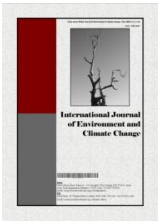

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Influence of Bio-fertilizers and Botanicals on Growth Yield and Yield Attributes of Field Pea (*Pisum sativu m* L.) Var. (Azad Pea-3)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The Field Experiment was conducted at Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agricultural Sciences and Technology, Prayagraj (U.P) during the year 2020-2021.The Experiment was laid out in a Randomized Block Design with 13 treatments and 3 replications. The treatments were T_0 - Control, T_1- Azotobacter @ 3g, T_2- Azotobacter @ 5g ,T_3- Phosphate Solubilizing Bacteria @ 3g, T_4-Phosphate Solubilizing Bacteria @ 5g, T_5- Azospirillum @ 3g, T_6-Azospirillum@ 5g,T_7- Rhizobium @ 3g, T_8-Rhizobium @ 5g , T_9-Moringa leaf extract @1%, T_{10}-Moringa leaf extract @3%, T_{11}- Lantana camera leaf extract @1%, T_{12}-Lantana camera leaf extract @ 3% with a soaking duration of 8 hours. The results showed that seeds primed with T_{8-} Rhizobium @ 5g improved Field emergence percentage, growth, yield and yield attributing traits followed by T_7-Rhizobium @ 3g and T_4- PSB@ 5g. The least performance was observed in T_0-Control when compared with the other treatments. This it indicated that the process of seed treatment by bio-fertilizers may be the better option for seed growers to achieve higher seed yield and yield attributes in Pea.

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1. INTRODUCTION

Pulses are referred as poor man's diet as they are major sources of protein and compliment the stable cereals in the diet with essential nutrients. They occupy pivotal position particularly in developing countries like India, where most of the population is vegetarian. Pulses belong to the family Leguminosae and sub-family Papilionoidaceae. They provide 22-24% protein and being seeds, they are considered easily digestible. The increasing demand of Protein rich raw material for animal feed are intermediary product for human nutrition, There is increasing interest in these crops as a protein source [1]. The per capita availability of pulses per day is only 47 g as against the minimum requirement of 104 g as recommended by Nutritional experts of the World Health Organization/ Food and Agriculture Organization [2].

Field Pea (*Pisum sativum* L.) is a temperate crop grown in higher altitudes in tropical areas in temperatures ranging between 7 to 30^0C. It is diploid with 2n=14, it is one of the sixth major pulse crop cultivated globally and is the second highest yielding grain legume next to broad bean (*Vicia faba*). Field Pea *(Pisum sativum* .L) is a self-pollinated annual crop which is developed for nourishment, feed and vegetables.

Field Pea originated from the Middle East and was first cultivated roughly 10,000years ago [3]. Field Pea is a cool season legume crop that is grown on over 25 millon acres world wide. It is marketed as a dry, shelled product for either human or livestock food. It is commonly used throughout the world in human diets and has high levels of amino acids, lysine and tryptophan, which are relatively in cereal grains and contains approximately 21-25% protein. Field Pea is rich in protein, carbohydrates, vitamin A and C , calcium and phosphorus.

Field Pea *(Pisum sativum* L.) is a popular pulse crop in India which is the second largest producer of pea in the world after Russia. It is represented as one of the world's most seasoned cultivated crop, in the early tenth and ninth centuries BC [4]. In India the state of Uttar Pradesh is ranked first both in area and production followed by Madhya Pradesh and Jharkhand where as in terms of productivity Rajasthan hold first rank followed by Punjab and Jharkhand. The lowest production was observed in Maharashtra followed by Chhattisgarh.

Among the various fertilizers, biofertilizers are important sources of nutrients. Biofertilizers and natural fertilizers containing micro-organisms which help in enhancing the productivity by Biological nitrogen fixation or solubilization of insoluble phosphate or producing hormones, vitamins and other growth regulators required for Plant growth [5].

Being a legume crop, Field Pea has the inherent ability to obtain much of its nitrogen requirement from the atmosphere by forming a symbiotic relationship with Rhizobium bacteria in the soil [6].

2. MATERIALS AND METHODS

The experimental study was conducted during the rabi season 2020-2021 at Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The site is located at latitude 25.35^0 N and longitude 82.25^0 E at an altitude of 78m above mean sea level. The soil is sandy loam in texture with moderate water holding capacity having pH between 7.0 to 8.0 . The field experiment was conducted in a randomized block design in three replications with thirteen treatments. Field Pea seeds were sown at 30x10 cm row-to-row and plant to-plant distance. Observations were recorded for each treatment on five randomly selected plants in each replication on field emergence, plant height, number of primary branches, days to 50% flowering,days to maturity, number of pods per plant, number of seeds per pod, pod weight per plant, pod length, seed yield per plant, seed yield per plot, biological yield and harvest index.

The Analysis of variance was being carried out according to the Randomized Block Design(RBD) procedure for each character as described by [7].

3. RESULTS AND DISCUSSION

The analysis of variance among each treatment showed significant differences for all characters as shown in Table 1.

Growth, yield and yield attributes showed significant variations with different concentrations of Bio-fertilizers and Botanicals.

3.1 Field Emergence

Field emergence was found to be significant between treatments, the highest recorded in the treatment Rhizobium @ 5g (92.45%) followed by Rhizobium @ 3 g (91.57%) Phosphate solubilizing bacteria @ 5 g (90.43%) and the lowest was found in the control (80.40%).

3.2 Plant Height

Among the various treatments Rhizobium @ 5 g (59.53 cm) recorded the highest plant height at 60DAS followed by Rhizobium @ 3 g (58.80 cm) and PSB @5 g (57.80 cm) respectively. The lowest was found in the control (50.20 cm). Similar results were reported by Rather et al., [8] and Dekhane et al., [9] who reported that inoculation of pea seeds with Rhizobium was responsible for significant increments in plant height compared to un-inoculated plants.

3.3 Number of Primary Branches

The maximum number of primary branches per plant were found in the treatment Rhizobium @ 5g (3.93) followed by Rhizobium @ 3g (3.81) and PSB @ 5g (3.35) respectively. The lowest was found in the control (2.11). Similar results were reported by Dekhane and chavan [9], Rather et.al., [8] and Solieman et.al., (2003) on pea plant studies. They confirmed that the inoculation of pea seeds with Rhizobium significantly increased plant height and the number of branches per plant compared to the un-inoculated ones.

3.4 Days to 50% Flowering

Days to 50% flowering decreased gradually with an increasing level of Rhizobium @ 5g (45.37%) which indicated its involvement in transition from vegetative apices to floral apices. Similar results were reported by Hukam Singh et.al., [10] who confirmed that seeds treated with Rhizobium significantly decreased days to 50% flowering when compared to untreated seeds.

3.5 Days to Maturity

Among the various treatments Rhizobium @ 5g (45.37) recorded the least days to maturity followed by Rhizobium @ 3g (45.47) respectively and the highest was found in the control (86.70).

3.6 Number of Pods Per Plant

Among the various treatments Rhizobium @ 5g (14.47) recorded the highest number of pods per plant followed by Rhizobium @ 3g (13.7)and PSB @ 5g (13.67) respectively and the lowest was found in the control (10.43). Similar findings were reported by Hukam singh et al., [10] and Mishra et al., [11] who found that the number of pods per plant significantly increased with Rhizobium inoculation compared with the un-inoculated ones.

3.7 Number of Seeds Per Pod

Among the various treatments Rhizobium @ 5g (7.83) recorded the highest number of seeds per plant followed by Rhizobium @ 3g (7.7)and PSB @ 5g (7.6) respectively and the lowest was found in the control (4.67). Similar findings have been reported by Hukam singh et al., [10] and Mishra et al., [11] who found that number of seeds per pod significantly increased with Rhizobium inoculation compared with the un-inoculated ones.

3.8 Pod Weight Per Plant

Among the various treatments Rhizobium @ 5g (5.93) recorded the highest Pod weight per plant followed by Rhizobium @ 3g (5.84) and PSB @ 5g (5.64) respectively and the lowest was found in the control (3.21).

3.9 Pod Length

Among the various treatments Rhizobium @ 5g (8.83) recorded the highest Pod length followed by Rhizobium @ 3g (8.73) and PSB @ 5g (8.53) respectively and the lowest was found in the control (6.03). These results are similar to those found by Dekhane and chavan [9] and Hukam Singh et al., [10] who found that Pod length significantly increased with Rhizobium inoculation compared with the un-inoculated ones.

3.10 Seed Yield Per Plant

Among the various treatments Rhizobium @ 5g (19.73gms) recorded the highest seed yield per plant followed by Rhizobium @ 3g (19.30g) and PSB @ 5g (18.70gms) respectively and the lowest was found in the control (13.5g). Similar results were reported by Hukam Singh et al., [10] who found that seeds treated with Rhizobium significantly increased the seed yield per plant when compared with the untreated seeds.

Table 1. Mean performance of various treatments in Field Pea(*Pisum sativum* L.)

Treatments	Field Emergence percentage	Plant Height	Number of Primary Branches	Days to 50% Flowering	Daysto maturity	Number of Pods per Plant	Number of Seeds per Pod	Pod weight per Plant	Pod Length	Seed Yield per Plant	Seed Yield per Plot	Biological Yield	Harvest Index
T_0	80.40	50.20	2.11	54.51	86.70	10.43	4.67	3.17	6.03	13.50	284.8	16.53	76.82
T_1	87.51	56.21	3.08	48.47	82.73	12.7	6.63	5.3	8.0	17.30	363.3	21.23	82.50
T_2	88.32	56.80	3.23	48.42	82.20	12.8	6.83	5.21	8.1	17.77	373.1	21.67	83.97
T_3	89.53	57.20	3.25	47.7	81.73	13.2	7.2	5.46	8.40	18.23	382.9	22.33	84.24
T_4	90.43	57.80	3.35	47.64	81.23	13.67	7.6	5.64	8.53	18.70	392.7	22.73	84.79
T_5	85.47	55.24	2.66	49.54	83.73	12.47	6.3	4.33	7.67	16.23	340.9	20.30	81.10
T_6	86.58	55.80	2.8	49.54	83.30	12.5	6.43	4.66	7.83	16.70	350.7	20.73	81.39
T_7	91.57	58.80	3.81	45.47	80.80	13.7	7.7	5.84	8.73	19.30	405.3	23.23	85.27
T_8	92.45	59.53	3.93	45.37	80.23	14.47	7.83	5.93	8.83	19.73	414.4	23.70	86.95
T_9	81.63	52.53	2.35	52.38	85.77	11.07	5.43	3.21	6.2	14.30	300.3	18.27	78.35
T_{10}	82.50	53.10	2.4	52.22	85.27	11.43	5.47	3.76	6.30	14.73	309.4	18.63	78.63
T_{11}	83.63	53.73	2.47	50.86	84.73	11.57	5.6	3.78	6.47	15.30	321.5	19.20	79.12
T_{12}	84.40	54.67	2.52	50.45	84.30	11.77	5.87	4.13	7.07	15.73	333.4	19.70	80.23
Mean	86.42	51.51	2.92	49.43	83.29	12.44	6.43	4.65	7.55	16.73	351.4	20.64	81.73
S.E.	0.15	0.68	0.09	0.11	0.63	0.1	0.19	0.18	0.15	0.23	0.82	0.28	0.26
C.D. 1%	0.59	2.69	0.34	0.43	2.50	0.38	0.76	0.72	0.58	0.89	3.26	1.09	1.03
C.D.5%	0.44	1.98	0.25	0.32	1.84	0.28	0.56	0.53	0.43	0.66	2.41	0.80	1.93

Legends :T_0-Control, T_1- Azatobacter @3gms, T_2-Azatobacter@5gms,T_3- Phosphate Solubilizing bacteria @3gms, T_4-Phosphate Solubilizing bacteria@5gms,T_5- Azospirillum @3gms T_6-Azospirillum@5gms ,T_7- Rhizobium@3gms, T_8-Rhizobium@5gms, T_9- Moringa leaf extract @1%, T_{10}-Moringa leaf extract@3%,T_{11}- Lantana camera leaf extract @1%, T_{12}-Lantana camera leaf extract @3%

3.11 Seed Yield Per Plot

Among the various treatments Rhizobium @ 5g (414.4g) recorded the highest seed yield per plot followed by Rhizobium @ 3g (405.3 g) and PSB @ 5 g (392.7) respectively and lowest the was found in the control (284.8 g). Similar results were reported by Mishra et al., [11] who found that seeds treated with Rhizobium significantly increased the seed yield per plot when compared with the untreated ones.

3.12 Biological Yield

Among the various treatments Rhizobium @ 5 g (23.70) recorded the highest seed yield per plot followed by Rhizobium @ 3 g (23.23) and PSB @ 5 g (22.73) respectively and lowest the was found in the control (16.53).

3.13 Harvest Index

Among the various treatments Rhizobium @ 5 g (86.95) recorded the highest seed yield per plot followed by Rhizobium @ 3 g (85.27) and PSB @ 5 g (84.79) respectively and the lowest was found in the control (76.82).

4. CONCLUSION

From the results of the study, it can be concluded that seed treatment with Rhizobium @ 5 g significantly influenced the growth, yield and yield attribute traits of Field Pea under the agro-climatic conditions in Prayagraj. Bio-fertilizers were found to be superior with regards to plant growth and yield characters over the control which was non treated. Further studies under field conditions might be needed to clarify the role of Bio-Fertilizers and Botanicals in Field Pea.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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