row planting methods and intercropping also might have influenced this.

There was no significant interaction among different factors.

#### **4.3.1.2.3 Number of secondary rhizome per plant**

The data pertaining to number of secondary rhizome per plant presented in Table 4.17(b) revealed that in both the years, number of secondary rhizome under  $M_2$  i.e. paired row 70/30 cm (9.14 and 9.53) were statistically higher than that in paired row 80/30 cm (9.60 and 10.07). This might be due to the fact that in both the years,  $M_2$  recorded higher number of mother rhizome and primary rhizome than that in  $M_1$ .

Intercropping of greengram showed significantly higher number of secondary rhizome (9.80 and 10.21) of turmeric than intercropping of baby corn (8.95 and 9.39) in both the years. This might be due to the fact that in both the years,  $I_2$  recorded superior primary rhizome over that in  $I_1$ .

Various weed management practices in turmeric had significant effect on number of secondary rhizome in 2013 and 2014. Among the weed management

treatments, non-chemical weed control practice i.e. mulching along with four hand weeding ( $W_2$ ) produced significantly higher number of secondary rhizome i.e. 12.4 and 12.68 in 2013 and 2014, respectively followed by that (8.5 and 8.7) in  $W_4$  i.e. pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP. Weedy check control ( $W_1$ ) resulted significantly lowest secondary rhizome (9.4 and 9.9). Superior mother rhizome and primary rhizome observed in non-chemical weed control treatment during both the years as compared to that in rest of the treatments could have brought in this effect.

The number of secondary rhizomes, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (14.0 and 13.4) and sole turmeric with modified weed control treatment (14.8 and 14.4) was significantly higher over treatment mean (9.3 and 9.8). The value of treatment mean, in regards to number of secondary rhizome, was reduced due to the effect of weedy check control that recorded significantly lowest number (7.2 and 7.8) of secondary rhizome of turmeric. Paired row planting methods and intercropping also might have influenced this.

The interaction effect among the factors was not significant.

#### **4.3.1.2.4 Number of total number of rhizome per plant**

The data pertaining to number of total number of rhizomes are presented in Table 4.17(b). In both the years, number of total rhizome under  $M_2$  i.e. paired row 70/30 cm (18.56 and 19.19) were statistically higher than that in paired row 80/30 cm (17.88 and 18.11). This might be attributed to statistically superior growth characters and higher number of mother, primary and secondary rhizomes recorded in paired row 70/30 cm method of planting than that in paired row 80/30 cm.

In both the years, number of total rhizome under  $I_2$  i.e. intercropping of greengram (18.68 and 19.55) were statistically higher than that in  $I_1$  i.e. intercropping of baby corn (17.07 and 17.75). The superior value of primary and secondary rhizome under intercropping with greengram might have caused higher number of rhizome per plant than intercropping with baby corn.

Various weed management practices on turmeric crop had significant effect on number of total rhizome in 2013 and 2014. Among the weed management treatments,  $W_2$  i.e. non-chemical weed management (Straw mulching and hand weeding

at 35, 65, 95 and 140 DAP) produced significantly higher number of total rhizome (24.36 and 24.80) which was followed by in W<sub>4</sub> i.e. pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (17.33 and 19.06) in both the years. This might be due to the fact that in both the years, W<sub>2</sub> recorded significantly higher number of mother rhizome, primary and secondary rhizome as compared to that in the remaining treatments. Sathiyavani (2014) reported that efficient weed control practice enhanced production of higher number of mother, primary and secondary and thus produced higher number of total rhizome in turmeric.

The number of total rhizomes, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (28.06 and 26.60) and sole turmeric with modified weed control practice (29.70 and 28.00) was significantly higher over treatment mean (18.22 and 18.65). The value of treatment mean, in regards to number of total rhizome, was reduced due to the affect of weedy check control that recorded significantly lowest number (12.93 and 14.03) of total rhizome of turmeric. Paired row planting methods and intercropping also might have affected this.

Different factors did not interact significantly.

#### **4.3.1.2.5 Length of mother rhizome**

The data pertaining to length of mother rhizome are presented in Table 4.18. In 2013, length of mother rhizome under paired row 70/30 cm (9.81) was statistically higher than that in paired row 80/30 cm (9.49). However, in 2014, the values of length of mother rhizome observed in both the methods were statistically at par. This might be due to the fact, paired row 70/30 cm recorded significantly superior growth characters like, number of tillers, number of leaves and LAI as compared to than that in paired row 80/30 cm in 2013; however, in 2014, two methods recorded similar values in regard to number of tillers and number of leaves.

Intercropping of greengram recorded significantly longer mother rhizome (9.88 and 10.05) of turmeric over that in intercropping of baby corn (9.42 and 9.40) in respective years. This might be due to the fact, during both the years, intercropping greengram recorded significantly superior growth characters of turmeric like plant height and LAI as compared to intercropping baby corn.

Various weed management practices had significant effect on length of mother rhizome in 2013 and 2014. Among the weed management treatments, non-

chemical weed control treatment ( $W_2$ ) produced significantly higher length of mother rhizome i.e. 11.45 and 11.36 in 2013 and 2014, respectively which were statistically superior to that in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ). This might be due to the fact  $W_2$  recorded significantly superior growth characters like plant height, LAI, number of tillers and leaves as compared to that in rest of the treatments tested during the two years of investigation.

The length of mother rhizome observed in control treatments i.e. sole turmeric with recommended practice (11.9 and 11.47) and sole turmeric with modified weed control practice (12.47 and 12.2) was significantly higher over treatment mean (9.65 and 9.75) during 2013 and 2014. This could be due to reason that control treatments recorded significantly higher values of growth characters like plant height, number of tillers, number of leaves and LAI over that in treatment mean.

There was no significant variation in interaction effect of the factors.

#### **4.3.1.2.6 Length of primary rhizome**

The data on length of primary rhizomes are presented in Table 4.18. In both the years of experimentation, length of primary rhizome was at par under both the methods of paired row planting i.e. 70/30 cm and 80/20 cm.

Intercropping of either baby corn or greengram did not significantly affect the length of primary rhizome in both the years of investigation.

Weed management treatments had significant effect on length of primary rhizome in 2013 and 2014 (Table 4.18). Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced longer primary rhizome i.e. 9.38 and 8.93 in 2013 and 2014, respectively which were statistically superior to that in pre-emergence application of metribuzine @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ). This might be due to the fact that  $W_2$  recorded significantly superior growth characters like plant height, number of tillers, number of leaves and LAI as compared to that in rest of the treatments tested in 2013 and 2014.

However, both the control treatments i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly longer primary rhizomes over that in treatment mean during 2013 and 2014. The value of length of primary rhizome in  $C_1$  and  $C_2$  was statistically superior as because these control treatments recorded significantly higher values of growth

characters like plant height, number of tillers, number of leaves and LAI over that in treatment mean. During both the years of experimentation, there was no significant difference between the sole turmeric (controls) i.e. C<sub>1</sub> and C<sub>2</sub> in regards to length of primary rhizome.

The factors did not interact significantly in both the years.

#### **4.3.1.2.7 Length of secondary rhizome (cm)**

The data on length of secondary rhizomes are presented in Table 4.18. In both the years of experimentation, length of secondary rhizome was at par under the two methods of paired row planting i.e. 70/30 cm and 80/20 cm.

Intercropping greengram recorded significantly longer (4.80) secondary rhizome than intercropping of baby corn (4.49) in 2013. However, intercropping systems were at par during 2014.

Weed management treatments had significant effect on length of secondary rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly longer secondary rhizome i.e. 5.48 and 5.71 in 2013 and 2014, respectively as compared to other treatments. This might be due to the fact that  $W_2$  recorded significantly superior growth characters like, plant height, number of tillers, number of leaves and LAI as compared to that in rest of the treatments tested in both the years.

The length of mother rhizome, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (10.3 and 9.9) and sole turmeric with modified weed control treatment (11.5 and 11.3) was significantly higher over that in treatment mean (8.3 and 8.0). The value of length of mother rhizome in sole turmeric was statistically superior as because these control treatments recorded significantly higher values of growth characters *viz.*, plant height, number of tillers, number of leaves and LAI over that in treatment mean.

The interaction effect among the factors was not significant.

#### **4.3.1.2.8 Girth of mother rhizome (cm)**

The data pertaining to girth of mother rhizome are presented in Table 4.19. In both the year of experimentation, it was at par between the paired row planting at 70/30 cm and 80/20 cm.

Intercropping of greengram recorded significantly higher girth (6.9) of primary rhizome over that in intercropping of baby corn (6.7) in 2013. However, it did not vary significantly between intercropping systems in 2014. Intercropping of greengram recorded significantly superior growth characters like number of tillers, number of leaves and LAI in 2013 which might have enhanced the girth of the mother rhizome. However, in 2014, the number of tillers and leaves observed under both the

intercropping system were statistically at par for which the girth of mother rhizome might have remained at par between the two treatments.

Various weed management practices had significant effect on girth of mother rhizome in 2013 and 2014. Treatment of non-chemical weed control ( $W_2$ ) produced significantly higher girth of mother rhizome i.e. 7.9 and 7.8 in 2013 and 2014, respectively which were statistically superior to that in treatment under pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding (7.0 and 7.3). Superior growth characters like plant height, number of tillers, number of leaves and LAI recorded in  $W_2$  during 2013 and 2014 might have increased the girth of the mother rhizome significantly over other treatments.

The girth of mother rhizome observed in control treatments i.e. sole turmeric with recommended practice (8.7 and 8.1) and sole turmeric with modified weed control practice (8.9 and 8.7) was significantly higher over that in treatment mean (6.8 and 7.0) during 2013 and 2014.

The significant interaction effect among the factors was not observed.

#### **4.3.1.2.9 Girth of primary rhizome (cm)**

The data pertaining to girth of primary rhizome are presented in Table 4.19. In 2013, girth of primary rhizome (6.20) under 70/30 cm paired row planting system was significantly higher (5.86) than that in 80/20 cm paired row planting. However, in 2014, girths of primary rhizome in both the paired row treatments were not significantly different. This might be due to the fact, growth characters like number of tillers, number of leaves and LAI under paired row 70/30 cm were significantly superior as compared to than that in paired row 80/30 cm in 2013. But, in 2014, both the paired row methods recorded similar values in regard to number of tillers and leaves which might have also influenced the girth of primary rhizome.

Intercropping of greengram between the paired rows recorded significantly higher girth (6.3) of primary rhizome over that in intercropping of baby corn (5.8) in 2013. But, in 2014, girth of primary rhizome observed in both the intercropping system was non-significant. Between the intercropping systems, intercropping of greengram recorded significantly superior growth characters like number of tillers, number of leaves and LAI in 2013. But both the intercropping system recorded values at par in regard to number of tillers and number of leaves in 2014.

Girth of primary rhizomes was significantly affected by various weed management practices in both the years of experimentation. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher girth of primary rhizome i.e. 7.3 and 7.55 in 2013 and 2014, respectively than that in treatment under pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding (6.2 and 6.1). This might be due to the fact,  $W_2$  recorded significantly superior growth characters like, plant height, number of tillers, number of leaves and LAI as compared to that of remaining treatments in two years of experimentation.

Both the sole turmeric ( $C_1$ - recommended practice and  $C_4$ -with modified weed control practice) recorded significantly higher girth of primary rhizomes over treatment mean during 2013 and 2014. It could be mentioned that control treatments i.e.  $C_1$  and  $C_4$  recorded statistically superior values in regards to growth and yield attributes over that in treatment mean. Moreover, the value of treatment mean, in regards to girth of primary rhizome, was reduced due to the effect of weedy check that recorded significantly lowest girth of primary rhizome of turmeric.

There was no significant interaction among the factors.

#### **4.3.1.2.10 Girth of secondary rhizome (cm)**

The data pertaining to girth of secondary rhizome are presented in Table 4.19. In both the years of experimentation, the paired row planting methods i.e. 70/30 cm and 80/20 cm were at par in respect of girth of secondary rhizome.

In 2013, Girth of secondary rhizome (4.05) of turmeric under intercropping of greengram ( $I_2$ ) was significantly higher (3.86) than that in intercropping of baby corn in 2013; but it was at par between two intercropping during 2014. Superior growth characters like number of tillers, number of leaves and LAI under intercropping of greengram during 2013 might have caused better girth of secondary rhizome; however, in 2014, both the intercropping systems recorded statistically similar values of number of tillers and leaves.

In both the years of experimentation, girth of secondary rhizome was significantly affected by various weed management practices (Table 4.19). Among the treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher girth (5.16 and 5.14 in 2013 and 2014, respectively ) of secondary rhizome followed by

that in treatment under pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding (4.2 and 4.3).

The control treatments i.e. sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) resulted significantly higher girth of secondary rhizomes over that in treatment mean during both the years. Superior values of growth and yield attributes under control treatments might have caused significantly higher girth of secondary rhizome as compared to treatment mean. Moreover, the treatment mean of girth in secondary rhizome was reduced due to the effect of weedy check control that recorded significantly lowest girth of secondary rhizome of turmeric. Similar reduction of rhizome girth were recorded by Ratnam *et al.* (2012) due to the competition offered by profuse weeds in between crop plants in unweeded check of turmeric.

Different factors under investigation did not show any interaction.

#### **4.3.1.2.11 Weight of mother rhizome (gram per plant)**

The data pertaining to weight of mother rhizome are presented in Table 4.20(a). In both the years, weight of mother rhizome under paired row 70/30 cm (124.0 in 2013 and 124.1 in 2014) was statistically higher than that in paired row 80/30 cm (118.8 and 119.3). This might be attributed to statistically superior growth and yield characters *viz.*, LAI and number of mother rhizome recorded in paired row of 70/30 cm method of planting than that in paired row of 80/30 cm.

In both the years, weight of mother rhizome under I<sub>2</sub> i.e. intercropping of greengram (123.8 in 2013 and 124.4 in 2014) was statistically higher than that in I<sub>1</sub> i.e. intercropping of baby corn (118.9 in 2013 and 119.1 in 2014). This might be due to the fact that I<sub>2</sub> recorded superior value of growth and yield characters *viz.*, LAI and number of mother rhizome as compared to that in I<sub>1</sub>.

Various weed management practices in turmeric caused significant effect on weight of mother rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment (W<sub>2</sub>) produced significantly heavier mother rhizome i.e. 164.2 and 164.5 in 2013 and 2014, respectively followed by pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (138.4 and 138.9). Significantly lowest mother rhizome weight (52.8 and 53.6) was observed in weedy check control. This might be due to superior

growth and yield characters *viz.*, number of tillers, number of leaves, LAI and number of mother rhizome observed in W<sub>2</sub> during both the years as compared to that in rest of the treatments tested in this investigation. This is in concurrence with results reported by Sathiyavani and Prabhakaran (2014).

The weight of mother rhizomes, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (192.0 and 190.5) and sole turmeric with modified weed control practice (196.4 and 198.0) was significantly higher over treatment mean (121.4 and 121.7). It might be for the fact that the control treatments i.e. sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) recorded statistically superior values in regards to growth and yield attributes over treatment mean. Moreover, values of treatment mean were reduced due to the effect of weedy check control that recorded significantly lowest values of number and weight of mother rhizome.

The interaction effect among the factors was not significant.

#### **4.3.1.2.12 Weight of primary rhizome (gram per plant)**

The data pertaining to weight of primary rhizome are presented in Table 4.20(a). In both the years, weight of primary rhizome under M<sub>2</sub> i.e. paired row 70/30 cm (165.3 and 166.3) were statistically higher than that in paired row 80/30 cm (159.3 and 160.1). The cause for this might be attributed to statistically superior growth and yield characters *viz.*, LAI and number of primary rhizome recorded in paired row 70/30 cm method of planting than that in paired row 80/30 cm.

In both the years, weight of primary rhizome under I<sub>2</sub> i.e. intercropping of greengram (166.2 and 167.4) was statistically higher than that in I<sub>1</sub> i.e. intercropping of baby corn (158.4 and 159.0). It could be due to a superior value of growth and yield characters *viz.*, LAI and number of primary rhizome under intercropping of greengram as compared to that in intercropping of baby corn.

Among the weed management treatments, non-chemical weed control treatment (W<sub>2</sub>) produced significantly heavier primary rhizome i.e. 214.2 and 215.1 in 2013 and 2014, respectively followed by that (183.9 and 184.3) in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP. Significantly lowest primary rhizome weight (90.6 and 92.2) was observed in weedy check control. This might have been resulted due to a superior growth and yield

characters *viz.*, number of tillers, number of leaves, LAI and number of primary rhizome observed in non-chemical weed control treatment during both the years as compared to that in rest of the treatments tested in this investigation. The current findings are in agreement with the earlier record of Lalmartha *et al.* (2001).

The weight of primary rhizomes observed in control treatments i.e. sole turmeric with recommended practice (253.3 and 251.1) and sole turmeric with modified weed control practice (273.20 and 270.3) was significantly higher over that in treatment mean (162.3 and 163.2) during 2013 and 2014. It might be for the fact that the sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) recorded statistically superior values in regards to growth and yield characters over that in treatment mean. Moreover, values of treatment mean were reduced due to the effect of weedy check control that recorded significantly lowest weight of primary rhizome.

There was no significant interaction of the factors.

#### **4.3.1.2.13 Weight of secondary rhizome (gram per plant)**

The data pertaining to weight of secondary rhizome are presented in Table 4.20(b). In both the years, weight of secondary rhizome under paired row 70/30 cm (66.2 and 67.0) were statistically higher than that in paired row 80/30 cm (62.3 and 63.0). Better growth and yield characters *viz.*, LAI and number of secondary rhizome in paired row 70/30 cm could cause a significantly higher weight of rhizome than paired row 80/30 cm.

In both the years, weight of secondary rhizome under I<sub>2</sub> i.e. intercropping of greengram (66.6 and 67.8) were statistically higher than that in I<sub>1</sub> i.e. intercropping of baby corn (61.9 and 62.3). Growth and yield characters like LAI and number of secondary rhizome were significantly increased by intercropping greengram and this might have significantly increased weight of secondary rhizome over intercropping baby corn.

Among the weed management treatments, non-chemical weed control treatment produced significantly heavier secondary rhizome (81.8 and 82.6 in 2013 and 2014) followed by in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (66.3 and 67.2). Weedy check control resulted significantly lowest secondary rhizome (48.7 and 49.7). The superior growth

and yield characters *viz.*, number of tillers, number of leaves, LAI and number of secondary rhizome observed in non-chemical weed control treatment during both the years as compared to that in rest of the treatments tested could have increased the weight of secondary rhizome.

Both the control treatments *viz.* sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) were significantly superior to treatment mean in both the years in respect of weight of secondary rhizomes. It might be for the fact that the control treatments i.e. C<sub>1</sub> and C<sub>4</sub> recorded statistically superior values in regards to growth attributes over that in treatment mean. Moreover, treatment mean were reduced due to the effect of weedy check control that recorded significantly lowest weight of secondary rhizome.

The interaction effect among the factors was not significant.

#### **4.3.1.2.14 Weight of total rhizome (gram per plant)**

The data pertaining to weight of total rhizome are presented in Table 4.20(b). In both the years, weight of total rhizome under M<sub>2</sub> i.e. paired row 70/30 cm (355.6 and 357.5) were statistically higher than that in paired row 80/30 cm (340.5 and 342.5). Statistically superior growth and yield characters in paired row 70/30 cm method of planting might have caused significantly higher weight of mother, primary and secondary rhizome which eventually reflected in higher total rhizome yield.

In both the years, weight of total rhizome under I<sub>2</sub> i.e. intercropping of greengram (356.8 and 359.6) were statistically higher than that in I<sub>1</sub> i.e. intercropping of baby corn (339.3 and 340.5). Statistically superior growth and yield characters recorded in I<sub>2</sub> might have resulted significantly higher weight of mother, primary and secondary rhizome which eventually reflected in total rhizome yield.

Various weed management practices in turmeric had significant effect on weight of total rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment (W<sub>2</sub>) produced significantly heavier total rhizome i.e. 460.3 and 462.3 in 2013 and 2014, respectively followed by pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (388.7 and 390.5). Significantly lowest total rhizome weight (192.3 and 195.5) was observed in weedy check control. Superior growth and yield characters recorded in W<sub>2</sub> might have resulted significantly higher weight of mother, primary and

secondary rhizome which eventually reflected in total rhizome yield. Nwokocha *et al.* (2009) revealed that straw mulch contained higher percentage of organic matter and improved the soil structure when compared with non mulch treatment, and the decomposition of mulch materials provided soil organic matter, which helped to stabilize the soil aggregates, thus making the soil conducive for rhizome development.

The weight of total rhizomes, during 2013 and 2014, observed in control treatments of sole turmeric with recommended practice (551.8 and 546.7) and sole turmeric with modified weed control practice (580.8 and 579.9) was significantly higher than treatment mean (348.0 and 350.0). The higher rhizome yield under the control treatments might have been produced due to statistically superior values of weight of mother, primary and secondary rhizome.

The interaction effect between the factors in regards to total weight of rhizome was not significant.

### **4.3.1.3 Yield**

#### **4.3.1.3.1 Fresh rhizome yield (tonne per hectare)**

The data presented in Table 4.21 revealed that fresh rhizome yield (24.2 and 24.6) obtained under paired row planting 70/30 cm (M<sub>2</sub>) were significantly higher than that in 80/20 cm (23.7 and 24.0) in both of 2013 and 2014. The total rhizome yield comprised of weight of mother, primary and secondary rhizome and higher values of the components under paired row 70/30 cm resulted significantly higher fresh rhizome yield.

Intercropping of greengram in between paired rows resulted significantly higher fresh rhizome yield (24.3 and 24.7) as compared to intercropping baby corn (23.6 and 23.9). This could be attributed superior growth and yield attributes recorded in intercropping greengram.

In both the years of experimentation, fresh rhizome yield was significantly influenced by various weed management practices. Among the weed management treatments, non-chemical (mulching along with hand weeding at 35, 65, 95 and 140 DAP produced significantly higher fresh rhizome yield i.e. 32.0 and 32.4 in 2013 and 2014, respectively followed by that in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> followed by hand weeding at 35, 65, 95, 140, 185 DAP (26.5 and 26.7). The fresh rhizome yield (12.1 and 12.5) was observed statistically lowest in

weedy check treatment and it was only 32.6 and 34.0 per cent of the recommended practice as followed in 2013 and 2014. Superior growth and yield attributes recorded in non-chemical weed control treatment might have resulted significantly higher weight of mother, primary and secondary rhizome which eventually reflected in total rhizome yield. Manhas *et al.* (2011) reported that weed free environment diverted all the available resources towards crop utilization and resulted in higher fresh rhizome yield.

The interaction of effect of planting methods, intercropping and weed management practices on fresh yield of rhizome was significant in both the years of experimentation (Table 4.22 a, b, c and d). In regards to interaction, in 2013 and 2014, planting of turmeric in paired row method of 70/30 cm along with non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) resulted significantly highest fresh rhizome yield ( $32.5 \text{ t ha}^{-1}$  and  $32.8 \text{ t ha}^{-1}$ ) which was followed by the treatment combination of paired row 80/20 cm and weed management practice  $W_2$  (31.5 and 31.9).

This might be attributed to the overall effect of the two the main factors i.e.  $M_2$  and  $W_2$ , both of which recorded significantly higher values of weight of mother rhizome, number and weight of primary rhizome as well as total number and weight of total fresh rhizome, even though their interaction effect on these yield attributes were non-significant.

In regards to interaction, in 2013 and 2014, growing of intercrop greengram in the intervening space between two paired rows of turmeric along with non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) resulted significantly highest fresh rhizome yield ( $32.5 \text{ t ha}^{-1}$  and  $32.9 \text{ t ha}^{-1}$ ) which was followed by the treatment combination of intercropping baby corn and weed management practice  $W_2$  (31.5 and 31.8).

This might be due to the overall effect of the two the main factors i.e.  $I_2$  and  $W_2$ , both of which recorded significantly higher values of weight of mother rhizome, number and weight of primary rhizome as well as total number and weight of total fresh rhizome, even though their interaction effect on these yield attributes were non-significant. Similar findings were reported by Deka (1997) in potato.

However, interaction effect of three factors i.e. paired row methods, intercropping and weed management practices could not bring about any significant

variation in regards to total fresh yield of turmeric during both the years of experimentation.

#### **4.3.1.3.2 Dry recovery (percentage)**

The data pertaining to dry recovery are presented in Table 4.23. In both the years of experimentation, methods of paired row planting and intercropping could not bring about any significant effect on this attribute.

During both the years of experimentation, dry recovery was significantly influenced by weed management practices. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher dry rhizome yield i.e. 23.7 and 23.6 in 2013 and 2014, respectively which was at par with that in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ) and pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding ( $W_4$ ) but significantly superior to that in weedy check control. In weedy check control, due to severe crop weed competition, the turmeric crop suffered from rigorous limitation of essential and necessary resources that might have led to the improper growth and development of rhizome including dry matter accumulation.

This finding is in concurrence with the findings of Rao and Rao (1998) who reported that lesser weed growth resulted in increase nutrient availability to the plants, which would results in greater increase in dry recovery percentage and dry rhizome yield of turmeric.

In 2013 and 2014, both the sole turmeric with recommended practice and modified weed management practice (controls i.e.  $C_1$  and  $C_4$ ) recorded significantly higher dry recovery as compared to that in treatment mean.

#### **4.3.1.3.3 Dry rhizome yield (tonne per hectare)**

The data pertaining to dry rhizome yield are presented in Table 4.21. In both the years of experimentation, dry rhizome yield (5.5 and 5.6) obtained under paired row planting 70/30 cm ( $M_2$ ) was significantly higher than that in 80/20 cm (5.4 and 5.4). The trend of this character followed the trend of result under fresh rhizome yield and dry recovery.

Intercropping of greengram in between paired rows resulted in significantly higher dry rhizome yield (5.5 and 5.6) as compared to that in intercropping of baby corn (5.4 and 5.4). This might be attributed to significantly higher total fresh yield obtained in intercropping greengram than intercropping baby corn during both the years of experimentation. 139

During the cropping period of 2013 and 2014, dry rhizome yield was significantly influenced by various weed management practices. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching along with hand weeding at 35, 65, 95 and 140 DAP (W<sub>2</sub>) produced significantly higher dry rhizome yield i.e. 7.6 and 7.1 in 2013 and 2014, respectively followed by that in W<sub>3</sub> i.e. pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (6.0 and 6.1). Production of statistically superior dry rhizome yield in W<sub>2</sub> might be attributed to significantly higher total fresh yield and dry recovery obtained under the treatment during both the years of experimentation.

Controls i.e. sole turmeric with recommended practice (C<sub>1</sub>) and sole turmeric with modified weed control practice (C<sub>4</sub>) recorded significantly higher dry yield as compared to that in treatment mean in both the years of experimentation. Mohanty (1991), Mannikeri (2006) and Behera *et al.* (2008) reported similar decrease in rhizome yield of turmeric due to intercropping.

#### **4.3.1.3.4 Curcumin content (Percentage)**

The data pertaining to curcumin content are presented in Table 4.23. In both the years of experimentation, methods of paired row planting and intercropping could not bring about any effect on this attribute during both the years. Similar findings in regards to intercropping and curcumin content were reported by Mannikeri (2006). Singh and Randhwa (1988) reported that the oil and *curcumin* contents were not affected when turmeric was intercropped with pigeonpea (*Cajanus cajan*), maize (*Zea mays*) or greengram (*Vigna radiata*).

In 2013, curcumin content was significantly influenced by weed management practices but during 2014, there was no significant variation. The weedy check control resulted in significantly lowest curcumin content as compared to that in all the remaining weed management practices in both the years. In weedy check control, due to severe crop weed competition, the turmeric crop suffered from rigorous limitation of essential and necessary resources that might have led to the improper

growth and development of rhizome including curcumin content. This result is in conformity of the result reported by Hossain (2005).

## **4.3.2 Baby corn**

### **4.3.2.1 Growth characters**

#### **4.3.2.1.1 Plant population (Number per metre square)**

Data pertaining to the population of baby corn are presented in Table 4.24. Planting methods of turmeric did not affect the plant population of baby corn during either of the two years of experimentation. This was due to the fact that the intercropping was done in the intervening space between the paired rows where in allotment of total number of rows of intercrop per unit area was equal in both the paired row system of planting. Moreover, baby corn completed life cycle just before emergence of the base crop and hence there might be least influence on population of intercrop.

Plant population, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching along with four hand weeding ( $W_2$ ) followed by that in pre-emergence application of oxadiargyl @  $90 \text{ g ha}^{-1}$  along with hand weeding at 35, 65, 95, 140 and 185 DAP ( $W_4$ ). The least population of baby corn was recorded due to weedy check in both the years of experimentation. This might be due to the fact that mulching has significantly improved the moisture content in soil (Appendix III, IV and V) as well soil physical environment like temperature etc. due to mulching under non-chemical method might have resulted establishment of higher plant population. Moreover, the same treatment also caused significantly lower weed density as well as superior WCE that might have facilitated better crop establishment.

The control treatment of sole baby corn recorded significantly higher plant population which was superior to treatment mean during 2013 and 2014. This was obvious from the fact that in sole crop 100 per cent plant population was accommodated.

The interaction effect among the factors was not found to be significant.

#### **4.3.2.1.2 Plant height (cm)**

Data pertaining to the height of baby corn as presented in Table 4.25 revealed that it did not vary significantly between planting methods in 2013 and 2014. This might be resulted due to maturity of inter crop just before emergence of base crop as well as avoidance of intra-crop competition in the widely spaced base crop (70 and 80 cm spacing between two rows).

Non-chemical treatment ( $W_2$ ) i.e. mulching along with four hand weeding resulted significantly taller plants as compared to other treatments and it was followed by that in pre-emergence application of oxadiargyl  $90 \text{ g ha}^{-1}$  along with hand weeding at 35, 65, 95, 140 and 185 DAP ( $W_4$ ). The unchecked weed growth in weedy check control resulted significantly lowest height of baby corn in both the years of experimentation. Efficient weed management in  $W_2$ , as evident from the significantly lower weed density was as well as superior WCE might have facilitated better growth and development of the intercrop. Moreover, mulching significantly improved the soil moisture content and soil physical environment by way of favourable temperature etc. due to mulching might have facilitated better growth and development of the intercrop.

The control treatment of sole baby corn recorded plant height value significantly higher than that in treatment mean during 2013 and 2014. In sole baby corn, there might have intra-crop competition which might have triggered taller plant.

The interaction effect among the factors was not significant.

#### **4.3.2.1.3 Number of leaves per plant**

Data pertaining to the number of leaves are presented in Table 4.25. In 2013 and 2014, the value of number of leaves recorded in different planting methods was found at par. In absence of intra-crop competition under these treatments, the intercrop grew normally and produced similar number of leaves.

Number of leaves, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching and four hand weeding ( $W_2$ ) followed by that in pre-emergence application of oxadiargyl @  $90 \text{ g ha}^{-1}$  along with hand weeding at 35, 65, 95, 140 and 185 DAP ( $W_4$ ). Weedy check control had resulted significantly lowest number of leaves in both the years of experimentation. A low weed density coupled with superior WCE could have resulted better crop growth and higher number of leaves under these treatments. The crop growth was also supported by better soil moisture availability under mulching in non-chemical method.

The control treatment (C<sub>2</sub>) i.e. sole baby corn recorded significantly higher number of leaves over that in treatment mean during 2013 and 2014. The values of treatment mean were relatively reduced as because of significantly lowest values observed in weedy check control during both the years.

The interaction effect among the factors was not significant.

#### **4.3.2.1.4 Leaf area index (LAI)**

The values of LAI as affected by the treatments are incorporated in Table 4.26. Planting system could not show any significant variation in regards to LAI in 2013 and 2014, which might be due to the fact that the number of leaves were at par between the methods.

Various weed management practices had significant effect on LAI in both the years. The highest LAI was observed in non-chemical weed control treatment (W<sub>2</sub>) which was significantly superior to that of rest of the treatments *viz.*, pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding (W<sub>3</sub>), pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding (W<sub>4</sub>) and weedy check control (W<sub>1</sub>). This might be due to the higher number of leaves recorded in W<sub>2</sub> that eventually lead to higher value of LAI.

Control treatment (sole baby corn) recorded significantly higher LAI value (13.6 and 13.2) over that in treatment mean (10.7 and 10.0) during 2013 and 2014. This might be due to the fact that sole baby corn recorded higher number of leaves than that of treatment mean and thus produced larger LAI.

The interaction among the factors did not show any significant variation.

#### **4.3.2.1.5 Days to 50 per cent tasseling and silking**

Data pertaining to days to 50 per cent tasseling and silking in baby corn are presented in Table 4.27. Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not influence significantly on days to 50 per cent tasseling and silking in 2013 and 2014. This was due to the fact that virtually there was not any effect of methods of planting on growth characters of corn thus the reproductive stage was set in uniformly.

Various weed management practices had significant effect on days to 50 per cent tasseling in both the years. Days (50.0 and 51.1) required to 50 per cent

tasseling were highest for non-chemical weed control treatment ( $W_2$ ) which was significantly higher than that in weedy check control ( $W_1$ ), pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ) and pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding ( $W_4$ ). Efficient control of weeds in  $W_2$  provided favourable condition for normal vegetative growth period leading to optimal period for tasseling without any reduction in days required for in contrast to the result observed in weedy check wherein the corn was subjected to stress. In 2013, days to 50 per cent silking was recorded significantly higher in  $W_2$  than that in other treatments tested. However, in 2014, days to 50 per cent silking was found at par amongst the weed management practices.

Sole baby corn ( $C_2$ ) took significantly higher number of days to 50 percent tasseling and silking as compared to treatment mean during 2013 and 2014. The values of treatment mean were reduced due to of significantly lowest values observed in weedy check control during both the years.

The factors did not show significant interaction effect.

#### **4.3.2.2 Yield character**

##### **4.3.2.2.1 Number of cob per plant and weight per cob (g)**

Data recorded for number and weight of cob in baby corn are presented in Table 4.28. Planting system did not affect number and weight of cob significantly in either 2013 or 2014. This was due to the fact that methods of planting did not have any significant effect on growth characters of baby corn thus resulting in similar values of number and weight of cob.

Various weed management practices had significant effect on number and weight of cob in both the years. During both years, the non-chemical weed control treatment ( $W_2$ ) resulted in significantly higher values of number (2.2 and 2.0) and weight (75.5 and 75.0) of cob than other treatments *viz.*, pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ), pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding ( $W_4$ ) and weedy check control ( $W_1$ ). Efficient control of weeds in  $W_2$  recorded statistically superior growth characters like, plant height, number of leaves and LAI which could have significantly enhanced the number and weight of cob.

Sole baby corn (C<sub>2</sub>) recorded significantly higher number and weight of cob as compared to treatment mean during 2013 and 2014. The values of overall treatment mean were relatively reduced as because of significantly lowest values observed in weedy check control during both the years.

The interaction effect among the factors was not significant.

#### **4.3.2.2.2 Cob and stover yield (tonne per hectare)**

Data pertaining to cob and stover yield in baby corn are presented in Table 4.29. Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not bring about any significant effect on yield of cob and stover in either of 2013 or 2014. This was might be to the reason that methods of planting did not have any significant effect on growth and yield characters of baby corn thus resulting in similar yield of cob and stover.

A significant effect of different weed management practices on yield of cob and stover was recorded in both the years. During both years, W<sub>2</sub> i.e. non-chemical weed control treatment resulted in significantly higher values of yield of cob (8.2 and 8.1) and stover 16.6 and 16.6 than that in other treatments *viz.*, pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding (W<sub>3</sub>), pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding (W<sub>4</sub>) and weedy check control (W<sub>1</sub>). Efficient control of weeds in W<sub>2</sub> recorded statistically superior growth and yield characters like, plant height, number of leaves, LAI, number and weight of cob etc, which could have significantly enhanced the yield of cob and stover in this treatment.

A significantly higher yield of cob and stover as compared to treatment mean during 2013 and 2014 was resulted in sole baby corn. The values of treatment mean were reduced as because of significantly lowest values observed in weedy check control during both the years.

The interaction effect among the factors did not vary significantly.

### **4.3.3 Greengram**

#### **4.3.3.1 Growth characters**

##### **4.3.3.1.1 Plant population (Number per metre square)**

Data presented in Table 4.30 showed that treatments on planting methods could not bring about any significant effect on plant population of greengram. This was due to the fact that the intercropping was done in the intervening space between the paired rows wherein allotment of total number of rows of intercrop per unit area was equal in both the paired row system of planting. Moreover, base crop turmeric emerged after completion of life cycle of intercrop and hence there might be no influence on population of greengram.

Plant population, was significantly higher in non-chemical treatment (mulching along with four hand weeding) followed by that in pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140, 185 DAP (W<sub>4</sub>) during 2013 and 2014. Weedy check had resulted significantly lowest population of greengram in both the years of experimentation. Mulching had significantly improved the moisture content in soil (Appendix III, IV and V) as it influenced in improvement of the soil physical environment. Moreover, under non-chemical treatment, weed density was significantly lower besides resulting superior WCE that might have facilitated better crop growth.

The plant population recorded in control treatment (C<sub>3</sub>) i.e. sole greengram was significantly higher over treatment mean during 2013 and 2014. This was obvious from the fact that in sole crop, 100 per cent plant population was accommodated.

The interaction effect among the factors was not significant.

#### **4.3.3.1.2 Plant height (cm)**

Data pertaining to the height of greengram are presented in Table 4.31. The planting methods did not affect the plant height of greengram significantly. This was due to the fact that as the intercrop matured before emergence of base crop and space between the rows of greengram was wide enough i.e. 70 cm in 70/30 and 80 cm in 80/20 cm paired row method to avoid intra-crop competition. Thus the base crop could not bring about any effect on greengram height.

Plant height, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching along with four hand weeding (W<sub>2</sub>) followed by that in pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140 and 185 DAP (W<sub>4</sub>). Weedy check control had resulted significantly lowest height of greengram in both the years of experimentation. Efficient weed management in W<sub>2</sub>, as evident from the significantly lower weed density was as well as superior weed control efficiency might have facilitated better growth and development of the intercrop. Moreover, mulching has significantly improved the moisture content in soil along with favourable soil physical environment particularly soil temperature which might have facilitated better growth and development of the intercrop.

The control treatment 'sole greengram' recorded significantly higher plant height as compared to treatment mean during 2013 and 2014. In sole greengram, an intra-crop competition might have triggered taller plant.

Different factors did not interact significantly.

#### **4.3.3.1.3 Number of primary branch**

Data on number of primary branch of greengram are presented in Table 4.31. In 2013 and 2014, both the planting methods were statistically at par in respect of number of primary. The intercrop matured before emergence of base crop as well as the intervening space between the rows of greengram was wide enough for development of branches of greengram. Hence, there might be least influence of base crop on the number of primary branch of intercrop. Thus the intercrop did not encounter any inter or intra-species competition and the crop might have achieved optimum growth.

The data also revealed a significantly higher number of primary branch in non-chemical treatment i.e. mulching along with four hand weeding ( $W_2$ ) followed by that in pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with hand weeding at 35, 65, 95, 140, 185 DAP ( $W_4$ ) during the two years. Weedy check had resulted significantly lowest number of primary branch of greengram in both the years of experimentation. Efficient weed management in  $W_2$ , as evident from the significantly lower weed density as well as superior WCE might have facilitated better growth and development of the intercrop. Moreover, improved moisture content (Appendix III, IV and V) and soil physical environment like temperature etc. due to mulching also might have facilitated better growth and development of the intercrop including number of primary branch.

The control treatment ( $C_3$ ) i.e. sole greengram recorded significantly higher number of primary branches over that in treatment mean during 2013 and 2014.

The interaction effect among the factors was not significant.

#### **4.3.3.1.4 Leaf area index (LAI)**

Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not induce any significant on LAI in 2013 and 2014 (Table 4.32) which might be due to the fact that the number of leaves was at par between the methods.

Various weed management practices had significant effect on LAI in both the years. LAI was observed (Table 4.32) highest for non-chemical treatment (W<sub>2</sub>) which was significantly superior to rest of the treatments. Efficient weed management as well as superior growth characters eventually caused higher values of LAI in non-chemical method.

Sole greengram recorded LAI (13.6 and 13.2) which was significantly higher than treatment mean (10.7 and 10.0) during 2013 and 2014.

The interaction effect among the factors was not significant.

#### **4.3.3.2 Yield characters**

##### **4.3.3.2.1 Number and length (cm) of pod**

Data pertaining to number of pod and length of pod in greengram are presented in Table 4.33. Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not influence significantly on yield of number and length of pod in 2013 and 2014. This was due to the fact that methods of planting did not have any significant effect on growth characters of greengram thus resulting in non-significant values in number and length of pod.

Various weed management practices had significant effect on number and length of pod in both the years. During both years, the non-chemical weed control treatment (W<sub>2</sub>) resulted in significantly higher values of number of pod (33.1 and 34.8) and length of pod (7.1 and 7.2) than other treatments and weedy check control. Efficient control of weeds in W<sub>2</sub> recorded statistically superior growth characters like plant height, number of primary branches, LAI and number of pod etc. which could have significantly enhanced the number and length of pod.

Control treatment (sole greengram) recorded significantly higher yield of number and length of pod over that in treatment mean during 2013 and 2014. The values of treatment mean were relatively reduced as because of significantly lowest values observed in weedy check during both the years.

The interaction effect among the factors was not significant.

##### **4.3.3.2.2 Test seed weight (g)**

The table 4.34 presenting the data on 1000 seed weight (test weight) showed that planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not

influence significantly on 1000 seed weight in 2013 and 2014. This was due to the fact that methods of planting did not have any significant effect on growth and yield characters of greengram thus resulting in non-significant values in individual seed weight.

Various weed management practices had significant effect on yield of grain and stover in both the years. During both years, the non-chemical weed control treatment ( $W_2$ ) resulted in significantly higher values in 1000 seed weight (40.48 and 40.67) than that in other treatment and weedy check control (Table 4.34). Efficient control of weeds in non-chemical weed control treatment recorded statistically superior growth and yield characters like plant height, number of primary branches, LAI and number of pod etc. which could have significantly enhanced the weight of seeds.

Control treatment i.e. sole greengram ( $C_3$ ) recorded similar values of 1000 seed weight with treatment mean during 2013 and 2014. This is due to the intra crop competition in sole greengram limited the individual seed weight.

There was no significant effect among the different factors in regard to 1000 seed weight during both the years of experimentation.

#### **4.3.3.2.3 Grain and stover yield (quintal per hectare)**

Data pertaining to grain and stover yield in greengram are presented in Table 4.35. Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not influence significantly on yield of grain and stover in 2013 and 2014. This was due to the fact that methods of planting did not have any significant effect on growth and yield characters of greengram thus resulting in non-significant values in yield of grain and stover.

Various weed management practices had significant effect on yield of grain and stover in both the years. During both years, the non-chemical weed control treatment ( $W_2$ ) resulted in significantly higher values in yield of grain (3.1 and 3.2) and stover (8.0 and 8.1) than that in other treatment and weedy check control (Table 4.35). Efficient control of weeds in non-chemical weed control treatment recorded statistically superior growth and yield characters like plant height, number of primary branches, LAI and number of pod etc. which could have significantly enhanced the yield of grain and stover.

Control treatment i.e. sole greengram (C<sub>3</sub>) recorded significantly higher yield of grain and stover over that in treatment mean during 2013 and 2014. The values<sup>162</sup> of treatment mean were relatively reduced as because of significantly lowest values observed in weedy check control during both the years.

Different factors could not bring any significant effect.

#### **4.4 Plant nutrients analysis**

##### **4.4.1 Nutrient removal by weeds**

The data pertaining to nitrogen, phosphorus and potassium removal by weeds are presented in Table 4.36(a), 4.36(b) and 4.36(c). In both the years, nitrogen, phosphorus and potassium removal by weeds was found to be non-significant due to planting methods and intercropping.

Various weed management practices in turmeric had significant effect on nitrogen, phosphorus and potassium removal by weeds in 2013 and 2014. Among the weed management treatments, non-chemical weed management treatment (W<sub>2</sub>) recorded significantly lowest nitrogen (2.33 and 2.15) phosphorus (0.21 and 0.17) and potassium (2.40 and 2.00) removal by weeds during both the years. On the contrary, significantly highest nitrogen (242.1 and 237.1), phosphorus (21.0 and 19.7) and potassium (200.9 and 182.3) removal by weeds were observed in weedy check control (W<sub>1</sub>) which was due to significantly higher dry matter production by weeds. This is in conformity with the findings of Kaur *et al.* (2008) who reported better weed control and favourable conditions for crop growth resulted in higher uptake by crop. But nearly 80 to 90 per cent removal of nutrients by weeds was noticed in unweeded check might be due to high weed density and more dry weight accumulation.

The controls (sole turmeric with recommended practice and sole turmeric with modified weed control treatment) recorded significantly lower value of N, P and K removal by weeds as compared to that in treatment mean in both the years. The trend of nutrient removal by weeds showed that effective weed control utmost checked the nutrient loss due to weeds.

Various factors did not interact significantly in regards to nutrient removal by weeds during both the years of experimentation.

## **4.4.2 Nutrient content, uptake in rhizome, stover of turmeric and total uptake**

### **4.4.2.1 Nitrogen, phosphorus and potassium content in rhizome**

The data pertaining to nitrogen, phosphorus and potassium content in rhizome are presented in Table 4.37(a), 4.38(a) and 4.39(a). In both the years, nitrogen and potassium content in rhizome due to planting methods and intercropping were found to be non-significant. However, phosphorus content in rhizome due to planting methods and intercropping were found to be significant.

Various weed management practices in turmeric had significant effect on nitrogen, phosphorus and potassium content in rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment produced significantly higher nitrogen, phosphorus and potassium content in rhizome during both the years. Significantly lowest nitrogen, phosphorus and potassium content in rhizome were observed in weedy check control.

The interaction effect among the factors in regards to nitrogen, phosphorus and potassium content in rhizome was not significant.

### **4.4.2.2 Nitrogen, phosphorus and potassium uptake in rhizome**

The data pertaining to nitrogen, phosphorus and potassium uptake in rhizome are presented in Table 4.37(b), 4.38(b) and 4.39(b) reveals that nitrogen and potassium uptake in rhizome due to planting methods and intercropping were not significant in both the years of experimentation. However, phosphorus uptake in rhizome due to planting methods and intercropping were found to be significant.

Various weed management practices in turmeric had significant effect on nitrogen, phosphorus and potassium uptake in rhizome in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment produced significantly higher nitrogen (154.1 and 150.5) phosphorus (20.4 and 19.5) and potassium (206.2 and 200.8) uptake in rhizome during both the years. Significantly lowest nitrogen, phosphorus and potassium uptake in rhizome were observed in weedy check control.

Different factors did not interact significantly in regards to nitrogen, phosphorus and potassium uptake in rhizome.

#### **4.4.2.3 Nitrogen, phosphorus and potassium content in shoot**

The data pertaining to nitrogen, phosphorus and potassium content in shoot are presented in Table 4.37(a), 4.38(a) and 4.39(a). Nitrogen content in shoot due to planting methods was found to be significant in 2013 and 2014. However, phosphorus and potassium content in shoot were found to be at par between the two methods of planting during both the years.

The nitrogen, phosphorus and potassium content in shoot due to intercropping could not bring any significant effect in both the years of experimentation.

Various weed management practices in turmeric had significant effect on nitrogen, phosphorus and potassium content in shoot in 2013 and 2014. Among the weed control treatments, non-chemical weed control treatment produced significantly higher nitrogen, phosphorus and potassium content in shoot during both the years. Significantly lowest nitrogen, phosphorus and potassium content in shoot were observed in  $W_1$  i.e. weedy check control.

The interaction effect among the factors in regards to nitrogen, phosphorus and potassium content in shoot was non-significant.

#### **4.4.2.4 Nitrogen, phosphorus and potassium uptake in shoot**

The data pertaining to nitrogen, phosphorus and potassium uptake in shoot are presented in Table 4.37(b), 4.38(b) and 4.39(b). In both the years, nitrogen uptake in shoot was found to be significantly influenced by the planting methods and intercropping. However, phosphorus and potassium uptake in shoot were found to be unaffected by planting methods and intercropping during both the years.

Various weed management practices in turmeric had significant effect on nitrogen, phosphorus and potassium uptake in shoot in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment produced significantly higher nitrogen (243.2 and 248.3), phosphorus (24.8 and 29.5) and potassium (189.8 and 189.7) uptake in shoot during both the years. Significantly lowest nitrogen, phosphorus and potassium uptake in shoot were observed in weedy check control.

The interaction effect among the factors in regards to nitrogen, phosphorus and potassium uptake in shoot was not significant.



### **4.4.3 Total uptake of nitrogen, phosphorus and potassium**

#### **4.4.3.1 Nitrogen**

The data pertaining to total uptake of nitrogen in turmeric rhizome are presented in Table 4.40. In both the years, total uptake of nitrogen by turmeric under  $M_2$  i.e. paired row 70/30 cm (391.1 and 391.3) were statistically higher than that in paired row 80/30 cm (375.1 and 380.9).

Total uptake of nitrogen under intercropping of baby corn (471.4 and 475.6) was statistically higher than that in intercropping of greengram (294.7 and 296.6) during 2013 and 2014.

Various weed management practices in turmeric had significant effect on total uptake of nitrogen in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher total nitrogen uptake (618.1 and 623.2) than that in other treatments *viz.*, pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ), pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding ( $W_4$ ) and weedy check control ( $W_1$ ).

Total nitrogen uptake by turmeric, during 2013 and 2014, observed in control treatments i.e.  $C_1$  (621.7 and 604.2) and  $C_4$  (716.2 and 706.4) was significantly higher over that in treatment mean (383.1 and 386.1).

The interaction effect among the factors was not significant.

#### **4.4.3.2 Phosphorus**

The data pertaining to total uptake of phosphorus in turmeric rhizome are presented in Table 4.40. Total uptake of phosphorus by turmeric under  $M_2$  i.e. paired row 70/30 cm (37.4 and 47.2) were statistically higher than that in paired row 80/30 cm (36.6 and 48.3) during 2013 and 2014.

In both the years of experimentation, total uptake of phosphorus under  $I_1$  i.e. intercropping of baby corn (46.1 and 55.1) were statistically higher than that in  $I_2$  i.e. intercropping of greengram (27.9 and 40.).

Various weed management practices in turmeric had significant effect on total uptake of phosphorus in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher total phosphorus uptake (67.4 and 78.9) than that in other treatments.

Total phosphorus uptake by turmeric, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (62.3 and 72.6) and sole turmeric with modified weed control practice (71.4 and 79.9) was significantly higher over that in treatment mean (37.0 and 47.7).

The different factors did not interact significantly in either of 2013 and 2014.

#### **4.4.3.3 Potassium**

The data pertaining to total uptake of potassium in turmeric rhizome are presented in Table 4.40. In both the years, total uptake of potassium by turmeric under  $M_2$  i.e. paired row 70/30 cm (504.7 and 501.2) were statistically higher than that in paired row 80/30 cm (571.7 and 567.2).

In both the years of experimentation, total uptake of potassium under  $I_1$  i.e. intercropping of baby corn (684.9 and 678.5) were statistically higher than that in  $I_2$  i.e. intercropping of greengram (391.5 and 389.9).

Various weed management practices in turmeric had significant effect on total uptake of potassium in 2013 and 2014. Among the weed management treatments, non-chemical weed control treatment ( $W_2$ ) produced significantly higher total potassium uptake (813.1 and 815.4) than that in other treatments.

Total potassium uptake by turmeric, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) was significantly higher over that in treatment mean.

The interaction effect among the factors was not significant.

## **4.4 Cropping system**

### **4.4.1 Total nutrient uptake (kilogram per hectare) by crops in the cropping system**

#### **4.4.1.1 Total Nitrogen uptake**

The data pertaining to total nitrogen uptake are presented in Table 4.41. Methods of paired row planting could not bring about significant effect on total nitrogen uptake.

In both the years, of experimentation, intercropping baby corn recorded significantly higher total nitrogen uptake (471.4 and 475.6) than that in intercropping of greengram (294.7 and 296.6). This was due to the significantly higher uptake of nitrogen by the baby corn.

Among the weed management treatments, non-chemical weed control treatment i.e. straw mulching along with four hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) recorded significantly higher total nitrogen uptake i.e. 618.1 and 623.2 in 2013 and 2014, respectively than that in remaining treatments. This was due to the significantly higher uptake of nitrogen by the turmeric and intercrops as well as significantly lower nitrogen uptake by weeds.

During both the years, the control  $C_1$  (sole turmeric with recommended practice) and  $C_4$  (sole turmeric with modified weed control practice) recorded significantly higher total uptake of nitrogen as compared to that in treatment mean.

#### **4.4.1.2 Total phosphorus uptake**

The data pertaining to total phosphorus uptake are presented in Table 4.41. In 2013 and 2014, planting methods could not bring about significant variation in total phosphorus uptake.

In both the years of experimentation, intercropping baby corn registered significantly higher total phosphorus uptake (46.1 and 55.1) than that in intercropping of greengram (37.9 and 40.4).

The total phosphorus uptake was significantly influenced by weed management practices in both the years. Non-chemical weed management practice i.e. straw mulching along with four hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) caused significantly higher total phosphorus uptake i.e. 67.4 and 78.9 in 2013 and 2014,

respectively than that in remaining treatments. This was due to the significantly higher uptake of P by the turmeric and intercrops as well as significantly lower P uptake by weeds.

The control C<sub>1</sub> (sole turmeric with recommended practice) and C<sub>4</sub> (sole turmeric with modified weed control practice) recorded significantly higher total uptake of phosphorus as compared to that in treatment mean during both the years of experimentation.

#### **4.4.1.3 Total potassium uptake**

The data pertaining to total potassium uptake are presented in Table 4.41. In both the years, planting methods could not bring significant variation in uptake of total potassium.

In both the years of experimentation, intercropping baby corn recorded significantly higher total potassium uptake (684.9 and 678.5) than that in intercropping of greengram (391.5 and 380.9).

Total potassium uptake was significantly influenced by weed management practices during both the years of experimentation. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching along with four hand weeding at 35, 65, 95 and 140 DAP (W<sub>2</sub>) recorded significantly higher total potassium uptake i.e. 813.1 and 815.4 in 2013 and 2014, respectively than that in remaining treatments. This was due to the significantly higher uptake of potassium by the turmeric and intercrops as well as significantly lower potassium uptake by weeds.

During both the years, the control C<sub>1</sub> i.e. sole turmeric with recommended practice and the control C<sub>4</sub> i.e. sole turmeric with modified weed control practice recorded significantly higher total uptake of potassium as compared to that in treatment mean.

#### **4.4.2 Microbial carbon, organic carbon and available nutrients in soil at harvest**

##### **4.4.2.1 Soil microbial carbon**

Data on soil microbial carbon are presented in Table 4.42. The treatment combination of paired row planting 70/30 cm, intercropping of greengram and weed management with non-chemical method resulted higher soil microbial carbon (461.9

and 469.0) in both the years. This might be attributed due to favourable soil condition modified by organic mulch and leguminous crop. This result was in agreement with Tu *et al.* (2005).

#### **4.4.2.2 Organic carbon (gram per kilogram)**

The data pertaining to soil organic carbon are presented in Table 4.43. In both the years of experimentation, methods of paired row planting and intercropping could not bring about significant effect on organic carbon in soil.

Organic carbon was significantly influenced by weed management practices in both the years of experimentation. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching along with hand weeding at 35, 65, 95 and 140 DAP (W<sub>2</sub>) produced significantly higher organic carbon i.e. 4.76 and 4.93 in 2013 and 2014, respectively than that in remaining treatments. The marginal but significantly higher increase in organic carbon might be due to addition of organic mulch. This result is in agreement with Nwokocho *et al.* (2009) who also reported that straw mulch contains higher percentage of organic matter and improves the soil structure when compared with non mulch treatment, and the decomposition of mulch materials provides soil-organic matter.

During both the years, the sole turmeric with recommended practice (C<sub>1</sub>) and the sole turmeric with modified weed control practice (C<sub>4</sub>) recorded significantly higher available organic carbon in soil as compared to that in treatment mean.

#### **4.4.2.3 Nitrogen (kilogram per hectare)**

The data pertaining to available nitrogen in soil are presented in Table 4.43. Planting method 80/20 cm recorded significantly higher available nitrogen in soil (359.5 and 365.1) than that in 70/30 cm (359.3 and 364.5) which might be due to significantly lower uptake of nitrogen in the former treatment.

In both the years of experimentation, intercropping greengram recorded significantly higher available nitrogen in soil (361.1 and 366.2) than that in intercropping of baby corn (357.7 and 363.4) which might be due to significantly lower uptake of nitrogen in the former treatment.

In both the years of experimentation, available nitrogen in soil was significantly influenced by weed management practices. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand

weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher available nitrogen in soil i.e. 372.2 and 378.9 in 2013 and 2014, respectively than that in remaining treatments. This might be due to efficient management of weeds which significantly reduced the removal of nitrogen by the weeds.

During both the years, the sole turmeric with recommended practice ( $C_1$ ) and the sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly higher available nitrogen in soil as compared to that in treatment mean.

#### **4.4.2.4 Phosphorus**

The data pertaining to available phosphorus in soil are presented in Table 4.44. Planting method 80/20 cm recorded significantly higher available phosphorus in soil (20.6 and 21.1) than that in 70/30 cm (20.4 and 20.9) which might be due to significantly lower uptake of P in the former treatment.

In both the years of experimentation, intercropping baby corn recorded significantly higher available phosphorus in soil (20.9 and 21.4) than that in intercropping of greengram (20.1 and 20.6) which might be due to significantly lower uptake of phosphorus in the former treatment.

Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher available phosphorus in soil i.e. 23.1 and 23.7 in 2013 and 2014, respectively than that in remaining treatments. This might be due to efficient management of weeds which significantly reduced the removal of phosphorus by the weeds.

During both the years of experimentation, the sole turmeric with recommended practice ( $C_1$ ) and the sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly higher available phosphorus in soil as compared to that in treatment mean.

#### **4.4.2.5 Potassium (kilogram per hectare)**

The data pertaining to available potassium in soil are presented in Table 4.44. Planting method 80/20 cm recorded significantly higher available potassium in soil (203.1 and 212.1) than that in 70/30 cm (202.8 and 211.4) which might be due to significantly lower uptake of K in the former treatment.

. In both the years of experimentation, intercropping baby corn recorded significantly higher available potassium in soil (203.1 and 212.0) than that in intercropping of greengram (202.8 and 211.5) which might be due to significantly lower uptake of K in the former treatment.

. Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher available potassium in soil i.e. 208.3 and 214.1 in 2013 and 2014, respectively than that in remaining treatments. This might be due to efficient management of weeds which significantly reduced the removal of potassium by the weeds. During both the years, the controls i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ) recorded significantly higher available potassium in soil as compared to that in treatment mean.

It was observed that weed control treatments registered higher available soil organic carbon and NPK at harvest of crop. This result in conformity with the findings of Mynavathi (2007) and Sathiyavani (2014). In contrast, it was observed that weedy checked registered lowest available soil nutrients due to removal of large amount of nutrients by profuse invasion of weeds.

#### **4.4.3 Turmeric equivalent yield (tonnes per hectare)**

The data pertaining to turmeric equivalent yield are presented in 4.45 and it revealed that in both the years of experimentation, methods of paired row planting and intercropping could bring about significant effect on turmeric equivalent yield during both the years. Paired row planting method 70/30 cm recorded significantly higher turmeric equivalent yield (29.68 and 30.07) than that in 80/20 cm (29.13 and 29.45). The two years pooled mean revealed that planting method 70/30 cm recorded significantly highest turmeric equivalent yield (29.87) followed by that in 80/20 cm (29.29).

Intercropping baby corn recorded significantly higher turmeric equivalent yield (33.49 and 33.80) than that in intercropping of greengram (25.32 and 25.72) in 2013 and 2014, respectively. The two years pooled mean also revealed that intercropping baby corn recorded significantly highest turmeric equivalent yield (33.64) followed by that in intercropping of greengram (25.52).

In both the years of experimentation, turmeric equivalent yield was significantly influenced by weed management practices. Among the weed management treatments, non-chemical weed control practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher turmeric equivalent yield i.e. 38.79 and 39.19 in 2013 and 2014, respectively which was at par with that in pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup> along with five hand weeding ( $W_3$ ) and pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup> along with five hand weeding ( $W_4$ ) but significantly superior to weedy check control. The two years pooled mean revealed that the treatment  $W_2$  recorded significantly highest turmeric equivalent yield (38.99) followed by  $W_3$  (31.96). The findings of pooled mean revealed that non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced highest turmeric equivalent yield 38.99 tonne per hectare while the sole turmeric with recommended weed management practice recorded 36.96 tonne per hectare. The trend of individual crop yield due to weed management practices reflected on the turmeric equivalent yield.

In 2013 and 2014, both the controls i.e.  $C_1$  (sole turmeric with recommended practice) and  $C_4$  (sole turmeric with modified weed control practice) recorded significantly higher turmeric equivalent yield as compared to that in treatment mean.

#### **4.4.4 Land equivalent ratio (LER)**

The data pertaining to land equivalent ratio are presented in Table 4.46 and perusal of the data on LER, in 2013 and 2014, revealed that the treatment combination of  $M_2I_1W_2$  i.e. planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP recorded highest values (1.57 and 1.59) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP (1.54 and 1.55). This could be due to the fact in this treatment combination  $M_2I_1W_2$ , turmeric yield was significantly highest and the additive yield due to intercrop baby corn was overwhelmingly more.

### **4.5 Economic evaluation**

#### **4.5.1 Cost of cultivation (R ha<sup>-1</sup>)**

The cost of cultivation was calculated based on prevailing rate of inputs, labour wage and cultivation operation for the two years of the experimentation separately. The summary of cost of cultivation of different sole crops and treatment combination are presented in Table 4.47 and also item wise expenditure of various operation/ inputs are presented in Appendices IX to XVII.

A perusal of the data on cost of cultivation, in 2013 and 2014, revealed that the treatment combination of planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (R 219660 and 219767) followed by planting of turmeric paired row of 70/30 cm and intercropping baby corn along with weed management practice of application metribuzin (PE) and five hand weeding at 35, 65, 95, 140 and 185 DAP (R 219474 and R 219572). The relatively higher cost of cultivation in the treatment combination of  $M_2I_1W_2$ , was due to higher cost of mulch materials and seeds of baby corn.

#### **4.5.2 Gross return (R ha<sup>-1</sup>)**

The data on gross returns (R ha<sup>-1</sup>) are presented in Table 4.47 and prices of outputs are presented in Appendix VIII.

A perusal of the data on gross return, in 2013 and 2014, revealed that the treatment combination of  $M_2I_1W_2$  i.e. planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching and by four hand weeding at 35, 65, 95 and 140 DAP recorded highest values (R 885567 and R 895837) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching and four hand weeding at 35, 65, 95 and 140 DAP (R 864700 and R 870129). This is evident from the fact that in the treatment combination of  $M_2I_1W_2$ , the relative gross return due investment in cultivation was higher.

During in 2013 and 2014, the gross return obtained under the treatment combination of  $M_2I_1W_2$  and  $M_1I_1W_2$  was higher than that of both the controls i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ).

#### **4.5.3 Net return per hectare (R ha<sup>-1</sup>)**

The data on net returns ( $\text{R ha}^{-1}$ ) are presented in Table 4.47 and prices of outputs are presented in Appendix VIII.

A perusal of the data on net return, in 2013 and 2014, revealed that the treatment combination of planting of turmeric in paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values ( $\text{R } 665907$  and  $\text{R } 676070$ ) followed by planting of turmeric in paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $\text{R } 645317$  and  $\text{R } 650657$ ). This could be due to the fact in this treatment combination  $M_2I_1W_2$ , the proportionate increase in net return due to incremental increase in cost of cultivation was higher.

During in 2013 and 2014, the net return obtained under the treatment combination of  $M_2I_1W_2$  and  $M_1I_1W_2$  was higher than that of both the controls i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ). Similar findings were reported by Behera *et al.* (2008).

#### **4.5.3 Benefit : Cost ratio**

The data pertaining to benefit cost ratio are presented in Table 4.48. The perusal data on benefit cost ratio, in 2013 and 2014, revealed that the treatment combination of  $M_2I_1W_2$  i.e. planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP recorded highest values (4.03 and 4.08) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP (3.94 and 3.96). This is evident from the fact that in the treatment combination of  $M_2I_1W_2$ , the relative gross return due to investment in cultivation was higher.

During in 2013 and 2014, the benefit cost ratio obtained under the treatment combination of  $M_2I_1W_2$  and  $M_1I_1W_2$  was higher than that of both the controls i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ).

#### **4.5.4 Net return $\text{R}^{-1}$ invested**

To evaluate the revenue generating competence of various treatment combinations, the net return per rupee invested was worked out and are presented in Table 4.48.

The perusal data on net return  $\text{R}^{-1}$  invested revealed that the treatment combination of planting of turmeric in paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values ( $\text{R } 3.03$  and  $\text{R}3.08$ ) followed by treatment  $M_1I_1W_2$  i.e. treatment combination of planting of turmeric in paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $\text{R } 2.94$  and  $\text{R } 2.96$ ). This could be due to the fact in this treatment combination  $M_2I_1W_2$ , the proportionate increase in gross return due to incremental increase in cost of cultivation was more.

During in 2013 and 2014, the net return per rupee invested obtained under the treatment combination of  $M_2I_1W_2$  and  $M_1I_1W_2$  was higher than that of both the controls i.e. sole turmeric with recommended practice ( $C_1$ ) and sole turmeric with modified weed control practice ( $C_4$ ).

#### **4.5.5 Monetary advantage**

The data pertaining to monetary advantage presented in Table 4.48 revealed that the treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching and four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values ( $\text{R } 826284$  and  $\text{R } 860961$ ) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching and four hand weeding at 35, 65, 95 and 140 DAP ( $\text{R } 770144$  and  $\text{R}787327$ ) during 2013 and 2014. This could be due to the fact in this treatment combination  $M_2I_1W_2$ , the relative values of combined base and intercrop, and the LER was much more.

### **4.6 Bioenergetics**

#### **4.6.1 Cultural energy use efficiency (CEUE) Output/ Input ratio**

The cultural energy use efficiency of the cropping system was worked out and presented in Table 4.49. which revealed that the treatment combination of

planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values of CEUE (13.25 and 13.96) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP (13.64 and 12.47) in 2013 and 2014. This may be due to fact that higher output was realized in that treatment combination.

#### **4.6.2 Energy production ratio (EPR) for turmeric**

The energy production ratio for turmeric was calculated and presented in Table 4.50. It revealed that the treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values of EPR (1.67 and 1.71) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching with four hand weeding at 35, 65, 95 and 140 DAP (1.64 and 1.60) in 2013 and 2014. This could be due to the fact in this treatment, LER was much more.

## **CHAPTER V**

### **SUMMARY AND CONCLUSION**

The investigation entitled “Effect of intercrop and weed management on productivity and resource use efficiency in turmeric (*Curcuma domestica* val.)” was conducted at the Instructional-cum-Research Farm of Assam Agricultural University, Jorhat, Assam during 2013 and 2014. The experiment was laid out in factorial randomized block design and replicated thrice. The treatments comprised of two methods of planting viz., (a) paired row 80/20 cm and (b) paired row 70/30 cm; two intercropping viz., (a) baby corn and (b) greengram; and three weed management practices viz., (a) non-chemical (mulching along with four hand weeding at 35, 65, 95 and 140 DAP); (b) pre-emergence application of metribuzin @ 500 gram per hectare along with five hand weeding at 35, 65, 95, 140 and 185 DAP and (c) pre-emergence application of oxadiargyl @ 90 gram per hectare along with five hand weeding at 35,

65, 95, 140 and 185 DAP. There was one weedy check control, one sole crop of each intercrop and two sole crop of turmeric, one with recommended package of practice and one with modified package of practice (weed free).

The salient findings of the experiment are summarised below separately on weed, individual crops and cropping systems.

## **5.1 Effect of paired row planting methods, intercropping and weed management practices**

### **5.1.1 Weed**

#### **5.1.1.1 Total weed density**

Paired row planting 70/30 cm ( $M_2$ ) recorded significantly lower weed density at all stages than that in paired row planting 80/20 cm ( $M_1$ ), except at 90 DAP in 2014 in which both of these were at par.

In 2013, intercropping baby corn ( $I_1$ ) recorded significantly lower weed density at 30, 60, 90 and 120 than that in intercropping greengram ( $I_2$ ). However, in 2014, weed density at 60, 120 and 180 DAP recorded under  $I_1$  was significantly lower than that in  $I_2$ .

In regards to weed management practices, non-chemical method ( $W_2$ ) i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed density at 30, 60, 90, 120, 150 and 180 DAP as compared to that in rest of the treatments. Weedy check control recorded significantly highest weed density at all the stages studied.

#### **5.1.1.2 Total weeds dry weight**

During both the years, paired row planting 70/30 cm recorded significantly lower value of total weed dry weight at all stages than that in paired row planting 80/20 cm.

Intercropping baby corn recorded significantly lower value of total weed dry weight at all the growth stages except at 30 DAP in both the years than that in intercropping greengram.

Non-chemical method i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP resulted significantly lowest weed dry weight in all the growth stages (30, 60, 90, 120, 150 and 180 DAP) as compared to that in rest of the treatments

during both the years. Weedy check control recorded significantly highest weed dry weight at all the stages.

### **5.1.1.3 Weed control efficiency**

During both the years of experiment, the highest weed control efficiency at 30 and 60 DAP was obtained under treatment combination of paired row 70/30 cm, intercropping baby corn and weed management practice i.e. mulching along with four hand weeding at 35, 65, 95, 140 DAP ( $M_2I_1W_2$ ) followed by under treatment combination of paired row 80/20 cm, intercropping baby corn and weed management practice i.e. mulching along with four hand weeding at 35, 65, 95, 140 DAP ( $M_1I_1W_2$ ).

## **5.1.2 Crop**

### **5.1.2.1 Turmeric**

#### **5.1.2.1.1 Growth characters**

##### **5.1.2.1.1.1 Plant population**

In both the years, plant population did not vary significantly due to planting methods and intercropping.

Plant population, during 2013 and 2014, was significantly higher in weed management practice i.e. mulching along with four hand weeding at 35, 65, 95, 140 DAP ( $W_2$ ).

##### **5.1.2.1.1.2 Plant height**

In both the years, plant height at 95 and 140 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm.

During 2013, plant height at 185 and 256 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm. In 2014, plant height at 256 DAP under paired row 80/20 cm were statistically higher than that in paired row 70/30 cm.

Intercropping with greengram resulted significantly higher plant height of turmeric than that of intercropping with baby corn at 95, 140, 185 and 256 DAP. Both the intercropping was at par in 2014 in regard to the plant height of turmeric at 140 DAP.

Plant height at all the growth stages was highest for non-chemical weed control treatment which was significantly superior to rest of the treatments.

#### **5.1.2.1.1.3 Number of tillers per plant**

Paired row 70/30 cm ( $M_2$ ) produced significantly higher tillers per plant in all the four growth stages over that in paired row 80/20 cm ( $M_1$ ) in 2013. During 2014,  $M_2$  also recorded higher number of tiller but were statistically at par with that in  $M_1$ .

Similarly, intercropping turmeric with greengram ( $I_2$ ) recorded significantly higher tillers per plant over that in baby corn ( $I_1$ ) in all the four growth stages during 2013. However, both  $I_1$  and  $I_2$  were statistically at par during 2014 at all the four growth stages except 140 DAP. The tiller per plant at 140 DAP in 2014 was statistically higher in intercropping greengram over intercropping baby corn.

During both the years, weed management practice i.e. mulching along with four hand weeding at 35, 65, 95, 140 DAP ( $W_2$ ) recorded the highest number of tillers per plant at all the four growth stages under record which were significantly superior to that in all other practices studied.

#### **5.1.2.1.1.4 Number of leaves per plant**

Paired row 70/30 cm ( $M_2$ ) produced higher number of leaves per plant at 95 DAP in 2013 which was statistically significant over that in paired row 80/20 cm ( $M_1$ ); however, in 2014 both were statistically at par. At 140 DAP,  $M_2$  recorded statistically higher number of leaves per plant over  $M_1$  during 2013 and 2014. In 2013,  $M_2$  recorded higher number of leaves per plant at 185 DAP which was statistically superior over  $M_1$ ; however in 2014, both were statistically at par in regards to number of leaves. At 256 DAP, both the planting methods were statistically at par in regard to this attribute in both the years.

Intercropping greengram ( $I_2$ ) recorded higher number of leaves per plant at 95, 140 and 185 DAP which was significant over that in intercropping baby corn ( $I_1$ ) during 2013 and 2014. At 256 DAP,  $I_2$  produced statistically higher number of leaves per plant over that in  $I_1$  during 2014; however both the intercropping was at par in 2013 in regard to number of leaves per plant.

The highest number of leaves was achieved in non-chemical weed control treatment which was statistically superior to all other treatments during 2013 and 2014.

#### **5.1.2.1.1.5 Leaf area index**

Paired row 70/30 cm ( $M_2$ ) produced higher leaf area index (LAI) at all the stages during both the years which was statistically significant over that in paired row 80/20 cm ( $M_1$ ).

Intercropping greengram ( $I_2$ ) recorded higher leaf area index (LAI) at all the stages during both the years of experimentation which was statistically significant over that in intercropping baby corn ( $I_1$ ).

The highest LAI was achieved in  $W_2$  which was statistically superior to all other practices during 2013 and 2014

#### **5.1.2.1.2 Yield attributing characters**

##### **5.1.2.1.2.1 Number of mother rhizome**

In both the years, number of mother rhizome under paired row 70/30 cm (2.28 and 2.26) were statistically higher than that in paired row 80/30 cm (2.01 and 2.10).

The intercropping with different crops had no significant effect on number of mother rhizome during both the years of experimentation.

Among the weed management treatments,  $W_2$  i.e. non-chemical weed management (Straw mulching and hand weeding at 35, 65, 95 and 140 DAP) produced significantly higher number of mother rhizome (2.6 and 2.6) in both the years.

The number of mother rhizomes, during 2013 and 2014, observed in control treatment ( $C_1$ ) i.e. sole turmeric with recommended practice (4.1 and 3.4) and  $C_4$  i.e. sole turmeric modified (weed free) package of practice (4.5 and 3.7) was significantly higher over that in treatment mean (2.2 and 2.2).

#### **5.1.2.1.2.2 Number of primary rhizome per plant**

Paired row 70/30 cm ( $M_2$ ) planting method recorded significantly higher number (6.68) of primary rhizome that that in  $M_1$  i.e. paired row 80/20 cm (6.03) in 2013, however both the methods were at par in 2014.

Intercropping of greengram ( $I_2$ ) resulted significantly higher number of primary rhizome (6.68 and 6.85) of turmeric over that in intercropping of baby corn (6.03 and 6.47) in both the years.

Among the weed management treatments,  $W_2$  (non-chemical method) produced significantly higher number of primary rhizome per plant i.e. 9.37 and 9.53 in 2013 and 2014, respectively.

#### **5.1.2.1.2.3 Number of secondary rhizome per plant**

In both the years, number of secondary rhizome under  $M_2$  i.e. paired row 70/30 cm (9.14 and 9.53) were statistically higher than that in paired row 80/30 cm (9.60 and 10.07).

Intercropping of greengram showed significantly higher number of secondary rhizome (9.80 and 10.21) of turmeric over that in intercropping of baby corn (8.95 and 9.39) in both the years.

Among the weed management treatments,  $W_2$  (non-chemical method) produced significantly higher number of secondary rhizome i.e. 12.40 and 12.68 in 2013 and 2014, respectively.

#### **5.1.2.1.2.4 Number of total number of rhizome per plant**

In both the years, number of total rhizome under  $M_2$  i.e. paired row 70/30 cm (18.56 and 19.19) were statistically higher than that in paired row 80/30 cm (17.88 and 18.11).

In both the years, number of total rhizome under  $I_2$  i.e. intercropping of greengram (18.68 and 19.55) were statistically higher than that in  $I_1$  i.e. intercropping of baby corn (17.07 and 17.75).

Among the weed management treatments,  $W_2$  i.e. non-chemical weed management (Straw mulching and hand weeding at 35, 65, 95 and 140 DAP) produced significantly higher number of total rhizome (24.36 and 24.80) in both the years.

The number of total rhizomes, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (28.06 and 26.60) and sole turmeric with modified weed control practice (29.70 and 28.00) was significantly higher over that in treatment mean (18.22 and 18.65).

#### **5.1.2.1.2.5 Length of mother rhizome (cm)**

In 2013, length of mother rhizome under paired row 70/30 cm (9.81) was statistically higher than that in paired row 80/30 cm (9.49). However, in 2014, the values of length of mother rhizome observed in both the paired row planting methods were statistically at par.

Intercropping of greengram recorded significantly longer mother rhizome (9.88 and 10.05) of turmeric over that in intercropping of baby corn (9.42 and 9.40) in 2013 and 2014.

Among the weed management treatments, non-chemical method ( $W_2$ ) produced significantly higher length of mother rhizome (11.45 and 11.36 in 2013 and 2014, respectively).

The length of mother rhizome, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (11.9 and 11.47) and sole turmeric with modified weed control practice (12.47 and 12.2) was significantly higher over that in treatment mean (9.65 and 9.75).

#### **5.1.2.1.2.6 Length of primary rhizome (cm)**

In both the years of experimentation, length of primary rhizome was not significantly influenced by the paired row planting and intercropping.

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly longer primary rhizome i.e. 9.38 and 8.93 in 2013 and 2014, respectively which were statistically superior to that in pre-emergence application of metribuzin @ 500 gram per hectare along with five hand weeding (W<sub>3</sub>).

#### **5.1.2.1.2.7 Length of secondary rhizome (cm)**

In both the years of experimentation, length of secondary rhizome was at par under the paired row planting i.e. 70/30 cm and 80/20 cm.

Intercropping greengram recorded significantly higher length (4.80) of secondary rhizome over that in intercropping baby corn (4.49) in 2013. However, during 2014 both the intercropping systems were at par.

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly longer secondary rhizome i.e. 5.48 and 5.71 in 2013 and 2014, respectively over other treatments.

The length of mother rhizome, during 2013 and 2014, observed in control treatments i.e. sole turmeric with recommended practice (10.3 and 9.9) and sole turmeric with modified weed control practice (11.5 and 11.3) was significantly higher over that in treatment mean (8.3 and 8.0).

#### **5.1.2.1.2.8 Girth of mother rhizome (cm)**

In two years of experimentation, girth of mother rhizome was at par between the paired row planting i.e. 70/30 cm and 80/20 cm.

Intercropping of greengram recorded significantly higher girth (6.9) of primary rhizome over that in intercropping of baby corn (6.7) in 2013. However, it was at par under both the intercropping system in 2014.

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly higher girth of mother rhizome i.e. 7.9 and 7.8 in 2013 and 2014, respectively which were statistically superior to that in W<sub>3</sub> i.e. pre-emergence application of metribuzin @ 500 gram per hectare along with five hand weeding (7.0 and 7.3).

#### **5.1.2.1.2.9 Girth of primary rhizome (cm)**

In 2013, girth of primary rhizome (6.20) under 70/30 cm paired row planting system was significantly higher (5.86) than that in 80/20 cm paired row planting. However, in 2014, girths of primary rhizomes observed in both the paired row treatments were at par.

Intercropping of greengram recorded significantly higher girth (6.3) of primary rhizome over that in intercropping of baby corn (5.8) in 2013. But, in 2014, girth of primary rhizome observed in both the paired row treatments was non-significant.

Among the weed management treatments, non-chemical method ( $W_2$ ) produced significantly higher girth of primary rhizome (7.3 and 7.55) in 2013 and 2014, respectively than that in pre-application of metribuzin @ 500 gram per hectare along with five hand weeding (6.2 and 6.1).

#### **5.1.2.1.2.10 Girth of secondary rhizome (cm)**

In both the year of experimentation, girth of secondary rhizome was at par between the paired row planting i.e. 70/30 cm and 80/20 cm.

In 2013, girth of secondary rhizome (4.05) of turmeric under intercropping of greengram ( $I_2$ ) was significantly higher (3.86) over that in intercropping of baby; but in 2014, girth of secondary rhizome observed in both the paired row treatments was non-significant.

Among the weed management treatments, non-chemical method ( $W_2$ ) produced significantly higher girth of secondary rhizome i.e. 5.16 and 5.14 in 2013 and 2014, respectively followed by that in pre-application of metribuzin @ 500 gram per hectare along with five hand weeding (4.2 and 4.3).

#### **5.1.2.1.2.11 Weight of mother rhizome (gram per plant)**

In both the years, the weight of mother rhizome under paired row 70/30 cm (124.0 and 124.1) were statistically higher than that in paired row 80/30 cm (118.8 and 119.3).

The weight of mother rhizomes under intercropping of greengram (123.8 and 124.4) was statistically higher than that in intercropping of baby corn (118.9 and 119.1) in respective years.

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly heavier mother rhizome i.e. 164.2 and 164.5 in 2013 and 2014, respectively. Significantly lowest mother rhizome weight (52.8 and 53.6) was observed in weedy check control.

#### **5.1.2.1.2.12 Weight of primary rhizome (gram per plant)**

In both the years, weight of primary rhizome under paired row 70/30 cm (165.3 and 166.3) were statistically higher than that in paired row 80/30 cm (159.3 and 160.1).

In both the years, weight of primary rhizomes under intercropping of greengram (166.2 and 167.4) was statistically higher than that in intercropping of baby corn (158.4 and 159.0).

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly heavier primary rhizome (214.2 and 215.1 in 2013 and 2014, respectively) than other treatments. Significantly lowest primary rhizome weight (90.6 and 92.2) was observed in weedy check control.

#### **5.1.2.1.2.13 Weight of secondary rhizome (gram per plant)**

In both the years, weight of secondary rhizome under paired row 70/30 cm (66.2 and 67.0) were statistically higher than that in paired row 80/30 cm (62.3 and 63.0).

In both the years, weight of secondary rhizome under intercropping of greengram (66.6 and 67.8) was statistically higher than that in intercropping of baby corn (61.9 and 62.3).

Among the weed management treatments, non-chemical method (W<sub>2</sub>) produced significantly heavier secondary rhizome (81.8 and 82.6 in 2013 and 2014, respectively). The lowest secondary rhizome weight (48.7 and 49.7) was observed in weedy check control.

#### **5.1.2.1.2.14 Weight of total rhizome (gram per plant)**

In both the years, weight of total rhizome under paired row 70/30 cm (355.6 and 357.5) were statistically higher than that in paired row 80/30 cm (340.5 and 342.5).

In both the years, weight of total rhizome under intercropping of greengram (356.8 and 359.6) was statistically higher than that in intercropping of baby corn (339.3 and 340.5).

Among the weed management treatments, non-chemical weed control method ( $W_2$ ) produced significantly heavier total rhizome i.e. 460.3 and 462.3 in 2013 and 2014, respectively. The lowest total rhizome weight (192.3 and 195.5) was observed in weedy check control.

### **5.1.2.1.3 Yield**

#### **5.1.2.1.3.1 Fresh rhizome yield (tonne per hectare)**

The fresh rhizome yield (24.2 and 24.6) obtained under paired row planting 70/30 cm ( $M_2$ ) were significantly higher than that in 80/20 cm (23.7 and 24.0) in each year of 2013 and 2014.

Intercropping of greengram resulted significantly higher fresh rhizome yield (24.3 and 24.7) as compared to intercropping baby corn (23.6 and 23.9).

Among the weed management treatments,  $W_2$  i.e. non-chemical (mulching with hand weeding at 35, 65, 95 and 140 DAP) produced significantly higher fresh rhizome yield i.e. 32.0 and 32.4 in 2013 and 2014, respectively. Significantly lowest fresh rhizome yield (12.1 and 12.5) was observed in weedy check control.

In regards to interaction, in 2013 and 2014, planting of turmeric in paired row method of 70/30 cm along with non-chemical weed management practice i.e. straw mulching and four hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) resulted significantly highest fresh rhizome yield (32.5 and 32.8) which was followed by the treatment combination of paired row 80/20 cm and weed management practice  $W_2$  (31.5 and 31.9).

In regards to interaction, in 2013 and 2014, growing of intercrop greengram in the intervening space between two paired rows of turmeric along with non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) resulted significantly highest fresh rhizome yield (32.5 and 32.9) which was followed by the treatment combination of intercropping baby corn and weed management practice with pre-application of metribuzin @ 500 gram per hectare along with five hand weeding (31.5 and 31.8).



#### **5.1.2.1.3.2 Dry rhizome yield (tonne per hectare)**

The dry rhizome yield (5.5 and 5.6) obtained under paired row planting 70/30 cm (M<sub>2</sub>) was significantly higher than that in 80/20 cm (5.4 and 5.4) in each year.

Intercropping of greengram in between paired rows resulted in significantly higher dry rhizome yield (5.5 and 5.6) as compared to that in intercropping of baby corn (5.4 and 5.4).

Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP produced significantly higher dry rhizome yield i.e. 7.6 and 7.1 in 2013 and 2014, respectively as compared to the rest of the treatments.

#### **5.1.2.1.3.3 Dry recovery (percentage)**

In both the year of experimentation, methods of paired row planting and intercropping could not bring about any effect on this attribute during both the years.

Among the weed management treatments, non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP produced significantly higher dry rhizome yield i.e. 23.7 and 23.6 in 2013 and 2014, respectively, over rest of the treatments.

#### **5.1.2.1.3.4 Curcumin content (Percentage)**

In both the years of experimentation, methods of paired row planting and intercropping could not bring about any effect on this attribute .

In 2013, curcumin content was significantly influenced by weed management practices but during 2014, there was no significant variation. Weedy check recorded the lowest curcumin content in both the years.

### **5.1.3 Baby corn**

#### **5.1.3.1 Growth character**

##### **5.1.3.1.1 Plant population (Number per metre square)**

In 2013 and 2014, the values of plant population recorded in different planting methods were at par.

Plant population, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching and four hand weeding (W<sub>2</sub>) than other treatments.

#### **5.1.3.1.2 Plant height (cm)**

In 2013 and 2014, the plant heights recorded in different planting methods were at par.

Plant height, during 2013 and 2014 was significantly higher in non-chemical treatment i.e. mulching and four hand weeding (W<sub>2</sub>). Weedy check control resulted significantly lowest height of baby corn in both the years of experimentation.

#### **5.1.3.1.3 Number of leaves per plant**

In 2013 and 2014, the values of number of leaves recorded in different planting methods were at par.

Number of leaves, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching and four hand weeding (W<sub>2</sub>) than other treatments.

#### **5.1.3.1.4 Leaf area index (LAI)**

Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not affect significantly LAI in either of 2013 and 2014.

LAI was highest due to non-chemical weed control treatment which was significantly superior to other treatments

#### **5.1.3.1.5 Days to 50 per cent tasseling and silking**

Planting systems did not affect on days to 50 per cent tasseling and silking significantly in each of 2013 and 2014.

Days (50.0 and 51.1) required to 50 per cent tasseling were highest for non chemical weed control treatment which was significantly higher than the remaining treatment. In 2013, days to 50 per cent silking was recorded significantly higher in W<sub>2</sub> than that in other treatments tested. However, in 2014, days to 50 per cent silking all the weed management practices were at par.

#### **5.1.3.2 Yield character**

##### **5.1.3.2.1 Number of cob per plant and weight per cob (g)**

Planting systems of paired row 80/20 cm and paired row 70/30 cm did not affect significantly on number and weight of cob in 2013 and 2014.

During both years, the non-chemical method (W<sub>2</sub>) resulted in significantly higher values of number (2.2 and 2.0) and weight of cob (75.5 and 75.0).

#### **5.1.3.2.2 Cob and stover yield (tonne per hectare)**

Planting system *viz.*, paired row 80/20 cm and paired row 70/30 cm did not influence significantly on yield of cob and stover in 2013 and 2014.

During both years, the non-chemical weed control treatment (W<sub>2</sub>) resulted in significantly higher values of yield of cob (8.2 and 8.1) and stover 16.6 and 16.6 than that in weedy check control, pre-application of metribuzin @ 500 gram per hectare along with five hand weeding and pre-application of oxadiargyl @ 90 gram per hectare along with five hand weeding.

#### **5.1.4 Greengram**

##### **5.1.4.1 Growth characters**

###### **5.1.4.1.1 Plant population (Number per metre square)**

In both 2013 and 2014, the value of plant populations recorded in two planting methods was at par.

Plant population, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching along with four hand weeding (W<sub>2</sub>). Weedy check control resulted significantly lowest population of greengram in both the years of experimentation.

###### **5.1.4.1.2 Plant height (cm)**

In 2013 and 2014, the plant heights recorded in different planting methods were identical.

Plant height, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching and four hand weeding (W<sub>2</sub>) followed by that in pre-emergence application of oxadiargyl @ 90 g per hectare with five hand weeding at 35, 65, 95, 140, 185 DAP (W<sub>3</sub>). Weedy check control resulted significantly lowest height of greengram in both the years of experimentation.

###### **5.1.4.1.3 Number of primary branch**

In both 2013 and 2014, the values of number of primary branch recorded in different planting methods were at par.

Number of primary branch, during 2013 and 2014, was significantly higher in non-chemical treatment i.e. mulching along with four hand weeding (W<sub>2</sub>).

#### **5.1.4.1.4 Leaf area index (LAI)**

Planting system viz., paired row 80/20 cm and paired row 70/30 cm were at par in respect of LAI in 2013 and 2014.

LAI was the highest for W<sub>2</sub> which was significantly superior to that of the other treatments.

#### **5.1.4.2 Yield characters**

##### **5.1.4.2.1 Number and length (cm) of pod**

Planting system viz., paired row 80/20 cm and paired row 70/30 cm were at par in respect of number and length of pod in either of 2013 and 2014.

During both years, the non-chemical method (W<sub>2</sub>) resulted in significantly higher values of number of pod (33.1 and 34.8) and length of pod (7.1 and 7.2) than other treatments.

##### **5.1.4.2.2 Test seed weight**

During both the years of experimentation, 1000 seed weight did not differ due to either planting method or intercropping. However, weed management practice of mulching and four hand weeding (W<sub>2</sub>) recorded significantly higher seed weight than that in other treatments.

##### **5.1.4.3 Grain and stover yield (quintal per hectare)**

Planting systems did not affect yield of grain and stover significantly in 2013 and 2014.

During both years, the treatment W<sub>2</sub> i.e. non-chemical method resulted in significantly higher values in yield of grain (3.1 and 3.2) and stover (8.0 and 8.1) than that in remaining treatments.

#### **5.1.5 Cropping system**

##### **5.1.5.1 Turmeric equivalent yield (tonnes per hectare)**

Planting method 70/30 cm recorded significantly higher turmeric equivalent yield (29.68 and 30.07) than that in planting method 80/20 cm (29.13 and

29.45). The two years pooled mean revealed that planting method 70/30 cm recorded higher turmeric equivalent yield (29.87) as compared 80/20 cm (29.29).

In both the years, intercropping baby corn recorded significantly higher turmeric equivalent yield (33.49 and 33.80) than that in intercropping of greengram (25.32 and 25.72). The two years pooled mean revealed that intercropping baby corn recorded significantly higher turmeric equivalent yield (33.64) than intercropping of greengram (25.52).

The weed management treatment of non-chemical weed control practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced significantly higher turmeric equivalent yield i.e. 38.79 and 39.19 in 2013 and 2014, respectively but it was at par with that in pre-emergence application of metribuzin @ 500 gram per hectare ( $W_3$ ) and pre-emergence application of oxadiargyl @ 90 gram per hectare ( $W_4$ ). The two years pooled mean revealed that the treatment  $W_2$  recorded significantly highest turmeric equivalent yield (38.99) followed by that  $W_3$  (31.96). The findings of pooled mean revealed that non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP ( $W_2$ ) produced highest turmeric equivalent yield 38.99 tonnes per hectare while the sole turmeric with recommended weed management practice recorded 36.96 tonnes per hectare.

#### **5.1.5.2 Land equivalent ratio**

The treatment combination of planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (1.57 and 1.59) followed by planting of turmeric paired row of 80/20 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP (1.54 and 1.55).

#### **5.1.5.3 Total nutrient uptake (kilogram per hectare)**

##### **Total nitrogen uptake**

In both the years of experimentation, methods of paired row planting could not bring about significant effect on total nitrogen uptake.

Intercropping baby corn recorded significantly higher total nitrogen uptake (274.8 and 278.3) than that in intercropping of greengram (266.1 and 267.5) in two years of study.

The non-chemical weed management practice i.e. straw mulching and hand weeding (W<sub>2</sub>) recorded significantly higher total nitrogen uptake i.e. 450.0 and 455.1 in 2013 and 2014, respectively than that in remaining treatments.

### **Total phosphorus uptake**

Planting methods could not bring about significant variation in total phosphorus uptake in either 2013 or 2014.

Intercropping greengram corn recorded significantly higher total phosphorus uptake (31.9 and 36.8) than that in intercropping of baby corn (31.9 and 35.8).

The non-chemical weed management practice (W<sub>2</sub>) showed significantly higher total phosphorus uptake i.e. 56.4 and 61.0 in 2013 and 2014, respectively than that in remaining treatments.

### **Total potassium uptake**

In both the years, planting methods and intercropping could not bring significant variation in uptake of total potassium.

The non-chemical weed management practice (W<sub>2</sub>) resulted significantly higher total potassium uptake of 505.4 and 507.8 in 2013 and 2014, respectively than that in remaining treatments.

#### **5.1.5.4 Organic carbon and available nutrients in soil at harvest**

##### **Organic carbon (gram per kilogram)**

The methods of paired row planting and intercropping could not cause about significant effect on organic carbon in soil in both the years.

The non-chemical weed management practice (W<sub>2</sub>) registered significantly higher soil organic carbon i.e. 4.76 and 4.93 in 2013 and 2014, respectively than that in remaining treatments.

##### **Available nitrogen (kilogram per hectare)**

Planting method 80/20 cm recorded significantly higher available nitrogen in soil (359.5 and 365.1) than that in 70/30 cm (359.3 and 364.5).

In both the years, of experimentation, intercropping greengram recorded significantly higher available nitrogen in soil (361.1 and 366.2) than intercropping of baby corn (357.7 and 363.4).

The non-chemical weed management practice i.e. straw mulching and hand weeding at 35, 65, 95 and 140 DAP (W<sub>2</sub>) produced significantly higher available nitrogen in soil i.e. 372.2 and 378.9 in 2013 and 2014, respectively than that in remaining treatments.

### **Available phosphorus**

Planting method 80/20 cm recorded significantly higher available phosphorus in soil (20.6 and 21.1) than that in 70/30 cm (20.4 and 20.9).

In both the year, of experimentation, intercropping baby corn recorded significantly higher available phosphorus in soil (20.9 and 21.4) than that in intercropping of greengram (20.1 and 20.6).

Among the weed management treatments, non-chemical weed management practice (W<sub>2</sub>) produced significantly higher available phosphorus in soil i.e. 23.1 and 23.7 in 2013 and 2014, respectively than those other treatments.

### **Available potassium (kilogram per hectare)**

Planting method 80/20 cm recorded significantly higher available potassium in soil (203.1 and 212.1) than that in 70/30 cm (202.8 and 211.4).

The intercropping baby corn recorded significantly higher available potassium in soil (203.1 and 212.0) than that in intercropping of greengram (202.8 and 211.5) in both the years.

The weed management treatments of non-chemical weed management (W<sub>2</sub>) produced significantly higher available potassium in soil i.e. 208.3 and 214.1 in 2013 and 2014, respectively than those other treatments.

### **5.1.5.5 Economic evaluation**

#### **5.1.5.5 .1 Cost of cultivation (₹ per hectare)**

The treatment combination of M<sub>2</sub>I<sub>1</sub>W<sub>2</sub> i.e. planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management

practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP recorded highest values of R 219660 and R 219767 during 2013 and 2014, respectively.

#### **5.1.5.5.2 Gross return (R per hectare)**

The treatment combination of  $M_2I_1W_2$  i.e. planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP recorded highest values (R 885567 and R 895837) in both the years.

#### **5.1.5.5.3 Net return per hectare (R per hectare)**

The treatment combinations of  $M_2I_1W_2$  i.e. planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (R 665907 and R 676070) in 2013 and 2014.

#### **5.1.5.5.4 Benefit : Cost ratio**

The treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (4.03 and 4.08).

#### **5.1.5.5.5 Net return $R^{-1}$ invested**

The highest values of R 3.03 and R 3.08 during first and second year was recorded with the treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ).

#### **5.1.5.5.6 Monetary advantage**

The treatment combination of planting of turmeric paired row of 70/30 cm, intercropping baby corn and non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (R 826284 and R 860961) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP (R 770144 and R 787327) during the respective years.



#### **5.1.5.5.7 Bioenergetics**

The treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values of cultural energy use efficiency (13.25 and 13.96) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP (13.64 and 12.47) in 2013 and 2014. Similarly, in regards of energy production ratio (EPR) for turmeric, the treatment combination of planting of turmeric paired row of 70/30 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching followed by four hand weeding at 35, 65, 95 and 140 DAP ( $M_2I_1W_2$ ) recorded highest values (1.67 and 1.71) followed by planting of turmeric paired row of 80/20 cm and intercropping baby corn along with non-chemical weed management practice i.e. mulching along with four hand weeding at 35, 65, 95 and 140 DAP (1.64 and 1.60) in 2013 and 2014.

#### **CONCLUSION**

**Based on the findings of the two years experimentation, it could be concluded that** “Planting turmeric in paired row 70/30 cm, intercropping baby corn and paired rows along with weed management practice *viz.*, mulching along with hand weeding at 35, 65, 95 and 140 DAP proved superior combination, followed by planting turmeric in paired row 80/20 cm intercropping baby corn in the intermediate space between paired rows and weed management practice *viz.*, mulching along with four hand weeding at 35, 65, 95 and 140 DAP”.

#### **FUTURE LINE OF RESEARCH WORKS**

1. Since, turmeric has slow initial growth, there will be ample space to grow a second intercrop after harvest of first intercrop which could be evaluated for their influence on weed suppression and yield of turmeric.
2. Keeping in view the aspects of soil health and smothering effect on weeds, growing of a green manuring cover crop in between paired rows of turmeric after harvest of first intercrop could also be evaluated.

3. Trials involving different cereals, pulses, vegetables and flower crops other than those used in the present study should also be tried to know the best intercrop compatibility in turmeric and to get maximum returns per unit area and time.
4. Only one row of greengram as intercrop was sown in between paired rows of turmeric in the present study but trial with more plant population of greengram may be evaluated for their influence on suppressing weed growth and increasing per day per unit area productivity.
5. Paired row of different row spacing other than those adopted in the present study can also be assessed.
6. Integrated weed management practices including post emergence herbicide also hold promise.
7. Trial on different low cost mulch materials for their influence on weed control under turmeric based intercropping system can be tried.
8. Different low cost mulch materials could also be tried for effective weed control under turmeric based intercropping system.
9. Evaluation of different turmeric varieties for curcumin content, sciolytic nature and productivity under intercropping system could also be an area of interest.

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\*Original not seen

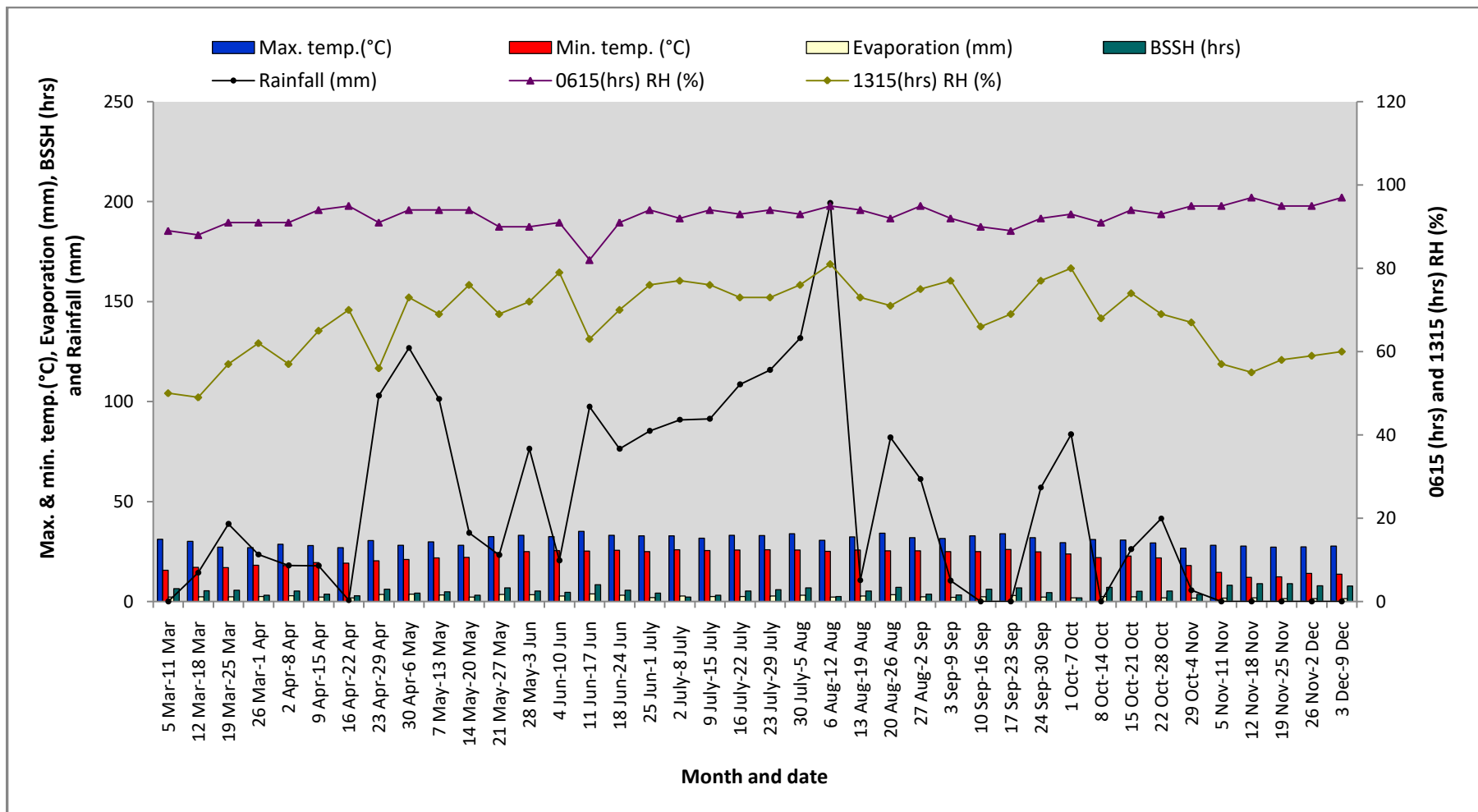
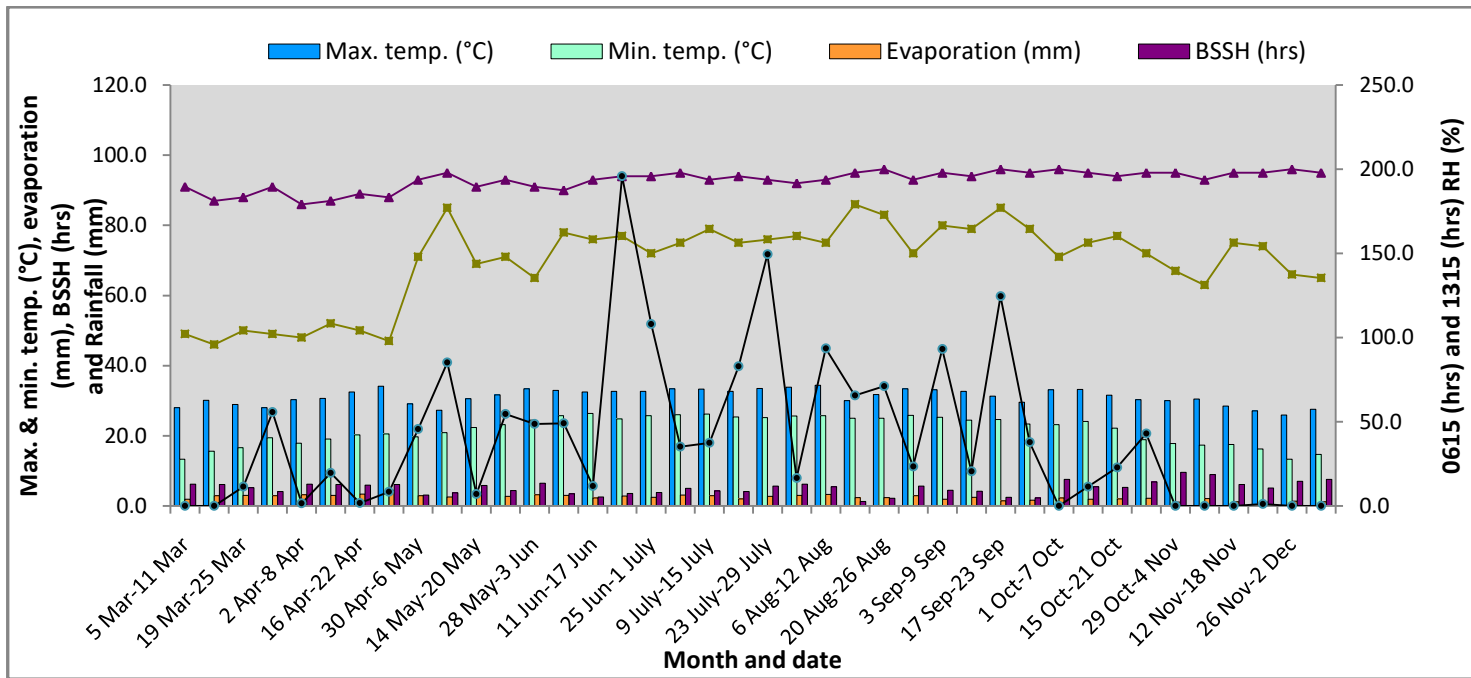
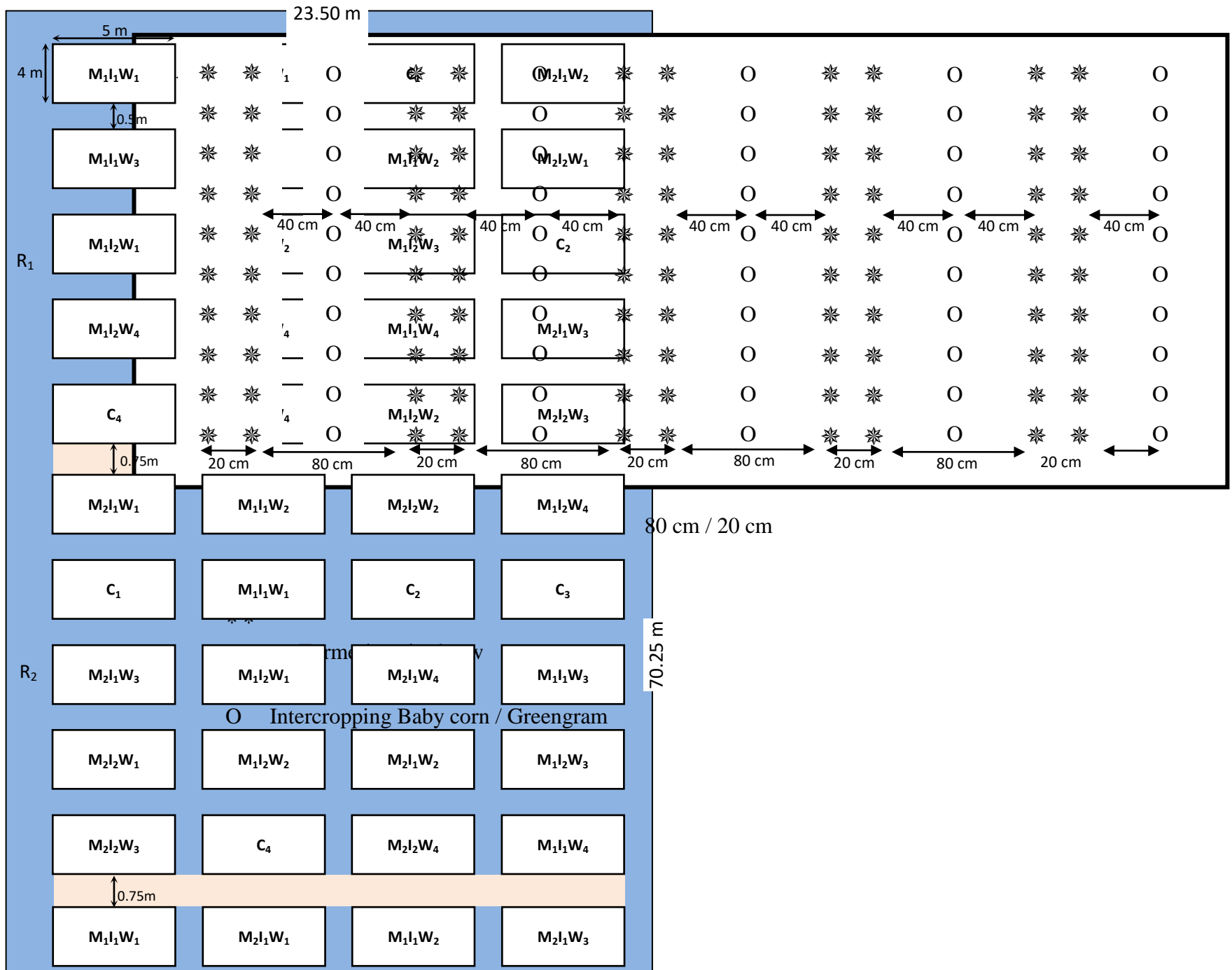


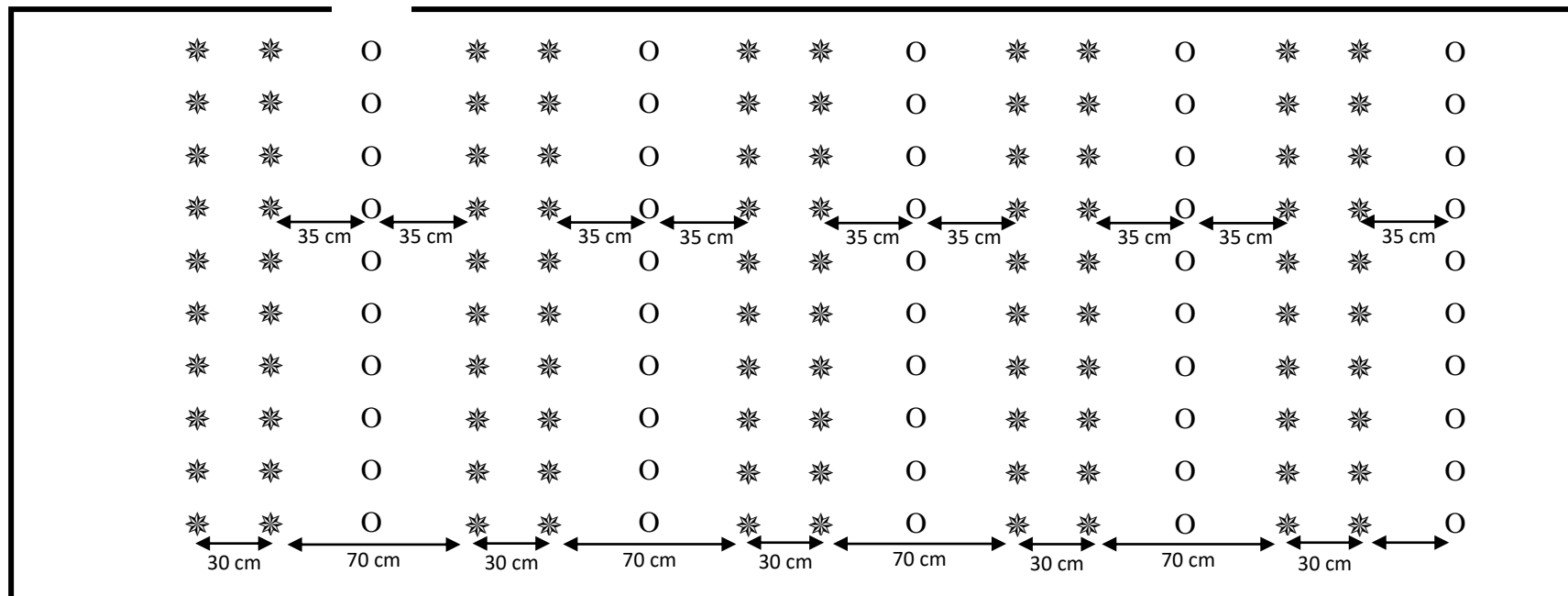
Fig. 3.1. Weather conditions prevailed during the crop period of 2013



**Fig. 3.2. Weather conditions prevailed during the crop period of 2014**



**Fig. 3.4. Illustrative sketch of paired row planting (80 cm / 20 cm) method of turmeric and intercropping baby corn / greengram**



Paired Row 70 cm / 30 cm

Legend

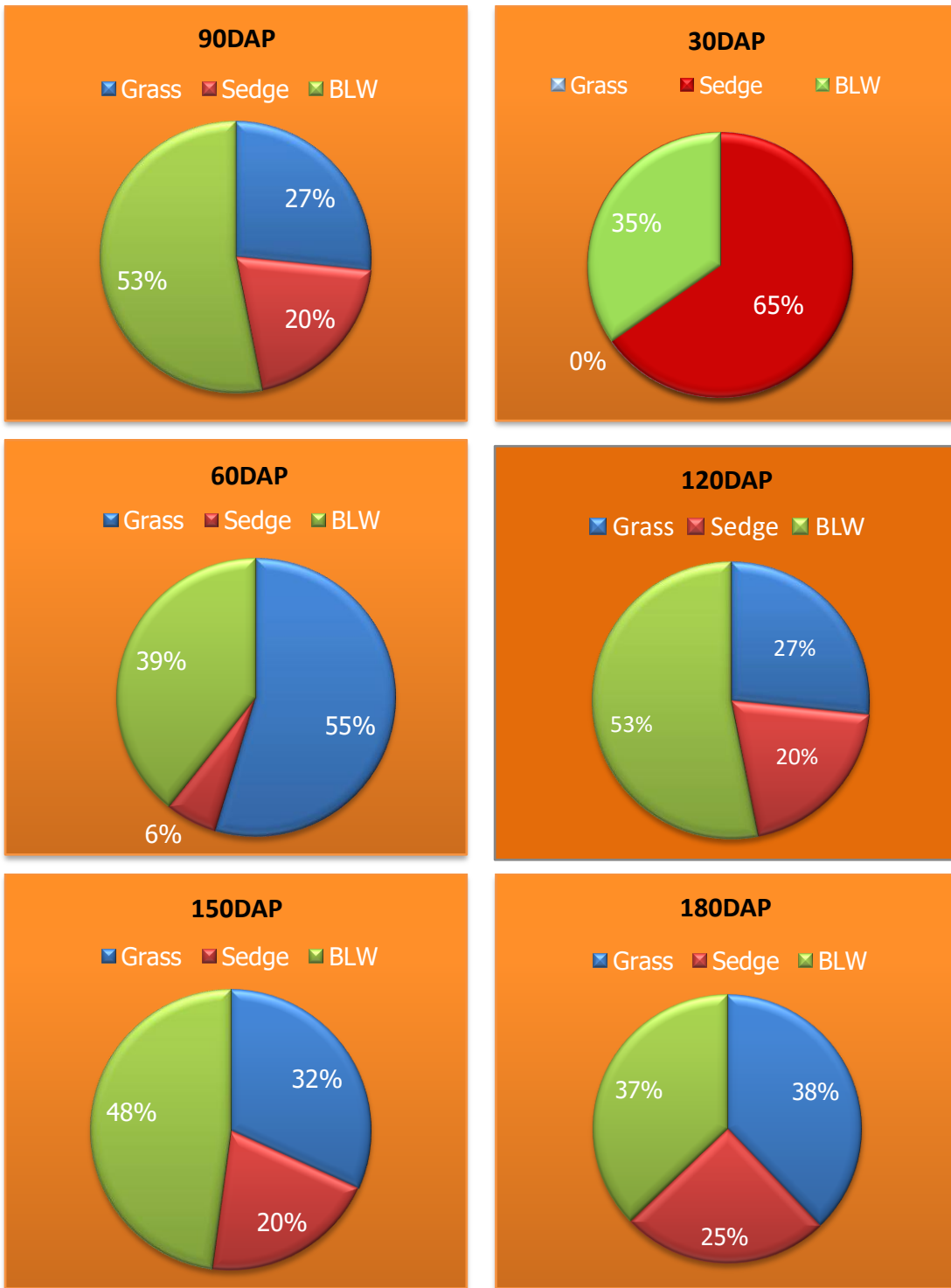
\* \*

Turmeric paired row

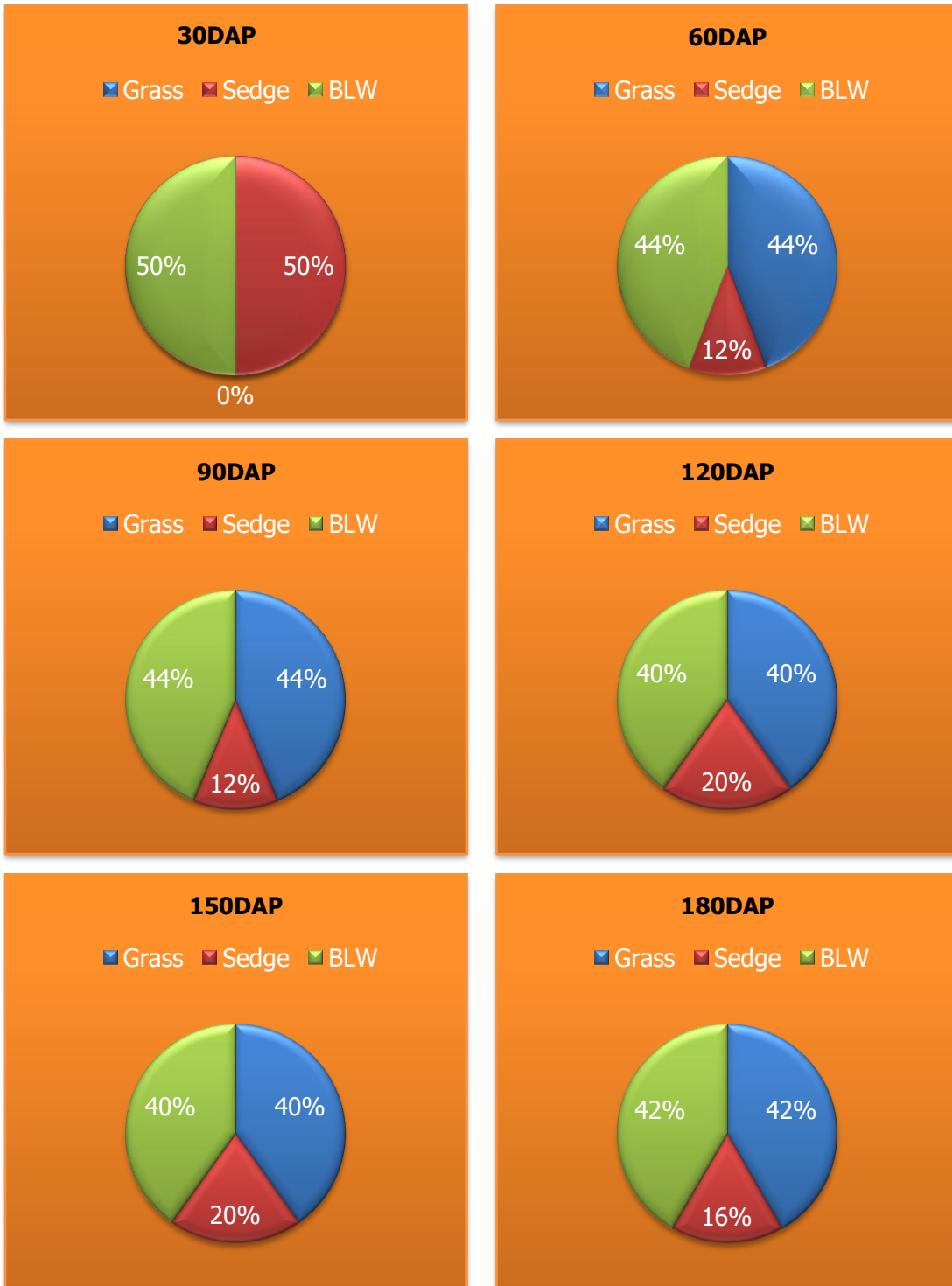
\* \*

O Intercropping Baby corn / Greengram

**Fig. 3.5. Illustrative sketch of paired row planting (70 cm / 30 cm) method of turmeric and intercropping baby corn / greengram**



**Fig. 4.1. Relative weed density of total grasses, sedges and BL weeds, 2013**



**Fig. 4.2. Relative weed density of total Grasses, Sedges and BL weed, 2014**

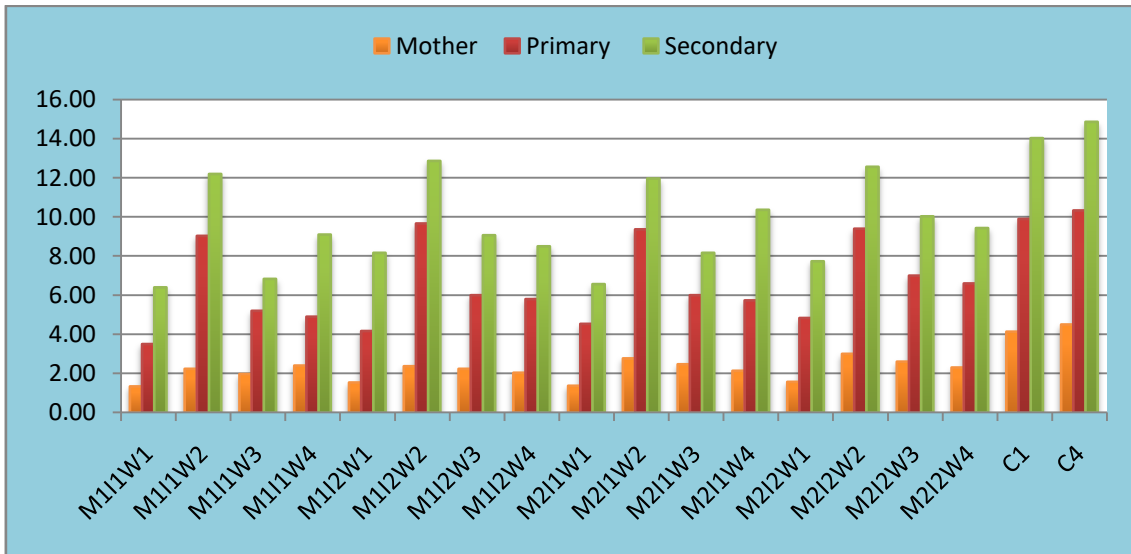


Fig. 4.3. Number of rhizome as influenced by different treatments, 2013

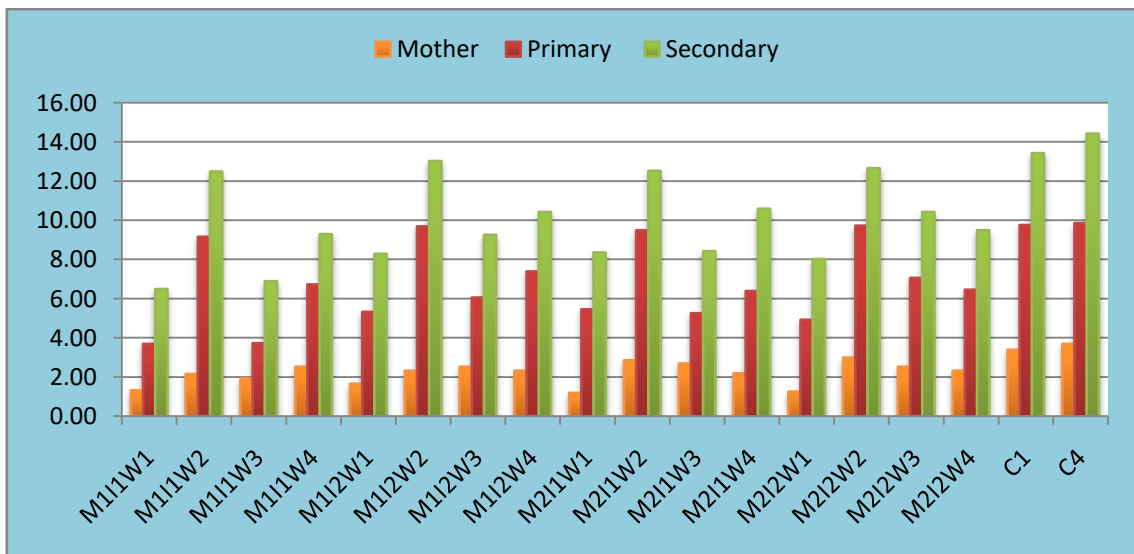


Fig. 4.4. Number of rhizome as influenced by different treatments, 2014

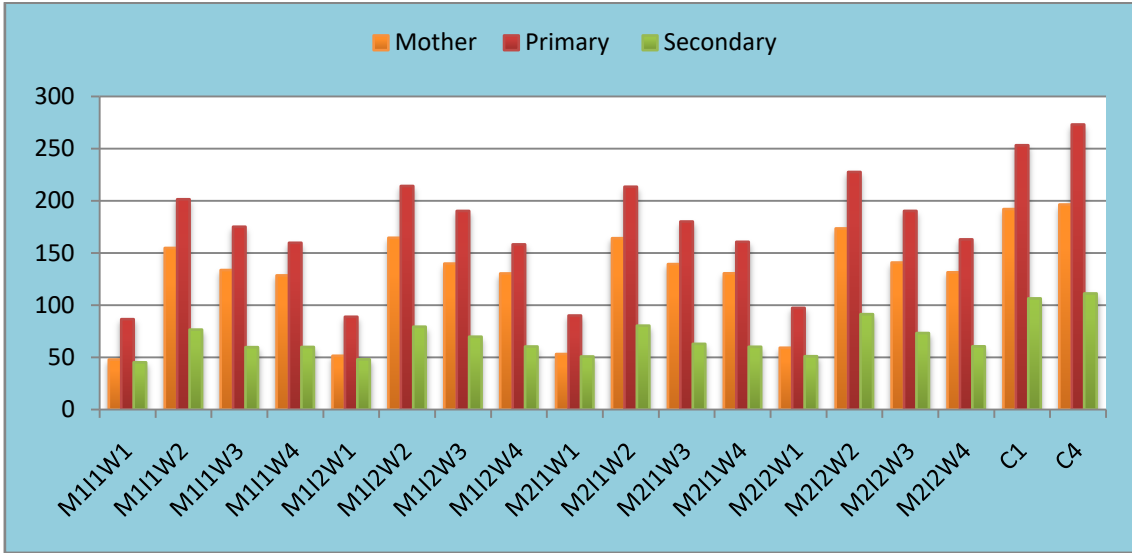


Fig. 4.5. Weight of rhizome as influenced by different treatments, 2013

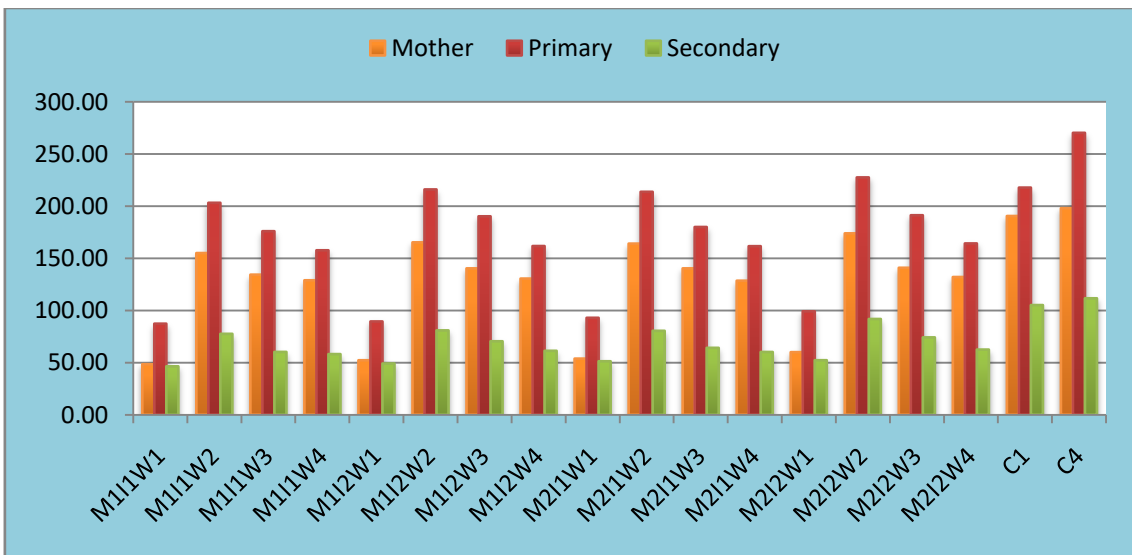


Fig. 4.6. Weight of rhizome as influenced by different treatments, 2014



**Plate 1. 80/20 cm; intercropping greengram; non-chemical weed control**



**Plate 2. 70/30 cm; intercropping baby corn; non-chemical weed control**



**Plate 3. 80/20 cm; intercropping baby corn; pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 4. Sole greengram**



**Plate 5. 80/20 cm; intercropping baby corn; non-chemical weed control**



**Plate 6. Sole baby corn**



**Plate 7. Sole turmeric (weedfree)**



**Plate 8. Sole turmeric (recommended)**



**Plate 9. 70/30 cm; intercropping greengram; non-chemical weed management**



**Plate 10. 80/20 cm; intercropping baby corn; non-chemical weed management**



**Plate 11. 80/20 cm; intercropping baby corn; pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 12. 80/20 cm; intercropping baby corn; pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 13. 80/20 cm; intercropping greengram; pre-emergence application of metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 14. 80/20 cm; intercropping greengram; pre-emergence application of oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 15. 70/30 cm; intercropping baby corn; weedy check control**



**Plate 16. 70/30 cm; intercropping greengram; weedy check control**



**Plate 17. 80/20 cm; intercropping baby**



**Plate 18. 80/20 cm; intercropping**

**corn; weedy check control**



*Digitaria setigera*

**greengram; non-chemical weed control**



*Cyperus iria*



*Mimosa pudica*



*Mimosa diplotricha*



*Borreria articularis*



*Panicum repens*



*Ageratum houstonianum*

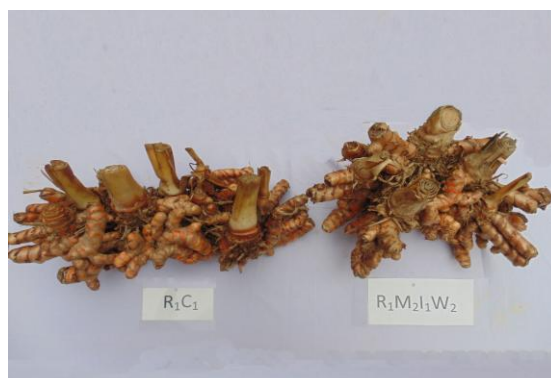


*Commelina diffusa*

**Plate 19. Pre-dominant weed flora of the experimental field**



**Plate 20. 80/20 cm vs. 70/30 cm**



**Plate 21. Sole turmeric vs. 70/30 cm, baby corn and non-chemical weed control**



**Plate 22. Sole turmeric vs. 80/20 cm, baby corn and non-chemical weed control**



**Plate 23. Sole turmeric vs. 70/30 cm, baby corn and metribuzin @ 500 g ha<sup>-1</sup>**



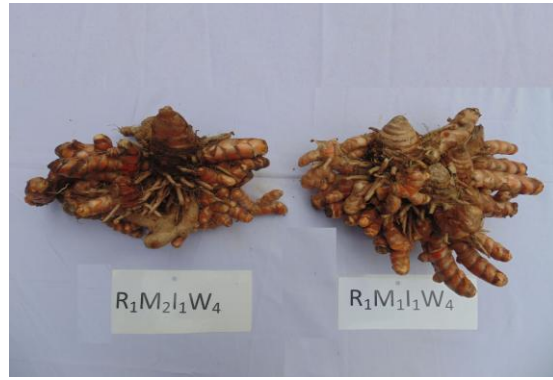
**Plate 24. Sole turmeric vs. 80/20 cm, baby corn and oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 25. Sole turmeric vs. 70/30 cm, baby corn and oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 26. 80/20 cm, baby corn, weedy check vs. 70/30 cm, baby corn, weedy check**



**Plate 27. 70/30 cm, baby corn, oxadiargyl @ 90 g ha<sup>-1</sup> vs. 80/20 cm, baby corn, oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 28. 70/30 cm, baby corn, non-chemical weed control vs. 80/20 cm, baby corn, oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 29. 80/20 cm, baby corn, non-chemical weed control vs. 70/30 cm, baby corn, non-chemical weed control**



**Plate 30. 80/20 cm, green gram, weedy check control vs. 70/30 cm, green gram, weedy check control**



**Plate 31. 80/20 cm, green gram, non-chemical weed control vs. 70/30 cm, green gram, non-chemical weed control**



**Plate 32. 70/30 cm, baby corn, non-chemical weed control vs. 70/30 cm, greengram, non-chemical weed control**



**Plate 33. 70/30 cm, greengram, metribuzin @ 500 g ha<sup>-1</sup> vs. 70/30 cm, greengram, non-chemical weed control**



**Plate 34. 70/30 cm, greengram, oxadiargyl @ 90 g ha<sup>-1</sup> vs. 70/30 cm, greengram, non-chemical weed control**



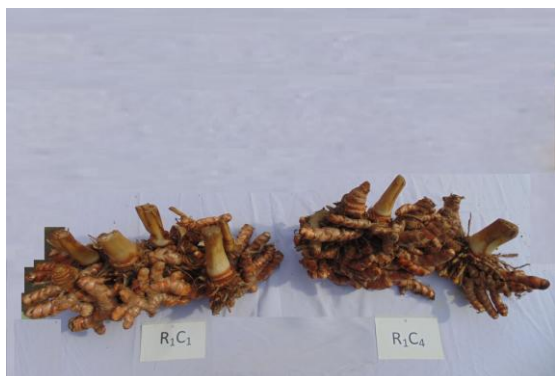
**Plate 35. 70/30 cm, greengram, oxadiargyl @ 90 g ha<sup>-1</sup> vs. 80/20 cm, baby corn, oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 36. 70/30 cm, greengram, oxadiargyl @ 90 g ha<sup>-1</sup> vs. 70/30 cm, greengram, metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 37. 80/20 cm, baby corn, metribuzin @ 500 g ha<sup>-1</sup> vs. 70/30 cm, greengram, metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 38. Sole turmeric (recommended) vs. sole turmeric (weed free)**



**Plate 39. 80/20 cm, greengram, metribuzin @ 500 g ha<sup>-1</sup> vs. 80/20 cm, greengram, oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 40. 80/20 cm, greengram, weedy check vs. 80/20 cm, greengram, oxadiargyl @ 90 g ha<sup>-1</sup>**



**Plate 41. 80/20 cm, greengram, weedy check vs. 80/20 cm, greengram, metribuzin @ 500 g ha<sup>-1</sup>**



**Plate 42. Sole turmeric (recommended) vs. rest of the treatment with intercropping greengram**



**Plate 43. Sole turmeric (recommended) vs. rest of the treatment with intercropping baby corn**

**Table 4.1. Weed flora of the experimental fields (2013 and 2014)**

Botanical name	Family	Habit	Common name	Vernacular name (Assamese)
<b>A. Grass weeds</b>				
1. <i>Cynodon dactylon</i> (L.) Pers	Poaceae	P	Bermuda grass	Dubari bon
2. <i>Digitaria setigera</i> Roth*	Poaceae	A	East Indian crabgrass	Sira bon
3. <i>Elusine indica</i> (L.) Gaertn.*	Poaceae	A	Indian goose grass	Bobosa bon
4. <i>Imperata cylindrica</i> (L.) Beauv.	Poaceae	P	Congograss	Ulu
5. <i>Panicum repens</i> L.*	Poaceae	P	Torpedo grass	----
6. <i>Saccharum spontaneum</i> L.	Poaceae	P	Tigergrass	Kohua
<b>B. Sedge weeds</b>				
1. <i>Cyperus iria</i> L.*	Cyperaceae	A	Yellow nut sedge	Murphula bon
2. <i>Cyperus rotundus</i> L.	Cyperaceae	P	Nut sedge	Keya bon
3. <i>Fimbristylis aestivalis</i> (Retz.) Vahl.*	Cyperaceae	A	Summer Fimbry	Mutha bon
4. <i>Cyperus difformis</i> L.	Cyperaceae	A	Common sedge	Murphula bon
5. <i>Cyperus compressus</i> L.	Cyperaceae	A	----	Murphula ban
6. <i>Cyperus tanuispica</i> Steud	Cyperaceae		----	Murphula bon
7. <i>Cyperus pilosus</i> Vahl.	Cyperaceae		----	Murphula bon
<b>C. Broad leaved weeds</b>				
1. <i>Ageratum houstonianum</i> Mill.*	Asteraceae	A	Blue Billygoat weed	Gondhoa bon
2. <i>Alternanthera sessilis</i> R. Br.	Amaranthaceae	A	Sessilis joyweed	Matikaduri
3. <i>Bidens pilosa</i> L.	Compositae	A	Spanish needle	----
4. <i>Borreria articularis</i> (L.f.) Will*	Rubiaceae	A	----	Gahoribon
5. <i>Chenopodium album</i> L.	Chenopodiaceae	A	Lamb's quarters	Jhilmil
6. <i>Commelina diffusa</i> Burm.f.*	Commelinaceae	A	Climbing dayflower	Kona himolu
7. <i>Gynura bicolor</i> (Roxb.ex Willd.) D C	Asteraceae	A	Velvet plant	Kopahibon
8. <i>Ludwigia linifolia</i> Poir.	Onagraceae	A	----	Bonlong
9. <i>Mimosa pudica</i> L.*	Mimosaceae	P	Touch-me-not	Nilajibon
10. <i>Mimosa diplotricha</i> C. Wright*	Mimosaceae	A	Climbing mimosa	Lota nilaji
11. <i>Scoparia dulcis</i> L.	Scrophulariaceae	A	Broom weed	Bondhonia

\*Predominant weeds in experimental plots; A=Annual, P=Perennial

**Table 4.2(a). Absolute and relative density of predominant weed species in turmeric at 30 and 60 DAP**

Weed	30DAP				60DAP			
	AD (No. m <sup>-2</sup> )		RD (%)		AD (No. m <sup>-2</sup> )		RD (%)	
	2013	2014	2013	2014	2013	2014	2013	2014
<b>Grasses</b>								
<i>Digitaria setigera</i>	0.0	0.0	0.0	0.0	18.5	16.3	11.3	10.5
<i>Elusine indica</i>	27.5	22.5	23.0	23.4	30.2	29.5	18.3	19.1
<i>Panicum repens</i>	43.5	31.3	36.4	32.5	32.2	32.7	19.6	21.1
Other grasses	7.0	6.0	5.9	6.2	8.3	7.2	5.1	4.6
Total grasses	78.0	59.8	65.3	62.1	89.2	85.7	55.1	55.0
<b>Sedges</b>								
<i>Cyperus iria</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Fimbristylis aestivalis</i>	0.0	0.0	0.0	0.0	3.5	4.2	2.1	2.7
Other sedges	0.0	0.0	0.0	0.0	6.3	6.2	3.9	4.0
Total sedges	0.0	0.0	0.0	0.0	9.8	10.3	6.0	7.0
<b>BLW</b>								
<i>Ageratum houstonianum</i>	0.0	0.0	0.0	0.0	7.7	8.5	4.7	5.5
<i>Borreria articularis</i>	19.5	13.8	16.3	14.4	21.8	17.3	13.3	11.2
<i>Commelina diffusa</i>	0.0	0.0	0.0	0.0	4.3	4.3	2.6	2.8
<i>Mimosa pudica</i>	6.7	6.7	5.6	6.9	7.2	7.3	4.4	4.7
<i>Mimosa diplotricha</i>	8.5	10.0	7.1	10.4	14.8	14.7	9.0	9.5
Other BLW	7.0	6.0	5.9	6.2	8.0	6.7	4.9	4.3
Total BLW	41.5	36.5	34.7	37.9	64.0	58.8	38.9	38.0
Total weed density	119.5	96.3	100.0	100.0	164.5	154.8	100.0	100.0

AD-Absolute density

RD-Relative density

BLW-Broad leaved weed

**Table 4.2(b). Absolute and relative density of predominant weed species in turmeric at 90 and 120 DAP**

Weed	90 DAP				120 DAP			
	AD (No. m <sup>-2</sup> )		RD (%)		AD (No. m <sup>-2</sup> )		RD (%)	
	2013	2014	2013	2014	2013	2014	2013	2014
<b>Grasses</b>								
<i>Digitaria setigera</i>	51.0	45.2	25.0	24.7	17.7	25.0	10.6	15.4
<i>Elusine indica</i>	30.7	31.8	15.0	17.4	26.2	25.5	15.7	15.7
<i>Panicum repens</i>	25.7	16.8	12.6	9.2	11.5	14.5	6.9	8.9
Other grasses	9.2	8.3	4.5	4.6	7.5	7.2	4.5	4.4
Total grasses	116.5	102.2	57.0	55.8	62.8	72.2	37.7	44.4
<b>Sedges</b>								
<i>Cyperus iria</i>	4.2	5.3	2.0	2.9	14.2	15.2	8.5	9.3
<i>Fimbristylis aestivalis</i>	4.7	5.5	2.3	3.0	5.3	7.2	3.2	4.4
Other sedges	8.7	7.2	4.2	3.9	9.2	7.5	5.5	4.6
Total sedges	17.5	18.0	8.6	9.8	28.7	29.8	17.2	18.3
<b>BLW</b>								
<i>Ageratum houstonianum</i>	11.2	10.5	5.5	5.7	12.5	11.7	7.5	7.2
<i>Borreria articularis</i>	25.2	21.0	12.3	11.5	34.3	22.5	20.6	13.8
<i>Commelina diffusa</i>	6.0	6.0	2.9	3.3	6.7	6.7	4.0	4.1
<i>Mimosa pudica</i>	7.3	7.5	3.6	4.1	7.2	7.5	4.3	4.6
<i>Mimosa diplotricha</i>	12.7	11.5	6.2	6.3	6.5	5.8	3.9	3.6
Other BLW	7.7	6.3	3.8	3.5	7.8	6.5	4.7	4.0
Total BLW	70.3	62.8	34.4	34.3	75.2	60.7	45.1	37.3
Total weed density	204.3	183.0	100.0	100.0	166.7	162.7	100.0	100.0

AD-Absolute density

RD-Relative density

BLW-Broad leaved weed

**Table 4.2(c). Absolute and relative density of predominant weed species in turmeric at 150 and 180 DAP**

Weed	150 DAP				180 DAP			
	AD (No. m <sup>-2</sup> )		RD (%)		AD (No. m <sup>-2</sup> )		RD (%)	
	2013	2014	2013	2014	2013	2014	2013	2014
<b>Grasses</b>								
<i>Digitaria setigera</i>	11.8	16.7	7.30	11.6	12.5	13.3	7.61	10.1
<i>Elusine indica</i>	22.2	20.8	13.7	14.5	16.2	15.2	9.8	11.5
<i>Panicum repens</i>	10.0	9.8	6.2	6.8	14.3	9.0	8.7	6.8
Other grasses	7.5	7.3	4.6	5.1	7.2	7.0	4.4	5.3
Total grasses	51.5	52.3	31.8	36.4	50.2	44.5	30.6	33.7
<b>Sedges</b>								
<i>Cyperus iria</i>	16.5	15.0	10.2	10.4	18.3	14.3	11.2	10.9
<i>Fimbristylis aestivalis</i>	6.2	4.7	3.8	3.2	4.8	4.2	2.9	3.2
Other sedges	10.3	10.3	6.4	7.2	10.0	6.5	6.1	4.9
Total sedges	33.00	30.0	20.4	20.9	33.2	25	20.2	18.9
<b>BLW</b>								
<i>Ageratum houstonianum</i>	14.2	12.8	8.7	8.9	15.3	13.3	9.3	10.1
<i>Borreria articularis</i>	35.8	26.2	22.1	18.2	36.0	22.8	21.9	17.3
<i>Commelina diffusa</i>	6.7	4.8	4.1	3.4	5.7	5.7	3.5	4.3
<i>Mimosa pudica</i>	6.5	6.7	4.1	4.6	6.5	5.8	4.0	4.4
<i>Mimosa diplotricha</i>	6.6	5.2	4.1	3.6	7.3	3.0	4.5	2.3
Other BLW	7.2	5.7	4.4	3.9	10.0	8.0	6.1	6.1
Total BLW	77.5	61.3	47.8	42.7	80.8	62.5	49.2	47.3
<b>Total weed density</b>	162.0	143.7	100.0	100.0	164.2	132	100.0	100.0

AD-Absolute density

RD-Relative density

BLW-Broad leaved weed

**Table 4.3(a). Total grass weed density at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total grass weed density (No. m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	6.3 (41.7)	5.8 (35.1)	6.9 (50.3)	6.7 (47.3)
M <sub>2</sub> : Paired row 70/30 cm	5.8 (35.8)	5.7 (33.4)	6.7 (47.7)	6.5 (45.1)
SEd (±)	0.044	0.041	0.054	0.045
CD (P=0.05)	0.09	0.08	0.11	0.09
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	6.0 (38.1)	5.8 (34.4)	6.7 (48.1)	6.6 (46.7)
I <sub>2</sub> : Greengram	6.1 (39.4)	5.8 (34.1)	6.9 (49.8)	6.6 (45.8)
SEd (±)	0.044	0.041	0.054	0.044
CD (P=0.05)	0.09	0.08	0.11	0.09
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	8.9 (78.0)	7.8 (59.8)	9.5 (89.2)	9.3 (85.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	5.0 (24.8)	4.9 (24.2)	4.6 (21.0)	4.4 (18.5)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.0 (24.7)	5.1 (25.3)	6.4 (40.3)	6.2 (38.5)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.3 (27.5)	5.3 (27.7)	6.8 (45.3)	6.5 (42.2)
SEd (±)	0.062	0.058	0.076	0.063
CD (P=0.05)	0.13	0.12	0.16	0.13
<b>Treatment Mean</b>	6.0	5.8	6.8	6.6
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	1.6 (12.0)	2.1 (8.0)	4.1 (16.0)	3.9 (14.7)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (10.0)	2.9 (8.0)	3.6 (12.7)	3.6 (12.7)
SEd (±)	2.43E-08	0.001	0.149	0.255
CD (P=0.05)	1.05E-07	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.045	0.037	0.243	0.225
Treatment mean vs. C <sub>4</sub>	0.045	0.037	0.099	0.093
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.13	0.10	0.67	0.62
Treatment mean vs. C <sub>4</sub>	0.13	0.10	0.27	0.26
CV (%)	2.5	2.5	2.8	2.4

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.3(b). Total grass weed density at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total grass weed density (No. m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	8.0 (68.6)	6.8 (49.5)	6.7 (47.0)	6.4 (42.8)
M <sub>2</sub> : Paired row 70/30 cm	7.0 (54.2)	6.7 (50.6)	6.0 (36.8)	6.0 (28.8)
SEd (±)	0.039	0.043	0.059	0.046
CD (P=0.05)	0.08	0.09	0.12	0.09
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	7.2 (57.7)	6.7 (49.1)	5.8 (34.9)	6.2 (40.3)
I <sub>2</sub> : Greengram	7.8 (65.1)	6.9 (51.0)	6.9 (48.8)	6.2 (31.3)
SEd (±)	0.039	0.043	0.059	0.46
CD (P=0.05)	0.08	0.09	0.12	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	10.8 (116.5)	10.1(102.2)	7.9 (62.8)	8.5 (52.2)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.9 (24.6)	4.0 (15.5)	4.7 (22.5)	4.1 (26.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.0 (50.0)	6.3 (39.7)	6.1 (37.2)	5.9 (39.5)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.4 (54.5)	6.6 (42.8)	6.7 (45.0)	6.2 (25.3)
SEd (±)	0.056	0.61	0.084	0.065
CD (P=0.05)	0.11	0.12	0.17	0.13
<b>Treatment Mean</b>	7.5	6.8	6.4	6.2
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	5.0 (24.8)	2.4 (5.3)	2.8 (7.3)	2.9 (8.0)
C <sub>4</sub> : (Sole turmeric-weed free)	1.94 (3.3)	1.4 (1.3)	2.1 (4.0)	2.3 (4.7)
SEd (±)	0.246	0.383	0.122	0.143
CD (P=0.05)	1.06	NS	0.52	0.61
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.082	0.144	0.123	0.044
Treatment mean vs. C <sub>4</sub>	0.187	0.292	0.014	0.149
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.23	0.40	0.34	0.12
Treatment mean vs. C <sub>4</sub>	0.52	0.81	0.04	0.41
CV (%)	1.8	2.2	3.2	2.6

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.3(c). Total grass weed density at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total grass weed density ( No. m <sup>-2</sup> )			
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	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.4 (13.8)	2.4 (13.8)	5.2 (28.9)	5.4 (31.0)
M <sub>2</sub> : Paired row 70/30 cm	2.2 (11.9)	2.3 (12.3)	5.2 (28.8)	5.3 (29.3)
SEd (±)	0.027	0.020	0.047	0.044
CD (P=0.05)	0.06	0.04	NS	0.09
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.3 (12.3)	2.4 (13.3)	5.1 (30.0)	5.3 (30.0)
I <sub>2</sub> : Greengram	2.4 (13.4)	2.3 (12.9)	5.3 (29.6)	5.3 (30.3)
SEd (±)	0.027	0.020	0.047	0.044
CD (P=0.05)	0.06	NS	0.09	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	7.2 (51.5)	7.3 (52.3)	7.1 (50.2)	6.7 (44.5)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	2.8 (7.2)	2.7 (6.8)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	5.3 (27.5)	5.8 (33.2)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	5.6 (30.7)	6.1 (36.2)
SEd (±)	0.039	0.029	0.066	0.063
CD (P=0.05)	0.08	0.06	0.13	0.13
<b>Treatment Mean</b>				
	2.3	2.4	5.2	5.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.7 (0.0)	0.7 (0.0)	1.6 (2.0)	1.3 (1.3)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)
SEd (±)	0.000	0.00	2.43E-08	0.291
CD (P=0.05)	NS	NS	1.05E-07	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.009	0.018	0.046	0.293
Treatment mean vs. C <sub>4</sub>	0.009	0.018	0.046	0.032
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.03	0.05	0.13	0.81
Treatment mean vs. C <sub>4</sub>	0.03	0.05	0.13	0.09
CV (%)	4.1	3.0	3.1	2.9

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.4(a). Total sedge weed density at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total sedge weed density (No. m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				

M <sub>1</sub> : Paired row 80/20 cm	0.7 (0.0)	0.7 (0.0)	2.3 (5.8)	2.3 (5.5)
M <sub>2</sub> : Paired row 70/30 cm	0.7 (0.0)	0.7 (0.0)	2.3 (5.8)	2.2 (5.3)
SEd (±)	0.001	0.00	0.047	0.037
CD (P=0.05)	NS	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	0.7 (0.0)	0.7 (0.0)	2.4 (6.0)	2.3 (5.8)
I <sub>2</sub> : Greengram	0.7 (0.0)	0.7 (0.0)	2.3 (5.6)	2.2 (5.1)
SEd (±)	0.001	0.00	0.047	0.037
CD (P=0.05)	NS	NS	NS	0.07
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	0.7 (0.0)	0.7 (0.0)	3.2 (9.8)	3.3 (10.3)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	0.7(0.0)	0.7 (0.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	2.5(6.0)	2.4 (5.2)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	2.8(7.3)	2.6 (6.2)
SEd (±)	0.001	0.001	0.066	0.052
CD (P=0.05)	NS	NS	0.13	0.12
<b>Treatment Mean</b>				
	0.7	0.7	2.3	2.2
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.72 (0.0)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)
SEd (±)	0.001	0.001	0.001	0.001
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.001	0.001	0.009	0.022
Treatment mean vs. C <sub>4</sub>	0.001	0.001	0.009	0.022
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	NS	NS	0.06
Treatment mean vs. C <sub>4</sub>	NS	NS	NS	0.06
CV (%)	2.3	2.8	7.0	5.7

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.4(b). Total sedge weed density at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total sedge weed density (No. m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.9 (15.3)	4.0 (16.3)	5.3 (28.8)	5.3 (27.8)
M <sub>2</sub> : Paired row 70/30 cm	4.0	4.0	4.7	4.78

	(15.9)	(16.1)	(22.1)	(23.2)
SEd ( $\pm$ )	0.062	0.076	0.056	0.044
CD (P=0.05)	NS	NS	0.11	0.08
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	4.0 (16.1)	4.1 (16.3)	5.1 (26.10)	4.9 (25.2)
I <sub>2</sub> : Greengram	3.9 (15.2)	4.0 (16.0)	4.9 (24.8)	5.0 (25.8)
SEd ( $\pm$ )	0.063	0.075	0.056	0.044
CD (P=0.05)	NS	NS	0.11	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	4.2 (17.5)	4.3 (18.0)	5.4 (28.7)	5.5 (29.8)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	3.1 (9.0)	3.1 (8.8)	3.8 (14.0)	3.6 (12.3)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.2 (17.0)	4.3 (18.0)	5.2 (27.0)	5.4 (28.3)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.4 (19.0)	4.5 (19.8)	5.7 (32.2)	5.6 (31.5)
SEd ( $\pm$ )	0.089	0.107	0.079	0.062
CD (P=0.05)	0.18	0.22	1.62	0.13
<b>Treatment Mean</b>	3.9	4.0	5.0	5.0
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	2.3 (4.7)	2.1 (4.0)	3.7 (13.3)	3.4 (11.3)
C <sub>4</sub> : (Sole turmeric-weed free)	2.1 (4.0)	2.1 (4.0)	3.7 (13.3)	3.0 (8.7)
SEd ( $\pm$ )	0.124	0.002	0.152	0.080
CD (P=0.05)	NS	NS	NS	0.35
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.147	0.048	0.176	0.194
Treatment mean vs. C <sub>4</sub>	0.036	0.048	0.092	0.117
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.41	0.013	0.49	0.54
Treatment mean vs. C <sub>4</sub>	0.10	0.13	0.26	0.32
CV (%)	5.5	6.5	3.9	3.0

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.4(c). Total sedge weed density at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total sedge weed density (No. m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.1 (8.6)	1.9 (7.8)	4.7 (22.4)	4.5 (20.3)
M <sub>2</sub> : Paired row 70/30 cm	1.6 (7.9)	1.9 (7.3)	4.6 (21.6)	4.5 (20.9)
SEd ( $\pm$ )	0.022	0.024	0.055	0.039
CD (P=0.05)	0.05	NS	NS	NS
<b>Intercropping (I)</b>				

I <sub>1</sub> : Baby corn	1.9 (8.2)	1.9 (7.3)	4.8 (23.1)	4.6 (21.1)
I <sub>2</sub> : Greengram	1.9 (8.3)	1.9 (7.3)	4.5 (20.9)	4.4 (20.2)
SEd (±)	0.022	0.024	0.055	0.039
CD (P=0.05)				
<b>Weed Management (W)</b>	5.8 (33.0)	5.5 (30.0)	5.8 (33.3)	5.1 (25.0)
W <sub>1</sub> : Weedy check (Control)	0.7 (0.0)	0.7 (0.0)	3.1 (9.2)	2.8 (7.5)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	4.7 (21.7)	4.9 (24.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	4.9 (24.0)	5.2 (26.0)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.032	0.034	0.079	0.056
SEd (±)	0.06	0.07	0.16	0.11
CD (P=0.05)	1.9	1.9	4.6	4.5
<b>Treatment Mean</b>				
<b>Control (C)</b>	0.7 (0.0)	0.7 (0.0)	2.1 (4.0)	2.1 (4.0)
C <sub>1</sub> : (Sole turmeric-recommended)	0.7 (0.0)	0.7 (0.0)	1.6 (2.0)	1.6 (2.0)
C <sub>4</sub> : (Sole turmeric-weed free)	0.002	0.002	0.07	0.077
SEd (±)	NS	NS	0.30	0.33
CD (P=0.05)				
<b>SEd (±) between</b>	0.018	0.013	0.090	0.012
Treatment mean vs. C <sub>1</sub>	0.018	0.013	0.090	0.012
Treatment mean vs. C <sub>4</sub>				
<b>CD (P=0.05) between</b>	0.05	0.04	0.25	0.03
Treatment mean vs. C <sub>1</sub>	0.05	0.04	0.25	0.03
Treatment mean vs. C <sub>4</sub>	3.9	4.4	4.2	3.1
CV (%)				

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.5(a). Total broad leaved weed density at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total BLW density (No. m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	4.9 (24.5)	4.5 (21.3)	6.2 (39.1)	6.2 (39.1)
M <sub>2</sub> : Paired row 70/30 cm	4.8 (23.2)	4.4 (19.9)	6.2 (39.1)	6.0 (37.9)
SEd (±)	0.064	0.056	0.061	0.055
CD (P=0.05)	NS	0.11	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	4.8 (23.3)	4.5 (20.4)	6.1 (38.6)	6.1 (38.3)

I <sub>2</sub> : Greengram	4.9 (24.4)	4.5 (20.8)	6.2 (39.5)	6.1 (38.8)
SEd (±)	0.064	0.056	0.061	0.055
CD (P=0.05)	0.13	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	6.5 (41.5)	6.1 (36.5)	8.0 (64.0)	7.7 (58.8)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	3.9 (14.8)	3.3 (10.0)	4.6 (20.7)	4.2 (17.3)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.3 (18.3)	4.2 (17.2)	5.8 (33.7)	6.1 (36.3)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.6 (23.8)	4.4 (20.6)	6.2 (38.0)	6.5 (38.5)
SEd (±)	0.090	0.071	0.086	0.077
CD (P=0.05)	0.18	0.16	0.17	0.16
<b>Treatment Mean</b>	4.8	4.5	6.2	6.1
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	1.9 (3.3)	1.6 (2.0)	3.6 (12.6)	3.3 (10.6)
C <sub>4</sub> : (Sole turmeric-weed free)	1.9 (3.3)	1.6 (2.0)	3.4 (11.3)	3.2 (10.0)
SEd (±)	0.179	0.247	0.189	0.108
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.111	0.143	0.095	0.099
Treatment mean vs. C <sub>4</sub>	0.208	0.143	0.102	0.179
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.31	0.39	0.26	0.27
Treatment mean vs. C <sub>4</sub>	0.58	0.14	0.28	0.49
CV (%)	4.6	4.4	3.4	3.1

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.5(b). Total broad leaved weed density at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total BLW density (No. m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	7.3 (54.4)	6.9 (50.2)	6.8 (47.8)	6.8 (46.9)
M <sub>2</sub> : Paired row 70/30 cm	7.1 (23.2)	6.7 (47.6)	6.4 (42.8)	6.4 (41.6)
SEd (±)	0.061	0.055	0.074	0.055
CD (P=0.05)	0.12	0.11	0.15	0.11
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	7.3 (23.3)	6.9 (50.1)	6.8 (47.2)	6.7 (45.9)
I <sub>2</sub> : Greengram	7.1 (24.4)	6.8 (47.8)	6.5 (43.3)	6.5 (42.6)

SEd ( $\pm$ )	0.061	0.055	0.074	0.055
CD (P=0.05)	0.13	0.11	0.15	0.11
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	8.4 (70.3)	7.9 (62.8)	8.7 (75.2)	7.8 (60.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	5.4 (29.0)	4.1 (16.2)	4.7 (22.2)	4.6 (21.2)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.3 (53.2)	7.6 (56.5)	6.31 (39.5)	6.8 (45.7)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.6 (57.8)	7.8 (60.2)	6.8 (44.2)	7.1 (49.6)
SEd ( $\pm$ )	0.087	0.078	0.104	0.078
CD (P=0.05)	0.18	0.16	0.21	0.16
<b>Treatment Mean</b>	7.2	6.8	6.6	6.6
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	3.1 (9.3)	1.9 (3.3)	3.5 (12.0)	3.4 (11.3)
C <sub>4</sub> : (Sole turmeric-weed free)	2.6 (6.0)	0.7 (0.0)	3.3 (10.7)	3.3 (10.7)
SEd ( $\pm$ )	0.108	0.180	0.189	0.197
CD (P=0.05)	0.47	0.77	NS	NS
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.110	0.182	0.168	0.101
Treatment mean vs. C <sub>4</sub>	0.019	0.026	0.104	0.101
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.31	0.51	0.47	0.28
Treatment mean vs. C <sub>4</sub>	0.05	0.07	0.29	0.28
CV (%)	3.0	2.8	3.9	2.9

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.5(c). Total broad leaved weed density at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total BLW density (No.m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.8 (20.3)	2.6 (16.2)	6.9 (50.8)	6.4 (43.4)
M <sub>2</sub> : Paired row 70/30 cm	2.7 (18.4)	2.4 (14.5)	6.6 (45.9)	6.1 (39.7)
SEd ( $\pm$ )	0.020	0.022	0.072	0.041
CD (P=0.05)	0.04	0.05	0.15	0.08
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.7 (18.8)	2.5 (15.0)	6.8 (49.4)	6.3 (42.4)
I <sub>2</sub> : Greengram	2.8 (18.9)	2.5 (15.0)	6.9 (49.5)	6.2 (40.7)
SEd ( $\pm$ )	0.020	0.022	0.072	0.041
CD (P=0.05)	0.04	NS	NS	0.08

<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	8.8 (77.5)	7.9 (61.3)	9.0 (80.8)	7.9 (62.5)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	4.7 (21.7)	3.2 (10.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	6.6 (42.7)	6.7 (44.7)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	6.9 (48.2)	7.0 (49.0)
SEd (±)	0.028	0.032	0.102	0.058
CD (P=0.05)	0.06	0.06	0.21	0.12
<b>Treatment Mean</b>	2.7	2.5	6.8	6.2
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	5.4 (28.7)	5.7 (32.0)	6.1 (36.7)	2.8 (5.3)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	3.0 (8.7)	2.4 (5.2)
SEd (±)	0.061		0.143	0.247
CD (P=0.05)	0.26		0.62	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.063	0.014	0.061	0.143
Treatment mean vs. C <sub>4</sub>	0.012	0.014	0.112	0.143
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.17	0.04	0.17	0.39
Treatment mean vs. C <sub>4</sub>	0.03	0.04	0.31	0.39
CV (%)	2.6	3.1	3.7	2.3

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.6(a). Total weed density at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total weed density (No. m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	8.0 (66.2)	7.4 (56.3)	9.6 (95.8)	9.6 (91.9)
M <sub>2</sub> : Paired row 70/30 cm	7.5 (59.0)	7.2 (53.3)	9.4 (92.3)	9.4 (88.3)
SEd (±)	0.049	0.057	0.465	0.465
CD (P=0.05)	0.10	0.12	0.10	0.10
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	7.6 (61.3)	7.3 (53.6)	9.4 (93.2)	9.4 (90.7)
I <sub>2</sub> : Greengram	7.8 (62.6)	7.3 (54.8)	9.5 (95.0)	9.5 (89.6)
SEd (±)	0.049	0.057	0.047	0.047
CD (P=0.05)	0.10	NS	0.10	0.10
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	11.0 (119.5)	9.8 (96.3)	12.8 (164.5)	12.8 (154.8)

W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	6.3 (39.7)	5.9 (34.2)	6.4 (40.8)	6.4 (35.8)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	6.6 (43.0)	6.6 (42.5)	9.0 (80.0)	9.0 (80.0)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.0 (48.2)	6.8 (46.3)	9.6 (91.0)	9.6 (89.8)
SEd (±)	0.071	0.081	0.066	0.066
CD (P=0.05)	0.14	0.16	0.13	0.13
<b>Treatment Mean</b>	7.7	7.3	9.5	9.5
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	4.0 (15.3)	3.2 (10.0)	5.5 (29.0)	5.5 (25.3)
C <sub>4</sub> : (Sole turmeric-weed free)	3.7 (13.3)	3.2 (10.0)	4.9 (23.3)	4.9 (22.7)
SEd (±)	0.255	0.000	0.209	0.209
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.171	0.045	0.219	0.219
Treatment mean vs. C <sub>4</sub>	0.103	0.045	0.077	0.077
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	0.12	NS	NS
Treatment mean vs. C <sub>4</sub>	NS	0.12	NS	NS
CV (%)	2.2	2.7	3.1	3.6

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.6(b). Total Weed density at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total weed density (No. m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	10.9 (123.9)	10.5 (116.0)	11.0 (123.6)	10.7 (117.5)
M <sub>2</sub> : Paired row 70/30 cm	11.4 (135.3)	10.4 (114.3)	9.9 (101.6)	9.9 (102.50)
SEd (±)	0.058	0.063	0.76	0.048
CD (P=0.05)	0.12	NS	0.16	0.09
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	11.1 (127.9)	10.5 (115.5)	10.3 (108.2)	10.4 (111.0)
I <sub>2</sub> : Greengram	11.3 (135.3)	10.4 (114.8)	10.7 (117.0)	10.2 (109.0)
SEd (±)	0.058	0.063	0.076	0.048
CD (P=0.05)	0.11	NS	0.16	0.09
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	14.3 (204.3)	13.6 (183.0)	12.9 (166.7)	12.8 (162.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	7.9 (62.6)	6.4 (40.5)	7.7 (58.7)	7.1 (49.5)

W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	11.0 (120.2)	10.7 (114.2)	10.2 (103.7)	10.4 (119.3)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	11.5 (131.3)	11.1 (122.8)	11.0 (121.3)	10.9 (119.3)
SEd (±)	0.082	0.089	0.108	0.061
CD (P=0.05)	0.17	0.18	0.22	0.12
<b>Treatment Mean</b>	11.2	10.4	10.5	10.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	6.3 (38.7)	3.6 (12.7)	17.3 (32.7)	5.6 (30.7)
C <sub>4</sub> : (Sole turmeric-weed free)	3.7 (13.3)	2.4 (5.3)	16.0 (28.0)	4.9 (24.0)
SEd (±)	0.144	0.288	0.251	0.224
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.062	0.190	0.230	0.167
Treatment mean vs. C <sub>4</sub>	0.096	0.144	0.113	0.130
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	0.53	NS	0.46
Treatment mean vs. C <sub>4</sub>	NS	0.40	NS	0.36
CV (%)	2.1	2.1	2.5	2.8

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.6(c). Total weed density at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Total weed density (No. m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.8 (42.8)	3.6 (37.8)	9.9 (102.1)	9.4 (94.8)
M <sub>2</sub> : Paired row 70/30 cm	3.6 (39.5)	3.5 (34.1)	9.5 (96.3)	9.2 (89.2)
SEd (±)	0.013	0.329	0.073	0.037
CD (P=0.05)	0.03	0.07	0.15	0.07
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	3.7 (40.3)	3.6 (36.3)	9.8 (100.6)	9.4 (93.5)
I <sub>2</sub> : Greengram	3.7 (40.7)	3.5 (35.6)	9.6 (96.3)	9.3 (91.2)
SEd (±)	0.013	0.032	0.073	0.037
CD (P=0.05)	NS	NS	NS	0.07
<b>Weed management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	12.7 (162.0)	12.0 (143.7)	12.8 (164.2)	11.5 (132.0)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	6.2 (38.0)	4.9 (24.3)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140	0.7 (0.0)	0.7 (0.0)	9.6 (91.0)	10.1 (101.8)

and 185 DAP				
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	10.2 (102.8)	10.6 (111.2)
SEd (±)	0.018	0.047	0.103	0.052
CD (P=0.05)	0.04	0.09	0.21	0.11
<b>Treatment Mean</b>	3.7	3.5	9.7	9.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	5.4 (28.7)	5.7 (32.0)	6.4 (40.7)	7.3 (52.7)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	3.6 (12.7)	2.8 (7.3)
SEd (±)	0.061	6.88E-08	0.125	0.186
CD (P=0.05)	0.26	2.96E-07	0.54	0.80
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.062	0.024	0.096	0.093
Treatment mean vs. C <sub>4</sub>	0.009	0.024	0.122	0.123
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.17	0.07	0.27	0.25
Treatment mean vs. C <sub>4</sub>	0.03	0.07	0.34	0.34
CV (%)	2.7	3.2	2.6	3.2

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.7(a). Dry weight of total grass weed at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total grass weed (g m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.0 (7.1)	2.3 (5.4)	7.7 (45.6)	5.8 (39.3)
M <sub>2</sub> : Paired row 70/30 cm	2.9 (6.7)	2.3 (5.2)	7.6 (44.7)	6.1 (42.9)
SEd (±)	0.012	0.013	0.032	0.249
CD (P=0.05)	0.02	0.03	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.9 (6.8)	2.31 (5.4)	7.6 (44.3)	5.8 (39.0)
I <sub>2</sub> : Greengram	3.0 (7.0)	2.3 (5.2)	7.8 (46.0)	6.1 (43.3)
SEd (±)	0.013	0.013	0.032	0.249
CD (P=0.05)	NS	NS	0.06	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	4.5 (13.6)	3.5 (11.4)	12.3 (111.2)	9.8 (96.3)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.4 (4.4)	1.7 (2.4)	5.8 (15.2)	3.6 (12.7)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.5 (4.7)	2.0 (3.5)	6.5 (26.0)	4.8 (23.0)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @	2.6	2.1	6.8	5.5

90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	(4.9)	(3.7)	(28.3)	(32.6)
SEd (±)	0.018	0.018	0.044	0.352
CD (P=0.05)	0.04	0.04	0.09	0.72
<b>Treatment Mean</b>	3.0	2.3	7.7	6.0
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	2.9 (2.2)	1.4 (1.4)	3.7 (10.2)	2.6 (6.2)
C <sub>4</sub> : (Sole turmeric-weed free)	3.0 (2.2)	1.3 (1.3)	3.1 (6.5)	2.3 (4.8)
SEd (±)	0.035	0.074	0.080	0.036
CD (P=0.05)	NS	NS	0.34	0.16
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.024	0.037	0.102	0.153
Treatment mean vs. C <sub>4</sub>	0.036	0.037	0.042	0.142
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.07	0.10	0.28	0.43
Treatment mean vs. C <sub>4</sub>	0.09	0.10	0.12	0.39
CV (%)	2.5	2.9	2.4	9.5

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.7(b). Dry weight of total grass weed at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total grass weed (g m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	9.2 (65.7)	6.5 (59.4)	11.3 (66.8)	6.6 (54.0)
M <sub>2</sub> : Paired row 70/30 cm	8.8 (72.4)	6.4 (57.8)	10.3 (53.9)	6.1 (48.7)
SEd (±)	0.022	0.000	0.035	0.018
CD (P=0.05)	0.05	0.02	0.07	0.04
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	8.5 (60.7)	6.3 (59.4)	10.4 (52.5)	6.4 (52.0)
I <sub>2</sub> : Greengram	9.5 (77.3)	6.6 (57.8)	11.2 (68.2)	6.3 (50.7)
SEd (±)	0.022	0.009	0.035	0.018
CD (P=0.05)	0.05	0.02	0.07	0.04
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	16.0 (191.4)	13.5 (182.3)	21.3 (136.2)	11.8 (138.0)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.9 (13.7)	2.6 (6.5)	5.3 (15.6)	2.6 (6.2)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.4 (34.2)	4.8 (22.3)	8.2 (43.9)	5.5 (30.0)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.7 (36.7)	4.9 (23.4)	8.5 (45.6)	5.6 (51.3)

SEd ( $\pm$ )	0.032	0.013	0.050	0.026
CD (P=0.05)	0.06	0.03	0.10	0.05
<b>Treatment Mean</b>	9.0	6.5	10.8	6.4
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	3.3 (8.0)	1.4 (1.4)	3.3 (1.8)	1.7 (2.4)
C <sub>4</sub> : (Sole turmeric-weed free)	1.8 (0.8)	1.1 (0.7)	3.1 (0.69)	1.6 (2.1)
SEd ( $\pm$ )	0.027	0.109	0.087	0.050
CD (P=0.05)	0.12	NS	NS	NS
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.028	0.059	0.091	0.057
Treatment mean vs. C <sub>4</sub>	0.016	0.078	0.035	0.021
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.08	0.17	0.25	0.16
Treatment mean vs. C <sub>4</sub>	0.04	0.22	0.09	0.06
CV (%)	3.1	2.8	3.6	3.1

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.7(c). Dry weight of total grass weed at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total grass weed (g m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	5.4 (28.9)	5.4 (28.7)	6.5 (41.7)	6.2 (38.2)
M <sub>2</sub> : Paired row 70/30 cm	5.3 (28.6)	5.2 (26.6)	6.4 (40.5)	6.0 (35.0)
SEd ( $\pm$ )	0.013	0.004	0.032	0.016
CD (P=0.05)	0.03	0.01	0.06	0.03
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	5.3 (28.6)	5.2 (27.4)	6.4 (40.9)	6.1 (37.0)
I <sub>2</sub> : Greengram	5.4 (28.9)	5.3 (27.9)	6.5 (41.3)	6.0 (36.2)
SEd ( $\pm$ )	0.013	0.004	0.032	0.016
CD (P=0.05)	0.03	0.01	0.06	0.03
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	22.1 (115.0)	10.5 (110.5)	10.5 (109.3)	9.9 (97.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	2.3 (4.6)	1.9 (3.5)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	4.6 (20.4)	4.7 (23.4)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	5.5 (30.1)	4.9 (36.6)
SEd ( $\pm$ )	0.018	0.005	0.044	0.022
CD (P=0.05)	0.04	0.01	0.09	0.05

<b>Treatment Mean</b>	6.1	3.2	10.3	5.4
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.7 (0.0)	0.7 (0.0)	1.6 (2.2)	1.9 (3.0)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)
SEd (±)	0.037	0.036	0.187	0.111
CD (P=0.05)	NS	NS	NS	0.22
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.037	0.001	0.076	0.111
Treatment mean vs. C <sub>4</sub>	0.037	0.001	0.151	0.010
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	0.01	0.21	0.31
Treatment mean vs. C <sub>4</sub>	NS	0.01	0.42	0.03
CV (%)	3.4	2.8	3.4	3.6

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.8(a). Dry weight of total sedge weed at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total sedge weed (g m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	0.7 (0.0)	0.7 (0.0)	1.2 (1.1)	1.2 (1.2)
M <sub>2</sub> : Paired row 70/30 cm	0.7 (0.0)	0.7 (0.0)	1.2 (1.0)	1.2 (1.0)
SEd (±)	0.001	0.001	0.032	0.024
CD (P=0.05)	NS	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	0.7 (0.0)	0.7 (0.0)	1.2 (1.2)	1.2 (1.1)
I <sub>2</sub> : Greengram	0.7 (0.0)	0.7 (0.0)	1.2 (1.0)	1.2 (1.1)
SEd (±)	0.001	0.001	0.032	0.024
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	0.8 (0.5)	0.8 (0.5)	1.4 (1.6)	1.5 (1.6)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	1.3 (1.3)	1.3 (1.2)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	1.4 (1.6)	1.4 (1.6)
SEd (±)	0.002	0.002	0.044	0.034
CD (P=0.05)	0.005	0.005	0.09	0.07
<b>Treatment Mean</b>	0.7	0.7	1.2	1.2
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.7	0.7	0.7	0.7

	(0.0)	(0.0)	(0.0)	(0.0)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7	0.7	0.7	0.7
	(0.0)	(0.0)	(0.0)	(0.0)
SEd (±)	0.026	0.026	0.026	0.026
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.001	0.001	0.026	0.005
Treatment mean vs. C <sub>4</sub>	0.001	0.001	0.026	0.009
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	NS	NS	0.01
Treatment mean vs. C <sub>4</sub>	NS	NS	NS	0.03
CV (%)	2.6	3.2	8.9	6.8

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.8(b). Dry weight of total sedge weed at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total sedge weed (g m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.0 (3.5)	1.9 (3.4)	3.2 (10.9)	3.4 (11.4)
M <sub>2</sub> : Paired row 70/30 cm	1.9 (3.4)	1.9 (3.4)	3.4 (11.6)	3.2 (9.8)
SEd (±)	0.033	0.024	0.026	0.089
CD (P=0.05)	NS	NS	0.05	0.18
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	1.9 (3.3)	1.8 (3.2)	3.1 (9.7)	3.2 (10.5)
I <sub>2</sub> : Greengram	2.0 (3.7)	2.0 (3.7)	3.6 (12.8)	3.3 (10.8)
SEd (±)	0.033	0.024	0.026	0.089
CD (P=0.05)	0.07	0.05	0.05	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.4 (5.1)	2.3 (4.9)	3.8 (14.3)	3.9 (14.8)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	1.5 (1.7)	1.5 (1.7)	2.4 (5.2)	2.3 (4.8)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.9 (3.3)	1.9 (3.2)	3.5 (12.2)	3.5 (11.8)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.1 (3.8)	2.0 (3.7)	3.7 (13.4)	3.4 (11.1)
SEd (±)	0.047	0.034	0.037	0.125
CD (P=0.05)	0.09	0.07	0.07	0.25
<b>Treatment Mean</b>	2.0	2.0	3.4	3.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	1.2 (0.8)	1.1 (0.8)	2.3 (4.7)	2.2 (4.1)
C <sub>4</sub> : (Sole turmeric-weed free)	1.1	1.1	2.3	2.1

	(0.7)	(0.7)	(4.8)	(4.1)
SEd ( $\pm$ )	0.024	0.039	0.025	0.017
CD (P=0.05)	NS	NS	NS	0.073
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.058	0.053	0.081	0.200
Treatment mean vs. C <sub>4</sub>	0.045	0.027	0.068	0.202
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.16	0.15	0.22	0.56
Treatment mean vs. C <sub>4</sub>	0.12	0.08	0.18	0.56
CV (%)	5.8	4.3	2.7	9.5

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.8(c). Dry weight of total sedge weed at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total sedge weed (g m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	1.6 (4.8)	1.6 (4.8)	2.8 (8.9)	2.7 (8.6)
M <sub>2</sub> : Paired row 70/30 cm	1.6 (4.8)	1.6 (4.7)	2.7 (8.3)	2.6 (8.0)
SEd ( $\pm$ )	0.009	0.002	0.028	0.009
CD (P=0.05)	NS	0.01	0.06	0.02
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	1.6 (4.8)	1.6 (4.8)	2.8 (8.7)	2.7 (8.4)
I <sub>2</sub> : Greengram	1.6 (4.8)	1.6 (4.7)	2.7 (8.5)	2.7 (8.1)
SEd ( $\pm$ )	0.009	0.002	0.028	0.009
CD (P=0.05)	NS	0.01	0.06	0.03
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	4.4 (19.1)	4.4 (18.9)	4.8 (22.3)	4.8 (22.0)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	1.5 (1.7)	1.4 (1.5)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	2.3 (4.9)	2.3 (4.5)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	2.4 (5.5)	2.4 (5.0)
SEd ( $\pm$ )	0.013	0.002	0.041	0.013
CD (P=0.05)	0.03	0.01	0.08	0.03
<b>Treatment Mean</b>	1.6	1.6	2.8	2.7
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.7 (0.0)	0.7 (0.0)	1.1 (0.7)	1.0 (0.6)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	0.9 (0.3)	0.9 (0.3)

SEd ( $\pm$ )	0.036	0.036	0.023	0.009
CD (P=0.05)	NS	NS	0.10	0.04
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.025	0.025	0.031	0.005
Treatment mean vs. C <sub>4</sub>	0.025	0.025	0.039	0.009
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	NS	0.08	0.01
Treatment mean vs. C <sub>4</sub>	NS	NS	0.11	0.03
CV (%)	3.4	3.8	3.6	2.2

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.9(a). Dry weight of total broad leaved weed at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total BLW (g m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	1.6 (2.3)	1.9 (3.6)	4.3 (19.5)	4.4 (19.9)
M <sub>2</sub> : Paired row 70/30 cm	1.5 (2.3)	1.9 (3.5)	4.4 (19.9)	4.3 (19.3)
SEd ( $\pm$ )	0.018	0.002	0.026	0.013
CD (P=0.05)	NS	0.01	0.05	0.03
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	1.6 (2.3)	1.9 (3.4)	4.3 (19.5)	4.4 (19.5)
I <sub>2</sub> : Greengram	1.6 (2.3)	1.9 (3.5)	4.4 (19.9)	4.4 (19.9)
SEd ( $\pm$ )	0.018	0.002	0.026	0.013
CD (P=0.05)	NS	0.01	NS	0.03
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.6 (6.3)	3.0 (8.5)	6.2 (37.8)	6.2 (37.6)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	1.1 (0.8)	1.6 (1.9)	3.2 (9.9)	3.2 (9.4)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.3 (1.1)	1.5 (1.8)	3.9 (14.8)	3.9 (15.1)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.3 (1.1)	1.6 (1.9)	4.1 (16.4)	4.1 (16.3)
SEd ( $\pm$ )	0.026	0.003	0.037	0.018
CD (P=0.05)	0.05	0.01	0.07	0.04
<b>Treatment Mean</b>	1.6	1.9	4.2	4.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	0.9 (0.5)	0.9 (0.4)	1.9 (3.2)	1.7 (2.8)
C <sub>4</sub> : (Sole turmeric-weed free)	1.0 (0.5)	0.9 (0.4)	1.7 (2.4)	1.7 (2.5)
SEd ( $\pm$ )	0.105	0.001	0.093	0.099
CD (P=0.05)	NS	NS	NS	NS

<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.071	0.002	0.065	3.95
Treatment mean vs. C <sub>4</sub>	0.049	0.002	0.042	3.95
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.19	0.01	0.18	NS
Treatment mean vs. C <sub>4</sub>	0.14	0.01	0.12	NS
CV (%)	4.0	3.5	2.1	3.7

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.9(b). Dry weight of total broad leaved weed at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total BLW (g m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	5.0 (27.3)	4.9 (26.7)	7.1 (87.6)	7.3 (89.4)
M <sub>2</sub> : Paired row 70/30 cm	4.8 (25.7)	4.7 (24.7)	6.6 (79.8)	7.1 (85.2)
SEd ( $\pm$ )	0.028	0.013	0.048	0.009
CD (P=0.05)	0.05	0.03	0.10	0.02
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	4.8 (25.3)	4.8 (26.1)	6.9 (84.7)	7.2 (88.1)
I <sub>2</sub> : Greengram	5.0 (27.7)	4.7 (25.3)	6.8 (82.6)	7.1 (86.4)
SEd ( $\pm$ )	0.028	0.013	0.048	0.009
CD (P=0.05)	0.05	0.03	0.10	0.02
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	7.7 (59.0)	7.8 (60.0)	17.4 (302.8)	17.6 (309.9)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	3.0 (8.8)	2.9 (8.0)	2.7(7.1)	3.1 (9.1)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.3 (18.0)	4.2 (16.8)	3.5 (11.6)	3.8 (13.9)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.6 (20.2)	4.3 (17.9)	3.7 (13.3)	4.1 (16.1)
SEd ( $\pm$ )	0.041	0.018	0.068	0.013
CD (P=0.05)	0.08	0.04	0.14	0.03
<b>Treatment Mean</b>				
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	1.5 (1.8)	1.5 (1.7)	2.1 (3.8)	2.0 (3.6)
C <sub>4</sub> : (Sole turmeric-weed free)	1.3 (1.2)	1.3 (1.1)	2.1 (3.8)	2.1 (3.7)
SEd ( $\pm$ )	0.047	0.037	0.089	0.002
CD (P=0.05)	0.20	0.16	NS	0.01
<b>SEd (<math>\pm</math>) between</b>				
Treatment mean vs. C <sub>1</sub>	0.035	0.035	0.062	0.004

Treatment mean vs. C <sub>4</sub>	0.018	0.004	0.062	0.004
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.09	0.09	0.17	0.01
Treatment mean vs. C <sub>4</sub>	0.05	0.01	0.17	0.01
CV (%)	2.1	2.5	2.5	3.4

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.9(c). Dry weight of total broad leaved weed (g m<sup>-2</sup>) at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total BLW(g m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	9.7 (94.3)	9.5 (89.4)	10.8 (116.2)	10.6 (111.7)
M <sub>2</sub> : Paired row 70/30 cm	9.1 (82.9)	9.4 (88.2)	10.7 (115.1)	10.5 (108.9)
SEd (±)	0.013	0.003	0.039	0.003
CD (P=0.05)	0.03	0.01	0.08	0.01
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	9.7 (93.4)	9.5 (89.0)	10.6 (111.7)	10.6 (111.0)
I <sub>2</sub> : Greengram	9.2 (83.8)	9.4 (88.5)	10.6 (112.8)	10.5 (109.6)
SEd (±)	0.018	0.003	0.039	0.003
CD (P=0.05)	0.04	0.01	0.08	0.01
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	18.8 (354.4)	18.9 (355.0)	20.2 (406.6)	19.9 (394.0)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	2.8 (7.5)	2.8 (7.3)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	4.5 (19.4)	4.4 (18.9)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	4.7 (22.3)	4.6 (20.9)
SEd (±)	0.018	0.004	0.056	0.004
CD (P=0.05)	0.04	0.01	0.11	0.01
<b>Treatment Mean</b>	9.4	9.5	10.8	10.6
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	4.1 (16.0)	4.1 (16.5)	4.63 (21.0)	4.9 (23.5)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	1.6 (1.9)	1.6 (2.1)
SEd (±)	4.87E-08	4.87E-08	0.146	0.012
CD (P=0.05)	2.09E-07	2.09E-07	0.62	0.05
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.007	0.001	0.024	0.001
Treatment mean vs. C <sub>4</sub>	0.007	0.001	0.147	0.012
<b>CD (P=0.05) between</b>				

Treatment mean vs. C <sub>1</sub>	0.02	0.01	0.06	0.01
Treatment mean vs. C <sub>4</sub>	0.02	0.01	0.41	0.03
CV (%)	3.7	2.5	1.7	2.3

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.10(a). Dry weight of total weed (g m<sup>-2</sup>) at 30 and 60 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total weed (g m <sup>-2</sup> )			
	30 DAP		60 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.1 (9.4)	3.0 (8.9)	8.2 (66.0)	4.4 (19.9)
M <sub>2</sub> : Paired row 70/30 cm	3.0 (9.0)	2.9 (8.6)	8.1 (65.9)	4.3 (19.3)
SEd (±)	0.013	0.009	0.032	0.013
CD (P=0.05)	0.03	0.02	0.06	0.03
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	3.0 (9.1)	2.9 (8.8)	8.1 (65.0)	4.4 (19.7)
I <sub>2</sub> : Greengram	3.1 (9.3)	2.9 (8.7)	8.2 (66.9)	4.3 (19.5)
SEd (±)	0.013	0.009	0.032	0.013
CD (P=0.05)	NS	NS	0.06	0.03
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	3.8 (19.9)	4.5 (19.9)	10.6 (150.3)	6.2 (37.6)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.2 (5.2)	2.2 (4.3)	4.0 (25.2)	3.2 (9.4)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.3 (5.8)	2.4 (5.3)	5.1 (41.9)	4.0 (16.3)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.3 (5.9)	2.5 (5.6)	5.4 (46.3)	4.1 (19.6)
SEd (±)	0.018	0.013	0.044	0.018
CD (P=0.05)	0.04	0.03	0.09	0.04
<b>Treatment Mean</b>	2.6	2.9	6.3	4.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	1.7 (2.7)	1.5 (1.9)	3.3 (13.1)	1.7 (2.8)
C <sub>4</sub> : (Sole turmeric-weed free)	1.6 (2.7)	1.5 (1.7)	2.6 (9.0)	1.7 (2.5)
SEd (±)	0.033	0.067	0.113	0.146
CD (P=0.05)	NS	0.29	0.49	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.022	0.034	0.127	3.950
Treatment mean vs. C <sub>4</sub>	0.020	0.033	0.049	0.004
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.06	0.09	0.35	NS
Treatment mean vs. C <sub>4</sub>	0.05	0.09	0.14	NS

CV (%)	3.4	3.2	2.8	4.6
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Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.10(b). Dry weight of total weed at 90 and 120 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total weed (g m <sup>-2</sup> )			
	90 DAP		120 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	7.6 (66.0)	8.4 (89.5)	12.9 (165.3)	10.6 (154.7)
M <sub>2</sub> : Paired row 70/30 cm	7.0 (65.9)	8.2 (85.9)	12.1 (145.3)	10.0 (143.7)
SEd (±)	0.016	0.047	0.022	0.047
CD (P=0.05)	0.03	0.09	0.05	0.09
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	6.6 (65.0)	8.2 (86.5)	12.3 (150.0)	10.4 (150.6)
I <sub>2</sub> : Greengram	8.0 (66.9)	8.4 (89.0)	12.7 (160.5)	10.2 (147.8)
SEd (±)	0.016	0.047	0.022	0.047
CD (P=0.05)	0.03	0.09	0.05	0.09
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	13.9 (150.3)	15.7 (247.2)	21.3 (453.3)	21.5 (462.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	3.7 (25.2)	4.1 (16.2)	5.3 (27.8)	4.5 (20.0)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.7 (41.9)	6.5 (42.4)	8.3 (67.7)	7.9 (55.8)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.9 (46.3)	6.8 (45.1)	8.5 (72.3)	7.7 (58.4)
SEd (±)	0.022	0.067	0.031	0.047
CD (P=0.05)	0.05	0.14	0.06	0.09
<b>Treatment Mean</b>	7.3	10.3	7.2	10.3
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	3.7 (13.1)	2.10 (3.9)	3.3 (10.3)	3.3 (10.2)
C <sub>4</sub> : (Sole turmeric-weed free)	3.0 (9.0)	1.7 (2.5)	3.1 (9.3)	3.2 (9.9)
SEd (±)	0.088	0.072	0.071	0.019
CD (P=0.05)	0.38	0.31	0.34	0.08
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.031	0.039	0.075	0.043
Treatment mean vs. C <sub>4</sub>	0.062	0.052	0.011	0.035
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.08	0.11	0.21	0.12
Treatment mean vs. C <sub>4</sub>	0.17	0.14	0.02	0.09
CV (%)	2.5	5.2	2.6	3.6

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.10(c). Dry weight of total weed at 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatments	Dry weight of total weed (g m <sup>-2</sup> )			
	150 DAP		180 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	11.3 (128.1)	11.1 (122.9)	12.9 (166.8)	12.6 (158.4)
M <sub>2</sub> : Paired row 70/30 cm	10.8 (116.3)	10.9 (119.4)	12.7 (160.5)	12.3 (151.8)
SEd (±)	0.009	0.013	0.018	0.009
CD (P=0.05)	NS	0.03	0.04	0.02
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	11.3 (127.1)	11.2 (121.6)	12.9 (164.7)	12.5 (156.4)
I <sub>2</sub> : Greengram	10.8 (117.2)	11.0 (120.6)	12.8 (162.6)	12.4 (153.9)
SEd (±)	0.009	0.013	0.018	0.009
CD (P=0.05)	NS	0.03	0.04	0.02
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	22.1 (488.7)	22.0 (484.5)	23.2 (538.2)	22.7 (513.7)
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.7 (0.0)	0.7 (0.0)	3.8 (13.8)	3.6 (12.2)
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	6.7 (44.8)	6.8 (45.2)
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.7 (0.0)	0.7 (0.0)	7.6 (57.8)	7.1 (49.3)
SEd (±)	0.013	0.018	0.025	0.013
CD (P=0.05)	0.03	0.04	0.05	0.03
<b>Treatment Mean</b>	11.1	11.0	12.8	12.5
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	4.1 (16.5)	4.1 (16.5)	5.1 (25.9)	2.5 (29.3)
C <sub>4</sub> : (Sole turmeric-weed free)	0.7 (0.0)	0.7 (0.0)	1.7 (2.3)	1.7 (2.4)
SEd (±)	4.87E-08	4.87E-08	0.163	0.077
CD (P=0.05)	2.09E-07	2.09E-07	0.70	0.33
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.005	0.005	0.043	0.074
Treatment mean vs. C <sub>4</sub>	0.005	0.005	0.151	0.010
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.01	0.01	0.12	0.20
Treatment mean vs. C <sub>4</sub>	0.01	0.01	0.42	0.30
CV (%)	3.4	2.9	4.5	4.2

Figures in parenthesis are mean of original values; Data subjected to square root transformation

**Table 4.11(a). Weed control efficiency (%) at 30, 60 and 90 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatment	Weed control efficiency (%)		
	30 DAP	60 DAP	90 DAP

		2013	2014	2013	2014	2013	2014
M <sub>11</sub> I <sub>1</sub> W <sub>1</sub>	80/20 cm; Baby corn; weedy check	0	0	0	0	0	0
M <sub>11</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95, 140 DAP	48	52	59	57	69	71
M <sub>11</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	46	47	47	48	59	59
M <sub>11</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	45	46	46	49	56	57
M <sub>12</sub> I <sub>1</sub> W <sub>1</sub>	80/20 cm; greengram; weedy check	0	0	0	0	0	0
M <sub>12</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	45	50	55	56	72	73
M <sub>12</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; greengram; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	44	45	48	46	57	58
M <sub>12</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	43	44	45	45	53	57
M <sub>21</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; baby corn; weedy check	0	0	0	0	0	0
M <sub>21</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	58	62	63	64	74	76
M <sub>21</sub> I <sub>1</sub> W <sub>3</sub>	70/30 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	47	46	48	48	58	61
M <sub>21</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	46	45	47	46	58	60
M <sub>22</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; greengram; baby corn; weedy check	0	0	0	0	0	0
M <sub>22</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	46	50	57	61	78	81
M <sub>22</sub> I <sub>1</sub> W <sub>3</sub>	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	44	46	44	47	49	56
M <sub>22</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	42	44	41	45	48	55

HW- Hand weeding

**Table 4.11(b). Weed control efficiency (%) at 120, 150 and 180 DAP as influenced by planting methods, intercropping and weed management practices in turmeric**

Treatment	Weed control efficiency (%)					
	120 DAP		150 DAP		180 DAP	
	2013	2014	2013	2014	2013	2014

M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	80/20 cm; Baby corn; weedy check	0	0	0	0	0	0
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95, 140 DAP	74	77	97	97	83	84
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	64	63	97	97	69	69
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	62	62	97	97	68	68
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	80/20 cm; greengram; weedy check	0	0	0	0	0	0
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	77	79	97	97	84	85
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	80/20 cm; greengram; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	54	63	97	97	71	70
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	53	62	97	97	69	68
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; baby corn; weedy check	0	0	0	0	0	0
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	76	79	97	97	84	85
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	70/30 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	66	67	97	97	74	71
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	63	66	97	97	62	69
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	70/30 cm; greengram; baby corn; weedy check	0	0	0	0	0	0
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	79	82	97	97	87	89
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	69	68	97	97	75	74
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	64	66	97	97	69	70

\*HW- Hand weeding

**Table 4.12. Plant population per square metre of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant population	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	5.71	6.25
M <sub>2</sub> : Paired row 70/30 cm	5.79	6.29
SEd (±)	0.214	0.242
CD (P=0.05)	NS	NS
<b>Intercropping (I)</b>		
I <sub>1</sub> : Baby corn	5.83	6.38
I <sub>2</sub> : Greengram	5.63	6.17
SEd (±)	0.214	0.242
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	4.50	5.17
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	7.25	7.67
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.75	6.17
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.50	6.08
SEd (±)	0.303	0.342
CD (P=0.05)	0.62	0.70
<b>Treatment Mean</b>	5.75 (74.68)*	6.27 (78.75)*
<b>Control (C)</b>		
C <sub>1</sub> : (Sole turmeric-recommended)	7.70	8.00
C <sub>4</sub> : (Sole turmeric-weed free)	8.00	8.00
SEd (±)	0.330	0.577
CD (P=0.05)	NS	NS
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>1</sub>	0.384	0.580
Treatment mean vs. C <sub>4</sub>	0.191	0.055
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>1</sub>	1.07	1.61
Treatment mean vs. C <sub>4</sub>	0.53	0.15
CV (%)	12.9	13.5

\*Figures in parentheses indicate per cent to the control C<sub>1</sub>

**Table 4.13(a). Plant height (cm) at 95 and 140 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant height			
	95 DAP		140 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	33.84	34.78	106.14	105.02
M <sub>2</sub> : Paired row 70/30 cm	33.14	33.71	103.39	103.29
SEd (±)	0.513	0.16	0.273	0.775
CD (P=0.05)	1.05	0.33	0.56	1.58
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	32.88	33.72	104.38	103.83
I <sub>2</sub> : Greengram	34.10	34.78	105.00	104.48
SEd (±)	0.513	0.16	0.273	0.775
CD (P=0.05)	1.045	0.33	0.56	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	26.69	28.23	77.43	78.13
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	39.64	40.29	117.52	118.64
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	33.70	34.63	112.28	109.26
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	32.92	33.82	111.83	110.58
SEd (±)	0.726	0.23	0.386	1.097
CD (P=0.05)	0.48	0.47	0.79	2.24
<b>Treatment Mean</b>	33.49	34.25	104.77	104.16
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	59.2	57.83	128.67	127.83
C <sub>4</sub> : (Sole turmeric-weed free)	61.37	60.70	130.77	129.87
SEd (±)	0.376	0.52	0.231	0.317
CD (P=0.05)	1.62	2.24	0.99	1.37
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.426	0.61	0.296	0.28
Treatment mean vs. C <sub>4</sub>	0.340	0.47	0.296	0.51
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.18	1.69	0.82	0.79
Treatment mean vs. C <sub>4</sub>	0.94	1.30	0.82	1.41
CV (%)	3.2	3.2	2.7	2.6

**Table 4.13(b). Plant height (cm) at 185 and 256 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant height			
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	185 DAP		256 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	159.59	158.51	155.25	154.67
M <sub>2</sub> : Paired row 70/30 cm	157.59	158.54	151.67	153.08
SEd (±)	0.236	1.06	0.361	0.759
CD (P=0.05)	0.48	NS	0.74	1.55
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	157.09	155.89	151.38	150.90
I <sub>2</sub> : Greengram	160.09	161.16	155.53	156.85
SEd (±)	0.236	1.06	0.361	0.759
CD (P=0.05)	0.48	2.16	0.74	1.55
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	113.65	113.86	107.86	108.67
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	195.07	196.31	191.17	192.68
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	167.79	167.68	164.36	163.64
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	157.85	156.26	150.43	150.52
SEd (±)	0.334	1.495	0.510	1.074
CD (P=0.05)	0.68	3.05	1.04	2.19
<b>Treatment Mean</b>	158.59	158.53	153.46	153.88
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	202.37	201.20	199.1	197.67
C <sub>4</sub> : (Sole turmeric-weed free)	203.6	202.3	200.57	199.43
SEd (±)	0.470	0.153	0.433	0.418
CD (P=0.05)	2.02	0.66	NS	1.80
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.642	0.623	0.735	0.811
Treatment mean vs. C <sub>4</sub>	0.425	0.578	0.564	0.476
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.78	1.73	2.04	2.25
Treatment mean vs. C <sub>4</sub>	1.18	1.61	1.56	1.32
CV (%)	3.5	2.3	3.2	2.7

**Table 4.14(a). Number of tillers per plant at 95 and 140 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of tillers			
	95 DAP		140 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.25	2.26	3.87	4.01
M <sub>2</sub> : Paired row 70/30 cm	2.36	2.40	4.16	4.12
SEd (±)	0.077	0.093	0.081	NS
CD (P=0.05)	0.16	NS	0.16	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.25	2.30	3.78	3.78
I <sub>2</sub> : Greengram	2.37	2.36	4.25	4.35
SEd (±)	0.077	0.093	0.081	0.100
CD (P=0.05)	0.16	NS	0.16	0.20
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	1.36	1.70	2.06	1.96
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.97	3.03	5.81	5.91
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.61	2.63	4.26	4.29
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.30	2.30	3.93	4.10
SEd (±)	0.110	0.323	0.114	0.141
CD (P=0.05)	0.22	0.27	0.23	0.29
<b>Treatment Mean</b>	2.31	2.33	4.02	4.07
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	3.80	3.633	5.90	5.80
C <sub>4</sub> : (Sole turmeric-weed free)	4.30	4.00	6.40	6.27
SEd (±)	0.153	0.193	0.273	0.121
CD (P=0.05)	0.66	0.54	NS	0.52
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.103	0.179	0.173	0.121
Treatment mean vs. C <sub>4</sub>	0.144	0.193	0.179	0.204
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.29	0.49	NS	0.34
Treatment mean vs. C <sub>4</sub>	0.39	0.54	NS	0.57
CV (%)	2.1	13.9	3.7	8.5

**Table 4.14(b). Number of tillers per plant at 185 and 256 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of tillers			
	185 DAP		256 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	4.70	4.68	3.75	4.29
M <sub>2</sub> : Paired row 70/30 cm	5.05	4.84	3.83	4.37
SEd (±)	0.084	0.140	0.093	0.153
CD (P=0.05)	0.17	NS	0.19	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	4.73	4.73	3.62	4.27
I <sub>2</sub> : Greengram	5.02	4.79	3.95	4.39
SEd (±)	0.084	0.140	0.093	0.153
CD (P=0.05)	0.17	NS	0.19	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.67	2.24	1.55	1.96
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	6.34	6.32	5.22	5.87
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.37	5.38	4.33	4.96
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	5.08	5.09	4.05	4.53
SEd (±)	0.119	0.198	0.131	0.217
CD (P=0.05)	0.24	0.40	0.27	0.44
<b>Treatment Mean</b>	4.88	4.76	3.79	4.33
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	7.00	6.80	6.43	6.43
C <sub>4</sub> : (Sole turmeric-weed free)	7.40	7.13	6.66	6.70
SEd (±)	0.058	0.134	0.033	0.177
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.309	0.093	0.262	0.103
Treatment mean vs. C <sub>4</sub>	0.256	0.200	0.268	0.229
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	0.26	NS	0.29
Treatment mean vs. C <sub>4</sub>	NS	0.56	NS	0.64
CV (%)	4.8	10.2	3.4	12.7

**Table 4.15(a). Number of leaves per plant at 95 and 140 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of leaves			
	95 DAP		140 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	9.37	10.37	16.09	16.78

M <sub>2</sub> : Paired row 70/30 cm	9.83	10.37	17.15	17.35
SEd (±)	0.092	0.290	0.167	0.245
CD (P=0.05)	0.19	NS	0.34	0.49
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	9.31	9.83	15.86	16.13
I <sub>2</sub> : Greengram	9.89	10.91	17.38	18.0
SEd (±)	0.920	0.290	0.167	0.245
CD (P=0.05)	0.19	0.59	0.34	0.50
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	5.63	5.73	8.70	8.95
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	16.31	17.64	26.08	26.85
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	8.63	9.70	16.77	17.24
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.80	8.40	14.95	15.22
SEd (±)	0.130	0.410	0.237	0.245
CD (P=0.05)	0.26	0.84	0.48	0.50
<b>Treatment Mean</b>	9.60	10.37	16.62	17.07
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	21.73	21.60	28.27	27.97
C <sub>4</sub> : (Sole turmeric-weed free)	22.33	21.77	33.53	33.37
SEd (±)	0.265	0.261	0.260	0.173
CD (P=0.05)	NS	NS	NS	0.75
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.177	0.520	0.203	0.420
Treatment mean vs. C <sub>4</sub>	0.241	0.515	0.357	0.290
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	1.44	NS	1.16
Treatment mean vs. C <sub>4</sub>	NS	1.43	NS	0.80
CV (%)	3.0	9.7	3.5	4.9

**Table 4.15(b). Number of leaves per plant at 185 and 256 DAP of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of leaves			
	185 DAP		256 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	23.62	24.5	18.65	16.43
M <sub>2</sub> : Paired row 70/30 cm	24.18	24.45	15.88	16.40
SEd (±)	0.112	0.371	0.404	0.195
CD (P=0.05)	0.23	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	23.64	23.78	15.40	15.71
I <sub>2</sub> : Greengram	24.17	25.21	16.11	17.12
SEd (±)	0.112	0.371	0.404	0.195
CD (P=0.05)	0.23	0.76	NS	0.40
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	12.28	12.25	7.01	7.24
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	32.2	33.18	24.48	25.88
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.46	26.90	16.46	17.01
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	24.68	25.64	15.10	15.52
SEd (±)	0.159	0.371	0.571	0.195
CD (P=0.05)	0.33	0.76	1.17	0.40
<b>Treatment Mean</b>	23.40	24.48	17.27	16.42
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	36.07	35.57	27.37	27.43
C <sub>4</sub> : (Sole turmeric-weed free)	40.2	39.70	28.8	28.00
SEd (±)	0.233	0.089	0.328	1.04
CD (P=0.05)	NS	0.38	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.171	0.497	0.463	1.010
Treatment mean vs. C <sub>4</sub>	0.297	0.523	0.688	0.730
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	NS	1.38	NS	2.79
Treatment mean vs. C <sub>4</sub>	NS	1.48	NS	2.03
CV (%)	4.5	4.1	3.5	4.1

**Table 4.16(a). Leaf area index of turmeric at 95 and 140 DAP as influenced by planting methods, intercropping and weed management practices**

Treatments	Leaf area index			
	95 DAP		140 DAP	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.41	2.41	14.14	14.47
M <sub>2</sub> : Paired row 70/30 cm	2.47	2.48	15.43	15.43
SEd (±)	0.016	0.013	0.338	0.204
CD (P=0.05)	0.03	0.03	0.69	0.42
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.39	2.36	14.39	14.72
I <sub>2</sub> : Greengram	2.54	2.52	15.18	15.18
SEd (±)	0.016	0.013	0.338	0.204
CD (P=0.05)	0.03	0.030	0.69	0.42
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	1.06	1.05	5.64	5.65
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	5.15	5.16	22.65	22.67
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.88	1.89	16.72	16.68
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.68	1.67	14.12	14.79
SEd (±)	0.022	0.018	0.478	0.289
CD (P=0.05)	0.05	0.04	0.98	0.58
<b>Treatment Mean</b>	2.44	2.44	14.78	14.95
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	8.33	8.47	29.91	29.89
C <sub>4</sub> : (Sole turmeric-weed free)	8.90	8.95	35.38	35.15
SEd (±)	0.165	0.052	0.103	0.034
CD (P=0.05)	NS	0.22	0.45	0.15
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.172	0.011	0.162	0.012
Treatment mean vs. C <sub>4</sub>	0.012	0.047	0.181	0.039
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.48	0.02	0.45	0.03
Treatment mean vs. C <sub>4</sub>	0.03	0.13	0.50	0.11
CV (%)	2.2	3.8	7.9	4.7

**Table 4.16(b). Leaf area index of turmeric at 185 and 256 DAP as influenced by planting methods, intercropping and weed management practices**

Treatments	Leaf area index	
	185 DAP	256 DAP

	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	21.66	26.63	11.10	10.95
M <sub>2</sub> : Paired row 70/30 cm	23.33	23.16	11.54	11.40
SEd (±)	0.059	0.168	0.066	0.039
CD (P=0.05)	0.12	0.34	0.14	0.08
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	22.05	22.04	11.08	10.94
I <sub>2</sub> : Greengram	22.93	22.74	11.56	11.41
SEd (±)	0.059	0.168	0.066	0.039
CD (P=0.05)	0.12	0.34	0.14	0.08
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	7.73	7.62	3.91	3.87
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	32.87	32.86	21.61	21.40
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	35.90	25.93	10.34	10.18
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	23.56	23.16	9.43	9.26
SEd (±)	0.083	0.238	0.094	0.056
CD (P=0.05)	0.17	0.49	0.19	0.11
<b>Treatment Mean</b>	22.49	22.39	11.32	11.18
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	40.70	39.41	27.92	27.79
C <sub>4</sub> : (Sole turmeric-weed free)	46.86	46.79	31.27	30.13
SEd (±)	0.455	0.067	0.319	0.006
CD (P=0.05)	1.96	0.29	1.37	0.03
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.430	0.119	0.155	0.033
Treatment mean vs. C <sub>4</sub>	0.040	0.101	0.228	0.034
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.19	0.33	0.43	0.09
Treatment mean vs. C <sub>4</sub>	0.11	0.28	0.63	0.09
CV (%)	4.5	2.6	2.0	3.2

**Table 4.17(a). Number of mother and primary rhizome per plant of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of rhizome			
	Mother		Primary	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.01	2.10	6.03	6.49
M <sub>2</sub> : Paired row 70/30 cm	2.28	2.26	6.68	6.86
SEd (±)	0.074	0.071	0.096	0.224
CD (P=0.05)	0.15	0.14	0.20	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.08	2.12	6.03	6.479
I <sub>2</sub> : Greengram	2.20	2.25	6.68	6.854
SEd (±)	0.074	0.071	0.096	0.224
CD (P=0.05)	NS	NS	0.20	0.46
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	1.45	1.37	4.26	4.86
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.59	2.59	9.37	9.53
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.32	2.43	6.05	5.53
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.22	2.35	5.76	6.75
SEd (±)	0.105	0.100	0.136	0.316
CD (P=0.05)	0.21	0.20	0.27	0.65
<b>Treatment Mean</b>	2.15	2.18	6.36	6.68
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	4.10	3.40	9.99	9.77
C <sub>4</sub> : (Sole turmeric-weed free)	4.50	3.70	10.33	9.87
SEd (±)	0.219	0.056	0.219	0.321
CD (P=0.05)	NS	0.25	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.449	0.129	0.059	0.131
Treatment mean vs. C <sub>4</sub>	0.361	0.082	0.167	0.375
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.24	0.36	0.16	0.37
Treatment mean vs. C <sub>4</sub>	1.00	0.23	0.46	1.04
CV (%)	12.0	11.2	5.2	11.6

**Table 4.17(b). Number of secondary and total rhizome per plant of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Number of rhizome			
	Secondary		Total	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	9.14	9.53	17.88	18.11
M <sub>2</sub> : Paired row 70/30 cm	9.60	10.07	18.56	19.19
SEd (±)	0.077	0.054	0.142	0.247
CD (P=0.05)	0.16	0.11	0.29	0.50
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	8.95	9.39	17.07	17.75
I <sub>2</sub> : Greengram	9.80	10.21	18.68	19.55
SEd (±)	0.077	0.054	0.142	0.247
CD (P=0.05)	0.16	0.11	0.29	0.50
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	7.22	7.80	12.93	14.03
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	12.4	12.68	24.36	24.80
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	8.50	8.76	16.89	16.72
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	9.40	9.96	17.33	19.06
SEd (±)	0.109	0.076	0.201	0.349
CD (P=0.05)	0.22	0.16	0.41	0.71
<b>Treatment Mean</b>	9.37	9.80	18.22	18.65
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	14.03	13.43	28.06	26.60
C <sub>4</sub> : (Sole turmeric-weed free)	14.87	14.43	29.70	28.00
SEd (±)	0.145	0.20	0.133	0.472
CD (P=0.05)	0.63	0.86	0.57	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.110	0.089	0.485	0.155
Treatment mean vs. C <sub>4</sub>	0.094	0.186	0.406	0.581
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.31	0.25	1.34	0.43
Treatment mean vs. C <sub>4</sub>	0.26	0.52	1.13	1.61
CV (%)	2.8	3.9	2.7	4.6

**Table 4.18. Length of rhizome (cm) of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Length of rhizome					
	Mother		Primary		Secondary	
	2013	2014	2013	2014	2013	2014
<b>Planting Methods (M)</b>						

M <sub>1</sub> : Paired row 80/20 cm	9.49	9.70	8.25	8.04	4.53	4.56
M <sub>2</sub> : Paired row 70/30 cm	9.81	9.80	8.37	8.05	4.76	4.83
SEd (±)	0.106	0.263	0.125	0.270	0.119	0.155
CD (P=0.05)	0.22	NS	NS	NS	NS	NS
<b>Intercropping (I)</b>						
I <sub>1</sub> : Baby corn	9.42	9.40	8.28	8.03	4.49	4.55
I <sub>2</sub> : Greengram	9.88	10.05	8.33	8.26	4.80	4.85
SEd (±)	0.106	0.263	0.125	0.270	0.119	0.155
CD (P=0.05)	0.22	0.537	NS	NS	0.24	NS
<b>Weed Management (W)</b>						
W <sub>1</sub> : Weedy check (Control)	6.48	6.85	6.94	7.13	3.63	3.54
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	11.45	11.36	9.38	8.93	5.48	5.71
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	10.35	10.34	8.65	8.49	4.99	5.16
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	10.33	10.36	8.25	8.03	4.48	4.40
SEd (±)	0.150	0.372	0.177	0.382	0.168	0.219
CD (P=0.05)	0.31	0.759	0.36	0.779	0.34	0.448
<b>Treatment Mean</b>	9.65	9.75	8.31	8.05	4.65	4.70
<b>Control (C)</b>						
C <sub>1</sub> : (Sole turmeric-recommended)	11.9	11.47	10.3	9.9	6.3	5.83
C <sub>4</sub> : (Sole turmeric-weed free)	12.47	12.2	11.53	11.37	6.8	5.90
SEd (±)	0.186	0.219	0.371	0.178	0.296	0.068
CD (P=0.05)	NS	NS	NS	NS	NS	NS
<b>SEd (±) between</b>						
Treatment mean vs. C <sub>1</sub>	0.067	0.155	0.222	0.267	0.211	0.186
Treatment mean vs. C <sub>4</sub>	0.149	0.161	0.217	0.236	0.095	0.252
<b>CD (P=0.05) between</b>						
Treatment mean vs. C <sub>1</sub>	0.86	0.43	0.62	0.74	0.59	0.52
Treatment mean vs. C <sub>4</sub>	0.41	0.45	0.60	0.656	0.26	0.70
CV (%)	3.8	9.4	5.2	14.0	8.9	5.5

**Table 4.19. Girth of rhizome (cm) of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Girth of rhizome					
	Mother		Primary		Secondary	
	2013	2014	2013	2014	2013	2014
<b>Planting Methods (M)</b>						
M <sub>1</sub> : Paired row 80/20 cm	6.79	7.01	5.86	6.23	3.90	3.99
M <sub>2</sub> : Paired row 70/30 cm	6.93	7.02	6.20	6.19	4.10	4.10
SEd (±)	0.202	0.202	0.078	0.183	0.063	0.125
CD (P=0.05)	NS	NS	0.16	NS	NS	NS

<b>Intercropping (I)</b>						
I <sub>1</sub> : Baby corn	6.73	7.02	5.8	6.15	3.86	3.95
I <sub>2</sub> : Greengram	6.98	7.01	6.3	6.27	4.05	4.13
SEd (±)	0.202	0.202	0.182	0.183	0.063	0.125
CD (P=0.05)	0.15	NS	0.37	NS	0.13	NS
<b>Weed Management (W)</b>						
W <sub>1</sub> : Weedy check (Control)	5.71	5.99	4.67	4.95	2.56	2.59
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	7.99	7.81	7.3	7.55	5.16	5.14
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.02	7.32	6.18	6.1	4.21	4.37
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	6.72	6.94	5.98	6.23	3.9	4.08
SEd (±)	0.106	0.287	0.111	0.258	0.089	0.177
CD (P=0.05)	0.22	0.59	0.23	0.53	0.18	0.36
<b>Treatment Mean</b>	6.86	7.02	6.03	6.21	4.00	4.05
<b>Control (C)</b>						
C <sub>1</sub> : (Sole turmeric-recommended)	8.73	8.17	8.0	9.1	5.7	5.35
C <sub>4</sub> : (Sole turmeric-weed free)	8.93	8.73	8.3	9.40	5.9	5.52
SEd (±)	3.04E-09	0.176	0.115	0.864	0.185	0.330
CD (P=0.05)	1.30E-08	NS	NS	NS	NS	0.14
<b>SEd (±) between</b>						
Treatment mean vs. C <sub>1</sub>	0.138	0.342	0.060	0.954	0.091	0.128
Treatment mean vs. C <sub>4</sub>	0.138	0.323	0.101	0.296	0.209	0.132
<b>CD (P=0.05) between</b>						
Treatment mean vs. C <sub>1</sub>	0.38	0.95	0.17	2.64	0.25	0.36
Treatment mean vs. C <sub>4</sub>	0.38	0.89	0.28	0.82	0.58	0.37
CV (%)	3.8	10.0	4.5	10.2	5.5	10.9

**Table 4.20(a). Weight (g) of mother and primary rhizome per plant of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Weight of rhizome			
	Mother		Primary	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	118.87	119.38	159.38	160.19
M <sub>2</sub> : Paired row 70/30 cm	124.00	124.19	165.35	166.31
SEd (±)	1.472	0.271	0.311	0.357
CD (P=0.05)	3.01	0.55	0.63	0.72
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	118.98	119.17	158.42	159.05
I <sub>2</sub> : Greengram	123.89	124.40	166.24	167.45
SEd (±)	1.472	0.271	0.311	0.357
CD (P=0.05)	3.01	0.55	0.63	0.73
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	52.87	53.62	90.68	92.21
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	164.26	164.56	214.22	215.12
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	138.41	138.97	183.99	184.38
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	130.21	129.99	160.43	161.31
SEd (±)	2.082	0.383	0.441	0.505
CD (P=0.05)	4.25	0.78	0.89	1.03
<b>Treatment Mean</b>	121.43	121.79	162.33	163.25
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	192.06	190.53	253.30	251.1
C <sub>4</sub> : (Sole turmeric-weed free)	196.46	198.06	273.20	270.3
SEd (±)	0.953	0.551	0.665	1.017
CD (P=0.05)	4.10	2.37	2.86	4.38
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.404	0.641	0.503	0.625
Treatment mean vs. C <sub>4</sub>	0.762	0.800	1.019	0.525
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.12	1.78	1.39	1.73
Treatment mean vs. C <sub>4</sub>	2.11	2.22	2.82	1.46
CV (%)	4.2	4.3	3.1	1.2

**Table 4.20(b). Weight (g) of secondary and total rhizome per plant of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Weight of rhizome			
	Secondary		Total	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	62.34	63.01	340.53	342.58
M <sub>2</sub> : Paired row 70/30 cm	66.26	67.09	355.61	357.59
SEd (±)	0.340	0.253	0.382	0.673
CD (P=0.05)	0.69	0.52	0.78	1.37
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	61.91	62.3	339.32	340.52
I <sub>2</sub> : Greengram	66.68	67.8	356.83	359.65
SEd (±)	0.340	0.253	0.382	0.673
CD (P=0.05)	0.69	0.52	0.78	1.37
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	48.72	49.77	192.30	195.59
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	81.88	82.68	460.37	462.35
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	66.38	67.24	388.78	390.58
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	60.20	60.52	350.84	351.82
SEd (±)	0.481	0.358	0.540	0.952
CD (P=0.05)	0.98	0.73	1.10	1.94
<b>Treatment Mean</b>	64.30	65.05	348.07	350.08
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	106.46	105.13	551.83	546.77
C <sub>4</sub> : (Sole turmeric-weed free)	111.20	111.63	580.86	579.93
SEd (±)	0.536	0.404	0.938	1.117
CD (P=0.05)	2.31	1.74	4.03	4.81
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.475	0.637	0.449	0.987
Treatment mean vs. C <sub>4</sub>	0.762	0.579	0.851	1.321
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	1.32	1.77	1.24	2.74
Treatment mean vs. C <sub>4</sub>	2.12	1.61	2.36	3.67
CV (%)	4.8	3.4	6.2	4.7

**Table 4.21. Fresh and dry yield (t ha<sup>-1</sup>) of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Rhizome yield			
	Fresh		Dry	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	23.70	24.04	5.45	5.48
M <sub>2</sub> : Paired row 70/30 cm	24.25	24.63	5.55	5.61
SEd (±)	0.070	0.078	0.020	0.018
CD (P=0.05)	0.14	0.16	0.04	0.04
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	23.63	23.97	5.43	5.48
I <sub>2</sub> : Greengram	24.33	24.7	5.57	5.62
SEd (±)	0.070	0.078	0.020	0.018
CD (P=0.05)	0.14	0.16	0.04	0.04
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	12.11	12.52	2.57	2.51
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	32.05	32.42	7.66	7.14
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.55	26.78	6.04	6.19
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	25.2	25.62	5.71	5.87
SEd (±)	0.099	0.110	0.029	0.026
CD (P=0.05)	0.20	0.23	0.06	0.05
<b>Treatment Mean</b>	23.98	24.33	5.50	5.54
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	37.13	36.8	8.61	8.99
C <sub>4</sub> : (Sole turmeric-weed free)	39.43	38.9	9.12	9.50
SEd (±)	0.208	0.152	0.106	0.136
CD (P=0.05)	0.89	0.66	0.46	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.089	0.136	0.078	0.075
Treatment mean vs. C <sub>4</sub>	0.177	0.188	0.071	0.067
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.25	0.38	0.21	0.21
Treatment mean vs. C <sub>4</sub>	0.49	0.52	0.20	0.19
CV (%)	3.0	4.1	2.3	4.1

**Table 4.22(a). Fresh rhizome yield (t ha<sup>-1</sup>) of turmeric under interaction of intercropping and weed management practices in 2013**

Weed management		Intercropping	
		Baby corn	Greengram
W <sub>1</sub>	Weedy check (Control)	11.82	12.40
W <sub>2</sub>	Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	31.52	32.58
W <sub>3</sub>	Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.02	27.08
W <sub>4</sub>	Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	25.17	25.23
SEd (±)		0.140	
CD (P=0.05)		0.29	
CV (%)		3.4	

**Table 4.22(b). Fresh rhizome yield (t ha<sup>-1</sup>) of turmeric under interaction of intercropping and weed management practices in 2014**

Weed management		Intercropping	
		Baby corn	Greengram
W <sub>1</sub>	Weedy check (Control)	12.27	12.77
W <sub>2</sub>	Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	31.88	32.95
W <sub>3</sub>	Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.30	27.27
W <sub>4</sub>	Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	25.42	25.82
SEd (±)		0.156	
CD (P=0.05)		0.32	
CV (%)		4.0	

**Table 4.22(c). Fresh rhizome yield (t ha<sup>-1</sup>) of turmeric under interaction of planting method and weed management practices in 2013**

Weed management		Pared row planting	
		80/20 cm	70/30 cm
W <sub>1</sub>	Weedy check (Control)	11.78	12.43
W <sub>2</sub>	Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	31.55	32.55
W <sub>3</sub>	Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.37	26.73
W <sub>4</sub>	Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	25.12	25.28
SEd (±)		0.140	
CD (P=0.05)		0.29	
CV (%)		3.0	

**Table 4.22(d). Fresh rhizome yield (t ha<sup>-1</sup>) of turmeric under interaction of planting method and weed management practices in 2014**

Weed management		Pared row planting	
		80/20 cm	70/30cm
W <sub>1</sub>	Weedy check (Control)	12.12	12.92
W <sub>2</sub>	Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	31.97	32.87
W <sub>3</sub>	Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	26.55	27.02
W <sub>4</sub>	Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	25.52	25.72
SEd (±)		0.156	
CD (P=0.05)		0.32	
CV (%)		3.0	

**Table 4.23. Dry recovery (%) and curcumin content (%) of turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	Dry recovery		Curcumin	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	22.83	22.34	6.77	6.52
M <sub>2</sub> : Paired row 70/30 cm	22.74	22.19	6.73	6.53
SEd (±)	0.058	0.074	0.024	0.021
CD (P=0.05)	NS	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	22.82	22.29	6.71	6.51
I <sub>2</sub> : Greengram	22.76	22.23	6.73	6.51
SEd (±)	0.058	0.074	0.024	0.021
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	20.83	20.48	6.6	6.42
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	23.76	23.64	6.81	6.52
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	23.3	22.55	6.74	6.51
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	23.27	22.36	6.73	6.51
SEd (±)	0.082	0.106	0.034	0.032
CD (P=0.05)	0.17	0.21	0.06	NS
<b>Treatment Mean</b>	22.79	22.26	6.72	6.53
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	24.2	23.39	6.8	6.51
C <sub>4</sub> : (Sole turmeric-weed free)	24.1	23.45	6.8	6.52
SEd (±)	0.231	0.188	0.058	0.053
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.188	0.154	0.336	0.335
Treatment mean vs. C <sub>4</sub>	0.093	0.080	0.336	0.335
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.52	0.43	NS	NS
Treatment mean vs. C <sub>4</sub>	0.26	0.22	NS	NS
CV (%)	2.7	4.2	3.2	3.3

**Table 4.24. Plant population of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant population (No. m <sup>-2</sup> )	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	4.87	4.85
M <sub>2</sub> : Paired row 70/30 cm	4.93	4.93
SEd (±)	0.057	0.065
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	4.90	4.93
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.00	5.00
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.80	4.74
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.90	4.88
SEd (±)	0.081	0.090
CD (P=0.05)	0.17	0.19
<b>Treatment Mean</b>	4.90 (61.25)*	4.89 (61.51)*
<b>Control (C)</b>		
C <sub>2</sub> : (Sole baby corn)	8.00	7.95
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>2</sub>	0.047	0.033
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>2</sub>	0.13	0.09
CV (%)	4.1	4.6

\*Figures in parentheses indicate per cent to the control C<sub>2</sub>

**Table 4.25. Plant height (cm) and number of leaves per plant of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant height		No. of leaves	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	164.39	163.00	11.17	11.17
M <sub>2</sub> : Paired row 70/30 cm	164.78	163.38	11.30	10.67
SEd (±)	1.957	1.989	0.190	0.070
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	141.39	140.95	9.20	10.33
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	179.41	178.92	13.7	11.33
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	168.39	167.02	10.70	10.83
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	169.17	165.87	11.30	11.17
SEd (±)	2.768	2.814	0.269	0.994
CD (P=0.05)	5.65	5.75	NS	NS
<b>Treatment Mean</b>	164.72	163.49	11.21	10.92
<b>Control (C)</b>				
C <sub>2</sub> : (Sole baby corn)	180.11	181.20	13.00	12.00
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>2</sub>	0.468	0.579	0.351	0.579
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>2</sub>	1.30	1.61	0.97	0.61
CV (%)	4.1	4.2	5.9	4.9

**Table 4.26. Leaf area index (LAI %) of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	LAI	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	10.69	10.08
M <sub>2</sub> : Paired row 70/30 cm	10.82	10.07
SEd (±)	0.154	0.251
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	7.17	7.09
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	13.18	13.65
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	10.79	10.13
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	11.10	9.44
SEd (±)	0.217	0.355
CD (P=0.05)	0.45	0.73
<b>Treatment Mean</b>	10.76	10.08
<b>Control (C)</b>		
C <sub>2</sub> : (Sole baby corn)	13.67	13.21
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>2</sub>	0.179	0.472
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>2</sub>	0.49	1.31
CV (%)	5.0	8.6

**Table 4.27. Days to 50 per cent tasseling and silking of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	Days to 50 % tasseling		Days to 50 % silking	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	49.00	48.75	59.40	58.92
M <sub>2</sub> : Paired row 70/30 cm	49.00	48.75	59.40	59.50
SEd (±)	0.619	0.578	0.736	0.790
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	46.50	45.83	58.30	56.83
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	52.00	51.17	60.50	60.00
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	47.80	48.33	59.6	60.67
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	47.80	47.67	59.2	59.33
SEd (±)	0.876	0.816	1.041	1.117
CD (P=0.05)	1.78	1.67	2.13	NS
<b>Treatment Mean</b>	49.00	48.75	59.40	59.21
<b>Control (C)</b>				
C <sub>2</sub> : (Sole baby corn)	50.00	52.00	61.00	61.00
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>2</sub>	0.351	0.657	0.373	0.443
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>2</sub>	0.97	1.83	1.03	1.23
CV (%)	4.4	4.2	4.3	4.6

**Table 4.28. Number of cob per plant and weight of cob (g) of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	Cob No. plant <sup>-1</sup>	Cob weight cob <sup>-1</sup>
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	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	1.92	1.93	70.71	70.35
M <sub>2</sub> : Paired row 70/30 cm	1.90	1.87	70.72	70.40
SEd (±)	0.042	0.039	0.841	0.816
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	1.70	1.68	65.77	63.6
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.20	2.08	75.7	75.02
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.80	1.92	70.76	70.50
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.90	1.90	70.92	70.37
SEd (±)	0.059	0.055	0.190	1.155
CD (P=0.05)	0.12	0.11	2.43	2.36
<b>Treatment Mean</b>	1.91	1.90	70.71	70.37
<b>Control (C)</b>				
C <sub>2</sub> : (Sole baby corn)	2.00	2.00	73.45	72.34
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>2</sub>	0.018	0.011	0.600	0.635
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>2</sub>	0.05	0.031	1.66	1.76
CV (%)	7.6	7.1	4.1	4.0

**Table 4.29. Cob and stover yield of baby corn as influenced by planting methods, intercropping and weed management practices**

Treatments	Yield (t ha <sup>-1</sup> )			
	Cob		Stover	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	6.57	6.52	11.52	11.49
M <sub>2</sub> : Paired row 70/30 cm	6.58	6.54	11.56	11.52
SEd (±)	0.084	0.082	0.144	0.145
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	5.3	5.1	8.17	8.21
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	8.2	8.1	16.62	16.66
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	6.4	6.3	10.58	10.54
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	6.4	6.1	10.80	10.85
SEd (±)	0.119	0.113	0.204	0.238
CD (P=0.05)	0.24	0.23	0.42	0.49
<b>Treatment Mean</b>	6.57	6.53	11.55	11.51
<b>Control (C)</b>				
C <sub>2</sub> : (Sole baby corn)	11.54	11.50	19.71	19.62
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>2</sub>	0.025	0.024	0.083	0.078
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>2</sub>	0.07	0.07	0.23	0.22
CV (%)	4.4	4.7	4.3	5.0

**Table 4.30. Plant population of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant population (No. m <sup>-2</sup> )	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	9.00	10.66
M <sub>2</sub> : Paired row 70/30 cm	8.80	10.58
SEd (±)	0.274	0.192
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	9.00	9.50
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	11.17	12.66
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.83	10.16
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	7.67	10.16
SEd (±)	0.387	0.272
CD (P=0.05)	0.79	0.55
<b>Treatment Mean</b>	8.92	10.62
<b>Control (C)</b>		
C <sub>3</sub> : (Sole greengram)	32.00	33.00
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>3</sub>	1.91	0.608
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>3</sub>	3.31	1.68
CV (%)	10.6	6.3

\*Figures in parentheses indicate per cent to the control C<sub>3</sub>

**Table 4.31. Plant height (cm) and number of primary branch per plant of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	Plant height		No. of primary branch	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	43.95	45.28	3.36	3.40
M <sub>2</sub> : Paired row 70/30 cm	44.21	42.3	3.09	3.33
SEd (±)	0.540	2.058	0.078	0.039
CD (P=0.05)	NS	NS	0.16	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	37.60	32.97	2.24	2.36
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	54.32	55.58	4.00	4.18
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	42.11	43.27	3.32	3.45
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	42.27	43.4	3.35	3.46
SEd (±)	0.763	2.910	0.110	0.056
CD (P=0.05)	1.55	5.94	0.23	0.11
<b>Treatment Mean</b>	44.07	43.81	3.22	3.36
<b>Control (C)</b>				
C <sub>3</sub> : (Sole greengram)	56.00	57.34	3.28	3.00
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>3</sub>	0.917	0.369	0.208	0.125
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>3</sub>	2.54	1.03	NS	NS
CV (%)	4.2	16.3	8.4	4.1

**Table 4.32. Leaf area index (LAI %) of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	LAI	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	4.76	4.83
M <sub>2</sub> : Paired row 70/30 cm	4.76	4.84
SEd (±)	0.082	0.064
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	4.19	4.27
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	5.12	5.18
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.88	4.97
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.83	4.94
SEd (±)	0.115	0.091
CD (P=0.05)	0.24	0.18
<b>Treatment Mean</b>	4.76	4.84
<b>Control (C)</b>		
C <sub>3</sub> : (Sole greengram)	4.47	4.55
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>3</sub>	0.013	0.005
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>3</sub>	0.03	0.01
CV (%)	5.9	4.6

**Table 4.33. Number of pod per plant, length of pod of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	No. of pod		Length of pod	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	23.33	25.00	7.01	7.09
M <sub>2</sub> : Paired row 70/30 cm	23.91	25.33	7.01	7.08
SEd (±)	0.403	0.316	0.087	0.086
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	16.83	18.33	6.75	6.76
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	33.17	34.83	7.13	7.25
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	22.33	23.83	7.14	7.16
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	22.17	23.66	7.06	7.16
SEd (±)	0.569	0.447	0.122	0.122
CD (P=0.05)	1.16	0.91	0.25	0.25
<b>Treatment Mean</b>	23.63	25.96	7.01	7.08
<b>Control (C)</b>				
C <sub>3</sub> : (Sole greengram)	23.0	22.00	7.10	7.22
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>3</sub>	0.963	0.587	0.046	0.020
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>3</sub>	NS	1.63	0.13	0.06
CV (%)	5.9	4.4	4.3	4.2

**Table 4.34. Test seed weight of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	1000 seed weight (g)
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	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	37.34	37.79
M <sub>2</sub> : Paired row 70/30 cm	37.73	37.88
SEd (±)	0.456	0.426
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	35.38	35.55
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	40.48	40.67
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	37.15	37.44
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	37.12	37.33
SEd (±)	0.645	0.589
CD (P=0.05)	1.32	1.17
<b>Treatment Mean</b>	37.53	37.84
<b>Control (C)</b>		
C <sub>3</sub> : (Sole greengram)	35.70	35.98
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>3</sub>	0.989	0.979
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>3</sub>	NS	NS
CV (%)	4.2	5.3

**Table 4.35. Grain and stover yield of greengram as influenced by planting methods, intercropping and weed management practices**

Treatments	Yield (q ha <sup>-1</sup> )
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	Grain		Stover	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.31	3.39	8.34	8.39
M <sub>2</sub> : Paired row 70/30 cm	3.28	3.40	8.24	8.35
SEd (±)	0.031	0.031	0.111	0.104
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.55	2.76	6.86	6.95
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.21	4.28	10.15	10.21
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	3.19	3.28	8.0	8.17
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	3.18	3.27	8.0	8.17
SEd (±)	0.042	0.044	0.158	0.147
CD (P=0.05)	0.09	0.09	0.32	0.30
<b>Treatment Mean</b>	3.29	3.39	8.29	8.37
<b>Control (C)</b>				
C <sub>3</sub> : (Sole greengram)	11.90	12.14	29.8	30.2
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>3</sub>	0.062	0.051	0.100	0.013
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>3</sub>	0.15	0.14	0.27	0.03
CV (%)	3.9	3.2	4.7	4.3

**Table 4.36(a). Nitrogen removal (kg ha<sup>-1</sup>) by weeds in turmeric as influenced by planting methods, intercropping and weed management practices**

Treatment	Nitrogen	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	68.46	67.20
M <sub>2</sub> : Paired row 70/30 cm	66.55	66.62
SEd (±)	1.485	1.112
CD (P=0.05)	NS	NS
<b>Intercropping (I)</b>		
I <sub>1</sub> : Baby corn	68.59	67.02
I <sub>2</sub> : Greengram	66.42	64.80
SEd (±)	1.485	1.112
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	242.14	237.16
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.33	2.15
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	11.27	11.64
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	14.28	12.69
SEd (±)	2.100	1.573
CD (P=0.05)	4.28	3.21
<b>Treatment Mean</b>	67.51	66.91
<b>Control (C)</b>		
C <sub>1</sub> : (Sole turmeric-recommended)	5.86	5.56
C <sub>4</sub> : (Sole turmeric-weed free)	0.428	0.29
SEd (±)	0.079	0.718
CD (P=0.05)	0.34	3.08
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>1</sub>	0.845	0.995
Treatment mean vs. C <sub>4</sub>	0.833	0.688
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>1</sub>	2.34	2.76
Treatment mean vs. C <sub>4</sub>	2.31	1.91
CV (%)	7.6	5.8

**Table 4.36(b). Phosphorus removal (kg ha<sup>-1</sup>) by weeds in turmeric as influenced by planting methods, intercropping and weed management practices**

Treatment	Phosphorus	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	5.65	5.33
M <sub>2</sub> : Paired row 70/30 cm	6.22	5.74
SEd (±)	0.380	0.281
CD (P=0.05)	NS	NS
<b>Intercropping (I)</b>		
I <sub>1</sub> : Baby corn	5.69	5.45
I <sub>2</sub> : Greengram	6.19	5.62
SEd (±)	0.380	0.281
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	21.08	19.71
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.21	0.17
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.09	1.11
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	1.37	1.16
SEd (±)	0.537	0.398
CD (P=0.05)	1.09	0.81
<b>Treatment Mean</b>		
Control (C)	5.94	5.54
C <sub>1</sub> : (Sole turmeric-recommended)	0.42	0.43
C <sub>4</sub> : (Sole turmeric-weed free)	0.04	0.04
SEd (±)	0.047	0.049
CD (P=0.05)	0.20	0.21
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>1</sub>	0.170	0.137
Treatment mean vs. C <sub>4</sub>	0.161	0.127
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>1</sub>	0.47	0.38
Treatment mean vs. C <sub>4</sub>	0.44	0.35
CV (%)	22.1	17.6

**Table 4.36(c). Potassium removal (kg ha<sup>-1</sup>) by weeds in turmeric as influenced by planting methods, intercropping and weed management practices**

Treatment	Potassium	
	2013	2014
<b>Planting Methods (M)</b>		
M <sub>1</sub> : Paired row 80/20 cm	57.4	51.9
M <sub>2</sub> : Paired row 70/30 cm	56.4	51.8
SEd (±)	0.351	1.728
CD (P=0.05)	NS	NS
<b>Intercropping (I)</b>		
I <sub>1</sub> : Baby corn	58.1	52.4
I <sub>2</sub> : Greengram	55.6	51.4
SEd (±)	0.351	1.728
CD (P=0.05)	NS	NS
<b>Weed Management (W)</b>		
W <sub>1</sub> : Weedy check (Control)	200.9	182.3
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.4	2.0
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	11.0	11.0
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	13.2	12.1
SEd (±)	0.497	2.444
CD (P=0.05)	1.01	4.99
<b>Treatment Mean</b>		
Control (C)	56.9	51.87
C <sub>1</sub> : (Sole turmeric-recommended)	4.1	4.9
C <sub>4</sub> : (Sole turmeric-weed free)	0.4	0.3
SEd (±)	0.040	0.112
CD (P=0.05)	0.17	0.48
<b>SEd (±) between</b>		
Treatment mean vs. C <sub>1</sub>	0.164	0.836
Treatment mean vs. C <sub>4</sub>	0.157	0.828
<b>CD (P=0.05) between</b>		
Treatment mean vs. C <sub>1</sub>	0.45	2.32
Treatment mean vs. C <sub>4</sub>	0.43	2.29
CV (%)	21.4	11.5

**Table 4.37(a). Nitrogen content (%) in turmeric rhizome and shoots as influenced by planting methods, intercropping and weed management practices**

Treatments	N-content			
	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	2.5	2.6	2.9	2.9
M <sub>2</sub> : Paired row 70/30 cm	2.4	2.4	3.4	3.3
SEd (±)	0.035	0.062	0.073	0.067
CD (P=0.05)	NS	NS	0.51	0.14
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	2.5	2.5	3.2	3.1
I <sub>2</sub> : Greengram	2.5	2.5	3.1	3.1
SEd (±)	0.035	0.062	0.073	0.067
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.2	2.3	2.2	2.1
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	2.7	2.9	3.8	3.8
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.5	2.4	3.1	3.2
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	2.5	2.4	3.5	3.5
SEd (±)	0.050	0.087	0.103	0.095
CD (P=0.05)	0.10	0.18	0.21	0.19
<b>Treatment Mean</b>				
Control (C)	2.5	2.5	3.1	3.1
C <sub>1</sub> : (Sole turmeric-recommended)	3.2	3.1	4.4	4.4
C <sub>4</sub> : (Sole turmeric-weed free)	3.3	3.2	4.6	4.5
SEd (±)	0.120	0.120	0.033	0.033
CD (P=0.05)	NS	NS	NS	0.14
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.036	0.132	0.057	0.068
Treatment mean vs. C <sub>4</sub>	0.089	0.104	0.033	0.036
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.10	0.36	0.16	0.19
Treatment mean vs. C <sub>4</sub>	0.25	0.29	0.09	0.09
CV (%)	4.9	8.5	8.1	7.4

**Table 4.37(b). Nitrogen uptake (kg ha<sup>-1</sup>) by turmeric as influenced by planting methods, intercropping and weeds management practices**

Treatments	N-uptake			
	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	140.1	138.7	121.3	128.5
M <sub>2</sub> : Paired row 70/30 cm	140.4	138.3	138.1	140.4
SEd (±)	1.990	1.902	2.761	2.802
CD (P=0.05)	NS	NS	5.64	5.70
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	141.6	139.5	133.2	138.8
I <sub>2</sub> : Greengram	139.9	137.4	126.2	130.1
SEd (±)	1.990	1.902	2.761	2.870
CD (P=0.05)	NS	NS	5.64	5.72
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	56.5	56.36	40.9	42.1
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	206.8	206.8	243.2	248.3
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	154.1	150.5	117.4	124.3
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	143.6	140.6	117.3	122.9
SEd (±)	2.814	2.690	3.905	3.962
CD (P=0.05)	5.74	5.49	7.97	8.09
<b>Treatment Mean</b>	140.2	138.6	129.7	134.5
Control (C)				
C <sub>1</sub> : (Sole turmeric-recommended)	284.5	263.8	337.2	340.4
C <sub>4</sub> : (Sole turmeric-weed free)	316.8	294.9	399.4	411.4
SEd (±)	12.713	7.929	7.455	7.601
CD (P=0.05)	NS	NS	32.08	32.73
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	3.536	5.433	6.222	6.024
Treatment mean vs. C <sub>4</sub>	9.580	3.734	2.648	2.360
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	9.82	15.10	17.27	16.72
Treatment mean vs. C <sub>4</sub>	26.61	10.40	7.35	6.55
CV (%)	4.9	4.8	7.4	7.2

**Table 4.38(a). Phosphorous content (%) in turmeric rhizome and shoots as influenced by planting methods, intercropping and weed management practices**

Treatments	P-content			
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	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	0.32	0.31	0.31	0.30
M <sub>2</sub> : Paired row 70/30 cm	0.33	0.32	0.30	0.29
SEd (±)	0.006	0.004	0.009	0.009
CD (P=0.05)	NS	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	0.32	0.31	0.31	0.30
I <sub>2</sub> : Greengram	0.33	0.32	0.30	0.29
SEd (±)	0.006	0.004	0.009	0.009
CD (P=0.05)	0.01	0.01	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	0.22	0.21	0.22	0.21
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	0.41	0.41	0.39	0.38
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.33	0.32	0.31	0.29
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	0.33	0.32	0.31	0.30
SEd (±)	0.008	0.005	0.013	0.012
CD (P=0.05)	0.02	0.01	0.03	0.02
<b>Treatment Mean</b>				
Control (C)	0.32	0.31	0.31	0.29
C <sub>1</sub> : (Sole turmeric-recommended)	0.45	0.44	0.40	0.39
C <sub>4</sub> : (Sole turmeric-weed free)	0.46	0.46	0.40	0.41
SEd (±)	0.054	0.025	0.009	0.029
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.026	0.020	0.030	0.018
Treatment mean vs. C <sub>4</sub>	0.031	0.012	0.024	0.015
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.07	0.05	0.08	0.05
Treatment mean vs. C <sub>4</sub>	NS	0.03	0.07	0.05
CV (%)	6.2	4.4	10.4	10.5

**Table 4.38(b). Phosphorous uptake (kg ha<sup>-1</sup>) by turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	P-uptake			
	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				

M <sub>1</sub> : Paired row 80/20 cm	18.78	18.40	13.14	17.60
M <sub>2</sub> : Paired row 70/30 cm	19.66	19.20	12.48	17.41
SEd (±)	0.260	0.272	0.451	0.421
CD (P=0.05)	0.53	0.55	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	18.50	18.30	13.44	17.51
I <sub>2</sub> : Greengram	19.80	19.31	12.18	17.51
SEd (±)	0.260	0.272	0.451	0.421
CD (P=0.05)	0.53	0.55	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	5.61	5.51	4.10	5.51
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	31.60	31.50	24.80	29.50
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	20.40	19.50	11.60	17.51
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	19.30	18.70	0.70	17.30
SEd (±)	0.367	0.386	0.013	0.596
CD (P=0.05)	0.75	0.78	0.03	1.21
<b>Treatment Mean</b>				
Control (C)	19.20	18.83	12.81	17.50
C <sub>1</sub> : (Sole turmeric-recommended)	40.47	38.40	31.18	34.10
C <sub>4</sub> : (Sole turmeric-weed free)	43.40	42.50	35.70	34.40
SEd (±)	5.438	2.390	0.911	2.970
CD (P=0.05)	NS	NS	3.92	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	2.680	1.814	2.442	1.819
Treatment mean vs. C <sub>4</sub>	3.203	1.213	1.698	1.379
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	7.44	5.03	6.78	5.05
Treatment mean vs. C <sub>4</sub>	7.89	3.36	4.71	3.83
CV (%)	4.7	5.0	10.3	8.3

**Table 4.39(a). Potassium content (%) in turmeric rhizome and shoots as influenced by planting methods, intercropping and weed management practices**

Treatments	K-content			
	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	3.3	3.3	1.8	1.6

M <sub>2</sub> : Paired row 70/30 cm	3.3	3.3	1.7	1.7
SEd (±)	0.094	0.059	0.046	0.046
CD (P=0.05)	NS	NS	NS	NS
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	3.4	3.3	1.8	1.7
I <sub>2</sub> : Greengram	3.3	3.3	1.8	1.7
SEd (±)	0.094	0.059	0.045	0.045
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	2.6	2.5	1.2	1.7
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.2	4.1	2.5	2.4
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	3.3	3.3	1.7	1.6
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	3.4	3.3	1.7	1.6
SEd (±)	0.132	0.083	0.065	0.065
CD (P=0.05)	0.27	0.17	0.13	0.13
<b>Treatment Mean</b>	3.4	3.3	1.8	1.7
Control (C)				
C <sub>1</sub> : (Sole turmeric-recommended)	4.3	4.2	2.6	2.6
C <sub>4</sub> : (Sole turmeric-weed free)	4.4	4.3	2.5	2.5
SEd (±)	0.102	0.115	0.145	0.208
CD (P=0.05)	NS	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.108	0.081	0.120	0.120
Treatment mean vs. C <sub>4</sub>	0.108	0.115	0.088	0.120
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.30	0.22	0.33	0.33
Treatment mean vs. C <sub>4</sub>	0.30	0.32	0.25	0.33
CV (%)	9.7	6.1	8.9	8.7

**Table 4.39(b). Potassium uptake (kg ha<sup>-1</sup>) by turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	K-uptake			
	Rhizome		Shoot	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	194.5	192.5	107.4	105.8
M <sub>2</sub> : Paired row 70/30 cm	197.3	195.0	104.4	102.1
SEd (±)	5.033	3.706	2.921	2.938
CD (P=0.05)	NS	NS	NS	NS

<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	197.2	192.51	105.9	103.8
I <sub>2</sub> : Greengram	194.7	195.0	106.12	104.2
SEd (±)	5.032	3.706	2.921	2.938
CD (P=0.05)	NS	NS	NS	NS
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	64.6	64.9	31.0	30.9
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	315.6	318.1	189.8	189.7
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	206.2	200.8	102.5	99.40
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	197.4	191.3	100.1	95.9
SEd (±)	7.117	5.242	4.131	4.156
CD (P=0.05)	14.50	10.70	8.43	8.48
<b>Treatment Mean</b>				
Control (C)	195.9	193.8	105.9	104.0
C <sub>1</sub> : (Sole turmeric-recommended)	386.5	364.3	236.8	266.6
C <sub>4</sub> : (Sole turmeric-weed free)	418.0	395.2	234.4	231.1
SEd (±)	5.545	12.345	15.746	21.220
CD (P=0.05)	23.90	NS	NS	NS
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	11.831	7.716	12.691	11.124
Treatment mean vs. C <sub>4</sub>	7.479	8.017	7.804	11.596
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	32.84	21.42	35.20	30.88
Treatment mean vs. C <sub>4</sub>	20.76	22.25	21.60	32.19
CV (%)	8.9	6.6	9.5	9.7

**Table 4.40. Total NPK uptake (kg ha<sup>-1</sup>) turmeric as influenced by planting methods, intercropping and weed management practices**

Treatments	N		P		K	
	2013	2014	2013	2014	2013	2014
<b>Planting Methods (M)</b>						
M <sub>1</sub> : Paired row 80/20 cm	261.4	267.2	31.9	36.1	301.9	298.3
M <sub>2</sub> : Paired row 70/30 cm	278.5	278.7	32.1	36.6	301.7	297.1
SEd (±)	2.375	2.386	0.261	0.273	7.954	6.644
CD (P=0.05)	NS	NS	NS	NS	NS	NS
<b>Intercropping (I)</b>						
I <sub>1</sub> : Baby corn	274.8	278.3	31.9	35.8	303.1	296.3

I <sub>2</sub> : Greengram	266.1	267.5	31.9	36.8	300.8	299.2
SEd (±)	2.375	2.386	0.261	0.273	7.953	6.644
CD (P=0.05)	4.75	4.77	0.54	0.56	NS	NS
<b>Weed Management (W)</b>						
W <sub>1</sub> : Weedy check (Control)	97.4	98.5	9.7	11.0	95.6	95.8
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	450.0	455.10	56.4	61.0	505.4	507.8
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	271.5	274.8	32.1	37.0	308.7	300.2
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	260.9	263.5	20.0	36.1	297.5	287.2
SEd (±)	3.359	3.326	0.327	0.375	7.11	5.24
CD (P=0.05)	6.71	6.65	0.65	0.75	14.50	10.70
<b>Treatment Mean</b>						
Control (C)						
C <sub>1</sub> : (Sole turmeric-recommended)	621.7	604.2	71.65	72.5	623.30	630.91
C <sub>4</sub> : (Sole turmeric-weed free)	716.2	706.3	79.1	76.90	652.4	626.3
SEd (±)	18.201	14.506	4.428	2.310	16.346	23.210
CD (P=0.05)	NS	NS	NS	NS	NS	NS
<b>SEd (±) between</b>						
Treatment mean vs. C <sub>1</sub>	4.213	4.221	2.681	1.815	13.691	10.124
Treatment mean vs. C <sub>4</sub>	5.231	5.213	3.203	1.213	9.804	7.901
<b>CD (P=0.05) between</b>						
Treatment mean vs. C <sub>1</sub>	8.32	8.23	4.56	2.1603	26.720	20.88
Treatment mean vs. C <sub>4</sub>	10.11	12.37	7.19	3.36	18.60	14.19
CV (%)	5.1	6.2	3.4	3.9	4.2	3.9

**Table 4.41. Total NPK uptake (kg ha<sup>-1</sup>) in cropping system as influenced by planting methods, intercropping and weed management practices**

Treatments	N		P		K	
	2013	2014	2013	2014	2013	2014
<b>Planting Methods (M)</b>						
M <sub>1</sub> : Paired row 80/20 cm	375.1	380.9	37.4	47.2	504.7	501.3
M <sub>2</sub> : Paired row 70/30 cm	381.1	381.3	36.7	48.3	571.7	567.2
SEd (±)	3.956	3.976	0.954	0.534	6.461	64.746
CD (P=0.05)	NS	NS	NS	NS	NS	NS
<b>Intercropping (I)</b>						
I <sub>1</sub> : Baby corn	471.4	475.6	46.1	55.1	684.9	678.5
I <sub>2</sub> : Greengram	294.7	296.6	27.9	40.4	391.5	389.9
SEd (±)	3.913	3.923	0.952	0.533	64.605	67.746

CD (P=0.05)	7.83	7.85	1.90	1.07	129.21	135.39
<b>Weed Management (W)</b>						
W <sub>1</sub> : Weedy check (Control)	171.6	172.8	15.4	18.3	229.6	229.9
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	618.1	623.2	67.4	78.9	813.1	815.4
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	374.8	378.3	33.7	47.6	624.6	616.2
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	367.8	370.1	31.5	46.2	485.4	475.2
SEd (±)	5.595	5.623	1.350	0.755	91.366	91.565
CD (P=0.05)	11.42	11.48	2.75	1.54	182.57	186.97
<b>Treatment Mean</b>						
Control (C)	383.1	386.1	37.0	45.8	538.2	534.2
C <sub>1</sub> : (Sole turmeric-recommended)	621.7	604.2	62.3	65.6	623.3	591.09
C <sub>4</sub> : (Sole turmeric-weed free)	716.2	706.4	71.4	79.9	653.4	626.4
SEd (±)	17.853	10.476	1.823	4.168	20.384	30.372
CD (P=0.05)	35.71	20.95	3.646	8.34	NS	NS
<b>SEd (±) between</b>						
Treatment mean vs. C <sub>1</sub>	8.076	6.440	4.880	3.494	38.298	36.402
Treatment mean vs. C <sub>4</sub>	12.109	4.521	13.540	0.703	33.494	31.345
<b>CD (P=0.05) between</b>						
Treatment mean vs. C <sub>1</sub>	22.41	17.87	3.39	9.70	76.60	72.80
Treatment mean vs. C <sub>4</sub>	33.61	12.55	9.41	1.95	66.98	62.69
CV (%)	3.8	3.6	8.9	3.8	4.1	4.1

**Table 4.42. Soil microbial carbon (SMBC) after harvest of base crop as influenced by treatments**

Treatment		SMBC ( $\mu\text{g/g}$ of soil )	
		2013	2014
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	80/20 cm; Baby corn; weedy check	275.2	278.7
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95, 140 DAP	442.8	449.4
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	280.8	282.5
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	280.4	285.2
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	80/20 cm; greengram; weedy check	276.5	279.0
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	465.7	472.2
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	80/20 cm; greengram; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185DAP	285.3	290.7
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	284.7	298.2
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; baby corn; weedy check	278.5	280.7
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	455.3	466.6
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	70/30 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	281.3	286.6
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	280.3	295.4
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	70/30 cm; greengram; baby corn; weedy check	278.6	279.7
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	461.9	469.0
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	291.2	298.3
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	290.2	300.9

**Table 4.43. Post harvest (base crop) soil available organic carbon (g kg<sup>-1</sup>) and nitrogen (kg ha<sup>-1</sup>) as influenced by planting methods, intercropping and weed management practices**

Treatments	Soil nutrients			
	Organic carbon		Nitrogen	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	4.55	4.69	359.54	365.12
M <sub>2</sub> : Paired row 70/30 cm	4.55	4.68	359.38	364.51
SEd (±)	0.016	0.020	0.065	0.093
CD (P=0.05)	NS	NS	0.13	0.19
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	4.51	4.67	357.76	363.40
I <sub>2</sub> : Greengram	4.53	4.70	361.17	366.24
SEd (±)	0.016	0.020	0.065	0.093
CD (P=0.05)	NS	NS	0.13	0.19
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	4.35	4.54	342.47	345.81
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	4.76	4.93	372.24	378.94
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.55	4.65	360.02	366.62
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	4.55	4.62	363.12	367.90
SEd (±)	0.022	0.029	0.091	0.131
CD (P=0.05)	0.05	0.06	0.19	0.27
<b>Treatment Mean</b>	4.55	4.69	359.46	364.81
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	4.87	4.97	373.47	379.27
C <sub>4</sub> : (Sole turmeric-weed free)	4.83	5.00	370.23	378.13
SEd (±)	0.067	0.088	0.066	0.067
CD (P=0.05)	NS	NS	0.09	0.29
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.035	0.067	0.051	0.067
Treatment mean vs. C <sub>4</sub>	0.035	0.100	0.051	0.067
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.09	0.19	0.14	0.19
Treatment mean vs. C <sub>4</sub>	0.09	0.28	0.14	0.19
CV (%)	3.2	2.5	2.1	2.1

**Table 4.44. Post harvest (base crop) soil available phosphorus (kg ha<sup>-1</sup>) and potassium (kg ha<sup>-1</sup>) as influenced by planting methods, intercropping and weed management practices**

Treatments	Soil nutrients			
	Phosphorus		Potassium	
	2013	2014	2013	2014
<b>Planting Methods (M)</b>				
M <sub>1</sub> : Paired row 80/20 cm	20.65	21.19	203.15	212.11
M <sub>2</sub> : Paired row 70/30 cm	20.46	20.93	202.88	211.48
SEd (±)	0.022	0.053	0.020	0.026
CD (P=0.05)	0.04	0.11	0.04	0.05
<b>Intercropping (I)</b>				
I <sub>1</sub> : Baby corn	20.98	21.43	203.19	212.09
I <sub>2</sub> : Greengram	20.14	20.68	202.84	211.50
SEd (±)	0.022	0.053	0.020	0.026
CD (P=0.05)	0.05	0.11	0.04	0.05
<b>Weed Management (W)</b>				
W <sub>1</sub> : Weedy check (Control)	18.14	18.50	192.52	104.40
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	23.16	23.71	208.37	214.12
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	20.31	20.73	205.25	213.00
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	20.62	21.30	205.93	213.64
SEd (±)	0.032	0.075	0.029	0.037
CD (P=0.05)	0.06	0.15	0.06	0.07
<b>Treatment Mean</b>	20.56	21.06	203.01	211.79
<b>Control (C)</b>				
C <sub>1</sub> : (Sole turmeric-recommended)	26.10	26.60	206.37	211.42
C <sub>4</sub> : (Sole turmeric-weed free)	24.98	25.33	205.27	210.44
SEd (±)	0.003	0.033	0.115	0.045
CD (P=0.05)	0.01	0.14	0.50	0.19
<b>SEd (±) between</b>				
Treatment mean vs. C <sub>1</sub>	0.003	0.064	0.068	0.040
Treatment mean vs. C <sub>4</sub>	0.005	0.072	0.068	0.032
<b>CD (P=0.05) between</b>				
Treatment mean vs. C <sub>1</sub>	0.01	0.18	0.19	0.11
Treatment mean vs. C <sub>4</sub>	0.01	0.20	0.19	0.09
CV (%)	2.1	1.2	2.2	1.1

**Table 4.45. Turmeric equivalent yield (t ha<sup>-1</sup>) as influenced by planting methods, intercropping and weed management practices**

Treatments	Turmeric equivalent yield		2-year's average
	2013	2014	
<b>Planting Methods (M)</b>			

M <sub>1</sub> : Paired row 80/20 cm	29.13	29.45	29.29
M <sub>2</sub> : Paired row 70/30 cm	29.68	30.07	29.87
SEd (±)	0.075	0.360	0.072
CD (P=0.05)	0.15	0.73	0.14
<b>Intercropping (I)</b>			
I <sub>1</sub> : Baby corn	33.49	33.80	33.64
I <sub>2</sub> : Greengram	25.32	25.72	25.52
SEd (±)	0.075	0.360	0.072
CD (P=0.05)	0.15	0.73	0.14
<b>Weed management (W)</b>			
W <sub>1</sub> : Weedy check (Control)	16.49	16.90	16.69
W <sub>2</sub> : Non-chemical (mulching + hand weeding at 35, 65, 95 and 140 DAP)	38.79	39.19	38.99
W <sub>3</sub> : Pre-emergence application of metribuzin @ 500 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	31.84	32.09	31.96
W <sub>4</sub> : Pre-emergence application of oxadiargyl @ 90 g ha <sup>-1</sup> + hand weeding at 35, 65, 95, 140 and 185 DAP	30.50	30.86	30.68
SEd (±)	0.107	0.509	0.102
CD (P=0.05)	0.21	1.04	0.20
<b>Treatment Mean</b>	29.40	29.76	29.58
<b>Control (C)</b>			
C <sub>1</sub> : (Sole turmeric-recommended)	37.13	36.80	36.96
C <sub>4</sub> : (Sole turmeric-weed free)	39.43	38.90	39.16
C <sub>2</sub> : (Sole baby corn)	17.29	17.38	17.33
C <sub>3</sub> : (Sole greengram)	3.60	3.61	3.60
SEd (±)	10.19	10.25	10.221
CD (P=0.05)	NS	NS	NS
<b>SEd (±) between</b>			
Treatment mean vs. C <sub>1</sub>	0.062	0.084	0.068
Treatment mean vs. C <sub>4</sub>	0.125	0.124	0.124
Treatment mean vs. C <sub>2</sub>	0.024	0.037	0.030
Treatment mean vs. C <sub>3</sub>	0.016	0.021	0.019
<b>CD (P=0.05) between</b>			
Treatment mean vs. C <sub>1</sub>	0.14	0.19	0.15
Treatment mean vs. C <sub>4</sub>	0.29	0.29	0.28
Treatment mean vs. C <sub>2</sub>	0.06	0.08	0.07
Treatment mean vs. C <sub>3</sub>	0.04	0.05	0.04
CV (%)	2.7	4.4	3.1

**Table 4.46. Land equivalent ratio (LER) of cropping system as influenced by treatments**

Treatment	LER		
	2013	2014	Average
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub> 80/20 cm; Baby corn; weedy check	0.77	0.78	0.77

M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95, 140 DAP	1.54	1.55	1.55
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.25	1.26	1.26
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.24	1.24	1.24
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	80/20 cm; greengram; weedy check	0.56	0.36	0.46
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	1.22	0.93	1.07
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	80/20 cm; greengram; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185DAP	1.00	0.77	0.88
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.95	0.73	0.84
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; baby corn; weedy check	0.79	0.80	0.79
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	1.57	1.59	1.58
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	70/30 cm; baby corn; metribuzine (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.26	1.28	1.27
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.24	1.24	1.24
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	70/30 cm; greengram; baby corn; weedy check	0.57	0.38	0.48
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	1.25	0.95	1.10
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.00	0.78	0.89
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.95	0.74	0.84

**Table 4.47. Economics of the treatments**

Treatments	Total cost of cultivation (R ha <sup>-1</sup> )		Gross return (R ha <sup>-1</sup> )		Net return (R ha <sup>-1</sup> )	
	2013	2014	2013	2014	2013	2014

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$M_{11}W_1$	147189	147296	387467	395866	240278	248569
$M_{11}W_2$	219383	219472	864700	870129	645317	650657
$M_{11}W_3$	219357	219411	708300	712638	488943	493227
$M_{11}W_4$	218848	218910	695000	696360	476152	477449
$M_{12}W_1$	144797	144868	258992	264600	114196	119732
$M_{12}W_2$	217098	217232	667000	677640	449902	460408
$M_{12}W_3$	217081	217126	558077	561640	340996	344514
$M_{12}W_4$	216277	216429	522227	533660	305950	317231
$M_{21}W_1$	147395	147529	403200	412353	255805	264825
$M_{21}W_2$	219660	219767	885567	895837	665907	676070
$M_{21}W_3$	219474	219572	717167	724968	497693	505397
$M_{21}W_4$	218884	218955	697667	700600	478783	481645
$M_{22}W_1$	144940	145065	269517	279187	124578	134122
$M_{22}W_2$	217357	217419	686593	691760	469236	474341
$M_{22}W_3$	217162	217215	563896	568407	346734	351192
$M_{22}W_4$	216330	216491	525745	538247	309414	321756
$C_1$	199057	198967	742667	736000	543610	537033
$C_4$	213073	212930	788667	778000	575594	565070
$C_2$	50620	50620	230800	230000	180180	179380
$C_3$	32284	32284	72000	72000	39716	39716

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**Table 4.48. Benefit-cost ratio, rupees per rupee invested and monetary advantage of the treatments**

Treatments	BCR		Return (₹ per ₹ invested)		Monetary advantage (₹ ha <sup>-1</sup> )	
	2013	2014	2013	2014	2013	2014
M <sub>11</sub> I <sub>1</sub> W <sub>1</sub>	2.63	2.69	1.63	1.69	-204854	-198745
M <sub>11</sub> I <sub>1</sub> W <sub>2</sub>	3.94	3.96	2.94	2.96	770144	787327
M <sub>11</sub> I <sub>1</sub> W <sub>3</sub>	3.23	3.25	2.23	2.25	318735	332338
M <sub>11</sub> I <sub>1</sub> W <sub>4</sub>	3.18	3.18	2.18	2.18	301316	301906
M <sub>12</sub> I <sub>2</sub> W <sub>1</sub>	1.79	1.83	0.79	0.83	-317451	-639744
M <sub>12</sub> I <sub>2</sub> W <sub>2</sub>	3.07	3.12	2.07	2.12	267019	-98440
M <sub>12</sub> I <sub>2</sub> W <sub>3</sub>	2.57	2.59	1.57	1.59	0	-296940
M <sub>12</sub> I <sub>2</sub> W <sub>4</sub>	2.41	2.47	1.41	1.47	-53597	-341469
M <sub>21</sub> I <sub>1</sub> W <sub>1</sub>	2.74	2.80	1.74	1.80	-191852	-185559
M <sub>21</sub> I <sub>1</sub> W <sub>2</sub>	4.03	4.08	3.03	3.08	826284	860961
M <sub>21</sub> I <sub>1</sub> W <sub>3</sub>	3.27	3.30	2.27	2.30	334450	361578
M <sub>21</sub> I <sub>1</sub> W <sub>4</sub>	3.19	3.20	2.19	2.20	302472	303744
M <sub>22</sub> I <sub>2</sub> W <sub>1</sub>	1.86	1.92	0.86	0.92	-319213	-628611
M <sub>22</sub> I <sub>2</sub> W <sub>2</sub>	3.16	3.18	2.16	2.18	308967	-70996
M <sub>22</sub> I <sub>2</sub> W <sub>3</sub>	2.60	2.62	1.60	1.62	0	-285369
M <sub>22</sub> I <sub>2</sub> W <sub>4</sub>	2.43	2.49	1.43	1.49	-53958	-329058
C <sub>1</sub>	3.73	3.70	2.73	2.70	-	-
C <sub>4</sub>	3.70	3.65	2.70	2.65	-	-
C <sub>2</sub>	4.56	4.54	3.56	3.54	-	-
C <sub>3</sub>	2.23	2.23	1.23	1.23	-	-

**Table 4.49. Cultural energy use efficiency (CEUE)/ Output / Input ratio)**

Treatment		CEUE	
		2013	2014
$M_{11}I_{11}W_1$	80/20 cm; Baby corn; weedy check	9.15	8.36
$M_{11}I_{11}W_2$	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	13.64	12.47
$M_{11}I_{11}W_3$	80/20 cm; baby corn; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.30	9.64
$M_{11}I_{11}W_4$	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.09	9.41
$M_{12}I_{12}W_1$	80/20 cm; greengram; weedy check	8.78	9.09
$M_{12}I_{12}W_2$	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	12.92	11.67
$M_{12}I_{12}W_3$	80/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.25	10.52
$M_{12}I_{12}W_4$	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	9.63	10.03
$M_{21}I_{21}W_1$	70/30 cm; baby corn; weedy check	9.41	8.64
$M_{21}I_{21}W_2$	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	13.75	13.96
$M_{21}I_{21}W_3$	70/30 cm; baby corn; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.47	9.86
$M_{21}I_{21}W_4$	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.13	9.47
$M_{22}I_{22}W_1$	70/30 cm; greengram; baby corn; weedy check	9.02	9.27
$M_{22}I_{22}W_2$	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	12.79	13.30
$M_{22}I_{22}W_3$	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	10.35	10.64
$M_{22}I_{22}W_4$	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	9.68	10.10

**Table 4.50. Energy production ratio (EPR) for turmeric**

Treatment	EPR		
	2013	2014	
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	80/20 cm; Baby corn; weedy check	0.79	0.79
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	80/20 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	1.64	1.60
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	80/20 cm; baby corn; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.13	1.14
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	80/20 cm; baby corn; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.11	1.11
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	80/20 cm; greengram; weedy check	0.99	1.00
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	80/20 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	1.12	1.16
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	80/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.89	0.90
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	80/20 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.84	0.85
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	70/30 cm; baby corn; weedy check	0.76	0.78
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	70/30 cm; baby corn; mulching + 4HW at 35, 65, 95 and 140 DAP	1.67	1.71
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	70/30 cm; baby corn; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.15	1.16
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	1.12	1.12
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	70/30 cm; greengram; baby corn; weedy check	1.01	1.03
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	70/30 cm; greengram; mulching + 4HW at 35, 65, 95 and 140 DAP	1.07	1.10
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	70/20 cm; greengram; metribuzin (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.90	0.91
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	70/30 cm; greengram; oxadiargyl (PE) + 5HW at 35, 65, 95, 140 and 185 DAP	0.84	0.86

## APPENDIX I

### Weather conditions prevailed during the cropping period 2013

Std	Month and date	Temperature	Relative humidity	Rainfall	Evaporation	*BSSH
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weeks		(°C)		(%)		(mm)	(mm)	(hrs)
		Max	Min	0615 (hrs)	1315 (hrs)			
10	5 Mar-11 Mar	31.2	15.6	89	50	0.0	2.2	6.5
11	12 Mar-18 Mar	30.1	17.1	88	49	14.4	2.4	5.4
12	19 Mar-25 Mar	27.2	17.0	91	57	38.8	2.4	5.6
13	26 Mar-1 Apr	26.9	18.1	91	62	23.5	2.5	3.1
14	2 Apr-8 Apr	28.6	18.0	91	57	18.0	2.9	5.2
15	9 Apr-15 Apr	28.0	19.5	94	65	17.9	2.2	3.7
16	16 Apr-22 Apr	26.9	19.2	95	70	0.6	1.9	2.9
17	23 Apr-29 Apr	30.5	20.4	91	56	102.9	3.5	6.2
18	30 Apr-6 May	28.1	21.0	94	73	126.8	3.7	4.2
19	7 May-13 May	29.9	21.8	94	69	101.3	3.3	4.9
20	14 May-20 May	28.1	22.1	94	76	34.3	2.3	3.2
21	21 May-27 May	32.5	24.5	90	69	23.3	3.6	6.8
22	28 May-3 Jun	33.1	25.0	90	72	76.4	3.4	5.3
23	4 Jun-10 Jun	32.5	25.5	91	79	20.5	2.8	4.6
24	11 Jun-17 Jun	35.1	25.3	82	63	97.4	3.8	8.4
25	18 Jun-24 Jun	33.1	25.6	91	70	76.4	3.2	5.6
26	25 Jun-1 July	32.8	25.0	94	76	85.3	2.0	4.2
27	2 July-8 July	32.8	25.9	92	77	90.9	2.8	2.3
28	9 July-15 July	31.7	25.5	94	76	91.4	2.5	3.1
29	16 July-22 July	33.1	25.8	93	73	108.6	2.5	5.3
30	23 July-29 July	33.0	25.9	94	73	115.8	2.7	5.9
31	30 July-5 Aug	33.9	25.7	93	76	131.7	3.2	6.9
32	6 Aug-12 Aug	30.6	25.1	95	81	199.3	2.2	2.5
33	13 Aug-19 Aug	32.4	25.8	94	73	10.6	2.7	5.3
34	20 Aug-26 Aug	34.2	25.4	92	71	82.0	3.4	7.1
35	27 Aug-2 Sep	32.0	25.4	95	75	61.2	2.4	3.7
36	3 Sep-9 Sep	31.5	25.0	92	77	10.4	2.1	3.3
37	10 Sep-16 Sep	32.9	25.0	90	66	0.0	2.4	6.2
38	17 Sep-23 Sep	33.9	26.0	89	69	0.0	3.0	6.8
39	24 Sep-30 Sep	31.9	24.8	92	77	57.0	2.3	4.5
40	1 Oct-7 Oct	29.5	23.8	93	80	83.6	1.9	1.8
41	8 Oct-14 Oct	31.0	21.9	91	68	0.0	2.5	7.1
42	15 Oct-21 Oct	30.8	22.7	94	74	26.2	2.4	5.1
43	22 Oct-28 Oct	29.3	21.8	93	69	41.5	1.9	5.3
44	29 Oct-4 Nov	26.7	18.0	95	67	5.6	1.7	3.5
45	5 Nov-11 Nov	28.1	14.6	95	57	0.0	1.7	8.1
46	12 Nov-18 Nov	27.7	12.1	97	55	0.0	1.8	8.9
47	19 Nov-25 Nov	27.2	12.4	95	58	0.0	1.5	8.9
48	26 Nov-2 Dec	27.3	14.1	95	59	0.0	1.4	7.9
49	3 Dec-9 Dec	27.7	13.7	97	60	0.0	1.5	7.7

\*BSSH-Bright Sun Shine Hours

## APPENDIX II

### Weather conditions prevailed during the cropping period 2014

Std weeks	Month and date	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Evaporation (mm)	*BSSH (hrs)
		Max	Min	0615 (hrs)	1315 (hrs)			
10	5 Mar-11 Mar	28.0	13.3	91	49	0.0	1.9	6.2
11	12 Mar-18 Mar	30.1	15.6	87	46	0.0	2.9	6.1
12	19 Mar-25 Mar	28.9	16.6	88	50	11.5	3.0	5.2
13	26 Mar-1 Apr	28.0	19.4	91	49	55.7	2.9	4.1
14	2 Apr-8 Apr	30.3	17.9	86	48	1.5	3.2	6.2
15	9 Apr-15 Apr	30.7	19.1	87	52	19.5	3.0	6.1
16	16 Apr-22 Apr	32.5	20.3	89	50	1.7	3.4	5.9
17	23 Apr-29 Apr	34.1	20.5	88	47	8.3	4.5	6.1
18	30 Apr-6 May	29.1	19.7	93	71	45.7	2.9	3.1
19	7 May-13 May	27.3	20.9	95	85	85.3	2.6	3.7
20	14 May-20 May	30.6	22.4	91	69	7.0	3.2	5.8
21	21 May-27 May	31.7	23.2	93	71	54.5	2.7	4.4
22	28 May-3 Jun	33.4	24.5	91	65	48.6	3.2	6.5
23	4 Jun-10 Jun	32.9	25.7	90	78	49.0	3.0	3.5
24	11 Jun-17 Jun	32.5	26.4	93	76	11.7	2.3	2.6
25	18 Jun-24 Jun	32.7	24.8	94	77	195.9	2.8	3.6
26	25 Jun-1 July	32.7	25.7	94	72	108.0	2.5	3.8
27	2 July-8 July	33.4	26.0	95	75	35.2	3.1	5.0
28	9 July-15 July	33.3	26.2	93	79	37.5	2.9	4.3
29	16 July-22 July	32.7	25.4	94	75	83.0	2.0	4.1
30	23 July-29 July	33.5	25.2	93	76	149.4	2.7	5.7
31	30 July-5 Aug	33.9	25.6	92	77	16.6	3.0	6.2
32	6 Aug-12 Aug	34.4	25.7	93	75	93.5	3.3	5.5
33	13 Aug-19 Aug	30.0	25.0	95	86	65.7	2.4	1.3
34	20 Aug-26 Aug	31.8	25.0	96	83	71.2	2.4	2.2
35	27 Aug-2 Sep	33.4	25.8	93	72	23.4	2.9	5.7
36	3 Sep-9 Sep	33.1	25.3	95	80	93.2	1.9	4.5
37	10 Sep-16 Sep	32.7	24.5	94	79	20.6	2.5	4.2
38	17 Sep-23 Sep	31.3	24.6	96	85	124.5	1.5	2.5
39	24 Sep-30 Sep	29.6	23.4	95	79	37.9	1.6	2.3
40	1 Oct-7 Oct	33.1	23.2	96	71	0.0	2.3	7.6
41	8 Oct-14 Oct	33.2	24.1	95	75	11.4	1.9	5.5
42	15 Oct-21 Oct	31.6	22.2	94	77	22.8	2.0	5.3
43	22 Oct-28 Oct	30.3	18.9	95	72	43.0	2.2	6.8
44	29 Oct-4 Nov	30.0	17.8	95	67	0.0	1.1	9.6
45	5 Nov-11 Nov	30.5	17.3	93	63	0.0	2.1	8.9
46	12 Nov-18 Nov	28.5	17.5	95	75	0.0	1.2	6.1
47	19 Nov-25 Nov	27.1	16.2	95	74	1.2	1.1	5.1
48	26 Nov-2 Dec	25.9	13.3	96	66	0.0	1.4	7.0

49	3 Dec-9 Dec	27.6	14.7	95	65	0.0	1.2	7.6
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\*BSSH-Bright Sun Shine Hours

## APPENDIX III

### Soil moisture at 30, 60 and 90 DAP

Treatments	Soil moisture (%)					
	30 DAP		60 DAP		90 DAP	
	2013	2014	2013	2014	2013	2014
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	19.39	19.12	23.58	23.24	25.01	24.93
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	21.13	20.56	25.39	24.59	26.74	26.56
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	20.45	20.10	24.22	23.62	26.16	25.92
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	20.33	20.16	24.50	23.55	25.11	25.71
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	19.44	19.13	23.54	23.21	25.25	25.76
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	22.07	21.18	25.71	24.89	26.63	26.96
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	20.88	20.22	24.18	24.01	25.17	25.74
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	20.88	19.58	24.06	23.81	25.46	26.00
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	19.60	19.23	23.37	23.71	25.10	24.89
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	21.06	20.39	25.14	24.70	26.90	26.57
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	20.79	20.16	24.50	23.29	25.53	25.77
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	20.81	19.76	24.28	23.68	25.60	25.83
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	19.77	19.72	23.74	23.49	24.63	25.42
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	21.66	20.97	25.74	24.95	26.50	26.41
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	20.88	19.97	24.48	24.17	25.41	25.43
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	20.82	20.44	24.26	23.72	25.20	25.55
C <sub>1</sub>	22.81	21.88	26.00	25.86	26.73	26.90
C <sub>4</sub>	23.21	21.70	26.41	26.15	26.66	27.40
C <sub>2</sub>	20.43	20.42	24.92	24.09	25.57	27.44
C <sub>3</sub>	20.84	21.81	24.55	23.89	26.00	26.88

## APPENDIX IV

### Soil moisture at 120, 150 and 180 DAP

Treatments	Soil moisture (%)					
	120 DAP		150 DAP		180 DAP	
	2013	2014	2013	2014	2013	2014
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	25.08	25.24	27.39	26.34	25.32	26.80
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	26.36	26.73	28.82	27.08	26.17	27.78
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	25.25	25.87	27.20	26.36	25.21	26.97
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	25.01	25.52	27.16	26.26	25.36	26.55
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	24.69	25.62	27.16	26.11	25.30	26.78
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	26.47	27.51	28.53	26.71	26.48	27.54
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	24.94	25.93	26.81	26.41	25.09	26.69
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	25.36	25.21	27.27	26.18	25.68	26.58
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	24.81	24.85	27.37	26.42	25.33	26.88
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	26.02	27.53	28.50	27.59	26.11	27.81
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	25.29	25.67	27.31	26.12	25.34	26.67
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	25.24	25.76	27.38	26.25	25.09	26.41
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	25.13	25.60	27.58	26.94	25.02	26.58
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	26.38	26.83	28.89	26.99	26.29	27.42
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	25.14	25.39	26.82	26.49	25.12	26.69
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	25.23	25.10	27.37	26.43	25.34	26.56
C <sub>1</sub>	26.70	28.10	29.04	26.87	26.91	27.63
C <sub>4</sub>	26.47	27.52	29.87	26.53	26.73	27.36
C <sub>2</sub>	28.49	29.03	30.63	29.22	27.76	29.33
C <sub>3</sub>	27.90	29.30	29.44	29.64	28.11	29.60

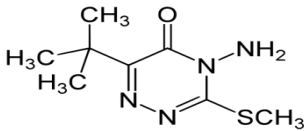
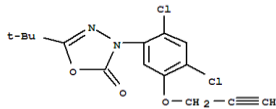
## APPENDIX V

### Soil moisture at 210, 240 and 270 DAP

Treatments	Soil moisture (%)					
	210 DAP		240 DAP		270 DAP	
	2013	2014	2013	2014	2013	2014
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	25.42	22.58	22.59	23.33	20.40	17.65
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	25.52	23.31	23.51	24.35	21.26	17.95
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	24.48	22.76	23.21	23.02	20.34	16.95
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	25.11	22.81	23.16	23.28	20.84	17.54
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	25.10	22.70	22.20	23.10	20.12	18.07
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	26.29	23.86	23.68	24.43	22.25	18.46
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	25.43	22.46	22.68	23.18	20.92	17.68
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	25.27	22.76	23.39	22.98	20.65	17.33
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	25.56	23.04	21.92	23.16	20.55	17.68
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	25.66	23.97	23.45	24.30	21.34	18.45
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	25.16	22.33	22.55	22.88	20.64	16.69
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	25.24	22.90	22.92	22.94	20.48	16.88
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	25.32	21.38	21.67	23.25	19.83	17.38
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	26.00	24.09	23.18	24.21	21.56	18.08
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	25.17	22.31	22.45	22.78	20.56	16.93
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	25.80	22.21	22.25	22.99	20.54	16.67
C <sub>1</sub>	26.17	24.45	23.71	24.42	22.01	19.43
C <sub>4</sub>	26.43	23.85	24.07	24.21	21.76	19.22
C <sub>2</sub>	27.79	27.19	27.41	25.68	25.40	20.78
C <sub>3</sub>	27.07	27.48	27.06	25.59	25.94	20.67

## APPENDIX VI

### Details of herbicides used in the experiment

Sl. No.	Properties	Metribuzin	Oxadiargyl
1	Chemical name	4-amino-6- <i>tert</i> -butyl-3(methylthio)-1, 2, 4-triazin-5-one	5- <i>tert</i> -butyl-3-(2,4-dichloro-5-propargyloxyphenyl)-1, 3, 4 oxadiazol-2(3H)-one
2	Chemical family	Triazinone	Oxadiazole
3	Chemical structure		
4	Molecular formula	C <sub>8</sub> H <sub>14</sub> N <sub>4</sub> OS	C <sub>15</sub> H <sub>14</sub> Cl <sub>2</sub> N <sub>2</sub> O <sub>3</sub>
5	Common name	Metribuzin	Oxadiargyl
6	Trade name and formulation	Sencor 70% WP	Topstar 80% WP
7	Manufacturer	Bayer crop science	Bayer crop science and Lianyungang Lien Agro-chemical Co-Ltd.
8	Physical state	White powder	White powder
9	Mode of action	Absorbed by the roots, but also by the leaves to a lesser extent. Inhibiting photo system II of photosynthesis by disrupting electron transfer. This results in death due to starvation in the target plant.	Absorbed more readily the foliage and especially the shoots and also roots with little translocation. Light is required for herbicidal activity. Inhibition of protoporphyrinogen oxidase (PPO).
10	Uses	Control of broad leaf weeds in soybean and potato.	Efficient broad-spectrum herbicides on annual grass, sedge, broadleaf weeds. Mainly used for rice, potato, sunflower, vegetables, sugar beets,

			and orchard crops.
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## APPENDIX VII

### Unit cost of inputs and produce (R) during 2013

Sl. No.	Item	Unit	Cost (R)
<b>Inputs</b>			
1	FYM	ton	1000/-
2	Seed Rhizome	kg	30/-
3	Tractor (ploughing)	ha	2800/-
4	Tractor (harrowing)	ha	1000/-
5	Urea	kg	9/-
6	SSP	kg	10.5/-
7	MoP	kg	12/-
8	Lime	kg	10/-
9	Metribuzin	kg	2100/-
10	Oxadiargyl	kg	7285/-
11	Paddy straw / Rapeseed Stover/Baby corn stover/ Greengram stover	ton	1000/-
12	Ridomil	kg	1600/-
13	Chloropyriphos	lit	400/-
14	Labour	man day	134/-
<b>Produce</b>			
1	Cured rhizome	q	10000/-
2	Baby corn (Fresh)	kg	30/-
3	Greengram	q	60/-

## APPENDIX VIII

### Unit cost of inputs and produce (R) during 2014

Sl. No.	Item	Unit	Cost (R)
Inputs			
1	FYM	ton	1000/-
2	Seed Rhizome	kg	30/-
3	Tractor (ploughing)	ha	2800/-
4	Tractor (harrowing)	ha	1000/-
5	Urea	kg	9/-
6	SSP	kg	10.5/-
7	MoP	kg	12/-
8	Lime	kg	10/-
9	Metribuzin	kg	2100/-
10	Oxadiargyl	kg	7285/-
11	Paddy straw / Rapeseed Stover/Baby corn stover/ Greengram stover	ton	1000/-
12	Ridomil	kg	1600/-
13	Chloropyriphos	lit	400/-
14	Labour	man day	134/-
Produce			
1	Cured rhizome	q	10000/-
2	Baby corn (Fresh)	kg	30/-
3	Greengram	kg	60/-

## APPENDIX IX

### Cost of cultivation of sole turmeric with recommended practice (R ha<sup>-1</sup>) during 2013

Sl. No.	Items/Operation	Unit/No./kg	Cost ha <sup>-1</sup> ( R)
A. Land preparation			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
B. Labour wages for cultural and other operations			
1.	Bed preparation	125	16750.00
2.	Planting/sowing	50	6700.00
3.	Mulching	25	3350.00
4.	Fertilizer application	10	1340.00
5.	PP materials application	9	1206.00
6.	Weeding	300	40200.00
7.	Leaf tying	25	3350.00
8.	Harvesting	125	16750.00
9.	Cleaning of rhizome	73	9782.00
C. Material inputs			
1.	Planting material	2000	60000.00
2.	FYM	10000	10000.00
3.	Urea	130.83	1177.50
4.	SSP	312.5	3281.25
5.	MOP	200	2400.00
6.	Lime	500	5000.00
7.	Pesticide	-	1170.00

8.	Straw (mulch)		10000.00
	<b>Total</b>	-	199057.80

## APPENDIX X

### Cost of cultivation of sole turmeric with recommended practice (₹ ha<sup>-1</sup>) during 2014

Sl. No.	Items/Operation	Unit/No./kg	Cost ha <sup>-1</sup> ( ₹ )
A. Land preparation			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
B. Labour wages for cultural and other operations			
1.	Bed preparation	125	16750.00
2.	Planting/sowing	50	6700.00
3.	Mulching	25	3350.00
4.	Fertilizer application	10	1340.00
5.	PP materials application	9	1206.00
6.	Weeding	300	40200.00
7.	Leaf tying	25	3350.00
8.	Harvesting	125	16750.00
9.	Cleaning of rhizome	73	9782.00
C. Material inputs			
1.	Planting material	2000	60000.00
2.	FYM	10000	10000.00
3.	Urea	130.83	1177.50
4.	SSP	312.5	3281.25
5.	MOP	200	2400.00
6.	Lime	500	5000.00
7.	Pesticide	-	1260.00
8.	Straw (mulch)		10000.00

	<b>Total</b>	-	<b>198967.80</b>
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## APPENDIX XI

### Cost of cultivation of sole turmeric with modified weed control practice (₹ ha<sup>-1</sup>) during 2013

Sl. No.	Items/Operation	Unit/No./kg	Cost ha <sup>-1</sup> (₹)
<b>A. Land preparation</b>			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
<b>B. Labour wages for cultural and other operations</b>			
1.	Bed preparation	125	16750.00
2.	Planting/sowing	50	6700.00
3.	Mulching	25	3350.00
4.	Fertilizer application	10	1340.00
5.	PP materials application	9	1206.00
6.	Weeding	400	53600.00
7.	Leaf tying	25	3350.00
8.	Harvesting	125	16750.00
9.	Cleaning of rhizome	78	10425.00
<b>C. Material inputs</b>			
1.	Planting material	2000	60000.00
2.	FYM	10000	10000.00
3.	Urea	130.83	1177.50
4.	SSP	312.5	3281.25
5.	MOP	200	2400.00
6.	Lime	500	5000.00
7.	Pesticide	-	1260.00

8.	Straw (mulch)		10000.00
	<b>Total</b>	-	213073.00

## APPENDIX XII

### Cost of cultivation of sole turmeric with modified weed control practice (R ha<sup>-1</sup>) during 2014

Sl. No.	Items/Operation	Unit/No./kg	Cost ha <sup>-1</sup> ( R )
A. Land preparation			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
B. Labour wages for cultural and other operations			
1.	Bed preparation	125	16750.00
2.	Planting/sowing	50	6700.00
3.	Mulching	25	3350.00
4.	Fertilizer application	10	1340.00
5.	PP materials application	9	1206.00
6.	Weeding	400	53600.00
7.	Leaf tying	25	3350.00
8.	Harvesting	125	16750.00
9.	Cleaning of rhizome	73	9782.00
C. Material inputs			
1.	Planting material	2000	60000.00
2.	FYM	10000	10000.00
3.	Urea	130.83	1177.50
4.	SSP	312.5	3281.25
5.	MOP	200	2400.00
6.	Lime	500	5000.00

7.	Pesticide	-	1000.00
8.	Straw (mulch)		10000.00
	<b>Total</b>	-	<b>212930.00</b>

## APPENDIX XIII

### Cost of cultivation of sole baby corn (R ha<sup>-1</sup>) during 2013

Sl. No.	Items/ Operation	Unit	Cost ha <sup>-1</sup> (R)
A. Land preparation			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
B. Labour wages for cultural and other operations			
1.	Sowing	25	3350.00
2.	Fertilizer application	5	670.00
3.	PP materials application	5	670.00
4.	Weeding	48	6432.00
5.	Harvesting	50	6700.00
6.	Cleaning/ packing	25	3350.00
C. Material inputs			
1.	Seed material	25	11250.00
2.	FYM	4000	4000.00
3.	Urea	407.60	3668.40
4.	SSP	210.90	2214.45
5.	MOP	104	1248.00
6.	Pesticide	-	400.00
	<b>Total</b>		<b>50,620.85</b>

## APPENDIX XIV

### Cost of cultivation of sole baby corn (R ha<sup>-1</sup>) during 2014

Sl. No.	Items/ Operation	Unit	Cost ha <sup>-1</sup> ( R)
<b>A. Land preparation</b>			
1.	Ploughing (Tractor operated)	2	5600.00
2.	Harrowing (Tractor operated)	1	1000.00
<b>B. Labour wages for cultural and other operations</b>			
1.	Sowing	25	3350.00
2.	Fertilizer application	5	670.00
3.	PP materials application	5	670.00
4.	Weeding	48	6432.00
5.	Harvesting	50	6700.00
6.	Cleaning/ packing	25	3350.00
<b>C. Material inputs</b>			
1.	Seed material	25	11250.00
2.	FYM	4000	4000.00
3.	Urea	407.60	3668.40
4.	SSP	210.90	2214.45
5.	MOP	104	1248.00
6.	Pesticide	-	400.00
	<b>Total</b>		<b>50,620.85</b>

## APPENDIX XV

### Cost of cultivation of sole greengram (₹ ha<sup>-1</sup>) during 2013

Sl. No.	Items/ Operation	Unit	Cost ha <sup>-1</sup> ( ₹)
<b>A. Land preparation</b>			
1.	Ploughing (Tractor operated)	1	2800.00
2.	Harrowing (Tractor operated)	1	1000.00
<b>B. Labour wages for cultural and other operations</b>			
1.	Sowing	25	3350.00
2.	Fertilizer application	5	670.00
3.	PP materials application	5	670.00
4.	Weeding	48	6432.00
5.	Harvesting	50	6700.00
6.	Cleaning/ packing	25	3350.00
<b>C. Material inputs</b>			
1.	Seed material	25	2250.00
2.	FYM	4000	4000.00
3.	Urea	22	198.00
4.	SSP	0	0.0
5.	MOP	33	396.00
6.	Pesticide	-	400.00
	<b>Total</b>		<b>32284.00</b>

## APPENDIX XVI

### Cost of cultivation of sole greengram (R ha<sup>-1</sup>) during 2014

Sl. No.	Items/ Operation	Unit	Cost ha <sup>-1</sup> ( R)
A. Land preparation			
1.	Ploughing (Tractor operated)	1	2800.00
2.	Harrowing (Tractor operated)	1	1000.00
B. Labour wages for cultural and other operations			
1.	Sowing	25	3350.00
2.	Fertilizer application	5	670.00
3.	PP materials application	5	670.00
4.	Weeding	48	6432.00
5.	Harvesting	50	6700.00
6.	Cleaning/ packing	25	3350.00
C. Material inputs			
1.	Seed material	25	2250.00
2.	FYM	4000	4000.00
3.	Urea	22	198.00
4.	SSP	0	0.0
5.	MOP	33	396.00
6.	Pesticide	-	400.00
	<b>Total</b>		<b>32284.00</b>

## APPENDIX XVII

**Total cost of production of turmeric ha<sup>-1</sup> for different treatments during 2013**

<b>Treatments</b>	<b>FIXED COST (R HA<sup>-1</sup>)</b>	<b>HERBICIDE/ MULCHING COST (R HA<sup>-1</sup>)</b>	<b>LABOUR WAGES (R MANDAY<sup>-1</sup>)</b>	<b>TOTAL COST (R HA<sup>-1</sup>)</b>
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	89459	0	125147	214607
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	89459	10000	202549	302009
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	89459	1050	201059	291568
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	89459	728	200379	290567
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	89459	0	125451	214910
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	89459	10000	203228	302688
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	89459	1050	201648	292158
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	89459	728	200576	290763
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	89459	0	125612	215071
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	89459	10000	203139	302598
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	89459	1050	201380	291890
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	89459	728	200469	290656
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	89459	0	125844	215303
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	89459	10000	203603	303063
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	89459	1050	201827	292336
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	89459	728	200701	290888



## APPENDIX XVIII

**Total cost of production of turmeric ha<sup>-1</sup> for different treatments during 2014**

Treatments	FIXED COST (₹HA <sup>-1</sup> )	HERBICIDE/ MULCHING COST (₹HA <sup>-1</sup> )	LABOUR WAGES (₹MANDAY <sup>-1</sup> )	TOTAL COST (₹HA <sup>-1</sup> )
M <sub>1</sub> I <sub>1</sub> W <sub>1</sub>	89459	0	125147	214607
M <sub>1</sub> I <sub>1</sub> W <sub>2</sub>	89459	10000	202549	302009
M <sub>1</sub> I <sub>1</sub> W <sub>3</sub>	89459	1050	201059	291568
M <sub>1</sub> I <sub>1</sub> W <sub>4</sub>	89459	728	200379	290567
M <sub>1</sub> I <sub>2</sub> W <sub>1</sub>	89459	0	125451	214910
M <sub>1</sub> I <sub>2</sub> W <sub>2</sub>	89459	10000	203228	302688
M <sub>1</sub> I <sub>2</sub> W <sub>3</sub>	89459	1050	201648	292158
M <sub>1</sub> I <sub>2</sub> W <sub>4</sub>	89459	728	200576	290763
M <sub>2</sub> I <sub>1</sub> W <sub>1</sub>	89459	0	125612	215071
M <sub>2</sub> I <sub>1</sub> W <sub>2</sub>	89459	10000	203139	302598
M <sub>2</sub> I <sub>1</sub> W <sub>3</sub>	89459	1050	201380	291890
M <sub>2</sub> I <sub>1</sub> W <sub>4</sub>	89459	728	200469	290656
M <sub>2</sub> I <sub>2</sub> W <sub>1</sub>	89459	0	125844	215303
M <sub>2</sub> I <sub>2</sub> W <sub>2</sub>	89459	10000	203603	303063
M <sub>2</sub> I <sub>2</sub> W <sub>3</sub>	89459	1050	201827	292336
M <sub>2</sub> I <sub>2</sub> W <sub>4</sub>	89459	728	200701	290888
C <sub>1</sub>	89459	10000	192079	291539
C <sub>4</sub>	89459	10000	206605	306064

## APPENDIX XIX

### Common energy inputs (MJ ha<sup>-1</sup>)

Common energy inputs	Crops			Energy values (MJ)		
	Turmeric	Baby corn	Greengram	Turmeric	Baby corn	Greengram
1. Diesel for land preparation	52.1	52.1	26.05	2918.12	2918.12	1459.06
2. Chemical fertilizers						
(a) N	60 kg ha <sup>-1</sup>	187 kg ha <sup>-1</sup>	10 kg ha <sup>-1</sup>	3636.00	11332.20	606.00
(b) P <sub>2</sub> O <sub>5</sub>	50 kg ha <sup>-1</sup>	33 kg ha <sup>-1</sup>	35 kg ha <sup>-1</sup>	555.00	366.3	388.50
(c) K <sub>2</sub> O	120 kg ha <sup>-1</sup>	63 kg ha <sup>-1</sup>	10 kg ha <sup>-1</sup>	804.00	422.10	67.00
3. Other chemicals						
(a) Metribuzin	0.5 kg ha <sup>-1</sup>	-	-	100.00	-	-
(b) Oxadiargyl	0.09 kg ha <sup>-1</sup>	-	-	16.65	-	-
(c) Chloropyriphos	1lit	-	-	120.00	-	-
(e) Ridomil	1.5 kg ha <sup>-1</sup>	-	-	450.00	-	-
(f) Lime	500 kg ha <sup>-1</sup>	-	-	88000.00	-	-
4. Others						
(a) FYM	10000kg ha <sup>-1</sup>	4000kg ha <sup>-1</sup>	4000kg ha <sup>-1</sup>	3000.00	1200.00	1200.00

## APPENDIX XX

### Equivalent for direct and indirect sources of energy

Particulars		Units	Equivalent energy (MJ)
<b>A. Inputs</b>			
1	Human labour	Man hour	1.96
2	Diesel including lubricants	Litre	56.31
3	Chemical fertilizers		
(i)	N	ha	60.60
(ii)	P <sub>2</sub> O <sub>5</sub>	kg	11.10
(iii)	K <sub>2</sub> O	kg	6.70
4	Farm yard manure	kg	0.30
5	Chemical		
(i)	Metribuzin	kg	200
(ii)	Oxadiargyl	kg	185
(iii)	Chloropyriphos	Lit	120
(iv)	Ridomil	kg	300
(v)	Lime	kg	176
6	Seeds		
(i)	Turmeric	kg	14.82
(ii)	Baby corn	kg	3.60
(iii)	Greengram	kg	1.25
7	Straw mulch	kg	5.21
<b>B. Outputs</b>			
a.	Main product		
(i)	Turmeric	kg	14.61
(ii)	Baby corn	kg	5.23
(iii)	Greengram	kg	13.98
b.	By-product		
(i)	Turmeric stover	kg	10.00
(ii)	Baby corn stover	kg	12.50
(iii)	Greengram stover	kg	12.50



## APPENDIX XXI

### Calendar of Cultural Operations

Sl. No.	List of operation	Date	
		2013	2014
1.	Ploughing	14.02.2013	17.02.2014
2.	Harrowing, Stubble removal and laddering	18.02.2013	19.02.2014
3.	Basal fertilizer application	28.02.2013	27.02.2014
4.	Planting/ sowing/Mulching	7.03.2013	7.03.2014
5.	Herbicide application	9.03.2013	9.03.2014
6.	Irrigation	16.03.2013 25.03.2013	13.03.2014 25.03.2014
7.	First Weeding	10.04.2013	10.04.2014
8.	Second weeding	10.05.2013	10.05.2014
9.	Harvesting of intercrops	06.05.2013 10.05.2013	06.05.2014 10.05.2014
10.	First split of fertilizer application	11.05.2013	12.05.2014
11.	Second dose of mulching	11.05.2013	12.05.2014
12.	Insecticide application	06.06.2013	05.06.2014
13.	Fungicide application	20.06.2013 30.06.2014	17.06.2014 28.06.2014
14.	Third weeding	10.06.2013	10.06.2014
15.	Second split of fertilizer application	12.06.2013	11.06.2014
16.	Forth weeding	15.07.2013	15.07.2014
17.	Fifth weeding	23.08.2013	23.08.2014
18.	Leaf tying	12.11.2013	12.11.2014
19.	Harvest	03.12.2013	03.12.2014
20.	Curing	6.12.2013	5.12.2014
21.	Drying	7.12.2013	6.12.2014

