Original Research Article

Impact of Integrated Use of Inorganic, Organic and Biofertilizers on Growth, Yield and Quality of Pea (*Pisumsativum* L.)

ABSTRACT

Aim: The experiment was carried out , to find out the impact of integrated use of inorganic, organic and biofertilizers on growth, yield and quality of pea (*Pisumsativum* L.).

Study design: Experiment was laid out in randomized block design (RBD) with three replications. Azad P-3 variety was grown to evaluate the effect of different treatments.

Place and Duration of Study: It was conducted during 2021 at Experimental Farm of Faculty of Agricultural Sciences, DAV University, Jalandhar.

Methodology: Thirteen treatments were used for the study which consisted of different combinations of organic, inorganic and biofertilizers (FYM, Vermicompost, NPK, Azotobacter and PSB) at different levels (100%, and 75% of the recommended dose of each nutrient). Observations were recorded on days to germination, days to first flowering, days to 50% flowering, plant height (cm), number of branches per plant, number of leaves per plant, pod length (cm), number of pods per plant, pod weight (g), pod yield per plant (g/plant), pod yield per plot (Kg/plot), Shelling percentage (%), total soluble solids (TSS).

Results: Analysis of variance (ANOVA) revealed significant effect of integrated use of inorganic, organic and biofertilizerson growth, yield and quality under study. Lowest number of days to germination(10.63 days); days to first flowering(59.33 days);number of days to 50% flowering(78.26 days) was recorded in T4 (100% NPK+FYM+PSB). The same treatment also resulted in highest pod length (9.18cm);number of pods per plant (16.27); pod weight (8.49g);plant height (62.37cm);pod yield per plant (55.24 g); pod yield per plot (4.32 kg);TSS (16.48^{0}B) andshelling percentage % (52.50).

Conclusion: It was observed that plants which were treated with the application of 100% NPK, FYM and PSB resulted in superior performance with respect to growth, yield and quality parameters of pea.

Keywords: *Pea, Integrated fertilizers use, FYM, Vermicompost, NPK*

1.INTRODUCTION

Pea (*Pisumsativum*L.) belonging to family Fabaceaeis an important rabi season vegetable in Northern plains of India and in hills it is grown as summer vegetable. It is herbaceous, annual in habit and self-pollinated vegetable crop. It is the second important food legume of the world. India is the second largest producer of pea in the world and accounts for 21% of the world production. In India it is mainly grown in Uttar Pradesh, Madhya Pradesh, Assam, Jharkhand, Himachal Pradesh, Haryana, Bihar, Uttarakhand, Punjab etc. [1]. Punjab is fifth largest producer of pea in the country and accounts for 6.7% of India's production. It is second important vegetable crop of Punjab and is grown on an area of 43.89 thousand hectare with annual production of 467.01 thousand tonnes,In India it is grown on an area of 575 thousand hectare with annual production of 5855 thousand tonnes[2].

It is cultivated for its pods and seeds which are used in fresh state as well as processed form. In fresh state, mainly snow pea and sugar snap are exports due to their high demand in theinternational market. Processed shelled peas are marketed in three ways frozen, canned and dehydrated but more than 95% of shelled peas are used in frozen form. It is grown for its pods and seeds. The green and dry foliage are used as cattle fodder and green pods of vegetable pea are highly nutritive so, preferred for culinary purpose.

With the increasing population there is ever increasing demand of food and to sustain the healthy population, there is need of ample supply of nutrient rich food such as vegetables. In order to meet the increasing demand of nutrition rich food, efforts are being made at national and international levels. Fertilizers play a vital role in maintaining the soil fertility and enhancing the production. Chemical fertilizers are conventionally used for increasing the production due their easy availability. But the main drawback of use of chemical fertilizers is their deleterious effects on soil structure, environment and human health. All these things have led to the search of alternative renewable source of nutrients for crop through fertilizers of biological origin which are bio-fertilizers. Biofertilizers are natural fertilizers which consist of micro organisms like bacteria, algae, fungi alone or in combination. They are the products containing carrier based (solid form or liquid form) living micro-organisms that are agriculturally useful which in turn fixes N, solubilization of P and mobilization of nutrient. 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 as reported by [3]. The use of biofertilizers is safe, cost effective and easy in application. Another source of plat nutrients i.e. organic manures are known to sustain cropping systems through better nutrient recycling and improved physical, chemical and biological properties of soil. The organic manures have the advantage of supplying secondary and micro nutrient along with

NPK, which is important for sustainable production. Commonly used organic manures are FYM, vermicompost, poultry manure, biogas slurry, urine and liquid manure etc. FYM manure release nutrients slowly and steadily and activate soil microbial activity [4]. The vermicompost is reported to significantly increase micronutrients in field as compared to animal manure [5]. Thus organic manures can serve as an alternative source to mineral fertilizers for improving soil structure and microbial biomass. These promote the healthy population of beneficial organisms in the soil while, biofertilizers are cost-effective and renewable source of plant nutrients to supplement the parts of chemical fertilizers. Integrated Nutrient Management involves the combined use of all the sources of plant nutrients. It helps in maintaining the soil fertility and supply plant nutrient in balanced proportion [6]. As single nutrient source may not supply the rest of required nutrients for the plant therefore, integrated use of all sources is required for balanced plant nutrition and it is necessary to make the judicious use of fertilizers in right proportion for harvesting better yield. Thus it has been realized that chemical fertilizers must be integrated through more economic and eco-friendly organic manure and biofertilizers to achieve sustainable productivity with high quality and minimum deterioration of the environment. Increased yield of pea through integrated use of chemical fertilizers and biofertilizers in nitrogen fixers like pea have also been reported [7].Thus keeping in view of importance of crop and need to integrate the use of inorganic, organic and bio-fertilizers, the present study was executed.

2. MATERIALS AND METHODS

The variety Azad P-3 was grown for the investigation and the experiment was laid out in Randomized Block Design and three replications. Thirteen treatments consisting of different combinations of organic, inorganic and biofertilizers (FYM, Vermicompost, NPK, Azotobacter and PSB) at different levels (100%, and 75% of the recommended dose of each nutrient), making combinations asT_1 (100% NPK); T_2(100% NPK+ FYM); T_3 (100% NPK+ FYM+ Azotobacter); T_4 (100% NPK+ FYM+ PSB); T_5 (75% NPK+ FYM+ Azotobacter);T_6 (75% NPK+ FYM+ PSB); T_7 (100% NPK+ Vermicompost); T_8 (100% NPK+ Vermicompost+ Azotobacter); T_9 (100% NPK+ Vermicompost+ PSB);T_{10} (75% NPK+ Vermicompost+ Azotobacter); T_{11} (75% NPK+ Vermicompost+ PSB); T_{12} (FYM+ Vermicompost+ Azotobacter);T_{13} (FYM+ Vermicompost+ PSB).The organic manure (FYM and Vermicompost), inorganic fertilizers (Urea, DAP and MOP) were applied in the experimental field as per the treatments and all the cultural practices were done as per the package of practices of Punjab Agricultural University. The data on various growth, yield and quality parameters collected during the course of investigation was subjected to statistical analysisby adopting analysis of varianceusing Randamized Block Design[8]. The interpretation of results was based on F test and critical difference (CD) at 5% level of significance.

3. RESULTS AND DISCUSSION

Analysis of Variance (ANOVA) revealed that the treatments significantly influenced all the characters viz, days to germination, days to first flowering, days to 50% flowering, number of leaves per plant, number of branches per plant, pod length (cm), number of pods per plant, pod weight (g), plant height (cm), pod yield per plant (g), pod yield per plot (kg), TSS (^{0}B) and shelling percentage(%) (Table 1).

3.1 Growth parameters

The data recorded on growth parameters as influenced by integrated use of inorganic, organic and biofertilizers has been presented in Table 2. Significantlylowest number of days to germination(7.25 days), days to first flowering (59.33 days), days to 50% floweringand significantlyhighestnumber of days to germination(10.63 days), days to first flowering (70.33 days), days to 50% flowering89.27 days was recorded in T_4 (100% NPK+FYM+PSB) and T_1(100% NPK), respectively. Earliness is one of the most desirable characteristics in pea as this will in turn lead to early maturity and helpful in fetching high returns from the early market. It was observed T_4 (100% NPK+FYM +PSB) resulted in lowest number of days to germination, days to first flowering, and days to 50% flowering. The application of inorganic, organic and biofertilizer might have resulted in increased carbohydrate accumulation and their remobilization to reproductive part of the plant, being the closet sink and hence, resulted in right time flowering [9]. The earliness of flowering may be attributed to the presence of biofertilizers which consequently lead to flower initiation, this may be due to easy uptake of nutrients and simultaneously transport of growth promoting substances like cytokinin to the auxillary buds resulting in breakage of apical dominance which eventually resulted in better sink for faster mobilization of photosynthesis and early transportation of plant parts from vegetative to reproductive parts [10].Similar findings are supported by [11,12, 13] in pea, [14] in dolichos bean, [15] in cowpea and [16] in french bean.

Significantly maximum number of leaves per plant (43.44), number of branches per plant (13.50) and plant height (62.37cm) was recorded in T_4 (100% NPK+FYM+PSB)which was significantly highest among all the treatments. It was revealed thatsignificantly lowest number of leaves per plant (28.38),number of branches per plant (7.19) and plant height (49.29cm)were observed in T_1 (100% NPK).

Number of leaves per plant has an important influence on the growth of plants, development and production. The highest number of leaves per plant with application of (100% NPK) supplemented by FYM and PSB can be attributed to the early and higher availability of plant nutrients in a soluble and easily absorbable form. In addition, presence of biofertilizer could have increased the available status of both macro and micro nutrients. The results corroborates with the findings of [17, 18,12, 11, 19] in pea, [20] in french bean,[14, 21] in dolichos bean, and [16] in french bean.

Number of branches per plant is a yield contributing character as it leads to increase in number of flowers and fruit and thus promises better yield and productivity. The number of branches significantly increased with the application organic and biofertilizer. It was noticed that comparatively higher number of branches per plant were found in integrated nutrient management than single or no chemical fertilizer application practices as also reported by [22]. [23] who observed that higher growth parameters with application of inorganic, organic and biofertilizers in an integrated use could be due to high initial microbial load supported by sufficient quantity of organic carbon which was later used for microbial proliferation and consequently releasing the nutrients that readily assimilates, supporting the biotic principle of carbon sequestration through biomass production.The results are in close conformity with the findings of [24] in pea, [22, 25] in cowpea. [14] in dolichos bean and [26] in moong bean.

Plant height greatly affects the yield as it influences the number of nodes per plant which leads to increased yield. The plant height was highest where plants were supplemented with FYM and PSB along with 100% NPK. Increase in plant height with the supplementation of inorganic fertilizers with FYM+PSB could be attributed to the increased availability of nutrients especially N and P leading to stem elongation due to cell development, rapid cell division and cell elongation in meristematic region of plants [27].The results are in line with the findings of [28, 29] in pea, [20,16] in French bean, [30,26] in chickpea, [31] in black gram, [32,33] in green gram, [34] in pigeon pea, [14] in dolichos bean, [15] in cowpea and [26] in moong bean

3.2Yield parameters

Yield parameters as influenced by integrated use of different inorganic, organic and biofertilizers are presented in Table 2. The highest pod length (9.18cm),number of pods per plant (16.27), pod weight (8.49g), pod yield per plant (55.24 g), pod yield per plot (4.32 kg)and shelling percentage % (52.50) was observed in T4 (100%NPK+FYM+PSB) which was significantly highest among all treatments. The lowest pod length (6.47cm), number of pods per plant (10.07), pod yield per plant (35.40 g) and pod yield per plot (1.29kg) was observed in T1(100% NPK) which was significantly lowest among all the treatments. Lowest pod weight(6.21g) was also observed in T1(100% NPK)which was statistically at par with T6

(75% NPK+ FYM+ PSB) (6.48g).The lowest shelling percentage (41.40%) was recorded in T1 (100% NPK) which was statistically at par with T11(75% NPK + FYM+ PSB) (41.97%).

Pod length (cm) is the yielding character which affects the yield and product appearance. Enhanced pod length with the application of integrated nutrient management could be attributed to improved soil physical, chemical and biological properties and thus leading to higher availability of all plant nutrients which in turn results in higher yield contributing traits like pod length. Similar results were observed by [13, 35,36] in pea, [22] in cowpea and [14] in french bean. The number of pods per plant is a prominent determination of yield in pea. The highest number of pods per plant was observed when integrated use of fertilizers was done i.e 100% NPK was supplemented by FYM and PSB. The hiked number of pods per plant might be ascribedby the higher scales of other growth parameters in the same treatment like number of leaves per plant and number of branches per plant leading to increased photosynthesis and increased number of pods per plant. Similar findings were observed by [4] who observed that with the application of PSB there was greater root extension under higher availability of phosphorous and organic manure which might have helped in greater uptake of other nutrients especially micronutrients and secondary nutrients, enhanced photosynthesis, and increased number of pods per plant in pea. The results are in conformity with the findings of [11, 12,13, 19, 28, 29,35, 37, 38, 39] in pea.

Pod weight has direct correlation with pod yield in pea. The improved pod weight with the combined application inorganic, organic and biofertilizers was probably due to adequate supply of nutrients and then availability which in turn helped in the photosynthesis and partitioning of photosynthesis as reported by [40].The results are in close conformity with the findings of [9, 39] in pea, [41] in cluster bean and[20] in french bean

The increase in pod yield per plant and per plot might have been due to the better performance of the yield attributes. The application of (100% NPK + FYM + PSB) resulted in highest plant height, number of branches, number of pods, pod length, pod weight which might have resulted in higher pod yield per plant. These may be due to the adequate and balanced supply of integrated application of organic sources with chemical fertilizers, plant received large amount of nutrients throughout their growth period and nourished properly which enhanced the yield of plant [4]. The increased yield with the integrated use of inorganic, organic and biofertilizers have alsobeen reported by earlier researchers viz. [9, 35, 37] in pea.

Shelling percentage is a yield contributing trait,higher shelling percentage represents the higher yield as it is the percentage of ratio of weight of green seeds to the weight of pods. The highest value of shelling percentage(50.92%) was observed with the application of

(100% NPK + FYM + PSB) which could be due to improved soil quality and availability of nutrients which further led to better translocation of photosynthesis resulting in better pod formation and grains. The results are supported by [13,42] in pea.

3.3 Quality Parameters

Total soluble solids (TSS) as influenced by integrated use of inorganic, organic and biofertilizers has been presented in Table 2. It revealed that highest value of TSS (16.48^{0}B)was recorded in T4 (100% NPK+FYM+PSB) which was significantly highest among all the treatments. T1 (100% NPK) resulted in minimum TSS (12.36^{0}B) which was statistically at par with T11(75%NPK+Vermicompost+PSB) resulting in TSS (12.77^{0}B).

Total Soluble Solids (TSS) is the quality character which is enhanced in favourable way due to integrated use of organic, inorganic and biofertilizers. The highest value(16.48^{0}B) of TSS was observed with the application of (100% NPK + FYM + PSB). Similar enhancement of TSS was also reported by [13,43] in pea who suggested that with the addition of FYM and PSB along with 100% NPK enhanced availability of phosphorous which is constituent of ADP, ATP and other higher energy compounds thus leading to increased level of polysaccharides and sugars in soyabean.

Table 1. Effect of Integrated Use of Inorganic, Organic and Biofertilizers on growth of pea (*Pisumsativum* L.)

Treatments	Days to germination	Days to first flowering	Days to 50% flowering	No. of leaves per plant	No.of branches per plant	Pod length (cm)	No. of pods per plant
T_1	10.63	70.34	89.27	28.38	7.19	6.47	10.07
T_2	9.34	65.24	84.23	30.17	10.24	7.51	12.36
T_3	8.94	61.21	82.43	32.16	9.43	8.40	14.06
T_4	7.25	59.33	78.26	43.44	13.50	9.18	16.27
T_5	8.31	64.33	80.42	35.37	11.47	7.30	13.09
T_6	9.43	67.06	83.38	33.08	8.56	7.22	12.50
T_7	8.28	62.20	81.47	37.42	12.43	8.19	12.04
T_8	9.35	66.26	83.33	30.22	10.55	8.03	15.53
T_9	8.57	60.32	80.48	31.52	11.38	8.44	11.58
T_{10}	9.23	63.00	79.31	32.58	12.43	8.74	14.57
T_{11}	8.39	65.57	83.48	41.47	10.10	7.60	13.08
T_{12}	9.24	63.32	81.26	39.50	9.22	8.21	12.23
T_{13}	8.40	67.39	86.16	33.30	8.99	8.43	12.68
C.D.	0.43	0.57	0.51	0.52	0.46	0.35	0.43
SE(m)±	0.14	0.19	0.17	0.17	0.15	0.12	0.15

T_1 (100% NPK); T_2 (100% NPK+ FYM); T_3 (100% NPK+ FYM+ Azotobacter); T_4 (100% NPK+ FYM+ PSB); T_5 (75% NPK+ FYM+ Azotobacter); T_6 (75% NPK+ FYM+ PSB); T_7 (100% NPK+ Vermicompost); T_8 (100% NPK+ Vermicompost+

Azotobacter); T_9 (100% NPK+ Vermicompost+ PSB);T_{10} (75% NPK+ Vermicompost+ Azotobacter); T_{11} (75% NPK+ Vermicompost+ PSB); T_{12} (FYM+ Vermicompost+ Azotobacter);T_{13} (FYM+ Vermicompost+ PSB)

Table 2. Effect of Integrated Use of Inorganic, Organic and Biofertilizers on yield and quality of pea (*Pisumsativum* L.)

Treatments	**Pod weight (g)**	**Plant height (cm)**	**Pod yield per plant (g)**	**Pod yield per plot (kg)**	**Shelling percentage (%)**	**TSS (^{0}B)**
T_1	6.21	49.29	35.40	1.29	41.40	12.36
T_2	7.52	52.96	42.35	2.29	45.25	13.64
T_3	6.54	58.25	46.08	2.37	47.67	15.20
T_4	8.49	62.37	55.24	4.32	52.50	16.48
T_5	7.09	51.47	37.40	3.17	43.33	14.52
T_6	6.48	53.70	39.32	3.39	49.56	13.20
T_7	7.18	55.43	39.14	3.31	50.13	13.14
T_8	7.41	57.26	50.48	3.26	42.26	12.25
T_9	7.98	59.42	45.49	4.08	48.20	15.15
T_{10}	8.56	60.55	52.28	2.38	50.92	14.05
T_{11}	7.86	52.24	49.17	3.42	41.97	12.77
T_{12}	7.68	53.52	38.24	2.61	46.65	15.32
T_{13}	7.29	55.38	40.25	2.18	44.07	13.13
C.D.	0.31	0.51	0.48	0.40	0.62	0.44

SE(m) ±	0.10	0.17	0.16	0.13	0.21	0.15

T_1 (100% NPK); T_2 (100% NPK+ FYM); T_3 (100% NPK+ FYM+ Azotobacter); T_4 (100% NPK+ FYM+ PSB); T_5 (75% NPK+ FYM+ Azotobacter); T_6 (75% NPK+ FYM+ PSB); T_7 (100% NPK+ Vermicompost); T_8 (100% NPK+ Vermicompost+ Azotobacter); T_9 (100% NPK+ Vermicompost+ PSB);T_{10} (75% NPK+ Vermicompost+ Azotobacter); T_{11} (75% NPK+ Vermicompost+ PSB); T_{12} (FYM+ Vermicompost+ Azotobacter);T_{13} (FYM+ Vermicompost+ PSB)

4. CONCLUSION

The results and discussion mentioned earlier about the effect of integrated use of inorganic, organic and biofertilizers on growth, yield and quality attributes of pea lead to the conclusion that use of inorganic, organic and biofertilizers plays an important role in terms of growth, yield and quality. Among all the treatments the use of FYM, NPK and PSB favoured growth, yield and quality.

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