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EFFECT OF INM ON GROWTH, QUALITY AND YIELD OF AFRICAN MARIGOLD (*Tagetes erecta* L.) UNDER HIGH HILL CONDITION OF UTTARAKHAND, INDIA

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ABSTRACT

The present experiment was carried out at Floriculture Block, College of Horticulture, VCSG, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal, Uttarakhand, during February to August, 2021 to find out the effect of INM on packages of flower production of African marigold cv. Pusa Narangi Gainda. The experiment consisted of thirteen treatments which replicated thrice in a Randomized Complete Block Design. The results revealed that tallest plant height (98.53 cm), maximum number of primary branches plant^{-1} (17.46), plant spread (66.56 cm) and number of leaves plant^{-1} (372.73) were recorded in plants applied with 75% RDF + 25% RD 'N' Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}). With respect to floral parameters, minimum number of days taken to first flower bud appearance and flowering (58.40 and 74.58 days, respectively) and maximum duration of flowering (55.73 days), flower diameter (8.24 cm), flower weight (8.56 g), shelf life (8.26 days), number of flowers plant $^{-1}$ (43.40), number of flowers plot^{-1}(694.40), flower yield plant^{-1}(371.98 g), flower yield plot^{-1}(5.94 kg) and Benefit : Cost ratio (3.17) was recorded from the plants grown in plots applied with 75% RDF + 25% RD 'N' Vermicompost+ *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}). Thus, the results obtained from the present investigation showed that application of 75% RDF + 25% 'N' VC +*Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) was found to be effective in improving quality, yield and economics of African marigold cv. Pusa Narangi Gainda.

(Key words: African marigold, *Azotobacter*, PSB, RDF and Vermicompost)

INTRODUCTION

African marigold (*Tagetes erecta* L.) accounts for more than half of Nation's loose flower production in India (Sreekanth *et al.,* 2008). The crop belongs to family Asteraceae and is native to Central and South America. The flowers are extensively used during religious and social functions. For landscaping, they are planted in beds, mixed borders and in pots. The petals of flowers are major source of xanthophyll pigment particularly lutein and nowadays it has been utilized in poultry industry as a feed additive to intensify the yellow colour of egg and broiler skin of chicken. Apart from poultry industry, marigold dye is also used in textile, pharmaceutical industries and food supplement. By keeping its industrial importance and ease of cultivation it become popular among farmers. For getting higher and immediate results nowadays farmers are applying excessive amount of chemical fertilizers which has adverse effect on flora and fauna(Bohra and Nautiyal, 2019). The continuous and indiscriminate use of agrochemicals has adversely affected the soil fertility, crop productivity, product quality and environment. No single source of nutrient is sufficient for fulfilling the nutritional requirement of plant. Therefore, nowadays integrated nutrient management is need of an hour. INM is a holistic approach that helps in minimizing the use of chemicals by maximum utilization of biological inputs. INM is a feasible option for maintaining a higher level of soil fertility and productivity. The use of organic manures with optimum doses of fertilizers under intensive farming system increases the turn of nutrient in soil plant system (Jadhav *et al*., 2018). Biofertilzers help in improving soil fertility by the way of accelerating biological nitrogen fixation from atmosphere solubilization of the insoluble nutrients in soil, generate little quantity of PGRs decomposing plant residues and stimulate plant growth and production. The inoculation of bio-fertilizers increases the yield of crops by 10 to 30 per cent (Mahala *et al.*, 2019). Therefore, keeping the above points in view, study was conducted to study the effect of INM packages on flower production of African marigold cv. Pusa Narangi under hill condition of Uttarakhand.

MATERIALS AND METHODS

The present study was conducted at Floriculture Block, College of Horticulture, VCSG Uttarakhand University

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of Horticulture and Forestry, Bharsar, District Pauri Garhwal (Uttarakhand). The experimental site is situates at the high hills of the Himalaya at 29°20'-29°75' N latitude and 78°10'-78°80'E longitude an altitude of 1900 msl. The climate of place is mild summer, higher precipitation and severe cold prolonged winter. The soil of the experimental site was sandy loam in texture, acidic to neutral in reaction (pH 5.5-6.0), soil organic carbon content (1.15 %), available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) to the tune of 294.10, 8.52 and 62.49 kg ha^{-1}, respectively. The experiment consisted of thirteen treatments which were replicated thrice in Randomized Complete Block Design. The treatments were T_1 : Control, T_2 : 100% RDF, T_3 : 75% RDF + 25% 'N' Vermicompost, T_4 : 50% RDF + 50% 'N' Vermicompost, T_5 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_6 : 75% RDF + 25% 'N' Vermicompost + PSB (2ml l^{-1}), T_7 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}), T_8 : 50% RDF + 50% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_9 : 50 % RDF + 50 % 'N' Vermicompost + PSB (2ml l^{-1}), T_{10} : 50% RDF + 50% 'N' Farmyard manure + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}), T_{11} : 75 % RD 'N' + 100 % P and K + *Azotobacter* (2ml l^{-1}), T_{12} : 75% RD 'P' + 100 % 'N & K' + PSB (2ml l^{-1}), T_{13} : 75% RD 'N & P' + 100% 'K' + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}). Vermicompost was applied 15 days prior to transplanting of seedlings. Half dose of nitrogen and full dose of phosphorus and potash were applied as a basal dose at the time of field preparation and remaining half dose of nitrogen was applied 30 days after planting. Bio-fertilizers i.e. *Azotobacter* (2 ml l^{-1}) and PSB (2 ml l^{-1}) were applied before transplanting by dipping the seedling roots in bio-fertilizers solutions for 30 minutes as per the treatments and treated seedlings were transplanted at a spacing of 40 cm × 30 cm. The observations on vegetative attributes *viz.*,plant height, number of primary branches $plant^{-1}$, plant spread (cm) and number of leaves $plant^{-1}$ were taken at the full bloom stage. The observations on floral attributes i.e. number of days taken for 1st flower bud appearance, 1st flower opening , flowering duration (days), flower diameter (cm), shelf life (days), individual flower weight (g), number of flowers $plant^{-1}$, number of flowers $plot^{-1}$, flower yield $plant^{-1}$ (g) and flower yield $plot^{-1}$ (kg) were also recorded. The final data of each characters recorded during the investigation were analyzed statistically using Analysis of Variance. The significance of various treatments was judged by following the methods of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of INM on vegetative attributes

The data pertaining to vegetative attributes studied *viz.,* mean plant height, number of primary branches $plant^{-1}$, plant spread and number of leaves $plant^{-1}$measured at fullbloom stage as influenced by various treatments are presented in Table1.

The tallest plant (98.53 cm) was recorded from the plants applied with T_7 [75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1})] and found statistically at par with T_5 [75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) i.e. 96.20 cm. The shortest plants (77.86 cm) were obtained in control. All the applied treatments were found significantly effective in increasing plant height as compared to control. The optimum availability of nutrients *viz*., nitrogen, phosphorus and potassium by plants through the use of inorganic fertilizers and vermicompost with combination of biofertilizers (*Azotobacter* and PSB) might have enhanced cell division and elongation and also increases metabolic activities in plant.Biofertilizers helps to keep the soil environment rich in all kinds of macro and micro-nutrients *via* nitrogen fixation, phosphate solubilization or mineralization, release of plant growth regulating substances and decomposing organic matter at faster rate and thus help in improving the soil fertility and boosting crop productivity (Saxena and Singh, 2020).The observation was inline with Kumar and Kumar (2017), who reported that application of 75% NPK + *Azotobacter* + PSB recorded maximum plant height in African marigold.

The maximum primary branches (17.46 cm) were recorded in treatment T_7[75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1})] and found statistically at par with plants applied with 100% RDF (16.53 cm) and 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* 2ml l^{-1} (16.06 cm).Similarly, maximum plant spread (66.56 cm) was recorded from the plants grown in plot applied with 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}) followed by plants applied with 100 % RDF (16.53 cm) and 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) (16.06 cm). Singh *et al*. (2015) stated that vermicompost not only provides nitrogen, phosphorus and potash but also a good source of micronutrients and enzymes. Application of inorganic fertilizers along with *Azotobacter* and PSB helps in adequate supply of nutrients with release of phytohormones which increase the photosynthesis and other biological processes that are reflected on cell division and lead to more number of primary branches and plant spread.Similar result have been reported by Naik and Dalawai (2014), who reported that application of 75% RDF + *Azospirillum* (60 g/m^2) + PSB (60 g/m^2) + FYM (2 kg/m^2) + Vermicompost (500 g/m^2) recorded maximum primary branches and plant spread in carnation.

The plants grown in plot applied with 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}) recorded maximum number of leaves $plant^{-1}$ (372.73) which was found significantly superior over the all the applied treatments.The minimum number of leaves $plant^{-1}$(242.86) were found in control. Singh *et al.* (2015) reported that vermicompost helps in increasing phootosynthetic efficacy of plants. Vermicompost, biofertlizers and recommended dose of fertilizers might have favoured for stimulation and production of auxiliary buds resulting in formation of more number of branches as well as leaves. The result is in close conformity with the finding of Singh *et al.* (2015), who found that application of 75 % RDF + Vermicompost (80 q ha^{-1}) + *Azotobacter* (3.3kg ha^{-1}) recorded maximum number of leaves $plant^{-1}$ in marigold.

Effect of INM on floral attributes

The significant effect on floral attributes *viz.,* number of days taken to 1st flower bud appearance and flower opening, flowering duration (days), flower diameter (cm), individual flower weight (g) and shelf life (days) were found due to different INM treatments on African marigold cv. Pusa Narangi Gainda (Table 1 and 2).

The earliness in days taken to first flower bud appearance and flower opening (58.40 and 74.58 days, respectively) was recorded from the plants applied with75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}) followed by treatment T_2i.e. 100 % RDF (60.80 and 76.80 days, respectively). The data showed that among all the treatments applied, treatment $T_7$was found significantly effective in improving earliness in flowering. However, delay in days taken to bud appearance and flower opening were recorded in control (67.20 and 85.70 days, respectively). The earliness in flowering could be attributed due to easy availability, uptake of nutrients by plants and simultaneous transport of growth promoting substances like cytokinins to the axillary buds resulting in breakage of apical dominance that leads to transformation of plant parts from vegetative to reproductive phase. The result is in close conformity with the finding of Vishnu *et al.* (2016), who reported that application of 75% RDF + 25 % Vermicompost resulted in earliness in flowering of African marigold.

It is apparent from the data presented in Table1 that all the applied treatments were found significantly effective in improving the flowering duration. The maximum duration of flowering was recorded in plants applied with 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}) (55.73 days) and found statistically at par with the application of 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2 ml l^{-1}) (54.60 days) and 50% RDF + 50% 'N' Farmyard manure + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) (54.47 days). The improvement in flowering duration might be due to combined doses of organic and inorganic fertilizers which improved soil health, water retension capacity and availability of microbes. Use of vermicompost in soil significantly increased in soil enzyme activities such as urease, phosphomonoesterase, phosphodisterase and anysulphatase.The present result is supported by finding of Mohanty *et al.* (2013), who reported that application of 25 % organic manures + 75 % RDF was found effective in increasing duration of flowering in marigold.

Among thirteen treatments applied maximum flower diameter (8.24 cm) and individual flower weight (8.56 g) were recorded in treatment T_7 [75% RDF + 25% RD 'N' through Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1})]. The treatment T_7 was found significantly effective in increasing the flower diameter and individual weight of flower as compared to all the applied treatments. However, minimum flower diameter and individual flower weight (5.44 cm and 5.32 g, respectively) were recorded in control. It could be due to the balanced utilization of nutrients by inorganic fertilizers, vermicompost, *Azotobacter* and PSB. Kumar *et al.* (2013) reported that vermicompost acts as a source of macro (N, P and K) and micronutrients (Zn, Fe, Cu, and Mn), enzymes and growth hormones. It decomposes slowly and provides nutrients throughout the life cycle of plants. The PSB and *Azotobacter* helps in solubilization of insoluble P and N through production of organic acid (Bohra *et al*., 2019). The results are corroborated with the finding of Kumar and Kumar (2017), who reported plants grown in plot applied with 75 % RDF + *Azotobacte*r + PSB recorded maximum flower diameter and weight in marigold.

The flowers harvest from the plants grown in plots applied with 75% RDF + 25% RD 'N' through Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) recorded maximum shelf life (8.26 days) followed by 100 % RDF (7.13 days). However, minimum shelf life of flowers (5.20 days) was recorded in control.Similar beneficial effect of INM on shelf life has been reported by Kumar *et al.* (2013) , who reported that application of 80 % RDF + Vermicompost (128 q ha^{-1}) + Azotobacter (5.28 kg ha^{-1}) recorded maximum shelf life in marigold.

Effect of INM on flower yield

Data regarding number of flowers $plant^{-1}$, number of flowers $plot^{-1}$, flower yield $plant^{-1}$ (g) and flower yield $plot^{-1}$ (kg) influenced by different INM treatments are presented in Table 2.

The maximum number of flowers $plant^{-1}$(43.40) was recorded in treatment T_7 [75% RDF + 25% RD 'N' through Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1})]and found statistically at par with treatment 100% RDF(42.20). Similarly, maximum number of flowers $plot^{-1}$ (694.40), flower yield $plant^{-1}$(371.98 g) and flower yield $plot^{-1}$(5.94 kg) was also recorded with 75% RDF + 25 % 'N' Vermicompst + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}). The data showed that treatment T_7 was found significantly superior over all the treatments applied. However, minimum number of flowers $plant^{-1}$(34.53), number of flowers $plot^{-1}$(552.53), flower yield $plant^{-1}$(181.93g) and flower yield $plot^{-1}$(2.91 kg) was recorded in T_1 (control). Bio-fertilizer when applied with organic and inorganic fertilizers helps in increasing the availability of essential plant nutrients which leads to enhanced root and shoot development thereby cause increase the growth and yield (Chaupoo and Kumar, 2021). The nitrogen increase the protein synthesis, thus promote the development of floral primordial, while phosphorus found to be involved in formation of floral premodial resulting more number of flowers. The maximum plant spread and individual flower weight was registered under the same treatment which leads to more flower yield. Similar finding has been reported by Bose *et al.* (2019), who reported that application of 75 % RDF +FYM (2 t ha^{-1}) + Vermicompost (0.6 t ha^{-1}) + *Azospirillum* (2.5 kg ha^{-1}) + PSB (2.5 kg ha^{-1}) recorded maximum flower yield ha^{-1} in China aster.

Effect of INM on economics

The data pertaining to economics i.e. cost of cultivation (Rs. ha^{-1}), net returns (Rs ha^{-1}) and B:C ratio as influenced by different treatments are presented in Table 3.

The maximum estimated yield $hectare^{-1}$ (30937.50 kg) was recorded in treatment 75% RDF + 25% RD 'N' through Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) followed by treatment 100 % RDF (27916.67 kg). The data showed that the highest cost of cultivation (Rs. 230612.50 ha^{-1}) was recorded in treatment 50% RDF + 50% 'N' Farmyard manure + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}). The maximum gross returns (Rs. 9,28,125.00ha^{-1}), net return (Rs.7,06,083.80 ha^{-1}) and benefit: cost ratio (3.17) was recorded in 75% RDF + 25% RD 'N' through Vermicompost + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}). The data also showed that minimumbenefit : cost ratio was recorded in treatment 75% RD 'N & P' + 100% 'K'+ *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) (1.39). The increase in benefit cost ratio might be due to the optimum use of nutrients sources by reducing the recommended dose of fertilizer to 75% and supplementing the deficit by using 25% vermicompost with *Azotobacter* and PSB. Moreover, higher flower yield of African marigold was recorded under same treatment. The above results are in close conformity with the findings of Vishnu *et al.* (2016), who found maximum B:C ratio with the application of 75% RDF + 25 % Vermicompost in African marigold.

Thus, the results obtained from the present investigation showed that application of 75% RDF + 25% 'N' VC +*Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}) was found to be effective in improving quality, yield and economic of African marigold cv. Pusa Narangi Gainda.

Table 1.Effect of INM on vegetative and floral attributes of African marigold cv. Pusa Narangi Gainda

Treatments	Vegetative attributes at full bloom				Floral attributes				
	Plant height (cm)	No. of primary branches plant^{-1}	Plant spread (cm)	Number of leaves plant^{-1}	No. of days taken to 1st flower bud appearance	No. of days taken to 1st flower opening	Duration of flowering (days)	Flower diameter (cm)	Shelf life (days)
T_1	77.86	9.13	46.36	242.86	67.20	85.70	40.80	5.44	5.20
T_2	95.07	16.53	63.63	340.06	60.80	76.80	54.47	7.42	7.13
T_3	94.86	15.46	59.43	315.06	61.46	79.82	52.40	6.82	6.13
T_4	92.26	12.60	52.66	281.93	63.66	80.55	43.53	6.49	5.60
T_5	96.20	16.06	63.26	324.20	61.86	79.05	54.60	6.73	6.06
T_6	95.53	14.46	57.16	304.26	63.60	78.41	52.53	6.22	5.67
T_7	98.53	17.46	66.56	372.73	58.40	74.58	55.73	8.24	8.26
T_8	91.33	13.86	56.66	291.40	62.26	80.45	50.93	6.84	6.06
T_9	90.20	12.40	52.43	281.86	63.86	81.16	47.73	6.70	5.73
T_{10}	94.26	13.73	54.76	284.73	61.53	79.61	52.45	7.08	6.60
T_{11}	87.00	14.66	57.70	313.26	63.80	80.58	43.80	6.00	5.73
T_{12}	89.60	11.73	49.26	267.66	64.93	81.93	42.93	6.22	5.86
T_{13}	90.40	13.26	54.20	283.40	63.46	80.72	43.53	6.36	5.93
SE(d)±	1.55	0.88	1.01	0.84	0.85	0.93	0.84	0.24	0.30
CD(P=0.05)	3.23	1.83	2.09	1.76	1.78	1.94	1.74	0.51	0.62

T_1 : Control, T_2 : 100% RDF, T_3 : 75% RDF + 25% 'N' Vermicompost, T_4 : 50% RDF + 50% 'N' Vermicompost, T_5 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_6 : 75% RDF + 25% 'N' Vermicompost + PSB (2ml l^{-1}), T_7 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}) + PSB (2ml l-^{1}), T_8 : 50% RDF + 50% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_9 : 50 % RDF + 50 % 'N' Vermicompost + PSB (2ml l^{-1}), T_{10} : 50% RDF + 50% 'N' Farmyard manure + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}), T_{11} : 75 % RD 'N' + 100 % P and K + *Azotobacter* (2ml l^{-1}), T_{12} : 75% RD 'P' + 100 % 'N & K' + PSB (2ml l^{-1}), T_{13} : 75% RD 'N & P' + 100% 'K' + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}).

Table 2.Effect of INM on flower yield of African marigold cv. Pusa Narangi Gainda

Treatments	Individual flower weight (g)	No. of flowers plant^{-1}	No. of flowers plant^{-1}	Flower yield plant^{-1} (g)	Flower yield plot^{-1} (kg)
T_1	5.32	34.53	552.53	181.93	2.91
T_2	7.98	42.20	687.33	335.12	5.36
T_3	6.79	41.00	667.13	278.77	4.46
T_4	6.14	39.06	635.06	239.29	3.83
T_5	6.86	40.73	647.13	291.90	4.66
T_6	6.27	39.86	644.13	250.40	4.00
T_7	8.56	43.40	694.40	371.98	5.94
T_8	6.22	41.06	658.73	254.92	4.08
T_9	6.65	39.06	632.06	259.36	4.15
T_{10}	7.47	37.53	600.53	277.20	4.43
T_{11}	6.04	37.00	595.66	201.89	3.23
T_{12}	6.05	38.26	612.26	203.30	3.26
T_{13}	6.12	35.86	580.20	198.10	3.17
SE (d) $\pm$	0.28	0.70	3.21	2.76	0.08
CD(P=0.05)	0.58	1.46	6.66	5.73	0.17

Table 3.Effect of INM on economics of African marigold cv. Pusa Narangi Gainda

Treatments	Estimated yield (kg ha^{-1})	Selling rate of flowers (Rs. kg^{-1})	Gross return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
T_1	15156.25	30	4,54,687.50	1,70,755.00	2,83,932.50	1.66
T_2	27916.67	30	8,37,500.10	2,12,025.00	6,25,475.10	2.95
T_3	23229.17	30	6,96,875.10	2,20,631.30	4,76,243.90	2.15
T_4	19947.92	30	5,98,437.60	2,29,202.50	3,69,235.10	1.61
T_5	24270.83	30	7,28,124.90	2,21,336.30	5,06,788.70	2.28
T_6	20833.33	30	6,24,999.90	2,21,336.30	4,03,663.70	1.82
T_7	30937.50	30	9,28,125.00	2,22,041.30	7,06,083.80	3.17
T_8	21250.00	30	6,37,500.00	2,29,907.50	4,07,592.50	1.77
T_9	21614.58	30	6,48,437.40	2,29,907.50	4,18,529.90	1.82
T_{10}	23072.92	30	6,92,187.60	2,30,612.50	4,61,575.10	2.00
T_{11}	16822.92	30	5,04,687.60	2,10,030.00	2,94,657.60	1.40
T_{12}	16979.17	30	5,09,375.10	2,08,823.80	3,00,551.40	1.43
T_{13}	16510.42	30	4,95,312.60	2,06,828.80	2,88,483.90	1.39

T_1 : Control, T_2 : 100% RDF, T_3 : 75% RDF + 25% 'N' Vermicompost, T_4 : 50% RDF + 50% 'N' Vermicompost, T_5 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_6 : 75% RDF + 25% 'N' Vermicompost + PSB (2ml l^{-1}), T_7 : 75% RDF + 25% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}) + PSB (2ml l^{-1}), T_8 : 50% RDF + 50% 'N' Vermicompost + *Azotobacter* (2ml l^{-1}), T_9 : 50 % RDF + 50 % 'N' Vermicompost + PSB (2ml l^{-1}), T_{10} : 50% RDF + 50% 'N' Farmyard manure + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}), T_{11} : 75 % RD 'N' + 100 % P and K + *Azotobacter* (2ml l^{-1}), T_{12} : 75% RD 'P' + 100 % 'N & K' + PSB (2ml l^{-1}), T_{13} : 75% RD 'N & P' + 100% 'K' + *Azotobacter* (2 ml l^{-1}) + PSB (2 ml l^{-1}).

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