E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(1): 25-29
Received: 09-11-2023
Accepted: 13-12-2023

Alok Singh Bargah
Research Scholar, College of Forestry, Sankra, Patan, Durg, Chhattisgarh, India

Dr. Pratap Toppo
Assistant Professor, Department of Forestry, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dr. Lalji Singh
Professor, Department of Forestry, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dr. SS Tuteja
Professor, Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Manish Kumar Mankur
Research Scholar, Department of Forestry, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Dayanand Sai Painkra
Research Scholar, Department of Forestry, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Pankaj
Research Scholar, College of Forestry, Sankra, Patan, Durg, Chhattisgarh, India

Corresponding Author:
Alok Singh Bargah
Research Scholar, College of Forestry, Sankra, Patan, Durg, Chhattisgarh, India

Effect of nutrient management on growth performance of Geranium (*Pelargonium graveolens*) under Karanj (*Pongamia pinnata*) based agroforestry system in Chhattisgarh plain

Alok Singh Bargah, Dr. Pratap Toppo, Dr. Lalji Singh, Dr. SS Tuteja, Manish Kumar Mankur, Dayanand Sai Painkra and Pankaj

DOI: https://doi.org/10.33545/2618060X.2024.v7.i1Sa.220

Abstract
The study titled "Impact of Nutrient Management on the Growth and Yield Performance of Geranium (*Pelargonium graveolens*) in a Karanj (*Pongamia pinnata*) Based Agroforestry System in the Chhattisgarh Plain" was conducted at the Herbal Garden, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the Rabi season of 2022-23. The experiment laid down in a Randomized Block Design (RBD) with three replications and featured eight different combinations of organic manure as treatments. Various parameters related to the growth and yield of Geranium, including plant height (cm), number of branches per plant, collar diameter (mm), were assessed. The treatments comprised T_1: N:P:K (0:0:0) Control, T_2: N:P:K (30:30:30), T_3: N:P:K (40:40:40), T_4: N:P:K (60:60:60), T_5: Recommended FYM @ 20 tonnes ha^{-1}, T_6: 50% (FYM+NPK) of (30:30:30), T_7: 50% (FYM+NPK) of (40:40:40), and T_8: 50% (FYM+NPK) of (60:60:60). Among these, treatment T_8: 50% (FYM+NPK) of (60:60:60) exhibited significant superiority in all growth parameters compared to the other treatments.

Keywords: Agroforestry, geranium, Karanj, nutrient, growth

1. Introduction

Agroforestry is a comprehensive term encompassing land-use systems where woody perennials like trees, shrubs, and bamboos are cultivated alongside herbaceous plants such as crops, pasture, and/or livestock. These elements are organized spatially or temporally, facilitating ecological and economic interactions between the tree and non-tree components. The principal constituents of agroforestry systems include trees, shrubs, crops, pastures, and livestock, along with factors like climate, soil, and the surrounding environment. The essential interplay between trees and the non-tree components within the system is vital. Agroforestry also involves processes such as the transfer of biomass or organic matter, such as the incorporation of leaf litter into the soil or its utilization as manure by livestock (Young, 1989) [15].

The cultivation of geranium is primarily undertaken to produce essential oil through the hydro steam distillation of fresh herbage, resulting in a pale yellow to light greenish oil. Stored properly, the oil develops a rich, almost rose-like fragrance that reportedly improves with time (Gulati and Duhan, 1982) [6]. According to Bhaskar *et al.* (2000) [4], global geranium oil production reaches approximately 800 tons annually, with India contributing only 5 tons (*Singh et al.* 2001) [14]. The essential oil finds application in perfuming soaps and cosmetics, as well as extracting Rhodinol, a costly aroma chemical used in perfumes (Prasad and Chattopadhayay, 1999) [10]. Despite once reaching a peak output of 120 tons (Sharma *et al.* 1996), geranium essential oil contains compounds such as alcohol and esters, with geraniol and citronellol as key constituents. Due to their shared ingredients, geranium and rose essential oils exhibit similarities (Anon, 2006) [1].

2. Material and methods: The Herbal Garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) was the site for the field experiment. Positioned in the mid-eastern part of Chhattisgarh at a latitude of 21°16'N and a longitude of 81°36'E, Raipur has an altitude of 289.56 meters above mean sea level. Based on prevailing climatic conditions, Raipur is classified as a slightly moist and sub-humid zone, with an average annual rainfall ranging from 1200 to 1400 mm. The experimental field's soil was identified as clay to loam soil.

2.1 Experimental details

The following experimental details are given below:

Year and season	:	(2022-23) Rabi
Kind of trial	:	Field Experiment
Experimental Design	:	Randomized Block Design (RBD)
Replication	:	3
Planting material	:	Cutting
Plant spacing	:	60 X 60 cm.
Total no. of plot	:	24
Plot size	:	5 X 5 m

2.2 Treatment details

The following treatment details are given below.

Treatment	Treatment details
T_1	N:P:K (0:0:0)Control
T_2	N:P:K (30:30:30)
T_3	N:P:K (40:40:40)
T_4	N:P:K (60:60:60)
T_5	Recommended FYM @ 20 tones ha^{-1}
T_6	50% (FYM+NPK) of 30:30:30.
T_7	50% (FYM++NPK) of 40:40:40.
T_8	50% (FYM+NPK) of 60:60:60.

2.3 Statistical analysis

The experimental setup employed the Randomized Block Design (RBD). The data collected from the personalities of the research subjects were analyzed following the analysis of variance approach as defined by Panse and Sukhatme (1967) [9]. A significance threshold of 5% for the "F" test was utilized. In cases where the "F" test demonstrated significance at the 5% level, a Critical Difference (CD) value is presented in the table.

3. Results and Discussions

Crop observations were recorded at 30, 60, and 90 days after transplanting (DAT), along with observations at harvest when the crop was in the full bloom stage. The recorded parameters encompassed plant height (cm), the number of branches per plant, and collar diameter (mm).

3.1 Growth attributes

The results, pertaining to plant height (cm), are presented in Table 1 and Fig. 1. Statistically significant variations in the geranium plant height were observed among different treatments at 30 DAT (Days After Transplanting). Treatment T_8 (: 50% (FYM+NPK) 60:60:60) demonstrated the highest maximum height (27.87 cm), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (26.13 cm), T_6 (50% (FYM+NPK) of 30:30:30) (24.11 cm). Treatment T_1 Control (: N:P:K (0:0:0)) exhibited a significantly minimum plant height (cm) of (21.55 cm). At 60 DAT, the maximum plant height (cm) (40.60) was significantly observed in treatment T_8 (: 50% (FYM+NPK) 60:60:60), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (38.39 cm), T_6 (50% (FYM+NPK) of 30:30:30) (35.33 cm). Treatment T_1 Control (: N:P:K (0:0:0)) showed a significantly minimum plant height (cm) (32.53 cm). At 90 DAT, treatment T_8 (: 50% (FYM+NPK) 60:60:60) recorded the highest maximum plant height (cm) (50.93 cm), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (47.89 cm), and T_6 (50% (FYM+NPK) of 30:30:30) (47.47 cm), T_5: Recommended FYM @ 20 tones ha-1 (43.30 cm), T_4 (N:P:K (60:60:60) (49.87 cm), T_3:N:P:K (40:40:40) (47.67 cm). Significantly, treatment T_1 Control (: N:P:K (0:0:0)) displayed a minimum plant height (cm) of (41.66 cm). At harvest, treatment T_8 (: 50% (FYM+NPK) 60:60:60) demonstrated a significant increase in maximum plant height (cm) (55.34 cm), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (51.13 cm), and T_6 (50% (FYM+NPK) of 30:30:30) (49.24 cm), T_5: Recommended FYM @ 20 tones ha-1 (46.47), T_4 (N:P:K 60:60:60) (52.80 cm), T_3:N:P:K (40:40:40) (50.14 cm). Significantly, treatment T_1 Control (: N:P:K (0:0:0)) showed a minimum plant height (cm) of (44.50 cm).

Kassahun *et al.* (2012) [7] conducted an experiment to evaluate the impact of plant population density on the agronomic and chemical characteristics of *P. graveolens* during the 2010-2011 growing season in six distinct locations. The study involved three different population densities: 111111, 27777, and 12345 plants/ha. The plants were transplanted in rows at intervals of 30, 60, and 90 cm. Data collected and analyzed included plant height, branch count, herb yield, internode count, biomass yield, fresh leaf yield, essential oil content, and oil output. The metrics unaffected by plant population density were the amount of essential oils, the number of internodes per plant, and the stem-to-leaf ratio. Notably, a plant population density of 1111.11 plants per hectare resulted in a significant increase in both fresh herb and essential oil yields.

Bhaskar (1995) [2] reported similar findings with patchouli and scented geranium (Bhaskar *et al.*, 1998) [3].

The data presented in Table 2 and Fig. 2, illustrating the number of branches per plant, clearly indicated significant variations resulting from the application of various organic manure treatments. The plant's capacity to produce branches per plant was significantly influenced by each treatment in both harvests. A statistically significant difference in the number of geranium branches among the treatments was observed at 30 DAT. Treatment T_8 (: 50% (FYM+NPK) 60:60:60) exhibited the highest number of branches (5.13), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (2.93), and T_6 (50% (FYM+NPK) of 30:30:30) (2.80), T_5: Recommended FYM @ 20 tones ha-1 (2.13), T_4 (N:P:K 60:60:60) (3.07). Significantly, the T_1 Control treatment (N:P:K (0:0:0)) had the lowest number of branches per plant (1.93). At 60 DAT, treatment T_8 (: 50% (FYM+NPK) 60:60:60) demonstrated the highest number of branches per plant (7.40), followed by treatments T_7 (50% (FYM+NPK) of 40:40:40) (4.39), T_6 (50% (FYM+NPK) of 30:30:30) (4.31), T_5: Recommended FYM @ 20 tones ha-1 (3.40), T_4 (N:P:K 60:60:60) (5.07). Significantly, the T_1 Control treatment (N:P:K (0:0:0)) had the lowest number of branches per plant (3.03). At 90 DAT, treatment T_8 (: 50% FYM+NPK of 60:60:60) recorded a significantly higher number of branches per plant (10.27) than treatment T_7 (50% FYM+NPK of 40:40:40) (9.33), T_6 (50% FYM+NPK of 30:30:30) (8.93), T_5 (Recommended FYM @ 20 tones ha-1) (7.11), T_4 (N:P:K (60:60:60) (9.47). Significantly, the T_1 Control (N:P:K (0:0:0)) had the lowest number of branches per plant (5.27). At harvest, treatment T_8 (: 50% FYM+NPK of 60:60:60) exhibited the highest number of branches per plant (10.38), followed by treatments T_7 (50% FYM+NPK of 40:40:40) (9.39), T_6 (50% FYM+NPK of 30:30:30) (9.20), T_5 (Recommended FYM @ 20 tones ha-1) (9.20), T_4 (N:P:K (60:60:60) (9.53). Significantly lowest branches per plant (5.31) were observed in the T_1 Control (N:P:K (0:0:0)).

Gebremeskel (2014) [5] examined the influence of various harvesting stages on the growth, herb production, and oil yield of *P. graveolens*. Five harvesting levels, conducted at 90, 105, 120, 135, and 150 days after transplanting, were organized in a randomized complete block design (RCBD) with replications. Uniformly growing seedlings were selected, acclimated, and transplanted into the nursery after 90 days after showing before being transferred to the testing area. Nitrogen (in the form of urea) was applied three times: once after transplanting and twice more at intervals of 30 and 60 days, each time at a rate of 120 kg/ha. All necessary agronomic practices, including manual weeding, watering, and hoeing, were consistently carried out in both the nursery and the experimental field. During the harvest period (days following transplantation), various parameters such as average plant height, branches plant^{-1}, leaves plant^{-1}, leaf area index, fresh leaf yield per hectare, fresh stem yield per hectare, harvest index, essential oil content (%), and essential oil production per hectare were measured in random samples from the two middle rows of the planted area. While the stage of harvesting did not significantly impact the calculated moisture content (%), it had a positive effect on the overall results.

Collar diameter measurements of the geranium crop were taken at 30, 60, 90 Days After Transplanting (DAT), and at harvest. As indicated in Table 3 and Fig. 3, the collar diameter (mm) per plant highlighted a significant impact of various organic manure treatments on the plant. All treatments substantially influenced the collar diameter during both harvests. There was a statistically significant difference in geranium collar diameter among the various treatments. At 30 DAT, treatment T_8 (: 50% (FYM+NPK) of 60:60:60) demonstrated the highest collar diameter (mm) at 4.97, followed by treatments T_7 (: 50% (FYM+NPK) of 40:40:40) at 4.93, T_6 (: 50% (FYM+NPK) of 30:30:30) at 4.41, T_5 (Recommended FYM @ 20 tones ha-1) at 4.27, and T_4 (N:P:K (60:60:60)) at 4.95. Significantly, T_1 Control (N:P:K 0:0:0) exhibited the lowest collar diameter (mm) at 4.08. At 60 DAT, the maximum collar diameter (mm) of 5.70 was observed in T_8 (: 50% (FYM+NPK) 60:60:60), followed by T_7 (50% (FYM+NPK) of 40:40:40) at 5.56, T_6 (50% (FYM+NPK) of 30:30:30) at 5.48, T_5 (Recommended FYM @ 20 tones ha-1) at 5.04, and T_4 (N:P:K (60:60:60)) at 5.64. Significantly, T_1 Control (N:P:K (0:0:0)) showed the lowest collar diameter (mm) at 4.37. At 90 DAT, treatment T_8 (: 50% (FYM+NPK) of 60:60:60) had the highest collar diameter (mm) at 7.92, followed by T_7 (FYM+NPK of 50% of 40:40:40) at 7.75, T_6 (50% (FYM+NPK) of 50% of 30:30:30) at 7.74, T_5 (Recommended FYM @ 20 tones ha-1) at 7.12. Significantly, T_1 Control (N:P:K (0:0:0)) showed the lowest collar diameter (mm) at 6.26. At harvest, treatment T_8 (: 50% (FYM+NPK) 60:60:60) displayed the highest collar diameter (mm) measurement at 8.86, followed by T_7 (50% (FYM+NPK) of 40:40:40) at 8.46, T_6 (50% (FYM+NPK) of 30:30:30) at 8.20, and T_5 (Recommended FYM @ 20 tones ha-1) at 7.30. Significantly, T_1 Control (N:P:K (0:0:0)) exhibited the lowest collar diameter (mm) at 6.81.

Gebremeskel (2014) [5] reported similar findings with *P. graveolens* in the experiment involved five levels of harvesting stages arranged in a randomized complete block design (RCBD) with three replications, conducted at 90, 105, 120, 135, and 150 days after transplantation.

Table 1: Growth performance of Geranium (*Pelargonium graveolens*) on plant height (cm) under Karanj (*Pongamia pinnata*) based agroforestry system

Tr. No.	Treatment details	Plant height (cm)			
		30 DAT	60 DAT	90 DAT	At harvest
T_1	N:P:K (0:0:0) Controls	21.55	32.53	41.66	44.50
T_2	N:P:K (30:30:30)	22.67	34.67	45.05	48.76
T_3	N:P:K (40:40:40)	25.08	37.60	47.67	50.14
T_4	N:P:K (60:60:60)	26.47	39.07	49.87	52.80
T_5	Recommended FYM @20 tones ha^{-1}	22.47	33.87	43.30	46.47
T_6	50% (FYM+NPK) of 30:30:30	24.11	35.33	47.47	49.24
T_7	50% (FYM+NPK) of 40:40:40	26.13	38.39	47.89	51.13
T_8	50% (FYM+NPK) of 60:60:60	27.87	40.60	50.93	55.34
	Sem ±	1.205	1.371	1.410	1.946
	CD (5%) =	3.66	4.16	4.28	5.90

Table 2: Growth performance of Geranium (*Pelargonium graveolens*) on number of branches plant^{-1} under Karanj (*Pongamia pinnata*) based Agroforestry System

Tr. No.	Treatment details	Number of branches plant^{-1}			
		30 DAT	60 DAT	90 DAT	At harvest
T_1	N:P:K (0:0:0) Control	1.93	3.03	5.27	5.31
T_2	N:P:K (30:30:30)	2.27	4.27	8.20	8.29
T_3	N:P:K (40:40:40)	2.73	4.29	8.60	9.09
T_4	N:P:K (60:60:60)	3.07	5.07	9.47	9.53
T_5	Recommended FYM @20 tones ha^{-1}	2.13	3.40	7.11	7.64
T_6	50% (FYM+NPK) of 30:30:30	2.80	4.31	8.93	9.20
T_7	50% (FYM+NPK) of 40:40:40	2.93	4.39	9.33	9.39
T_8	50% (FYM+NPK) of 60:60:60	5.13	7.40	10.27	10.31
	Sem ±	0.107	0.181	0.245	0.421
	CD (5%) =	0.32	0.55	0.74	1.28

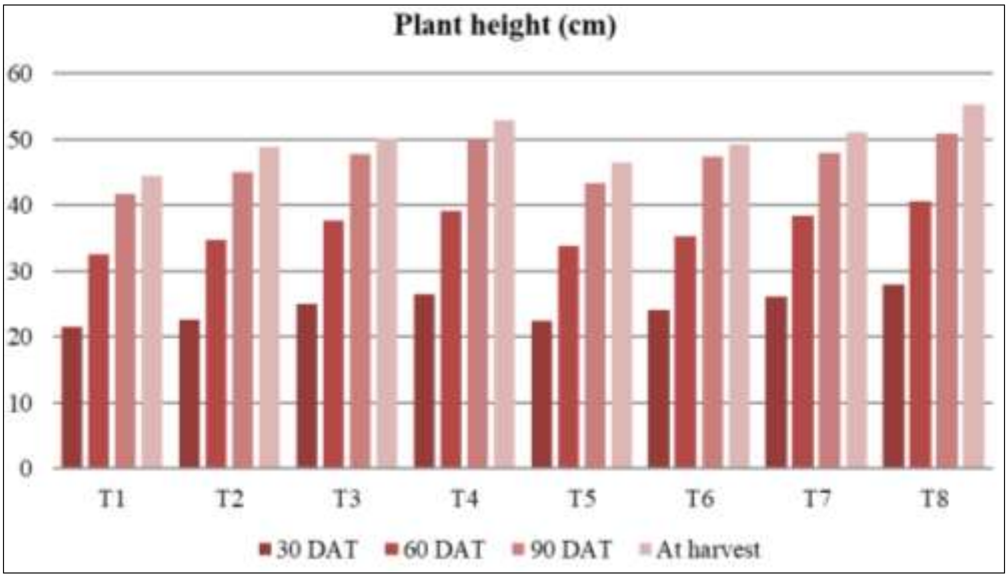

Fig 1: Growth performance of Geranium (*Pelargonium graveolens*) on plant height (cm) under Karanj (*Pongamia pinnata*) Based Agroforestry System

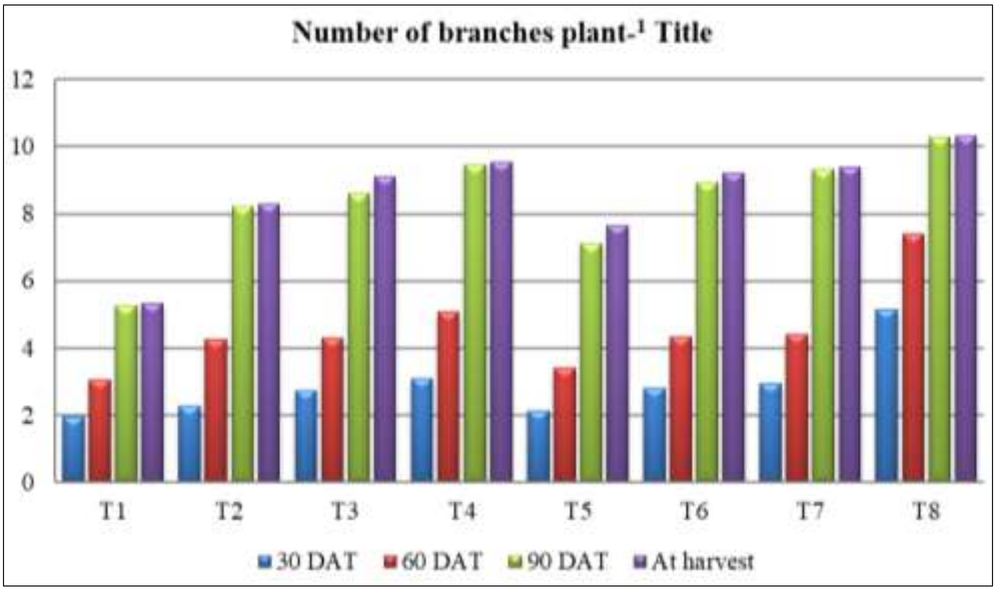

Fig 2: Growth performance of Geranium (Pelargonium graveolens) on number of branches plant-1 under Karanj (*Pongamia pinnata*) based Agroforestry System

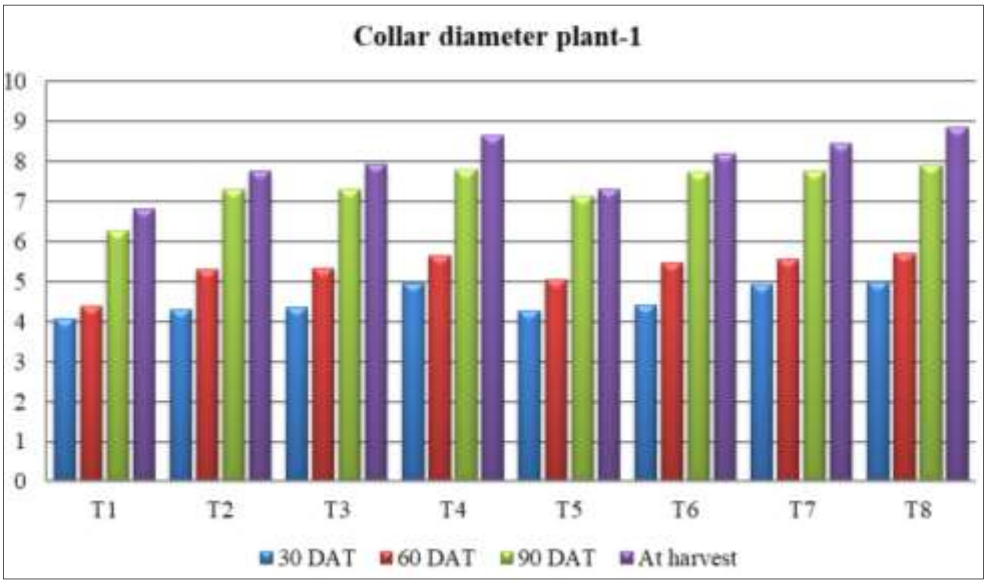

Fig 3: Collar diameter plant^{-1} of Geranium intercropped under *Pongamia pinnata* based Agroforestry System

Table 3: Collar diameter plant-1 of Geranium intercropped under *Pongamia pinnata* based Agroforestry System

Tr. No.	Treatment details	Collar diameter plant-1			
		30 DAT	60 DAT	90 DAT	At harvest
T_1	N:P:K (0:0:0) Control	4.08	4.37	6.26	6.81
T_2	N:P:K (30:30:30)	4.29	5.30	7.30	7.76
T_3	N:P:K (40:40:40)	4.34	5.33	7.31	7.93
T_4	N:P:K (60:60:60)	4.95	5.64	7.78	8.66
T_5	Recommended FYM @20 tones ha^{-1}	4.27	5.04	7.12	7.30
T_6	50% (FYM+NPK) of 30:30:30	4.41	5.48	7.74	8.20
T_7	50% (FYM+NPK) of 40:40:40	4.93	5.56	7.75	8.46
T_8	50% (FYM+NPK) of 60:60:60	4.97	5.70	7.92	8.86
	Sem ±	0.206	0.231	0.279	0.393
	CD (5%) =	0.63	0.70	0.85	1.19

4. Conclusion
Plant height (cm), Number of branches per plant, and collar diameter (mm) of the crop were significantly maximum in treatment T_8 (50% (FYM+NPK) 60:60:60) compared to treatments T_7 (50% (FYM+NPK) of 40:40:40), T_6 (50% (FYM+NPK) of 30:30:30), T_5 (Recommended FYM @ 20 tones ha^{-1}), T_4 (N:P:K) 60:60:60), T_3 ((N:P:K) 40:40:40), T_2 (N:P:K) 30:30:30). Significantly, treatment T_1 Control (N:P:K (0:0:0)) exhibited the minimum values.

5. Acknowledgement
The authors express their gratitude to the authorities of Indira Gandhi Krishi Vishwavidyalaya University Raipur for their support and the provision of facilities to conduct the study.

6. References
1. Anon. Rose-scented geranium uses. [Internet]. 2006. Available from: www.ageless.co.za/rose_scented_geranium.
2. Bhaskar S. Growth, herbage and oil yield of patchouli (*Pogostemon patchouli*) as influenced by cultivars and nitrogen fertilization. Indian Perfum. 1995;39(1):35-38.
3. Bhaskar S, Kumar TV, Srivastava HC. Growth and yield of scented geranium (*Pelargonium graveolens*) genotypes in relation to nitrogen fertilization. J. Med. Arom. Pl. Sci. 1998;20:731-734.
4. Bhaskar S, Kumar TV, Shivananda TN, Arun MN, Janrdhan G, Ramchandra C. Effect of farm yard manure, nitrogen levels and its method of application on scented geranium (*Pelargonium graveolens*). J. Med. Arom. Plant Sci. 2000;23:388-391.
5. Gebremeskel H. Growth, biomass and oil yield of rose-scented geranium (*Pelargonium graveolens* L. Herit) as influenced by different harvesting stages. Int J Novel Res Life Sci. 2014;1(1):48-55.
6. Gulati BC, Duhan SPS. Cultivation of Pelargonium graveolins as annual crop. In: Atal CD, Kapur BM, editors. Cultivation and Utilization of Aromatic Plants. Jammu Tawi: RRL; 1982. p. 559-565.
7. Kassahun BM, Zigene ZD, Teferi Z, Mekonnen A, Yalemtesfa B, Gebretenssay F. Yield and yield components of rose-scented Geranium (*Pelargonium graveolens*) as influenced by plant population density in Ethiopia. Int J Med Arom Plants. 2012;2(1):60-68.
8. Kaul PN, Rao BRR, Bhattacharya AK, Singh KL. Effect of weather parameters on yield and quality of the essential oil rose-scented geranium. Agric Sci Dig. 1999;19(2):84-86.
9. Panse UG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: ICAR; 1967. p. 97–123.
10. Prasad A, Chattopadhyay A. Response of rose-scented geranium (*Pelargonium graveolens*) to liming in an acid soil. J. Med. Arom. Pl. Sci. 1999;21:982-986.
11. Sastry KP, Krishnan KR, Saleem SM, Kumar S. Influence of time and method of storage of harvested herbage before distillation on the oil content and quality of essential oil in rose-scented geranium (*Pelargonium graveolens*) chemotypes. J. Med. Arom. Pl. Sci. 2001;22/4A and 23/1A:352-355.
12. Sharma JR, Sharma A, Singh AK, Kumar S. Economic potential and improved varieties of aromatic plants of India. J Med. Arom. Pl. Sci. 1996;18:5-9.
13. Singh M, Singh S, Yaseen M. Standardization of planting time for optimum growth and oil production of geranium (*Pelargonium graveolens* L. Her.) under north Indian plains. J Spices Arom Crops. 2008;17(3):247–250.
14. Singh SR, Mohod RP, Kumar N. Study of geranium cultivated in North Indian Plain. J. Essenl. Oil Bearing Plants. 2001;4(1):33-36.
15. Young A. Agroforestry for Soil Conservation. Wallingford, England: C.A.B. International; 1989.