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# Effect of organic and inorganic fertilizers on the growth and flowering of *Calendula officinalis* L.

**Nawazish Mehdi, Thaneshwari and Sabina Raut**

**Abstract**
A field experiment was carried out in the Agri-farm of Horticulture of Lovely Professional University, Kapurthala district, Punjab, India during the year 2021-2022 on "Effect of organic and inorganic fertilizer on growth and development of *Calendula officinalis* L." to elucidate the effectiveness of integrated nutrient management on crop calendula. The experiment was laid out in randomized block design with 10 treatments and 3 replications and the treatments included T1 [control], T2 [NPK dose (45:90:75 kg/ha)], T3 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha], T4 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha], T5 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha, T6 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5ton/ha], T7 [ 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha], T8 [50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha], T9 [50% NPK + Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha], T10 [50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 25q/ha]. The result of the study revealed that there was significant difference between the treatments. The treatment T6 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 25quintal/ha] seems to shows significant increase in all the parameters that being plant height, number of branches per plant, stem diameter, number of leaves per plant, leaf area, plant spread, flower weight, number of flowers per plant, flower diameter and vase life.

**Keywords:** Azotobacter, calendula, FYM, integrated nutrient management, PSB, vermicompost

## Introduction
*Calendula officinalis* is commonly known as pot marigold and it belongs to family asteraceae. The common name of the Calendula plant is marigold, Scottish marigold, garden marigold, or English marigold and despite its fast-growing characteristics, it is an easy plant to nurture and germinate (Golestani *et al*., 2013) [6]. Originally named after a Latin word that means "the first day of the month," the genus is also known as a flower of summer, associated with the astrological sign of Leo, and used to treat heart conditions and heat syndrome. It can be used as borders, rock gardens, balcony plants, and as cut flowers (Khalid and Silva, 2012) [7]. The plant is an annual, rarely biennial, and grows to between 30 and 50 cm high, as well as having a thin, secondary root system and a 20 cm long taproot. Branches are found from the base of the stem upwards, and the stem is erect, angular, and downy. Leaves on the alternates, are hairy, and almost spatulate at the base, but oblong to lanceolate above (Muley *et al*., 2009). Every stem is topped with a flower head that is 5 to 7 cm in length, comprised of an epicalyx with numerous narrow-lanceolate sepals densely covered with glandular hairs on both sides (Khalid and Silva, 2012) [7]. The yellow inflorescences have a thick capitulum or flower head measuring 4–7 cm (1.5–3 in) in diameter and two rows of hairy bracts encircling the center disc florets; in the wild, they have a single ring of ray florets surrounding the central disc florets. The disc florets are tubular and hermaphrodite, with a brighter orange-yellow color than the female, tridentate ray florets (Ashwlayan and Verma, 2018) [1].
The excess use of chemical fertilizers has consistently damaged soil health and inorganic fertilizers have been linked to decreased crop output, soil acidity, and nutritional imbalance in intensive agriculture (Singh *et al*., 2015) [12]. Integrated Nutrient Management (INM) has evolved as an important strategy for sustaining soil fertility and crop yield over the years and using fertilizer, manure, and bio-fertilizer together not only improves soil health but also increases crop growth and output (Sowmya and Prasad, 2017) [15]. The utilization of organic matter as a nutrient input is a smart method for crop development with minimal environmental pollution as a trend toward sustainable and organic production will lessen the impact of

agriculture on the environment (Liu *et al*., 2009) [9]. Integrated use of bio-fertilizers and organic manures not only helps to reduce the use of inorganic fertilizers but also improves the quality and quantity of flowers. It has also been found that when inorganic fertilizers when coupled with organic manures, their efficacy increases (Kumar *et al*., 2016) [8]. In this experiment an effort was made to find the effect of integrated nutrient management on growth and flowering of calendula, an medicinally and aesthetically important flower.

## Materials and Methods

The present investigation named "Effect of organic and inorganic fertilizers on the growth and flowering of *Calendula officinalis*" was done in the Agri-farm of Department of Horticulture (of Lovely Professional University, Kapurthala district, Punjab, India. The soil of the experimental plot was well prepared by repeated ploughing followed by planking to obtain a fine tilth. Well- rotted FYM, Neem cake and Vermicompost alongside PSB and Azotobacter were added as per the requirement of the treatments. The experiment was laid out in randomized block design with 10 treatments and 3 replications and the treatments included T1 [control], T2 [NPK dose (45:90:75 kg/ha)], T3 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha], T4 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM5 ton/ha], T5 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha, T6 [75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5ton/ha], T7 [ 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha], T8 [50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha ], T9 [50% NPK + Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha], T10[50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 25q/ha]. RBD (Randomized Block Design) was followed for this experiment and the qualitative parameters characters were analyzed by the analysis of variance (ANOVA). The critical difference values were calculated at 5 percent level of significance.

## Results and Discussion

### Vegetative Parameters

### Plant height

Among different treatments of INM (Table 1), the maximum plant height was recorded in treatment T6 (75% of the total dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neemcake 2.5ton/ha) followed by T4 (75% of the total dose of NPK+ Azotobactor 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha) and T5 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM+ Vermicompost2.5ton/ha). Here, among all the ten treatments, T6 showed statistically superior result while the treatment T1 *i.e.* control recorded the minimum plant height. In Treatment T6, there was a constant increase in plant height at 30 DAT (12.83cm) followed by sharp increase in height at 45 DAT (24.71cm) and 90 DAT (33.66cm) while at 120 DAT (38.55), the growth slowed down.

### Number of branches per plant

Among different INM treatments (Table 2), the treatment T6 (75% of the total dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) showed statistically superior result, followed by the treatment T9 (50% of the total dose of NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) and T5 (75% of the total dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) while T1 *i.e.* control recorded the lowest number of branches.

### Number of leaves per plant

Among different INM treatments (Table 2), the treatment T6 (75% of the total dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) showed statistically superior result, followed by T9 (50% of the total dose of NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) and T5 (75% of the total dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) while T1 *i.e.* control recorded the lowest number of branches.

### Plant spread (cm)

Among different treatments (Table 2), the highest plant spread was recorded by treatment T6 (75% NPK+ Azotobacter3kg/ha+ PSB3kg/ha+ FYM5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) followed by T5 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) and T10 (50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) while the least plant spread was recorded in T1 *i.e.* control. Here among all the ten treatments, T6 showed statistically superior results.

### Leaf area ($cm^2$)

From Table 2, the maximum leaf area was recorded in T6 *i.e.* with the application of 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5ton/ha and it was found to be at par with T8 and T9 which received treatments 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha and 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha. Whereas the minimum leaf area per plant was recorded in T1 *i.e.* control followed by T3 and T2 *i.e.* with the application of 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha and 100% NPK /ha, respectively. Hence, among all the ten treatments, T6 showed statistically superior result for leaf area.

### Stem diameter (cm)

Among different INM treatments (Table 2), the treatment T6 (75% of the dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) showed the statistically superior result which was then followed by T5 (75% of the dose of NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) and T10 (50% of the dose of NPK+ Azotobacter 5kg/ha+ PSB5 kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) while the control *i.e.* T1 recorded the lowest stem diameter.

The increase in all the vegetative parameters with the combined application of inorganic and organic fertilizers may be because of the more nutrient flow into the plants and accordingly leaning towards the plant development and excitement of auxiliary buds bringing about additional plant height and width. Also these results may be because of the way that natural composts are good source of different full scale and miniature components which might have brought about most extreme number of leaves, branches, plant spread and the stem diameter. These outcomes are in lined up with those discovered by Sunitha *et al*., (2007) [14] and Gaur *et al*.,

(2008) [4] in marigold. An increment in the stem diameter may be because of nitrogen, which plays a major role in advancing the plant development. These findings are similar with the findings of Mandloi *et al*., (2008) [11] and Singh and Singh (2003) [13].

**Flowering Parameters**

**Flower weight (g)**

From Table 3, the maximum flower weight was recorded in treatment T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) followed by T10 (50% NPK+ Azotobacter5kg/ha+ PSB5kg/ha+ FYM5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) and T2(100% NPK *i.e.* 45:90:75 kg/ha) while the minimum flower weight was recorded in treatment T1 *i.e.* control. Thus, we can say that among all the treatments, T6 was found to be statistically superior and was found to be best for the good flower weight of calendula.

**Flower diameter (cm)**

Among different INM treatments (Table 3), treatment T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) was found to be statistically superior which was then followed by T10 (50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) and T5 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) while T1 *i.e.* control recorded the least flower diameter.

**Number of flowers per plant**

Among different INM treatments (Table 3), the treatment T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) was found to be statistically superior and was then followed by T10 (50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 25quintal/ha) and T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 25quintal/ha) while treatment T1 *i.e.* control recorded lowest number of flowers.

**Number of flowers per meter square**

Among different INM treatments (Table 3), the treatment T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 25quintal/ha) was found to be statistically superior and was then followed by T10 (50% NPK+ Azotobacter5kg/ha+ PSB5kg/ha+ FYM5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5 ton/ha) and T7 (50% NPK+ Azotobacter5kg/ha+ PSB5kg/ha) while treatment T1 *i.e.* control recorded the lowest number of flowers.

The increased flower weight, flower diameter and number of flowers per plant while using treatment T6 (75% NPK+ Azotobacter3kg/ha+ PSB3kg/ha+ FYM5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 25quintal/ha) might be because of the utilization of chemical fertilizers, organic fertilizers and bio-fertilizer application because of which, the vermicompost expanded the nutritive status of macro and micro nutrients in soil, while azotobacter further developed growth promoting substance in soil as well as in plant. This result might also be due to ample quantities of nutrients, vitamins and growth substances in RDF + Azotobacter +PSB+FYM at higher level and also robust growth and maximum increase in flowering span that might have resulted in production of a greater number of flowers per plant. Consequently, the consolidated utilization of nitrogen, phosphorus, potash, compost and bio-fertilizer all the while expanded the vegetative and reproductive period of plant (Chandrikapure *et al*., 1999 and Singh *et al*., 2015) [3, 12]. Similar observations have been reported by Chaitra and Patil, 2007 [2] on China aster and Giri and Beura, 2021 [5] on Gerbera.

**Vase life (days)**

From Table 3, the longest vase life was recorded in the treatment T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) followed by T9(50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) and T8(50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha) while treatment T1 *i.e.* control recorded the shortest vase life. The interaction of INM was found to exhibit significant effect on vase life of flowers, giving statistically superior result from T6.

Increased vase life might be due to the reduced physiological (weight loss and lesser water uptake by flowers. Restricted respiration due to the unavailability action of these nutrient sources might increase the vase life. This finding was in agreement with the findings of Lodhi *et al*., 1991, where the best results were recorded with ½ RDF + ½ PSB + ½ Vermicompost, in French marigold (*Tagetes patula* L.) *cv*. Pusa Arpita.

**Table 1:** Effect of organic and inorganic fertilizers at different stages of the plant height of *Calendula officinalis*

| Treatments | Plant Height at 30 DAT | Plant Height at 45 DAT | Plant Height at 90 DAT | Plant Height at 120 DAT |
|---|---|---|---|---|
| T1- Control | 9.22 | 17.83 | 25.33 | 27.71 |
| T2- NPK dose (45:90:75kg/ha.) | 11.16 | 18.44 | 25.77 | 29.52 |
| T3- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha. | 12.16 | 20.00 | 25.05 | 27.94 |
| T4- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha | 12.11 | 23.38 | 30.16 | 36.77 |
| T5- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 12.50 | 23.01 | 32.22 | 34.55 |
| T6- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5ton/ha | 12.83 | 24.71 | 33.66 | 38.55 |
| T7- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha | 12.05 | 21.66 | 27.66 | 32.66 |
| T8- 50% NPK+Azotobacter5kg/ha+ PSB5kg/ha+ FYM5ton/ha | 12.27 | 19.33 | 28.38 | 29.88 |
| T9- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 12.55 | 21.33 | 26.99 | 32.77 |
| T10- 50% NPK+ Azotobacter 5kg/ha+ PSB5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5t/ha | 12.83 | 21.44 | 27.92 | 31.88 |
| CD at 5% (0.05) | 0.186 | 0.524 | 0.821 | 1.50 |

**Table 2:** Effect of organic and inorganic fertilizer on different vegetative parameters of *Calendula officinalis* (Calendula)

| Treatments | Number of branches per plant | Stem diameter (cm) | Number of leaves per plant | Leaf area ($cm^2$) | Plant spread (cm) |
|---|---|---|---|---|---|
| T1- Control | 6.11 | 0.58 | 67.88 | 4.99 | 28.22 |
| T2- NPK dose (45:90:75kg/ha.) | 6.22 | 0.67 | 108.44 | 6.03 | 32.22 |
| T3- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha. | 6.33 | 0.75 | 105.21 | 5.31 | 32.55 |
| T4- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha | 6.54 | 0.85 | 82.22 | 6.63 | 33.0 |
| T5- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 7.10 | 0.93 | 100.99 | 7.31 | 39.33 |
| T6- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5ton/ha | 7.44 | 0.96 | 110.55 | 7.82 | 41.77 |
| T7- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha | 7.10 | 0.85 | 87.66 | 6.77 | 33.33 |
| T8- 50% NPK+Azotobacter5kg/ha+ PSB5kg/ha+ FYM5ton/ha | 5.66 | 0.86 | 97.10 | 7.61 | 34.33 |
| T9- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 7.11 | 0.89 | 106.77 | 7.46 | 35.0 |
| T10- 50% NPK+ Azotobacter 5kg/ha+ PSB5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5t/ha | 5.88 | 0.92 | 84.10 | 7.33 | 36.50 |
| CD at 5% (0.05) | 0.796 | 0.022 | 2.014 | 1.82 | 1.476 |

**Table 3:** Effect of organic and inorganic fertilizer on different flowering parameters of *Calendula officinalis* (Calendula)

| Treatments | Flower weight (g) | Number of flowers per plant | Number of flowers per meter square | Flower diameter (cm) | Vaselife (days) |
|---|---|---|---|---|---|
| T1- Control | 0.94 | 24.00 | 144.00 | 2.24 | 4.16 |
| T2- NPK dose (45:90:75kg/ha.) | 1.42 | 31.50 | 189.20 | 2.27 | 4.34 |
| T3- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha. | 1.38 | 43.25 | 259.50 | 2.44 | 5.54 |
| T4- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha | 1.34 | 31.50 | 189.00 | 3.16 | 6.15 |
| T5- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 1.36 | 34.08 | 204.50 | 3.28 | 5.95 |
| T6- 75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha + Neem cake 2.5ton/ha | 1.74 | 47.16 | 282.96 | 3.51 | 6.78 |
| T7- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha | 1.27 | 43.75 | 262.5 | 2.57 | 5.55 |
| T8- 50% NPK+Azotobacter5kg/ha+ PSB5kg/ha+ FYM5ton/ha | 1.32 | 32.66 | 195.96 | 2.60 | 6.15 |
| T9- 50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha | 1.34 | 41.50 | 249.00 | 3.22 | 6.27 |
| T10- 50% NPK+ Azotobacter 5kg/ha+ PSB5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5t/ha | 1.54 | 45.15 | 273.9 | 3.33 | 5.89 |
| CD at 5% (0.05) | 0.020 | 1.352 | 8.42 | 0.046 | 0.071 |

## Conclusion

Most of the growth parameters were significantly affected by different INM treatments while T6 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 2.5 ton/ha) performed better in comparison to other treatments followed by T10 (50% NPK+ Azotobacter 5kg/ha+ PSB 5kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha+ Neem cake 25quintal/ha) and T5 (75% NPK+ Azotobacter 3kg/ha+ PSB 3kg/ha+ FYM 5ton/ha+ Vermicompost 2.5ton/ha) while T1 *i.e.* control recorded the minimum parameters under the Punjab condition.

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