

**PERFORMANCE OF Sim saumya [*Ocimum basilicum*
(L.)] UNDER EUCALYPTUS (*Eucalyptus tereticornis*)
BASED AGROFORESTRY SYSTEM**

M.Sc. (FORESTRY) THESIS

by

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DEPARTMENT OF FORESTRY

COLLEGE OF AGRICULTURE

**INDIRA GANDHI KRISHI VISHWAVIDYALAYA RAIPUR
(C.G.)**

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**PERFORMANCE OF Sim saumya [*Ocimum basilicum*
(L.)] UNDER EUCALYPTUS (*Eucalyptus tereticornis*)
BASED AGROFORESTRY SYSTEM**

Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

YAMINI NETAM

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THE DEGREE OF**

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CERTIFICATE –I

This is to certify that the thesis Viva-voce in respect of Miss. **YAMINI NETAM** student of **M.Sc. (Forestry)** has been conducted under the chairmanship of Head of the Department/Dean (in case of out campii) along with Advisory Committee on **23-10-2020**. The necessary corrections have also been made as per comments/suggestions made by the Advisory Committee and Head of the Department/Dean.

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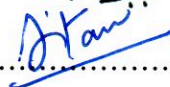
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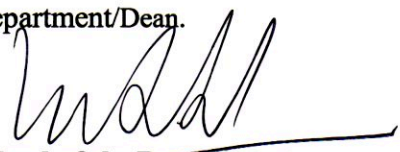

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CERTIFICATE-II

This is to certify that the thesis entitled "**Performance of Sim saumya [Ocimum basilicum (L.)] under Eucalyptus (Eucalyptus tereticornis) based Agroforestry system**" submitted by **Yamini Netam** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) in partial fulfilment of the requirement 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.


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LIST OF SYMBOLS AND ABBREVIATIONS

ABBERRAVIATION	DESCRIPTION
%	Percent
&	And
=	Equal to
>	More Than
AFS	Agroforestry System
°C	Degree centigrade
c.d.	Collar diameter
C.G.	Chhattisgarh
cm	Centimeter
cm ²	Centimeter square
DAP	Days After Planting
DBH	Diameter at breast heigh
<i>et al</i>	And others/co-workers
Fig.	Figure
ha ⁻¹	per hectare
<i>i.e.</i>	that is
t ha ⁻¹	tones per hectare
m	Meter
m ²	Meter square
NS	Non- significant
S	Significant
SEm	Standard error of mean
SEd	Standard error of difference
RBD	Randomized Block Design

THESIS ABSTRACT

- (a) Title of the thesis : “Performance of Sim Saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system”
- (b) Full name of student : Yamini Netam
- (c) Major subject : Forestry
- (d) Name and Address of the major advisor : Dr. Pratap Toppo, Assistant Professor
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- (e) Degree to be awarded : Master of science (Forestry)
-


Signature of Major Advisor


Signature of the student

Date

31/10/2020


Signature of the head of the department

ABSTRACT

The present investigation on “**Performance of Sim Saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system**” was carried out during season 2019– 2020 in Herbal Garden of Indira Gandhi Krishi Vishwavidyalya Raipur, Chhattisgarh . The experiment was conducted during the month of June 2019 to December 2019. For this the suitable experimental design was laid out on Randomized block design (RBD) with three replication under agroforestry system.

Tulsi crop was cultivated with combination of different organic manure *i.e.* FYM, Vermicompost ,Neem cake. The experiment comprised of the nine

treatments on the field, the treatment were divided into T₁ FYM 100% (5t/ha), T₂ Vermicompost 100% (2.5 t/ha), T₃ Neem cake 100%(2t/ha), T₄ FYM 75% (3.75t/ha) + Vermicompost 25% (0.625t/ha), T₅ FYM75% (3.75t/ha) +Neem cake 25%(0.5t/ha),T₆ Vermicompost 50%(1.25t/ha) + Neem cake 50%(1t/ha) , T₇ FYM 50%(2.5t/ha) + Neem cake 25%(0.5t/ha) + Vermicompost 25%(0.625t/ha), T₈ FYM 25% (1.25 t/ha) +Neem cake 50% (1t/ha) +Vermicompost 25% (0.625 t/ha) T₉ control (No manures). All these treatments significantly influenced the growth and yield of Sim saumya . The analyzed result showed that the 100% FYM gave higher growth (Plant height (cm), collar diameter(mm) and Number of branch/plant). The treatment gave highest yield (herbage and oil yield). All the above results were lowest where organic manure is not applied (control). Over all these results clear that the FYM is the best for the soil improvement, growth and yield of Sim saumya plant. The tree growth (plant height and DBH) of Eucalyptus showed non significant result. In the present experiment cots-benefit ratio was also analyzed. It was found that the highest gross returns (Rs 102212) and net returns per ha (Rs. 69780) were registered in T₁ treatment with 100% FYM and the lowest were recorded in the T₉ treatment with control zero fertilizer. The highest Benefit-cost ratio (3.15) registered in the T₁ treatment with 100% FYM while the minimum (1.00) was obtained with T₉ treatment with control zero fertilizer. The treatment - T₁(100% FYM) gave colossal net realization Rs 69780 ha⁻¹ and an unmatched B:C ratio(3.15).

शोध सारांश

क) शोध ग्रंथ का शीर्षक	:	यूकेलिपटस (यूकेलिपटस टेरेटिकोर्निस) आधारित कृषि वानिकी पद्धति के तहत तुलसी [ओसिमम बेसिलिकम (एल.)] का प्रदर्शन।
ख) छात्र का पूरा नाम	:	यामिनी नेताम
ग) प्रमुख विषय	:	वानिकी
घ) मुख्य सलाहकार का नाम एवं पता	:	डॉ. प्रताप टोप्पो सहायक प्रध्यापक वानिकी विभाग कृषि महाविद्यालय रायपुर (छ.ग.)
इ) उपाधि से सम्मानित किया जाएगा	:	एम. एस. सी. (वानिकी)

मुख्य सलाहकार के हस्ताक्षर

दिनांक 31/10/2020

छात्र का हस्ताक्षर

विभाग प्रमुख के हस्ताक्षर

सारांश

यूकेलिपटस (यूकेलिपटस टेरेटिकोर्निस) आधारित कृषि वानिकी पद्धति के तहत तुलसी [ओसिमम बेसिलिकम (एल.)] का प्रदर्शन की जाँच इंदिरा गाँधी कृषि विश्व विद्यालय रायपुर 492012 छ.ग. के हर्बल गार्डन में 2019-2020 के मौसम के दौरान किया गया जिसका उद्देश्य नीलगिरी के वृक्षों के प्रभाव का कृषि वानिकी के अन्तर्गत तुलसी के फसल के विकास एवं उपज व्यवहार तथा नीलगिरी वृक्ष के विकास का अध्ययन करना है। यह प्रयोग जुन 2019 से दिसम्बर 2019 तक आयोजित किया गया उक्त शोध अध्ययन के प्रयोग की परिकल्पना संख्यिकी प्रारूप में RBD के रूप तैयार किया गया था जिसमें 9 उपचार और तीन प्रतिकृति क्षेत्र में की गयी थी उपचारों को T₁ FYM 100% (5t/ha), T₂ वर्मीकम्पोस्ट 100% (2.5 t/ha) , T₃ नीम केक 100%(2t/ha) , T₄ FYM

75%(3.75t/ha) +वर्मीकम्पोस्ट 25%(0.625t/ha), T₅ 75% FYM (3.75t/ha) + 25% नीम केक (0.5t/ha),T₆ 50% वर्मीकम्पोस्ट (1.25t/ha) + 50 % नीम केक (1t/ha),T₇ 50% FYM (2.5t/ha) + 25 % वर्मीकम्पोस्ट (0.625t/ha) + 25% नीम केक (0.5t/ha) ,T₈ : 25% FYM (1.25t/ha) + 25 % वर्मीकम्पोस्ट (0.625t/ha) + 50 % नीम केक (1t/ha),T₉ ;नियंत्रण (शून्य उर्वरक) में विभाजित किया गया था। यह सब उपचार सीम सौम्या की वृद्धि और उपज को प्रभावित करता हैं। विशेषण के परिणामों से पता चला कि 100% FYM में (पौध ऊँचाई (सेमी), कॉलर व्यास (मिमी), शाखा/पौधा, हर्ब और तेल उपज) पाया गया। उपरोक्त सभी उपचार में से सबसे कम जहाँ जैविक खाद लागू नहीं होती। इन सभी परिणामो से यह स्पष्ट हुआ कि FYM मिट्टी में सुधार, वृद्धि और उपज के लिए सबसे अच्छा हैं। नीलगिरी पेड़ के वृद्धि (पेड़ की ऊँचाई और DBH) में गैर महत्वपूर्ण परिणाम पाया गया। इसमें 100% FYM शुद्ध प्राप्ति 69780 रु. /हेक्टेयर एव बी.सी. अनुपात 3.15 पाया गया।

CHAPTER – I

INTRODUCTION

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, *etc.*) are used on the same land-management units as agricultural crops and animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. Agroforestry systems are multifunctional systems that can provide a wide range of economic, sociocultural, and environmental benefits.

Woody and herbaceous perennials are grown on land in agroforestry systems which also support agriculture crops or animals. The combination of these elements, as a spatial course of action or temporal sequence, enhances the manageability of environmental intensity and development. This combination helps the segments to support one another in their use of assets and in the preparation of that usage. Perennials have deeper roots and higher shelters than those of annuals, enabling better use of resources above and below ground. Under optimal conditions annuals may use nutrients transferred from the subsoil to the surface by deeply formed perennials. Leguminous perennials fix climate nitrogen which annuals can use. Owing to the difference bottom from which the root of annuals and perennials extracts water from the soil there is negligible competition for water. A few perennials cause allelopathic disturbances which can cover weeds. Contrasts in the structure of perennials and annuals, inciting a multi-story cover, decreasing light composition among plants. Agroforestry systems could be developing and extending the agronomic and biological manageability of helpless asset ranchers in humid tropics. Practically speaking, be that as it may, the likely

advantages of agroforestry frameworks can be outfit just through dexterous and work concentrated administration of viable frameworks. There are no straightforward diagrams of a generally pertinent framework that can tackle all potential advantages conceivable under ideal conditions. A wide scope of agroforestry frameworks has been intended to ease agronomic, ecologic, or administrative limitations.

Sim Saumya is belong to the family of Lamiaceae. Its botanical name is [*Ocimum basilicum* (L.)] . Sim Saumya Tulsi is local to tropical and subtropical Asia. It is a perennial plant and can grow between 30 to 130 cm tall. Sim Saumya (now spelled Tulsi) or Tulsi, is a perennial sweet-smelling Tulsi plant known for the purposes of religious and traditional medicine, and for its essential oil. It is usually used as a home-grown tea, widely used in Ayurveda, and includes a place inside Hinduism's Vaishnava convention where fans enjoy seeing blessed basil plants or leaves. Tulsi is an aromatic tropical perennial bush originating in India and Southeast Asia and is an important emblem in the Hindu's religious traditions. The primary aim of the current innovation is to create a new assortment of Indian basil *Ocimum basilicum* called Sim Saumya with early, short-lived, dwarf, high essential oil yield characteristics combined with consistently high methyl chavicol and linalool yield in the basic oil.

Tulsi [*Ocimum basilicum*(L.)] is believed the “Queen of Herbs”, the Legendary, “Incomparable One” is one of the holiest and highly respectable for most therapeutic and restorative herbs distributed mainly in the all regions of India Tulsi is widely grown, sacred plant, it is found growing in environment having moist soil nearly all over the world which is original from its wild form (Vana Tulsi). *Ocimum* varieties have around 50 to 150 types of spices and bushes from the tropical native of Asia. Tulsi has square stems, fragrant inverse leaves and whorled bloom on spiked inflorescence. The essential oil of Tulsi is extracted by hydro distillation from the leaves and flavouring tops are used into foods, dental and oral items, in aromas and in conventional ceremonies and medications Extracted basic oils have additionally been appeared to contain naturally dynamic constituents that are insecticidal are nematicidal and fungicidal. Tulsi chemical

component is essential oil those are methyl chavicol, eugenol, linalool, and methyl cinnamate. The all family plants in India; *Ocimum basilicum* (Tulsi) is the most well-known and usually worshipped. It can grow as a perpetual in warm atmospheres, but is seen as an annual in cold winter month's atmospheres. *Ocimum basilicum* has Iranian roots. *Ocimum basilicum* in the tropical and subtropical region of the world is typically discovered wild. *Ocimum basilicum* is flourishing in humid, quiet atmospheres. The plant grows to around 130 cm tall and the blossoms should be squeezed off to progress with growth. It prefers full sun but partial shade can be tolerated. *Ocimum basilicum* is precious for increasing memory capacity. Spewing, queasiness, obstruction, depression, demanding hack, cerebral discomfort, fever, and cold are all good. The leaves of *Ocimum basilicum* (L.) contain some kind of bright yellow volatile oil that is useful against insects and bacteria.

This plant is a traditional wellspring of natural medicines. The Tulsi *Ocimum basilicum* (L.) is upright, branched, very fragrant and bristling. It prevents the production of cold, fever and cough *etc.* Tulsi is beneficial monetarily. Tulsi leaves contained higher Na, Cu and Zn proportions (Bhowmik *et al.*, 2008). Fresh leaves and *Ocimum sanctum* L. Extricated developed several phenolic blends. *Ocimum basilicum* leaves contain 0.7 percent volatile oil that includes about 71 percent eugenol and 20 percent methyl eugenol. The oil also includes carvacrol and hydrocarbon-caryophyllene sesquiterpine (Uma Devi P, 2001). Two orientine and andvicenine flavonoids from *Ocimum basilicum* watery leaf concentrate have been restricted (Gupta *et al.*, 2002). *Ocimum basilicum* (Tulsi) has an apparent fragrant scent due to the presence of volatile or uncertain oil, which is ultimately moved in the herb. This sweet-smelling flimsy oil fundamentally contains phenols, terpenes and aldehydes. The oil isolated from seeds is called fixed oil and generally made out of unsaturated fats. Other than oil, the plant also contains alkaloids, glycosides, saponins and tannins. The leaves contain ascorbic destructive and carotene moreover.

Tulsi *Ocimum basilicum*(L.) is a major medicinal plant .The plant is valuable in the treatment of stomach pains, fever, cough, worms and gout. The leaf

juice is utilized as a nasal douche, a remedy for ear wound and croup for which it is given with nectar. The seeds are invigorating and have narcotic properties. Sweet basil is utilized as food flavourant in perfumery and beauty care products businesses. The synthetic constitutions of fundamental oils obtain from different species have demonstrated that there exist a number of types available which can be interesting to perfumes. The usage in industry found in following chemical constituent of the Tulsi (*Ocimum species*) are in case of oil in *Ocimum basilicum* 0.5-2.0 percent fundamental oil, *Ocimum canum* 2.0-4.0 percent, *Ocimum americanum* 3.6-6.5 percent, *Ocimum kilimandscharicum* 1.5-3.5 percent, *Ocimum sanctum* 0.5-1.0 per cent. The whole plant is medicinal. Essential oil got from vegetative part of the *Ocimum sp.* is expensive. There is excellent scope for its cultivation. Indigenous basil is distributed in India, Sri Lanka, Bangladesh, Thailand, China, Myanmar and Malaysia. In India, *Ocimum basilicum* is grown in temple, household precinct and is found throughout in plains to 1800- 2000 m in Himalayas. The various source of organic composts, viz., animal, plant, wastage and bio-dynamic manure which contains variable measure of nutrients among the different source of organic manure, FYM, decayed press mud, vermicompost, bio-fertilizer, other plant based waste materials and micro nutrients are mainly used as organic manures. The application of organic sources is also helpful to improve the soil properties and microbial population. The use of vermicompost in horticultural, medicinal crops found to be most effective organic which influence the physico-chemical properties of soil viz. soil structure, porosity and good aeration.

Eucalyptus tereticornis tree belong to Myrtaceae family native to Australia, and adjusted an excessive number of various territories. It is the most typical decision to be planted along the edges, or bunds of agricultural field and gives off an impression of being very much incorporated and accepted in agroforestry in India (Tejwani, 1994) for the paper and pulp. The tree develops to a height of 20 to 50 meters with a girth of up to 2 meters dbh. The trunk is straight and is usually un-branched for most of the tree's full length. Later on, for a Eucalyptus tree, the limbs are exceptionally steeply inclined. The bark is shed in irregular sheets, producing a smooth surface of the trunk hued in patches of white, dim and blue referring to regions that shed their bark at different occasions. It has small,

lanceolate green leaves, length 10 to 20 cm, and width one to about 3 cm. Blossoms occur in 7 to 11 flowering inflorescences. The tree has heartwood which is powerful, hard and heavy. It is utilized for development in weighty building. The leaves of *E. tereticornis* are utilized in the creation of cineole based eucalyptus oil.

There are various forms of eucalyptus trees that can be grown in the home scene including popular assortments such as Gum tree and Silver-Dollar tree. This tree will literally make an alluring expansion with fascinating bark and leaves, lovely blossoms and a good fragrance. They do especially well in territories that impersonate their local state. The majority of these trees are fast producers, arriving at tallness of around 30 to 180 feet or more, contingent upon the assortment, with roughly 60 percent of their development set up inside the first 10 year and flowers are in cymose panicles.

They offer many attractive features for use as furniture, timber, firewood, and pulpwood. Additionally, Eucalyptus wood is used in various companies, from fence posts (where high protection from decomposing is valued for the oil-rich wood) and charcoal to biofuel cellulose extraction. Furthermore, rapid growth makes eucalypts ideal as windbreaks and to minimise disintegration. Eucalyptus oil is promptly steam refined from the leaves and can be utilized for cleaning and as a modern dissolvable, as a sterile, for freshening up, and in minute amounts in food supplements, particularly desserts, hack drops, toothpaste and decongestants. It has creepy crawly repellent properties, and fills in as a functioning fixing in some business mosquito-anti-agents. Smell advisors have received eucalyptus oils for a wide scope of purposes.

Both Eucalyptus parts may be used to create colors that are meaningful on protein strands (*e.g.* silk and fleece), simply by using water to handle the plant component. The colors to obtain range from yellow and orange to grey, brown, chocolate, and deep red rust. After the preparation, the residual material may be used safely as mulch or compost. In addition to this, eucalyptus tree care requires annual pruning (in summer) to monitor top growth and overall tallness. Both

Eucalyptus parts may be used to create colors that are meaningful on protein strands (*e.g.* silk and fleece), simply by using water to handle the plant component. The colors to obtain range from yellow and orange to grey, brown, chocolate, and deep red rust. After the preparation, the residual material may be used safely as mulch or compost. In addition to this, eucalyptus tree care requires annual pruning (in summer) to monitor top growth and overall tallness. Eucalyptus trees also produce to the litter in the fall, shedding bark, leaves, and branches. As its shred-like bark is viewed as combustible, keeping this garbage tidied up is ideal. Whenever wanted, you can gather some seed once it falls, and afterward plant it in another territory of your yard or in a holder.

Therefore, the present study was undertaken to work out the **“Performance of Sim Saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system”** with following objectives:-

1. To study the effect of different Organic manure on growth, herbage and oil yield of Tulsi (*Ocimum basilicum*. Var. Sim Saumya) under agroforestry system.
2. To study the performance of Eucalyptus (*Eucalyptus tereticornis*) under agroforestry system.
3. To study the economics of Tulsi (*Ocimum basilicum*. Var. Sim Saumya) under different nutrient management in agroforestry system.

CHAPTER- II

REVIEW OF LITERATURE

Agroforestry has attracted the interest of scientists and development planners because it provides variety of products for meeting varied requirements of the people, insurance against risks caused by weather aberrations, controlling erosion hazards and ensuring sustainable production of the intercrops (Nair, 2007). The survey revealed that the wide spectral potential of agroforestry practices in sustenance of agriculture as they provide food, fodder, fruit, vegetables, fuel wood, timber, medicines, fiber *etc.* from the same piece of land at a time which not only fulfils the demand of people but also evaluate their socioeconomic status and standard of life (Pathak *et al.*, 2000). The return of agroforestry are realized only after 6 to 8 years and during those year the loss from agriculture serves as a limiting factor due to shading effect of the trees and land use for tree planting.

Ocimum basilicum (L.) is native to India, where it enjoys a religious add-on and liked to be grown in shrines and homes as an aromatic perennial shrub. It is also grown in temperate climates. The natural habitat of Tulsi crop varies from the sea level to an altitude of 2000 m. Commercial production has significance due to valuable aroma chemicals extracted from the essential oil of Tulsi. Tulsi leaves contain a bright yellow volatile oil which is useful against insects and bacterial. In this chapter , the relevant literature related to the study of **“Performance of Sim Saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system”** Has been reviewed under the following titles:

- 2.1 Effect of different Organic manure on growth of Tulsi under agroforestry system.
- 2.2 Effect of different Organic manure on herbage yield of Tulsi under agroforestry system.
- 2.3 Effect of different Organic manure on oil yield of Tulsi under the agroforestry system

2.4 Performance of Eucalyptus (*Eucalyptus tereticornis*) under agroforestry system.

2.5 Economics under the agroforestry system.

2.1 Effect of different Organic manure on growth of Tulsi under agroforestry system

Anwar *et al.*, (2004) a study was carried out in India and their goal was to contemplate the impact of organic and inorganic composts on development of basil and nature of basic oils. The dirt was sandy topsoil with pH of 8.38. The creators picked two natural composts ranch yard excrements (FYM) and vermicompost. There were six treatments control: FYM (10 t ha^{-1}), vermicompost (10 t ha^{-1}), inorganic compost NPK ($100:50:50 \text{ kg ha}^{-1}$), FYM (5 t ha^{-1}) + manure NPK ($50:25:25 \text{ kg ha}^{-1}$), vermicompost (5 t ha^{-1}) + compost NPK ($50:25:25 \text{ kg ha}^{-1}$). The seedlings were planted in mid-June in favorable time of sowing. The plants were harvested at ground level towards the end of October and basil oil were extracted by hydro-refining.

Arancon *et al.*, (2004) Watched the Vermicompost is considered as a rich wellspring of accessible plant supplements, development controllers, proteins, antifungal and antibacterial compound.

Ansari (2005) studied that, the highest significant result was obtained from cowdung treatment, because cowdung and poultry manure is more efficient than other organic manures.

Anwer *et al.*, (2005) also conducted a experiment with six different mixes of organic compost (FYM and vermicompost) and inorganic manures nitrogen, phosphorus, potassium (NPK) to examine their impact on yield and oil quality in basil (*Ocimum basilicum*). Results from the trial covered that among the six treatments the mix of vermicompost at 5 t ha^{-1} + fertilizer NPK $50:25:25 \text{ kg ha}^{-1}$ played out the best regarding development, spice, dry issue, oil substance, and oil yield. Substance of major constituents of basil oil (Methyl chavicol and Linalool) was likewise higher under coordinated supplement the executives particularly

when Vermicompost was applied in blend with NPK.

Anwer *et al.*, (2005) reported that use of natural excrement (FYM and vermicompost) and inorganic manures nitrogen, phosphorus, potassium (NPK) increment soil natural carbon (C), accessible N, and P in soils. The dirt got natural compost alone or in mixes with inorganic composts have higher accessible supplements and soil natural carbon than control (no compost or excrement) and inorganic manure treated soil. This examination showed that consolidated use of compost and manure assists with expanding crop efficiency and quality and keeping up soil richness.

Thakur and Kumar (2006) Observed that experiment on alley cropping reported that different plant spacing within hedgerows of *Leucaena leucocephala* and *Morus alba* differentially affected growth and production of *Tagetes minuta* and *Ocimum basilicum* mainly under hedgerows with closer plant spacing and distance from the hedgerow line. Their findings revealed that *T. minuta* and *O. basilicum* can be grown successfully as companion crops in the alleys of *Morus* and *Leucaena* for diversification and profitability.

Pramanik *et al.*, (2007) Studied that compost is an odorless, clean and organic material containing adequate quantities of N, P, K and different micronutrients essential for plant growth. Vermi-compost is eco-friendly, non-toxic and consumes low energy input for composting and is a recycled biological product. Humic acids isolated from vermi-compost enhance the root elongation and formation of lateral roots in maize. Vermi-compost enhances the nutrient uptake by the plants by increasing the permeability of root cell membrane, stimulating root growth and increasing proliferation of root hairs.

Sehgal and Thakur (2008) Studied that the developing therapeutic and fragrant spices, viz. *Ocimum basilicum* and *Tagetes minuta* and to discover the impacts of natural composts, for example vermicompost, FYM and enhanced excrement on the development execution and profitability of restorative spices, intercropped between hedgerows of *Morus*, a significant fuel and grub tree species under agroforestry conditions. The utilization of natural excrements improves

execution and creation effectiveness of therapeutic spices intercropping with trees. The separation of the harvest from *Morus* hedgerows additionally influenced the development and yield of intercropping natural harvests. Out of the three natural excrements; relatively more significant returns were acquired in treatment getting advanced compost than vermicompost and FYM. Therapeutic and fragrant plants can be developed effectively in blend with *Morus* hedgerows.

Bhowmik *et al.*, (2008) studied that Tulsi leaves contain Na, Cu and Zn in leaves and tender shoots as well as. Along these lines, in that circumstance it is rise natural development, improvement and examination of Tulsi and Pudina restorative plant for ecological parity. Hence, this examination was attempted to discover to contemplate the impacts of compost and fertilizers on development and yield of Tulsi and Pudina.

Sehgal (2011) reported in the field experiment that effect of spacing and organic manure on *Ocimum basilicum* intercropped with *Leucaena leucocephala*. The use of the organic manure benefits the intercrop by improving the growth even in the presence of hedgerows as compared to control plots.

Rahman *et al.*, (2014) worked out a trial to assess the impact of compost and fertilizers on the development and yield of *Ocimum*. There were six treatments comprising of control, cowdung, poultry compost, cowdung + NPK manure, poultry excrement + NPK manure and blended manure. All the treatments fundamentally impacted the greater part of the development and yield segments. The plant stature, no. of branch/plant, no. of leaf/plant, leaf length, 1000 new leaf weight and yield were most noteworthy where dairy animals excrement was applied in the experiment.

Singh *et al.*, (2014) Worked out the sweet basil (*O. basilicum*) developed with consolidated utilizations of compost and inorganic manure in various extents demonstrated the most elevated substance of N, P and K when plants were prepared with half every one of inorganic manure and fertilizers with 3.37% N, 3.14% K and 0.70% P. In light of plants developed with excrement, the substance results were N 2.37%, K 1.63% and P 0.58% better than plants developed with just

inorganic fertilizer N 2.28%, K 1.92% and P 0.42%.

Vijaya Rachel and Sirisha., (2016) studied that the application of biofertilizers promoted healthy growth of *Ocimum* plants, increased the secondary metabolite production which augmented in antioxidase activity.

2.2 Effect of different Organic manure on herbage yield of Tulsi under agroforestry system

Vieira and Simon (2000) Observed that fresh and dry leaves of plant are used in food and spice industries, perfumery, dental and oral products.

El Gendy *et al.*, (2001) Reported that the planting of *Ocimum* in 15 cm between the rows gave highest yield.

Khatik *et al.*, (2001) Studied that the significantly higher number of branches at harvest (18.10) was recorded in the treatment FYM @ 15 t/ha, it was at par with application of vermicompost @ 7.5 t/ha (16.78) and castor cake @ 2.5 t/ha (16.80). The reason might be due to the organic manure like FYM, castor cake and vermicompost helps to maintain soil fertility and nitrogen give continuous nutrient so better branches on plant.

Ram *et al.*, (2002) reported that Spacing had significant effect on production of fresh and dry leaves yield. The closer spacing (40×40cm) recorded higher yield than that of wider spacing (50×50cm). In closer spacing, more number of plants could be accommodated. As such, it produced more leaves per unit area. Narrow spacing (40×40cm) was found to produce more oil yield than that of wider spacing (50×50cm). This might be due to more yield of leaves under wider spacing which ultimately influenced the oil yield.

Ved and Goraya, (2008) studied in India that the dried leaf, seed, and whole plant are used separately in the conventional medicinal systems of Unani, Ayurveda, and Siddha.

Pattanayak *et al.*, (2010) studied that on *Ocimum sanctum* plant contains vitamin C and A, and minerals like calcium, zinc and iron, as well as chlorophyll

and many other phytonutrients. It also enhances the efficient digestion, absorption and use of nutrients from food and herbs.

Singh *et al.* ,(2010) Studied that the oils extracted from the leaves and inflorescence of Tulsi have been professed to have various helpful properties, including as expectorants, analgesics, enemies of emetics, and antipyretics; stress reducers and aggravation relievers; and as hostile to asthmatic, hypoglycemic, hepatoprotective, hypotensive, hypolipidemic, and immune modulatory specialists.

Eirini Sarrou *et al.*,(2016) Research that the application of organic Agrobiosol and neem cake in *Ocimum* increased the herbage yield by 33 and 47.75% respectively when compared to control.

2.3 Effect of different Organic manure on oil yield of Tulsi under agroforestry system

Uma Devi P., (2001) studied that the leaves of *Ocimum sanctum* contain 0.7% unstable oil involving about 71% eugenol and 20% methyl eugenol. The oil additionally contains carvacrol and sesquiterpine hydrocarbon caryophyllene .

Zheljazkov *et al.*, (2008) reported that the oil of specific types of *Ocimum* has the antifungal, bactericidal and insecticidal properties as well. Sweet basil (*Ocimum basilicum* L.) and heavenly basil (*Ocimum sanctum* L.) are the most generally developed basil species on the planet either for the new market or for basic oil creation *O. americanum*, *O. basilicum*, *O. sanctum* are among the 178 high exchange species.

Thakur *et al.*, (2009) reported that higher oil yield from *Ocimum sanctum* grown under agroforestry systems in W. Himalayas has also been but with higher nitrogen application.

Jadav *et al.*, (2010) reported that continuous application of NPK fertilizers results in Sulphur deficiency along with very much deficit of organic matter make the situation worst for oilseed crops. Oilseed crops give significant results with sulphur use.

Basavaraju *et al.*, (2012), Singh and Ramesh, (2002) studied that the Oil yield had significantly differed for different nutrient doses. Application of 60:20:20 N: P₂O₅:K₂O kg/ha + 3t/ha Vermicompost had highest oil yield followed by 40:15:15 N: P₂O₅:K₂O kg/ha + 3t/ha Vermicompost, 20:10:10 N: P₂O₅:K₂O kg/ha + 3t/ha Vermicompost and 6ton/ha Vermicompost. Higher doses of N increase the methyl chavicol content in the oil. Moreover, higher doses of nutrients yield more foliage which directly increases the oil content.

2.4 Performance of Eucalyptus (*Eucalyptus tereticornis*) under agroforestry system.

Jan *et al.*, (1996) Reported that Farmers' brought enthusiasm up in eucalypt ranch ranger service has now caused for transformation of croplands into eucalypt woodlots Eucalyptus estate brings about progress in soil supplement (N, P, K, and natural issue) when contrasted with normal soil.

Chauhan *et al.*, (1997) Reported the performance of medicinal and aromatic plants *viz*; Citronella flexuous, Citronella winterianus, Citronella martini and Japanese mint under shade of *E. tereticornis* plantation, they found that biomass and essential oil lowest of Citronella flexuous ,and highest for Citronella winterianus, medium for Citronella martini.

Jagger and Pender, (2003) Study the Eucalyptus trees are generally planted along cropland outer edge and the main street to satisfy the requirement for fuel wood, development and to create pay.

Kidanu *et al.*, (2005) Reported that the result of yield is relies on tree dividing, thickness, type and nature of existing bund ranch and their concealing impacts. Good ways from tree base additionally assumed critical function on the yield of grain crops. The yield of harvests expanded with the expansion in good ways from the limit timberlines.

Mohsin Faiz., (2005) studied the higher herbage and oil yield in unadulterated fields of Mentha crops than the harvests developed under Poplar and Eucalyptus stands. The complete expansion of supplements recorded was

additionally higher in poplar and Eucalyptus than unadulterated field of Mentha crops.

Nasim *et al.*, (2007) Worked out the Eucalyptus plantation can ameliorate salinity and sodicity of soil by improving decreasing soil EC, pH and SAR.

Singh and Sharma (2007) research that the higher supplement status close to the tree may be because of the expansion of enormous amount of leaf litter. The higher disintegration of leaf litter kindnesses the higher supplement status of the dirt.

Dereje *et al.*, (2012) worked out the mixing into the different cultivating frameworks and their planting has brought about high monetary gainfulness contrasted and conventional harvest creation.

Sarvade *et al.*, (2014) Worked out the Wheat (*Triticum aestivum* L.) is broadly intercropped grain crop during rabi season (November-April) with Eucalyptus, Poplar, and other quickly developing tree species in Northern conditions of India viz., Uttarakhand, Punjab, Haryana, Uttar Pradesh and Bihar, portions of Central and Eastern states for example, Madhya Pradesh, Chhattisgarh and West Bengal. Intercropping with high thickness short pivot tree species is the most ideal alternative to meet the expanding food and modern crude material prerequisite through economical use of characteristic assets.

Raj *et al.*, (2016) studied that Eucalyptus based agroforestry system is most commonly accepted practice in India by the farmers for fulfilling the market demand of plywood, paper, pole and furniture industries. The boundary planting of Eucalyptus is preferred by farmers due to their less interference with agricultural operations. Boundary plantation under agroforestry helps in holding the dirt against disintegration and improving soil fertility by fixing nitrogen or getting minerals from profound the dirt and keeping them by leaf fall. Such an appropriate mix assume an essential part in improvement of better yield profitability, soil supplement status and microbial populace elements which assumes a significant function in supplement cycling to look after biological system.

2.5 Economics under agroforestry system

Viswanath *et al.*, (2000) studied that agroforestry (rice + babul) framework, ranchers gets higher money returns on a present moment (10-year) collect pattern of trees, and the work input (both family-and employed) on ranches was appropriated more consistently during the time than in rice monoculture.

Singh *et al.*, (2001) studied the financial and profitability of raising restorative and sweet-smelling plants as intercrops in long term old poplar (*Populus deltoides*) based Agroforestry framework. All the yields in particular *Mentha arvensis*, *M. gracilis*, *Zingiber officinale*, *Ocimum basilicum*, *Curcuma domestica* and *Piper longum*, aside from *Costus presumptive*, performed well. Most extreme net return was acquired in *Curcuma domestica* (Rs 64,700 and Rs 68,300) and for *Ocimum basilicum* net return was Rs. 25852 and Rs. 23437 ha⁻¹ in the first and second year, individually.

Harsh and Tewari, (2003) studied that the *Salvodora oleoides* (density 10 trees ha⁻¹) were intercropped with bajra with a production of average 9.5 qha⁻¹ Farmers can earn Rs.13000 ha⁻¹ yr⁻¹ from *Salvodora sp.* based agroforestry system.

Harsh and Tewari, (2003) Reported that the Farmers intercropped *Ziziphus nummularia* and *Ziziphus rotundifolia* with Bajra or legume crops. In the month of October - November, after harvest of bajra crops, *Ziziphus spp* are cut from the ground level and allowed to dry. This dry leaf called „pala“ is stored for lean period to feed livestock. This agroforestry system gave gross return of Rs. 7000 – 8000 ha⁻¹.

Dutt and Thakur (2004) observed the financial status of cropping system for two sequential years under Shivalik Ranges of external Himalayas, joining restorative and sweet- smelling spices with business wood species. Four home grown harvests specifically *Ocimum sanctum*, *Spilanthes acmella*, *Tagetes minuta* and *Withania somnifers* were intercropped with long term old manor of *Populus* mixture (G-48) having 8 × 3 m, 6 × 4 m, 5 × 5 m and 4 × 6 m dividing. Net returns were similarly more under agroforestry frameworks consolidating *Ocimum*

sanctum and *Tegetes minuta* with poplar at various dividing in contrast with monocropping. In any case, in *Spilanthes*, the net returns were higher from sole editing and in *Withania somnifera* because of high shore of development, the net return got negative. Among various separating 8×3 m and 6×4 m dividing exceeded expectations more than 5×5 m and 4×6 m dispersing, which guaranteed fundamentally higher net gets back from the combination.

Tewari and Singh, (2006) Worked out the intercropping with millet, legumes and oil seeds. It was planted to make micro windbreaks in arid region. Rainfed crops such as mungbean, cluster bean, mothbean and pearl millet are grown with *Ziziphus nummularia* in areas where mean annual rainfall is less than 400mm. Maximum leaf forage of $169 \text{ kg DM ha}^{-1} \text{ yr}^{-1}$ was obtained from this plant in deep alluvial sandy soils.

Harsh and Tewari (2007) reported that the economic analysis of khejri based traditional agroforestry system showed that from bajra alone gross income of Rs. 1600 per ha can be obtained whereas bajra intercropped with khejri (30 trees ha^{-1}) is capable of providing an income of Rs. 4600 per ha. Thus it revealed that khejri + bajra based agroforestry system is much more remunerative.

Tewari *et al.*, (2007) studied that the *Prosopis cineraria* based agroforestry system was the most dominant agroforestry system in western Rajasthan which occupy 47% of the total area followed by *Ziziphus nummularia* based agroforestry system (28%). *Acacia nilotica*, *Tecomella undulata* and *Acacia tortilis* based agroforestry system occupy about 26%.

Singh *et al.*, (2009) conducted a experiment at AFRI, Jodhpur indicated, at 12th year (208 tree ha^{-1}) *Prosopis cineraria* provides utilizable biomass of 19.96 tonnes ha^{-1} including leaf fodder of 0.85 tonnes ha^{-1} as the additional output. In addition to the crop harvested farmer may obtain an annual return of Rs. 3000-3500 per hectare as per the present rate of leaf forage and firewood.

Patil *et al.*, (2010) Experimented on arable yields (maize, paddy, grain maize and sunhemp) green harvests Sapota and silvicultural crops *Eucalyptus*

tereticornis, *Albizia molucana*, *Casuarina equisetifolia*, *Tectona grandis* and *Dalbergia sissoo*. Financial investigation following 17 years demonstrated that, advantage cost proportion and inside pace of profits were most elevated in Agroforestry framework with *T. grandis* (1.67:1 and 23.2%, separately) and were least in Sapota + *Casuarina equisetifolia* (0.99:1 and 12%, individually). The monetary examination toward the finish of 28 years demonstrated that advantage cost proportion was higher in Sapota + *T. grandis* + field crops (3.23:1) trailed by Sapota+ *Lagerstroemia lanceolata* + field crops (2.71:1) and sole Sapota (2.36:1).

Chandra (2014) conducted a study on economic parameters of two intercrops *Amorphophallus paeoniifolius* (Var - Gajendra 1) and *Curcuma longa* L. (Var- Narendra haldi-1) in 11 year old guava (Var- Allahabadi Safeda) orchard. He reported that gross profit was Rs. 3.76 lakh ha⁻¹ for longa and Rs. 5.48 lakh for paeoniifolius in intercropping than pure crops which rendered gross profit of Rs.3.32 lakh ha⁻¹ and Rs. 4.51 lakh ha⁻¹, respectively. The Benefit Cost Ratio (BCR) was recorded 4.74 for Fruit tree + *Curcuma longa* and 2.70 for fruit tree +paeoniifolius, respectively while the same parameters computed 2.78 and 1.52 for *Curcuma longa* and paeoniifolius with monocropping. The cultivation of paeoniifolius proved more remunerative and better intercrop than longa. However, Bhardwaj (2012) reported that under the temperate conditions, turmeric crop gives higher returns under both *Dendrocalamus Hamiltonian* as well as *Phyllostachys pubesense*. Although, highest returns (Rs2.71 lakh ha⁻¹ yr⁻¹) were obtained when turmeric was raised Under the *Phyllostachys pubesense* the highest returns was obtained of Rs. 2.71 lakh ha⁻¹ yr⁻¹.

CHAPTER III

MATERIAL AND METHODS

The present investigation on **“Performance of Sim Saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system”** was carried out during season of 2019 – 2020 in Herbal Garden of Indira Gandhi Krishi Vishwavidyalya Raipur. The details about the experimental site, materials used and methodology adopted for this study are discussed in this chapter.

3.1 The Study Area

Location, Climate, Geology and soil condition of experimental site are given as under:

3.1.1 Location

The experimental site Raipur is located in the South – Eastern part of Chhattisgarh with 21⁰.23 “39 .77” N latitude and 81⁰ .69”44.30”E longitude and having an altitude of 295m above mean sea level. The experiment was conducted on Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry System.

3.1.2 Climate and weather

The climate of the study area is dry sub-humid tropical with an average rainfall of 1250 mm. Most of the rainfall (90%) is received during monsoon season from mid- June to mid- September. The average number of rainy days varies from 65 to 79. The mean monthly maximum temperature ranges from 30.2°C to 32.4 °C in the month of July 19 to November 19 and the minimum temperature 26. °C in January 2020. Maximum relative humidity varied from mid-June to September while, minimum relative humidity was recorded during April and May.

The Experiment was started in the month of June 2019 and crop was finally 1st harvested in September 2019 and 2nd harvested in December 2019. The meteorological data ranges from experiment time in maximum temperature 43°C and minimum temperature 29.5 °C, relative humidity 41.9% and the rainfall 2mm

was recorded in transplanting time of seedling on June month and the harvesting time Relative humidity increase. The maximum average temperature 30.3 °C and minimum average temperature 15.8 °C.

The mean monthly data on different weather parameter viz. temperature, rainfall, relative humidity, sunshine hours and wind speed during the crop growing period (2019-20) are shown in Table 3.1.

3.1.3 Geology

Raipur posses distinct geological formation viz, Bijapur, Cuddaph, Dharwar and Archeau. Lithologically, it is further classified in to Raipur shale and limestone, Gunderdehi shale, Khairagarh sand stone, Cuddaph bar charmer limestone rocks and Chandrapur sandstone grit, Dharwar rock and granite and genesis.

3.1.4 Soil

The soil of Raipur belongs to four different order viz, Entisoles, Vertisoles, Inceptisols and Alfisols. The black clayey soil of experimental field belongs to the order Vertisols and it is locally known as Kanhar. This Kanhar soil are characterized by fine texture, sticky nature, angular blocky structure low to medium Nitrogen, high Potassium and low to medium Phosphorus with low Organic matter. The soil of experimental area is rich in organic carbon and other nutrient because of the addition of litter in the soil every year.

3.2 Experimental details:

- | | |
|-------------------------------|--|
| 1. Crop | : Tulsi Sim Saumya [<i>Ocimum basilicum</i> (L.)] |
| 2. Season | : Kharif 2019-20 |
| 3. Experimental site | : Herbal Garden, IGKV, Raipur |
| 4. Experimental Design | : Randomized block design |
| 5. Replication | : Three |
| 6. Planting material | : Seedling |
| 7. Variety of Tulsi | : Sim Saumya |
| 8. Spacing | : 20 cm x 40 cm. |
| 9. Irrigation | : Twice in a week/ as and when required |
| 10. Cropping system | : Agroforestry system |
| 11. Plot size | : 7.5 m ² |
| 12. Transplanting time | : 26/06/19 |
| 13. Harvesting time | : 1 st harvesting 25/09/19
2 nd harvesting 28/12/19 |

Table 3.1 Climatic features of Raipur during cropping season June 2019–March 2020

Months	Fortnight	Temperature		Rainfall (mm)	Relative humidity (%)			Vapor pressure			Sunshine (hr)
		MAX(°C)	MIN(°C)		I	II	AV	I	II	AV	
Jun-19	1	43.3	29.5	2	56	27.8	41.9	19.96	17.1	18.53	7.06
	2	37.7	26.8	3	78.5	51	64.75	22.7	21.1	21.9	5
Jul-19	1	31.8	25.4	5.6	86.6	70.7	78.65	22.81	22.99	22.9	2.1
	2	33	25.6	7.9	85.9	68.81	77.35	22.9	23.04	22.97	4.45
Aug-19	1	29.2	25	13.5	90.1	82.06	86.08	22.42	23.64	23.03	1.63
	2	31.3	25.3	6.1	91.3	72.87	82.08	23.06	23.75	23.405	3.15
Sep-19	1	30.3	24.8	18	92.6	79.26	85.93	23.02	24.11	23.565	2.14
	2	31.6	24.8	12	90	68.13	79.06	22.8	22.54	22.67	6.1
Oct-19	1	31.7	23.8	0.2	90.8	62.7	76.75	21.4	19.3	20.35	6.3
	2	29.6	22.19	4.9	91.8	66.9	79.35	19.9	19.5	19.7	2.5
Nov-19	1	30.3	18.8	0	90.6	65	77.8	16.08	14.8	15.44	7.05
	2	30.06	15.84	0	89.8	39.73	64.76	13.04	12.13	12.585	7.94
Dec-19	1	28.5	14.2	0	86.8	38.3	62.55	1.4	10.8	6.1	6.2
	2	26.7	13.3	0.1	84.1	40.7	62.4	10.6	9.9	10.25	5.4
Jan-20	1	24.6	11.8	1.5	86.7	49.5	68.1	10	10.1	10.05	5.1
	2	28.6	14.2	0	85.8	42.7	64.25	11.4	11.7	11.55	6.1
Feb-20	1	24.2	13.2	3.3	86.8	52.8	69.7	10.8	10.6	10.7	4.8
	2	30.2	14.4	2.6	88.6	37.3	63	122	11.2	66.6	8
Mar-20	1	30.9	19.3	2.6	86.9	51.4	69.15	16	16.2	16.1	7
	2	33.8	21	0.6	81.9	39.1	60.5	17.2	14.9	16.05	7.8

Note: As data available from meteorological dept. of IGKV Raipur for 2019-2020

3.3 Experimental methodology

3.3.1 Field preparation

Land was prepared thoroughly by deep plugging with tractor drawn cultivator three times. Weeds and crop residue were removed manually then the FYM was mixed with the soil. The total plot is 27 in grow under the Eucalyptus tree plantation.

3.3.2 Layout and design

The experiment was laid out in a randomized block design (RBD) for 9 treatments with 3 replications. Tulsi was transplanting as intercrop under Eucalyptus tree and Plot size is 3m x 2.5 m. were prepared manually. This plot of arrangement of each treatment was made in randomized as per the statically form.

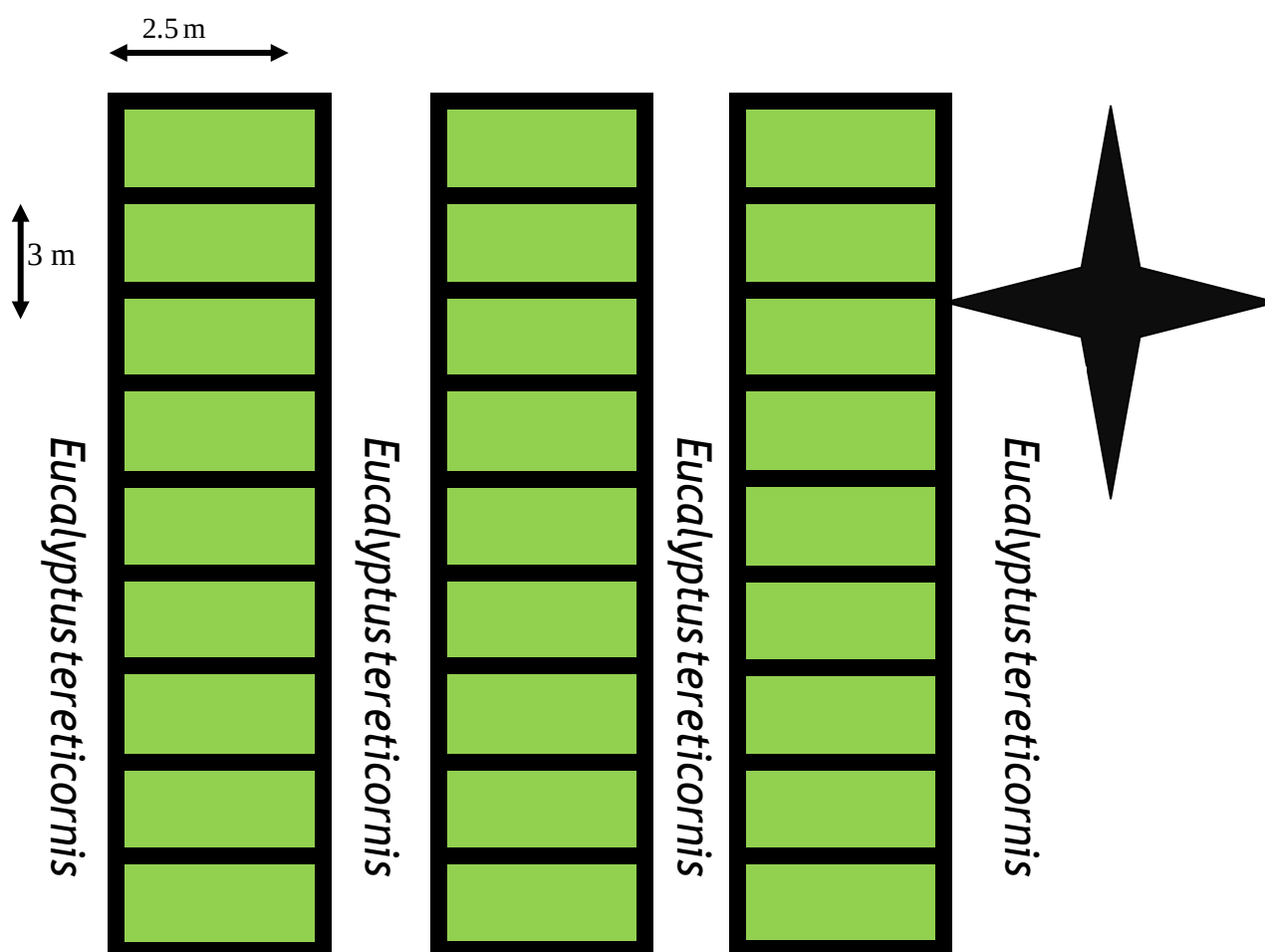


Fig. 3.1 Layout plan of the treatment in experimental field.

3.3.3 Manure application

After delimitation of plots and before transplanting each plot has been treated with the particular treatment according to the designed layout and as per recommended quantity of manure. Following the standard practice of cultivation in maintaining spacing of cropping system manuring was done in each plots with the combination of appropriate treatments.

3.3.4 Treatment:

T₁ : 100 % FYM (Recommended dose)

T₂ : 100% Vermicompost (Recommended dose)

T₃ : 100% Neem cake (Recommended dose)

T₄ : 75% FYM + 25 % Vermicompost

T₅ : 75% FYM + 25% Neem cake

T₆ : 50% Vermicompost + 50 % Neem cake

T₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake

T₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake

T₉ : control zero organic manure

3.3.5 Transplanting

Tulsi were transplanted at a spacing of 20 × 40 cm to get high herbage and oil yield. The plots are irrigated immediately after transplanting.

3.3.6 Irrigation

Tulsi crop was irrigated as requirement depends upon the season and moisture content of soil. The crop will be irrigated once in 15 days as required.

3.3.7 Weeding

Weeds have managed before they started competing with the main crop for nutrients and light. First weeding was done once in the month after planting and the second weeding was carried out after 4 weeks later. After this, no further weeding is required as the plants become bushy there by suppress the weeds.

3.3.8 Harvesting

The 1st harvesting of Tulsi crop was done on 25/09/ 19 and 2nd harvesting was done on 28/12/19. The crop was harvested at full bloom stage to obtain maximum essential oil yield and better quality oil. The crop was harvested at 90-95 days after planting in a stage when the plant was in full bloom and the lower leaves start turning yellowish. Harvesting was done with the help of sickles. It is not desirable to harvest the crop if there was a rain in the previous day.

3.4 Experimental observation

Following observation were made in Tulsi crop and *Eucalyptus tereticornis* plantation along with the microclimatic features. Data was collected from ten plant randomly selected from each plots to represent the crop of per plot.

Crop Parameters

A. Growth Parameters

1. Plant Height (cm)
2. No. of branches per plant
3. Collar diameter(mm)

B. Yield Parameters

1. Herbage yield /ha
2. 2.Oil yield / ha

Tree crop: Eucalyptus (*Eucalyptus tereticornis*)

C. Observation of Eucalyptus

1. Tree height (m)
2. Diameter at breast height *i.e.* DBH (cm)

A. Growth Parameters

The following morphological growth parameters on Tulsi, subjected to different treatments were taken on ten randomly selected plants from each plot and observations was done at 30 days interval after transplanting at 30, 60, 90 Days and 30 days after 1st harvesting, 60 days after 1st harvesting and 90 days after 1st harvesting.

1. Plant height

The height of ten representative plants per plot was measured by Tape in centimeters and recorded for further analysis. The average plant height per plot was calculated for statistical analysis.

2. Number of branches per plant

Numbers of branches from main branches arising from the main stem were counted before the harvesting from each randomly ten plant selected and the average values were calculated under each plot.

3. Collar diameter

Collar diameter of each Tulsi plant was measured with the help of digital vernier calliper. The collar diameter are presented after working out the standard deviation.

B. Yield Parameters

1. Herbage yield /ha

Fresh herbage yield was recorded after harvesting the intercrop. Fresh

herbage yield weight was taken with the help of electronic balance machine. Thereafter, the representative sample, from all treatment and replications were taken and brought to laboratory and dried in sheds room in one days.

2. Oil yield / ha

Oil recovery was estimated by hydro distillation method using Clevenger Apparatus. To estimate the oil of fresh herbage sample, comprising of leaves, inflorescence and very small twigs was taken. The chopped sample was put in 500 ml capacity flask half filled with water. Distillation was done for about four hour. The oil being lighter than water was collected in the burette and reading was recorded and the moisture content for the distilled oil is removed by sodium chloride for every liter of oil. The oil yield per hectare was estimated.

C. Observation of Eucalyptus

1. Trees Height (m)

The height of Eucalyptus tree was measured with the help of Ravi Multimeter. The measurements were made in two times *i.e.* in the month of June 2019 and month of December 2019 height growth was expressed in meters after working out the standard deviation.

2. Diameter at breast height *i.e.* DBH (cm)

Diameter at breast height of each Eucalyptus tree was also measured by vernier caliper 1.37 m above the ground. The average of the observation was find data of DBH of a tree.

3.5 Statistical analysis

The data of all the parameters of Tulsi collected precisely and tabulated, computed and statistically analyzed by using word-excel spreadsheet a randomized block design. The growth data of Eucalyptus tree growth parameters height, and DBH were summarized with standard deviation and presented.

3.6 Photographic records

Photographs of experimented plot area was taken different stages of crop growth and harvesting by digital camera and presented.



Plate 3.1: Standing Sim Saumya [*Ocimum basilicum* (L.)] crop under Eucalyptus tree



Plate 3.2: Measurement of collar diameter (mm) of Sim Saumya [*Ocimum basilicum* (L.)]

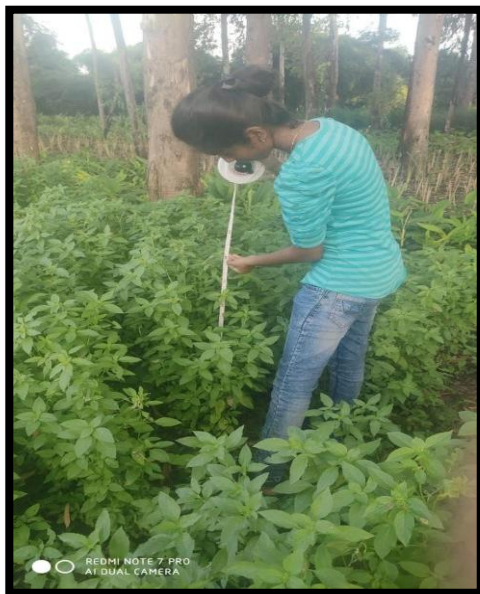


Plate 3.3 Measurement of plant height (cm) of Sim Saumya [*Ocimum basilicum* (L.)]



Plate 3.4: Counting Number of branches of Sim Saumya [*Ocimum basilicum* (L.)]



Plate 3.5: 1st harvesting of Sim Saumya [*Ocimum basilicum* (L.)]



Plate 3.6: 2nd harvesting of Sim Saumya [*Ocimum basilicum* (L.)]



Plate 3.7: Herbage of Sim Saumya [*Ocimum basilicum* (L.)]



Plate 3.8: Oil distillation of Sim Saumya [*Ocimum basilicum* (L.)]

CHAPTER-IV

RESULT AND DISCUSSIONS

The experimental results and discussion on “**Performance of Sim saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system**” are presented in this chapter. Data were recorded for various growth and yield parameters of Sim saumya crop and Eucalyptus tree during the study period. All these data were tabulated and subjected to their statistical analysis for interpretation of the results. The present study was carried out to investigate the effect of organic manure on growth and yield of Tulsi (Var. Sim saumya). The results obtained from the experiments have been cited and discussed in the Figure.

4.1 Growth Parameters of Tulsi crop

Results on growth parameters viz; Plant height, Number of branches, collar diameter are described from 30, 60 and 90 DAP and the full bloom stage was 90 days after transplanting.

4.1.1 Plant height (cm)

Plant height of Tulsi crop was measures at 30, 60 and 90 days after transplanting .The data on the effect of different organic manure on the plant height of Tulsi (Var. Sim saumya) are presented in Fig. 4.1 and 4.2. The plant height of Sim saumya was statistically significantly difference were observed among the different treatments in 1st harvesting and 2nd harvesting.

4.1.1.1 1st harvesting

At 30 DAP maximum plant height per plant was observed in T₁ 100% FYM (66.33 cm) followed by T₂ 100% vermicompost (54.23cm), T₄ 75% FYM + 25 % Vermicompost (48.77cm) and minimum plant height was obtained in T₉ control no organic manure (40.70cm).

At 60 DAP maximum plant height per plant was observed in T₁ 100%

FYM (95.73 cm) followed by T₂ 100% vermicompost (76.30cm),T₄ 75% FYM+25% Vermicompost (66.73cm) and minimum plant height was obtained in T₉ control no organic manure (50.70cm).

At 90 DAP maximum plant height per plant was observed in T₁ 100% FYM (102.53 cm) and followed by T₂ 100% vermicompost (95.70cm) , T₄ 75% FYM + 25 % Vermicompost (86.93 cm) and minimum plant height was obtained in T₉ control no organic manure (62.93cm).

4.1.1.2 2nd harvesting

At 30 days after 1st harvesting maximum plant height per plant was observed in T₁ 100% FYM (62.57 cm) followed by T₂ 100% vermicompost (48.83cm), T₄ 75% FYM + 25% Vermicompost (45.37cm) and minimum plant height was obtained in T₉ control no organic manure (38.73cm).

At 60 days after 1st harvesting maximum plant height per plant was observed in T₁ 100% FYM (76.73 cm) followed by T₂ 100% vermicompost (68.83cm), T₄ 75% FYM + 25% Vermicompost (50.17cm) and minimum plant height was obtained in T₉ control no organic manure (42.47cm).

At 90 days after 1st harvesting maximum plant height per plant was observed in T₁ 100% FYM (97.77 cm) followed by T₂ 100% vermicompost (78.33cm) , T₄ 75% FYM + 25% Vermicompost (61.57 cm) and minimum plant height was obtained in T₉ control no organic manure (48.57cm).

Plant height is considered as one of the bio parameter, indicating the growth as well as development of the crop .The plant height fig 4.1 and 4.2 was significantly affected by the presence of Eucalyptus and the application of different organic manure. The result showed that the growth of plant height of Sim saumya was higher where organic manure was applied as compare to no organic manure application under the Eucalyptus based agroforestry system.

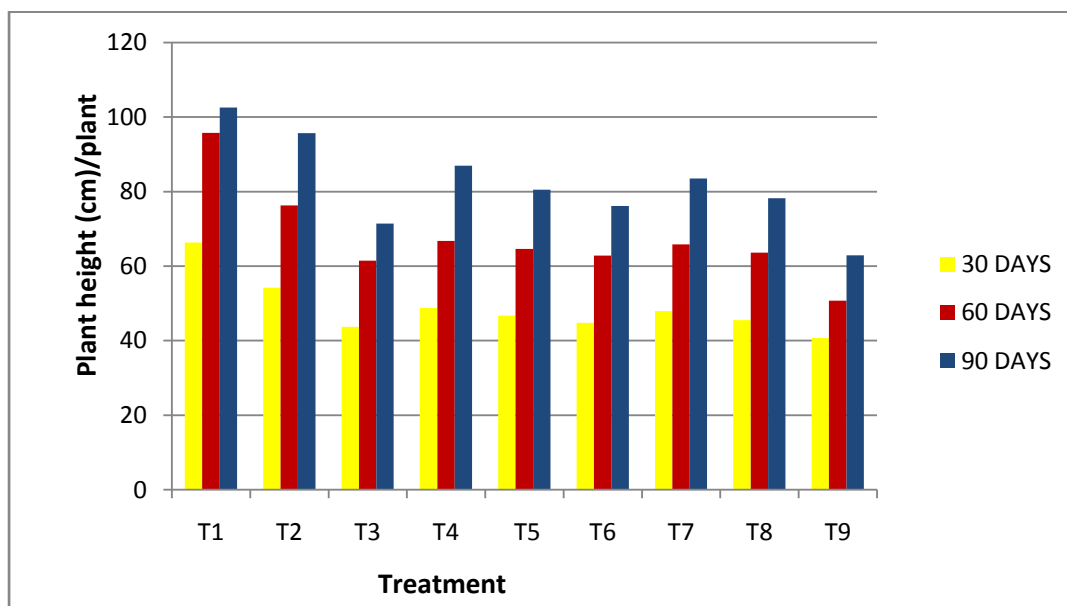


Fig. 4.1: Effect of different organic manure on plant height (cm)/plant of Simsaumya [*Ocimum basilicum*(L.)] of 1st harvesting under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

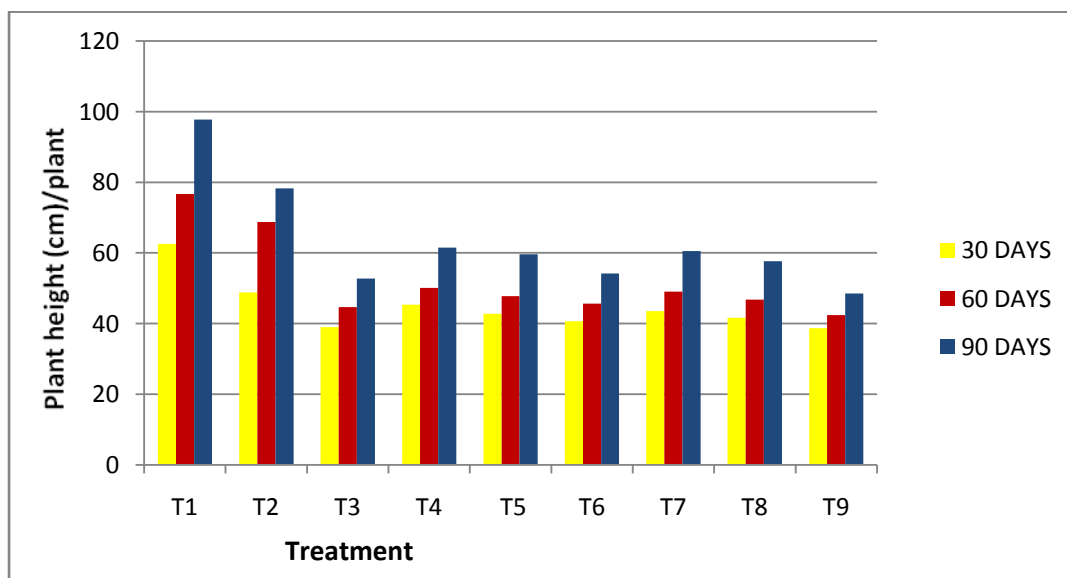


Fig. 4.2: Effect of different organic manure on plant height (cm)/plant of Simsaumya [*Ocimum basilicum*(L.)] of 2nd harvesting under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Similar finding results were cited by Islam (2004). The plant height was higher where cow dung was applied as manure and lowest in control. In another study carried out by Vijaya Rachel and Sirisha (2016). Increasing in plant height might be attributed due to the effect of organic fertilizer that improves physical, chemical, and biological properties of soil; that is, increasing soil organic matter, cation exchange capacity, and water holding capacity and availability of mineral nutrients and, this in turn, increases plant height (Al-Fraihat, 2011) The increase in plant height due to application of organic manure might be attributed to the effect of organic fertilizer that improves physical, chemical, and biological properties of soil; that is, increasing soil organic matter, cation exchange capacity, water holding capacity and availability of mineral nutrients which increases plant height.

4.1.2 No. of branches / plant

Number of branches of Tulsi crop was measures at 30, 60 and 90 days .The data presented in Fig. 4.3 and 4.4 clearly showed the number of branches per plant indicated that significant variation observed due to application of different organics manure treatments. In the both harvest all the treatment exhibited significant influence over the number of branches produced per plant.

4.1.2.1 1st harvesting

At 30 DAP maximum No. of branches per plant was observed in T₁ 100% FYM (9.87) and followed by T₂ 100% vermicompost (8.46) , T₄ 75% FYM + 25 % Vermicompost (7.66) and minimum no. of branches was obtained in T₉ control no organic manure (1.97).

At 60 DAP maximum No. of branches per plant was observed in T₁ 100% FYM (14.87) followed by T₂ 100% vermicompost (13.76) , T₄ 75% FYM + 25 % Vermicompost (12.43) and minimum No. of branches was obtained in T₉ control no organic manure (5.83).

At 90 DAP maximum No. of branches per plant was observed in T₁ 100% FYM (18.06) and followed by T₂ 100% vermicompost (16.60) , T₄ 75% FYM + 25 % Vermicompost (15.36) and minimum No. of branches was obtained in T₉

control no organic manure (8.70).

4.1.2.2 2nd harvesting

At 30 days after 1st harvesting maximum No. of branches per plant was observed in T₁ 100% FYM (8.66) followed by T₂ 100% vermicompost (7.86) , T₄ 75% FYM + 25 % Vermicompost (6.83) and minimum No. of branches was obtained in T₉ control no organic manure (1.87).

At 60 days after 1st harvesting maximum No. of branches per plant was observed in T₁ 100% FYM (14.13) and followed by T₂ 100% vermicompost (11.57) , T₄ 75% FYM + 25% Vermicompost (10.53) and minimum No. of branches was obtained in T₉ control no organic manure (4.50).

At 90 days after 1st harvesting maximum No. of branches per plant was observed in T₁ 100% FYM (16.87) and followed by T₂ 100% vermicompost (15.56) , T₄ 75% FYM + 25% Vermicompost (14.73) and minimum No. of branches was obtained in T₉ control no organic manure (6.86).

Number of branches were maximum in T₁ where 100% organic manure was applied (FYM) as compared to without organic manure (control) this might be due to application of organic manure the number of branches were increased in the Eucalyptus based agroforestry system.

The reason might be due to the organic manure like FYM and vermicompost helps to maintain soil fertility and nitrogen give continuous nutrients to plant.

Similar findings were cited by Khatik *et al.* (2001). The FYM doses were significantly superior over to control. The application of FYM increased number of branches per plant. Similar results were observed by Hosni *et al.* (1998) in Tulsi. The no. of branch/plant was highest where cow dung was applied and lowest in control.

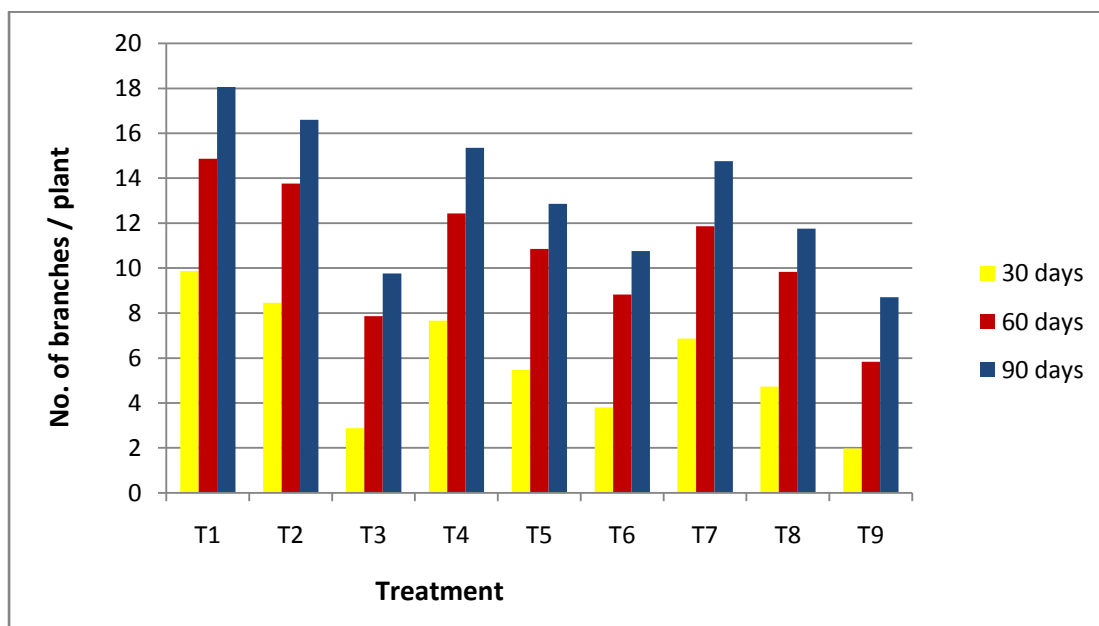


Fig 4.3 Effect of different organic manure on number of branches /plant in 1st harvesting of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

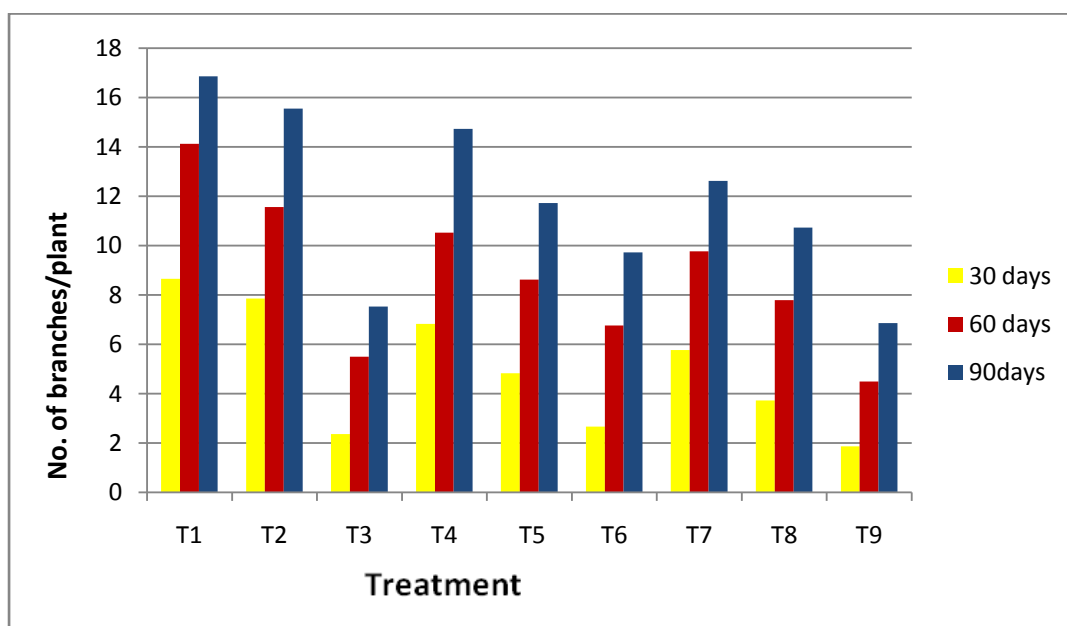


Fig 4.4 Effect of different organic manure on number number of branches / plant in 2nd harvesting of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

4.1.3 Collar diameter (mm)

Collar diameter of Tulsi crop was measured at 30, 60 and 90 DAP. The data presented in Fig. 4.5 and 4.6 showed the collar diameter (mm) per plant indicated the significantly influenced in different organic manure. In both harvesting all the treatments significantly influence the collar diameter.

4.1.3.1 1st harvesting

At 30 DAP maximum Collar diameter per plant was observed in T₁ 100% FYM (11.93 mm) followed by T₂ 100% vermicompost (10.63 mm), T₄ 75% FYM + 25 % Vermicompost (7.47 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (2.37mm).

At 60 DAP maximum Collar diameter per plant was observed in T₁ 100% FYM (17.6 mm) followed by T₂ 100% vermicompost (14.27 mm), T₄ 75% FYM + 25 % Vermicompost (8.43 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (2.93 mm).

At 90 DAP maximum Collar diameter per plant was observed in T₁ 100% FYM (18.57 mm) and followed by T₂ 100% vermicompost (15.97mm), T₄ 75% FYM + 25 % Vermicompost (10.20 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (4.57 mm).

4.1.3.2 2nd harvesting

At 30 days after 1st harvesting maximum Collar diameter per plant was observed in T₁ 100% FYM (18.23 mm) followed by T₂ 100% vermicompost (15.97 mm), T₄ 75% FYM + 25 % Vermicompost (10.70 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (5.63mm).

At 60 days after 1st harvesting maximum Collar diameter per plant was observed in T₁ 100% FYM (18.33 mm) followed by T₂ 100% vermicompost (16.10 mm), T₄ 75% FYM + 25% Vermicompost (10.87 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (5.83 mm).

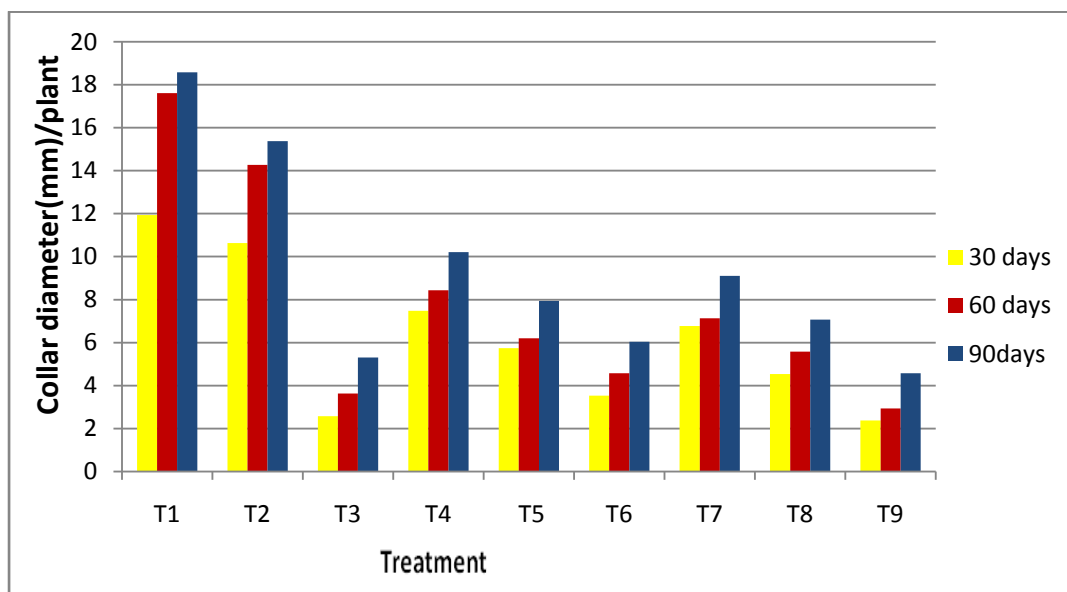


Fig 4.5 Effect of different organic manure on collar diameter (mm) / plant in 1st harvesting of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

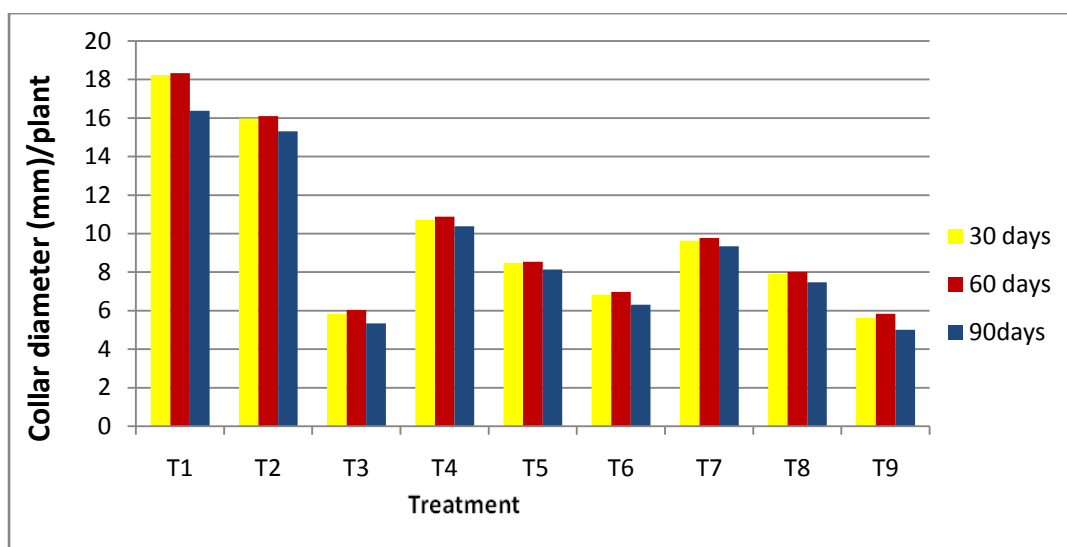


Fig. 4.6: Effect of different organic manure on collar diameter (mm) / plant in 2nd harvesting of Sim saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*)based agroforestry system

At 90 days after 1st harvesting maximum Collar diameter per plant was observed in T₁ 100% FYM (16.37 mm) and followed by T₂ 100% vermicompost (15.30mm), T₄ 75% FYM+ 25 % Vermicompost (10.37 mm) and minimum Collar diameter was obtained in T₉ control no organic manure (5.00 mm).

The collar diameter measurements have taken 2 cm above the ground level. The Fig. 4.5 and 4.6 showed that the collar diameter was significantly affected by the Eucalyptus based agroforestry system and the application of different organic manure. The result showed that the collar diameter of Sim saumya was maximum in organic manure as compared to no organic manure treatment. The collar diameter was record maximum in with the application of 100% FYM.

4.2 Yield parameter of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

The yield parameter of Sim saumya such as both herbage yield and oil yield are presented in table 4.1 and 4.2

4.2.1 Harbage yield of Sim saumya

In both the harvest herbage yield was significant influenced by the different organic manure. Application of various organic manure in treatment and observed the maximum and minimum herbage yield was clearly presented in Table 4.1.

4.2.1.1 1st harvesting

After harvesting maximum herbage yield was obtain in T₁ 100% FYM (19.83t/ha) followed by T₂ 100% vermicompost (18.73t/ha), T₄ 75% FYM + 25 % Vermicompost (17.86t/ha) and minimum herbage yield was recorded in T₉ control with no organic manure (11.73t/ha).

4.2.1.2 2nd harvesting

And the 2nd harvesting also performed the same pattern of yield in all attributes. The highest herbage yield was obtained in T₁ 100% FYM (18.56t/ha) followed by T₂ 100% vermicompost (17.63t/ha) , T₄ 75% FYM + 25 % Vermicompost (16.67t/ha) and minimum herbage yield was recorded in T₉ control no organic manure (10.73t/ha).

The herbage yield evinced that agroforestry system significant affected the yield of Eucalyptus based agroforestry system. Different treatment was applied and then observed the the yield attributes .Maximum herbage yield was obtained in T1 with application of 100% organic manure (FYM) under the agroforestry system and minimum yield was recorded in control without organic manure.

Table 4.1: Effect of different organic manure on herbage yield (t/ha) of Sim saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Treatment	Herbage yield (t/ha)	
	1st harvesting (t/ha)	2 nd harvesting (t/ha)
T ₁ : 100 % FYM	19.83	18.56
T ₂ : 100% Vermicompost	18.73	17.63
T ₃ : 100% Neem cake	12.76	11.77
T ₄ : 75% FYM + 25 % Vermicompost	17.86	16.67
T ₅ : 75% FYM + 25% Neem cake	15.73	14.63
T ₆ : 50% Vermicompost + 50 % Neem cake	13.73	12.76
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	16.76	15.73
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	14.77	13.83
T ₉ : control zero organic manure	11.73	10.73
SEm±	0.09	0.11
CD @ (P=0.05)	0.28	0.33

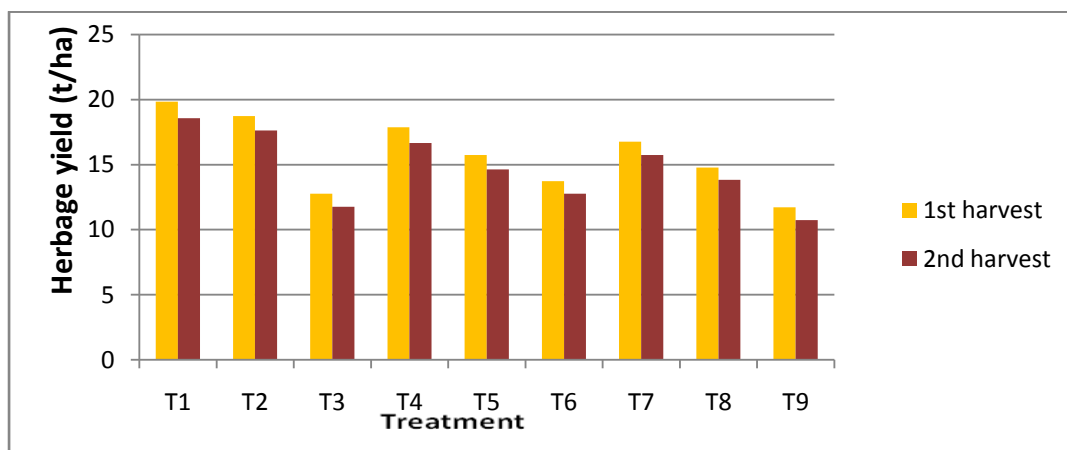


Fig. 4.7: Effect of different organic manure on herbage yield (t/ha) of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

The beneficial responses of FYM on the herbage yield have also been reported by other workers. The maximum dry herbage yield was obtained due to application of FYM 10ton/ha. Similar result was observed by (Gill *et al.* 1992, Prakash *et al.* 2005, Sandeep-Sanhgal; Thakur, P-S *et al.*, 2009)

Similar result finding might be that performance of organic manures gives slow mineralization of organics and even immobilization which results in to availability of plant nutrients at early growth stage of plant and this are organic manures add higher phosphorus and potassium content in soil than conventional farming (Jin *et al.*,1996).

4.2.2 Oil yield of Sim saumya

The data of oil yield revealed that significantly influenced by the different organic manure treatments and both the harvest shows that the significant differences to the data related to oil yield in Table 4.2.

4.2.2.1 1st harvesting

After 1st harvesting maximum oil yield was obtained in T₁ 100% FYM (22.67kg/ha) followed by T₂ 100% vermicompost (21.76 kg/ha) , T₄ 75% FYM + 25 % Vermicompost (20.73kg/ha) and minimum oil yield was recorded in T₉

control no organic manure (14.76kg/ha).

4.2.2.1 2nd harvesting

In The 2nd harvesting oil yield was noted that the similar pattern of yield was recorded. maximum oil yield was obtained in T₁ with application of 100% FYM (21.77kg/ha) followed by T₂ 100% vermicompost (20.76kg/ha) , T₄ 75% FYM + 25 % Vermicompost (19.73kg/ha) and minimum oil yield was recorded in T₉ control no organic manure (13.67kg/ha).The oil yield of Tulsi were found to be higher during first harvesting of study as compared to second harvesting.

Essential oil yield highly depends on herbage yield of Tulsi crop. The presented result of yield may be due to the influence of FYM in promoting the vegetative growth, which resulted in increased herbage production, consequently, essential oil yield increased

Table 4.2: Effect of different organic manure on oil yield (kg/ha) of Simsaumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Treatment	Oil yield (kg/ha)	
	1 st Harvesting (kg/ha)	2 nd Harvesting (kg/ha)
T ₁ : 100 % FYM	22.67	21.77
T ₂ : 100% Vermicompost	21.76	20.76
T ₃ : 100% Neem cake	15.66	14.63
T ₄ : 75% FYM + 25 % Vermicompost	20.73	19.73
T ₅ : 75% FYM + 25% Neem cake	18.73	17.83
T ₆ : 50% Vermicompost + 50 % Neem cake	16.77	15.73
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	19.73	18.63
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	17.83	16.87
T ₉ : control zero organic manure	14.76	13.67
SEm±	0.08	0.17
CD @ (P=0.05)	0.24	0.52

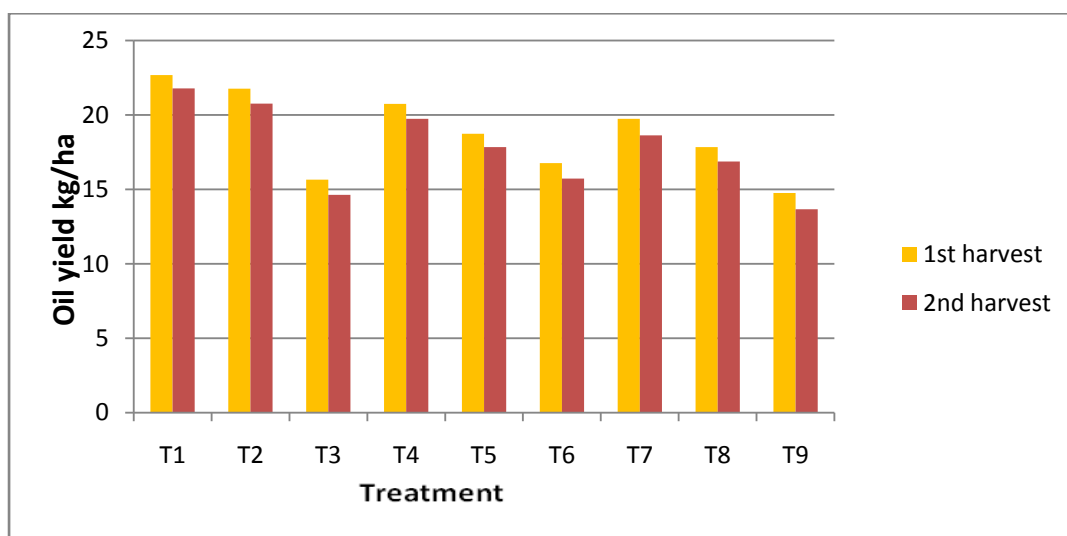


Fig. 4.8 Effect of different organic manure on oil yield (kg/ha) of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

The application of FYM @ 5 t/ha significantly increased fresh herbage yield as compare to the rest of the treatments which ultimately results in higher oil yield (22.67 kg /ha). Oil yield is significantly influence by the different treatment under the agroforestry system. Similar result supports. It is demonstrated that using vermicompost and compost increase the relative content of linalool and methyl chavicol in basil (*Ocimum basilium*) (Anwar *et al.*, 2012).

4.3 Tree growth parameter

Tree growth characteristic *i.e.* tree height (m) and DBH (Diameter at breast height) were recorded before sowing of Tulsi crop *i.e.* June 2019 and after the harvest of Tulsi crop *i.e.* December 2019 and data are presented in table 4.3.

4.3.1 Height (m)

It is clearly depicted in the above Table 4.3 that average tree height growth of *Eucalyptus tereticornis* was observed as before sowing and after harvesting of Sim saumya. The before sowing average tree height was 27.31 m and after harvesting average tree height was 27.54 m.

Table 4.3 Growth characteristic of Eucalyptus (*Eucalyptus tereticornis*)

No. Of tree	Before sowing		After harvesting	
	Height (m)	DBH(cm)	Height (m)	DBH(cm)
1	30.14	26.9	30.21	26.9
2	17.2	19.9	17.9	20.1
3	32.12	27.7	32.21	27.8
4	20.12	21.8	20.21	21.9
5	29.4	26.5	29.9	26.6
6	25.9	24.6	26.1	24.7
7	19.15	20.2	19.22	20.3
8	22.13	23.5	22.21	23.6
9	21.15	22.8	21.22	22.9
10	30.12	26.5	30.19	26.5
11	22.16	23.9	22.21	23.9
12	22.9	24.1	23.1	24.2
13	35.4	29.5	35.9	29.6
14	29.5	26.8	29.9	26.9
15	23.5	24.4	23.9	24.5
16	25.9	25.7	26.12	25.8
17	32.13	27.8	32.22	27.9
18	33.15	28.6	33.24	28.7
19	26.2	25.9	26.9	25.9
20	28.5	26	28.9	26.1
21	34.9	28.9	35.11	28.9
22	30.9	26.2	31.12	26.3
23	30.5	26.1	30.9	26.2
24	32.6	27	32.15	27.1
Average	27.31	25.47	27.54	25.55

4.3.2 Diameter at Breast Height (cm)

Table shows that the average tree DBH is 25.47 cm before transplanting of Tulsi and after harvesting the crop measure the average tree DBH is 55cm.

Before sowing of Tulsi crop and after harvesting of crop respectively, the results showed that there was a minor difference in height and diameter. As a result, after the harvest of intercrops due to 06 months period did not showed much differences in height and diameter at breast height.

Normally agroforestry practices of Eucalyptus with Tulsi crop reduced the growth parameter viz; Tree height and DBH (at breast height) as compared to pure plantation due to nutrient supply to rainfed farming .However provision of irrigation gave little better result for growth performance of Eucalyptus. Eucalyptus based agroforestry system with better tree growth performance in case of Eucalyptus with maize and sorghum. (Sunil Pankaj *et.al.*2012.)

4.4 Economics of different organic nutrient in Sim saumya [*Ocimum basilicum*(L.)]

4.4.1 Cost of cultivation (Rs/ha)

Data on Cost of cultivation were given in Table 4.4 Data regarding cost of cultivation showed the highest (Rs. 68105) was obtained under the treatment T₃ 100% Neem cake, followed by T₉ control zero organic manure (Rs.63833), T₆ 50% Vermicompost + 50 % Neem cake (Rs.62303), T₈25% FYM + 25 % Vermicompost + 50 % Neem cake (Rs.58205), T₅75% FYM + 25% Neem cake (Rs.50372), T₇50% FYM + 25 % Vermicompost + 25% Neem cake (Rs.49797), T₂ 100% Vermicompost (Rs.43702), T₄75% FYM + 25 % Vermicompost (Rs. 42032) and the lowest recorded in T₁ 100 % FYM was (Rs.32432).

4.4.2 Gross return (Rs/ha)

Data on Gross return were given in Table 4.4 Data regarding Gross return showed the highest (Rs. 102212) was obtained under the treatment T₁ 100 % FYM , followed by T₂ 100% Vermicompost (Rs. 97796), T₄ 75% FYM + 25 % Vermicompost (Rs. 93058), T₇ 50% FYM + 25 % Vermicompost + 25% Neem cake (Rs. 88228) T₅ 75% FYM + 25% Neem cake (Rs. 84088), T₈ 25% FYM + 25 % Vermicompost + 50 % Neem cake (Rs. 79810), T₆ 50% Vermicompost + 50 % Neem cake (Rs. 74750) and T₃100% Neem cake (Rs. 69667)while the lowest

recorded in T₉ (Control) was (Rs. 65389).

4.4.3 Net return (Rs/ha.)

Data on Net return were given in Table Data regarding net return showed the highest (Rs. 69780) was obtained under the treatment T₁ 100 % FYM , followed by T₂ 100% Vermicompost (Rs. 54094), T₄ 75% FYM + 25 % Vermicompost (Rs. 51026), T₇ 50% FYM + 25 % Vermicompost + 25% Neem cake (Rs. 38431) T₅ 75% FYM + 25% Neem cake (Rs. 33716), T₈ 25% FYM + 25 % Vermicompost + 50 % Neem cake (Rs. 21605), T₆ 50% Vermicompost + 50 % Neem cake (Rs. 12447) and T₃ (100% Neem cake Rs. 1505) while the lowest recorded in T₉ (Control) was (Rs. 746).

4.4.4 B: C ratio

Data on Benefit Cost Ratio were given in Table Data regarding benefit cost ratio (B/C) showed the highest (3.15) was obtained under the treatment T₁ 100 % FYM (3.15) , followed by T₂ 100% Vermicompost (2.23), T₄ 75% FYM + 25 % Vermicompost (2.21), T₇ 50% FYM+ 25 % Vermicompost + 25% Neem cake (1.77), T₅ 75% FYM + 25% Neem cake (1.66), T₈ 25% FYM + 25 % Vermicompost + 50 % Neem cake (1.37), T₆ 50% Vermicompost + 50 % Neem cake (1.19) and T₃ 100% Neem cake (1.02) while the lowest recorded in T₉ (Control) was (1.01).

The data revealed that the highest gross returns (Rs 102212) and net returns per ha (Rs. 69780) were registered in T₁ treatment with 100% FYM and the lowest were recorded in the T₉ treatment with control zero fertilizer. The highest Benefit-cost ratio (3.15) registered in the T₁ treatment with 100% FYM while the minimum (1.00) was obtained with T₉ treatment with control zero fertilizer.

Similar results were observed by (Thakur *et al.*, 2009) in Tulsi . The outcome of net return from oil production in the present study were higher than those accrued from essential oil of *O. sanctum* cultivated under different agroforestry systems.

Table 4.4 Effect of different nutrient on Benefit Cost Ratio of Sim saumya [*Ocimum basilicum* (L.)] under Eucalyptus(*Eucalayptus tereticornis*) based agroforestry system

Treatment	Cost of cultivation (Rs./ha)	Oil yield (kg/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Benefit cost ratio (B:C)
T ₁ : 100 % FYM	32432	44.44	102212	69780	3.15
T ₂ : 100% Vermicompost	43702	42.52	97796	54094	2.23
T ₃ : 100% Neem cake	68105	30.29	69667	1562	1.02
T ₄ : 75% FYM + 25 % Vermicompost	42032	40.46	93058	51026	2.21
T ₅ : 75% FYM + 25% Neem cake	50372	36.56	84088	33716	1.66
T ₆ : 50% Vermicompost + 50 % Neem cake	62303	32.5	74750	12447	1.19
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	49797	38.36	88228	38431	1.77
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	58205	34.7	79810	21605	1.37
T ₉ : control zero organic manure	63833	28.43	65389	1556	1.00

CHAPTER V

SUMMARY AND CONCLUSION

The present investigation on “**Performance of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based Agroforestry system**” was carried out during season 2019 – 2020 in Herbal Garden of Indira Gandhi Krishi Vishwavidyalya Raipur. The investigation aims to analyzing the effect of Eucalyptus tree and different organic manure on the growth and yield of Tulsi crop. The experiment was laid out in randomized block design with three replication comprising of organic manure and control treatment under the Eucalyptus tree.

Tulsi [*Ocimum basilicum*(L.)] was grown under the plantation of Eucalyptus as a cover crop. The data were observed at days after transplanting an interval of 30, 60, 90 DAP during growth period of Tulsi crop and 30 days after 1st harvesting, 60 days after 1st harvesting and 90 days after 1st harvesting. Growth parameter such as plant height, No. of branches and collar diameter were regularly recorded. Yield parameter of Tulsi crop such as herbage yield and oil yield were recorded after 1st and 2nd harvesting.

Plantation of Eucalyptus (*Eucalyptus tereticornis*) tree also measured for their growth characteristic viz; total tree height (m) and diameter at breast height (cm) before sowing and after harvesting of tree parameter for the Tulsi crop.

Growth parameter of Tulsi crop

Growth in morphological parameter of Tulsi crop viz; plant height, collar diameter and No. of branches were observed.

Plant height (cm)

The results indicated that the plant height per plant of Tulsi were significantly affected by the application of organic manures 100% FYM under Eucalyptus .

In 1st harvesting plant height in T₁ showed maximum height in cm at 30,

60, 90 days after transplanting.

Similarly the 2nd harvesting plant height in T₁ showed maximum height in cm at 30, 60, 90 days after 1st harvesting. In case of different organic manure it was in order of plant height T₁>T₂>T₄>T₇>T₅>T₈>T₆>T₃>T₉.

Number of branches

The outcomes demonstrated that the maturity parameter of Tulsi plants. Number of branches per plant was significantly influenced by the utilization of organic manure under Eucalyptus.

In 1st harvesting number of branches per plant in T₁ showed maximum branches at 30, 60, 90 days after transplanting.

Similar the 2nd harvesting number of branches per plant in T₁ showed maximum branches at 30,60, 90 days after 1st harvesting. In case of different organic manure it was in order of number of branches T₁>T₂>T₄>T₇>T₅>T₈>T₆>T₃>T₉.

Collar diameter (mm)

The results indicated that the collar diameter per plants of Tulsi were significantly affected by the application of organic manures FYM under Eucalyptus. In 1st harvesting collar diameter per plant in T₁ showed maximum diameter in mm at 30,60, 90 days after transplanting.

Similar the 2nd harvesting collar diameter per plant in T₁ showed maximum diameter in mm at 30, 60, 90 days after 1st harvesting.

Yield parameter

Different yield parameter of Tulsi such as herbage yield and oil yield were recorded after harvesting.

Herbage yield t/ha

In both the harvest is herbage yield was significant influenced by the

different organic manure. Application of various organic manure in treatment and observed the maximum and minimum herbage yield.

In both the 1st and 2nd harvesting the herbage yield of Tulsi crop was observed maximum in T₁ after harvesting of crop. In case of different organic manure it was in order of herbage yield T₁>T₂>T₄>T₇>T₅>T₈>T₆>T₃>T₉.

Oil yield kg/ha

Essential oil yield highly depends on herbage yield than the oil content of Tulsi. The presented result may be due to the influence of FYM in promoting the vegetative growth, which resulted in increased herbage production, consequently, essential oil yield increased. The oil yield of Tulsi is significantly variance under different organic manure.

In both the 1st and 2nd harvesting the oil yield of Tulsi crop was also observed maximum in T₁ after harvesting of crop. In case of different organic manure it was in order of oil yield T₁>T₂>T₄>T₇>T₅>T₈>T₆>T₃>T₉.

Tree growth parameter of Eucalyptus tree height and DBH

The growth parameter *i.e.* Height (m) and DBH(cm) of the Eucalyptus (*Eucalyptus tereticornis*) were observed not significant in 6 month of period.

Economics

Cost of cultivation is FYM is low as compare to other organic manure. The result indicated the highest gross return and net return is observing the FYM.

Conclusion

- The oil yield was obtained in Tulsi crop (22.67 kg/ha) and (21.77 kg/ha) in 1st harvesting and 2nd harvesting under agroforestry system. The overall data is significant under the Eucalyptus tree. The Sim saumya [*Ocimum basilicum*(L.)] plant growth was maximum in 100% FYM (102.53 cm) as compare to control (62.93 cm).

- The cultivation of Tulsi as cover crop are because the production of Eucalyptus at its maturity can generate extra income after harvest. Here Tulsi crop shown better results in 100% FYM treatment thus it can be acceptable for cultivation as cover crop under the plantation to generate income.
- Considering the above conversation, It is an clearly identifiable that FYM and vermicompost manure its predominance on plant tallness, no. of branches , collar diameter, oil yield and herbage yield of Tulsi as standard to the control. So as to keep up great soil and keep nature sound, it would be the best to inform former for the application concerning FYM and vermicompost for development home grown therapeutic plant.
- The results acquired from the current examination demonstrated that the exhibition of Sim saumya under agroforestry framework when contrasted with control treatment. The development, yield and physiological credits of Tulsi spices were not antagonistically influenced by the presence of Eucalyptus tree. The plants becoming under agroforestry framework indicated better development and yield.
- The utilization of organic manure had positive effect on the development and yield of Tulsi spices in presence of trees. Higher portion of organic manure for example 5t/ha FYM and 2.5t/ha vermicompost more viable in improving development and yield ascribes of Tulsi plants intercropped under Eucalyptus. The use of organic manures improves the soil structure, bulk density, water holding capacity of soil which in turn increases the growth and production of Tulsi herbs under agroforestry system.

SUGGESTION FOR FUTURE

- The intensive research work are needed to conduct for a detailed study pertaining to the tree-crop relationship, microclimate as well as bio-parameters under the Eucalyptus based agroforestry land utilization program for more effective recommendation of management practices.

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APPENDICES

APPENDIX A

Table: Effect of different organic manure on Plant height (cm)/plant of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Treatment	Plant height (cm)					
	1st harvesting			2nd harvesting		
	30 days	60 days	90 days	30 days	60 days	90 Days
T ₁ : 100 % FYM	66.33	95.73	102.53	62.57	76.73	97.77
T ₂ : 100% Vermicompost	54.23	76.3	95.7	48.83	68.83	78.33
T ₃ : 100% Neem cake	43.73	61.47	71.43	39.07	44.7	52.77
T ₄ : 75% FYM + 25 % Vermicompost	48.77	66.73	86.93	45.37	50.17	61.57
T ₅ : 75% FYM + 25% Neem cake	46.73	64.6	80.47	42.8	47.77	59.63
T ₆ : 50% Vermicompost + 50 % Neem cake	44.8	62.83	76.13	40.73	45.67	54.23
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	47.93	65.8	83.53	43.57	49.1	60.6
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	45.5	63.63	78.23	41.7	46.83	57.7
T ₉ : control zero organic manure	40.7	50.7	62.93	38.73	42.47	48.57
SEm±	0.57	0.72	0.80	0.33	0.57	0.65
CD @ (P=0.05)	1.71	2.15	2.39	1.00	1.72	1.944

APPENDIX B

Table: Effect of different organic manure on number of branches/plant of Sim saumya [*Ocimum basilicum*(L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Treatment	Number of branches					
	1st harvesting			2nd harvesting		
	30 days	60 days	90 days	30 days	60 days	90 days
T ₁ : 100 % FYM	9.87	14.87	18.06	8.66	14.13	16.87
T ₂ : 100% Vermicompost	8.46	13.76	16.60	7.86	11.57	15.56
T ₃ : 100% Neem cake	2.87	7.86	9.76	2.37	5.50	7.53
T ₄ : 75% FYM + 25 % Vermicompost	7.66	12.43	15.36	6.83	10.53	14.73
T ₅ : 75% FYM + 25% Neem cake	5.46	10.86	12.86	4.83	8.63	11.73
T ₆ : 50% Vermicompost + 50 % Neem cake	3.8	8.83	10.76	2.67	6.77	9.73
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	6.86	11.86	14.76	5.77	9.77	12.63
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	4.73	9.83	11.76	3.73	7.80	10.73
T ₉ : Control zero organic manure	1.97	5.83	8.7	1.87	4.50	6.86
SEm±	0.10	0.13	0.19	0.16	0.13	0.10
CD @ (P=0.05)	0.30	0.38	0.58	0.49	0.40	0.29

APPENDIX C

Table: Effect of different organic manure on collar diameter (mm)/plant of Sim saumya [*Ocimum basilicum* (L.)] under Eucalyptus (*Eucalyptus tereticornis*) based agroforestry system

Treatment	Collar Diameter (mm)					
	1st harvesting			2nd harvesting		
	30 days	60 days	90 days	30 days	60 days	90 days
T ₁ : 100 % FYM	11.93	17.6	18.57	18.23	18.33	16.37
T ₂ : 100% Vermicompost	10.63	14.27	15.37	15.97	16.10	15.30
T ₃ : 100% Neem cake	2.57	3.63	5.30	5.83	6.03	5.33
T ₄ : 75% FYM + 25 % Vermicompost	7.47	8.43	10.20	10.70	10.87	10.37
T ₅ : 75% FYM + 25% Neem cake	5.73	6.20	7.93	8.47	8.53	8.13
T ₆ : 50% Vermicompost + 50 % Neem cake	3.53	4.57	6.03	6.83	6.97	6.30
T ₇ : 50% FYM + 25 % Vermicompost + 25% Neem cake	6.77	7.13	9.10	9.63	9.77	9.33
T ₈ : 25% FYM + 25 % Vermicompost + 50 % Neem cake	4.53	5.57	7.07	7.90	8.00	7.47
T ₉ : control zero organic manure	2.37	2.93	4.57	5.63	5.83	5.00
SEm±	0.38	0.51	0.49	0.55	0.56	0.44
CD @ (P=0.05)	1.14	1.54	1.47	1.66	1.68	1.33

APPENDIX D

Table 1 Cost of cultivation of Tulsi at treatment T₁

S.No.	Operation/particulars	No. of units		Rate (RS.)/unit	Value in RS.
COMMON COST					
1	Preparatory tillage	1		1000	1000
2	Seed	300gm		90	90
3	Nursery bed preparation	1		312	312
4	Transplanting	4		312	1248
5	Weeding and hoeing /herbicide	1		312	312
6	Manure application (Labour)	1		312	312
7	Labour for irrigation	1		312	312
8	Plant protection	1		312	312
9	Harvesting for labour	8(labour)		312	2496
10	Cost of distillation of Herbage	34days (1 labour) for 38.39t/ha		312	10608
11	FYM	5000		2Rs./kg	10000
12	Transportation				800
13	Miscellaneous				400
14	Working capital (1 to 13)				28202
15	Interest on working capital @ 5% per annum capital@ 5% per annum				1410
16	Management charge (10 % of 14)				2820
	Total				32432
	OUTPUTS				
	Particulars	Price	Kkg/ha		Total
	Oil yield	2300/liter	44.44		102212

Table 2 Cost of cultivation of Tulsi at treatment T₂

S.No.	Operation/particulars	No. of units	Rate (RS.)/unit	Value in RS.
COMMON COST				
1	Preparatory tillage	1	1000	1000
2	Seed	300gm	90	90
3	Nursery bed preparation	1	312	312
4	Transplanting	4	312	1248
5	Weeding and hoeing /herbicide	1	312	312
6	Manure application (Labour)	1	312	312
7	Labour for irrigation	1	312	312
8	Plant protection	1	312	312
9	Harvesting for labour	8(labour)	312	2496
10	Cost of distillation of herbage	34days (1 labour) for 36.36t/ha	312	10608
11	Vermicompost	2500kg/ha	8Rs./kg	20000
12	Transportation			800
13	Miscellaneous			200
14	Working capital (1 to 13)			38002
15	Interest on working capital @ 5% per annum capital@ 5% per annum			1900
16	Management charge (10 % of 12)			3800
	Total			43702
OUTPUTS				
	Particulars	Price	Kg/ha	Total
	Oil yield	2300/liter	42.52	97796

Table 3 Cost of cultivation of Tulsi at treatment T₃

S.No.	Operation/particulars	No. of units	Rate (RS.)/unit	Value in RS.
COMMON COST				
1	Preparatory tillage	1	1000	1000
2	seed	300gm	90	90
3	Nursery bed preparation	1	312	312
4	Transplanting	4	312	1248
5	Weeding and hoeing /herbicide	1	312	312
6	Manure application (Labour)	2	312	624
7	Labour for irrigation	1	312	312
8	Plant protection	1	312	312
9	Harvesting for labour	5(labour)	312	1560
10	Cost of distillation of herbage	21days (1 labour) for 24.53t/ha	312	6552
11	Vermicompost	2000	23	46000
12	Transportation			800
13	Miscellaneous			100
14	Working capital (1 to 13)			59222
15	est on working capital @ 5% per annum capital@ 5% per annum			2961
16	Management charge (10 % of 9)			5922
	Total			68105
OUTPUTS				
	Particulars	Price	kg/ha	Total
	oil yield	2300/liter	30.29	69667

Table 4 Cost of cultivation of Tulsi at treatment T₄

S.No.	Operation/particulars	No. of units		Rate (RS.)/unit	Value in RS.
COMMON COST					
1	Prepratory tillage	1		1000	1000
2	Seed	300gm		90	90
3	Nursery bed preparation	1		312	312
4	Transplanting	4		312	1248
5	Weeding and hoeing /herbicide	2		312	624
6	Manure application (Labour)	2		312	624
7	Labour for irrigation	2		312	624
8	Plant protection	2		312	624
9	Harvesting for labour	8(labour)		312	2496
10	Cost of distillation of Herbage	34days (1 labour) for 34.53t/ha		312	10608
11	FYM	3750		2 Rs./kg	7500
12	Vermicompost	625		8 Rs./kg	5000
13	Transportation				800
14	Miscellaneous				5000
15	Working capital (1 to 14)				36550
16	Interest on working capital @ 5% per annum Capital @ 5% per annum				1827
17	Management charge (10 % of 13)				3655
	Total				42032
	OUTPUTS				
	Particulars	Price	kg/ha		Total
	oil yield	2300/liter	40.46		93058

Table 5 Cost of cultivation of Tulsi at treatment T₅

S.No.	Operation/particulars	No. Of units		Rate (RS.)/unit	value in RS.
COMMON COST					
1	Prepratory tillage	1		1000	1000
2	seed	300gm		90	90
3	Nursery bed preparation	1		312	312
4	Transplanting	4		312	1248
5	Weeding and hoeing /herbicide	2		312	624
6	Manure application (Labour)	2		312	624
7	Labour for irrigation	2		312	624
8	Plant protection	2		312	624
9	Harvesting for labour	8(labour)		312	2496
10	Cost of distillation of herbage	30days (1 labour) for 30.36t/ha		312	9360
11	FYM	3750		2Rs./kg	7500
12	Neem cake	500		23	11500
13	Transportation				800
14	Miscellaneous				7000
15	Working capital (1 to 14)				43802
16	Interest on working capital @ 5% per annum capital@ 5% per annum				2190
17	Management charge (10 % of 13)				4380
	Total				50372
	OUTPUTS				
	Particulars	Price	kg/ha		Total
	Oil yield	2300/liter	36.56		84088

Table 6 Cost of cultivation of Tulsi at treatment T₆

S.No.	Operation/particulars	No. of units	Rate (RS.)/unit	Value in RS.
COMMON COST				
1	Preparatory tillage	1	1000	1000
2	Seed	300gm	90	90
3	Nursery bed preparation	1	312	312
4	Transplanting	4	312	1248
5	Weeding and hoeing /herbicide	2	312	624
6	Manure application (Labour)	2	312	624
7	Labour for irrigation	2	312	624
8	Plant protection	2	312	624
9	Harvesting for labour	6(labour)	312	1872
10	Cost of distillation of herbage	30 days (1 labour) for 26.49t/ha	312	9360
11	Vermicompost	1250	8	10000
12	Neem cake	1000	23	23000
13	Transportation			800
14	Miscellaneous			4000
15	Working capital (1 to 14)			54178
16	est on working capital @ 5% per annum capital@ 5% per annum			2708
17	Management charge (10 % of 13)			5417
	Total			62303
OUTPUTS				
	Particulars	Price	Kg/ha	Total
	oil yield	2300/liter	32.5	74750

Table 7 Cost of cultivation of Tulsi at treatment T₇

S.No.	Operation/particulars	No. of units	Rate (RS.)/unit	Value in RS.
COMMON COST				
1	Preparatory tillage	1	1000	1000
2	Seed	300gm	90	90
3	Nursery bed preparation	1	312	312
4	Transplanting	4	312	1248
5	Weeding and hoeing /herbicide	2	312	624
6	Manure application (Labour)	2	312	624
7	Labour for irrigation	2	312	624
8	Plant protection	2	312	624
9	Harvesting for labour	8(labour)	312	2496
10	Cost of distillation of Herbage	30days (1 labour) for 32.49t/ha	312	9360
11	FYM	2500	2Rs./kg	5000
12	Vermicompost	625	8	5000
13	Neem cake	500	23	11500
14	Transportation			800
15	Miscellaneous			4000
16	Working capital (1 to 15)			43302
17	Interest on working capital @ 5% per annum capital@ 5% per annum			2165
18	Management charge (10 % of 14)			4330
	Total			49797
	OUTPUTS			
	Particulars	Price	Kg/ha	Total
	Oil yield	2300/liter	38.6	88228

Table 8 Cost of cultivation of Tulsi at treatment T₈

S.No.	Operation/particulars	No. of units	Rate (RS.)/unit	Value in RS.
COMMON COST				
1	Preparatory tillage	1	1000	1000
2	seed	300gm	90	90
3	Nursery bed preparation	1	312	312
4	Transplanting	4	312	1248
5	Weeding and hoeing /herbicide	2	312	624
6	Manure application (Labour)	2	312	624
7	Labour for irrigation	2	312	624
8	Plant protection	3	312	936
9	Harvesting for labour	8(labour)	312	2496
10	Cost of distillation of herbage	30days (1 labour) for 28.6t/ha	312	9360
11	FYM	1250	2Rs./kg	2500
12	Vermicompost	625	8	5000
13	Neem cake	1000	23	23000
14	Transportation			800
15	Miscellaneous			2000
16	Working capital (1 to 15)			50614
17	Interest on working capital @ 5% per annum capital@ 5% per annum			2530
18	Management charge (10 % of 14)			5061
	Total			58205
	OUTPUTS			
	Particulars	Price	kg/ha	Total
	oil yield	2300/liter	34.7	79810

Table 9 Cost of cultivation of Tulsi at treatment T₉

S.No.	Operation/particulars	No. of units		Rate (RS.)/unit	Value in RS.
COMMON COST					
1	Prepratory tillage	1		1000	1000
2	Seed	300gm		150	1500
3	Nursery bed preparation	1		312	312
4	Transplanting	4		312	1248
5	Weeding and hoeing /herbicide	16		312	4992
6	Labour for irrigation	2		312	624
7	Plant protection	10		312	3120
8	Harvesting for labour	5(labour)		312	9360
9	Cost of distillation of herbage	(1labour) for 28.43 kg/ha		312	6552
10	Transportation				800
11	Miscellaneous				26000
12	Working capital (1 to 11)				55508
13	Interest on working capital @ 5% per annum capital@ 5% per annum				2775
14	Management charge (10 % of 10)				5550
	Total				63833
	OUTPUTS				
	Particulars	Price	kg/ha		Total
	Oil yield	2300/liter	28.43		65389

RESUME

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