

**STUDIES ON INTERCROPPING OF  
CUCURBITACEOUS VEGETABLES UNDER  
HIGH DENSITY PLANTED MANDARIN  
ORCHARD**

**THESIS**

**Submitted to  
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola  
in partial fulfilment of the requirements  
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**MASTER OF SCIENCE  
IN  
HORTICULTURE  
(VEGETABLE SCIENCE)**

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## **DECLARATION OF STUDENT**

I hereby declare that the experimental work and its interpretation of thesis entitled “**STUDIES ON INTERCROPPING OF CUCURBITACEOUS VEGETABLES UNDER HIGH DENSITY PLANTED MANDARIN ORCHARD**” or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis or publication of any University or scientific organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.

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## CERTIFICATE

This is to certify that the thesis entitled “**STUDIES ON INTERCROPPING OF CUCURBITACEOUS VEGETABLES UNDER HIGH DENSITY PLANTED MANDARIN ORCHARD**” submitted in partial fulfilment of the requirements for the degree of “**Master of Science in Horticulture (Vegetable Science)**” of Dr. Panjabrao Deshmukh KrishiVidyapeeth, Akola is a record of bonafide research work carried out by **CHAURIPAGAR UMESH VISHNUPANT** under my guidance and supervision.

The subject of the thesis has been approved by the student’s Advisory Committee.

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## (D) List of Abbreviations

%	-	percent
/	-	per
Avg.	-	Average
<sup>o</sup> B	-	Degree Brix
<sup>o</sup> C	-	Degree Celsius
CD	-	Critical difference
cm	-	Centimeter
cm <sup>2</sup>	-	Centimeter square
cv.	-	Cultivar
et al.	-	et alia (and others)
etc.	-	etcetera
Fig.	-	Figure
RBD	-	Randomized Block Design
Rs	-	Rupees
g	-	Gram
HDP	-	High Density Planting
ha	-	Hectare
i.e.	-	That is
kg	-	Kilogram
m	-	Meter
m <sup>3</sup>	-	Cubic Meter
NS	-	Non significant
q	-	quantal
SE(m)±	-	Standard error of mean
Sig.	-	Significant
T	-	Treatment
TSS	-	Total Soluble Solids
viz.,	-	(Vide licet) namely

## E) Thesis Abstract

- a) Title of the thesis : **STUDIES ON INTERCROPPING OF CUCURBITACEOUS VEGETABLES UNDER HIGH DENSITY PLANTED MANDARIN ORCHARD**
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---

## ABSTRACT

An experiment entitled “Studies on intercropping of cucurbitaceous vegetables under high density planted mandarin orchard” was carried out during *summer*, season of academic year 2016-2017, at All India Coordinated Research Project on Fruits, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

The experiment was conducted in Randomized Block Design, with three replications and eleven treatments. There were five different cucurbitaceous crop viz. watermelon, muskmelon, cucumber, bitter gourd, ridge gourd were taken as intercrops in mandarin and same as sole crop with the control treatment mandarin as sole crop.

The results of present investigation indicated that, growth, yield and quality had significant difference among cucurbitaceous crops taken as intercrop and sole crop.

The bitter gourd for length of vine, watermelon for number of branches found to be more vigorous when grown sole as well as intercrop in mandarin.

However watermelon recorded maximum yield  $\text{ha}^{-1}$  as intercrop as well as sole crop and found to have maximum returns as intercrop when grown in high density planted mandarin on raised bed.

The difference in growth yield as well as quality parameters of cucurbitaceous vegetables viz. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber as intercrop in mandarin versus similar crop grown as sole crop was non significant suggests performance of growing cucurbitaceous crops as intercrop was not affected by mandarin. Similarly, non significant differences in growth parameters of mandarin when grown with cucurbitaceous crops as well as sole crop indicates compatibility of growing viz. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber with mandarin on raised bed conditions.

However, due to suitability of spreading habit on ground, watermelon followed by muskmelon was found to be most suitable for growing as intercrop in mandarin on raised bed condition which also experienced in its yield potential as well as maximum B:C ratio (3.36 and 3.31 respectively).

# CHAPTER I

## INTRODUCTION

### 1.1 Background Information

Vegetables occupy an important place in diversification of Indian agriculture and have played a pivotal role in food and nutritional security of growing population of our country, as Indian population is placed predominantly poor and vegetarian, the increase in production and consumption of vegetables is emphasized to assure all the people of balanced diet. Vegetable production supports agri-business and related service industries, thereby creating more economic opportunities in the developing countries. Ironically, in spite of all bright aspects and plenty of opportunity to grow further, there is severe short supply of vegetables in most Asian nations including India.

In India, vegetables are grown in 5.8 million hectares area with production 87.5 million ton. The total cropped area under vegetable is 2.8%. Several cucurbitaceous crops are grown in India in garden lands well as in the river beds. In river beds generally mix cropping is followed hence exact data in area and production is not available. Nevertheless, it is estimated that the melons are grown on 1, 66,000 ha area.

Cucurbits comprise 117 genera and 825 species. Out of these 30 species of nine genera are used as cultivated plants. Most of the cucurbits viz., cucumber, bottle gourd, ridge gourd, bitter gourd, snake gourd, water melon and muskmelons are monoecious and annual in habit. However plants like pointed gourd, spine gourd, ivy gourd and chow-chow are dioecious and perennials. It is of high market demand with a special delicacy for the people of India and it fetches premium price in the market.

Cucurbits are important and big group of vegetable crops cultivated exclusively in the sub-tropical and tropical countries. These are annual, semi perennial and perennial vegetable crops. These are monoecious and dioecious vegetables which are grown for its taste and nutritive value. The centre of origin is tropical Africa. This group consists of wide range of vegetables, either used as salad (Cucumber) or for cooking

(all the gourds) or pickling (cucumber) or for desert fruits (muskmelon and water melon) which are more popular now a days. Most of the cucurbits viz., cucumber, bottle gourd, ridge gourd, bitter gourd, snake gourd, water melon and muskmelons are monoecious and annual in habit. The cucurbits are long tap root system. Leaves are dark green, simple cordate, ovate and oblong. Flowers are tubular, white and fruits are round, oblong and smooth. Cucurbits are high nutrient vegetables compared to other vegetables as it is rich in proteins, vitamin A and C, fat, carbohydrates and minerals like calcium, potassium and phosphorus.

In severe winter it becomes dormant and sprouts again in summer and it is available for ten months in a year i.e. February to November. The green tender and mature fruits are consumed as a vegetable. However new tender shoots and leaves are also used as vegetable. It is easily digestible with good diuretic and laxative properties and also invigorates the heart and brain as well as useful in the disorders of the circulatory system. The fruits also possesses anti - cancer properties. Its roots also used in treatment of jaundice besides the leaves reduce blood sugar levels. Due to its high medicinal value, it is becoming popular day by day in the country.

Watermelon crop is grown in garden lands and river beds in India. In river beds, mix-cropping system. *Citullus lanatus* is the well-known and widely cultivated watermelon. The sweet, juicy pulp of the ripe fruit is eaten fresh through the tropics and subtropical regions, the seed is also eaten as a snack after shelling and roasting. The fruit has cooling effect and is used as an expectorant, diuretic and stomachic and in allaying thirst. It is a potential crop for arid lands. However, its most important use is in medicine including 'Unani' and 'Ayurveda'. The fruits are round and about 5 cm in diameter. They are bitter pungent in taste. They are cooling, purgative, anthelmintic, antipyretic and carminative in action. They cure a wide range of ailments such as ulcers, asthma bronchitis, and jaundice, enlargement of spleen, dyspepsia, constipation and anaemia. The ground roots are applied externally to control inflammation of breasts and pain in the joints and uterus. It is a common man's fruit relished by both rich and

poor alike. The fruits juice is also consumed by many after adding a pinch of salt and black pepper. The 95 % water, 0.2% protein, 0.3% minerals and 3.3% carbohydrate's per 100 g fresh weight. It is also a rich source of iron. The seed kernels are also used in various sweets and other delicacies. The unripe fruits are also cooked as vegetable in some parts of India.

Muskmelon (*Cucumis melo L.*) is a beautiful, juicy, tasty and delicious fruit popular and commercial crop of the tropics and sub tropics, grown all over the world for its nutritive and medicinal properties. Melons valued as a summer fruit, In 'Ayurveda' and 'Unani' medicinal. Melon (*Cucumis melo L.*) is an important summer vegetable crop. The origin of melon is in dispute, most authorities consider that it originated in Africa. Recently phylogenetic data demonstrated that *Cucumis* originated from Asia. It ranks second after watermelon. The main areas under muskmelon cultivation in India are riverbeds of Yamuna, Ganges and Narmada rivers in the north and Pennar, Kaveri, Krishna and Godavari rivers in the south.

Muskmelon is gaining lot of importance due to its short duration, high production potential with high nutritive value, taste and delicacy and also its suitability for cultivation under rainfed, irrigated, green house conditions almost throughout the year. Muskmelon fruits are an extremely healthful food choice as they are rich in ascorbic acid, carotene, folic acid, and potassium as well as a number of other human health-bioactive com-pounds. Muskmelon fruits are also a rich source of vitamin A, C,  $\beta$ -carotene, carbohydrates, sugars, protein and traces of vitamin K, B1, B2, B6 and niacin. However, very little work has been carried out on improvement of the muskmelon crop.

Muskmelon fetches premium price in the market compared to other vegetables and is a popular vegetable grown under both rain fed and irrigated conditions almost throughout the year. It has great importance due to its short duration and high production potential as well as high nutritive value.

Bitter gourd (*Momordica charantia L.*) also called bitter melon is tropical and subtropical crop belonging to the family cucurbitaceae which has 90 genera and 75 species. It is grown up to an elevation 1600-1700 in

above mean sea level. The centre of origin of this crop is India with a secondary centre of diversity in China and South East Asia.

Bitter gourd is grown for its bitter tender fruits. Fruits are covered with blunt tubercles. The fruits turn to an orange-yellow colour when ripe. The fruits are rich in iron, Vitamin A, B, C and are an inexpensive source of protein and mineral. The fruit is reported to have germicidal effect and is a laxative and easily digestible. It is considered good for curing blood diseases, rheumatism, diabetes and asthma.

Ridge gourds is grown as mixed cropping in the river beds and as monocrop in the garden lands, hence the exact area and production are unknown. Nevertheless the estimated area under all the gourds is 4.05 lakh hectares in our country.

Ridge gourd belongs to genus *Luffa* species of cucurbitaceae family. It is rather difficult to assign accurately the indigenous areas of *Luffa* species. Ridge gourd is low in saturated fat and cholesterol, high in dietary fibre, vitamin C, riboflavin, zinc, thiamine, iron, magnesium and manganese. The nutritional value of gourd makes it suitable for maintaining optimum health and weight loss. It has excellent cooling properties. Ridge gourd contains a gelatinous compound called luffein. Ridge or ribbed gourd is cultivated on commercial scale and in kitchen gardens throughout India. Ridge gourd is popular vegetable as spring- summer and rainy season crop.

The cucumber is (*Cucumis sativus* L.) is warm season crop mainly grown in tropical and subtropical region where it is cultivated in the field. Cucumber is grown in garden lands and riverbeds. Also it can be grown as mixed crop. The immature fruits of *Cucumis sativus* L. ( $2n=14$ ) (Cucumber, gherkin) are used as salad and for pickling. The fruit are also consumed raw. Tender leaves are also used as vegetable. It is the second most widely cultivated cucurbits after watermelon. In temperate countries it is extensively grown in glasshouse. The fruits and seed possess cooling properties. The seed oil is also used as antipyretic. Fruit are good for people suffering from constipation, jaundice and indigestion

### Nutrient values of cucurbits:

Sr.no.	Nutritive values per 100g fresh weight	Crops				
		Watermelon	Muskmelon	Bitter gourd	Ridge gourd	cucumber
1	Protein	0.2%	0.2%	7%	0.5%	0.4%
2	minerals	0.3%	0.4%	0.3%	0.2%	0.2%
3	carbohydrates	3.3%	3%	2%	3.4%	2.5%
4	Carotene	-	-	-	37mg	-
5	Iron	1%	1%	5%	2%	2%
6	Vitamins	Vit. A, Vit C	Vit.A, Vit C	Vit.A, Vit C Vit.D	Vit. C 18 mg	Vit.C 2mg

(Thamburaj S & Narendra Singh, Text book of Vegetable Tuber crops and Spices,ICAR)

Most of the vegetable crops are grown as sole crop, there has been a rapidly growing interest in intercropping of vegetable as a potentially beneficial system of crop production. Yet many worker have found it difficult to initiate research program because of the complexity of the intercropping situation. Outside the field, little is known about the advantages of intercropping really are, how they arise and how they might be improved.

Intercropping is intended to maximize land and space use efficiency to generate supplemental income, to protect the interspaces from losses through weeds, erosion, and impact of radiation, temperature, wind and water. 7-10 Selection of suitable intercrops in orchard is essential to increase production from main crop as well as from the intercrops.

Intercropping is the growing of two or more crops simultaneously on the same field such that the period of overlap is long enough to include the vegetative stage. Intercropping, double cropping and other mixed cropping practices that allow more efficient uses of on farm resources are among the agricultural practices associated with sustainable crop production.

Intercropping is a technique of crop intensification in both space and time where in the competition between crops may occur during a part or whole of crop growth period. It has been a common practice followed by the farmers of India, Africa, Sri Lanka and West Indie. Intercropping is an excellent system of cropping which ensure better

utilization of resources and inputs if the selection of crops were made appropriately. The basic idea of intercropping is not only that two or more crop species grown together can exploit the resources better than either of them grown separately, but also to cover inherent risk in agriculture and more so, under dry land condition which is buffer to some extent and is called as “biological insurance”.

## **1.2 Scope and Importance of the study**

It is estimated around 2015 India’s population likely to reach up to 1.282 billion. For the nutritional security of such huge population it become obvious to increase the production of the vegetable crops which are known for rich source of minerals and vitamins “protective food”.

The land and that to cultivable land is limited and vertical growth i.e. yield’s level are stabilized and exploited mostly by use of hybrids and high yielding varieties. Now it become important to adopt new use system which include the judicious use of land which is being limited natural resources.

The fruit crops are grown at larger spacing, the juvenile period is long and it takes time to occupy the given area. Thus it takes time to occupy the given area. Thus it makes possible to use early juvenile growth period of fruit crop for cultivation of short duration vegetable crops which could be decide using interspace will be source of income till the main crop come to bearing.

The choice of intercrops largely depend upon growth compatibility of main and intercrop. Now a days land is architect in a way to support growth, yield and manage soil born disease in main crop, such architect land is also need to consider while growing of intercrop.

Nagpur mandarin is a major fruit crop of vidarbha region and occupies area of 1.5 lakh ha. The Nagpur mandarin is largely cultivated on plane table land at spacing of 6 x 6 (m). However, to receive better yield, productivity and return from unit area the HDP mandarin at a spacing of 6 x 3 (m) planted on raised bed of size (50 cm height and 3 m width and 3 m spacing between the raised bed ) recommended by Anonymous (2016)

Maharashtra Agriculture Universities Joint Agresco held at Dr.P.D.K.V., Akola

The juvenile age of mandarin is 4 year thereafter it comes to bearing. This period can be exploited for the intercropping of vegetable and the land architect is such manner that permit vine type vegetables.

As a general conclusion, through intercropping, farmers can achieve the full production of the main crop and also an additional yield (bonus) associated with an increased plant population of the second component. Hence, intercropping can increase income obtained by smallholder farmers through reduction of economic risk and market fluctuation resulting from growing a single crop which is more prone to natural hazards and helping the farmers in better utilization of land by having more than one crop produced per unit area.

The long juvenile phase of mandarin do not permit return to the farmers for the initial year's famer's family sustenance and orchard maintenance is a question. By growing intercrop like cucurbitaceous vegetables like the initial main crop orchard maintenance and sustenance of farmer can be resolve at better extend.

Even few year after bearing of main crop when yield levels are low and main crop canopy is not completely spread over area, the introduction of cucurbitaceous crop is feasible which provide insurance against risk and give stable returns even under unfavorable weather conditions. So, also for the further years the farmers could better use the appropriate population of component crops in intercropping systems in order to maximize yield of both crops as well as total productivity. It is, therefore, important to support intercropping systems with appropriate agronomic practices such as timely irrigation, pest protection and the likes to sustain the cropping system. It is also useful when main crops fails due to natural hazards like insect-pest attacks on main crops.

Intercropping of cucurbitaceous crop will provides year-round ground cover, or at least for a longer period than monocultures, in order to protect the soil from desiccation and erosion. By growing more than one i.e.

mandarin with cucurbitaceous vegetables crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility, and minimize soil erosion, which are the serious drawbacks of mono-cropping and burning issues of future.

Numerous researchers postulated the theory and mechanisms of yield stability in intercropping. Intercropping gives higher yields in a given season and greater stability of yields in different seasons compared with sole cropping. Moreover, in intercropping systems, yields are more stable. Its relation to yield stability is the notion of risk, in terms of either productivity or income or both.

### **1.3 Objectives of the study**

- 1 To study the growth, yield and quality performance of vine vegetables under high density planted mandarin orchard.
- 2 To find the most suitable and profitable intercropping system of vine vegetable with high density planted mandarin orchard.

### **1.4 Hypothesis**

HDP mandarin is planted at a spacing 6 x 3 (m) on raised bed of size (50 cm height x 3 m width) the mandarin has long juvenile phase it will take 8 to 10 years to cover the given area the space between two plants can be efficiently utilize for the cultivation of short duration vegetable crops so also the land is architect for the main crop could permit sufficient space for land cover vegetables that to cucurbitaceous vegetables.

## CHAPTER II

### REVIEW OF LITERATURE

Very little information available with respect to intercropping of vegetables that to under high density planted mandarin raised is very meagre as high density planting mandarin is recent approach commercially adopted. However, available literature on these aspects as follows

Aiyelaagbe *et al.* (1992) conducted research on growth and yield response of vegetable crops to intercropping with papaya. Okra, water- melon, sweet potato, bush greens, jews' mallow and *Solanum gilo* Raddi were intercropped with papaya trees. The aim of the experiment was to select crops suitable for intercropping in the alleys of papaya plants in orchards. Land Equivalent Ration (LER) for papaya intercropped with okra, water-melon, sweet potato, bush greens jews' mallow and *Solanum gilo* Raddi were 3.86, 3.13, 2.06, 1.86, 1.60 and 1.54, respectively; indicating that all the combinations were more advantageous than the monocrop of papaya. Although intercropping in papaya orchards is beneficial, it should be limited to the early vegetative and late fruiting phases of papaya when the Leaf Area Index (LAI) of papaya is low.

Yildirim *et al.* (2005) carried out experiment Intercropping based on cauliflower: more productive, profitable and highly sustainable. Results of this study indicated that, different intercropping systems compared to sole did not affect some growth characteristics and yield of cauliflower. Net income increased when used lettuce, bean, leaf lettuce or onion as intercrop. The study showed that, cauliflower based intercrop treatments might provide the highest total yield as well as profitability. Intercropping can result in an increase in the productivity of vegetables per unit area, and improve net income. The results of the present study indicated that, cauliflower intercropped with other vegetables like lettuce, leaf lettuce, bean or onion would be a remunerative cropping system which produced higher yields and economic returns when compared to a monocrop of cauliflower.

Moniruzzama *et al.* (2007) carried out experiment on productivity and profitability of bilatidhonia intercropped with cucurbit vegetables. The experiment was conducted to find out a suitable intercrop combination of bilatidhonia and winter pumpkin relayed with different summer cucurbits (Bilatidhonia + winter pumpkin)/summer cucurbits). The results revealed that, all the intercrop combinations gave the highest fresh yield of bilatidhonia than that of the sole bilatidhonia with an exception of bilatidhonia + winter pumpkin followed by ash gourd and summer pumpkin combination. Maximum fresh yield of bilatidhonia (50.13 t/ha) was recorded from bilatidhonia + winter pumpkin closely followed by ribbed gourd and bitter gourd (50.00 t/ha) combination which showed 1515.5% higher than that of sole bilatidhonia.

Chattopadhyay *et al.* (2008) carried out research on short duration vegetables as intercrops in elephant foot yam in the gangetic alluvium of West Bengal for this analysis of growth, yield and economics. Results revealed that, growth parameters viz., height of pseudo stem, pseudo stem girth and canopy spread were superior when elephant foot yam was grown as a pure crop followed by vegetable cowpea grown as an intercrop. Intercrops encouraged sprouting of main crop as compared to sole crop of elephant foot yam. Sprouting enhancement of elephant foot yam by 10 days was noticed when cowpea was grown as an intercrop. However, the longest period (50 days) of attainment of 50% emergence of shoots was achieved when elephant foot yam was grown as a sole crop. The results clearly indicated that, vegetable cowpea can be profitably intercropped with elephant foot yam.

Rodge *et al.* (2009) conducted experiment studies of intercropping in vegetables. The vegetables tomato, brinjal and chillies are well known and very popular vegetable grown successfully throughout the year in India, at the spacing of 45 to 60 cm in rows and 30 to 60 cm in plants and they require approximately 55 to 70 days for flowering after transplanting. Therefore, the inter space of these crops can be utilized by taking the intercrops of either of short duration like radish, coriander and palak our having straight growth like onion. The result revealed that,

intercropping of coriander, onion, palak and radish in rabi season with solanaceous vegetable crops is profitable. Intercropping of coriander with brinjal gave highest net profit followed by radish with tomato and palak with chilli.

Ouma and Jeruto (2010) studied the intercropping is the cultivation of two or more crops at the same time in the same field. Its advantages are risk minimization, increased income and food security, reduction of soil erosion and pest and disease control. The practice of intercropping in horticultural crop production to promotes sustainability.

Adeniyi (2011) conducted experiments economic aspects of intercropping systems of vegetables (okra, tomato and cowpea). Various field experiments were conducted to evaluate the agro-economic returns obtainable from the intercrop involving tomato, okra and cowpea at varying levels of cropping densities. Results of analyses using net returns, benefit-cost ratio and increased net returns as economic indicators showed that the most favourable mix of vegetables which could be recommended for adoption to farmers was the intercrop of a pair rows of tomato with one row of cowpea (TC 2:1) and net return, benefit-cost ratio and increased net return show promising results for intercropping of vegetables as against planting them sole.

Hadidi *et al.* (2011) conducted experiment effect of intercropping on the performance of some summer vegetable crops grown under different row arrangements in a private farm in Madaba region during 2007 summer growing season. Four vegetable crops namely bush bean, okra, lettuce and squash were planted in six combinations. Found that the efficiency of intercropping as it was judged by LER, the results showed that almost all the intercropping combinations with their row arrangements tested gave LER values more than one indicating the superiority of intercropping over sole cropping.

Xuemei *et al.* (2012) carried out experiment intercropping with garlic alleviated continuous cropping obstacle of cucumber in plastic tunnel. Continuous cropping obstacle is prevalent for protected cultivated cucumber. Intercropping garlic may effectively relieve this obstacle due to

its allelopathic and antimicrobial effects. Results showed that, green garlic exhibited the inhibitory effect on the growth of cucumber in spring cultivation. Garlic cucumber intercropping system increased yield of cucumber differently depending on garlic cultivars, with only cv. G005 showing significant increase (13.4%). Intercropping systems were evaluated as a greater net benefit system as compared to monoculture cultivation. Populations of soil bacteria and actinomycetes were stimulated, while fungi were inhibited under intercropping system. These results suggest that intercropping system can improve soil biology environment and alleviate continuous cropping obstacle of cucumber at different levels. Intercropping systems could influence soil biological environment due to production of root exudates, most of which as allelopathic substances.

Olubode *et al.* (2012) carried out the study of effect of stage of introduction on performance of okra as an intercrop in pawpaw orchards. In conclusion, cultivating okra in pawpaw depressed component crops compared with the monocrops, and okra was more productive in the juvenile pawpaw stage than in mature pawpaw. Nonetheless, okra performed better in Sunrise pawpaw than when cultivated in Homestead, and both the early and simultaneous introductions under both pawpaw varieties were better than in late introduction, indicating the significant importance of earliness in intercropping under pawpaw. Also, the intercropping advantages from the productivity indices and the estimated profit margins both indicated that component crops in okra-pawpaw mixtures made better use of resources than the monocrops.

Vanlanhruaia *et al.* (2013) carried out the study of production and economic feasibility of intercropping lemon and vegetable crops. The productivity of the intercropping system was found to differ significantly. The highest gross return was obtained from sole lemon for two years in a row. The highest benefit cost ratio was recorded in lemon + French bean intercropped (3.94), followed by T<sub>7</sub> (3.70) and T<sub>4</sub> (3.54). The lemon – French bean intercropping system was found to be the best from the view point of equivalent yield and economic.

Singh *et al.* (2013) carried out experiment on yield assessment of elephant foot yam grown under multilayer vegetable cropping system. Field experiments were conducted during the year 2010-11 and 2011-12 to assess the yield and yield attributing characters of elephant foot yam sown with bottle gourd, ridge gourd and bitter gourd under multilayer vegetable cropping system. The days taken to 50 per cent crop (elephant foot yam) emergence (51 days), girth of pseudostem (21 cm), canopy spread (82.4 cm) and yield of corms (376.07 q/ha) was observed highest in the sole crop of elephant foot yam followed by elephant foot yam + bitter gourd with non-significant difference and additional yield of bitter gourd (138.8 q/ha). The results clearly indicated that the vegetable bitter gourd can be profitably intercropped with the elephant foot yam.

Swain (2014) carried out an intercropping experiment comprising of nine treatments such as mango, ginger, turmeric, tomato cowpea, French bean, ragi, niger, upland paddy and control (without intercrop) was laid out in Randomized Block Design with three replication to assess the effect of various intercrops on the performance of mango in the rain fed uplands of Odisha. The result of study revealed that the mango + guava + cowpea Intercropping system exhibited better performance which has been reflected in the form of plant height, girth, canopy area, fruit weight and fruit yield of mango closely followed by mango + guava + French bean system.

Pitan *et al.* (2016) revealed a study on Intercropping cucumber with amaranth (*Amaranthus cruentus L.*) to suppress populations of major insect pests of cucumber (*Cucumis sativus L.*). A study was conducted in 2007 and 2008 to investigate the effectiveness of grain amaranth (*Amaranthus cruentus L.*) planted at different times in an amaranth/cucumber intercrop to reduce the density of cucumber insect pests. Populations of the insects were influenced by cropping system and time of introducing amaranth. Fruit damage by cucumber beetles and fruit flies was lower with 2 WBC and SDC than with 2 WAC. However, the damage was reduced in the intercrop compared with the monocropped cucumber. With SDC, the reduction was about 75 and 50% in 2007 and

2008, respectively. In intercrops and monocrops, cucumber fruit yield was influenced by the time of intercropping; in the mono- and inter-crop, the highest yield was with SDC.

Tiwari *et al.* (2014) conducted the research that the growth of the mango plants, in respect of plant height and canopy volume were slightly improved due to growing of different intercrops in the interspace of the plants. Better growth of mango plants was observed where leguminous crops like pigeon pea, cluster bean, soybean, black gram, cowpea and Bengal gram were grown as intercrops. However, growth parameters were non-significant and the results are accordance with the findings of Singh and Ram (1994).

Oyedele *et al.* (2015) conducted experiment during 2010 and 2011 at the National Horticultural Research Institute, Ibadan to evaluate the response of three spices and one vegetable crop as intercrops with juvenile Citrus at different spacing regimes. Citrus was intercropped with pepper, turmeric, ginger and basil at three inter spacing regimes of 1m, 2m, and 3m from the juvenile Citrus trees with sole Citrus and the sole crop of each of the component as control. Results showed that, growth and yield of the juvenile citrus tree were not significantly affected by the components crop except in citrus/turmeric intercrop where significant decrease in plant height was observed.

Reddi *et al.* (2015) carried out experiment conducted at AICRP on Palms (Oil Palm), ARS Campus, Gangavathi, University of Horticulture Sciences, Bagalkot to evaluate the intercrops in young oil palm garden. The different vegetables *viz.*, brinjal, tomato, okra chilli, onion, cluster bean and french beans were grown as intercrop in juvenile garden of the oil palm. There is ample scope for intercropping in oil palm plantation during initial years of planting since the canopy is not fully developed. Among the different vegetables Okra & Tomato recorded higher fruit yield than other vegetables. The pooled data of two years indicated that, the vegetable are intercropped with oil palm recorded higher fruit yield per plant, fruit yield per plot, fruit yield per ha and high gross return net returns and B:C ratio.

Singh *et al.* (2016) conducted research that guava responds well to vegetable crops as intercrops and are not adversely affected in respect to yield and fruit quality. Intercropping can not only improve the health of orchard but also generate additional income and employment to the farmers, without any adverse effect on guava production.

Swain *et al.* (2016) conducted research to evaluate the performance of different root vegetables and spices as intercrops along with banana in terms of production potential and selling price under coastal plain zone of Odisha. It was observed that as compared to control, a banana crop with varied combination of intercrops is giving more return depending on yield and prevailing cost of the produce. As compared to control where around Rs. 2 lakhs was profit per hectare in banana two fold increase i.e. around Rs. 3.98 lakhs was obtained with banana + arrow root intercropping followed by turmeric.

Massawel Prosper I. *et al.* (2016) effect of *Rhizobium* and intercropping systems on soil nutrients and biological nitrogen fixation as influenced by legumes (*Phaseolus vulgaris* and *Dolichos lablab*). The fertility status of the soils and their suitability for cereal/ legumes production at the experimental site was evaluated based on technical indicators of soil fertility. From the soil analytical results, the major soil fertility limitations included low soil organic matter, low total nitrogen and medium available phosphorus for season 1 hence the soils were categorized as of low fertility status and moderately suitable for cereal/ legumes production. This was opposite in season 2 due to legumes biological nitrogen fixation and incorporation of legumes crop residues into the soil as the results of the first season harvest.

Kabiraj *et al.* (2017) carried out a field experiment to study the performance of cauliflower based intercropping system. Sole crop of cauliflower recorded the highest performance for all the growth characters, yield attributes and yield. Whereas, inclusion of legumes in intercropping system was helpful towards improvement of physical as well as biochemical properties of cauliflower curd. LER also improved with legume intercropping. However, the combined gross biomass production, net return

in monetary value and B: C ratio were at a bit higher side with cauliflower + beet, cauliflower + carrot and cauliflower + coriander intercropping system. The study directed towards the fact that intercropping with root crops may be advocated for more return per unit area, while to get promising quality of cauliflower legume intercrops are always preferable.

Saswati Ghosh *et al.* (2017) carried out experiment on influence of guava (*Psidium guajava* L.) based intercropping systems on soil health and productivity in alluvial soil of west Bengal, India. An experiment using various guava-based intercropping systems was conducted to find out the effect of intercropping on soil health and productivity in the alluvial soil of west Bengal, India. The popular intercrops viz. eggplant, banana and pointed gourd were taken as treatments in the guava orchard along with control (a treatment without intercrop). The study revealed that the guava + banana and guava + eggplant systems were proved to be the most significant intercropping system by improving physio-chemical properties like bulk density, water holding capacity, soc, available npk of the soil. The maximum system equivalent yield and economic return were obtained from the same system. Thus the guava + banana intercropping system is not only the best for restoring soil fertility but also obtaining the maximum economic return for guava growers of West Bengal.

Sangeeta Kumari *et al.* (2018) carried out experiment on onion as vegetable intercrop in mango mother tree orchard augments yield and economic return. The eight different vegetable intercrops viz., garlic (Local variety), pea (Azad P-1), carrot (Pusa Kesar), palak (All green), coriander (Pant haritima), onion (Patna red), radish (Snow White) and French bean (P-44) were grown in the orchard. Based on pooled mean yield of intercrops over three years, result indicated that yield of different intercrops varied significantly and the maximum yield (206.07 q/ha) was recorded in palak followed by onion (197.78 q/ha). Thus, the result demonstrated that intercropping of vegetables particularly onion in mango mother tree orchard is a highly remunerative proposition augmenting yield and economic return to farmers.

Dodiya *et al.* (2018) mono-cropping style production has significant problems and that there exists a sufficient justification for studying intercropping approaches. Intercropping provide insurance against risk and give stable returns even under unfavorable weather conditions. The most common advantage of intercropping is the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, and height and nutrient requirements based on the complementary utilization of growth resources by the component crops.

Singh *et al.* (2016) carried out experiment on evaluating significance of vermicompost and intercropping *amorphophallus* for integrated Indian goose berry orchard management. Integrated management of the orchard through intercropping vegetable crops and application of vermicompost or/and mustard cake is an effective approach to achieve high economic yield. From result it was concluded that intercropping of elephant foot yam under canopy of Indian Goose Berry plantation and application of vermicompost or/and mustard cake for two years successfully increased nutrient level of soil.

Chandrashekhar *et al.* (2018) studied economics of different horticultural crops under arecanut based multistoreyed cropping system. Multi storey cropping is practiced for growing two or more crops in the inter spaces during main crop growing season and which include both inter and mixed cropping. Mixed cropping in arecanut plantation has promoted more growth and yield of main crop of arecanut as indicated by increased number of leaves (fronds) and increased yield per palm compared to sole crop. Maximum mean yield of arecanut was observed to be in var. Mohitnagar (1.590 kg/plant), while minimum was in var. Mangala (1.348 kg/plant).

## CHAPTER III

### MATERIAL AND METHODS

The present study entitled “Studies on intercropping of cucurbitaceous vegetables under high density planted mandarin orchard” was carried out at, All India Co-ordinated Research Project on Fruits. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Akola during *summer* 2016-17. Material used and methods adopted during the course of investigations outlined in this chapter.

#### 3.1 Experimental site and Soil

The field experiment was conducted in the farm of All India Co-ordinated Research Project on Fruits, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *summer* season of 2016-17. The experimental site comprised of medium- heavy soil and well in organic carbon. The site was architect to raised bed of size (50 cm height x 3 m width) for high density planting of mandarin at the spacing of 6 x 3 m.

#### 3.2 Climatic and weather conditions

Akola is situated in sub-tropical region between 22.20 N latitude and 77.020 E longitude. The altitude of place is 307.2 m above mean sea level. The climate of Akola is semi arid and characterised by three distinct seasons. Hot and dry summer from March to May, warm humid and rainy monsoon from July to November, and mild cold winter from November to February.

The meteorological data in respect of maximum and minimum temperature, rainfall and humidity was recorded at meteorological observatory, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the course of investigation for the period from January 2017 to May 2017 and presented in Appendix – I.

### 3.3 Details of experiment

#### 3.3.1 Experimental details

- 1) Name of Intercrops : 1) Watermelon cv. Sugarbaby  
2) Muskmelon cv. Pusa sharbati  
3) Cucumber cv. Poona khira  
4) Bitter gourd cv. Phule green gold  
5) Ridge gourd cv. Pusa nasdar
- 2) Family of intercrops : Cucurbitaceae
- 3) Name of main crop : Mandarin
- 4) Family of main crop : Rutaceae
- 5) Variety of mandarin : Nagpur mandarin
- 6) Design : RBD
- 7) Treatments : 11 (Six)
- 8) Replication : 3 (Three)
- 9) Planting Season : *Summer* season
- 10) Year of study : 2017

#### 3.3.2 Treatment details

T <sub>1</sub>	Watermelon (Sole crop on raised bed)
T <sub>2</sub>	Muskmelon (Sole crop on raised bed)
T <sub>3</sub>	Bitter gourd (Sole crop on raised bed)
T <sub>4</sub>	Ridge gourd (Sole crop on raised bed)
T <sub>5</sub>	Cucumber (Sole crop on raised bed)
T <sub>6</sub>	Mandarin + Watermelon on raised bed
T <sub>7</sub>	Mandarin + Muskmelon on raised bed
T <sub>8</sub>	Mandarin + Bitter gourd on raised bed
T <sub>9</sub>	Mandarin + Ridge gourd on raised bed
T <sub>10</sub>	Mandarin + Cucumber on raised bed
T <sub>11</sub>	Mandarin (Sole crop)

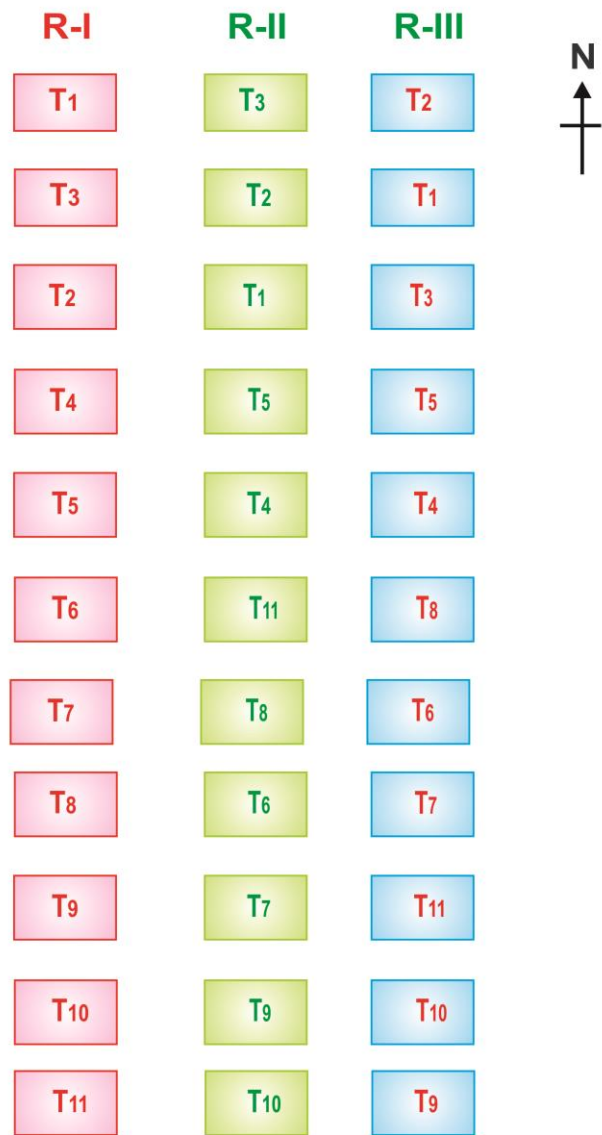


Fig. 1. Layout plan of experiment

### 3.4 Cultural operations

The plot was kept weed free by attending timely weeding and another cultural operation such as manuring, harrowing and fertilization. Plant protection measures and irrigation were undertaken uniformly at appropriate time.

#### 3.4.1 Fertilizer application

The recommended dose of fertilizer was given as below

Sr.no.	Crops	Recommended dose of fertilizers (kg/ha)		
		Nitrogen	Phosphorus	Potassium
1	Watermelon	80	40	40
2	Muskmelon	80	40	40
3	Bitter gourd	50	25	
4	Ridge gourd	50	25	
5	Cucumber	50	25	

Besides to the main crop i.e. Nagpur mandarin fertilizer dose of 240:120:120 kg/ha NPK was applied in three split doses i.e. June-Dec & Jan.

### 3.5 Observations recorded

Observations were recorded on the following characters by randomly selecting five plants from each replication except for the characters days to 50 percent flowering and days to maturity where observations were recorded on plot basis.

#### 3.5.1 Growth observations of intercrop crop.

##### 3.5.1.1 Length of vine (cm):

The length of vine was recorded with help of meter scale.

##### 3.5.1.2. Inter nodal length (cm):

The gap between two nodes or two leaf bearing node were measured at different place on plant with help of scale.

### **3.5.1.3 Stem Girth (cm):**

Five plants were selected from each treatment of each replication and girth of stem was measured by using Vernier caliper.

### **3.5.1.4 No. of Branches:**

Number of branches emerging on main stem of plant were counted at final stage 90 days after planting.

### **3.5.1.4 Leaf area (cm<sup>2</sup>)**

Ten leaves were taken randomly from each treatment and leaf area was measured with graph method.

### **3.5.2 Yield Attributes:**

#### **3.5.2.1 Number of node at which the first female flower observed.**

The lowest node at which first female flower appeared was noted in each treatment and the average node number of occurrence of the first female flower was worked out.

#### **3.5.2.2 Days required for 50 % flowering**

Number of days required for flowering of 50 per cent plants in the plot from date of sowing was recorded.

#### **3.5.2.3 Sex ratio (Female: Male):**

The sex ratio was expressed in terms of number of female and male flower per plant. It was recorded at seven days interval from last week of February till first week of April. Finally, it was summed up and calculated sex ratio.

#### **3.5.2.4. Days required for fruit set:**

A sample of five randomly selected plants were used in each treatment in each replication for recording days to fruit set by observing first fruit set in each treatment.

#### **3.5.2.5 Days required for first harvest:**

Number of days required from sowing to first harvest was recorded.

#### **3.4.2.6 No. of fruits plant<sup>-1</sup> and Yield vine<sup>-1</sup>(kg):**

Well-developed, tender and edible fruits were harvested and weighted from time to time recorded as per total number of fruit and fruit yield (kg) per vine.

#### **3.5.2.7 Fruit yield plot<sup>-1</sup> (kg) and hectare<sup>-1</sup> (q/ha):**

The number of fruit harvested from each net plot from time to time were weighted in kilogram and the total yield per plot was calculated. Similarly, the fruit yield was estimated on hectare basis and it was expressed in q/ha.

#### **3.5.3 Quality Parameter**

##### **3.5.3.1 Average weight of fruit (g):**

Ten fruits treatment<sup>-1</sup> were weighted and average fruit weight (gm) was worked out.

##### **3.5.3.2 Length of Fruit (cm):**

Five fruit were selected randomly from each treatment and each replication and measured in cm from base to tip of fruit to record the mean value of fruit length.

##### **3.5.3.3 Diameter of Fruit (cm):**

Five fruit were selected randomly from each treatment and each replication and measured at middle of fruit to record the mean value of fruit diameter

##### **3.5.3.4 Total Soluble Solid (°Brix):**

A sample of fruit was randomly drawn from harvested lot from each replication. The fruits were thoroughly washed in tap water. Fruit were then cut longitudinally in to two halves by a steel knife and squeezed to obtain the juice. The juice was filtered through two muslin cloth. The juice the used to determined T.S.S. with the help of hand refractometer.

### **3.5.4. Growth parameter of main crop:**

#### **3.5.4.1 Height of Plant (m):**

Height of plant were calculated form the ground level to tip of plant canopy using measuring tape.

#### **3.5.4.2 Girth of scion (cm):**

Girth of scion were measured by using Vernier caliper 10 cm above the union stock.

#### **3.5.4.3 Girth of stock (cm):**

Girth of stock were measured by using Vernier caliper 10 cm above the ground level.

#### **3.5.4.4. Stock: Scion ratio (cm):**

Stock: scion ratio were calculated by dividing the girth of stock by girth of scion

#### **3.5.4.5. No. of branches:**

Number of branches emerging on main stem of plant were counted.

#### **3.5.4.6. Canopy spread (cm):**

Plant spread was measured by using measuring tape (East-West and North- South).

#### **3.5.4.7. Canopy Volume (m<sup>3</sup>):**

The value of experimental plant was calculated by using Formula.

$$\text{Canopy Volume (m}^3\text{)} = \frac{4}{6} \pi(r)^2h$$

$$r = \text{canopy (E+W) + (N+S)}/4$$

$$h = \text{height of plant}$$

## **ECONOMICS**

### **COST OF CULTIVATION OF INTERCROP**

The prices of all the inputs and labour cost that were prevailing at the time of their use were considered to work out the cost of cultivation.

#### **Gross income**

The gross income was worked out based of the prevailing market price when the produce was ready to market.

#### **Net income**

Net income per hectare calculated on the basis of gross income and cost of cultivation per hectare.

#### **Benefit: cost ratio of intercrop.**

The benefit cost ratio was worked out by using the following formula.

$$\text{Benefit : Cost ratio} = \frac{\text{Gross return (Rs /ha)}}{\text{Cost of cultivation (Rs /ha)}}$$

### **3.5 Statistical Analysis**

The data recorded in respect of all the above parameters were subjected to statistical analysis and for interpretation of results (Gomez and Gomez, 1984).



Plate 1. General view of experiment plots

## CHAPTER IV

### RESULTS AND DISCUSSION

An experiment entitled “Studies on intercropping of cucurbitaceous vegetables under high density planted mandarin orchard.” was carried out during 2016 -2017 at, AICRP, Fruit. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola with the following objectives

1. To study the growth, yield and quality performance of vine vegetables under high density planted mandarin orchard.
2. To find the most suitable and profitable intercropping system of vine vegetable with high density planted mandarin orchard.

The results of the investigation based on the various observations related to on growth, yield, and quality performance of watermelon, muskmelon, bitter gourd, ridge gourd, cucumber planted as intercrop and sole crop in high density planted mandarin, along with the growth parameter of main crop are presented in this chapter under the appropriate heads.

#### **4.1 Growth parameters of cucurbitaceous crops (Sole crop and Intercrop).**

#### **4.2 Yield parameters of cucurbitaceous crops (Sole crop and Intercrop).**

#### **4.3 Quality parameters of cucurbitaceous crops (Sole crop and Intercrop).**

#### **4.4 Growth parameter of mandarin (main crop).**

#### **4.5 Economics**

## 4.1 Growth parameters of cucurbitaceous crops (Sole crops and Intercrop)

### 4.1.1 Length of vine (cm)

The data with respect to length of vine of cucurbitaceous intercrops grown in mandarin on raised bed is presented in Table 1.

**Table 1. Performance of cucurbitaceous crop as sole crop and intercrop on length of vine (cm)**

Treatments	Length of vine (cm)
T <sub>1</sub> (Watermelon sole crop on raised bed)	194.43
T <sub>2</sub> (Muskmelon sole crop on raised bed)	167.73
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	280.78
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	240.14
T <sub>5</sub> (Cucumber sole crop on raised bed)	229.90
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	204.67
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	176.56
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	295.56
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	252.78
T <sub>10</sub> (Mandarin + Cucumber)	242.00
T <sub>11</sub> (Mandarin sole)	-
<b>'F' test</b>	Sig
<b>SE (m)±</b>	7.86
<b>CD at 5%</b>	23.37

The data pertaining to the length of vine of different cucurbitaceous vegetables showed significant differences among each other. The bitter gourd recorded maximum length of vine i.e. 295.56 cm when grown as intercrop in mandarin, which was at par with bitter gourd sole crop on raised bed, i.e. 280.78 cm

However the length of vine of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant

values. This indicates that the length of vine is not affected by growing as intercrop in mandarin on raised bed.

The length of vine is slightly more when cucurbitaceous vegetables are grown as intercrop in mandarin orchard than cucurbitaceous vegetables grown as sole crop. This may be due the fact that nutrients provided to mandarin were also made available to the intercrops and also partial shade of main crop which leads to increased growth of intercrops. The present findings are also in conformity to the observations recorded by Singh *et al.* (2014) who recorded slightly increase in plant height and spread of all intercrops under shade of guava orchard than their height and spread under open condition.

The results are also in conformity with the observations recorded by Chuntawat (1993) Gosh and Chand (1984) and Nelliate *et al.* (1974) who suggested the successful cultivation of intercrop viz. elephant foot yam, turmeric, ginger, sweet potato and pulses in coconut plantation.

#### **4.1.2 Inter nodal length (cm)**

The data with respect of inter nodal length of cucurbitaceous intercrops grown in mandarin on raised bed is presented in Table 2 revealed that, the inter nodal length of different cucurbitaceous vegetables showed significant difference among each other. The ridge gourd recorded maximum inter nodal length i.e. 13.56 cm when grown as intercrop in mandarin, which was at par with ridge gourd sole crop on raised bed, i.e. 13.30 cm.

Whereas, the inter nodal length of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant difference. This shows inter nodal length of vine is not affected by growing as intercrop in mandarin on raised bed compared to grown as sole crop.

**Table 2. Performance of cucurbitaceous crops as sole crop and intercrop on inter nodal length (cm)**

Treatments	Inter nodal length (cm)
T <sub>1</sub> (Watermelon sole crop on raised bed)	7.10
T <sub>2</sub> (Muskmelon sole on raised bed)	8.60
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	10.40
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	13.30
T <sub>5</sub> (Cucumber sole crop on raised bed)	7.00
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	7.40
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	8.89
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	10.49
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	13.56
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	7.19
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.11
CD at 5%	0.33

#### 4.1.3 Stem girth (cm)

From the data presented in Table 3 the results revealed that, the stem girth of different cucurbitaceous vegetables showed significant difference among each other. The muskmelon recorded maximum stem girth i.e. 0.88 cm when grown as intercrop in mandarin which was at par with muskmelon sole crop on raised bed, i.e. 0.87 cm.

However, the stem girth of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant difference. Thus results revealed that stem girth of vine is not affected by growing as intercrop in mandarin on raised bed as compared to the sole crop.

The significant variation in stem girth among the different cucurbitaceous crop is largely due to its genetic potential of that crops.

Similar result were recorded by Moniruzzaman *et al.* (2007) for stem girth different summer cucurbits when intercrop with bilatidhonia.

Similarly, the highest stem girth was observed in muskmelon when grown as intercrop in mandarin than grown as sole crop may be due to mandarin created partial shade on the canopy of muskmelon, also muskmelon recorded highest leaf area which results in creating a microclimate that may have resulted in efficient utilization of nutrients and organic matter from the soil which might be the reason for increase in stem girth of muskmelon.

**Table 3. Performance of cucurbitaceous crops as sole crop and intercrops on stem girth (cm)**

Treatments	Stem girth (cm)
T <sub>1</sub> (Watermelon sole crop on raised bed)	0.58
T <sub>2</sub> (Muskmelon sole crop on raised bed)	0.87
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	0.62
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	0.73
T <sub>5</sub> (Cucumber sole crop on raised bed)	0.85
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	0.59
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	0.88
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	0.63
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	0.74
T <sub>10</sub> (Mandarin + Cucumber)	0.86
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.006
CD at 5%	0.019

#### 4.1.4 No. of branches

It is evident from the data presented in Table 4 that the number of branches of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded

maximum number of branches i.e. 6.80 when grown as intercrop in mandarin.

**Table 4. Performance of cucurbitaceous crops as sole crop and intercrop on number of branches**

Treatments	No. of Branches
T <sub>1</sub> (Watermelon sole crop on raised bed)	6.20
T <sub>2</sub> (Muskmelon sole crop on raised bed)	5.20
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	5.80
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	5.40
T <sub>5</sub> (Cucumber sole crop on raised bed)	5.20
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	6.80
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	5.40
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	6.60
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	5.60
T <sub>10</sub> (Mandarin + Cucumber)	5.40
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.04
CD at 5%	0.12

The number of branches of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This shows that, number of branches is not affected by growing as intercrop in mandarin on raised bed.

The highest number of branches were observed in watermelon when grown as intercrop in mandarin than grown as sole crop. These variation of number of branches per vine of different cucurbitaceous crops might be due to the reason of growth habit of those plants. Similar results were also reported by Moniruzzaman *et al.* (2007) in different summer cucurbits when intercrop with bilatidhonia.

#### 4.1.5 Leaf area (cm<sup>2</sup>)

The data presented in Table 5 revealed that, the leaf area of different cucurbitaceous vegetables showed significant difference among each other. The muskmelon recorded maximum leaf area i.e. 367.00 cm<sup>2</sup> when grown as intercrop in mandarin, which was at par with muskmelon sole crop on raised bed, i.e. 366.73 cm<sup>2</sup>.

However, the leaf area of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates leaf area is not affected by growing as intercrop in mandarin on raised bed.

**Table 5. Performance of cucurbitaceous crops as sole crop and intercrop on leaf area (cm<sup>2</sup>)**

Treatments	Leaf area (cm <sup>2</sup> )
T <sub>1</sub> (Watermelon sole crop on raised bed)	234.27
T <sub>2</sub> (Muskmelon sole crop on raised bed)	366.73
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	228.70
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	336.05
T <sub>5</sub> (Cucumber sole crop on raised bed)	344.06
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	341.33
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	367.00
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	229.00
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	336.33
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	344.33
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	2.89
CD at 5%	8.60

The difference in growth performance (Length of vine, stem girth, leaf area, number of branches etc.) of cucurbitaceous crops among each other is largely due to genetic potential. Similar results were also

reported by Moniruzzaman *et al.* (2007) in different summer cucurbits when intercrop with bilatidhonia. Although the variation in growth parameters of cucurbitaceous crops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber grown as intercrop in mandarin compared with same crop as sole crop were non significant, however the slightly better growth performance of cucurbitaceous crop as intercrop compare to sole crop due to the additional provision of nutrient and water to the main crop was efficiently utilized by cucurbitaceous intercrops. The results are in conformity with the findings of Swain (2014).

## 4.2 Yield parameters of cucurbitaceous crops (Sole crop and Intercrop)

### 4.2.1 No. of node at which first female flower observed

**Table 6. Performance of cucurbitaceous crops as sole crop and intercrop on node at which first female flower observed**

Treatments	No. of node at which first female flower observed
T <sub>1</sub> (Watermelon sole crop on raised bed)	9.20
T <sub>2</sub> (Muskmelon sole crop on raised bed)	7.40
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	20.80
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	10.20
T <sub>5</sub> (Cucumber sole on raised bed)	8.80
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	8.40
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	6.80
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	20.20
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	9.40
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	8.00
T <sub>11</sub> (Mandarin sole)	
'F' test	Sig
SE (m)±	0.31
CD at 5%	0.92

It is evident from data presented in Table 6 the number of node at which first female flower observed of different cucurbitaceous

vegetables showed significant difference among each other. The muskmelon recorded lowest node number at which the first female flower observed i.e. 6.80 when grown as intercrop in mandarin which was at par with muskmelon sole crop on raised bed, i.e. 7.40

Whereas the node at which the first female flower observed of various cucurbitaceous intercrops *viz.* watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates that the character number of node at which first female flower observed was not affected by growing as intercrop in mandarin on raised bed.

#### **4.2.2 Days required for 50% flowering**

From the data presented in Table 7 the results revealed that, the days required for 50% flowering of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded minimum days required for 50% flowering of vine i.e. 40.00 days when grown as intercrop in mandarin which was at par with watermelon sole crop on raised bed, i.e. 43.00 days.

However the days required for 50% flowering of cucurbitaceous intercrops *viz.* watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This revealed that growth of vine not affected by growing as intercrop in mandarin on raised bed, which was reflected in days required for 50% flowering.

Adoption of intercropping systems in mandarin orchard helped in efficient utilization of nutrients which were applied to the mandarin as well as it improved the nutrients input use efficiency in the intercropping system. This might be the reason for increase in growth parameter of all cucurbitaceous crop when grown as intercrop in mandarin orchard.

**Table 7. Performance of cucurbitaceous crops as sole crop and intercrop on days required for 50% flowering**

Treatments	Days required for 50% flowering
T <sub>1</sub> (Watermelon sole crop on raised bed)	43.00
T <sub>2</sub> (Muskmelon sole crop on raised bed)	47.00
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	59.00
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	46.00
T <sub>5</sub> (Cucumber sole crop on raised bed)	46.00
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	40.00
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	46.00
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	57.00
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	44.00
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	44.00
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.84
CD at 5%	2.49

Similarly the growth habit of watermelon is in such a way that the raised bed conditions support spreading on land and this also help for water melon. This ultimately results early flowering of the watermelon. When compared to the rest of crop *viz.* cucumber, bitter gourd and ridge gourd which required support for the growth.

This results are in conformity of results obtained by Nweke *et al.* (2013), Karthick *et al.* (2017) who achieved better growth and yield of cucurbits when grown on staking.

#### 4.2.3 Sex ratio (Male: Female)

**Table 8. Performance of cucurbitaceous crops as sole crop and intercrop on sex ratio**

Treatments	Sex ratio (Male: Female)
T <sub>1</sub> (Watermelon sole crop on raised bed)	8.72
T <sub>2</sub> (Muskmelon sole crop on raised bed)	7.93
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	8.96
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	9.68
T <sub>5</sub> (Cucumber sole on raised bed)	9.78
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	8.82
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	8.03
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	9.07
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	9.76
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	9.90
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.04
CD at 5%	0.13

It is evident from the data presented in Table 8 pertaining to the sex ratio (male:female) of different cucurbitaceous vegetables showed significant difference among each other. The cucumber recorded maximum sex ratio i.e. 9.90 when grown as intercrop in mandarin which was at par with cucumber sole crop on raised bed, i.e. 9.78.

However, the sex ratio (male:female) of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates sex ratio is not affected by growing as intercrop in mandarin on raised bed.

#### 4.2.4 Days required for fruit set

From the data presented in Table 9 the results indicated that, the days required for fruit set of different cucurbitaceous vegetables showed significant difference among each other. The muskmelon recorded minimum days for fruit set i.e. 38.60 days when grown as intercrop in mandarin, which was at par with ridge gourd when intercrop with mandarin, i.e. 39.00 days.

**Table 9. Performance of cucurbitaceous crops as sole crop and intercrop on days required for fruit set**

Treatments	Days required for fruit set
T <sub>1</sub> (Watermelon sole crop on raised bed)	42.60
T <sub>2</sub> (Muskmelon sole crop on raised bed)	43.00
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	43.60
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	43.40
T <sub>5</sub> (Cucumber sole crop on raised bed)	42.40
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	41.40
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	38.60
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	39.20
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	39.00
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	39.60
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.19
CD at 5%	0.55

Similarly, the days required for fruit set of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed significant difference. This may be due to the microclimate

provided by the main crop i.e. mandarin in the cucurbitaceous intercrop as well as additional nutrition provided to the mandarin may had resulted in early fruit set in cucurbitaceous crop viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compare to the grown as sole crop. The result are in conformity with the results of Singh *et. al.* (2014).

#### 4.2.5 Days required for first harvest

The data presented in Table 10, revealed significant difference due to various treatments.

The data pertaining that, the days required for first harvest of different cucurbitaceous vegetables showed significant difference among each other. The cucumber recorded significantly minimum days required for harvest i.e. 48.00 days when grown as intercrop in mandarin.

**Table 10. Performance of cucurbitaceous crops as sole crop and intercrop on days required for first harvest**

Treatments	Days required for first harvest
T <sub>1</sub> (Watermelon sole crop on raised bed)	82.00
T <sub>2</sub> (Muskmelon sole crop on raised bed)	83.00
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	65.00
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	66.00
T <sub>5</sub> (Cucumber sole crop on raised bed)	53.00
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	74.00
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	74.00
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	58.00
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	59.00
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	48.00
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	1.60
CD at 5%	4.90

Similarly, the days required for first harvest of cucurbitaceous intercrop *viz.* watermelon (74.00), muskmelon (74.00), bitter gourd (58.00), ridge gourd (59.00), and cucumber (48.00) compared with same crop grown on raised bed as sole crop showed significantly less number of days.

This might be due to the fact that, microclimate provided by main crop to the cucurbitaceous intercrops as well as efficient utilization of additional nutrition to the mandarin which resulted in early growth followed by early fruit set and finally results in minimum number of days for first harvest of cucurbitaceous intercrops compare to the same grown as sole crop. The results are in conformity with the results obtained by Singh *et al.* (2014).

#### 4.2.6 No. of fruits /plant

**Table 11. Performance of cucurbitaceous crops as sole crop and intercrop on number of fruit per plant**

Treatments	No. of fruits /plant
T <sub>1</sub> (Watermelon sole crop on raised bed)	1.40
T <sub>2</sub> (Muskmelon sole crop on raised bed)	2.20
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	9.60
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	5.30
T <sub>5</sub> (Cucumber sole crop on raised bed)	12.20
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	1.60
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	2.40
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	10.40
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	5.80
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	12.40
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m) <sub>±</sub>	0.42
CD at 5%	1.28

It is evident from data presented in Table 11 the number of fruit per plant of different cucurbitaceous vegetables showed significant

difference among each other. The cucumber recorded maximum number of fruit i.e. 12.40 when grown as intercrop in mandarin, which was at par with cucumber sole crop on raised bed, i.e. 12.20

Furthermore, the number of fruit per vine of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd, and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates that number of fruit on vine of cucurbitaceous intercrops were not affected by growing as intercrop in mandarin on raised bed.

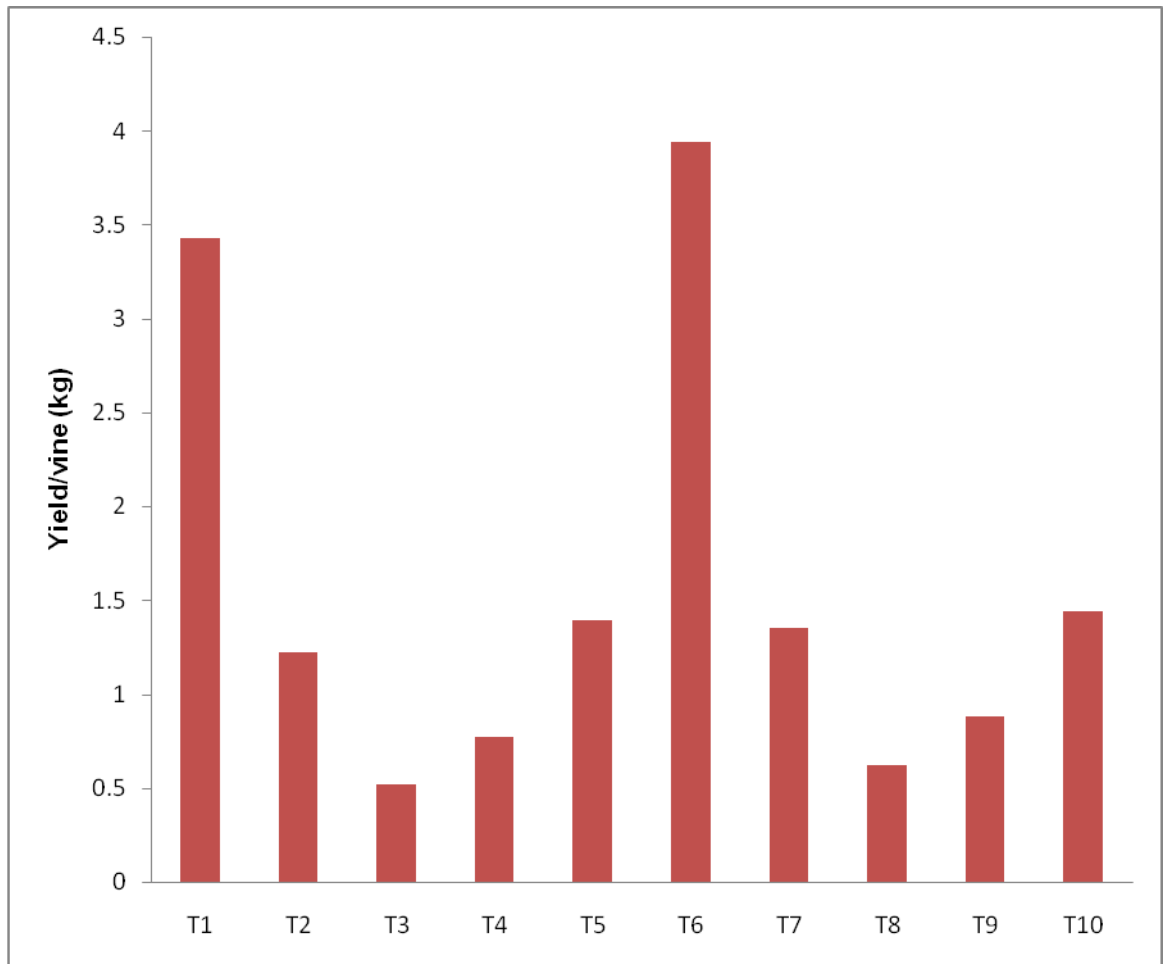
However better performance of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber compare to the grown sole crop may be microclimate conditions and additional nutrition provided to the mandarin efficiently utilized by the cucurbitaceous intercrops. Anim and Limbaini (2007) reported similar result when cucumber was planted as sole crop number of fruit per vine was significantly lower as compare to intercropping with okra.

#### **4.2.7 Yield vine<sup>-1</sup> (kg)**

From the data presented in Table 12 and depicted in Fig. 2 the results found that, the yield per vine of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded maximum yield per vine i.e. 3.94 kg when grown as intercrop in mandarin which was at par with watermelon sole crop on raised bed, i.e. 3.43 kg.

Whereas, the yield per vine of cucurbitaceous intercrops viz. watermelon (3.94 kg), muskmelon (1.35 kg), bitter gourd (0.62 kg), ridge gourd (0.88 kg) and cucumber (1.44 kg) compared with same crop grown on raised bed as sole crop showed non significant values. This indicates yield per vine was not affected by growing as intercrop in mandarin on raised bed.

Similar results were recorded by Moniruzzaman *et al.* (2007) for the yield variation among different summer cucurbits when intercrop with bilatidhonia.



**Fig. 2 Performance of cucurbitaceous crops as sole crop and intercrop on yield / vine (kg)**

**Table 12. Performance of cucurbitaceous crops as sole crop and intercrop on yield / vine (kg)**

Treatments	Yield /vine (kg)
T <sub>1</sub> (Watermelon sole crop on raised bed)	3.43
T <sub>2</sub> (Muskmelon sole crop on raised bed)	1.22
T <sub>3</sub> (Bitter gourd sole crop raised bed)	0.52
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	0.77
T <sub>5</sub> (Cucumber sole crop on raised bed)	1.39
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	3.94
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	1.35
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	0.62
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	0.88
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	1.44
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	0.35
CD at 5%	1.01

#### 4.2.8 Yield plot<sup>-1</sup> (kg)

The data presented in Table 13 revealed significant differences in yield levels (kg/plot) among cucurbitaceous crops. The watermelon recorded maximum yield plot<sup>-1</sup> i.e. 55.12 kg when grown as intercrop in mandarin which was at par with watermelon sole crop on raised bed, i.e. 48.04 kg

However the yield plot<sup>-1</sup> (kg) of cucurbitaceous intercrops *viz.* watermelon (55.12 kg), muskmelon (18.87 kg), bitter gourd (9.47 kg), ridge gourd (12.36 kg), and cucumber (20.21 kg) compared with same crop grown on raised bed as sole crop showed non significant difference. This indicates yield <sup>-1</sup> plot is not affected by growing as intercrop in mandarin on raised bed.

**Table 13. Performance of cucurbitaceous crops as sole crop and intercrop on yield plot<sup>-1</sup> (kg)**

Treatments	Yield/plot (kg)
T <sub>1</sub> (Watermelon sole crop on raised bed)	48.04
T <sub>2</sub> (Muskmelon sole crop on raised bed)	17.04
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	7.32
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	10.81
T <sub>5</sub> (Cucumber sole crop on raised bed)	19.52
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	55.12
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	18.87
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	9.47
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	12.36
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	20.21
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	2.48
CD at 5%	7.43

#### 4.2.9 Yield (q ha<sup>-1</sup>)

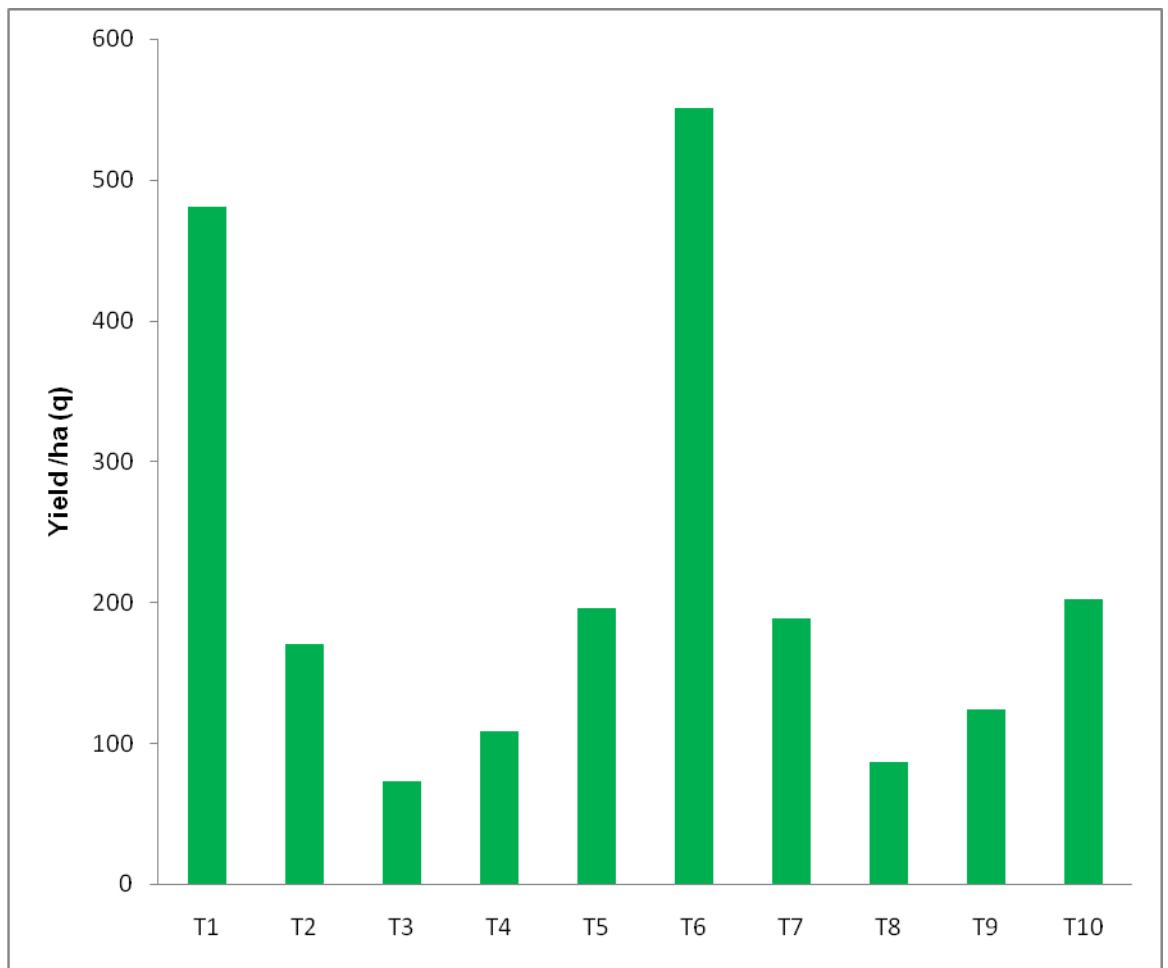
It is evident from the data presented in Table 14 and depicted in Fig. 3 the yield (q/ha) of different cucurbitaceous vegetables showed significant differences among each other. The watermelon recorded maximum yield i.e. 551.21 q/ha when grown as intercrop in mandarin, which was at par with watermelon sole crop on raised bed, i.e. 480.42 q/ha. The lowest yield level were recorded by bitter gourd as intercrop (86.10 q/ha) as well as sole crop (73.17 q/ha).

**Table 14. Performance of cucurbitaceous crops as sole crop and intercrop on yield hectore<sup>-1</sup> (q)**

Treatments	Yield/ha (q)
T <sub>1</sub> (Watermelon sole crop on raised bed)	480.42
T <sub>2</sub> (Muskmelon sole crop on raised bed)	170.36
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	73.17
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	108.11
T <sub>5</sub> (Cucumber sole crop on raised bed)	195.59
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	551.21
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	188.69
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	86.10
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	123.62
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	202.00
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	24.24
CD at 5%	70.49

Whereas, the yield (q ha<sup>-1</sup>) of cucurbitaceous intercrops *viz.* watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates yield of cucurbitaceous crops is not affected by growing as intercrop in mandarin on raised bed. These might be due to the nutrition provided to the main crop efficiently utilize by intercrops as well as micro climate form by the main crop attribute to slightly better yield levels of cucurbitaceous vegetables as intercrops compare to the growing as sole crop on raised beds.

Lowest yield was observed in bitter gourd in both condition intercrop as well as sole crop among different cucurbitaceous vegetables this may be due to reason of bearing habit and genetic yield potentiality.



**Fig. 3 Performance of cucurbitaceous crops as sole crop and intercrop on yield per hectare (q)**

However, better performance of muskmelon and watermelon is due the growth habit of vine that supports spreading on ground which was provided both as intercrop and sole crop when grown on raised beds.

The poor performance of bitter gourd, ridge gourd and cucumber also attributed to growth, flowering and fruit bearing were not supported by the raised bed conditions both as sole crop and intercrop, where these crops were not supported and allowed to spread over the ground only

The observations recorded on the yield of intercrop reveals that there is increase in yield of intercrop in citrus orchard comparison with cucurbitaceous vegetable grown as sole crop. 0

These results are in conformity with Swain (2014) who reported that, the higher yield advantages particularly average fruit weight and fruit yield under intercropping systems were mainly attributed to efficient utilization of natural resources like solar radiation, soil moisture, and nutrients because of complimentary interaction between the component crops and base crop.

#### **4.3 Quality parameters of cucurbitaceous crops (Sole crop and Intercrop).**

##### **4.3.1 Average weight of fruit (g)**

The data presented in Table 15, revealed significant difference due to various treatments.

The data indicates that, the average weight of fruit of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded maximum average weight of fruit i.e. 2590.23 g when grown as intercrop in mandarin which was at par with watermelon sole crop on raised bed, i.e. 2580.10 g.

Furthermore, the average weight fruit of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd, and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates average weight of fruit was not affected by growing as intercrop in mandarin on raised bed condition.

**Table 15. Performance of cucurbitaceous crops as sole crop and intercrop on average weight of fruit (g)**

Treatments	Average weight of fruit (g)
T <sub>1</sub> (Watermelon sole crop on raised bed)	2580.10
T <sub>2</sub> (Muskmelon sole crop on raised bed)	582.77
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	59.16
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	153.36
T <sub>5</sub> (Cucumber sole crop on raised bed)	118.38
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	2590.23
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	591.53
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	62.25
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	160.25
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	122.53
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	6.65
CD at 5%	19.93

Highest average weight was observed in watermelon in both condition intercrop as well as sole crop among different cucurbitaceous vegetables this may be due to reason of bearing habit and genetic yield potentiality. Similar results were recorded by Moniruzzaman *et al.* (2007) for the yield variation among different summer cucurbits when intercrop with bilatidhonia.

#### **4.3.2 Length of fruit (cm)**

From the data presented in Table 16 indicates that, the length of fruit of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded maximum length of fruit i.e.

50.17 cm when grown as intercrop in mandarin, which was at par with watermelon sole crop on raised bed, i.e. 49.97cm

Whereas, the length of fruit of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant values. This indicates that length of fruit was not affected by growing as intercrop in mandarin on raised bed.

Highest length of fruit was observed in watermelon in both condition intercrop as well as sole among different cucurbitaceous vegetables this may be due to reason of bearing habit and genetic yield potentiality. Similar results were recorded by Moniruzzaman *et al.* (2007) for the yield variation among different summer cucurbits when intercrop with bilatidhonia.

**Table 16. Performance of cucurbitaceous crops as sole crop and intercrop on length of fruit (cm)**

Treatments	Length of fruit (cm)
T <sub>1</sub> (Watermelon sole crop on raised bed)	49.97
T <sub>2</sub> (Muskmelon sole crop on raised bed)	8.09
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	18.34
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	15.84
T <sub>5</sub> (Cucumber sole crop on raised bed)	11.00
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	50.17
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	8.22
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	19.30
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	16.56
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	11.39
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m)±	2.37
CD at 5%	7.12

### 4.3.3 Diameter of Fruit (cm)

It is evident from the data presented in Table 17 the results showed that, the diameter of different cucurbitaceous vegetables showed significant difference among each other. The watermelon recorded maximum diameter of fruit i.e. 42.31 cm when grown as intercrop in mandarin, which was at par with watermelon sole crop on raise bed, i.e. 42.14 cm

**Table 17. Performance of cucurbitaceous crops as sole crop and intercrop on diameter of fruit (cm)**

Treatments	Diameter of Fruit (cm)
T <sub>1</sub> (Watermelon sole crop on raised bed)	42.14
T <sub>2</sub> (Muskmelon sole crop on raised bed)	11.04
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	2.42
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	2.80
T <sub>5</sub> (Cucumber sole crop on raised bed)	2.89
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	42.31
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	11.21
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	2.55
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	2.93
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	3.00
T <sub>11</sub> (Mandarin sole)	-
'F' test	Sig
SE (m) $\pm$	0.80
CD at 5%	2.04

However the diameter of fruit of cucurbitaceous intercrop viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant difference. This indicates diameter of fruit is not affected by growing as intercrop in mandarin on raised bed.

Highest diameter and length observed in watermelon in both condition intercrop as well as sole among different cucurbitaceous vegetables this may be due to reason of bearing habit and genetic yield potentiality. Similar results were recorded by Moniruzzaman *et al.* (2007) for the yield variation among different summer cucurbits when intercrop with bilatidhonia.

Similarly, better performance of watermelon and muskmelons may be largely due to the fact that these crops are well adopted to the spreading on the ground where the yield potential is reflected.

#### 4.3.4 TSS (°Brix )

**Table 18. Performance of cucurbitaceous crops as sole crop and intercrop on TSS (°Brix)**

Treatments	TSS (°Brix )
T <sub>1</sub> (Watermelon sole crop on raised bed)	11.20
T <sub>2</sub> (Muskmelon sole crop on raised bed)	11.80
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	2.20
T <sub>4</sub> (Ridge gourd sole crop on raised bed)	3.20
T <sub>5</sub> (Cucumber sole crop on raised bed)	3.40
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	11.40
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	12.20
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	2.46
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	3.53
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	3.80
T <sub>11</sub> ( Mandarin sole)	-
'F' test	Sig
SE (m)±	0.19
CD at 5%	0.56



Watermelon



Muskmelon



Bitter gourd



Ridge gourd



Cucumber

Plate 2. Quality of cucurbitaceous fruit grown as a intercrop in HDP mandarin

However, other cucurbitaceous crops viz. bitter gourd, ridge gourd, cucumber requires support for growth which was not feasible when grown as intercrops in mandarin on raised beds.

The data presented in Table 18 revealed that, the TSS of different cucurbitaceous vegetables showed significant difference among each other. The muskmelon recorded maximum TSS i.e. 12.20 °Brix when grown as intercrop in mandarin, which was at par with muskmelon sole crop on raised bed, i.e. 11.80 °Brix.

Whereas the TSS values of cucurbitaceous intercrops viz. watermelon, muskmelon, bitter gourd, ridge gourd and cucumber compared with same crop grown on raised bed as sole crop showed non significant difference. This indicates TSS was not affected by growing as intercrop in mandarin on raised bed.

The difference in TSS values of different crop is attributed to the genetic potentiality. The results are in conformity to with the results recorded by Moniruzzaman *et al.* (2007) among different summer cucurbits when intercrop with bilatidhonia.

However slightly better performance of cucurbitaceous crop viz. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber as intercrop compare to the sole crop may be due the fact that the microclimate condition and additional natural resource (nutrient and water) applied to main crop were also efficiently utilized by intercrops. These results are in conformity with findings of Singh *et al.* (2014)

#### **4.4 Growth parameters of mandarin (main crop)**

##### **4.4.1 Height of mandarin (m)**

The data on the effect of intercrops on the plant height of mandarin are presented in Table 19. It is evident from table that plant height as well as incremental height of mandarin was not affected by different intercrops at 4 MAS (at the time of harvesting) of intercrops.

However, at time 4 MAS (at the time of final harvesting) of intercrops i.e. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber highest height of mandarin (2.03 m) was recorded when watermelon grown

as intercrop. Similarly maximum incremental height of mandarin (36 cm) in muskmelon as well as cucumber. The influence of intercrops were non significant with respect to height of mandarin.

**Table 19. Performance of mandarin (main crop) on plant height (m)**

Treatment	Plant height (m)		
	At planting	4 MAS	Increment(cm)
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	1.66	2.03	35.
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	1.26	1.62	36
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	1.23	1.57	34
T <sub>9</sub> (Mandarin+ Ridge gourd on raised bed)	1.05	1.40	35
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	1.22	1.58	36
T <sub>11</sub> (Mandarin sole)	1.50	1.80	30
'F' test	NS	NS	
SE (m)±	0.12	0.12	
CD at 5%	-	-	

The results indicates that slightly better performance of mandarin grown with intercrop with compare to sole mandarin (control) attributed to adoption of intercropping system in citrus orchard helps in efficient utilization of natural resources as well as it improves the input use efficiency in the system this might be the reason for increase in height of main crop mandarin which is evident from incremental height.

Similar findings for increase in tree height of mango due to intercropping was recorded by Bhuva *et al.* (1988), Sing *et al.* (1996), Mishra and swain (2001), Vishal nath *et al.* (2003) and Swain and Patro (2007). Swain *et al.* (2016) reported that banana plant recorded the highest height in association with ginger and it was found to be more as compare to control.

#### **4.4.2 Girth of stock of mandarin plants (cm)**

The data on the effect of intercrops on the girth of stock of mandarin are presented in Table 20. It is evident from table that girth of

stock of mandarin was not affected by different intercrops 4 MAS (at the time of harvesting) of intercrops. However, at the final harvest of intercrops highest girth of stock of mandarin was recorded grown with watermelon i.e. 3.88 cm

**Table 20. Performance of mandarin (main crop) on girth of stock (cm)**

Treatment	Girth of stock (cm)	
	At planting	4 MAS
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	2.34	3.88
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	1.77	3.51
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	2.71	3.68
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	2.74	3.77
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	2.84	3.55
T <sub>11</sub> (Mandarin sole)	3.05	3.57
'F' test	NS	NS
SE (m)±	0.28	0.20
CD at 5%	-	-

Mandarin rootstock girth was not significantly affected when cucurbitaceous vegetable were grown as intercrop. Similar findings were also reported by Oyedele *et al.* (2015) when the research conducted for productivity responses of spice and vegetable crops in citrus juvenile orchard. They reported that citrus stem girth was not significantly affected in the intercrop system.

#### **4.4.3 Girth of scion (cm)**

The data on the effect of intercrops on the girth of scion of mandarin are presented in Table 21. It is evident from table that girth of scion of mandarin was not affected by different intercrops at 4 MAS of intercrops (at the time of harvesting) of intercrops. However, at time of final harvest of intercrops highest girth of scion of mandarin was recorded from the with treatment bitter gourd as intercrop.

**Table 21. Performance of growth parameter of mandarin (main crop) on girth of scion (cm)**

Treatment	Girth of Scion (cm)	
	At planting	4 MAS
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	1.82	2.69
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	1.53	3.32
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	2.13	3.49
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	2.16	3.25
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	2.10	3.02
T <sub>11</sub> (Mandarin sole)	2.35	3.05
'F' test	NS	NS
SE (m)±	0.26	0.22
CD at 5%	-	-

Girth of scion of mandarin was not significantly affected when cucurbitaceous vegetable were grown as intercrop. Similar findings were also reported by Oyedele *et al.* (2015) when the research conducted for productivity responses of spice and vegetable crops in Citrus juvenile orchard. Oyedele *et al.* (2015) reported that citrus scion girth was not significantly affected in the intercrop system.

#### **4.4.4 Stock: scion ratio**

The data on the effect of intercrops on the stock: scion ratio of mandarin are presented in Table 22. It is evident from table that plant stock: scion ratio mandarin was not affected by different intercrops at 4 MAS (at the time of harvesting) of intercrops. However, at the time of final harvest highest stock: scion ratio of mandarin was recorded in treatment with watermelon as intercrop.

**Table 22. Performance of mandarin (main crop) on stock scion ratio**

Treatment	Stock: scion ratio	
	At planting	4 MAS
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	1.29	1.44
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	1.15	1.06
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	1.27	1.05
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	1.26	1.16
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	1.35	1.17
T <sub>11</sub> (Mandarin sole)	1.30	1.17
'F' test	NS	NS
SE (m)±	0.26	0.22
CD at 5%	-	-

**4.4.5 No. of branches**

The data on the effect of intercrops on the number of branches of mandarin are presented in Table 23.

**Table 23. Performance of mandarin (main crop) on number of branches**

Treatment	No. of branches	
	At planting	4 MAS
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	25.78	27.84
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	25.64	27.07
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	24.22	25.03
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	24.48	26.15
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	24.11	25.89
T <sub>11</sub> (Mandarin sole)	25.00	27.47
'F' test	NS	NS
SE (m)±	0.50	0.60
CD at 5%	-	-

It is evident from table that number of branches of mandarin was not affected by different intercrops at 4 MAS (at the time of harvesting) of intercrops. However, at time of sowing highest number of branches of mandarin was recorded in treatment with watermelon, Similar trend was observed at 4 MAS at the time of final harvest of intercrop. These indicates that influence of intercrops were non significant with respect to number of branches mandarin.

#### 4.4.6 Canopy Spread (cm)

The data on the effect of intercrops on the canopy spread of mandarin are presented in Table 24. It is evident from table that canopy spread of mandarin was not affected by different intercrops at 4 MAS (at the time of harvesting) of intercrops. However, at time of sowing of intercrops and at 4MAS highest canopy spread of mandarin was recorded from treatment with cucumber.

**Table 24. Performance mandarin (main crop) on the canopy spread (cm)**

Treatment	Canopy spread (cm)	
	At planting	4 MAS
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	95.84	122.39
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	92.64	122.18
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	96.05	121.60
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	92.69	118.55
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	97.78	123.7
T <sub>11</sub> (Mandarin sole)	94.51	121.45
'F' test	NS	NS
SE (m)±	1.19	1.26
CD at 5%	-	-

Mandarin canopy spread was not significantly affected when cucurbitaceous vegetable were grown as intercrop. Similar findings were also reported by Oyedele *et al.* (2015) when the research conducted for

productivity responses of spice and vegetable crops in Citrus juvenile orchard. Oyedele *et al.* (2015) reported that citrus canopy spread was not significantly affected in the intercrop system.

#### 4.4.7 Canopy volume (m<sup>3</sup>)

The data on the effect of intercrops on canopy volume (m<sup>3</sup>) of mandarin are presented in Table. It is evident from table that canopy volume of mandarin was not affected by different intercrops 4 MAS (at the time of harvesting) of intercrops.

However, at time of harvesting of intercrops (i.e. 4MAS) highest canopy volume of mandarin was recorded from the treatment mandarin grown with intercrop of watermelon.

So also incremental volume of mandarin reflected non significant differences among the canopy volume of mandarin grown with different cucurbitaceous intercrops, however in incremental volume of mandarin (0.86 m<sup>3</sup>) was more when mandarin grown with watermelon as intercrop.

**Table 25 Performance of growth parameter of mandarin (main crop) on canopy volume (m<sup>3</sup>)**

Treatment	canopy volume (m <sup>3</sup> )		
	At planting	4 MAS	Increment
T <sub>6</sub> (Mandarin + Watermelon on raised bed)	0.57	1.43	0.86
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	0.58	1.26	0.70
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	0.60	1.22	0.63
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed)	0.75	1.47	0.72
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	0.61	1.26	0.64
T <sub>11</sub> (Mandarin sole)	0.72	1.43	0.71
'F' test	NS	NS	
SE (m)±	0.01	0.12	
CD at 5%	-	-	

#### 4.6 Economics

**Table 26 Net return, Gross monetary return, Cost of cultivation and B:C ratio**

<b>Treatment</b>	<b>Cost of Cultivation (Rs)</b>	<b>Gross Monetary Return (Rs)</b>	<b>NET RETURN (Rs)</b>	<b>B:C ratio</b>
T <sub>1</sub> (Watermelon sole crop on raised bed)	100147	336028	235881	3.36
T <sub>2</sub> (Muskmelon sole crop on raised bed)	97747	323684	225937	3.31
T <sub>3</sub> (Bitter gourd sole crop on raised bed)	106833	146340	39507	1.37
T <sub>4</sub> ( Ridge gourd sole crop on raised bed)	96833	151354	54521	1.56
T <sub>5</sub> (Cucumber sole crop on raised bed)	98433	195240	96807	1.98
T <sub>6</sub> (Mandarin + Watermelon on raised bed )	100147	385847	285700	3.85
T <sub>7</sub> (Mandarin + Muskmelon on raised bed)	97747	358511	260764	3.67
T <sub>8</sub> (Mandarin + Bitter gourd on raised bed)	106833	172200	65367	1.61
T <sub>9</sub> (Mandarin + Ridge gourd on raised bed )	96833	173068	76235	1.79
T <sub>10</sub> (Mandarin + Cucumber on raised bed)	98433	242484	144051	2.46

The Net return, Gross monetary return, Cost of cultivation and B:C ratio of present experiment are shown in Table 26. The data presented revealed that the best combination was, intercropping of watermelon in mandarin orchard. Intercropping of watermelon in mandarin orchard showed higher economic performance, that is highest net return (28,5700 Rs), gross monetary return (38,5847Rs) and B: C (3.85) ratio was among all the treatments. Intercropping of muskmelon in mandarin orchard found second best combination. Net return, Gross monetary return and B: C ratio in muskmelon- mandarin intercropping were 26,0764 Rs, 35,8511 Rs, 3.67 respectively.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### SUMMARY

The present investigation entitled, "Studies on intercropping of cucurbitaceous vegetables under high density planted mandarin orchard" was carried out during 2016-2017 at AICRP, Fruit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Randomized Block Design with eleven treatments and three replications with the following objectives

- 1) To study the growth, yield and quality performance of vine vegetables under high density planted mandarin orchard.
- 2) To find the most suitable and profitable intercropping system of vine vegetable

Observations were recorded in respect of growth parameters viz. length of vine, inter nodal length, stem girth, number of branches and leaf area. Yield parameters viz. node at which first female flower observed, days required for 50% flowering, sex ratio, days for fruit set, days required for first harvest, number of fruit, yield per vine, yield per plot and yield per hectare. Quality parameters viz. average weight of fruit, length of fruit, diameter of fruit, total soluble solid were also recorded.

Significantly the maximum growth parameters viz., length of vine in bitter gourd(295 cm), inter nodal length in ridge gourd(13.56), stem girth of muskmelon(0.88 cm), number of branches in watermelon( 6.80), leaf area in muskmelon(367 cm<sup>2</sup>) were recorded when grown as intercrop in mandarin. Maximum yield viz. number of fruit in cucumber (12.40), yield vine<sup>-1</sup> in watermelon (3.94 kg), yield plot<sup>-1</sup> in watermelon (55.12 kg) and yield in watermelon (3.94 kg) were recorded when grown as intercrop in mandarin. Maximum quality parameter viz. average weight of fruit in watermelon(2580 g), length of fruit in watermelon( 50.17), diameter of fruit in watermelon( 42.31), total soluble solid in muskmelon(12.20°Brix) were recorded when grown as intercrop in mandarin.

Minimum yield parameters viz. node at which first female flower observed in muskmelon (6.80) , days required for 50% flowering in watermelon (40.00 days), sex ratio in cucumber (9.90), days for fruit set in muskmelon (38.60 days), days required for harvest in cucumber (48.00 days )in present investigation.

Although the crop to crop variation for growth yield and quality were significant, however variation in growth, yield and quality attributes when cucurbitaceous crops viz. watermelon, muskmelon, bitter gourd, ridge gourd, cucumber were grown as intercrops in mandarin were compared with same crop grown as sole on raised beds were non significant for all the growth (Length of vine, inter nodal length, stem girth, number of branches and leaf area), yield (No. of node at which first female flower observed, days required for 50% flowering, sex ratio, days required for fruit set days required for first harvest, no of fruit plant<sup>-1</sup>, yield vine<sup>-1</sup>, yield plot<sup>-1</sup>, yield ha<sup>-1</sup> ),and quality parameters (Average weight of fruit, length of fruit, diameter of fruit ,TSS).

Similarly growth parameter viz. height of plant,Girth of scion, no. of branches. Girth of stock, Stock: scion ratio, canopy spread, canopy volume of mandarin differ significantly when grown with intercrop of vegetables as well as sole crop

The Net return, Gross monetary return, Cost of cultivation and B:C ratio of cucurbitaceous crops as sole crop and intercrop on raised bed gives the best combination of intercropping of watermelon in mandarin orchard. Intercropping of watermelon in mandarin orchard showed higher economic performance, highest net return (28,5700 Rs), gross monetary return (38,5847Rs) and B: C (3.85) ratio was among all the treatments. Intercropping of muskmelon in mandarin orchard found second best combination. Net return, Gross monetary return and B:C ratio in muskmelon- mandarin intercropping were 26,0764 Rs, 35,8511 Rs,3.67 respectively.

## Conclusions

The cucurbitaceous crops watermelon, muskmelon, bitter gourd, ridge gourd, cucumber were successfully grown as intercrop in mandarin planted on raised beds.

Which is evident from the non significant differences in growth parameters (length of vine, inter nodal length, stem girth no. of branches, leaf area) and yield parameter (Days required for first harvest, no. of fruits plant<sup>-1</sup>, yield vine<sup>-1</sup>, yield plot<sup>-1</sup>, yield ha<sup>-1</sup>) of watermelon, muskmelon, bitter gourd, ridge gourd, cucumber as intercrop on raised bed in mandarin versus the same cucurbitaceous crop as sole crop.

Similarly, the growth of main crop i.e. mandarin HDP on raised bed was not influenced at all by growing cucurbitaceous as intercrop, which is evident from growth comparison of mandarin grown with intercrop of watermelon, muskmelon, bitter gourd, ridge gourd, cucumber verses mandarin as sole crop on raised bed, had non significant values for the growth parameters.

However, the muskmelon followed by watermelon was found to be most economical cucurbitaceous intercrop in HDP mandarin as well as sole crop on raised bed.

The better performance of muskmelon and watermelon may be due to the crop growth are well acclimatized for the spreading on the ground surface which was provided on raised bed condition compared to the other cucurbitaceous crops viz. bitter gourd, ridge gourd and cucumber those largely requires support, which is not at all feasible under raised bed condition of high density planted mandarin.

This suggest watermelon followed by muskmelon are most suited as intercrop in HDP planted mandarin on raised beds.

The conclusion drawn are limited to the study however for the confirmation further replicated years study is necessary.

## CHAPTER VI

### LITERATURE CITED

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**Signature of Student**

## Appendix

Weeks	Dates	T MAX (°C)	T MIN (°C)	BSH (hrs)	WS (Km/hr)	RH I (%)	RH II (%)	Evap (mm)	RF (mm)	Rainy Days
		A	A	A	A	A	A	A	A	A
48	26-2 Dec	31.9	10.9	8.9	0.2	85	31	3.8	0.0	0.0
49	3-9	30.1	10.7	8.0	0.8	88	35	3.5	0.0	0.0
50	10-16	30.2	10.7	8.0	1.2	79	32	4.2	0.9	0.0
51	17-23	29.2	8.6	8.5	0.5	85	35	3.5	0.0	0.0
52	24-31	29.5	8.4	8.5	0.5	83	29	3.4	0.0	0.0
1	1-7 Jan	29.5	9.3	8.1	0.5	82	33	3.5	0.0	0.0
2	8-14	27.3	8.4	7.6	0.6	84	40	3.3	0.0	0.0
3	15-21	29.3	12.2	5.8	0.8	79	36	3.8	0.0	0.0
4	22-28	31.3	13.8	7.7	1.4	77	35	5.1	0.0	0.0
5	29-4 Feb	31.6	11.8	8.8	0.8	80	27	4.8	0.0	0.0
6	5-11	32.5	14.2	8.5	1.7	72	27	5.7	0.0	0.0
7	12-18	33.2	16.4	7.7	2.2	74	27	6.2	0.5	0.0
8	19-25	35.1	14.8	9.4	2.9	59	14	8.3	0.0	0.0
9	26-4 Mar	36.4	15.6	9.2	1.4	42	12	8.0	0.0	2.0
10	5-11	34.7	17.4	9.0	4.2	46	16	9.5	0.0	0.0
11	12-18	34.2	16.0	8.3	3.5	42	14	9.1	0.0	2.0
12	19-25	37.7	18.9	9.1	2.7	35	13	10.0	0.0	0.0
13	26-1 Apr	42.4	22.5	9.0	1.8	32	11	10.6	0.0	0.0
14	2-8 Apr	40.7	26.2	9.1	6.4	33	15	13.6	0.0	0.0
15	9-15	41.9	20.0	9.5	2.3	27	8	11.3	0.0	2.0
16	16-22	43.9	27.7	10.0	8.3	25	6	17.6	0.0	0.0
17	23-29	41.5	25.5	10.1	8.3	35	10	14.9	0.0	0.0
18	30-6 May	42.2	26.7	9.3	3.5	28	14	13.2	0.0	0.0
19	7-13	43.5	27.7	8.7	3.7	30	15	13.8	0.3	0.0
20	14-20	43.8	30.4	9.2	10.2	37	17	17.5	0.0	0.0
21	21-27	43.6	30.1	8.9	9.2	41	18	17.3	0.0	0.0
22	28-3 Jun	40.5	28.9	7.3	8.2	58	31	13.7	0.8	0.0
23	4-10	38.0	25.5	7.1	10.0	74	41	10.9	24.6	1.0