

Study on growth yield and quality of Pea under the influence of different combinations of biofertilizers and organic manures

ABSTRACT: The present investigation was carried out at Vegetable Research & Demonstration Block, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar Pauri Garhwal during Rabi season (2023-2024) to assess the performance of pea to different organic cultivation practices. The experiment was laid out in Randomized Complete block Design (RCBD) with 13 treatments and 3 replications. The treatments were a combination of different doses of biofertilizers i.e. (*Rhizobium leguminosarum* and PSB along with application of organic manures (FYM, Vermicompost and Compost). Parameters like germination (%), plant height (67.813 cm), leaf count (60.333), LAI (4.357), RLWC % (80.963 %), number of cluster/plant (13.633), number of root nodules (27.433), root active nodules (14.217), fresh and dry weight of root nodules (1257.807 mg), (146.467 mg), pod length (10.267 cm), pod yield/plant (77.230), seed yield/plant (60.760 g), shelling percentage (48.920 %) and 100 seed weight (46.470 g), TSS (14.0 °Brix) and Ascorbic acid (25 mg/100g) also found highest in T₉. The data depicted best results in T₉ for all the treatments which was found statistically at par with T₅. But considering economic point of view cost benefit ratio (1:1.73) was found to be maximum under treatment T₅[*Rhizobium leguminosarum* (20ml)+ PSB (20ml) +FYM (10 t/ha)] and therefore T₅ should be recommended to the farmers for deriving maximum profit for organic cultivation of pea.

Keywords: Pea, FYM, *Rhizobium*, PSB, Yield, Quality

Introduction

The most significant vegetable crop among legumes, garden peas (*Pisum sativum* L.) have a long history of domestication and are cultivated all over the world as a valuable export oriented cash crop (Devi *et al.*, 2023). It is a diploid (2n=14), short-duration and cleistogamous crop belonging to the family Fabaceae. The young green seeds can be consumed raw, cooked, dehydrated or as the main ingredient in frozen vegetable recipes. It is one of the top ten vegetable crops and one of the most significant vegetable globally. There

are two subspecies of pea: garden pea (*Pisum sativum* var. hortense) and field pea (*Pisum sativum* var. arvense), which are used in a variety of food processing sectors and can be eaten as a pulse or as a raw vegetable.

Pea is a native of South West Asia and is widely grown in temperate countries like USA, China, France, Holland and Hungary. Cool climates with cardinal temperatures between 10-18° degrees Celsius are ideal for pea growth. (Kumar and Choudhary, 2014). In India, it is grown as a winter vegetable in the plains of North India and as summer vegetable in the hills. Pea may be cultivated in nearly all kind of soils that has sufficient drainage. The ideal pH range for pea cultivation is between 5.5 to 6.5 for silt loam and clay loam. (Srivastava *et al.*, 2020).

Garden peas are highly nutritive and rich source of protein, sugar, carbohydrates, vitamins and minerals. It is used as vegetable in the form of cooked, soup, canned, frozen or dehydrated. It is an important off- season cash crop besides having ecological advantage due to fixation of atmospheric nitrogen through root nodules. The stovers are used as fodder. Garden pea contains 7.2 g protein, 0.1 g fats, 0.8 g minerals, 15.8 g carbohydrates, 20 mg calcium, 34 mg magnesium, 13 mg phosphorous, 0.23 mg copper, 1.5 mg iron, 0.01 mg riboflavin, 0.8 mg nicotinic acid and 9.0 mg vitamin C per 100g of edible portion (Khichiet *al.*, 2016).

The extensive use of chemical fertilizers leaves toxic residues that have a devastating long-term impact on the health of humans, animals, and soil and utilization of these artificial inputs has resulted in a decline in soil fertility, soil microbiological activity, and crop nutritional status. Adding organic sources like FYM, compost, vermicompost, etc. has made it possible to reduce the usage of chemical fertilizers in order to maintain a healthy and sustainable agro-ecosystem. Moreover biofertilizers are essential for preserving soil fertility over the long term and are a key element of organic farming. They fix nitrogen from the atmosphere and mobilize different micro and macronutrients in the soil, increasing their availability and effectiveness. (Kaushal and Kukreja, 2020).

MATERIALS AND METHODS

The experiment was conducted at Vegetable Demonstration Block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal, Uttarakhand, Pauri Garhwal is one of the thirteen districts of Uttarakhand and is located between 29 20'-29 75' N latitude and 78 10'-78 80' E

longitude. Bharsar is situated at about 57 km from the district headquarter of Pauri Garhwal, situated at an altitude of about 1900 meters above mean sea level. The meaning of Bharsar in local dialect is flourished with natural wealth. Since the ancient time it is famous for its vast reserve of biodiversity and geographically the temperature, climate conditions of the region are quite congenial for the horticulture. The farm area falls in the high mid zone of Uttarakhand (Bisht and Sharma, 2014). Before laying out the experiment random sample was collected from the different spots with the help of khurpi in 'V' shaped manner from the furrow slice (0-15 cm depth) of each plots from which a composite sample was prepared for the determination of different soil characteristics. The entire analysis of soil was carried out in the laboratory of Natural Resource Management College of Horticulture, VCSG UHF, Bharsar, Pauri Garhwal, Uttarakhand.

The present experiment comprised of 13 treatments, which were carried out in a randomized complete block design along with 3 replications. The details of experimental site and materials used in the present study are presented in Table 1 and 2. Cultivar "Arkel" of garden pea was selected for the present study. The cultivar has recommended for different agro-climatic zones. Seeds of Garden Pea were obtained from the "UttarakhandbeejBhandar store" market of Dehradun. Different organic inputs were used in the experiment viz., FYM, Vermicompost, Compost and *Rhizobium leguminosarum*. FYM was obtained through Organic Block, College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal (Uttarakhand). The Vermicompost, Compost and *Rhizobium leguminosarum*, PSB were obtained from the "UttarakhandbeejBhandar store" market of Dehradun.

The experimental field was once ploughed by power tiller. The clods were crushed and weeds were removed manually. The land was divided into 39 plots of required size (1m×0.6 m). After preparation of experimental plots each of the plots was tagged according to the layout and different treatments were applied. Garden pea was normally sown directly by scattering the seeds along drill at a depth of 3-5cm and spacing of 30cm × 10cm and cover with soil using a rake after sowing. Before dibbling the seeds were treated with *Rhizobium leguminosarum* and Phosphate solubilizing bacteria (PSB) culture as per treatments. 100g of Jaggery was dissolved in 100ml of warm water. Seeds were soaked in Jaggery solution for 15-20 minutes and seeds were dried under shade. Thereafter, these seeds were coated with *Rhizobium leguminosarum* culture with different concentration and Phosphate Solubilizing

Bacteria with different concentration and with mixed culture of *Rhizobium leguminosarum* and Phosphate Solubilizing Bacteria as per the treatments. Treated seeds were dried in shade before planting. Data were collected on different growth, yield and quality contributing characters. Five plants were selected randomly and tagged for identification. The plants in the outer rows and at extreme end of the middle rows were excluded from the random selection to avoid the border effect. The following observations were made regarding plant growth, yield and quality contributing characters as affected by different types of biofertilizers and organic manures. The following parameters were recorded:

Observations recorded:

Data were collected on different growth, yield and quality contributing characters. Five plants were selected randomly and tagged for identification. The plants in the outer rows and at extreme end of the middle rows were excluded from the random selection to avoid the border effect. The following observations were made regarding plant growth, yield and quality contributing characters as affected by different types of biofertilizers and organic manures. The following parameters were recorded:

Growth parameters: Plant height (cm), number of leaves per plant, LAI, RLWC (%), number of branches, number of cluster per plant, number of days taken to first flowering, pod length (cm) and pod girth (cm).

Yield parameters: number of pods/plants, number of seeds/pods, pod yield/ plant (g), pod yield/plot (kg/0.6m²), seed yield/plant (g), seed yield/plot (kg/0.6m²), shelling (%), 100 seed weight (g).

Quality parameters: Total soluble solids (°Brix), ascorbic acid (mg/100 g) and dry matter content (%).

Statistical Analysis

Statistical analysis was performed on the observations collected for various characters. The data were analysed using the analysis of variance technique for Randomized Block Design with three replications (Gomez and Gomez, 1984). The significance of variance among treatments was determined using the Analysis of Variance (ANOVA) and Critical Difference (C.D) tests at a 5% probability level.

RESULTS AND DISCUSSION:

The result involved in present study recorded maximum germination per cent (93.333%) in treatment T₉. However, treatment T₁ Control (Untreated) had the lowest germination per cent (71.667). *Rhizobium leguminosarum* strains secrete growth hormones like Indole acetic acid (IAA), which shows positive influence on plant growth and also plays an important role in the formation and development of root nodules. The results are in strong conformity with the Anandrao and Arshiya (2022) in certain leguminous plant including pea, Sneka *et al.* (2022) in green gram.

Fastest days taken to initial germination (6.667) was recorded in treatment T₉, similar in T₈ (6.667) and T₅ (6.667). On the other hand, treatment T₁ Control (Untreated) exhibited the most delayed initial germination (9.000). It might be due to organic nutrient sources which are rich in humus, gibberellins, and humic acids in vermicompost hence enable nitrogen fixation by microbes, microbial decomposition regulates nitrogen supply to the plants which created better condition. These favorable conditions seemed to have created better nutrient absorption and favors faster and better germination, growth and development of root system which in true reflects of better vegetative growth and photosynthetic activity. Biofertilizers and organic manure also improved the water holding capacity of soil and moisture helps in germination rapid cell elongation leading to longer root formulation. Similar results have been reported by Chauhan *et al.* (2010) in pea and Shalu *et al.* (2023) in pea.

The tallest plant height 30.120 cm, 49.010 cm, 58.680 cm, 67.813 cm at 45, 60, 75 and 90 DAS observed was in treatment T₉ except at 15 and 30 DAS the tallest plant height (6.687 cm and 16.237 cm) was recorded in T₅ and T₈. Similar findings were also recorded by Bunker *et al.* (2022) in garden pea and Siddiqui and Debbarma (2022) in pea.

The highest number of leaf 45, 60, 75 and 95 DAS, respectively except at 15 and 30 DAS where the highest number of leaf count i.e., (10.267 and 20.100) was recorded in T₁₃ and T₅. Observing (10.267, 20.100). Similar results were observed by Negi *et al.* (2006) in garden pea who noticed increased plant height with co-inoculation of biofertilizers viz., *Rhizobium* and PSB. Similar results have been reported by Verma *et al.* (2019) in chickpea.

The highest leaf area index 0.2.317, 3.553, 4.310 and 4.357 at 45, 60, 75 and 90 DAS observed under T₉ and 0.560, 0.787 at 15 and 30 DAS observed in T₅. Similar results have been reported by Samsurrahman *et al.* (2021) in mung bean and Verma *et al.* (2019) in chickpea.

The RLWC values 78.987 %, 78.503 % and 80.63 % at 30, 60 and 90 DAS was found to be highest under T₉. At the harvest maximum number of branches (3.567) was recorded in

treatment T₅. Similar results were also obtained Kazeminasabet *et al.* (2016) in lemon balm and Hafez *et al.* (2020) in wheat

At the harvest maximum number of branches (3.567) was recorded in treatment T₅ which was found statistically at par with treatment T₉ (3.533), T₈ (3.500), T₁₃ (3.400), T₄ (3.367), T₇ (3.333), T₃ (3.333) and T₁₂ (3.267) respectively. While, the minimum number of branches (2.633) was recorded with treatment T₁ Control (Untreated). Lakshmipathy *et al.* (2011) in cluster bean, who reported that number of branches per plant was significantly increased with the application of FYM + *Rhizobium* + PSB inoculation as compare to un-inoculated one.

Maximum number of cluster per plant (13.633) was recorded with treatment T₉ which was found statistically at par with treatment T₅ (13.427), T₄ (13.100), T₁₃ (13.067), T₇ (12.713), T₃ (12.713) and T₁₂ (12.763) respectively. However, minimum number of cluster (9.667) with treatment T₁ Control (Untreated). Similar results have been recorded by Ramana *et al.* (2010) in French bean, Chauhan *et al.* (2016) in cowpea.

Among different treatments fastest flowering (45.333) was noticed in treatment T₅ and it was found statistically at par with treatment T₉ (45.667), T₈ (46.000), T₄ (46.333) and T₁₃ (46.667) respectively. On the other hand, delayed flowering (49.667) was recorded in treatment T₁ Control (Untreated). Similar results were reported by Kothyari *et al.* (2017) in pea Soniya *et al.* (2023) in pea.

Highest number of root nodules (27.433), root active nodules (14.217), maximum fresh weight (1,257.807 mg) and dry weight (146.467 mg) of root nodules observed under treatment T₉. Similar results were noticed by Negi *et al.* (2006) in garden pea who reported that number of root nodules increased with the application of biofertilizers viz., *Rhizobium* and PSB. Lakshmipathy *et al.* (2017) in cluster bean reported increase in root nodules per plant with organic manure and biofertilizers viz., *Rhizobium* and PSB.

The longest pod length (10.267 cm) was observed in T₉ which was found statistically at par with T₅ (10.030 cm). Where, the shortest pod length (6.820 cm) was obtained from the treatment T₁ Control (Untreated). Similar finding were noticed by Teli *et al.* (2016), in pea, Khan *et al.* (2017) in pea

Pod girth was affected significantly by different combinations of biofertilizers and organic manures. The highest pod girth (1.477 cm) was observed in T₅ (which was found statistically at par with T₉ (1.463 cm), T₈ (1.440 cm) and T₁₃ (1.433 cm) and T₄ (1.463 cm) respectively. However, the shortest pod girth (1.190 cm) was obtained under the

treatment T₁ Control (Untreated). The accumulation of carbohydrates and increase in metabolic activities gives better vegetative growth which leads to manufacture of food materials, which are then translocated to the developing pod and ultimately led to increase in diameter of pod. The results are in strong conformity with the and Gupta *et al.* (2017) in pea and Bhutia *et al.* (2019) in pea.

The maximum number of pods per plant (16.167) was observed in T₈ and it was found statistically at par with T₉ (16.133), T₅ (16.067) respectively. Similar results were also reported by Harireddy and Dawson (2021) in cowpea and Pandey *et al.* (2017) in field pea.

The highest number of seeds per pod (9.667) was observed in T₉ and it was found statistically at par with T₅ (9.467) and T₁₃ (9.367) respectively. Increase in number of seeds per pod might be due to application of *Rhizobium*, Phosphate Solubilizing Bacteria and FYM that enhanced the availability of nutrients in soil, which in turn encouraged more vegetative growth, metabolic activities and chlorophyll content and increased accumulation of more amounts of carbohydrates in the pods and thereby increasing the number of seeds per pod. Similar results were observed by Meena *et al.* (2014) in cowpea.

The maximum pod yield per plant (77.230g) observed in T₉ (and it was statistically at par with treatment T₅ (75.703g) and T₁₃ (74.657 g)). Fig. 1. All the treatments were found statistically significant as compared to T₁ Control (Untreated). These results are in line with the finding of Lakshmi pathy *et al.* (2017) in cluster bean and Ram *et al.* (2021) in pea.

The highest pod yield per plot (1.400 kg/0.6m²), was recorded in T₉ and it was statistically at par with treatment T₅ (1.363 kg/0.6m²). Composite inoculation with Bacteria might have increased the growth, yield attributes and ultimately the yield, due to increased nitrogenase activity and available phosphorus status in soil as reported by Negi *et al.* (2006) in garden pea. Similar findings were also reported by Jaipaul *et al.* (2011) in pea and Bunker *et al.* (2018) in pea.

The highest seed yield per plant (60.760 g) was recorded in T₉ which was statistically at par with T₅ (60.557 g) and T₁₃ (59.157 g) respectively. While, the lowest seed yield per plant (41.560 g) was observed in treatment T₁ Control (Untreated). The increase in seed yield is due to more availability of nutrients, which in turn encourages more vegetative growth, metabolic activities and chlorophyll content thereby increasing the number of seeds per pod. Similar results were reported by Reeturaj and Chil (2021) in cowpea.

The highest seed yield per plot (1.133 kg), was observed in T₉ which was statistically at par with T₅ (1.110 kg/0.6m²), seed yield per hectare (18.478 tonnes /ha). Rapid synthesis and translocation of photosynthates from source (leaves) to sink (roots) might have contributed to

increase fresh weight and dry weight of root. Similar results were reported by Ganesh *et al.* (2021) in cowpea and Mohanty *et al.* (2017) in French bean.

The maximum shelling percent was recorded (48.920%) in T₉ and it was statistically at par with treatment T₅ (47.683 %), T₈ (46.697 %) and T₁₃ (46.137 %) respectively. The minimum shelling percent (40.177%) was observed in the treatment T₁ Control (Untreated). These results are in conformity with the findings of Singh *et al.* (2019) who reported maximum shelling percent with the application of *Rhizobium* in garden pea. Similar results were reported by Rajput *et al.* (2022) in pea and Shalu and Rattan (2023) in pea.

The maximum 100g seed weight (46.470g) was observed in T₉ and it was statistically at par with treatment T₅ (45.457 g). The similar results are in Shah and Kataria (2019) in soyabean and Gaharwar *et al.* (2023) in pea.

The highest TSS (15.083°Brix) was recorded in the treatment T₉ and it was found statistically at par with T₁₃ (14.707 °Brix) and T₅ (14.630 °Brix). The lowest TSS (10.433°Brix) was recorded in T₁ Control (Untreated). Similar findings were reported by Sangma *et al.* (2018) in pea and Kumari *et al.* (2023) in pea.

The maximum ascorbic acid (34.387mg/100g) was recorded in the treatment T₉ and it was found statistically at par with T₁₂ (33.863mg/100g), T₄ (33.743mg/100g) and T₈ (32.683 mg/100g). While, the minimum ascorbic acid (28.783 mg/100g) was recorded in T₁ Control (Untreated). Increase in ascorbic acid might be due to the availability of nitrogen leading to balanced C: N ratio enhancing the vegetative growth resulting in high photosynthetic activity Vermicompost 10 t/ha). While, the minimum ascorbic acid (10.433) was recorded in T₁ Control (Untreated). These results are in conformity with the result obtained and. (Gayathri and Krishnaveni (2015) in okra and Verma *et al.* (2024) in pea and garlic.

The highest starch content (25.445 %) was recorded in the treatment T₈ and it was found statistically at par with T₁₂ (25.287 %) and T₃ (24.363 %). However, the lowest starch content (21.110) was recorded in T₁ Control (Untreated). These results are in conformity with the result obtained by Sepheya *et al.* (2015) in pea.

The highest dry matter content of seed (30.487%) was observed in T₁₀ (*Rhizobium leguminosarum* (5ml) + PSB (5 ml) + Compost (10 t/ha) and found statistically at par with T₄ (30.433 %), T₅ (30.270 %), T₈ (30.070%), T₃ (29.427%), T₆ (29.103%), T₇ (30.070) and T₁₃ (29.303 %). While, the lowest dry matter content of seed (28.133 %) was observed from T₅. These results are in conformity with the result obtained by Chauhan *et al.* (2023) in pea.

CONCLUSION:

From the present study it can be concluded that treatment T₉ (*Rhizobium leguminosarum* (20ml) + PSB (20ml) + Vermicompost (10t/ha) was found effective in improving growth, yield and quality attributes of pea (*Pisumsativum* L.) which was found statistically at par with treatment T₅ (*Rhizobium leguminosarum* (20ml)+ PSB(20ml) +FYM (10 t/ha) exceptin growth parameter with respect to number of branches per plant, number of days taken for fastest flowering,pod girthT₅ was found to be more significant and for number of pods/plant T₈ (*Rhizobium leguminosarum*(15ml)+ PSB (15ml) + Vermicompost (10 t/ha) showed best result. In case of quality characters, treatment T₈(*Rhizobium leguminosarum*(15ml) + PSB (15ml) + Vermicompost (10 t/ha)recordedhighest starch content and T₁₀ (*Rhizobium leguminosarum*(5ml) + PSB (5ml) +Compost (10 t/ha) recorded maximum dry matter content.But, considering economic point of view T₅(*Rhizobium leguminosarum* (20ml)+ PSB (20ml) +FYM (10 t/ha) was found most profitable because of high yield and low investment and should be recommended to the farmers for generating profitable returns.

Table 1: Detail of experimental site conducted during December, 2023 – March, 2024 are as under

Crop	Garden Pea
Variety	Arkel
Experimental site	Vegetable Demonstration Block, CoH, Bharsar
Growing condition	Natural ventilated polyhouse condition
Design	Randomized complete Block Design (RCBD)
Number of Replications	03
Number of Treatments	13
Number of plots	39
Spacing	30 cm × 10 cm
Plot size	1 m × 0.6m
Number of plants/ plots	20
Total number of plants	780
Area of one plot	0.6 m ²
Net experimental area	23.4 m ²

Table 2: Details of treatments

Treatment	Treatment details
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T₁	Control
T₂	<i>Rhizobium leguminosarum</i> (5ml)+ PSB (5ml) + FYM (10 t/ha)
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)
T₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost (10 t/ha)
T₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)
T₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5 ml) +Compost (10 t/ha)
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)
T₁₂	<i>Rhizobiumleguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)
T₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)

Table 3: Influence of different combinations of biofertilizers and organic manures on germination per cent (%) and number of days taken to initial germination

Treatment	Treatment details	Germination Percent \pmS.E (m)	No of days taken to initial germination \pmS.E (m)
T₁	Control	71.667 \pm 1.667	9.000 \pm 0.577
T₂	<i>Rhizobium leguminosarum</i> (5ml)+ PSB	83.333* \pm 3.333	7.667* \pm 0.333

	(5ml) + FYM (10 t/ha)		
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	85.000*±2.887	7.333* ±0.333
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	88.333*±1.667	7.333*±0.333
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	91.667*±1.667	6.667*±0.333
T₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml)+ Vermicompost (10 t/ha)	85.000*±2.887	7.333*±0.333
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost (10 t/ha)	86.667*±1.667	7.000* ±0.577
T₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	88.333*±1.667	6.667*±0.333
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	93.333*±1.667	6.667*±0.333
T₁₀	<i>Rhizobium leguminosarum</i> (5ml)+ PSB (5ml) +Compost (10 t/ha)	83.333*±3.333	7.000*±0.577
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	81.667±3.333	7.667*±0.333
T₁₂	<i>Rhizobiumleguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	86.667*±3.333	7.333*±0.333
T₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	88.333*±4.410	7.000*±0.577
	S.E(d)	3.307	0.561
	C.D_(0.05)	6.865	1.165

Table 4.: Influence of different combinations of biofertilizers and organic manures on plant height (cm) at different time interval

Treatments		Plant height (cm) \pm S.E (m)					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T₁	Control	3.013 \pm 0.338	9.760 \pm 0.086	21.727 \pm 0.777	41.533 \pm 0.786	46.197 \pm 0.381	54.633 \pm 1.217
T₂	<i>Rhizobium leguminosarum</i> (5ml)+ PSB (5ml) + FYM (10 t/ha)	4.473* \pm 0.324	13.027* \pm 0.315	23.703 \pm 0.922	44.463* \pm 0.515	52.543* \pm 0.138	60.423* \pm 0.547
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	4.563* \pm 0.313	14.237* \pm 0.532	25.363* \pm 0.103	45.123* \pm 0.951	54.020* \pm 0.365	62.800* \pm 0.361
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	4.723* \pm 0.451	15.400* \pm 0.934	28.490* \pm 0.644	46.607* \pm 1.191	54.930* \pm 0.470	64.230 \pm 0.416
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	6.687* \pm 0.631	16.090* \pm 0.059	29.663* \pm 0.602	48.250* \pm 0.616	58.113* \pm 0.412	66.823* \pm 0.742
T₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml)+ Vermicompost (10 t/ha)	5.113* \pm 0.561	13.050* \pm 0.257	24.283* \pm 0.419	46.153* \pm 0.467	52.713* \pm 0.127	61.783* \pm 1.117
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost (10 t/ha)	4.967* \pm 0.355	14.287* \pm 0.394	27.763* \pm 0.805	46.520* \pm 1.121	54.123* \pm 0.354	63.347* \pm 0.676
T₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	5.860* \pm 0.156	16.237* \pm 0.540	28.530* \pm 0.629	48.773* \pm 0.632	55.163* \pm 0.453	64.060* \pm 0.331
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	6.527* \pm 0.518	16.053* \pm 0.479	30.120* \pm 0.741	49.010* \pm 0.757	58.680* \pm 0.130	67.813* \pm 0.817
T₁₀	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) +Compost (10 t/ha)	4.197* \pm 0.724	13.083* \pm 0.289	24.497* \pm 1.225	44.153* \pm 0.725	51.840* \pm 0.687	60.007* \pm 0.407
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	3.863* \pm 0.398	14.183* \pm 0.217	25.130* \pm 0.755	44.770* \pm 1.290	53.933* \pm 0.335	62.710* \pm 0.374
T₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	4.517* \pm 0.323	14.860* \pm 0.360	26.197* \pm 0.4*59	46.580* \pm 0.601	54.827 \pm 0.544	64.693* \pm 0.269
T₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) + Compost (10 t/ha)	6.430* \pm 0.377	15.800* \pm 0.379	28.323* \pm 0.549	47.193* \pm 0.425	57.540* \pm 0.653	65.960* \pm 1.017
	S.E(d)	0.413	0.511	1.016	1.075	0.486	0.823
	C.D_(0.05)	0.858	1.060	2.110	2.231	1.010	1.709

Table 5: Influence of different combinations of biofertilizers and organic manures on leaf area index at different time period

Treatments		Leaf area index±S.E (m)					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
T ₁	Control	0.317±0.009	0.587±0.012	1.153±0.018	1.457±0.041	2.697±0.015	2.767±0.024
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	0.353*±0.009	0.637±0.019	1.197±0.023	1.847±0.026	3.140*±0.345	3.533*±0.290
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	0.397*±0.009	0.767*±0.015	1.283±0.023	2.447*±0.048	3.183*±0.359	3.753*±0.094
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	0.393*±0.018	0.787*±0.018	1.387±0.023	2.730*±0.386	3.620*±0.012	3.657*±0.020
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	0.560*±0.012	0.950*±0.020	2.267*±0.121	3.410*±0.015	4.280*±0.012	4.307*±0.018
T ₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) + Vermicompost (10 t/ha)	0.480*±0.012	0.767*±0.033	1.417±0.009	2.073*±0.349	2.883±0.009	3.120*±0.026
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost (10 t/ha)	0.517*±0.015	0.853*±0.037	1.813*±0.343	2.560*±0.136	2.947±0.018	3.250*±0.021
T ₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	0.550*±0.015	0.900*±0.030	1.943*±0.347	3.513*±0.01	3.637*±0.020	3.500*±0.115
T ₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	0.553*±0.019	0.947*±0.015	2.317*±0.133	3.553*±0.018	4.310*±0.021	4.357*±0.018
T ₁₀	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5 ml) +Compost (10 t/ha)	0.353*±0.015	0.603±0.015	1.173±0.035	1.707±0.023	2.777±0.015	3.827*±0.015
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	0.387*±0.007	0.733*±0.015	1.203±0.017	2.180*±0.230	2.837±0.020	3.900*±0.017
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	0.403*±0.024	0.697*±0.012	1.387±0.020	2.263*±0.257	3.583*±0.009	3.600*±0.012
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml) + Compost (10 t/ha)	0.427*±0.030	0.763*±0.012	1.750*±0.325	3.410*±0.015	4.240*±0.023	4.347*±0.018
	S.E(d)	0.015	0.026	0.236	0.243	0.187	0.133
	C.D_(0.05)	0.031	0.055	0.490	0.504	0.388	0.277

Table 6: Influence of different combinations of biofertilizers and organic manures on RLWC (%)

Treatments	Relative leaf water content (%) \pm S.E (m)			
	Treatment details	At 30 DAS	At 60 DAS	At 90 DAS
T₁	Control	62.543 \pm 1.183	66.467 \pm 0.579	66.613 \pm 1.250
T₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	66.033 \pm 1.924	70.500* \pm 1.066	72.400* \pm 1.098
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	72.807* \pm 1.462	72.257* \pm 1.551	73.993* \pm 0.918
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	71.817* \pm 1.395	73.050* \pm 1.556	74.767* \pm 1.321
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	78.070* \pm 2.278	77.627* \pm 1.173	77.793* \pm 1.386
T₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) + Vermicompost (10 t/ha)	68.323* \pm 1.705	70.653* \pm 1.157	72.410* \pm 1.111
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) + Vermicompost (10t/ha)	70.333* \pm 1.453	73.887* \pm 1.024	76.080* \pm 1.028
T₈	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Vermicompost (10 t/ha)	75.427* \pm 1.188	76.300* \pm 1.190	76.537* \pm 1.191
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	78.987* \pm 2.619	78.503* \pm 1.796	80.963* \pm 1.267
T₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) +Compost (10 t/ha)	64.600 \pm 1.249	66.400 \pm 0.488	68.013 \pm 0.888
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	75.500* \pm 0.604	69.580 \pm 0.511	70.037 \pm 1.389
T₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	70.610* \pm 0.583	72.217* \pm 0.993	71.970* \pm 1.386
T₁₃	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml) + Compost (10 t/ha)	74.737* \pm 1.122	76.017* \pm 1.524	77.897* \pm 1.405
	S.E(d)	2.153	1.742	1.727
	C.D_(0.05)	4.470	3.617	3.586

Table 7: Influence of different combinations of biofertilizers and organic manures on number of branches, number of cluster and days taken to first flowering

Treatment	Treatment details	Number of branches per plant \pm S.E(m)	Number of cluster per plant \pm S.E(m)	Days taken to first flowering \pm S.E (m)
T ₁	Control	2.633 \pm 0.285	9.667 \pm 0.291	49.667 \pm 0.333
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	2.867 \pm 0.384	11.847* \pm 0.439	48.000* \pm 0.577
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	3.267* \pm 0.240	12.680* \pm 0.591	47.667* \pm 0.333
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	3.367* \pm 0.338	13.100* \pm 0.379	46.333* \pm 0.333
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+PSB(20ml) +FYM (10 t/ha)	3.567* \pm 0.120	13.427* \pm 0.757	45.333* \pm 0.333
T ₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) + Vermicompost (10 t/ha)	3.233* \pm 0.418	11.733* \pm 0.533	47.333* \pm 0.333
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost (10 t/ha)	3.333* \pm 0.273	12.713 \pm 0.582	47.000* \pm 0.577
T ₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	3.500* \pm 0.153	13.277 \pm 0.357	46.000* \pm 0.577
T ₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	3.533* \pm 0.167	13.633* \pm 0.636	45.667* \pm 0.667
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB(5 ml) +Compost (10 t/ha)	2.900 \pm 0.351	11.697 \pm 0.353	48.333 \pm 0.667
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	3.200* \pm 0.306	11.730* \pm 0.221	47.667* \pm 0.333
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	3.250* \pm 0.340	12.763* \pm 0.739	47.000* \pm 0.577
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	3.400* \pm 0.115	13.067* \pm 0.219	46.667* \pm 0.667
	S.E(d)	0.206	0.664	0.744
	C.D_(0.05)	0.428	1.378	1.546

Table 8: Influence of different combinations of biofertilizers and organic manures on total no of root nodules, root active nodules, fresh weight of root nodules (mg) and dry weight of root nodules (mg)

Treatment	Treatment details	Total no of root nodules±S.E (m)	Root active nodules±S.E (m)	Fresh weight of nodules (mg) ±S.E(m)	Dry weight of root nodules (mg) ±S.E(m)
T ₁	Control	19.167±1.129	10.333±0.882	537.050±0.647	118.827±0.612
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	23.057*±1.851	11.217±0.707	717.777*±1.417	134.480*±1.851
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	23.553*±1.25	11.243±0.338	817.143*±6.255	127.760*±2.344
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	25.310*±0.955	12.190*±0.766	948.64*±6.943	130.397*±2.593
T ₅	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml) + FYM (10 t/ha)	27.693*±1.553	14.180*±0.448	1,155.16*±2.961	144.157*±2.053
T ₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) + Vermicompost (10 t/ha)	23.857*±0.823	11.133±0.458	734.407*±3.171	141.723*±2.523
T ₇	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + Vermicompost (10 t/ha)	22.260*±1.044	10.220±0.032	847.370*±4.066	143.743*±2.070
T ₈	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Vermicompost (10 t/ha)	25.750*±1.554	12.317*±0.745	1155.113*±3.104	141.563*±3.882
T ₉	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml) + Vermicompost (10 t/ha)	27.433*±0.977	14.217*±0.911	1,257.807*±7.358	146.467*±2.408
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5 ml) + Compost (10 t/ha)	21.510*±0.665	10.890±0.459	723.773*±1.798	135.587*±0.695
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + Compost (10 t/ha)	25.120*±1.036	11.850*±0.675	816.320*±0.589	123.600*±0.541
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Compost (10 t/ha)	24.893*± 1.658	12.527*±0.514*	943.357*±0.623	132.057*±0.872
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20 ml) + Compost (10 t/ha)	27.373*±1.010	13.353*±0.340	1055.797*±0.910	134.200*±2.120
	S.E(d)	1.087	0.716	5.638	2.269
	C.D_(0.05)	2.258	1.486	11.705	4.711

Table 9: Influence of different combinations of biofertilizers and organic manures on podlength (cm) and pod girth (cm)

Treatment	Treatment details	Pod length (cm) ±S.E (m)	Pod girth (cm)±S.E (m)
T₁	Control	6.820±0.133	1.190±0.006
T₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	7.380*±0.242	1.260±0.038
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	8.060*±0.399	1.333*±0.035
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	8.433*±0.145	1.463*±0.045
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	10.030*±0.395	1.477*±0.033
T₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	7.667*±0.291	1.353*±0.037
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost(10t/ha)	8.200*±0.173	1.380*±0.038
T₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	8.450*±0.104	1.440*±0.031
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	10.267*±0.203	1.463*±0.020
T₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5 ml) +Compost (10 t/ha)	7.093±0.411	1.243±0.032
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	7.940±0.271	1.290*±0.032
T₁₂	<i>Rhizobiumleguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	8.313*±0.104	1.380*±0.015
T₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	9.473*±0.093	1.433*±0.0035
	S.E(d)	0.247	0.043
	C.D(0.05)	0.513	0.089

Table 10: Influence of different combinations of biofertilizer and organic manure on number of pods/plant and number of seeds /pods

Treatment	Treatment details	Number of pods/plant± S.E (m)	Number of seeds /pods±S.E (m)
T ₁	Control	10.167 ± 0.145	6.200 ± 0.115
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	13.267* ± 0.353	7.800* ± 0.306
T ₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	14.267*± 0.546	8.000* ± 0.306
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	15.167* ± 0.145	8.467* ± 0.145
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	16.067* ± 0.467	9.467* ± 0.145
T ₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	13.600*±0.116	7.467*±0.318
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost(10t/ha)	15.050*±0.355	8.067*±0.240
T ₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	16.167*±0.484	8.767*±0.318
T ₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	16.133*±0.418	9.667*±0.176
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5 ml) +Compost (10 t/ha)	13.067*±0.296	6.667±0.481
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	14.233*±0.426	7.667*±0.033
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	14.876*±0.437	8.233*±0.219
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	15.600*±0.265	9.367*±0.186
	S.E(d)	0.235	0.247
	C.D_(0.05)	0.487	0.512

Table 11 Influence of different combinations of biofertilizers and organic manures on pod yield/plant (g) and pod yield/plot (kg/0.6m²)

Treatment	Treatment details	Pod yield/plant (g) ±S.E (m)	Pod yield/plot (kg/0.6m²) ±S.E (m)
T₁	Control	62.123 ± 0.767	0.877 ± 0.027
T₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	65.540*±0.701	1.083*±0.058
T₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	67.097* ± 0.819	1.133*±0.050
T₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	72.957* ± 1.433	1.313*±0.027
T₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	75.703* ± 1.252	1.363*±0.047
T₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	68.853* ± 0.987	1.163*±0.052
T₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB(10ml) +Vermicompost(10t/ha)	71.333* ± 0.946	1.223*±0.039
T₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	73.627* ± 1.225	1.277*±0.012
T₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	77.230* ± 0.807	1.400*±0.051
T₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5 ml) +Compost (10 t/ha)	64.363 ± 0.637	1.063*±0.039
T₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	68.837* ± 0.842	1.117*±0.030
T₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	70.907* ± 0.780	1.213*±0.037
T₁₃	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml) + Compost (10 t/ha)	74.657* ± 1.254	1.353* ± 0.007
	S.E(d)	1.345	0.042
	C.D_(0.05)	2.792	0.088

Table 12: Influence of different combination of biofertilizers and organic manures on seed yield per plant (g) and seed yield per plot (kg/0.6m²)

Treatment	Treatment details	Seed yield/plot (g)	Seed yield/plot (Kg/0.6 m ²)
T ₁	Control	41.560 ± 0.668	0.590±0.017
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	49.127* ± 1.174	0.807*±0.057
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	53.623* ± 0.905	0.903* ± 0.043
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	56.440* ± 0.803	1.013* ± 0.032
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml) + FYM (10 t/ha)	60.557* ± 0.738	1.110*±0.031
T ₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	48.840*±1.354	0.827*±0.049
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Vermicompost (10t/ha)	54.187*±0.593	0.930*±0.025
T ₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	57.427*±0.624	1.010*±0.015
T ₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	60.760*±0.826	1.133*±0.033
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Compost (10 t/ha)	43.430*±0.715	0.713*±0.030
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Compost (10 t/ha)	45.683*±1.926	0.797*±0.111
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Compost (10 t/ha)	54.627*±1.221	0.940*±0.060
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	59.157*±0.763	1.073*±0.030
	S.E(d)	0.794	0.051
	C.D(0.05)	1.649	0.106

Table 13: Influence of different combination of biofertilizers and organic manures on shelling percent (%) and 100 seed weight (g)

Treatment	Treatment details	Shelling Percent (%) ±S.E (m)	100 seed weight (g) ±S.E (m)
T ₁	Control	40.177±1.172	38.757±0.809
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	42.220±1.064	40.640±0.405
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	44.777*±1.042	42.753*±1.455
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	45.493*±1.401	44.807*±0.841
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml) + FYM (10 t/ha)	47.683*±1.114	45.457*±0.638
T ₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	42.660±1.210	40.507±1.051
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Vermicompost (10t/ha)	45.550*±0.951	42.403*±0.561
T ₈	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Vermicompost (10 t/ha)	46.697*±0.882	44.230*±1.798
T ₉	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml)+ Vermicompost (10 t/ha)	48.920*±1.286	46.470*±1.189
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Compost (10 t/ha)	41.403±0.887	39.200±1.293
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Compost (10 t/ha)	43.747*±0.703	42.110*±0.390
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Compost (10 t/ha)	44.413*±1.225	41.653±1.202
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	46.137*±0.993	43.627*±1.228
	S.E(d)	1.343	1.432
	C.D_(0.05)	2.789	2.973

Table 14: Influence of different combinations of biofertilizers and organic manures on TSS (°Brix), ascorbic acid (mg/100g), starch content (%) and dry matter content (%)

Treatment	Treatment details	TSS (°Brix) ±S.E (m)	Ascorbic acid (mg/100g)±S.E (m)	Starch content (%) ±S.E (m)	Dry matter content (%) ±S.E (m)
T ₁	Control	10.43±0.145	28.783±0.363	21.110±0.770	28.397±0.969
T ₂	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + FYM (10 t/ha)	11.467*±0.564	29.763±0.366	21.857±0.729	28.133±0.297
T ₃	<i>Rhizobium leguminosarum</i> (10ml) + PSB (10ml) + FYM (10 t/ha)	13.067*±0.285	30.670*±0.365	24.363±1.139	29.427±0.178
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	13.203*±0.370	32.893*±0.826	23.707*±0.301	30.433*±0.097
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml) + FYM (10 t/ha)	14.630*±0.137	33.743*±0.158	22.747*±0.297	30.270*±0.186
T ₆	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Vermicompost (10 t/ha)	11.473*±0.411	29.827±0.324	23.417±0.554	29.103±0.540
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Vermicompost (10t/ha)	13.200*±0.306	32.333*±1.180	22.920±0.353	29.097±0.368
T ₈	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Vermicompost (10 t/ha)	13.620*±0.607	32.683*±0.028	25.440±0.577	30.070*±0.447
T ₉	<i>Rhizobium leguminosarum</i> (20ml) + PSB (20ml)+ Vermicompost (10 t/ha)	15.083*±0.225	34.387*±0.397	23.497±0.509	29.080±0.345
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) + Compost (10 t/ha)	11.227±0.318	29.557±0.532	22.397±1.080	30.487*±0.952
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + Compost (10 t/ha)	12.023*±0.313	30.320±0.031	25.287±0.253	28.587±0.209
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + Compost (10 t/ha)	12.787*±0.311	33.863*±1.402	23.180*±0.642	28.210±0.614
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	14.707*±0.058	32.493*±0.057	23.217*±0.784	29.303±0.388
	S.E(d)	0.483	0.907	0.605	0.674
	C.D_(0.05)	1.003	1.882	1.256	1.400

Table 15:Effect of different treatments on economics of treatments

Treatments	Treatment details	Cost of cultivation (₹)	Gross return (₹)	Net returns(₹)	C:B
T ₁	Control	1,47,003	2,92,222	1,45,219	1:0.99
T ₂	<i>Rhizobium leguminosarum</i> (5ml)+ PSB (5ml) + FYM (10 t/ha)	1,64,038	3,61,111	1,96,182	1:1.20
T ₃	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) + FYM (10 t/ha)	1,64,771	3,77,780	2,13,009	1:1.29
T ₄	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) + FYM (10 t/ha)	1,65,504	4,37,780	2,72,276	1:1.64
T ₅	<i>Rhizobium leguminosarum</i> (20ml)+ PSB(20ml) +FYM (10 t/ha)	1,66,237	4,54,440	2,88,203	1:1.73
T ₆	<i>Rhizobium leguminosarum</i> (5 ml) + PSB (5ml) + Vermicompost (10 t/ha)	3,04,038	3,87,780	83,742	1:0.28
T ₇	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Vermicompost (10 t/ha)	3,04,771	4,07,780	1,03,009	1:0.34
T ₈	<i>Rhizobium leguminosarum</i> (15ml)+ PSB (15ml) + Vermicompost (10 t/ha)	3,05,504	4,25,560	1,20,056	1:0.39
T ₉	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20ml)+ Vermicompost (10 t/ha)	3,19,162	4,66,660	1,47,498	1:0.46
T ₁₀	<i>Rhizobium leguminosarum</i> (5ml) + PSB (5ml) +Compost (10 t/ha)	2,74,038	3,54,440	80,402	1:0.29
T ₁₁	<i>Rhizobium leguminosarum</i> (10ml)+ PSB (10ml) +Compost (10 t/ha)	2,74,771	3,72,220	97,449	1:0.35
T ₁₂	<i>Rhizobium leguminosarum</i> (15ml) + PSB (15ml) +Compost (10 t/ha)	1,58,673	4,04,440	2,45,767	1:1.54
T ₁₃	<i>Rhizobium leguminosarum</i> (20ml)+ PSB (20 ml) + Compost (10 t/ha)	2,76,237	4,51,120	1,74,883	1:0.63

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