

**“EFFECT OF FERTILIZER AND ORGANIC MANURES ON  
PERFORMANCE OF CHANDRASUR (*Lepidium sativum* L.)  
UNDER *Acacia mangium* BASED MULTITIER AGROFORESTRY  
SYSTEM”**

**M. Sc. (FORESTRY) THESIS**

**By**

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COLLEGE OF AGRICULTURE  
INDIRA GANDHI KRISHI VISHWAVIDYALAYA  
RAIPUR (C. G.)**

**2020**

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SYSTEM”**

**Thesis**

**Submitted to the  
Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.)**

**By  
GORAKH DAS**

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COLLEGE OF AGRICULTURE, RAIPUR (CHHATTISGARH)

//CERTIFICATE - I//

This is to certify that the thesis entitled “**Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum L.*) under *Acacia mangium* based Multitier Agroforestry System**” submitted in partial fulfilment of the requirements for the degree of **Master of Science in Forestry** in the **Department of Forestry** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Mr. Gorakh Das** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.



**Chairman**

Advisory Committee

Date: 2/11/2020

**THEESIS APPROVED BY THE STUDENT’S ADVISORY COMMITTEE**

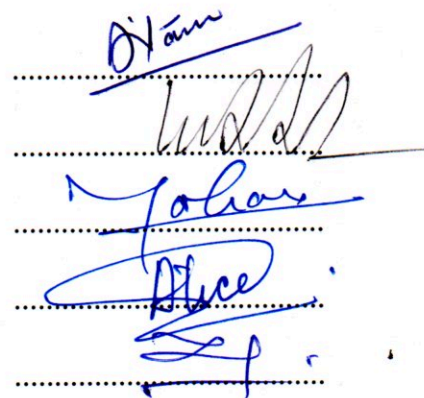
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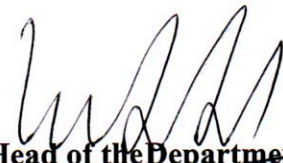


**//CERTIFICATE – II//**

This is to certify that the thesis entitled “**Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum L.*) under *Acacia mangium* based Multitier Agroforestry System**” submitted by Mr. **GORAKH DAS** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfilment of the requirements for the degree of **Master of Science in Forestry** in the **Department of Forestry** has been approved by the **external evaluator** and Student’s Advisory Committee after oral examination, **under the chairmanship of head of the Department/Dean (in case of out campii).**

*Atam*  
26.12.2020  
Major Advisor

**Smt Sarita Bodalkar**

  
Signature of Head of the Department

**Name – Dr. Lalji Singh**

**Date:**

**Faculty Dean :** .....

**Approved/Not approved**

**Director of the Instructions** .....

## **ACKNOWLEDGEMENT**

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Department of Forestry  
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**GORAKH DAS**

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## LIST OF NOTATIONS/ SYMBOLS

Notations	Description
%	Per cent
@	At the rate of
<sup>o</sup> C	Degree Celsius
&	And
CD	Critical difference
cm	Centimeter
DAS	Days after sowing
<i>et al.</i>	And co-worker/ and others
Etc.	So on
Fig.	Figure
gm	Gram
ha	hectare
<i>i.e.</i>	That is
kg	Kilogram
mm	Millimeter
m	Meter
q	Quintal
t	Tonne
<i>viz.,</i>	Namely
/	Per
N	Nitrogen
P	Phosphorus
K	Potassium
RBD	Randomized block design
RDF	Recommended dose of fertilizer
VC	Vermicompost
NC	Neem Cake
No.	Number

---

NS	Non significant
SEm±	Standard error of mean
ANOVA	Analysis of variance

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## THESIS ABSTRACT

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- a. **Title of the Thesis** : “Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System”
- b. **Full name of the Student** : Gorakh Das
- c. **Major Subject** : Forestry
- d. **Name and Address of the Major Advisor** : Smt. Sarita Bodalkar  
Department of Forestry, COA, Raipur (C.G.)
- e. **Degree to be Awarded** : Master of science in Forestry

Signature of the Student

Signature of Major Advisor

Date:

Signature of Head of the Department

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## ABSTRACT

A study entitled “Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System” was executed at herbal Garden at I.G.K.V., Raipur (C.G.) during Rabi season of 2018-19 . The trial was carried out under Multitier Agroforestry System in RBD (Randomized block design) with 8 treatments and 3 replications.

The growth parameters of Chandrasur viz., plant height, no. of branches, no. of leaves, collar diameter and post harvesting parameter viz., shoot and root biomass, seed yield, seed test weight were estimated by using RBD (Randomized block design). The outcome showed that the growth parameters of Chandrasur viz., plant


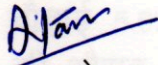
height ( 28.55 cm), no. of branches (9.36), no. of leaves (18.97) and collar diameter (1.42 cm) were recorded highest in treatment (T<sub>5</sub>) 1.5 ton/ha vermicompost combined with RDF @ 40:40:15 kg/ha NPK. The yield attributes viz., shoot and root biomass were found maximum in T<sub>5</sub> treatment, further maximum seed yield (7.71 q/ha) and seed test weight (1.74 gm) was recorded in treatment T<sub>5</sub> followed by T<sub>8</sub> ( RDF 50% + VC 25% + NC 25%), T<sub>6</sub> (RDF 50% + VC 50%), T<sub>7</sub> (VC 50% + NC 50%), T<sub>3</sub> (VC 100%), T<sub>4</sub> (NC 100%) and T<sub>2</sub> (RDF 100%) treatments. However, minimum plant growth and productivity was observed in treatment T<sub>1</sub> where no fertilizers were applied.

The results revealed that the average height of *Acacia mangium* tree varied from 15.02 m and 15.97 m before sowing of Chandrasur and after harvesting of crop respectively, the results showed that there was a minor difference in height increment in the tree after harvesting of crop. The results revealed that the average DBH varied from 25.07 cm and 25.95 cm before sowing and after harvesting of crop respectively. Average crown length and crown width of Mangium tree was recorded 4.31m and 5.63 m. The results revealed that the average tree height of Aonla varied from 7.50 m and 8.41m, DBH of 13.06 cm and 13.67 cm and average crown length and crown width was recorded 3.92 m and 5.28 m respectively. The results revealed that average tree height of Curry leaf varied from 3.50 m and 4.49 m, crown length and crown width 2.55 m and 3.17 m was recorded respectively.

In agroforestry long term cultivation of shade loving crop always gives economical viable system. From economical perspective it is found that Chandrasur under *Acacia mangium* gives maximum growth and seed yield with organic manure and proper fertilizer dose. So it is concluded that Chandrasur under *Acacia mangium* based multitier agroforestry system was more profitable by application of organic manure and fertilizer combination as compared to without fertilizer.

In future it is suggested while calculating the economics of multitier agroforestry system yield of crop as well as yield of trees will be taken into consideration.

## शोध ग्रंथ सारांश

(अ) शोध का शीर्षक :	“अकेशिया मैजियम आधारित बहुस्तरीय कृषि वानिकी प्रणाली के तहत चंद्रसूर (लेपिडियम सैटिवम एल.) के प्रदर्शन पर उर्वरक और जैविक खादों का प्रभाव”
(ब) विद्यार्थी का पूरा नाम :	गोरख दास
(स) प्रमुख विषय :	वानिकी विभाग
(द) प्रमुख सलाहकार का नाम व पता :	श्रीमती सरिता बोदलकर, (वैज्ञानिक) वानिकी विभाग, कृषि महाविद्यालय रायपुर (छत्तीसगढ़)
(इ) डिग्री से सम्मानित किया जाना है :	वानिकी स्नातकोत्तर
	
	छात्र के हस्ताक्षर
	
	मुख्य सलाहकार के हस्ताक्षर
दिनांक :	विभाग प्रमुख के हस्ताक्षर

## सारांश

वर्तमान अध्ययन “अकेशिया मैजियम आधारित बहुस्तरीय कृषि वानिकी प्रणाली के तहत चंद्रसूर (लेपिडियम सैटिवम एल.) के प्रदर्शन पर उर्वरक और जैविक खादों का प्रभाव” नामक एक अध्ययन रबी मौसम 2018-19 के दौरान इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छत्तीसगढ़) के हर्बल गार्डन में अध्ययन किया गया था। यह परीक्षण 8 उपचार और 3 प्रतिकृतियों के साथ आर.बी.डी. (रैंडमाइज्ड ब्लॉक डिजाइन) में बहुस्तरीय कृषि वानिकी प्रणाली के तहत किया गया था।

चंद्रसूर के वृद्धि मापदंडों अर्थात, पौधों की ऊंचाई, शाखाओं की संख्या, पत्तियों की संख्या, कॉलर व्यास और कटाई के बाद के मापदंडों अर्थात शूट और रूट बायोमास, बीज उपज, बीज वजन परीक्षण का अनुमान आर.बी.डी. (रैंडमाइज्ड

ब्लॉक डिजाइन) का उपयोग करके किया गया था। परिणाम से पता चला है कि चंद्रसूर के वृद्धि मापदंडों अर्थात्, पौधों की ऊंचाई (28.55 सेमी), शाखाओं की संख्या (9.36), पत्तियों की संख्या (18.97) और कॉलर व्यास (1.42 सेमी) उपचार टी<sub>5</sub> (1.5 टन/हेक्टेयर वर्मीकम्पोस्ट के साथ संयुक्त आर.डी.एफ. 40:40:15 किलोग्राम/हेक्टेयर एन.पी.के.) में सबसे अधिक दर्ज की गई। उपज गुण अर्थात्, शूट और रूट बायोमास टी<sub>5</sub> उपचार में अधिकतम पाए गए इसके अलावा अधिकतम बीज उपज (7.71क्विंटल/हेक्टेयर) और बीज वजन परीक्षण (1.74ग्राम) उपचार टी<sub>5</sub> में दर्ज किया गया था और इसके पश्चात क्रमशः टी<sub>8</sub> (आर.डी.एफ. 50% + वर्मीकम्पोस्ट 25% + नीम खली 25%), टी<sub>6</sub> (आर.डी.एफ. 50% + नीम खली 50%), टी<sub>7</sub> (वर्मीकम्पोस्ट 50% + नीम खली 50%), टी<sub>3</sub> (वर्मीकम्पोस्ट 100%), टी<sub>4</sub> (नीम खली 100%), टी<sub>2</sub> (आर.डी.एफ. 100%) उपचार में पाया गया, हालांकि उपचार टी<sub>1</sub> में न्यूनतम पौधों की वृद्धि और उत्पादकता देखी गई जहाँ कोई उर्वरक उपयोग नहीं किया गया था।

परिणामों से पता चला है कि चंद्रसूर की बुवाई से पहले अकेशिया मैजियम के पेड़ की औसत ऊंचाई क्रमशः 15.02 मीटर और 15.97 मीटर से भिन्न थी और फसल की कटाई के बाद परिणामों से पता चला कि फसल की कटाई के बाद पेड़ की ऊंचाई वृद्धि में न्यूनतम अंतर था। विविध परिणामों से पता चला है कि औसत डी.बी.एच. 25.07 सेमी और 25.95 सेमी क्रमशः फसल लगने से पहले और फसल की कटाई के बाद थी। अकेशिया मैजियम पेड़ की औसत मुकुट लंबाई 4.31 मीटर और मुकुट चौड़ाई 5.63 मीटर दर्ज की गई थी। परिणामों से पता चला है कि आँवला पेड़ की औसत ऊंचाई 7.50 मीटर और 8.41 मीटर, डी.बी.एच. 13.06 सेमी और 13.67 सेमी क्रमशः फसल लगने से पहले और फसल की कटाई के बाद तथा औसत मुकुट की लंबाई 3.92 मीटर और मुकुट की चौड़ाई 5.28 मीटर दर्ज की गई थी। परिणामों से पता चला है कि मीठा नीम की औसत पेड़ की ऊंचाई 3.50 मीटर और 4.49 मीटर क्रमशः फसल लगने से पहले और फसल की कटाई के बाद तथा मुकुट की लंबाई 2.55 मीटर और मुकुट की चौड़ाई 3.17 मीटर दर्ज की गई।

कृषि वानिकी में छाया पसंद फसल की दीर्घकालिक खेती हमेशा किफायती नजरिये से यह पाया गया है कि अकेशिया मैजियम के अंतर्गत चंद्रसूर जैविक खाद और उचित उर्वरक मात्रा के साथ अधिकतम वृद्धि एवं बीज उपज देता है। इसलिए यह निष्कर्ष निकाला गया है कि अकेशिया मैजियम आधारित बहुस्तरीय कृषिवानिकी प्रणाली के तहत चंद्रसूर बिना उर्वरक की तुलना में जैविक खाद और उर्वरक के अनुशंसित मात्रा के अनुप्रयोग से अधिक लाभदायक था।

भविष्य में यह सुझाव दिया जाता है कि फसल की बहुस्तरीय कृषि वानिकी प्रणाली उपज की अर्थशास्त्र की गणना में फसल के साथ - साथ पेड़ों की उपज को भी साथ में लिया जायें

# CHAPTER-I

## INTRODUCTION

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India's diverse agro climatic condition and topography have a large number of medicinal plant species. The herbal wealth is about 5000 species known aromatic and medicinal plants used in different systems of Indian medicine. Siddha, Unani Ayurveda and from time immemorial.

Cultivation of medicinal plants has assumed higher importance in the changing world scenario because of the tremendous potential in the health care provision of world's population. MAPs are important from several perspectives like preventive and curative treatments and are source of income to underprivileged or aboriginal people who collect these herbal plants from forests or cultivate on their field. The expanding demand of restorative plants items is abundantly felt by the people and the diversified agro-climate of India is a boon for cultivation and is rightly called the botanical garden of the world. India being one of the 12 mega diversity centres in the world, with its bio-resource wealth, it ranks 10<sup>th</sup> in the World and 4<sup>th</sup> in Asia having 15 to 20 thousand plants species with medicinal values of which 30 percent are considered as endemic to India. About 960 species of medicinal plants are estimated to be in all India trade of which 178 species have annual consumption level in excess of 100 metric tonnes. (Marichamy *et al*, 2014).

Within conventional and alternative healthcare systems, there is an international renaissance resulting within world herbal trade at US\$ 120 billion, expected to reach US\$ 7 trillion by 2050. India's share of medicinal plants and goods on the world market is just 2.5 per cent. It is estimated that the Indian market is 550 crores per year.

In India, with an annual production of 605000 million tons (Anon 2011), the medicinal and aromatic cultivated over an area of 510000 million hectares. The *sativum* genus is native to Ethiopia and introduced to Europe, Asia and the United States. In India, its cultivation is spread across the states of Rajasthan, Madhya Pradesh, Uttar Pradesh, Gujarat, and Maharashtra in an area of approximately 5,000 hectares (Choudhary *et.al*, 2010). It is traditionally grown in northern central Gujarat, Kutch, Gujarat, and some part of the district of Bharuch in Gujarat

Chandrasur (*Lepidium sativum* L.) is popularly known as Ariya, Hali, Sialoo, Asaliyo, and Halim in local, Chandrasur in Sanskrit, an annual herb of the winter season belongs to the family Brassicaceae, botanically linked to mustard, sharing similar tangy aroma and flavor. The upper part of the plant has a lot of branches. The white to pink flowers, clustered in branched racemes, are only 2 mm wide. The leaves are lobbed or pinnate entirely or differently. Pods (silique) are beak-like structures on a single plant, varying from few to thousand.

In general, unfavorable climatic conditions such as low rainfall and variations in temperature are accepted. It has medicinal properties like antiscorbutic, depurative and stimulant. Chandrasur leaves have the following compositions: moisture (82.3%), protein (5.8%), fat (1.0%), carbohydrate (8.7%), mineral matter (2.2%), nickel (40 µg / kg), vitamin A, 3.300IU; riboflavin, 0.15mg calcium (0.36%) cobalt (12 µg / kg), iodine (110 µg / kg), vitamins (cooked leaves) and phosphorous (0.11%); trace elements: iron (28.6 mg/100 g. (anon1962).

Chandrasur seeds are primarily used in medicine preparation, but there are also therapeutic qualities for roots and leaves. Mucilage in the seed coat is used to treat diarrhoea and dysentery inflammation of the mucous membrane of the intestine (Maiti, 2008) Unlike sinapic acid ethyl ester, an alkaloid 'Lepidine' is also isolated from seeds (Herbalcure, 2008). In Northern part of India it is frequently used as a good preventive measure against the chronic diseases. Leaves are used for salad or cooked as vegetables. These are effective sprain and leprosy poultices, diarrhoea, splenomegal skin diseases, dysentery, asthma (Nayak *et al.*, 2009).

It is estimated that the total area under Chandrasur crop in India is around 8450 hectare. In spite of higher medicinal values and skyrocketing market price of the seeds of this crop, the average productivity at present is very less (320 kg/ha), mainly on account of lack of appropriate agrotechniques, which require immediate scientists attention, policy makers and of course farmers. It is an established fact that growth and development of *Lepidium sativum*, apart from being governed by genetic factors, depend largely on a number of external factors, of which climate and agronomical culture, particularly optimum dates of sowing and suitable irrigations schedules are basic important.

**Multitire Agroforestry System** – Multitier or multistoried cropping is an agroforestry system of growing together the crops of different height at the same time on the same piece of land thus using lands, water and space most efficiently and economically. Multitier agroforestry system aims at intercepting maximum possible solar radiation and producing maximum dry matter per unit area (Anonymous 2014). This system is prevalent in areas receiving high rainfall viz. Eastern and Western Ghats mountainous ranges of India. Integration of remunerative horticulture or forest trees along with profitable agricultural crop forms potential alternatives in comparison to traditional monocropping system of millets. Short-cycle perennial vegetable trees suit more to tribal farmers of the region. Because of poverty and lack of alternative livelihood as tribal farmers believe in short-term gains from labour and capital investments made in the small land holdings.

Chandrasur is commonly known as garden cress (*Lepidium sativum*) is an edible underutilized medicinal plant belonging to family Cruciferae. Height of Chandrasur is 45-50 cm in India, the southern area is especially involves in the commercial production of Chandrasur. In India, it is grown mainly in UP, MP, Rajasthan, Gujarat and Maharashtra. Apart from India, it is also cultivated in North America and part of Europe (Gokaviet al. 2004). Seed, leaves and roots are the economic parts of this crop. However, the crop is mainly cultivated for seed in India. The seed are known to contain a light yellow coloured fixed oil and alkaloids such as lepidin, glucotropeolin, besides sinapin and sinapic acid.

Mandal *et al.* (2008) stated that *Lepidium sativum* dry seed is used as feed additive. Traditional sweets for lactating mothers are prepared from the seeds. The seeds of Chandrasur are used to manufacture ayurvedic medicines. Chandrasur seeds are good source to enhance the milk percentage in cattle as well as in nursing mothers. Fresh leaves and young seedlings are mainly used as spice and are rich source of glucosinolates and also used as salads. Roots are bitter, acrid and are useful in treatment of secondary syphilis. Seed kheer- seed are boiled with datepalm and milk eaten upto 6 month help to increase human height.

## Component of Multitier system-

**Mangium-** *Acacia mangium* is a fast-growing tree species belonging to the family Leguminosae is an important multipurpose and nitrogen fixing tree species for low lands and one of major fast growing species used in Agroforestry system. This tree has increasingly important role in efforts to sustainable supply of tree products viz., timber, poles etc., while reducing the pressure on natural ecosystem. *A. mangium* is a popular species for shade loving crop like Bach, Pachauli, Ban tulusi, Lemon grass, Khus grass.

**Aonla (*Emblica officinalis*)** belonging to the family Euphorbiaceae. It is a small or middle – sized deciduous tree. It is a very rich source of vitamin C and is valuable in disease caused by deficiency of vitamin C, like scurvy. **Aonla** tree is quite fast growing type. However, *in* initial 3 to 4 years sufficient space is available which could be, advantageously used for raising intercrops. Vegetables, flowers and a few medicinal / aromatic plants are well suited for intercropping in Aonla orchards.

The **Curry leaf tree (*Murraya koenigii*)**- is a tropical to sub-tropical tree in the family Rutaceae, which is native to India and Sri Lanka. Its leaves are used in many dishes in India.

The plant has uses in soap making, body lotions, potpourri, scent, air fresheners, body fragrance, perfume, bath and massage oils, aromatherapy, towel scenting, spas and health clinics, incense, facial steams or hair treatments. In multitier system tallest components have foliage of strong light and high evaporatives demands and shorter components with foliage requiring shade and or relatively high humidity.

The main characters of Chandrasur is that it can grow in any types of climate and soil condition, Chandrasur is a shade loving crop keeping the above fact in view, the present investigation entitled “**Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System**” will be carried out during *Rabi* season of 2018-19 at the Herbal Garden , I.G.K.V., Raipur (C.G.) with the following objectives.

1. To evaluate the effect of inorganic fertilizer and organic manure on growth and yield of Chandrasur.
2. To study the growth performance of Chandrasur under *Acacia mangium* based Silvi-agriculture system.
3. To study the interaction between *Acacia mangium* and Chandrasur (*Lepidium sativum* L.).

## CHAPTER-II

### REVIEW OF LITERATURE

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An attempt was made in this chapter to review findings on agroforestry practices with special focus on medicinal crops in association with trees, since there is very little literature on (*Lepidium sativum* L.) known as Chandrasur. Therefore, studies have been integrated into this chapter on the associated Multitier Agroforestry System. In the following headings, the literature has been reviewed:

1. To evaluate the effect of inorganic fertilizer and organic manure on growth and yield of Chandrasur.
2. To study the growth performance of Chandrasur under *Acacia mangium* based Silvi-agriculture system.
3. To study the interaction between *Acacia mangium* and Chandrasur (*Lepidium sativum* L.).

#### **To evaluate the effect of inorganic fertilizer and organic manure on growth and yield of Chandrasur:**

Maheshwari *et al.*, (1992) obtained higher production of biomass and oil by planting palmarosa at 30 x 30 cm spacing and fertilized with 25-50 kg N/ha in shallow clay loam soil of average fertility. The oil and geraniol did not respond to spatial arrangement and N levels.

Katiyar *et al.* (1999) studied the response of the annual and biennial turmeric crop (*Curcuma longa* L.) to the application of N and P under the intercropping system with poplar on sodium soils. The crop performed well under the partial shade of 6-9 years of poplar planted. The biennial crop yielded 2.5 times more than 10.6 tones ha<sup>-1</sup> obtained from the annual harvest by increasing the doses of nitrogen, encouraging vegetative growth, resulting in maximum plant height, leaf area and no. of tillers per plant. The results showed that 90 kg N and 60 kg P per hectare were useful for obtaining maximum yield of fresh rhizomes from biennial and annual harvests.

Tiwari and Kulmi (2004) studied the effect of nitrogen and phosphorus on chandrasur, They reported that increased levels of nitrogen and phosphorus from 0 to 60 kg / ha showed significantly higher crop and seed yield growth rates. The use of nitrogen at 60 kg ha<sup>-1</sup> and phosphorus at 60 kg ha<sup>-1</sup> increased the seed yield by 30,28 k percent and 32,61 percent respectively, with a net return of Rs. 8824 and 8696 ha<sup>-1</sup> and a gain cost ratio of 1,02 and 0,98 with 60 kg N and 60 kg P<sub>2</sub>O<sub>5</sub> / ha respectively.

Meshram, S. and Prajapati, R.K. (2005) studied that growth characters of chandrasur viz., plant height, number of leaves, collar diameter, shoot and root biomass were found maximum in T2 (6t FYM + N18+ P46)/ha Additionally, the highest seed yield (8.14 q / ha) was recorded in T2 treatment, while the minimum (5.40 q / ha) was recorded in T5 treatment where no fertilizer except FYM was used.

Santosh et al. (2010), Gupta (2006) studied the increase in plant height, number of branches, number of leaves and dry matter production per hectare was observed in Chandrasur with an increase in fertilizer dose. Maximum plant height (78.60 cm), number of branches (17.04), number of leaves at 50 DAS (49.41), dry matter production (12.00 t/ha) were recorded with the application of 80:80:30 kg of NPK/ha.

Thakur et al. (2009) studies that the significant enhancement in the height and collar girth of the tree varying from 10% to 21% over the sole tree. Fruit weight, fruit size and pulp weight improved significantly due to growing of turmeric as intercrop under the aonla orchard.

Choudhary et al. (2012) studied an sufficient dose of ashwagandha organic manure and fertilizers. Treatment consists of nitrogen (N) and phosphatic (P) fertilisers at 20 kg ha<sup>-1</sup> and 40 kg ha<sup>-1</sup> respectively, and, along with control, two levels of manure from the farm yard (FYM) and Vermicompost and their combinations. In Randomized Block Design, the treatments were repeated thrice. Results showed that the application of 40 kg ha<sup>-1</sup> of N and P as urea and SSP + 2.5 t ha<sup>-1</sup> per Vermicompost reported significant values for plant height, number of branches per plant, leaf area, yield attributing characteristics, root (8.60 q ha<sup>-1</sup>) and seed yield (85.6 kg ha<sup>-1</sup>) as well as soil physical characteristics such as organic carbon, hydraulic conductivity and retention of water at 33 and 1500 kpa in addition to the highest B:C ratio (2.57).

Patil et al. (2012) studied the growth and nutrient statuses of *A. esculentus* are influenced by organic and inorganic fertilizers. *A. esculentus* (okra plant) has been examined. In the life cycle of the okra plant, observations of physical parameters such as plant height, number of leaves and stem circumference were reported at four significant growth stages. Leaf chlorophyll, fresh and dry plant / pod weight and protein, fat and carbohydrate content were estimated to be 72 DAS (days after sowing) in the okra fruit. Various fertilizer combinations, such as Vermicompost (VC), Chemical Fertilizer (CF) and Farmyard Manure (FYM), were prepared and applied for the experiment. T1 = Power, T2 = (FYM 100 percent), T3 = (VC 100 percent), T4 = (CF 100 percent), T5 = (VC 75 percent + CF 25 percent), T6 = (VC 75 percent + FYM 25 percent), T7 = (VC 50 percent + FYM 50 percent) and T8 = (VC 50 percent + CF 50 percent) were the preparatory plots. The nutrient requirement for okra crops was 67 kg / ha of nitrogen, 470 kg / ha of phosphorus and 63 kg / ha of potassium in the experimental field soil. The analysis of the data showed that the physical characteristics of plants were improved with the use of inorganic fertilisers compared to other treatments, whereas the maximum nutrient status of okra fruit was reported in treatment T3 (VC 100%) and followed by T6 (VC 75% + FYM 25%). While treatment T4 showed a high potential for rapid plant growth, treatment T5 (VC 75 percent + CF 25 percent) showed comparatively similar results for plant growth. The mixture of organic fertiliser and inorganic fertiliser is therefore advantageous for the physical growth of the okra plant, while the nutrient content of the okra fruit depends only on the dose of organic fertilizer.

Lokesh C. and Prajapati, R. K. (2017) revealed that the morphological characters of Muskdana viz., plant height, number of leaves and collar diameter were recorded maximum in vermicompost 100% (T<sub>2</sub>) treatment. Further the highest number of capsules/plant (22.37), number of seed/capsules (110.33), seed test weight (1.78 gm), seed yield (10.04 q/ha) was recorded in T<sub>2</sub> treatment 100% vermicompost @ 10 ton/ha was applied which is superior value among other treatments.

Saraswathi, G. and Vidya, K.M. (2013) studied that maximum plant height, higher number of branches and leaves, higher output of dry matter per hectare, maximum seed yield per plant and seed yield per hectare were recorded when the garden cress was sown on 1 November and delivered 80:80:30 kg of NPK / ha (D2F4) to the northern dry zone of Karnataka.

Meshram (2005) studied the growth and productivity of Chandrasur (*Lepidium sativum* L.) under the MPTs-based silvi-agriculture system during the 2004-05 Rabi season in research farm, Department of Forestry, IGAU, Raipur (C.G.). On 12.08.1997, MPTs (*D. sissoo*, *A. procera*, *M. oleiofera*, *M. indica*) were planted in vertisole soil. The impact of natural, inorganic composts and green manure on single crops and intercrops under different MPTs has been studied. The experiment was set out in Randomized Block Design with five treatment and four replications, under MPTs and without tree (control). The outcomes indicated that the highest plant height, numbers of leaves, collar diameter, shoot and root biomass of chandrasur were found maximum under *D. sissoo* and minimum under *M. indica*. *D. sissoo* under seed yield was discovered higher. Yield of seeds established in following orders *D. sissoo* (8.14 q ha<sup>-1</sup>) > *A. procera* (7.98 q ha<sup>-1</sup>) > *M. oleiofera* (6.29 q ha<sup>-1</sup>) > control treatment (6.00 q ha<sup>-1</sup>) > *M. indica* (5.34 q ha<sup>-1</sup>). Improvement attributes of chandrasur viz. , plant height, number of leaves, collar diameter, shoot and root biomass were obtained to be the higher for T2 treatment, further maximum seed yield (8.14 q ha<sup>-1</sup>) was accounted for T2 treatment, while the minimum (5.40 q ha<sup>-1</sup>) was accounted for T5 treatment where no fertilizer aside from FYM was applied. The highest collection of supplements (N, P and K) was discovered (0.53 % N, 0.17 % P and 1.86 % K) in plant shoots intercropped under *D. sissoo* was recorded and the base was recorded under *M. indica* (0.43%N, 0.12% P, and 1.56% K). The supplement collection in the harvest was additionally essentially affected by fertilizer treatments. Maximum supplement gathering (N, P and K) was found in grown crop shoots with T2 treatment, while the minimum was found in T5-treated yield shoots.

Panwar and wani (2014) conducted the field experiments at the forest nursery and research centre, College of Forestry, Allahabad Agriculture Institute, Deemed University, Allahabad, on the growth and productivity of *Ipomoea batatas* under the poplar-based agroforestry system during the kharif seasons of 2012-14. The experiment was laid out in shade condition (under trees) with 7 replicated thrice in randomized block design treatment. For the analysis, a sweet potato variety known as Pusa Red was used. The of 15 cm long vine cutting with 4-6 nodes of the Pusa Red variety of sweet potato was planted 45cm × 60cm apart. The 15 cm long vine cutting with 4-6 nodes of the Pusa Red variety of sweet potato was planted 45 cm x 60 cm apart. In the form of organic manure, nitrogen, potash, and phosphorus were added to

farm yard manure, vermicompost, and neem cake. Highest survival percent, vine duration, number of branches / vine, shoot fresh weight, shoot dry weight, tuber yield / plot, number of tuber per plot under poplar trees were reported in T3 (Vermicompost).

Lokesh, C., and Prajapati, R. K. (2018) studied the observations regarding morphological growth characters viz., plant height, number of leaves, collar diameter and number of branch. Yield attributes viz., seed yield plant<sup>-1</sup>, weight of the seed test and hectare of seed yield<sup>-1</sup> were tabulated using randomized block design and statistically analysed. The results showed that the morphological characteristics of Chandrasur viz., plant height (49.33 cm.), collar diameter (1.94 cm) number of leaves (30.33) and number of branches (14.33) were reported as a maximum of 3 tonnes of vermicompost with 18, 46 kg of NP ha<sup>-1</sup> in treatment (T7). Furthermore, the highest seed yield / plant (2.33 gm), seed test weight (1.94 gm) and seed yield (7.23 q / ha) were reported in (T7) 3 tonne vermicompost combination treatment with 18, 46 kg NP ha<sup>-1</sup> was used, which among other treatments is higher. In treatment T8 (control) Chandrasur, however, minimum plant growth and productivity were observed without intercropping as a sole crop.

### **To study the growth performance of Chandrasur under *Acacia mangium* based Silvi-agriculture System**

Singh *et al.* (1985) reported to have decreased herbage and oil yields of intercropped mentha species under tarai conditions in Uttar Pradesh compared to their pure cropping in the second and third years of poplar growth and that off *Cymbopogon sp.* In all of the three years of study, it remained similarly economical. Since *Mentha sp.* needed bright sunshine for essential oil synthesis and growth, this reduction has been attributed to shading effect of the tree.

Attared, S. B. *et al.* (2012) the data revealed that with the use of inorganic fertilizers plants physical characteristics were enhanced compared to other treatments, Where as nutrient status of okra fruit was recorded maximum in treatment T<sub>3</sub> (VC 100%) and followed by T<sub>6</sub> ( VC 75% + FYM 25%). Although, treatment T<sub>4</sub> has shown high potential for rapid growth of plant comparatively similar results in the growth of plant were observed in treatment T<sub>5</sub> (VC 75% + CF 25%).

Chauhan *et al.* (1997) studied the exhibition of lemon grass, *Citronella java*, palmarosa and Japanese mint in Eucalyptus plantation. They detailed that Eucalyptus growth regarding height and diameter improved with the intercrops production. Among the intercrops, herb and oil yield were least if there should arise an occurrence of lemon grass, while oil yield was most elevated in the event of *Citronella java* and halfway in palmarosa. Herb and oil yield of lemongrass didn't diminish with increment in the age of trees, while oil yield in citronella and palmarosa diminished with increment in the age of trees after third year when contrasted with sole harvest. Execution of lemongrass was seen to be the best concerning supported herb and oil profitability during whole growth period.

Nayak *et al.* (2014) studied Economics and yield production under the agrisilvicultural system of some short-lived fruit and medicinal crops in the rainfed uplands of Odisha. The agri-silvicultural system consisting of two forestry species, viz. *Acacia mangium* (Mangium) and *Gmelina arborea* (Gamhar) were planted 8 m x 2 m apart in 2000 and four agricultural crops, namely. In the 1st week of July 2011, *Ananas comosus* (Pineapple), *Aloe vera* (Aloevera), *Andrographis paniculata* (Kalmegh) and *Curcuma amada* (Mango ginger) were raised. Mangium with pineapple ( $16.53 \text{ m}^3 \text{ ha}^{-1}$ ) achieved the highest volume rise. The maximum fruit yield of  $9981 \text{ Kg} / \text{ha}^{-1}$  under Mangium and the minimum under Gamhar ( $9106 \text{ Kg} / \text{ha}^{-1}$ ) was also reported for pineapple. Aloevera ( $8635 \text{ Kg} / \text{ha}^{-1}$ ) fresh leave yield was maximal Under Mangium, which is statistically equivalent to Gamhar. However, under open conditions, Kalmegh registered a maximum dry plant yield of  $1239 \text{ Kg} / \text{ha}^{-1}$ , followed by  $1072 \text{ Kg} / \text{ha}^{-1}$  under Gamhar and  $823 \text{ Kg} / \text{ha}^{-1}$  under Mangium, similarly, under open conditions, mango ginger displayed a maximum rhizome yield of  $3300 \text{ Kg} / \text{ha}^{-1}$  followed by  $1979 \text{ Kg} / \text{ha}^{-1}$  under Gamhar in and  $1597 \text{ Kg} / \text{ha}^{-1}$  under Mangium the both trees open conditions, the crop yield pattern was: Pineapple > Aloevera > Mango ginger > Kalmegh. Compared to other agri-silvicultural systems and single crops, *A. mangium* with a pineapple-based agrisilvicultural system showed the highest gross return, net return and BCR.

Muni Ram *et al.* (1999) reported that Patchouli when intercropped with papaya transplanted at 2 m x 2 m plant spacing, improved the oil yield by 76 per cent and the quality of oil by 8-11 per cent over its sole crop. The intercropping of patchouli with papaya (2 m x 1 m) increased the economic return by Rs. 25,480 over

sole crop of papaya. Intercropping of patchouli with papaya is recommended to derive maximum monetary advantage and to make efficient utilization of crop growth resources.

Patil *et al.* (2011-12) conducted an experiment to evaluate the expansion and productivity of *A. mangium* clones at the main agricultural research station, UAS, Dharwad, in depleted red soil during 2002. The analysis consisted of five genotypes of *A. mangium* viz., *A. mangium* SV-40 hybrid, *A. mangium*, A. Good spring, A. Clone (seed) hybrid and with four replications; the hybrid (root) was planted in RBD. He observed, height and diameter at breast height were significantly superior in *A. mangium* hybrid SV - 40 genotype (10.30 m and 24.18 cm respectively) as compared to the others. The present annual and mean annual increments in height (0.90 cm and 1.29 cm respectively) and in diameter were higher at Breast height (2.58 cm and 3.02 cm respectively). Compared to the other genotype of *A. mangium* hybrid SV-40 With *A. mangium*.

### **To study the interaction between *Acacia mangium* and Chandrasur (*Lepidium sativum* L.):**

Patil *et al.*, (1994) reported that the height and diameter increases with the availability of nutrient and moisture. In clonal orchard up to 8 years growth of the mangium trees take water and nutrient from the soil and growth was better as compare with the trees in the well maintained clonal orchard.

Maheswarappa *et al.* (1998) studied the *Kaempferia galangal*, traditionally intercropped in mature coconut gardens in Kerala, India and intercropping of this species in a 30 year-old coconut plantation produced 6.1 Mg ha<sup>-1</sup> of rhizomes compared with 4.8 Mg ha<sup>-1</sup> as a sole crop.

Gangadharan and Menon (2003) studied the performance of three Kacholam (*Kaempferia galanga*) ecotype, which are grown as intercrop in a coconut plantations providing 50 and 70 per cent shade, with the soil loosened to two depths viz. 10 cm and 20 cm. They observed that rhizome yield was favoured by shallower depth of soil loosening and higher light intensity, while essential oil content was promoted by deeper soil loosening and highly Shaded situations.

Gosh *et al.* (2007) studies divulged that the regular water and nutrient management followed for medicinal and aromatic crops in addition to recommended management practices for fruit crops favoured improvement in soil nutrient status and nutrient uptake by coconut.

Prajapati *et al.* (2007) studied intercropping of patchouli under *Gmelina arborea* based Agroforestry system the intercropped field is always provide suitable climatic conditions and residual nutrient availability for the tree crop for better growth.

Manjunath *et al.* (2002) revealed that Patchouli intercropped under the Agroforestry system produced 100 percent vermi compost (60.15 kg/ha and 38.35 kg/ha) maximum oil yield in treatment at first and second harvests. However, the minimum oil yield reported for Patchouli under open condition was (27.72 kg/ha and 10.61 kg/ha) in control treatment. Suvera *et al.*, 2015 reported that elevated oil recovery from *O. sanctum*. Due to better soil nutrient status and the positive impact of tree shadow, *O. sanctum* under Silvi-medicinal may have resulted.

Thakur *et al.* (2009) reported significant impacts on essential oil recovery from have also been recorded and grown under Peach, Grewia, and Morus based on Agroforestry system. Vermicompost acts as a chelating agent and regulates the availability of micronutrients to plants, thereby resulting in increased growth and yield by providing nutrients in available form. Among the organic sources, vermicompost performed better than other organic fertilizer. Vermicompost can have very good effects upon germination, growth, flowering, fruiting and yield of most of the crops, particularly fruits and vegetables.

## CHAPTE-III

### MATERIALS ANDS METHODS

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The present investigation on “**Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System**” was carried out during Rabi season of 2018-19 at the herbal garden, Indira Gandhi Krishi Vishwavidhayalaya, Raipur. The details about the experimental site, materials and methodology used for the study are discussed in this chapter.

#### **3.1 Location and Experimental site**

The Raipur experimental site is situated in the south-eastern part of Chhattisgarh. The location of the experimental site is Herbal Garden Indira Gandhi Krishi Vishwavidyalaya, Raipur.

#### **3.2 Geographical situation**

Raipur (Chhattisgarh) It is located at 21°4 ' N latitude and 81 °39 ' E longitude at an altitude of 298 meters above sea level with sub-humid climate.

#### **3.3 Climate Conditions**

The climate of Raipur region is sub humid with hot and dry summer and mild winter. It comes under the Chhattisgarh plains agro-climatic sub zone of seventh agro climatic region of India. The average annual rainfall is about 1320 mm, of which about 88 % is received during a span of four months i.e. between June to September. The rainfall is largely contributed by south-west monsoon. The maximum temperature raise up to 45 °C during summer and minimum temperature falls to 5-6 °C during winter season. The relative humidity reaches maximum 93 % and minimum 41 % in August and March, respectively

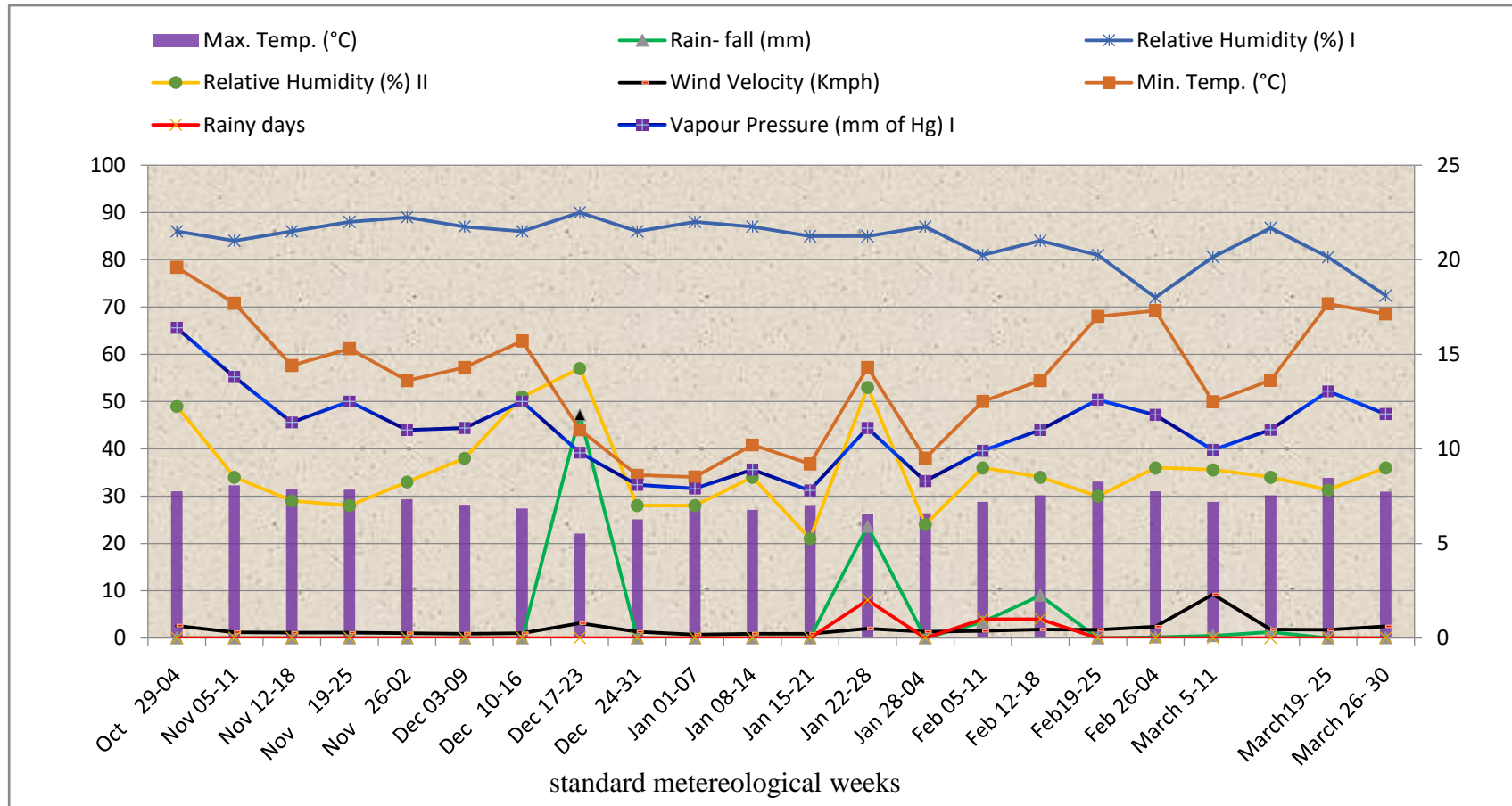
#### **3.4 Weather condition during crop period**

The meteorological data of rainfall, temperature, sunshine hour, relative humidity, vapour pressure, and wind velocity during crop period from October to March 2019 is presented in fig. 3.1 and appendix I. Maximum temperature ranges from 22.1 °C in third week of December to 33.9 °C in third week of March and minimum temperature ranges from 19.6°C in fourth week of October to 8.5 °C in first week of January. Relative humidity throughout the crop season ranges between 72 to 90 per cent at morning and 21 to 57 per cent at evening hours, whereas sunshine hour ranges from 1.2

to 9.3 hours. Vapour pressure varied from 7.8 to 16.4 mm Hg at morning and 5.4 to 14.8 mm Hg at evening and wind velocity varied from 1 to 9.2 Km/h.

### **3.5 Physico –Chemical properties of experimental site**

The soil of Raipur belongs to four different orders viz. entisols, vertisols, inceptisols and alfisols. The black clayey soil of the experimental field belongs to the order vertisols and is locally known as Kanhar. Kanhar soils are characterized by fine texture, sticky nature, angular blocky structures, low to medium nitrogen, high potassium and low to medium phosphorus status with low organic matter. The chemical properties of soil before sowing and after harvesting of Chandrasur was analyzed and presented in Table 3.1.



**Fig 3.1:** weekly meteorological observations during crop growth period (29 october 2018 to 30 march 2019)

**Table 3.1: Physico-chemical properties of the experimental site**

No	Particulars	Values	Rating	Methods used
<b>A.</b>	<b>Physical-mechanical composition</b>			
1	Sand (%)	20.54		International pipette method (Black, 1965)
2	Silt (%)	35.29		-
3	Clay (%)	44.10		-
4	Textured class	Clayey		-
5	Bulk density (g cm <sup>-3</sup> )	1.35		Soil core method (Black, 1965)
<b>B.</b>	<b>Chemical composition</b>			
1	Available N (kg ha <sup>-1</sup> )	183.58		Alkaline permanganate method (Subbiah & Asija, 1956)
2	Available P (kg ha <sup>-1</sup> )	11.87	Low	Olsen's method (Olsen, 1954)
3	Available K (kg ha <sup>-1</sup> )	167.32	Medium	Flame photometric method (Jackson, 1973)
4	pH (1:2.5, Soil : water)	7.6	Neutral	Glass electrode pH meter (Piper, 1967)
5	Organic carbon (%)	0.39	low	Walkey and Black method (Black, 1965)
6	Electrical Conductivity (m mhos m <sup>-1</sup> at 25 °C)	0.18	Normal	Solubridge method (Black, 1965)

**Table 3.2: Experimental details**

The experiment was laid out in a randomized block design (RBD) with eight treatments and three replications. The treatments are randomly distributed in plots under four multitier agroforestry system treatments are also randomly distributed in without tree (control) plots. The seeds of chandrasur (*Lepidium sativum* L.) were sown in line in each plot at distance of 30 cm between lines.

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<b>Design</b>	: Randomized block design (RBD)		
<b>Replications</b>	: 3	<b>Treatments</b>	: 8
<b>Crop</b>	: Chandrasur	<b>Seed rate</b>	: 10 kg/ha
<b>Plot size</b>	: 3 m x 5m (15m <sup>2</sup> )		
<b>Spacing</b>	: 30 x 10 cm		

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**Table 3.3: Treatment details**

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1.	T1	Control
2.	T2	RDF(100% ) @ 80:80:30 kg /ha NPK
3.	T3	Vermi- compost (100%) @ 3 ton/ha
4.	T4	Neem cake (100%) @ 2 ton/ha
5.	T5	RDF (50%) @ 40:40:15kg/ha NPK + Vermi-compost (50% )@ 1.5 t/ha
6.	T6	RDF(50%) @ 40:40:15kg/ha NPK + Neem cake (50%) @ 1 t/ha
7.	T7	Vermi- compost (50%) @ 1.5 t/ha + Neem cake (50%) @ 1 t/ha
8.	T8	RDF (50%) @ 40:40:15kg/ha NPK + Vermi- compost (25%) @ 0.75 t/ha + Neem cake (25%) @ 0.5 t/ha

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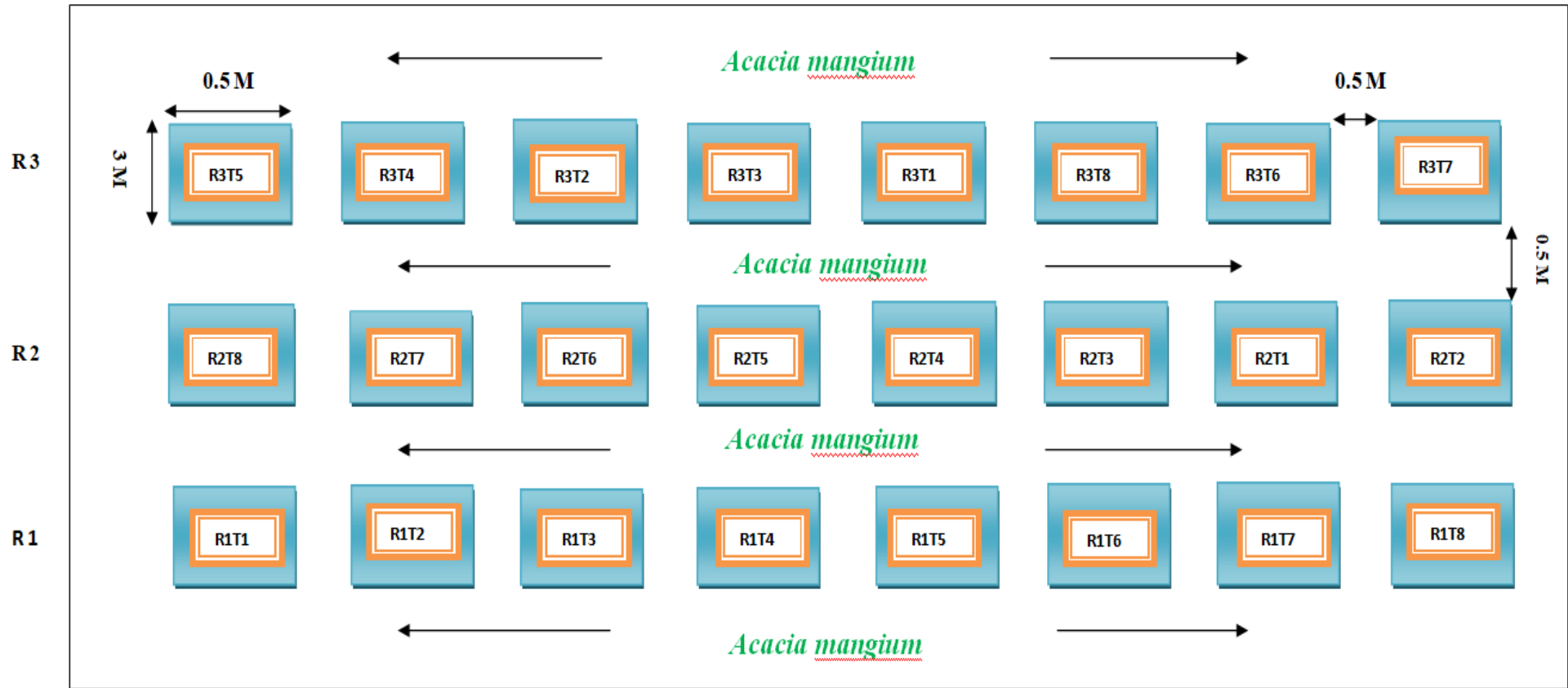


Fig.3.2 Layout of the experiment





**Plate I: Growth of Chandrasur after 30 DAS**

**Table 3.4: Schedule for cultural operations**

<b>S. No.</b>	<b>Cultural operation</b>	<b>Date of operation</b>
1.	Ploughing and harrowing	26-10-2018
2.	Planking	26-10-2018
3.	Layout of experimental field	29-10-2018
4.	Sowing	30-10-2018
5.	Fertilizer application	30-10-2018 and 25-11-2018
6.	Weeding	22-11-2018
7.	Harvesting	29-02-2019
8.	Threshing and winnowing	7-03-2019

### **3.6 Field preparation**

The preparation of field was started when the soil reached to the working condition. To obtain fine tilth, the field was ploughed by tractor drawn plough followed by harrowing to obtain a well pulverized seed bed. The weeds and crop residues were removed to get weed and stubble free field, it was leveled with the help of tractor driven leveler.

### **3.7 Fertilizer application**

The recommended fertilizer was applied @ 80:80:30 kg N: P: K ha<sup>-1</sup> through Urea, Single Super Phosphate and Murate of Potash, in rows uniformly below the seed as basal. The half amount of nitrogen and full amount of P and K fertilizer was applied at basal the amount of nitrogen are applied through top dressing.

### **3.8 Seeds and Sowing:**

Chandrasur seeds were sown on the stipulated dates in row to row and plant to plant 30 and 10 cm spacing respectively. The sowing was done manually by dropping the seeds in lines at a depth of about 1-2 cm in the furrows. With the help of brushwood, the seeds are covered with thin layer of soil and irrigation was given immediately after sowing through a slow stream.

### **3.9 Irrigations:**

The irrigations were applied to crop as treatment basis *i.e.* 25, 50 and 75 days after sowing, irrigations were given manually by check basin method through a slow stream.

### **3.10 Harvesting**

Harvesting was done manually from net plot area when the seed became hard and leaves turned yellow in colour. The plants were left in plot for five days to sun dry and thereafter bundles were made and the bundle weight plot<sup>-1</sup> was recorded.

### **3.11 Threshing and winnowing**

Threshing of produce of each net plot was done manually by beating with wooden stick and after manual winnowing seed yield plot<sup>-1</sup> was noted.

### **3.12 Vegetative phases**

In vegetative phase, various growth parameters were recorded. Sample consisting of ten plants was selected at random from each plot. Observations on various pre-harvest parameters were made from the sample at different stages of crop growth (at 15, 30, 60, 90 DAS and at harvest) and reported as per plant basis.

#### **3.12.1 Plant height (cm)**

Ten randomly selected plants were tagged and the height of the plant was measured by using the meter scale from the plant base to the tip of the top most leaf at 15, 30, 60, 90 DAS and harvest stage.

### **3.12.2 Number Branches per plant**

Branches of ten randomly selected plants tagged were recorded at 15, 30, 60, 90 DAS and at harvest and then average was worked out.

### **3.12.3 Numbers of Leaves per plant**

In each plot, the number of leaves of ten randomly plant was counted separately at 15, 30, 60 and 90 DAS.

### **3.12.4 Collar diameter**

Collar diameter was measured with the help of digital caliper in millimeters simultaneously. The average collar diameter was recorded for further statistical analysis to observe the growth pattern of main stem of plant in different treatment.

## **3.13 Post harvest phases**

### **3.13.1 Shoot weight or biomass**

Fresh weight of the separated shoots was weighed in an analytical balance. After weighing, samples were oven dried at 80<sup>0</sup>C for 72 hours and then dry weight of shoots was recorded. An average shoot weight was recorded for further statistical analysis.

### **3.13.2 Root weight or biomass**

The plants uprooted for the estimation of shoot biomass were also used for estimating root biomass. The fresh weight of the separated roots was taken in analytical electronic balance and then oven dried at 80<sup>0</sup>C for 72 hours and the dry weight was recorded. Average dry weight of root was evaluated for further statistical analysis.

### **3.13.3 Seed yield**

After full maturity of crop, plot wise crop were harvested and kept for 2 days in sunlight. And then threshing was done and seed yield per plot was recorded.

### **3.13.4 Seed test weight**

Randomly seed samples were taken from each plot. 1000 healthy seeds from the produce of each plot were counted then weight was recorded in gram accurately by using an electronic digital balance.



**Plate II: Measurement of tree height and diameter of *Acacia mangium*.**

### **3.14 Tree parameters**

The morphological characters of ten year old *Acacia mangium* tree were measured. The methods used for measurement are as follows.

#### **3.14.1 Tree Height (m)**

The tree height in experimental plot was measured with the help of Ravi Multi meter marked in meter. The height was measured from the base to the tip (apex) of the tree and observation was recorded.

#### **3.14.2 Diameter at breast height**

Diameter at breast height was measured at 1.37 meter height from the base using tree caliper. Two measurements at right angle to each other were taken in each tree and mean of the two represent DBH.

#### **3.14.3 Crown length**

The crown length was measured using a long calibrated bamboo stick of 10 m length as was used for measuring the plant height.

#### **3.14.4 Crown width**

The crown width was measured by attaching a 10 m long tape to a plank fixed perpendicularly to a long stick, which act as handle. Crown width of trees was measured twice at right angles to each other and near of the two was taken as its width.

### **3.15 Statistical analysis of data**

Tree parameters were tabulated and analyzed statistically using simple randomized block design. Crop parameters (morphological, physiological, yield and tree parameters) were tabulated and analyzed statistically using factorial randomized block design. Critical differences (CD) were calculated at 5% level of significance.



## CHAPTER-IV

# RESULTS AND DISCUSSION

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A study on “Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System” are presented in this chapter. Data was recorded in various parameters of Chandrasur crop in field experiment. All the data were tabulated and subjected to their statistical analysis for the interpretation of the results as recorded, observed and analyzed. “Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System”

Results on growth parameter viz. plant height (cm), number of branches per plant , number of leaves per plant, collar diameter (mm) and yield parameter such as shoot biomass, root biomass, seed yield and seed test weight are described in this section.

### **4.1 Weather conditions during the crop growth and development period**

#### **4.2 Growth parameters**

#### **4.3 Yield attributes**

#### **4.4 Tree parameter**

### **4.1 Weather conditions during the crop growth and development period**

The foremost vital weather parameters are rain, temperature and solar radiation. Once considering the growth stages of Chandrasur, reproductive and pod development stages are the foremost sensitive stages to weather. The Chandrasur plant normally takes 3-4 months from germination to maturity, depending on the varieties and also in the environmental condition. Growth cycles of plants are divided into three stages: vegetative, reproductive, and pod development stage. Variations in growth period are primarily due to variations within the length of the vegetative growth stage.

The meteorological rainfall data, temp., sunshine hour, RH, vapour pressure, and wind velocity during crop period from October to March 2019 is presented in fig. 3.1 and appendix I. During crop period a rainfall of (12.17 mm) mm was received the maximum temperature ranges between 22.1°C in third week of December to 33.9°C in third week of

March where minimum temperature ranges between 19.6°C in fourth week of October to 8.5°C in first week of January. Relative humidity throughout the crop season ranges varied from 72 to 90 % at morning and 21 to 57 per cent at evening hours, whereas sunshine hour ranges between 1.2 to 9.3 hours. Vapour pressure varied between 7.8 to 16.4 mm Hg at morning and 5.4 to 14.8 mm Hg at evening and wind velocity varied from 1 to 9.2 Kmph.

## **4.2 Growth parameter**

### **4.2.1 Plant height (cm)**

The plant height of Chandrasur under various treatments was recorded at 15, 30, 45, 60, 75 and 90 days after sowing and their result are presented in Table 4.1, 4.5 and Fig. 4.1. Plant height showed statistically significant ( $P < 0.05$ ) by inorganic fertilizer and organic manure treatment under multitier agroforestry system. The plant height ranges from (4.35 cm to 4.50 cm), (8.21 cm to 8.64 cm), (11.44 cm to 13.35 cm), (34.75 cm to 40.77 cm), (44.46 cm to 48.26 cm) and (50.87 cm to 55.78 cm) at 15, 30, 45, 60, 75 and 90 days respectively.

The maximum average plant height of Chandrasur was recorded in T<sub>5</sub> (28.55cm), where we applied to 50% RDF + 50% Vermicompost followed by T<sub>8</sub> (27.73cm), where we applied to 50% RDF + 25% Vermicompost + 25% Neem Cake. Minimum plant height was observed in T<sub>1</sub> (25.68cm) Control treatment in full maturity.

In present experiment T<sub>5</sub> ( RDF 50% + Vermicompost 50%) performed best among all treatments it is because of the useful impact of recommended dose of fertilizer and vermicompost in improving the soil condition which thus supports proliferous root development resulting in better assimilation of moisture, supplements and thus producing maximum plant height of Chandrasur. Application of RDF and Vermicompost application in high humus and carbon content soil under multitier agroforestry system made good climatic condition for the crop and slow release of nutrient to crop may have reform cell division and evolution of more tissues, resulting in vegetative growth and accordingly increase plant height in Chandrasur crop. Hence, the results obtained in this investigation are similar as reported by other workers and confirm the impact of RDF and vermi compost with agroforestry system.

Similar results were reported by Lokesh, C., and Prajapati, R. K. (2018). regarding morphological growth characters viz., plant height. The outcomes indicated that the morphological attributes of Chandrasur viz., plant height (49.33 cm.) were accounted higher for 3 tons of vermicompost with 18, 46 kg of NP ha<sup>-1</sup> in treatment (T7). Where in treatment T8 (control) Chandrasur, notwithstanding, least plant development and efficiency were seen.

**Table 4.1 Plant Height of Chandrasur crop under *Acacia mangium* based Multitier Agroforestry System.**

TREATMENT	Plant height (cm)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T <sub>1</sub>	4.35	8.21	11.44	34.75	44.46	50.87
T <sub>2</sub>	4.37	8.24	12.53	36.34	45.36	53.67
T <sub>3</sub>	4.43	8.25	11.55	37.49	47.43	53.56
T <sub>4</sub>	4.36	8.30	11.32	35.14	45.25	53.46
T <sub>5</sub>	4.50	8.64	13.35	40.77	48.26	55.78
T <sub>6</sub>	4.45	8.27	11.78	37.88	47.52	54.72
T <sub>7</sub>	4.38	7.99	11.57	36.47	46.70	53.76
T <sub>8</sub>	4.48	8.29	13.23	37.96	47.63	54.83
SEm (±)	0.01	0.05	0.37	2.22	1.33	0.88
CD (at 5%)	0.03	0.15	1.13	6.74	4.05	2.68

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

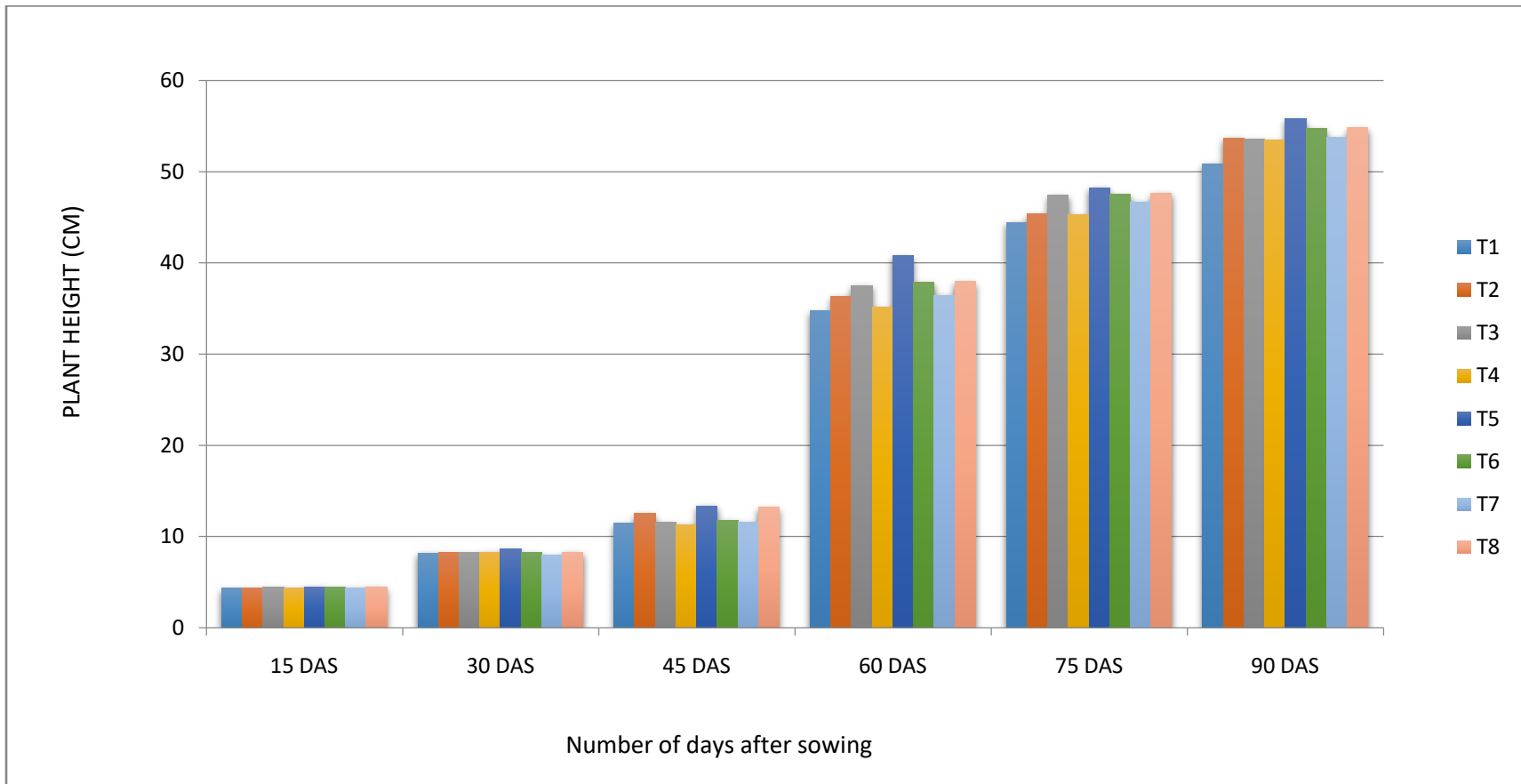
**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.1** Effect of fertilizer and organic manures on plant height of Chandrasur under *Acacia mangium* based Multitier Agroforestry System.



**Plate III: Growth of Chandrasur crop in different treatment.**

#### 4.2.2 Number of branches per plant

Number of branches of Chandrasur under various treatments was recorded at 15, 30, 45, 60, 75 and 90 DAS and their results are introduced in table 4.2, 4.5 and Fig. 4.2. Number of branches showed statistically significant ( $P < 0.05$ ) results by the use of inorganic fertilizer and organic manure treatment under multitier agroforestry system. The numbers of branches was significantly influence with the increasing age in all the treatment. Numbers of branches ranges from (2.54 to 4.05), (4.61 to 6.30), (6.58 to 8.57), (8.07 to 10.62), (10.36 to 12.83) and (11.10 to 13.84) at 15, 30, 45, 60, 75 and 90 days respectively. The maximum average numbers of branches was recorded in T<sub>5</sub> (9.36), where we applied 50% RDF + 50% Vermicompost followed by T<sub>8</sub> (8.90) treatment 50% RDF + 25% Vermicompost + 25% Neem Cake. The minimum number of branches was observed in T<sub>1</sub> (7.21) Control treatment.

Similarly, Choudhary et al. (2012) studied a reasonable portion of natural composts and manures for ashwagandha. They reported that usage of 40 kg ha<sup>-1</sup> of N and P each as urea and SSP + 2.5 t ha<sup>-1</sup> Vermi Compost enlisted imperative characteristics for no. of branches per plant, yield crediting qualities, root (8.60 q ha<sup>-1</sup>) and seed yield (85.6 kg ha<sup>-1</sup>).

**Table 4.2 Number of branches per plant under *Acacia mangium* based Multitier Agroforestry System.**

TREATMENT	No of branches per plant					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T <sub>1</sub>	2.54	4.61	6.58	8.07	10.36	11.10
T <sub>2</sub>	3.12	5.44	7.61	9.27	11.42	11.86
T <sub>3</sub>	3.34	5.27	7.41	9.48	11.67	12.17
T <sub>4</sub>	3.23	4.42	7.74	8.21	10.38	12.61
T <sub>5</sub>	4.05	6.30	8.57	10.62	12.83	13.84
T <sub>6</sub>	3.53	5.65	6.55	9.56	11.23	12.26
T <sub>7</sub>	3.49	5.50	7.27	8.63	10.52	11.83
T <sub>8</sub>	3.67	5.73	7.78	10.18	12.79	13.29
SEm (±)	0.017	0.013	0.012	0.022	0.025	0.020
CD (at 5%)	0.051	0.040	0.038	0.068	0.075	0.061

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

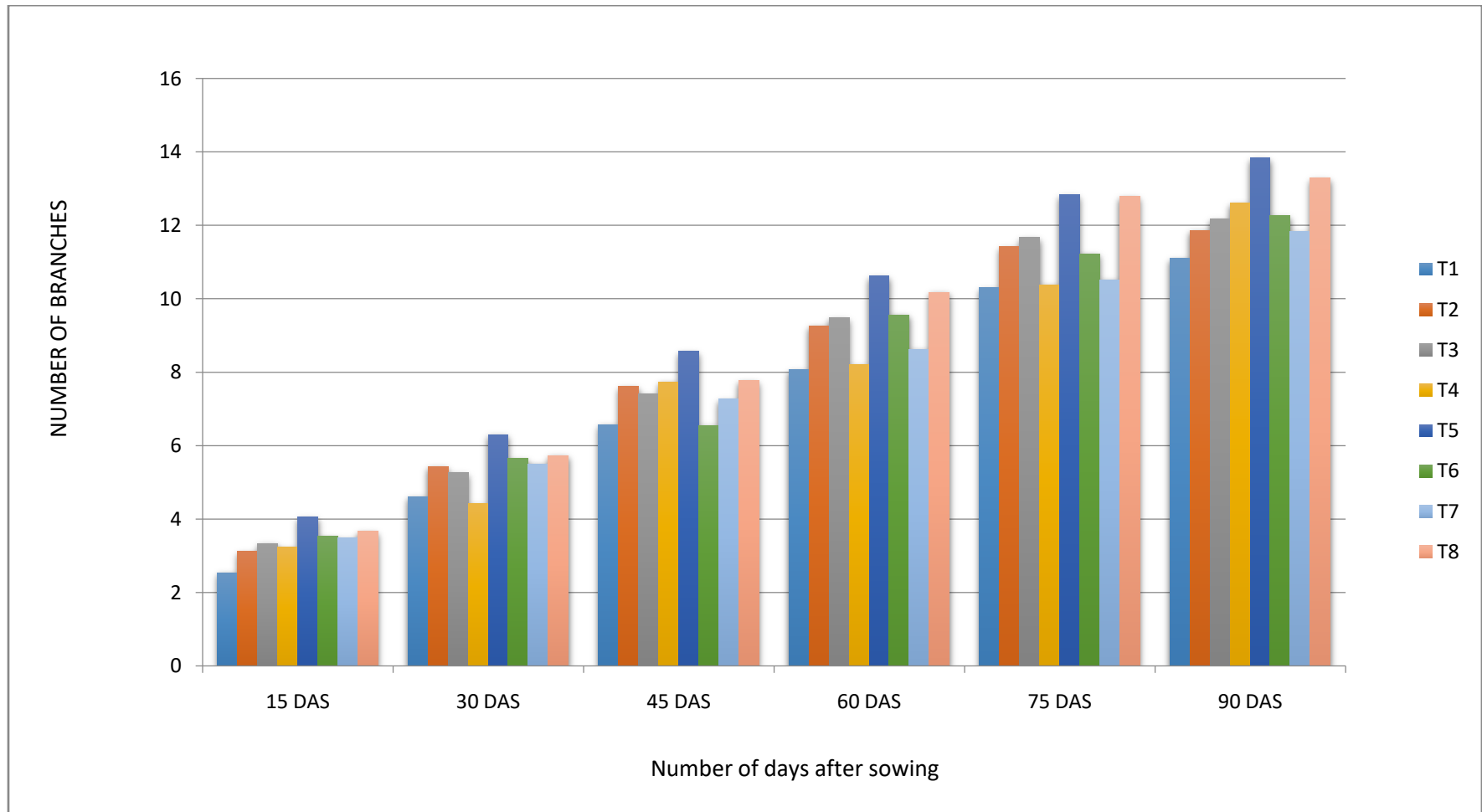
**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.2** Effect of fertilizer and organic manures on number of branches per plant under *Acacia mangium* based Multitier Agroforestry System.

### 4.2.3 Number of leaves per plant

Number of leaves of Chandrasur crop under various treatments was recorded at 15, 30, 45, 60, 75 and 90 days after sowing and their result are introduced in Table 4.3, 4.5 and Fig. 4.3. Number of leaves showed statistically significant ( $P < 0.05$ ) results by the use of inorganic fertilizer and organic manure treatment under multitier agroforestry system. The numbers of leaves of Chandrasur was significantly influence with the increasing age in all the treatment. Numbers of leaves ranges from (5.17 to 9.14), (8.39 to 13.59), (12.29 to 17.61), (16.81 to 21.68), (20.73 to 24.67) and (22.20 to 27.18) at 15, 30, 45, 60, 75 and 90 days respectively. The maximum average numbers of leaves of Chandrasur was recorded in T<sub>5</sub> (18.97) where we applied 50% RDF + 50% Vermicompost followed by T<sub>8</sub> (17.81). The minimum average number of leaves was observed in T<sub>1</sub> (14.26) Control treatment.

A similar finding was reported by Patil et al. (2012) studied the growth and nutrient status of *A. esculentus* are influenced by organic and inorganic fertilizers. *A. esculentus* (okra plant) has been examined. In the life cycle of the okra plant, observations of physical parameters such as number of leaves and stem circumference were reported at four significant growth stages. Various fertilizer combinations, such as Vermicompost (VC), Chemical Fertilizer (CF) and Farmyard Manure (FYM), were prepared and applied for the experiment. T<sub>1</sub> = Power, T<sub>2</sub> = (FYM 100 percent), T<sub>3</sub> = (VC 100 percent), T<sub>4</sub> = (CF 100 percent), T<sub>5</sub> = (VC 75 percent + CF 25 percent), T<sub>6</sub> = (VC 75 percent + FYM 25 percent), T<sub>7</sub> = (VC 50 percent + FYM 50 percent) and T<sub>8</sub> = (VC 50 percent + CF 50 percent) were the preparatory plots. The nutrient requirement for okra crops was 67 kg / ha of nitrogen, 470 kg / ha of phosphorus and 63 kg / ha of potassium in the experimental field soil.

**Table 4.3 Number of leaves per plant under *Acacia mangium* based Multitier Agroforestry System.**

Number of leaves per plant						
TREATMENT	15	30	45	60	75	90
	DAS	DAS	DAS	DAS	DAS	DAS
T <sub>1</sub>	5.17	8.39	12.29	16.81	20.73	22.20
T <sub>2</sub>	6.26	10.13	15.71	18.15	22.88	23.44
T <sub>3</sub>	7.75	11.16	16.83	20.26	24.28	26.56
T <sub>4</sub>	6.34	8.44	14.78	16.64	21.71	24.16
T <sub>5</sub>	9.14	13.59	17.61	21.68	24.67	27.18
T <sub>6</sub>	7.46	10.91	12.45	18.28	23.51	25.83
T <sub>7</sub>	5.26	10.20	14.75	16.67	20.70	22.37
T <sub>8</sub>	7.75	11.16	16.83	20.26	24.28	26.56
SEm (±)	0.027	0.015	0.013	0.014	0.014	0.016
CD (at 5%)	0.082	0.046	0.041	0.045	0.045	0.050

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

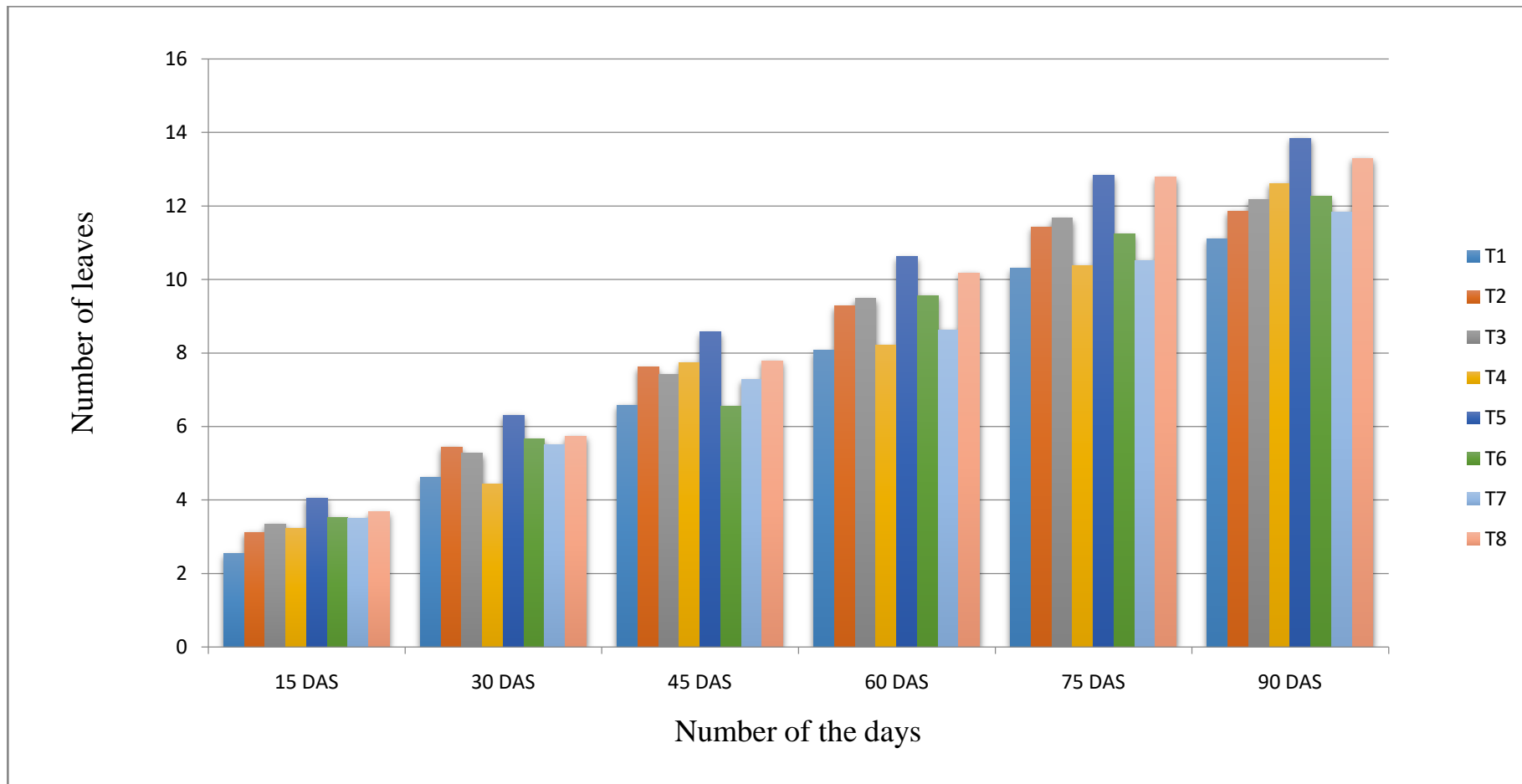
**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.3 Effect of fertilizer and organic manures on number of leaves per plant under *Acacia mangium* based Multitier Agroforestry System.**

#### 4.2.4 Collar diameter (cm)

Collar diameter of Chandrasur crop under various treatments was recorded at 15, 30, 45, 60, 75 and 90 days after sowing and their result are introduced in Table 4.4, 4.5 and Fig. 4.4. Collar diameter showed statistically significant results ( $P < 0.05$ ) by the use of inorganic fertilizer and organic manure treatment under multitier agroforestry system. The collar diameter of Chandrasur was significantly influence with the increasing age in all the treatment. Collar diameter ranges from (0.44cm to 0.56cm), (0.58 to 0.83), (1.46cm to 1.65cm), (1.58cm to 1.77cm), (1.62cm to 1.83cm) and (1.66cm to 1.91cm) at 15, 30, 45, 60, 75 and 90 days respectively. The maximum average collar diameter of Chandrasur was recorded in T<sub>5</sub> (1.42cm) where we applied 50% RDF + 50% Vermicompost followed by T<sub>8</sub> (1.32cm) where we applied 50% RDF + 25% Vermi compost + 25% Neem Cake. The minimum average collar diameter was observed in T<sub>1</sub> (1.22cm) Control treatment in interaction effects.

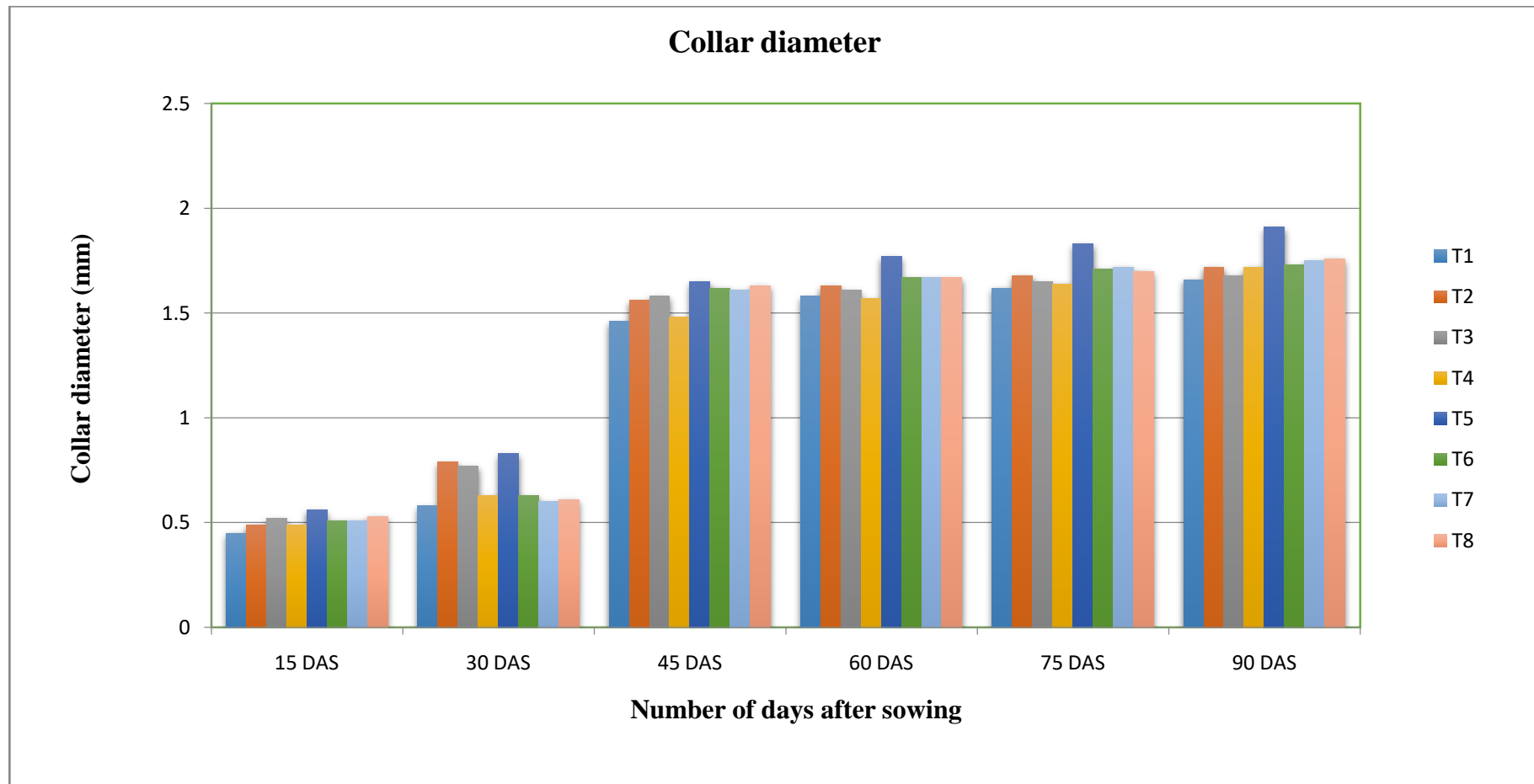
Similar findings were reported by Meshram et al. (2005) According to the outcomes uncovered that the, collar diameter and other growth parameter found highest in T<sub>2</sub> treatment and lowest in T<sub>5</sub> treatment (without manure).

Santosh et al. (2010) reported the increase in plant height, number of branches, number of leaves and dry matter production per hectare was observed in Chandrasur with an increase in fertilizer dose. Maximum plant height (78.60 cm), number of branches (17.04), number of leaves at 50 DAS (49.41), dry matter production (12.00 t/ha) were recorded with the application of 80:80:30 kg of NPK/ha.

**Table 4.4 Collar diameter under *Acacia mangium* based Multitier Agroforestry System.**

TREATMENT	Collar diameter (mm)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T <sub>1</sub>	0.45	0.58	1.46	1.58	1.62	1.66
T <sub>2</sub>	0.49	0.79	1.56	1.63	1.68	1.72
T <sub>3</sub>	0.52	0.77	1.58	1.61	1.65	1.68
T <sub>4</sub>	0.49	0.63	1.48	1.57	1.64	1.72
T <sub>5</sub>	0.56	0.83	1.65	1.77	1.83	1.91
T <sub>6</sub>	0.51	0.63	1.62	1.67	1.71	1.73
T <sub>7</sub>	0.51	0.60	1.61	1.67	1.72	1.75
T <sub>8</sub>	0.53	0.61	1.63	1.66	1.70	1.76
SEm (±)	0.010	0.031	0.194	0.191	0.010	0.012
CD (at 5%)	0.030	0.094	0.589	0.581	0.031	0.036

**T<sub>1</sub> - CONTROL****T<sub>5</sub> - RDF 50% + Vermicompost 50%****T<sub>2</sub> - RDF 100%****T<sub>6</sub> - RDF 50% + Neem Cake 50%****T<sub>3</sub> - Vermicompost 100%****T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%****T<sub>4</sub> - Neem Cake 100%****T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.4** Effect of fertilizer and organic manures on collar diameter under *Acacia mangium* based Multitier Agroforestry System.



**Plate IV: Measurement of collar diameter of Chandrasur plant.**

**Table: 4.5 Average of different growth parameter of crop under *Acacia mangium* based Multitier Agroforestry System.**

<b>Treatment</b>	<b>Plant height (cm)</b>	<b>No. of branches</b>	<b>No. of leaves</b>	<b>Collar diameter (mm)</b>
<b>T<sub>1</sub></b>	25.68	7.21	14.26	1.22
<b>T<sub>2</sub></b>	26.75	8.12	16.09	1.31
<b>T<sub>3</sub></b>	27.11	8.22	17.80	1.30
<b>T<sub>4</sub></b>	26.30	7.76	15.34	1.25
<b>T<sub>5</sub></b>	28.55	9.36	18.97	1.42
<b>T<sub>6</sub></b>	27.43	8.13	16.40	1.31
<b>T<sub>7</sub></b>	26.81	7.87	14.99	1.31
<b>T<sub>8</sub></b>	27.73	8.90	17.81	1.32
<b>SEm (±)</b>	<b>0.81</b>	<b>0.01</b>	<b>0.01</b>	<b>0.07</b>
<b>CD (at 5%)</b>	<b>2.46</b>	<b>0.05</b>	<b>0.05</b>	<b>0.22</b>

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**

### 4.3 Post harvesting phases

#### 4.3.1 Shoot biomass (g/plant)

The result on shoot biomass of Chandrasur grown under *Acacia mangium* based multitier agroforestry system and as sole crop was presented in Table 4.6 and Fig. 4.5. The shoot biomass showed significant differences under *Acacia mangium* based multitier agroforestry System and fertilizer treatment. Fresh and dry weight of shoot ranges from (3.35 to 4.76 g/plant) and (2.53 g/plant to 3.57 g/plant) respectively. Maximum fresh and dry shoot biomass was found in T<sub>5</sub> (4.76 g/plant and 3.57 g/plant) followed by T<sub>8</sub> (4.72 g/plant and 3.52 g/plant) and minimum fresh and dry shoot biomass of Chandrasur recorded in T<sub>1</sub> (3.35 g/plant and 2.53 g/plant).

Similar findings were reported by Meshram, S. and Prajapati, R.K. (2005) studied the yield parameter of Chandrasur viz., shoot biomass were found highest in T<sub>2</sub> (6t FYM + N18+ P46)/ha minimum was recorded in T<sub>5</sub> treatment where no fertilizer were applied. Proper dose of RDF and Vermicompost has promoted the growth of plant. Therefore shoot biomass their found maximum in T<sub>5</sub> where we applied (RDF 50% + Vermicompost 50%).

**Table 4.6 Shoot biomass (g/plant) under *Acacia mangium* based Multitier Agroforestry System.**

Treatments	Shoot biomass	
	Fresh	Dry
T <sub>1</sub>	3.35	2.53
T <sub>2</sub>	4.66	3.43
T <sub>3</sub>	3.42	2.58
T <sub>4</sub>	3.78	2.57
T <sub>5</sub>	4.76	3.57
T <sub>6</sub>	3.77	2.55
T <sub>7</sub>	4.57	3.37
T <sub>8</sub>	4.72	3.54
SEm±	0.131	0.048
CD (at 5%)	0.399	0.147

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.5** Effect of fertilizer and organic manures on shoot biomass (g/plant) under *Acacia mangium* based Multitier Agroforestry System.

### 4.3.2 Root biomass (g/plant)

The result on root biomass of Chandrasur grown under *Acacia mangium* based multitier agroforestry system was presented in Table 4.7 and Fig. 4.6. The root biomass showed significant differences under *Acacia mangium* based multitier agroforestry system with use of fertilizer treatments. Fresh and dry weight of root biomass ranges from (0.097 g/plant to 0.131 g/plant) and (0.076 g/plant to 0.108 g/plant) respectively. Maximum fresh and dry root biomass of Chandrasur was found in T<sub>5</sub> (0.131 g/plant and 0.108 g/plant) followed by T<sub>8</sub> (0.127 g/plant and 0.105 g/plant) and minimum fresh and dry root biomass of Chandrasur recorded in T<sub>1</sub> (0.097 g/plant and 0.076 g/plant). Proper dose of RDF and Vermicompost has promoted the growth of plant. Therefore root biomass their found maximum in T<sub>5</sub> where we applied (RDF 50% + Vermicompost 50%).

Fresh weight of root biomass of Chandrasur was recorded just after harvesting and dry weight of root was taken after drying for 72 hours in oven.

**Table 4.7: Root biomass (g/plant) under *Acacia mangium* based Multitier Agroforestry System.**

<b>Root biomass</b>		
Treatments	Root weight (g/plant)	
	Fresh	Dry
<b>T<sub>1</sub></b>	0.097	0.076
T <sub>2</sub>	0.113	0.098
T <sub>3</sub>	0.122	0.102
T <sub>4</sub>	0.121	0.098
T <sub>5</sub>	0.131	0.108
T <sub>6</sub>	0.108	0.085
T <sub>7</sub>	0.118	0.093
T <sub>8</sub>	0.127	0.105
SEm±	0.005	0.004
CD (at 5%)	0.015	0.012

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

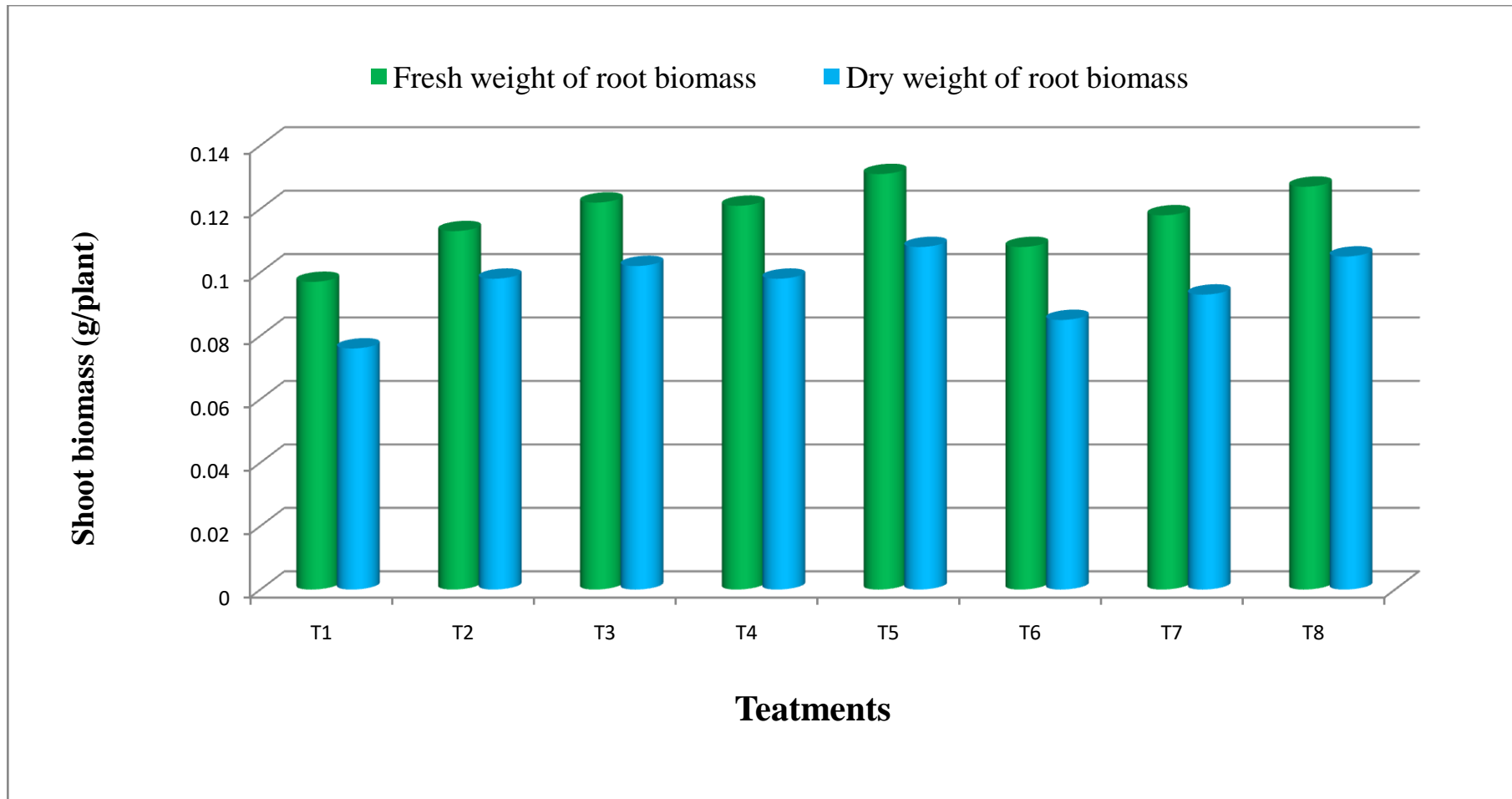
**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.6: Effect of fertilizer and organic manures on Root Biomass (g/plant) under *Acacia mangium* based Multitier Agroforestry System.**

### 4.3.3 Seed yield (q/ha)

After harvest the seed yield was computed and presented in Table 4.8 and Fig 4.7. It was observed that the seed yield differed significantly under *Acacia mangium* based multitier agroforestry system. This is due to the effect of organic manure and fertilizer dose, as well as shade effect of tree component on seed yield. The seed yield ranges from (5.48 to 7.71 q/ha). The seed yield was recorded maximum (7.71 q/ha) in T<sub>5</sub> followed by T<sub>8</sub> (7.56 q/ha) and minimum was recorded in T<sub>1</sub> (5.48 q/ha).

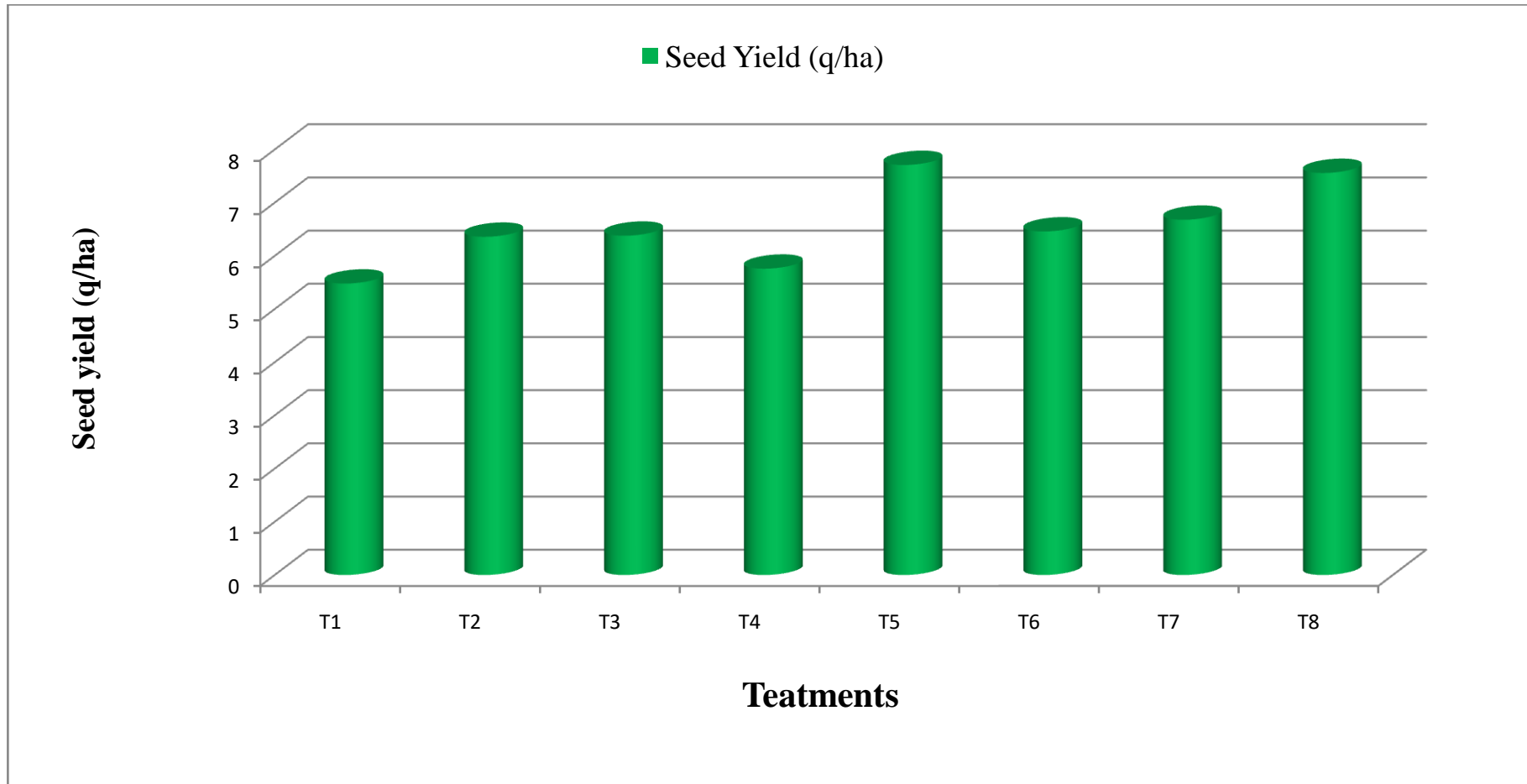
Similarly, Tiwari and Kulmi (2004) studied the effect of nitrogen and phosphorus on Chandrasur, they reported that increased levels of nitrogen and phosphorus from 0 to 60 kg / ha showed significantly higher crop and seed yield growth rates. The use of nitrogen at 60 kg ha<sup>-1</sup> and phosphorus at 60 kg ha<sup>-1</sup> increased the seed yield by 30.28 percent and 32.61 percent respectively.

Saraswathi, G. and Vidya, K.M. (2013) reported that higher seed yield per plant and seed yield per hectare were recorded when the nursery cress was planted on 1 November and conveyed 80:80:30 kg of NPK/ha (D2F4) toward the northern dry zone of Karnataka.

**Table 4.8: Seed yield (q/ha) under *Acacia mangium* based Multitier Agroforestry System.**

<b>Seed yield (q/ha)</b>	
<b>Treatments</b>	<b>Seed yield (q/ha)</b>
<b>T<sub>1</sub></b>	5.48
<b>T<sub>2</sub></b>	6.36
<b>T<sub>3</sub></b>	6.38
<b>T<sub>4</sub></b>	5.76
<b>T<sub>5</sub></b>	7.71
<b>T<sub>6</sub></b>	6.46
<b>T<sub>7</sub></b>	6.68
<b>T<sub>8</sub></b>	7.56
<b>SEm±</b>	<b>0.014</b>
<b>CD (at 5%)</b>	<b>0.045</b>

**T<sub>1</sub> - CONTROL****T<sub>5</sub> - RDF 50% + Vermicompost 50%****T<sub>2</sub> - RDF 100%****T<sub>6</sub> - RDF 50% + Neem Cake 50%****T<sub>3</sub> - Vermicompost 100%****T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%****T<sub>4</sub> - Neem Cake 100%****T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.7:** Effect of fertilizer and organic manures on seed yield (q/ha) under *Acacia mangium* based Multitier Agroforestry System.



**Plate V: Seed yield of Chandrasur crop.**

#### 4.3.4 Seed Test weight (g)

The results on seed test weight depicted in Table 4.9 and Fig. 4.8 showed very less variation under *Acacia mangium* based multitier Agroforestry System. Seed test weight ranges from 1.56 gm to 1.74 gm/1000 seeds. The maximum value (1.74 gm) was recorded in T<sub>5</sub> treatment followed by T<sub>8</sub> (1.71 gm) where as minimum was found in T<sub>1</sub> treatment (1.56 gm). This clearly indicates that there is not much variation in seed test weight, but variation was obtained in seed yield.

Similarly, Tiwari and Kulmi (2004) studied the effect of nitrogen and phosphorus on Chandrasur, they reported that increased levels of nitrogen and phosphorus from 0 to 60 kg / ha showed significantly higher crop and seed yield growth rates. The use of nitrogen at 60 kg ha<sup>-1</sup> and phosphorus at 60 kg ha<sup>-1</sup> increased the seed yield by 30.28% and 32.61% respectively. The interaction effect was no significant when nitrogen and phosphorus applied in combination. In present study the result also showed similar observations where N and P applied in combination not in separate level and organic manure was applied on the different treatments. The above findings are confirmation of present investigation.

**Table 4.9 Seed test weight (g) under *Acacia mangium* based Multitier Agroforestry System.**

Seed test weight (gm)	
Treatments	Seed test weight (gm)
T <sub>1</sub>	1.56
T <sub>2</sub>	1.58
T <sub>3</sub>	1.63
T <sub>4</sub>	1.65
T <sub>5</sub>	1.74
T <sub>6</sub>	1.68
T <sub>7</sub>	1.67
T <sub>8</sub>	1.71
<b>SEm±</b>	<b>0.012</b>
<b>CD (at 5%)</b>	<b>0.038</b>

**T<sub>1</sub> - CONTROL**

**T<sub>5</sub> - RDF 50% + Vermicompost 50%**

**T<sub>2</sub> - RDF 100%**

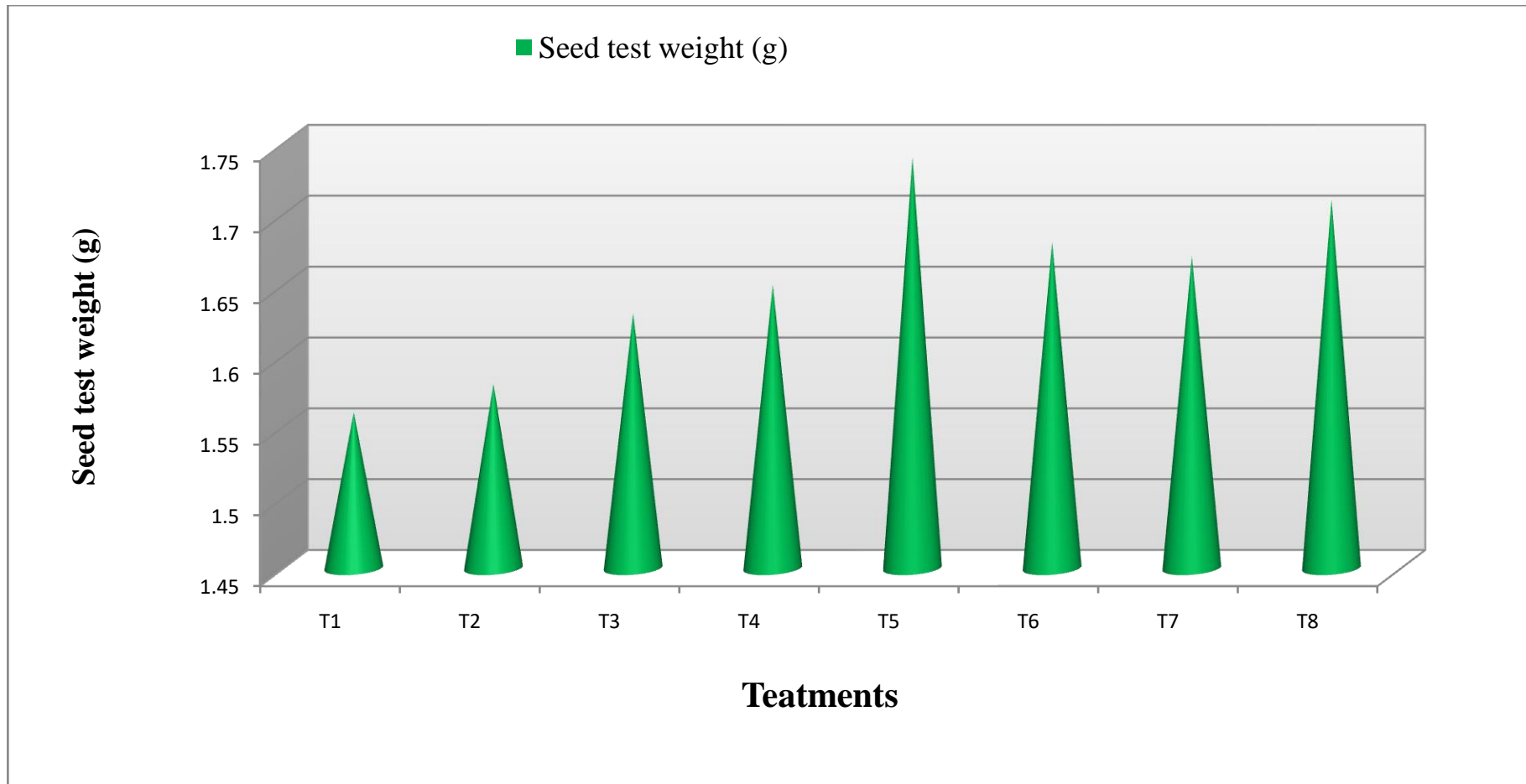
**T<sub>6</sub> - RDF 50% + Neem Cake 50%**

**T<sub>3</sub> - Vermicompost 100%**

**T<sub>7</sub> - Vermicompost 50%+ Neem Cake 50%**

**T<sub>4</sub> - Neem Cake 100%**

**T<sub>8</sub> - RDF 50% + Vermicompost 25%+ Neem Cake 25%**



**Fig. 4.8** Effect of fertilizer and organic manures on seed test weight (g) under *Acacia mangium* based Multitier Agroforestry System.

## 4.5 Tree parameter

### 4.5.1 Tree height (m) and DBH (cm) of *Acacia mangium* tree during crop period.

The effect the data on growth of tree (*Acacia mangium*) with respect to tree height is presented in Table 4.10. The results revealed that the average tree height varied from 15.02 m and 15.97 m before sowing of Chandrasur and after harvesting of crop respectively, the results demonstrated that there was a minor distinction in height increase in the tree after harvesting of crop under multitier agroforestry system due to few month time span didn't indicated a lot of addition in height and diameter. The average height increment in trees was (0.95 m.) this clearly indicate the soil working, nutrient and water input in the system made the better microclimate for tree growth as compared with the tree without any input.

The data pertaining to the diameter at breast height of tree are presented in table 4.9. The results revealed that the DBH was recorded of 25.07 cm and 25.95 cm before sowing and after harvesting of crop respectively. The above results clearly indicate that after harvest of crops the increment in the diameter was 0.88 cm under multitier agroforestry system. The diameter increment in trees showed significant difference under multitier agroforestry system. The increment in diameter is because of nutrient moisture and microclimate found in agroforestry system which is favorable for tree growth.

Similar findings were reported by Patil *et. al.*, (1994). The height and diameter increases with the availability of nutrient and moisture. In clonal orchard up to 8 years growth of the *A. mangium* trees take water and nutrient from the soil and growth was better as compared with the trees in the well maintained clonal orchard. Therefore, the results of the present study are in confirmatory with the findings of Prajapati *et al.* (2007) intercropping of patchouli under *Gmelina arborea* based Agroforestry system the intercropped field is always provide suitable climatic conditions and residual nutrient availability for the tree crop for better growth.

**Table 4.10: Height and DBH of *Acacia mangium* trees during crop period.**

	Before sowing of Chandrasur crop		After harvesting of Chandrasur crop	
S. No.	Height (m)	DBH (cm)	Height (m)	DBH (cm)
1	15.4	28.9	16.7	29.4
2	14.4	20.1	15.6	21.75
3	11.2	15.5	12.4	15.8
4	12.7	16.1	13.3	16.15
5	16.4	22.3	17.2	23.64
6	19.7	27.7	20.1	28.27
7	14.7	16.3	15.5	16.65
8	13.4	37.1	14.1	39.5
9	13.3	34.7	14.2	35.5
10	14.4	28.7	15.6	29.2
11	16.8	34.8	17.3	35.5
12	15.5	22.2	16.5	23.7
13	15.2	27.9	16.2	29.2
14	17.3	18.8	18.9	19.15
<b>Avg.</b>	<b>15.02</b>	<b>25.07</b>	<b>15.97</b>	<b>25.95</b>

#### 4.5.2 Crown length (m) and Crown width (m) of *Acacia mangium* trees during crop period.

Crown length and crown width was measured in *Acacia mangium* trees during cropping period. The data with respect to tree crown length and crown width is presented in Table 4.11.

**Table 4.11: Crown length (m) and Crown width (m) of *Acacia mangium* trees during crop period.**

S. No.	Crown length (m)	Crown width (m)
1	4.32	5.94
2	4.26	5.58
3	3.63	4.74
4	3.96	5.1
5	4.47	5.95
6	5.46	7.06
7	4.38	5.67
8	4.72	5.83
9	3.69	5.17
10	5.10	6.15
11	3.64	4.78
12	4.13	6.02
13	5.22	6.07
14	3.39	4.86
<b>Avg.</b>	<b>4.31</b>	<b>5.63</b>

#### **4.5.3 Tree height (m) and DBH (cm) of *Emblica officinalis* tree during crop period.**

The effect the data on growth of tree (*Emblica officinalis*) with respect to tree height is presented in Table 4.9. The results revealed that the average tree height varied from 7.50 m to 8.41m before sowing of Chandrasur and after harvesting of crop respectively.

The average height increment in trees was found 0.91 m, this clearly indicate the soil working, nutrient and water input in the system made the better microclimate for tree growth as compared with the tree without any input.

The data pertaining to the diameter at breast Height of trees are presented in table 4.9. The results revealed that DBH was recorded 13.06 cm and 13.67 cm before sowing and after harvesting of crops respectively. The above results clearly indicate that after harvest of crops the increment in the diameter was 0.61 cm under multitier agroforestry system. The diameter increment in trees showed significant difference in multitier agroforestry system. The increment in diameter is high because of nutrient moisture and microclimate is found better in multitier agroforestry system.

Thakur et al. (2009) studies that the significant enhancement in the height and collar girth of the tree varying from 10% to 21% over the sole tree. Fruit weight, fruit size and pulp weight improved significantly due to growing of turmeric as intercrop under the aonla orchard.

**4.12: Height and DBH of *Emblica officinalis* (Aonla) trees during crop period.**

S. No.	Before sowing of Chandrasur crop		After harvesting of Chandrasur crop	
	Height (m)	DBH (cm)	Height (m)	DBH (cm)
1	6.4	5.8	7.1	7.63
2	7.7	21.3	8.6	21.8
3	4.9	11.6	5.4	12.6
4	7.6	42.7	8.5	43
5	4.7	14.6	5.8	15
6	7.2	10.1	8.2	10.6
7	8.1	13.3	9.3	13.9
8	7.4	10.3	8.5	10.6
9	9.3	13.5	10.1	14.4
10	10.2	5.2	11	5.9
11	6.5	5	7.2	5.7
12	9.3	12.8	10.2	13
13	8.4	6.9	9.3	7.2
14	7.4	9.7	8.6	10.1
<b>Avg.</b>	<b>7.50</b>	<b>13.06</b>	<b>8.41</b>	<b>13.67</b>

#### 4.5.4 Crown length (m) and crown width (m) of *Emblica officinalis* trees during crop period.

The data with respect to tree crown length and crown width is presented in Table 4.13. Average crown length and crown width of Aonla tree was recorded 3.92 m and 5.28 m respectively.

Similar findings were reported by Gosh et al. (2007) studies divulged that the regular water and nutrient management followed for medicinal and aromatic crops in addition to recommended management practices for fruit crops favoured improvement in soil nutrient status and nutrient uptake by coconut.

**Table 4.13: Crown length and crown width, of *Emblica officinalis* (Aonla) trees during crop period.**

S. No.	Crown length (m)	Crown width (m)
1	3.21	4.28
2	3.52	4.21
3	4.22	5.62
4	4.35	5.74
5	5.11	6.24
6	3.62	4.38
7	3.43	4.49
8	2.86	4.12
9	4.36	5.86
10	3.45	5.29
11	3.53	5.75
12	4.41	6.19
13	5.23	6.33
14	3.71	5.42
<b>Avg.</b>	<b>3.92</b>	<b>5.28</b>

#### **4.5.5 Tree height (m) of *Murraya koenigii* tree during crop period.**

The effect the data on growth of tree of *Murraya koenigii* is presented in Table 4.14. The average tree height varied from 3.50 m and 4.49 m before sowing and after harvesting of crop respectively, the outcomes indicated that there was a minor distinction in height of tree after gather of multitier agroforestry system. The average height increment in trees was (0.99 m.) this clearly indicate the soil working, nutrient and water input in the system made the better microclimate for tree growth as compared with the tree without any input.

Similar findings were reported by. Patil *et. al.*, (1994) that height and diameter increases with the availability of nutrient and moisture. The findings of Prajapati et al. (2007) further support the results of the current study, as he reported that intercropping of patchouli under *Gmelina arborea* based Agroforestry system, the intercropped field is always provide suitable climatic conditions and residual nutrient availability for the tree crop for better growth.

**Table 4.14: Height (m) of *Murraya koenigii* trees during crop period.**

S. No.	Tree Height (m)	
	Before sowing of crop	After harvesting of crop
1	4.12	5.32
2	3.22	4.28
3	3.36	4.43
4	2.86	3.92
5	3.56	4.49
6	4.07	5.21
7	4.21	5.27
8	3.23	5.34
9	2.78	4.82
10	3.62	4.58
11	3.74	4.67
12	3.45	4.52
13	2.92	3.86
14	3.25	3.94
15	2.87	3.93
16	2.68	3.76
17	4.15	5.26
18	4.26	5.37
<b>Avg.</b>	<b>3.50</b>	<b>4.49</b>

#### 4.5.6 Crown length (m) and crown width (m) of *Murraya koenigii* trees during crop period.

The observation was recorded for crown length and crown width of *Murraya koenigii* trees during cropping period. The data with respect to tree crown length and crown width is presented in Table 4.10. Crown length and crown width of Curry leaf was recorded 2.55 m and 3.17 m respectively.

#### 4.15 Crown length (m) and crown width (m) of *Murraya koenigii* trees during crop period.

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S. No.	Crown length (m)	Crown width (m)
1	2.15	3.45
2	1.94	3.62
3	3.08	2.74
4	2.45	2.91
5	2.26	1.96
6	3.12	3.16
7	1.84	4.04
8	1.67	3.69
9	2.52	2.85
10	2.46	2.73
11	2.74	1.89
12	3.14	2.64
13	2.56	3.57
14	2.53	4.21
15	3.21	2.83
16	2.48	4.25
17	3.19	3.42
18	2.59	3.27
<b>Avg.</b>	<b>2.55</b>	<b>3.17</b>

## CHAPTER-V

### SUMMARY, CONCLUSION AND SUGGETIONS FOR THE FUTURE WORK

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The investigation on “Effect of Fertilizer and Organic Manures on Performance of Chandrasur (*Lepidium sativum* L.) under *Acacia mangium* based Multitier Agroforestry System” was carried out in the research farm, Department of Forestry, Indira Gandhi Agriculture University during Rabi season of 2018-19.

The Multitier Agroforestry system was established in the year 2003 in the research farm in which the three tier top canopy, middle canopy and lower canopy trees were planted to undertake the experiments. The Chandrasur a medicinal value crop was raised as intercrop in randomized block design with 8 treatment and 3 replications in which 24 plots under multitier agroforestry system made to laid the experiment. The RDF for the crop was tested with Organic manure, includes Vermicompost and Neem cake were taken in different combinations and randomly distributed in each plot to develop a package of practice for Chandrasur to be cultivated under tree based Agroforestry system in Chhattisgarh with the aim of organic farming.

Observations on vegetative growth parameter of Chandrasur viz. plant height, number of branches, number of leaves and collar diameter were estimated at 15, 30, 45, 60, 75 and 90 DAS. Shoot biomass (g/plant), Root biomass (g/plant), Seed yield (q/ha) and Seed test weight (g/1000 Seeds) of various treatments were recorded after harvest of crop. Information on morphological characters of *Acacia mangium*, *Embllica officinalis* and *Murraya koenigii* were additionally recorded before sowing and after harvest of crop.

The data subjected to statistical analysis and the salient findings of the results obtained in the present investigation are summarized below:

1. The finding of the current investigation revealed that plant height of Chandrasur was found maximum in T<sub>5</sub> followed by T<sub>8</sub> and minimum was found in T<sub>1</sub> treatment (50% RDF + 50% Vermicompost > 50% RDF + 25% Vermicompost + 25% Neem cake).
2. Maximum no. of branches per plant was found in T<sub>5</sub>. While minimum no. of branches per plant was found in treatment T<sub>1</sub> (Control).

3. The treatment T<sub>5</sub> was found best which is the combinations of inorganic fertilizer and organic manure in which highest numbers of leaves per plant were recorded. While least number of leaves were found in treatment T<sub>1</sub> (Control).
4. Maximum collar diameter also observed maximum in T<sub>5</sub> followed by T<sub>8</sub> and minimum was observed in T<sub>1</sub>.
5. The maximum shoot biomass was recorded in T<sub>5</sub> followed by T<sub>8</sub> and minimum shoot biomass was found in T<sub>1</sub>.
6. The maximum root biomass was found in T<sub>5</sub> followed by T<sub>8</sub> and minimum root biomass was found in T<sub>1</sub>.
7. Seed yield was also obtained highest in treatment T<sub>5</sub> followed by T<sub>8</sub> and minimum seed yield was obtained in control T<sub>1</sub>.
8. The seed test weight was obtained maximum in T<sub>5</sub> followed by T<sub>8</sub> and minimum seed test weight was obtained in T<sub>1</sub>.
9. The morphological characters of *Acacia mangium*, *Emblica officinalis* and *Murraya koenigii* viz., tree height, DBH, crown length and crown width was recorded before sowing and after harvesting of Chandrasur crop. Average height, DBH, crown length and crown width was recorded 0.95 m, 0.88cm, 4.31 m and 5.63 m in *Acacia mangium*, 0.91m, 0.61cm, 3.92m and 5.28 m in *Emblica officinalis* and 0.99m, 2.55m and 3.17m in *Murraya koenigii* was also recorded respectively. The trees height, DBH, crown length and crown width was recorded lower in control plot than the experimental plot because of the nutrient and water availability during cropping period.

## CONCLUSION

Medicinal crops are more advantageous and cost effective crops than many traditional Agricultural crops in different agro-ecosystems due to increasing demand. Chandrasur has appeal for its seed and plant; there is a need to build up a total agro-innovation to diminish the gap among demand and supply. As Chandrasur is normally producing in forest areas is required limited shade adoring crop that is the reason

Chandrasur is very appropriate under multitier agroforestry system to acquire great plant growth and high profitability of seed which is having economical value in Harbal drug store.

The integration of important high value medicinal and aromatic herbs with multipurpose tree species have been found good option for achieving diversification as well as better economic returns from the systems. Organically grown crop no use of insecticide and pesticide fetching high economic returns and a source of foreign exchange for our country.

There is no data accessible on impact of multitier *Acacia mangium* identifying with the performance of Chandrasur crop. Subsequently an attempt has been made to measure, the effect of inorganic fertilizer and natural compost on growth and productivity of Chandrasur under *Acacia mangium* based Multitier Agroforestry System. Based on results it is concluded that under *Acacia mangium* based multitier agroforestry system Chandrasur crop gave significant results:-

1. RDF @ 40:40:15 kg/ha NPK + Vermi-compost@ 1.5 Ton/ha (50%) gives highest growth and productivity in Chandrasur as compared to other treatments. Highest plant height (28.55cm), number of branches (9.36), number of leaves (18.97) and collar diameter (1.42 cm) was observed in treatment T<sub>5</sub> in the present investigation.
2. Different yield parameter of Chandrasur such as shoot biomass and root biomass (g/plant), seed yield (q/ha) and seed test weight (g) were recorded after harvesting.
3. The yield of fresh as well as oven dry weight of shoot biomass was found maximum in T<sub>5</sub> (4.76 g/ plant and 3.57 g/ plant).
4. The yield of fresh as well as oven dry weight of root biomass was found maximum in T<sub>5</sub> (0.131 g / plant and 0.108 g /plant).
5. In present investigation the seed yield was obtained maximum in T<sub>5</sub> (7.71q/ha) where we applied 50% RDF + 50% Vermi-compost and minimum seed yield was obtained in T<sub>1</sub> (5.76 q/ ha)

6. Chandrasur crop performed well under *Acacia mangium* based multitier agroforestry system as compared to control (without fertilizers) condition of crop. The treatment T1 showed lowest in terms of growth of plants, productivity and seed yield.
7. Vermicompost in combination with inorganic fertilizer provides more seed yield as compared to Vermicompost in combination with organic manure and Vermicompost alone.
8. In this experiment generally the farmers can also get extra income by the production of *Acacia mangium* trees. The shade loving Chandrasur crop shown better results in 50% RDF + 50% Vermi-compost treatment thus it can be acceptable for cultivation.
9. The overall growth performance of Chandrasur sown under *Acacia mangium* based multitier agroforestry system is superior in every part of crop viz., growth, shoot and root biomass, seed yield and seed test weight. The superior treatment was found RDF (50%) + Vermicompost (50%) @1.5 t/ha as compared to other treatments in the present study.

#### **SUGGETION FOR THE FUTURE RESEARCH WORK:-**

1. The complete research work are expected to direct for pertaining investigation relating to the tree-crop relationship, microclimate as well as bio-parameter under the *Acacia mangium* based agroforestry land use program for more viable recommendation of management practices.
2. The growth and productivity of crop varied under different trees species as intercropped with Chandrasur. So the tree crop interaction must be studied.
3. The retarded growth and productivity of Chandrasur as intercropped under *A mangium* may be a good finding, to study its allelopathic effect on this crop.
4. More fertilizer treatments of inorganic, organic and green manure must be studied to standardize the requirement of crop for its optimum productivity under multitier agroforestry system for commercial cultivation and higher economic return.



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## Appendix-A

**Appendix-A:** Meteorological data of research farm of IGKV during Rabi season 2018.

Date	Max. Temp. (°C)	Min. Temp. (°C)	Rain-fall (mm)	R.H. (%) I	R.H. (%) II	V.P. (mm of Hg) I	V.P. (mm of Hg) II	Wind Velocity (Kmph)	Evaporation (mm)	Sun Shine (hours)
Oct 29-04	31	19.6	0	86	49	16.4	14.8	2.6	28.8	9.3
Nov 05-11	32.3	17.7	0	84	34	13.8	11.9	1.2	23.3	8.5
Nov 12-18	31.5	14.4	0	86	29	11.4	10.1	1.1	23.3	9.1
Nov 19-25	31.4	15.3	0	88	28	12.5	9.4	1.1	23.2	7.8
Nov 26-02	29.3	13.6	0	89	33	11	9.7	1	19.7	7.5
Dec 03-09	28.2	14.3	0	87	38	11.1	10.4	0.9	17.7	4.4
Dec 10-16	27.4	15.7	0	86	51	12.5	13.1	1	13.9	1.2
Dec 17-23	22.1	11	47.2	90	57	9.8	10.5	3.1	15.3	4.5
Dec 24-31	25.1	8.6	0	86	28	8.1	6.3	1.3	16.6	7.5
Jan 01-07	27.4	8.5	0	88	28	7.9	7.3	0.7	16.8	6.6
Jan 08-14	27.1	10.2	0	87	34	8.9	8.7	0.9	16.5	6.1
Jan 15-21	28.1	9.2	0	85	21	7.8	5.8	0.9	18.7	6.8
Jan 22-28	26.3	14.3	23.6	85	53	11.1	11.2	2	18.5	4
Jan 28-04	26.4	9.5	0	87	24	8.3	7.3	1.3	20.6	8.2
Feb 05-11	28.8	12.5	3.4	81	36	9.9	8.7	1.5	21.3	7.6
Feb 12-18	30.2	13.6	9	84	34	11	5.8	1.8	20.4	8.3
Feb 19-25	33.1	17	0	81	30	12.6	11.2	1.7	30.3	9.1
Feb 26-04	31	17.3	0.2	72	36	11.8	6.4	2.4	30.7	7.8
March 5-11	28.8	12.5	0.5	80.6	35.6	9.9	9.2	9.2	3.0	7.6
March 12-18	30.2	13.6	1.3	86.7	34.0	11.0	10.0	1.8	2.9	8.3
March 19- 25	33.9	17.7	0.0	80.6	31.3	13.0	12.1	1.7	4.3	9.3
March 26- 30	31.0	17.1	0.0	72.4	36.0	11.8	11.3	2.4	4.4	7.8

**Source:** Department of agricultural meteorology, I.G.K.V., Raipur Chhattisgarh Raipur

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