ADVANCE RESEARCH JOURNAL OF
CROP IMPROVEMENT
Volume 8 | Issue 1 | June, 2017 | 99-108
e ISSN-2231-640X

DOI :
10.15740/HAS/ARJCI/8.1/99-108
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Effects of biofertilizers on plant growth and yield characters of *Pisum sativum* L.

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ABSTRACT : The present study was elucidated the effects of biofertilizers on plant growth and yield characters of *Pisum sativum* L. The research was conducted during *Rabi* 2016-2017 at the field experimentation centre of the Department of Agronomy, Bhagwant University Ajmer, during the year of 2016-2017. The data were recorded on 11 characters. Based on the mean performance the treatment- 8 (100% RDF + *Rhizobium* 30g/kg) was found best treatment for plant growth and seed yield. This obtained high in plant height (cm), number of primary branches per plant, number of leaves per plant, days to 50 per cent flowering, number of pods per plant, days to maturity, pod length (cm), number of seed per pod, seed index, seed yield per plant, nodules per plant. Interaction effect of biofertilizers was significant for all characters. Thus, it indicates that the process of biofertilizers may be better option for seed growers to achieve seed yield and yield components in pea.

KEY WORDS : *Azotobacter, Rhizobium,* PSB, Growth parameters, Pea

How to cite this paper : Khan, Insaf, Singh, Devendra and Jat, Bhanwar Lal (2017). Effects of biofertilizers on plant growth and yield characters of *Pisum sativum* L. *Adv. Res. J. Crop Improv.,* **8** (1) : 99-108, **DOI : 10.15740/HAS/ARJCI/8.1/99-108**.

Paper History : Received : 19.04.2017; **Revised :** 12.05.2017; **Accepted :** 20.05.2017

India, production of pulses is around 13.5-15 million tonnes during the last decade, while annual domestic demand is 18-19 million tones. The yield of pulses has remained virtually stagnant for the last 40 years (539 kg/ha in 1961 to 544 kg/ha in 2001 to 696 kg/ha in 2011). India is short of supply by 2 to 3 million tonnes annually Due to stagnant in production, per capita pulses consumption over the has come down from 61g/day in 1951 to 30 g/day in 2008 against the Indian Council of Medical Research recommendation of 65g/day/capita. Pulse crops have a specific importance for the vegetarian population of our country because pulses are the major source of protein. However, due to population explosion and low productivity of pulse crops, per capita availability of pulses is consistently decreasing. Per capita availability of pulses per day is only 47g as against the minimum requirement of 104 g as recommended by nutritional experts of World Health Organization/Food and Agriculture Organization. Pea is one of the most important and popular vegetables grown in India. Pea is a highly nutritious vegetable containing higher percentage of digestive proteins along with carbohydrates and vitamins. Large proportion of pea is processed into canned, frozen or dehydrated peas for consumption in the off-season. Being a proteinous vegetable it forms a valuable dish in the vegetarian diet. In India, it is grown as a winter vegetable in the plains of the North and as a summer vegetable in the hills. It is an excellent food for human consumption taken into either as a vegetable or in soup. Major pea growing states are Bihar, Haryana, Punjab, H.P., Orissa and Karnataka. In Tamil Nadu, peas is grown in the Nilgiris district and Kodaikanal hills during the winter months of the year. Pea (*Pisum sativum* L.) is amongst the most important legume crop of India belongs to family leguminoseae largely confined to cooler temperate zone between the tropic of cancer and Mediterranean region. Pea probably originated in south western Asia, possibly north western India, Pakistan or adjacent areas of former USSR and Afghanistan and thereafter spread to the temperate zones of Europe. Pea is commonly used in human diet throughout the world and it is rich in protein (21-25%), carbohydrates, vitamin A and C, Ca, phosphorus and has high levels of amino acids lysine and tryptophan. The protein content of pea ranges from 15.5-39.7 per cent. Fresh peas contain per (100g) 44 calories, 75.6 per cent water, 6.2g protein, 0.4 g fat, 16.9 carbohydrate, 2.4 g crude fibre, 0.9 g ash, 32 mg Ca, 102 mg P, 1.2 mg Fe, 6 mg Na and 350mg K. Presently India produces around area 438000 ha with an annual production of 41.65 million tone. It occupies a position of considerable worth because of its importance in agricultural economy of the country. India's estimated food requirement will be about 240 million tons. One of the key limiting factors in crop productivity is the availability of nitrogen. Because of the constraints on the production, availability and use of chemical nitrogenous fertilizers, biologically fixed nitrogen will play an important role in increasing the crop production. India is the largest producer and importer of the leguminous crop. The term biofertilizer or called 'microbial inoculants' can be generally defined as a preparation containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulytic micro-organisms used for application of seed, soil or composting areas with the objective of increasing the numbers of such micro-organisms and accelerate certain microbial process to augment the extent of the availability of nutrients in a form which can assimilated by plant. The knowledge of applied microbial inoculums is long history which passes from generation to generation of farmers. It started with culture of small scale compost production that has evidently proved the ability of biofertilizer. This is recognize when the cultures accelerate the decomposition of organics residues and agricultural by-products through various processes and gives healthy harvest of crops. Nitrogen fixing micro-organisms are either symbiotic of the genus *Rhizobium*; which associate with plant and form nodules, or non-symbiotic as bacteria of the genera *Azotobacter*, *Azospirillum;* that generate ammonia for their own use and provide the plant with nitrogen as an exchange for carbon and protected habitat. A judicious use of organic manures and biofertilizers may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizers of crop (Jaipaul *et al*., 2011). A small dose of biofertilizer is sufficient to produce desirable results because each gram of carrier of biofertilizers contains at least 10 million viable cells of a specific strain (Anandaraj and Delapierre, 2010). Among the various fertilizers, biofertilizers are important sources of nutrients. Biofertilizers are natural fertilizers containing micro-organism which help in enhancing the productivity by biological nitrogen fixation or solubilization of insoluble phosphate or producing harmones, vitamins and other growth regulators required for plant growth. Biofertilizers are living micro-organisms, which when applied through seed or soil treatment, promote growth by increasing the supply or availability of nutrients to the host plant (Stephens and Rask, 2000 and Moinuddin *et al*., 2014). Biofertilizers on the other hand are cost-effective and renewable source of plant nutrients to supplement the parts of chemical fertilizers. Biofertilizers are known to play an important role in increasing availability of nitrogen and phosphorus besides improving biological fixation of atmospheric nitrogen and enhance phosphorus availability to crop (Bhat *et al*., 2013). For the last one-decade, biofertilizers are used extensively as an eco-friendly approach to minimize the use of chemical fertilizers, improve soil fertility status and for enhancement of crop production by their biological activity in the rhizosphere. Extensive researches were carried out on the use of bacteria (*Azotobacter, Azospirillum, Rhizobium,* phosphobacteria) and VAM fungi as biofertilizers to supplement nitrogen and phosphorus fertilizers and observed considerable improvement in the growth of several crop plants. Dual inoculation of vermi compost and bacteria biofertilizers proved more effective in increasing the growth of different crop plants. Biofertilizers are products containing living cells of different types of micro-organisms which when, applied to seed, plant surface or soil, colonize the rhizosphere or the interior of the plant and promotes growth by converting nutritionally important elements (nitrogen, phosphorus) from unavailable to available form through biological process such as nitrogen fixation and solubilization of rock phosphate (Rokhzadi *et al*., 2008). The integrated uses of biofertilizers with chemicals fertilizer can contribute to the increase in nitrogen contain of the soil as well as increase the long time productivity. Amongst various nitrogen fixing micro-organism *Azotobacter* and *Azospirillum* are the most predominant and important ones. Both are known to provide a nitrogen economy of 20-30 kg nitrogen ha^{-1}, coupled with production of growth promoting substance, besides improving growth yield quality attributes of fruit and thus, leading to the improvement of crop. Biofertilizers used in conjunction with chemical fertilizers improve crop productivity and nutrient use efficiency. Positive effect of azotobacterization on growth and yield of brinjal also been reported by many workers. There is a positive influence of PSB on the growth and yield attributes of brinjal-cv. KRISHNA. Biofertilizer is a natural product carrying living micro-organisms derived from the root or cultivated soil. So they don't have any ill effect on soil health and environment. Besides their role in atmospheric nitrogen fixation and phosphorus solubilization, these also help in stimulating the plant growth hormones providing better nutrient uptake and increased tolerance towards drought and moisture stress. A small dose of biofertilizer is sufficient to produce desirable results because each gram of carrier of biofertilizers contains at least 10 million viable cells of a specific strain (Anandaraj and Delapierre, 2010). The seed inoculation with *Rhizobium* increases nodulation, influences seed yield and economies the input cost of fertilizers to some extent and protects against chances of soil deterioration and environmental pollution caused by heavy use of chemical fertilizers. The efficient strains of *Rhizobium* can fix about 90 kg of nitrogen per hectare in one season and enrich soil nitrogen.Introduction of efficient strains of *Rhizobium* in soils with low nitrogen may help augment nitrogen fixation and thereby boost production of crops. Phosphorus is known to play an important role in growth and development of the crop and have direct relation with root proliferations, straw strength, grain formation, crop maturation (Bhat *et al*., 2013). *Rhizobium* association has been extensively explored in the root nodules of legumes where they fix atmospheric nitrogen but recent studies also suggest that *Rhizobium* can exhibit plant growth promoting (PGP) activities with non-legumes. *Rhizobium* inoculation increased the root nodulation through better root development and more nutrient availability, resulting in vigorous plant growth and dry matter production which resulted in better flowering, fruiting and pod formation and ultimately there was beneficial effect on seed yield (Sardana *et al*., 2006). The favourable effect of *Azotobacter* and mineral nitrogen fertilizer on growth, chemical composition of leaves, and yield was reported on pea indicated that both inoculation with *Azotobacter* and application of N increased seed yield. *Azotobacter* in free living nitrogen fixer, however in plant *Rhizosphere* due to availability of various readily utilizable carbon compounds, the bacteria are considered to be advantage for plant growth and yield. Biofertilizers which are preparation of efficient nitrogen fixing, P solubilizing or cellulose decomposing micro-organisms, when applied to seed or soil enhances availability of nutrients to plant providing an economically viable and ecological sound means of reducing external input of chemical fertilizers. *Azotobacter* and *Azospirillum* are the two most important non-symbiotic N-fixing bacteria in non-leguminous crops. Under appropriate conditions, *Azotobacter* and *Azospirillum* can enhance plant development and promote the yield of several agricultural important crops in different soils and climatic regions. These beneficial effects of *Azotobacter* and *Azospirillum* on plants are attributed mainly to an improvement in root development, an increase in the rate of water and mineral uptake by roots, displacement of fungi and plant pathogenic bacteria and to a lesser extent, biological nitrogen fixation. The fixed phosphorus in the soil can be solubilized by phosphate solubilizing bacteria (PSB), which have the capacity to convert inorganic unavailable phosphorus form to soluble forms HPO_4^{2-} and $H_2PO_4^-$ through the process of organic acid production, chelating and ion exchange reactions and make them available to plants. Therefore, the use of PSB in agricultural practice would not only offset the high cost of manufacturing phosphate fertilizers but would also mobilize insoluble in the fertilizers and soils to which they are applied (Chang and Yang, 2009 and Banerjee *et al*., 2010). Among the whole microbial population in soil, phosphate solubilizing bacteria (PSB) constitute 1 to 50 per cent, while phosphorus solubilizing fungi (PSF) are only 0.1 to 0.5 per cent in P solubilization potential (Chen *et al*., 2005). Positive effects of phosphorein (PSB or PDB) and chemical phosphorus fertilizer on growth, yield, seed yield and quality were found on fibre bean. Enhancing P availability to crop through phosphate-solubilizing bacteria (PSB) holds promise in the present scenario of escalating prices of phosphate fertilizers and a general deficiency of p in Indian soils.

Objectives:

To study the effect of different biofertilizers on growth characters in pea. To assess the effect of biofertilizer on seed yield and yield characters in pea.

Research Procedure

The details of experimental procedures adopted, materials used and techniques followed during the course of present field investigation on effects of biofertilizers on plant growth and yield characters of *Pisum sativum* L. carried out during *Rabi* season of the year 2016-2017 are described in this chapter.

Fertilizer application:

The fertilizer was applied at the time of sowing. The recommended dose of nitrogen, phosphorus and potash was applied in all the plots except control.

Seed treatment and sowing:

Rhizobium culture:

200g of jaggery was dissolved in 200ml of water. Jaggery solution as per the volume of seed was prepared. The *Rhizobium* culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing.

Azotobactor culture:

200g of jiggery was dissolved in 200ml of water. Jiggery solution as per the volume of seed was prepared. The *Azotobactor* culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing.

PSB culture :

200g of jaggery was dissolved in 200ml of water. Jaggery solution as per the volume of seed was prepared. The PSB culture was thoroughly mixed for slurry preparation in above solution. Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. Treated seeds were dried under shade on gunny bags and then used for sowing.

Seed and sowing:

Seeds were sown in line sowing method with 30cm row to row spacing and 10cm plant to plant spacing. Recommended seed rate of 60-80kg per hectare was used for sowing. The seeds were drilled in previously opened furrows in the field.

Weeding and inter culturing:

Two inter culturing and hand weeding was carried out for the management of weeds.

Table A : Treatment detail

Treatments	Treatment combinations
T_0	Control
T_1	RDF+ *Azotobactor* (10g/kg seed)
T_2	RDF+ *Rhizobium* (10g/kg seed)
T_3	RDF+ Phosphate solubilising bacteria (10g/kg seed)
T_4	RDF+ *Azotobactor* (20g/kg seed)
T_5	RDF+ *Rhizobium* (20g/kg seed)
T_6	RDF+ Phosphate solubilising bacteria (20g/kg seed)
T_7	RDF+ *Azotobactor* (30g/kg seed)
T_8	RDF+ *Rhizobium* (30g/kg seed)
T_9	RDF+ Phosphate solubilising bacteria (30g/kg seed)

Recommended dose of fertilizer (100% RDF): (25: 40: 60 NPK kg per ha)

Days to 50 per cent flowering:

Plants were observed daily for flowering. The day on which 50 per cent of the plants showed flowers in the plot was considered as 50 per cent flowering. The number of days of sowing to flowering was calculated and expressed add days taken for 50 per cent flowering.

Number of primary branches per plant:

There were recorded by counting the total number of primary branches presented on main stem of each selected plant of the time of harvest. Branches for ten randomly selected plants from each net plot at the time of harvesting were counted and average number was calculated.

Number of leaves per plant:

The number of leaves present on each plant was counted manually from the five tagged plants. The mean number of leaves per plant was calculated and expressed in number of plant.

Number of pods per plant:

This will be recorded by counting the number of pods present on main stem and branches in each of the five selected plant. The total number of pods from ten tagged plants under each treatment was counted and average value was computed.

Number of seeds per pod:

Five pods were selected at randomly from the total number of pods harvested from tagged five plants. The seeds from each pod were separated, counted and average was worked out and expressed as number of seeds per pod.

Pod length (cm):

The length of pods of selected five plants from each plot will be measured with the help of measuring tape; the average length will be worked out in cm and subjected to statistical analysis.

Plant height (cm):

Height of the main stem from the ground level to the top of the main stem will be measured in centimeters net the time of harvesting. Height of randomly selected 10 plants from each net plot was measured from ground level to the top of the main shoot at harvest were counted and recorded.

Days to maturity:

The number of days required from date of sowing to the of physiological maturity in each experimental plot are counted averaged.

Seed index (g):

Hundred seed weight will be computed by weighting 100 grain which is randomly Chosen filled grain from complete sample made by mixing the grains of all the five plants in each replication and recorded in grams.

Seed yield per plant (g):

The number of seeds per plant is calculated from randomly selected plants and then averaged for seed yield per plants.

Nodules per plant:

The number of nodules per plant is calculated from randomly selected plants and then averaged for nodules per plant.

Standard error of mean:

Standard error of mean was calculated by the following formula:

$$\mathbf{SEm} \; Z \; \frac{\sqrt{\mathbf{2EMS}}}{r}$$

Critical difference:

Critical difference was calculated by the following formula :

$$\mathbf{C.D.} = \sqrt{2}\,\frac{\mathbf{EMS}}{\mathbf{r}}\,\mathbf{x\ tedf\ at\ 5\%}$$

where, r = Number of replications, EMS= Error mean sum of squares, t = Table value of‘t’ at error degrees of freedom at 0.05 level of significance.

Test of significance:

If the variance ratio (calculated F) was greater than the tabulated F value at 5 per cent level of significance the difference between the different genotypes in terms of different character was considered to be significant and if it was lower than the tabulated value, it was considered to be non-significant.

Mean:

Mean value of each character was worked out by dividing the totals by the corresponding number of observations.

$$\mathbf{Mean} = \frac{\mathbf{\Sigma X}}{\mathbf{N}}$$

where, Σ X = Sum of all the observations for each character in each replication. N = Corresponding number of observations.

Range:

Range is the difference between the lowest and highest mean values for each character were taken in the observation in a sample. $\mathbf{R = R_2 - R_1}$ where, R_1= Highest mean R_2 = Lowest mean.

RESEARCH ANALYSIS AND REASONING

The present investigation on effects of biofertilizer on plant growth and yield character of *Pisum sativum* L.” variety Azad P-1 was carried out during *Rabi* 2016-2017. Biofertilizer brought about significant improvement in different yield attributes. Increase in this parameter could be ascribed to the improvement in plant growth, and production of sufficient photosynthesis during later part of growth period due to biofertilizers application. *Rhizobium* is free living bacteria have specific role in fixing atmospheric nitrogen in soil which enhance the soil fertility with respect to nitrogen. Application of biofertilizers is an acceptable approach for higher yield with good quality and safe for human consumption. Our results show that either single or mixed inoculation gave positive response to the studied parameters. This response was accompanied by significant increase in fresh and dry weight and the other parameters. Growth parameters increased due to the mixed of biofertilizers with chemical treatments. The number of nodules increased significantly in treatments with combined inoculation. Number of nodules reported to be the maximum in combined effect of *Rhizobium* with chemical fertilizer (100% RDF) inoculation. The yield of pea showed minimum in control and maximum in biofertilizers inoculation of *Rhizobium* with 100 per cent RDF. The control could not increase the yield as compared to *Rhizobium* with chemical (100% RDF) inoculation. The dual inoculation of chemical fertilizer (100% RDF) and *Rhizobium* gave highest yield. It is evident that the increases in plant height, number of pods per plant and number of seed per pod have contributed to increased yield.

The result obtained from the present experiment were described below and discussed in the light of available literature.

Table 1 : Effect of different treatments on days to 50 per cent flowering

Treatments	Days to 50 % flowering
T_0	53.33
T_1	51.65
T_2	52.60
T_3	53.00
T_4	51.00
T_5	50.33
T_6	51.33
T_7	50.00
T_8	49.33
T_9	52.66
Grand mean	51.52
S.E.±	1.00
C.D. (P=0.05)	2.97

Mean performance for days to 50 per cent flowering ranged from 49.33 to 53.33 with mean value of 51.52. Days to 50 per cent flowering varied from 49.33 days to 50.33 days. Early days to 50 per cent flowering is a desirable character, Treatment-8 (*Rhizobium* @ 30g/kg seed) may be considered as the best treatment for early duration, followed by T_7 (50.00), T_4 (51.00), T_5 (50.33), T_6 (51.33), T_1 (51.65), T_2 (52.60), T_9 (52.66) and T_3 (53.00). The control recorded high value days to 50 per cent flowering (53.33). Present investigation that treatment T_8 (*Rhizobium* @ 30g/kg seed) may be considered as the best treatment for early duration in days to 50 per cent flowering (49.33).

Mean performance for plant height (cm) ranged from 42.20 to 50.65 with mean value of 46.05. T_8 with application of 100% RDF + *Rhizobium* 30g/kg seed recorded high plant height (cm) (50.65). T_8 was at par with T_9 (50.30) with application of 100% RDF + PSB 30g/kg followed by T_6 (47.55), T_5 (46.90), T_4 (45.35), T_3 (45.30), T_7 (44.65), T_2 (44.45), T_1 (43.15), and T_0 (42.20) with control (Table 2).

Table 2 : Effect of different treatments on plant height (cm)

Treatments	Plant height(cm)
T_0	42.20
T_1	43.15
T_2	44.45
T_3	45.30
T_4	45.35
T_5	46.90
T_6	47.55
T_7	44.65
T_8	50.65
T_9	50.30
Grand mean	46.05
S.E.±	1.44
C.D. (P=0.05)	4.30

Mean performance for number of primary branches ranged from 11.65 to 13.75 with mean value of 12.54. T_8 with application of 100% RDF + *Rhizobium* + 30g/kg recorded high number of primary branches (13.75) was at par with T_9 (13.35) with application of 100% RDF + PSB 30g/kg followed by T_6 (13.25), T_5 (13.00), T_2 (12.55), and T_3 (12.20), T_4 (12.06), T_7 (11.85), T_1 (11.80), T_0 (11.65), with control its recorded less number of primary branches (11.65) (Table 3).

Mean performance for number of leaves/plant ranged from 30.45 to 33.10 with mean value of 31.42. T_8 with application of 50% RDF + *Rhizobium* + 30g/kg seed recorded high number of leaves per plant (33.10). T_8 was at par with T_9 (32.40) with application of 100% RDF + PSB 30g/kg followed by T_5 (32.00), T_3 (31.65), T_1 (31.26), T_2 (30.95), T_7 (30.85), T_6 (30.80), T_4 (30.75) and T_0 (30.45) with control recorded the less number of leaves/plant (Table 4).

Table 3: Effect of different treatments on number of primary branches/plant

Treatments	Primary branches/plant
T_0	11.65
T_1	11.80
T_2	12.55
T_3	12.20
T_4	12.06
T_5	13.00
T_6	13.25
T_7	11.85
T_8	13.75
T_9	13.35
Grand mean	12.54
S.E.±	0.25
C.D. (P=0.05)	0.74

Table 4 : Effect of different treatments on number of leaves per plant

Treatments	Leaves/plant
T_0	30.45
T_1	31.26
T_2	30.95
T_3	31.65
T_4	30.75
T_5	32.00
T_6	30.80
T_7	30.85
T_8	33.10
T_9	32.40
Grand mean	31.42
S.E.±	0.75
C.D. (P=0.05)	2.23

Mean performance for number of pods per plant ranged from 10.75 to 16.00 with mean value of 13.60. T_8 with application of 100% RDF + *Rhizobium* + 30g/kg seed recorded high number of pods per plant (16.00). T_8 was at par with T_9 (14.75) with application of 100% RDF + PSB 30g/kg seed followed by T_7 (14.60), T_3 (13.90), T_6 (13.70), T_1 (13.25), T_5 (13.15), T_2 (13.00), T_4 (12.90) and T_0 (10.75) with control and it's recorded less number of pods per plant (10.75) (Table 5).

Mean performance for days to maturity ranged from 81.65 to 84.65 with mean value of 83.15. T_0 with control recorded high days to maturity (84.65). T_0 was at par with T_7 (84.30) with application of 50% RDF +

Table 5 : Effect of different treatments on number of pods per plant

Treatments	Pods/plant
T_0	10.75
T_1	13.25
T_2	13.00
T_3	13.90
T_4	12.90
T_5	13.15
T_6	13.70
T_7	14.60
T_8	16.00
T_9	14.75
Grand mean	13.60
S.E.±	1.30
C.D. (5 %)	3.87

Azatobactor 30g/kg seed followed by T_2 (84.00), T_3 (83.65), T_5 (83.30), T_1 (83.00), T_4 (82.65), T_6 (82.30), T_9 (82.00) and T_8 (81.65) with application of 100% RDF + *Rhizobium* 30 g/ kg seed recorded less value of days to maturity (81.65) (Table 6).

Table 6 : Effect of different treatments on days to maturity

Treatments	Days to maturity
T_0	84.65
T_1	83.00
T_2	84.00
T_3	83.65
T_4	82.65
T_5	83.30
T_6	82.30
T_7	84.30
T_8	81.65
T_9	82.00
Grand mean	83.15
S.E.±	0.67
C.D. (P=0.05)	2.00

Mean performance for pod length (cm) ranged from 7.15 to 8.10 with mean value of 7.64. T_8 with application of 100% RDF + *Rhizobium* 30g/kg seed recorded high pod length (8.10cm). T_8 was at par with T_9 (8.00cm) with application of 100% RDF + PSB 30g/kg seed followed by T_1 (7.90cm), T_6 (7.75cm), T_5 (7.70cm), T_2 (7.60cm), T_7 (7.50cm), T_3 (7.40cm), T_4 (7.35cm) and T_0 (7.15cm) with and it's recorded less pod length (7.15 cm) (Table 7).

Mean performance from number of seeds per pod

Table 7 : Effect of different treatments on pod length (cm)

Treatments	Pod length(cm)
T_0	7.15
T_1	7.90
T_2	7.60
T_3	7.40
T_4	7.35
T_5	7.70
T_6	7.75
T_7	7.50
T_8	8.10
T_9	8.00
Grand mean	7.64
S.E.±	0.16
C.D. (P=0.05)	0.48

ranged from 4.80 to 6.45 with mean value of 5.43. T_8 with application of 100% RDF + *Rhizobium* 30g/ kg seed recorded high number of seeds per pod (6.45). T_8 was at par with T_9 (5.75) with application of 100% RDF + PSB 30g/kg seed followed by T_7 (5.60), T_1 (5.45), T_6 (5.40), T_3 (5.30), T_5 (5.25), T_2 (5.20), T_4 (5.15) and T_0 (4.80) with control and T_0 is recorded less value number of seeds per pod (4.80) (Table 8).

Table 8 : Effect of different treatments on number of seed per pod

Treatments	Seed/pod
T_0	4.80
T_1	5.45
T_2	5.20
T_3	5.30
T_4	5.15
T_5	5.25
T_6	5.40
T_7	5.60
T_8	6.45
T_9	5.75
Grand mean	5.43
S.E.±	0.27
C.D. (P=0.05)	0.82

Mean performance from seed index ranged from 15.90g to 17.45g with mean value of 16.59g. T_8 with application of 100% RDF + *Rhizobium* 30g/kg seed recorded high seed index (17.45g). T_8 was at par with T_9 (16.90g) with application of 100% RDF + PSB 30g/kg seed followed by T_7 (16.70g), T_3 (16.70g), T_4 (16.65g), T_5 (16.60g), T_1 (16.50g), T_2 (16.35g), T_6 (16.15g) and T_0 (15.90g) with control recorded less value of seed index (15.90g) (Table 9).

Table 9 : Effect of different treatments on seed index (g)

Treatments	Seed index (g)
T_0	15.90
T_1	16.50
T_2	16.35
T_3	16.70
T_4	16.65
T_5	16.60
T_6	16.15
T_7	16.70
T_8	17.45
T_9	16.90
Grand mean	16.59
S.E.±	0.28
C.D. (P=0.05)	0.83

Mean performance from seed yield per plant ranged from 14.55g to 17.35g with mean value of 15.73. T_8 with application of 100% RDF + *Rhizobium* 30g/kg recorded high seed yield per plant (17.35g). T_8 was at par with T_9 (16.30g) with application of 100% RDF + PSB 30g/kg seed followed by T_5 (16.00g), T_6 (15.90g), T_3 (15.80g), T_7 (15.75g), T_4 (15.55g), T_2 (15.20g), T_1 (14.95g) and T_0 (14.55g) with control recorded less value of seed yield per plant (3.63g) (Table 10).

Table 10 : Effect of different treatments on seed yield/plant (g)

Treatments	Seed yield/plant(g)
T_0	14.55
T_1	14.95
T_2	15.20
T_3	15.80
T_4	15.55
T_5	16.00
T_6	15.90
T_7	15.75
T_8	17.35
T_9	16.30
Grand mean	15.73
S.E.±	0.15
C.D. (P=0.05)	0.47

Mean performance for number of nodules per plant ranged from 12.60 to 21.95 with mean value of 17.10. T_8

with application of 100% RDF + *Rhizobium* 30g/ kg seed recorded high number of nodules per plant (21.95). T_8 was at par with T_9 (20.60) with application of 100% PSB 30g/kg seed followed by T_7 (18.80), T_5 (18.05), T_6 (18.00), T_4 (16.55), T_3 (15.20), T_2 (14.95), T_1 (14.35) and T_0 (12.60) with control recorded less value of number of nodules per plant (12.60) (Table 11).

Table 11 : Effect of different treatments on nodules/plant

Treatments	Nodules/plant
T_0	12.60
T_1	14.35
T_2	14.95
T_3	15.20
T_4	16.55
T_5	18.05
T_6	18.00
T_7	18.80
T_8	21.95
T_9	20.60
Grand mean	17.10
S.E.±	0.56
C.D. (P=0.05)	1.67

Conclusion :

The experiment was conducted to know the effect of different biofertilizer on growth characters, seed yield and other yield characters in pea. Eleven treatment was carried out with combined application of 100% RDF (Recommended dose of fertilizers) (25:60:40kg per ha) and biofertilizers (*Rhizobium, Azotobacter,* PSB) were laid in Randomized Block Design with three replications.

Effect on growth parameters:

The results of the experiments indicated that maximum values of plant growth characters *viz*., plant height (50.65cm), number of leaves per plant (33.10), number of primary branches per plant (13.75), number of pods per plant (16.00), number of seeds per pod, (6.45) and pod length, (8.10cm) were recording under treatment T_8 (100% RDF + *Rhizobium* 30g/kg seed). Treatment T_9 (100% RDF + PSB 30g/kg seed), T_7 (100% RDF + *Azotobactor* 30g/kg seed), T_6 (100% RDF + PSB 20g/ kg) and T_5 (100% RDF + *Rhizobium* 20g/kg seed) were found effective in respect of recorded higher values of these plant growth characters than rest of the treatments.

Effect on yield attributes :

Among all the treatments, treatment T_8 (100% RDF + *Rhizobium* 30g/kg seed), found significantly superior by higher values of yield attributes *viz*., number of pods per plant (16.00) number of seeds per pod (6.45), seed index (17.45g), seed yield per plant (17.35g) and number of nodules/plant (21.95). It is concluded from the present investigation that treatment T_8 (100% RDF + *Rhizobium* 30g/ kg of seed) exhibited higher mean value for seed yield per plant (17.35g) and high mean performance for number of primary branches, number of leaves per plant, number of pods per plant, pod length, number of seeds per pod, plant height, seed yield per plant, seed index and nodules per plant etc. T_3 (100% RDF + PSB 10g/kg of seed) showed high mean performance in 50 per cent days to flowering (53.33) and T_8 (100% RDF + *Rhizobium* 30g/kg seed) T_7 (100% RDF + *Azotobactor* 30g/ kg seed) and T_5 (100% RDF + *Rhizobium* 20g/kg seed) showed less days to 50 per cent flowering (35). T_8 (RDF + *Rhizobium* 30g/kg seed) recorded less days to maturity (81.65). Further experimentation is suggested to confirm the consistency of results.

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