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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD AND QUALITY OF DWARF PEA (*PISUM SATIVUM* L.)

ANUPMA KUMARI, ON SINGH, RAKESH KUMAR, AK SINGH AND RASHMI SINGH[1]
Institute of Agricultural Sciences, Banaras Hindu University, Varanasi – 221005
[1]Department of Mathematics, Amity University, Noida (UP)

Summary

Among the various combinations of inorganic (IN) and organic nutrition (ON) to dwarf pea (*Pisum sativum L.*), superimposition of 50% nitrogen (equivalent to 20 kg N) through vermicompost over the recommended dose i.e 40 – 17 – 16 – 20 kg N – P – K – S ha^{-1} (100% IN + 50% ON) resulted in significantly higher values for yield, harvest index, B: C ratio, protein and nutrient content. Seed inoculation with biofertilizer (Rhizobium + PSB + PGPR) in combination with application of Zn was also conducive for these parameters. Moreover, the interaction between the 100% IN + 50% ON fertility level with biofertilizer + Zn gave significantly higher grain yield.

सारांश

मटर की फसल को दिये गये विभिन्न अकार्बनिक एवं कार्बनिक मिश्रणो में से 40 किलो नेत्रजन, 17 किलो फास्फोरस, 16 किलो पोटाश एवं 20 किलो सल्फर के साथ–साथ वर्मीकम्पोस्ट द्वारा 50 प्रतिशत नेत्रजन (20 किलो नेत्रजन के बराबर) देने पर पैदावार एवं मुनाफे के अलावा गुणवत्ता में बढ़ोत्तरी पायी गयी। जैविक खादों (राईजोबियम, पी.यस.बी. एवं पी.जी.पी.आर.) के साथ जस्ता का प्रयोग भी इस बढ़ोत्तरी में सहायक पाया गया।

Introduction

Pea is an important pulse crop of the country and is gaining popularity due to its high productivity (1356 kg ha^{-1}). It is rich in protein content (21.0–32.3%) and may play a strategic role in India's battle against protein caloric malnutrition. Advent of dwarf pea cultivars like HFP-4 and HUDP–15 marked its dent as a high input pea crop responding to higher fertility and plant population for yield maximization. The growing needs of chemical fertilizers and continuous decline in crop response to chemical fertilizers not only seem to be uneconomiced, but also endanger the basic production system. Biofertilizer and vermicompost are the important components used in supplementing to the effectiveness of chemical fertilizers. The greatest need of the day is to contribute pollution free atmosphere and popularize the use of organics to reduce the dependence on chemical fertilizers. Integrated plant nutrient supply system involving chemical, organic and biofertilizers is an important utility option. Therefore, the, present study was undertaken to find out the effect of integrated use of biofertilizers, chemical fertilizer and vermicompost on qualitative and quantitative yield of pea (*Pisum sativum L.*).

Materials and Methods

A field experiment was conducted during winter (rabi) seasons of 2007-08 and 2008-09 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil of experimental field was Gangetic alluvial (Ustrochrept) having sandy clay loam texture with pH 7.42. It was moderate in fertility status being low in organic carbon (0.44%), available nitrogen (197.02 kg ha^{-1}), available sulphur (17.5 kg ha^{-1}) and medium in available phosphorus (19.07 kg ha^{-1}) and potassium (210.20 kg ha^{-1}). Available zinc (0.52 ppm) was below the critical limit. The experiment was laid out in a split – plot design with three replications. The treatments comprised of five fertility levels, viz. control (No fertilizer application), 100% IN, 100% ON, 100% IN + 50% ON and 100% ON + 50% IN allotted to main plot and three different treatments viz. biofertilizer (*Rhizobium* + *Bacillus* + *Peudomonas*), zinc and biofertilizer + zinc in addition to one control allocated to subplots. IN represents recommended dose of N, P, K, and S (40- 17- 16- 20 kg ha^{-1}) through inorganic fertilizers and ON represents recommended dose of N (40 kg ha^{-1}) through vermicompost. Urea, single super phosphate, muriate of potash, and zinc

sulphate were used as inorganic sources of N, P, K, sand zn.. As per treatment, full dose of nitrogen, phosphorus, potassium and zinc were applied as basal (just before sowing the crop). The sulphur requirement was met through SSP. Crop variety "HUDP- 15" was sown after seed inoculation with Rhizobium (*Rhizobium leguminosarum),* PSB (*Bacillus polymixa*) and PGPR (*Pseudomonas fluorescence*) @ 200g culture 10 kg^{-1} seeds as per treatments respectively . The crop was sown on 7th Nov. and 10th Nov. in the 2007-08 and 2008-9, respectively and harvested on 20th March, in the first year and 21st March, in the second year.

Results and Discussion

Yield and harvest index: The yield (grain and straw) increased significantly up to the 100% IN + 50% ON fertility level (Table-1). This envisages a direct role of nitrogen to seed growth and a guided help in minimizing osmotic imbalance present during final stage of grain filling (Kachot et al., 2001). Combined use of vermicompost and fertilizer might have enhanced the nutrient uptake vis- a vis yield (Rajkhowa et al., 2003). Even though the dose of applied nitrogen was same in 100% IN and 100% ON applied plots, lower yields were recorded in 100% ON applied plots. Probably, vermicompost (ON) alone could not provide all the necessary nutrient elements in adequate quantities at critical stages for proper growth and yield of peas. The mismatch between crop nutrient demand and supply potential from organic sources limits the plant growth (Pang and Letey, 2000). As it is grown in irrigated condition the beneficial effect of FYM with minerals is envisaged by its greater and longer availability of nitrogen as per the demand of the crop (Khanda and Mohapatra, 2003).The higher mean harvest index (Table 1) about 41.37% was recorded which was significantly superior to other treatments. Whereas, other treatments except control were at par to each other, this envisage similar rate of partitioning of dry matter under these fertility levels.

Seed inoculation resulted in higher yield over control. This may be attributed to increased nodulation, nitrogen fixation, more solubilization of native P and production of secondary metabolites by the bacteria. Biofertilizer (Rhizobium, Bacillus and Pseudomonas) have splendid prospects as N fixer and P solubilizer / mobilizer and plant growth promoters (Negi et al. 2007). Zinc application also contributed increase in grain yield probably owing to its influence on auxin synthesis, nodulation and N fixation, which in turn might have improved leaf–area index and photosynthesis, there by, favorably influencing grain yield (Kasturikrishna and Ahlawat, 2000). Application of micronutrient (zinc) along with the microbial inoculations might have a synergistic effect, which enhanced the quality of nitrogenase, supply of nitrogen by fixation for better growth and finally increased the yield and harvest index of the crop (Krouma and Abdelly, 2003).

Application of 50% nitrogen through vermicompost (50% ON) integrated with 100% IN (recommended dose of inorganic fertilizers) along with biofertilizer and zinc increased the grain yield by 38.59% and

Table 1: Effect of biofertilizer, vermicompost and inorganic fertilizers on yield, harvest index and B:C ratio of dwarf pea.

Treatment	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Harvest Index (%)		B:C ratio	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
A. Fertility Level								
Control (No application)	919	859	1565	1463	37.00	37.01	1.32	1.17
100% IN	1559	1461	2304	2157	40.34	40.38	2.22	2.02
100% ON	1383	1297	2060	1939	40.17	40.09	1.76	1.60
100% IN + 50% ON	1773	1661	2518	2342	41.28	41.46	2.32	2.10
100% ON + 50% IN	1590	1490	2338	2189	40.47	40.50	1.93	1.75
SEm ±	21	22	21	23	0.305	0.387	0.014	0.013
CD (P=0.05)	67	72	68	76	0.99	1.26	0.05	0.04
B. Biofertilizer + Micronutrient								
Control	1346	1261	2045	1912	39.51	39.55	1.82	1.73
Biofertilizer	1432	1342	2150	2012	20.81	39.73	1.75	1.86
Zn @ 5 kg ha^{-1}	1454	1362	2176	2038	21.07	39.82	1.87	1.78
Biofertilizer + Zn	1547	1450	2257	2110	21.84	40.35	2.00	1.91
SEm ±	9.7	9.2	13.4	13.8	0.094	0.166	0.005	0.008
CD (P=0.05)	28	27	39	40	0.260	0.48	0.02	0.02

I N= NPKS through inorganic fertilizer; ON = N through Vermicompost; Biofertilizer= Rhizobium + PSB + PGPR

38.89% in first and second year, respectively, over the application of 100% IN only (Table 2). The microbial population in vermicompost, in addition to the role of biofertilizer and production of chelating agents with the help of organic manures which form soluble complexes with Zn (Poonia, 1998) could be the reason for the favorable effect of integrated application of vermicompost, inorganic fertilizers, biofertilizer and zinc on grain yield of the pea (Singh and Rai, 2004).

Benefit: Cost ratio: Economics of different treatments showed that the highest B: C ratio was associated with 100% IN + 50% ON fertility level i.e. 2.32 and 2.10 during first and second years, respectively (Table 1) and was followed by the 100% IN. Combined application of biofertilizer and zinc also resulted in significantly higher B: C ratio.

Quality parameters: The grain protein content increased with 100% IN + 50% ON fertility level with maximum values (26.44% and 26.19%) in both the years respectively. This may be attributed to fortification of recommended dose of fertilizers with organic manures (Vermicompost) which helped in a more efficient translocation of nitrogen from the vegetative parts to the developing seeds as well as the synthesis of protein. Nitrogen, phosphorus, potassium, sulphur and zinc content influenced significantly due to adoption of integrated nutrient management practices and were relatively higher with 100% IN + 50% ON level (Table 3). Probably, balanced nutrients favoured the root proliferation by stimulating the cellular activities and translocation of certain growth stimulatory compounds to the roots. The organic manures in adequate amount along with balanced

Table 2: Interaction effect of treatments on grain yield (kg ha^{-1}) of dwarf pea

Bio. + Micronutrient	Fertility levels									
	First year (2007-08)					Second year (2008-09)				
	Control	100% IN	100% ON	100% IN +50% ON	100% ON + 50% IN	Control	100% IN	100% ON	100% IN + 50% ON	100% ON + 50% IN
Control	887	1394	1282	1649	1521	829	1306	1203	1543	1425
Biofertilizer	907	1532	1369	1762	1595	848	1436	1284	1648	1492
Zn @ 5 kg ha^{-1}	912	1635	1405	1751	1568	852	1532	1318	1638	1470
Biofertilizer + Zn	971	1675	1476	1932	1680	907	1569	1385	1814	1574
							SEm ±	CD (P= 0.05)	SEm ±	CD (P= 0.05)
Two sub plot means at the same main plot treatment							21.7	63	20.6	60
Two main plot means at same or different sub plot treatment							27.9	86	28.5	89

I N = NPKS through inorganic fertilizer; ON = N through Vermicompost; Biofertilizer = Rhizobium + PSB + PGPR

Table 3: Effect of biofertilizer vermicompost and inorganic fertilizers on protein and nutrient content in grain.

Treatment	Content in grain											
	Protein (%)		N (%)		P (%)		K (%)		S (%)		Zn (ppm)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09	2007-09	2008-09	2007-08	2008-09
A. Fertility Level												
Control (No application)	20.30	20.36	3.25	3.26	0.88	0.89	0.572	0.565	0.411	0.412	28.102	28.130
100% IN	24.75	24.88	3.96	3.98	1.263	1.283	0.743	0.733	0.447	0.448	29.435	29.470
100% ON	22.14	22.28	3.52	3.57	1.063	1.073	0.628	0.608	0.411	0.411	28.338	28.362
100% IN + 50% ON	26.44	26.19	4.23	4.19	1.320	1.338	0.793	0.763	1.457	0.457	29.757	29.724
100% ON + 50% IN	23.76	23.52	3.80	3.76	1.275	1.294	0.740	0.733	1.436	0.436	29.655	29.688
SEm ±	0.095	0.075	0.016	0.012	0.008	0.008	0.003	0.007	0.001	0.001	0.001	0.002
CD (P=0.05)	0.309	0.245	0.052	0.039	0.027	0.027	0.009	0.023	0.004	0.004	0.005	0.006
B. Biofertilizer + Micronutrient												
Control	21.81	21.81	3.49	3.49	1.078	1.093	0.662	0.646	0.421	0.421	28.350	28.350
Biofertilizer	23.74	23.61	3.78	3.78	1.186	1.202	0.690	0.674	0.432	0.432	28.637	28.659
Zn @ 5 kg ha^{-1}	23.39	23.38	3.74	3.74	1.122	1.138	0.702	0.688	0.433	0.433	29.122	29.145
Biofertilizer + Zn	24.98	24.98	4.00	3.99	1.252	1.268	0.726	0.712	0.445	0.445	30.120	30.144
SEm ±	0.135	0.141	0.021	0.023	0.005	0.006	0.003	0.004	0.0009	0.0009	0.003	0.003
CD (P=0.05)	0.39	0.407	0.061	0.065	0.016	0.016	0.008	0.012	0.003	0.003	0.009	0.01

I N = NPKS through inorganic fertilizer; ON = N through Vermicompost; Biofertilizer = Rhizobium + PSB + PGPR

fertilizer application that leads to extensive root system might have assisted the efficient absorption and utilization of other nutrient elements.

The protein content in grain increased significantly with seed inoculation over control which might be due to the increased availability of nutrients through Rhizobium PSB, PGPR and finally increased supply of nitrogen to sink or to increased N uptake and accumulation of assimilates in the grain which contributed to increase in protein content. Similarly, combined application of biofertilizer and zinc increased the content of all the nutrients is per seeds which might be due to synergy between biofertilizer and zinc. Improved translocation of proteins to grain under Zn application along with seed inoculation might be due to the beneficial effect of Zn in nitrogen assimilation, indirectly through its influence on the nitrate reductase activity and in nucleic acid metabolism (Nayar, 1990). Similarly, nutrient content in the grain increased with the combined application of biofertilizer and micronutrient which might be due to enhanced effect of Rhizobium by fixing more atmosphere nitrogen and solubilization of unavailable inorganic phosphate in soil by PSB and PGPR in facilitating the availability of nutrient for quite a longer period (Srivastava and Ahlawat, 1995). Bioinoculants have favourable influence on the addition and accumulation of N and P in soil whereby plants can accumulate more nutrients with increased growth and yield (Sonboir and Sarawgi, 1998).

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