



Response of Different Pre-sowing Seed Treatments with Biofertilizers, Plant Growth Regulators and Botanical Extract on Growth and Yield Parameters of Field Pea (*Pisum sativum* L.)

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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

A field experiment was conducted during *rabi* season in the year (2021-2022) at post graduate Central Research Farm, Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The experiment was laid out in Randomized Block Design (RBD) with 13 treatments and 3 replications. Pea seeds were treated with (NAA, GA₃, Rhizobium, Azatobacter, Neem Leaf Extract, Lantana Camera Extract) were subjected to growth and yield parameters. The results showed that seed treatment with treatment (T₂) (NAA@100 ppm for 12hours) recorded the highest germination percentage, maximum plant height, minimum days for 50% flowering and days to pod maturity, maximum number of branches/plant, number of pods/plant, number of seeds/pod, highest pod

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length and pod width, maximum seed yield, biological yield, harvest index was significant in all and highest gross returns, net returns and cost benefit ratio was recorded in treatment (T₂) seed treatment with NAA@100ppm for 12hours.

Keywords: Field Pea; biofertilizers; plant growth regulators; botanical extracts.

1. INTRODUCTION

Field pea (*Pisum sativum* L.) is one self-pollinated diploid (2n=14) annual of the most important cool season pulse crop and is valued as high protein food. It is widely grown in the cooler temperate zones and in the highlands of tropical regions of the world.

Field pea (*Pisum sativum* L.), a legume crop, belongs to the Leguminosae family and contains a high amount of protein including amino acids, especially lysine [1]. Beans are considered to be the most nutritious part of the human diet because they contain 42.65% carbohydrates, 27.8% protein and iron (Fe), sodium (Na), phosphorus (P), potassium (K), and some other important elements [2]. They provide 22-24 per cent protein and the seeds are considered easily digestible and the increasing demand of protein rich raw material for animal feed or intermediary product for human nutrition, there is raising interest in these crops as a protein source [3].

In India, total pulse production is 25.23 M tonnes (2017-18) total area under pea production is 9.01 lakh ha and total production of 8.49 lakh tons were recorded. In India Uttar Pradesh ranked first both in area and production (37.90% and 41.58%). In Karnataka, area and production is about 1.54 thousand ha and 20.37 thousand tonnes respectively, with a productivity of 13.26 t/ha [4].

Application of growth promoting hormones is a recent technique in this direction. Plant hormones in a broad sense are organic compounds which play an important role in plant growth development and yield of crops to prevent the fruit and flower drop for a longer period. The plant growth regulators are organic compounds, other than nutrients which in small concentration influence the physiological processes of plants. They have been used for various beneficial effects such as promoting root growth, increasing number of flowers, fruit size and inducing early and uniform fruit ripening. NAA (Naphthalene Acetic Acid) in the synthetic auxin with the identical properties to that naturally occurring auxin. It prevents formation of abscission layer and there by flower drop. Plant growth regulators

are used widely to improve plant performance, GA3 (Gibberellic acid) is one of those growth regulators that have positive effect on plant growth rate through the effect on cell division and elongation Batlang et al., [5]. Biofertilizers are natural fertilizers containing micro-organism 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 [6]. Biofertilizer is a natural product carrying living micro-organisms derived from the root or cultivated soil. 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 [7]. Among the various fertilizers, biofertilizers are important sources of nutrients. *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. The favorable 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 [8]. Many botanical extracts have been studied on seed and seedling characters, they gain much importance in growth, yield and quality parameters. Seed treatment with neem leaf extract and lantana camera extract effect can be seen in growth and yield of a plant. Botanical seed treatment is extracted from naturally occurring sources based on botanical ingredients. It has a synergistic effect on early and uniform seed germination and enhances tolerance to pest and disease during early crop stage.

The objective of this study is to determine the response of different doses of selected biofertilizers, plant growth regulators and botanical extracts on growth and yield parameters for field pea.

To identify suitable pre sowing seed treatments favorable for field pea.

To estimate the benefit cost ratio for field pea.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The experiment was conducted during *Rabi* season of 2021-22. The soil of experimental plot was sandy loam in texture, (pH 7.1), in order to study the different pre-sowing seed treatments of Field pea var. Rachana. The experiment was conducted using Randomized Block Design consisting of 13 treatments with three replication in field condition at the department of Genetics & Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. Prayagraj is located in the south eastern part of Uttar Pradesh, India. This region has subtropical Climate with extreme of summer and winter. The temperature falls to as low as 2-3⁰c during winter season especially in the month of December and January.

2.2 Experimental Design and Treatment Details

T ₀	-	CONTROL
T ₁ , T ₂	-	NAA @ 50, 100ppm for 12 hours
T ₃ , T ₄	-	GA ₃ @ 50, 100ppm for 12 hours
T ₅ , T ₆	-	Rhizobium @ 50, 100g for 12 hours
T ₇ , T ₈	-	Azatobacter @ 40, 80g for 12 hours
T ₉ , T ₁₀	-	Neem leaf extract @ 5, 10% for 12 hours
T ₁₁ , T ₁₂	-	Lantana camera extract @ 5, 10% for 12 hours

From the sowing till the physiological maturity and harvest the observations were recorded on different growth parameters viz field emergence on 4th day, 7th day, 10th day, days for 50% flowering, days to pod maturity, plant height at 30days, 60days, 90days, number of branches per plant and yield parameters viz number of pods per plant, number of seeds per plant, pod length, pod width, seed yield per plant, seed yield per plot, seed yield per hectare, biological yield, harvest index were recorded and statistically analyzed using analysis of variance was carried out according to the procedure of Randomized Block Design (RBD) for each character as per methodology advocated by Panse and Sukhatme, [9]. Field pea was harvested 90% when pods turns in brown colour. Five random plants were selected in each plot of all replications.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The maximum germination % on 4th day was recorded in treatment T₂ NAA @ 100ppm for 12 hours is (17.33) on 7th day (65.33) and on 10th day (89.33) and followed by T₄ GA₃ @100ppm which was significantly superior over all other treatments and whereas the lowest was found in treatment T₀ (0.00) on 4th day, (14.67) on 7th day and (52.00) on 10th day. Similar results was observed by Tharunasree et al.[10] showed that seed treatment with NAA@ 100ppm recorded the highest germination percentage in field pea.

Days to 50% flowering in field pea was observed that significantly minimum days in days to 50% flowering and days to pod maturation found in the treatment T₂ NAA @ 100ppm for 12 hours where seeds may be considered as the best treatment for early period in days to 50% (45.33) and the minimum days taken for pod maturity in the field pea was observed from the date of sowing seeds to the physiological maturity of pea seeds. The early pod maturation period was found in treatment T₂ NAA @ 100ppm for 12 hours (96.00) and followed by T₄ GA₃ @100ppm (64.00) the maximum days was recorded in treatments T₀ (55.67) in days to 50% flowering in field pea and (104.33) in days to pod maturation. Similar results were confined by Chandiniraj et al. [11] in chilli, Kanhaiyalal Sanodiya et al. [12] in okra and SaiTharunasree et al. [10] in field pea.

The highest plant height in our experiment found on 30, 60, 90 DAS was recorded in treatment T₂ NAA @ 100ppm for 12 hours (30.99)cm on 30 days and (72.75)cm was found in 60 days and (121.92)cm was found in 90 days after sowing which was significantly superior over all other. In case of branches per plant of pea is significantly increase in number of branches per plant which was recorded in the treatment T₂ NAA @ 100ppm for 12 hours (11.33) whereas the lowest in all different stages of plant height and number of branches per plant was found in treatment T₀ control. Similar results were observed by Mondol [13] in groundnuts, Samsuzzaman [14] in ground nuts, Singh et al.[15] showed that NAA at 45ppm recorded highest height in pea, Foyalkabir et al. [16] in mungbean, SaiTharunasree et al.,(2021) in field pea.

3.2 Yield Parameters

The number of pods per plant are significantly maximum in pods per plant and number of seeds per pod in the treatment T₂ NAA @ 100ppm for 12 hours (25.27) and (6.70) respectively and minimum number of pods and number of seeds per pod were recorded in treatment untreated T₀. Similar results were confined with work of Khanzada et al. [17] who stated that application of NAA increased number of seeds per pod, Anonymous [18] in green gram, Pandey et al. [19] observed that maximum number of seeds was obtained with application of NAA 1500ppm in pea, Asaduzzaman [20] in green gram, Muhammad Aslam et al. [21] in chickpea, Singh et al. [22] in pea, SaiTharunasree et al. [10] in field pea.

The length of pods of five random selected plants from each plant were measured. Significantly maximum pod length and pod width was found in the treatment T₂ NAA @ 100ppm for 12 hours (5.73) and (1.45) respectively. The minimum in both was recorded in treatment T₀ untreated seeds. These observations were consistent with the results of Upadhyay [23] in chickpea, Anonymous [18] in green gram, Das and Prasad [24] found that application of NAA at 20ppm pod length in mung bean, Asaduzzaman [20] showed that NAA at 20ppm has significant effect on length of pod in green gram, Kumanan et al.,(2020) showed that NAA@100ppm obtained the maximum pod length and pod width in lab.

As number of pods increases the yield increases. Significantly maximum seed yield per plant, seed yield per plot and seed yield per hectare was found in the treatment T₂ NAA @ 100ppm for 12

hours (18.73), (317.73) and (18.20) respectively and followed by GA₃ @100ppm. Minimum seed yield in field pea was recorded in untreated control seeds in treatment T₀. It implied that NAA decreases the dropping of flower, pod forming and increased in number of pods and seed yield. Similar results was observed by Mondol (2003) in groundnuts, Pandey.,(2004) reported the increase in yield by application of NAA 1500ppm on pea, Samsuzzaman (2004)., Singh and Lal (2002) found the maximum number of fruits per plant by NAA, Asaduzzaman.(2013) in green gram and SaiTharunasree et al., (2021) in field pea.

The seed yield and dry plant weight of the pea plant both weighed and recorded. Significantly the maximum biological yield per plot was found in the treatment T₂ NAA @ 100ppm for 12 hours (666.80). The minimum biological yield was recorded in untreated control seeds T₀ (465.10). Similar results was found by Upadhyay (2002) in chickpea, Asaduzzaman (2013) showed that NAA @20ppm have a significant effect on biological yield in green gram and SaiTharunasree et al., (2021) in field pea.

Significantly maximum percent of harvest index was observed in the treatment T₂ NAA @ 100ppm for 12 hours (47.67) with grand mean (45.57). The minimum percent of harvest index per plot is found in untreated seed treatment T₀ (41.67). The results were agree with Anonymous (2003) in green gram, Muhammad Aslam et al., (2010) indicated that NAA have a significant effect on harvest index in chickpea, and SaiTharunasree et al., (2021) found that NAA @100ppm showed maximum harvest index in field pea.

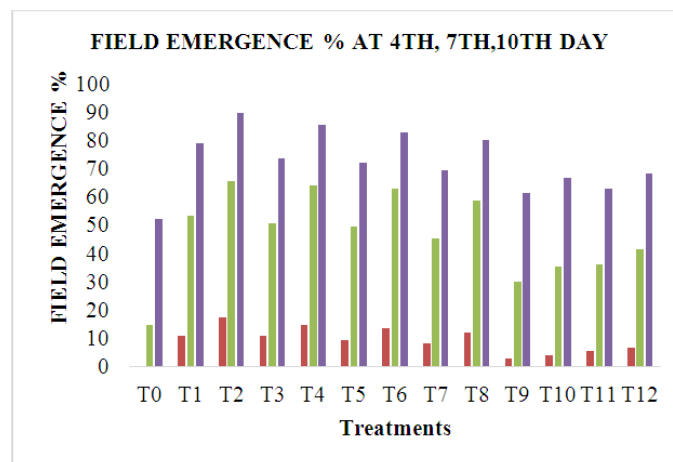


Fig. 1. Response of different treatments on Field emergence on 4th, 7th and 10th day

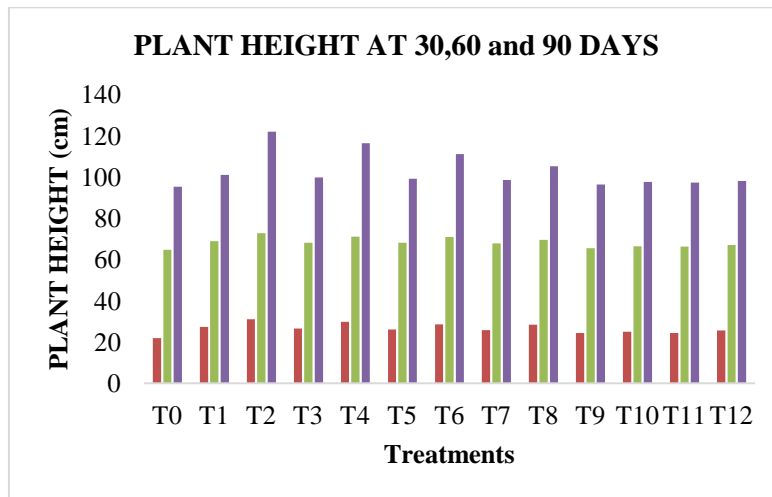


Fig. 2. Response of different treatments on plant height on 30, 60, 90 days

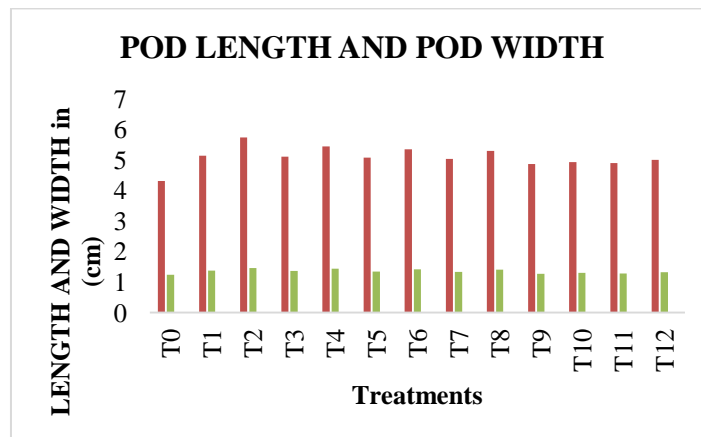


Fig. 3. Response of different treatments on pod length and pod width



Fig:4 Field pea plants at flowering stage



Fig:5 Field pea plants at pod setting stage



Fig :6 Field pea plants at 120 days

Table1. Analysis of Variance for response of treatments on growth and yield parameters in field pea

Characters	Mean sum of square		
	Replications (df=2)	Treatments(df=12)	Error (df=24)
Field emergence percentage at 4 th day	5.33	75.15*	3.56
Field emergence percentage at 7 th day	21.33	672.67*	10.00
Field emergence at 10 th day	54.56	338.12*	42.12
Days to 50% flowering	0.18	23.36*	3.15
Days to pod maturity	1.14	19.77*	3.20
Plant height at 30 Days	0.75	18.37*	0.34
Plant height at 60 Days	2.84	16.61*	0.97
Plant height at 90 Days	20.29	223.72*	6.40
Number of branches per plant	1.24	4.86*	0.46
Number of pods per plant	4.88	17.83*	2.07
Number of seeds per pod	0.05	1.00*	0.12
Pod length	0.35	0.01*	0.00
Pod width	0.00	0.01*	0.00
Seed yield per plant	1.42	4.68*	0.42
Seed yield per plot	133.83	3026.91*	52.33
Seed yield per hectare	0.18	16.40*	0.50
Biological yield	192.63	8389.77*	107.49
Harvest index	0.54	7.40*	0.51

At 5% level of significance

Table 2. Mean performance of growth parameters in field pea

SI. NO.	Treatments	Field Emergence % at 4 th day	Field emergence % at 7 th day	Field emergence % at 10 th day	Days to 50% flowering	Days to pod maturity	Plant height at 30 DAS (cm)	Plant height at 60 DAS (cm)	Plant height at 90 DAS (cm)	Number of branches per plant
1	T ₀	0.00	14.67	52.00	55.67	104.33	21.93	64.67	95.20	6.30
2	T ₁	10.67	53.33	78.67	48.67	99.63	27.33	68.82	101.00	9.53
3	T ₂	17.33	65.33	89.33	45.33	96.00	30.99	72.75	121.92	11.33
4	T ₃	10.67	50.67	73.33	49.67	99.77	26.57	68.13	99.75	9.13
5	T ₄	14.67	64.00	85.33	46.00	96.77	29.73	71.02	116.31	10.33
6	T ₅	9.33	49.33	72.00	50.00	100.50	26.03	68.04	99.14	9.00
7	T ₆	13.33	62.67	82.67	50.67	98.00	28.56	70.85	110.95	9.70
8	T ₇	8.00	45.33	69.33	50.33	101.77	25.68	67.69	98.51	8.80
9	T ₈	12.00	58.67	80.00	48.00	99.20	28.35	69.46	105.07	9.60
10	T ₉	2.67	30.00	61.33	53.33	103.57	24.30	65.47	96.28	7.57
11	T ₁₀	4.00	35.33	66.67	51.33	102.27	24.99	66.43	97.51	8.47
12	T ₁₁	5.33	36.00	62.67	52.00	102.77	24.33	66.16	97.23	7.87
13	T ₁₂	6.67	41.33	68.00	50.67	101.80	25.55	67.04	98.06	8.63
Grand Mean		8.82	46.67	72.41	50.12	100.49	26.48	68.19	102.84	8.94
C.D. (5%)		3.18	5.33	10.94	2.99	3.01	0.98	1.66	4.26	1.15
SE (m)		1.09	1.83	3.75	1.02	1.03	0.34	0.57	1.46	0.39
SE (d)		1.54	2.58	5.30	1.45	1.46	0.47	0.80	2.07	0.56
C.V.		21.38	6.78	8.96	3.54	1.78	2.19	1.45	2.44	7.61

Table 3. Mean performance of yield parameters in field pea

Sl. NO.	T Treatments	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Pod width (cm)	Seedyield per plant (g)	Seed yield per plot (g)	Seed yield per hectare (t/ha)	Biological yield per plot (g)	Harvest index(%)
1	T ₀	15.93	4.73	4.30	1.23	14.41	191.50	10.57	465.10	41.67
2	T ₁	20.47	6.20	5.13	1.37	17.48	288.93	15.90	636.07	45.41
3	T ₂	25.27	6.70	5.73	1.45	18.73	317.73	18.20	666.80	47.67
4	T ₃	19.87	6.03	5.10	1.36	17.19	287.67	15.57	626.40	45.12
5	T ₄	22.80	6.47	5.44	1.43	18.32	306.00	17.20	657.20	46.55
6	T ₅	19.23	5.93	5.07	1.34	16.76	284.70	13.97	616.63	46.16
7	T ₆	21.57	6.37	5.34	1.41	17.83	299.03	17.00	651.93	45.86
8	T ₇	18.93	5.80	5.03	1.33	16.60	282.10	13.77	610.07	46.23
9	T ₈	20.73	6.33	5.29	1.40	17.61	293.93	16.70	642.70	45.74
10	T ₉	17.60	5.10	4.86	1.26	15.32	250.93	12.03	569.27	44.07
11	T ₁₀	18.37	5.47	4.92	1.30	15.85	276.13	13.13	592.37	46.66
12	T ₁₁	17.83	5.37	4.89	1.28	15.61	254.63	12.17	576.00	44.21
13	T ₁₂	18.70	5.67	4.99	1.32	16.50	281.10	13.57	595.63	47.18
Grand Mean		19.79	5.85	5.08	1.34	16.78	278.02	14.59	608.16	45.60
C.D. (5%)		2.42	0.59	0.32	0.06	1.09	12.19	1.19	17.47	1.20
SE (m)		0.83	0.20	0.11	0.02	0.37	4.18	0.41	5.99	0.41
SE (d)		1.17	0.29	0.16	0.03	0.53	5.91	0.58	8.47	0.58
C.V.		7.27	6.01	3.79	2.46	3.86	2.60	4.84	1.70	1.57

Table 4. Gross returns, Net returns and Benefit cost ratio

Treatments	Cost of treatments(Rs/ha)	Cost of cultivation(Rs/ha)	Total cost of cultivation(Rs/ha)	Gross return (Rs/ha)	Net return(Rs/ha)	B:C Ratio
T ₀	0	33,001	33,001	52,833.33	19832.33	0.60
T ₁	2,500	33,001	35,501	1,59,000.00	123499.00	3.47
T ₂	5,000	33,001	38,001	1,82,000.00	143999.00	3.78
T ₃	2,525	33,001	35,526	1,55,666.67	120140.67	3.38
T ₄	5,050	33,001	38,051	1,72,000.00	133949.00	3.52
T ₅	1,860	33,001	34,861	1,39,666.67	104805.67	3.00
T ₆	3,720	33,001	36,721	1,70,000.00	133279.00	3.62
T ₇	1,240	33,001	34,241	1,37,666.67	103425.67	3.02
T ₈	2,480	33,001	35,481	1,67,000.00	131519.00	3.70
T ₉	2,380	33,001	35,381	1,20,333.33	84952.33	2.40
T₁₀	4,670	33,001	37,671	1,31,333.33	93662.33	2.48
T ₁₁	1,820	33,001	34,821	1,21,666.67	86845.67	2.49
T ₁₂	3,640	33,001	36,641	1,35,666.67	99025.67	2.70

4. CONCLUSION

Plant growth regulators promotes germination, early growth rapid seed germination and seed development. It is concluded that NAA gave best results to enhance early seed emergence, plant height, early flowering and good seed yield. Therefore, it can be concluded that application of NAA @100ppm for 12 hours significantly recorded highest seed yield (18.20t/ha), higher gross returns (Rs1,82,000/ha), net returns (Rs1,43,999/ha) and benefit cost ratio (3.78) as compared all other treatments. Since all these findings are based on the research done in *rabi* season in SHUATS, U.P.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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