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RESEARCH PAPER

Integrated nutrient management practices on growth and yield of field pea (*Pisum sativum* L.) under mid hill condition

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Abstract : A field experiment was conducted during two consecutive *Rabi* seasons of 2011-12 and 2012-13, to study the effect of various source of nutrient in combination with bio-fertilizers and PSB on growth and yield of field pea at Regional Research Station (Hill Zone), Kalimpong. The experiment was laid out in Randomized Block Design with three replications. The experiment comprised of thirteen treatment combinations. Results indicated that the combined application of 75 % RDF + 25% N through vermicompost (@1.90 tonn/ha) and seed inoculation with *Rhizobium* + PSB improved all the growth, yield attributes and yields of field pea. Plant height, number of leaves/plant, number of branches/plant, number of nodules/plant, fresh and dry weight of nodule/ plant were significantly varied with various treatments and was maximum with full dose of RDF along with *Rhizobium* and PSB combination and showed parity with 75% RDF + vermicompost + *Rhizobium* + PSB . Number of seeds/pod, number of pods/ plant and other yield attributing characters significantly more with 75% RDF + vermicompost + *Rhizobium* + PSB. Maximum grain yield was registered with full dose of RDF along with *Rhizobium* and PSB (26.74 q/ha) and remained at par with 75% RDF + vermicompost + *Rhizobium* + PSB (25.08 q/ha). Increase in grain yield in the tune of 135.2 and 120.7 % more with RDF + *Rhizobium* + PSB and 75% RDF + vermicompost + *Rhizobium* + PSB, respectively over control. Economics revealed that highest benefit cost ratio was registered with 75% RDF + vermicompost + *Rhizobium* + PSB (2.62) and was closely followed by full dose of RDF along with *Rhizobium* and PSB (2.50). Therefore, it can be suggested that to obtain the maximum grain yield and net profit from field pea, seed should be inoculated with *Rhizobium* + PSB in addition to 75 % RDF + 25 % nitrogen through vermicompost.

Key Words : Field pea, PSB, *Rhizobium*, Vermicompost, Yield

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INTRODUCTION

Field pea (*Pisum sativum*) derives from the Middle East and was first cultivated roughly 10,000 years ago (Mithen, 2003). Field pea is a cool-season legume crop that is grown on over 25 million acres worldwide. In north eastern Himalaya field pea or dry pea 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 low in cereal grains and contains approximately 21-25 per cent protein. Being a legume crop and 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 (Schatz and Endres, 2009). This is also as summer crop in high altitude zone of Darjeeling district. Field pea ability to use the atmospheric nitrogen through biological nitrogen fixation (BNF) is economically sound and environmentally acceptable (Saikia and Jain, 2007).

In hill agriculture biofertilizer act as important role in increasing fertilizer use efficiency and ultimately influence crop productivity. Bio-fertilizer or microbial inoculants can be generally defined as preparation containing live or latent cells of efficient strains of nitrogen fixing and phosphate solubilizing micro-organism used for treatment of seed or soil. They are composting the area with the objective of increasing the number of such micro organisms and accelerate microbial process to augment the extant of the availability of the nutrient in a form which can easily assimilated by plant (Subba Rao, 1986). It has been established that inoculation of seed with *Rhizobium* increases the seed yield over the un-inoculted seeds. The *Rhizobium* as fertilizer in pulses could fix 50-200 kg of N/ha/season and is able to meet 80-90 per cent of the crop requirement for nitrogen. Inoculation in these crops was found to increase the crop yield by about 10-15 per cent under on farm conditions (Khurana and Dudeja, 1997). *Rhizobium* improves soil fertility and is a very cost effective method of nitrogen management in leguminous crops. Most of the soils in Darjeeling hill are poor in phosphorus due to phosphate fixation as acidic soil in nature. Therefore, use of phosphate solubilizing bacteria (PSB) may enhance availability of phosphorus in soil and its use by plant (De and Singh, 2010) PSB is a group of beneficial bacteria capable of hydrolysing organic and inorganic phosphorus from insoluble compounds. P-solubilization ability of the microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition.

Different source of organic nutrient are available in plenty in hills of Darjeeling. Farmer generally uses organic manure from their local available sources to different crops. FYM (farmyard manure) although not useful as a sole source of nutrients, is, however, a good complementary and supplementary source with mineral fertilizer (Chandhary *et al*., 2004). It has been observed from the past experiment that vermicompost also play vital role in improving crop productivity and also enrich the soil by enhancing water holding capacity (Mukherjee, 2010). Keeping the facts in consideration, the present investigation was under taken to estimate the effect of different source of nutrient along with bio-fertilizers (*Rhizobium* and PSB) on growth, yield attributes and economics of field pea.

MATERIAL AND METHODS

The present experiment was conducted during *Rabi* season of 2011-12 and 2012-13, with a view to find out the effect of different source of nutrient either alone or in combination with bio-fertilizers on growth and yield of field pea at Regional Research Station (Hill Zone) under the aegis of Uttar Banga Krishi Viswavidyalay, Kalimpong with an altitude of 1250 m asl. The soil was sandy loam in texture, high in organic carbon (0.73%), available N (239.5 kg/ha), P_2O_5 (22.7 kg/ha) and K_2O (116.9 kg/ha) content with pH 5.4. The experiment was laid out in a Randomized Block Design with three replications. The treatments comprised of 13 treatment combinations as in Table 1. The total rainfall recorded during crop growth period was 17.3 and 13.5 mm, minimum temperature ranges from 1.4 to 11.6 and 3.7 to 15.9, and maximum temperature 16.2 to 28.4 and 16.7 to 31.9^0 C during winter 2011 and 2012, respectively. Sowing of inoculated seed as per treatment of fieldpea (*Pisum sativum* L.) variety VL 40 was done in furrows at 22.5 cm apart using seed at 70 kg/ha. Recommended dose of fertilizer (RDF) 30:60:40 kg/ha N:P:K as per treatments was incorporated into the field at the time of sowing. Well rotten FYM (@ 3 tonn/ha) and vermicompost (@1.90 tonn/ha) were applied as per treatment for fulfillment of 25 per cent nitrogen demand. This was incorporated before sowing. For inoculation, 10 per cent sugar solution was prepared by dissolving 100 g sugar in 1 litre water and heated for 20-25 min. The solution was cooled at room temperature and mixed with culture treatment wise. The pea seed were inoculated (1 kg +10 g culture) with the solution and then dried under shade before sowing. The irrigation was given and other recommended packages of practice were adopted during the crop growth period in both the years. Data on growth pattern were taken at 90 days after sowing and yield components and yield were recorded as per normal procedure during the harvest. The effect of treatments was evaluated on pooled analysis basis on growth, yield attributes and yields. For working out the economics, prevailing market prices for pea seeds (Rs. 27.50/kg), urea (Rs. 9.15/kg), SSP (Rs. 13.60/kg), MOP (Rs. 7.75/kg) and cost of labour (Rs. 112.50 /day) were considered.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth characters :

Data presented in Table 1 indicate that the plant height was significant, with doses of fertilizers along with various nutrient combination, similar findings was also reported by Bisen *et al*. (1985). Maximum plant height was observed with full dose of RDF along with *Rhizobium* and PSB combination and significantly superior to the rest of the tested treatments combination. Number of leaves/plant was significantly higher with the treatment received full dose of RDF along with *Rhizobium* and PSB (14.11), and was followed by RDF + *Rhizobium* (13.92). Number of branches/plant was recorded significantly higher with 75% RDF + vermicompost + *Rhizobium* + PSB (5.60) and was remained at par with RDF + *Rhizobium* + PSB (5.11), RDF (4.92), 75% RDF + vermicompost + *Rhizobium* (4.87) and RDF + *Rhizobium* (4.86). Number of nodules/ plant was recorded significantly maximum of 35.47 at 75% RDF + vermicompost + *Rhizobium* + PSB and showed parity with RDF + *Rhizobium* + PSB (33.66). However, least nodule formation was recorded with control (17.26). Fresh weight of nodule was more with 75% RDF + vermicompost + *Rhizobium* + PSB and was significantly better then rest of the treatment combinations. This was followed by 75% RDF + vermicompost + *Rhizobium* and RDF + *Rhizobium* + PSB treatment combination. Dry weight of nodules/plant showed significant response and due to various treatment combinations. This was reported to be maximum of 56.64 mg at 75% RDF + vermicompost + *Rhizobium* + PSB and significantly superior to rest of the treatment combination. This was followed by 75% RDF + FYM + *Rhizobium* + PSB (54.98 mg) and RDF + *Rhizobium* + PSB (52.12 mg). The effect of variation in fertility levels by combination of biofertilizer and PSB on number and dry weight of nodules/plant also corroborate the results of Solaiman and Rabbani (2006) and Maurya and Prasad (1998).

Yield attributes :

Table 2 revealed that all the yield attributing characters were statistically influenced by various tretmets combinations. Length of pods at maturity was recorded significantly higher with 75% RDF + vermicompost + *Rhizobium* + PSB (7.92cm) and showed parity with RDF + *Rhizobium* + PSB (7.72 cm), RDF + *Rhizobium* (7.36 cm) and 75% RDF + vermicompost (6.71cm). Amongst the treatments least of pod length was recorded with 75% RDF + FYM + PSB and showed parity with control, which had lowest pod length recorded. Number of pods/plant at harvest was recorded considerably more of 20.92 at RDF + *Rhizobium* + PSB, and being at par with 75% RDF + vermicompost +

Table 1 : Effect of treatments on growth parameters of field pea (pooled data of 2 years)

Treatments	Plant height (cm)	Leaves/ plant (no.)	Branches/ plant (no.)	Nodules/ plant (no.)	Fresh weight of nodules/ plant (mg)	Dry weight of nodules/ plants (mg)
Control	38.11	11.23	2.96	17.26	213.98	23.94
RDF	43.94	13.01	4.92	30.56	311.19	41.67
75% RDF + vermicompost	42.77	10.82	2.40	24.63	291.61	39.49
75% RDF + farm yard manure	40.11	10.62	2.36	23.11	264.92	36.93
RDF + *Rhizobium*	45.26	13.92	4.86	30.71	314.11	50.97
RDF + PSB	43.30	12.91	4.80	27.11	281.64	45.03
RDF + *Rhizobium*+PSB	46.74	14.11	5.11	33.66	322.31	52.12
75% RDF + vermicompost + *Rhizobium*	43.11	10.28	4.87	30.61	337.84	46.98
75% RDF + vermicompost + PSB	42.07	11.82	3.15	26.25	309.91	40.11
75% RDF + vermicompost + *Rhizobium* + PSB	45.63	12.32	5.60	35.47	384.33	56.64
75% RDF + FYM+ *Rhizobium*	41.00	10.52	4.49	25.13	298.45	44.11
75% RDF + FYM + PSB	39.46	9.13	2.96	24.22	271.64	38.92
75% RDF + FYM + *Rhizobium*+PSB	42.27	11.39	3.95	31.23	281.92	54.98
S.E. ±	0.32	0.10	0.33	0.37	2.56	0.69
C.D. (P=0.05)	0.94	0.29	0.98	1.10	7.46	2.01

Rhizobium + PSB (19.63). This was followed by treatment which received 75% RDF + vermicompost + PSB (16.08), however, least of number of pods/plant was registered with control (10.72). Number of seeds/pod at maturity was recorded significantly highest of 6.98 at 75% RDF + vermicompost + *Rhizobium* + PSB, and remained at par with RDF + *Rhizobium* + PSB (6.07), RDF + PSB (6.46), RDF + *Rhizobium* (6.01) and 75% RDF + vermicompost (5.91). Amongst various treatment combinations least of seeds/pod was observed with 75% RDF + FYM + *Rhizobium* (4.14), which was closely followed, by control (4.13). Test weight also varied significantly with various treantment combinations and it was statistically highest of at 100% RDF + *Rhizobium* + PSB combination (194.68 g), and was at par with 75% RDF + vermicompost + *Rhizobium* + PSB (188.72 g). These results are in harmony with those reported by Negi *et al.* (2007).

Yield parameters :

Significantly maximum grain yield of 26.74 q/ha was obtained under RDF + *Rhizobium* + PSB and was statistically at par with 75% RDF + vermicompost + *Rhizobium* + PSB (25.08 q ha^{-1}), RDF + *Rhizobium* (23.71 q/ha), RDF (22.89 q/ha) and 75% RDF + vermicompost + *Rhizobium* (22.71 q/ha). However, least grain yield was recorded with control (11.36 q/ha), and was followed by 75% RDF + FYM (15.91 q/ha) (Table 2). Further our study revealed that 135.2 and 120.7 % more grain yield with RDF + *Rhizobium* + PSB and 75% RDF + vermicompost + *Rhizobium* + PSB, respectively over control. Control showed significantly poor performance due to decease in all yield attributing characters which influence ultimately yield, compared to rest all other tested treatment. Straw yield was recorded significantly more with the application of 75% RDF + vermicompost + *Rhizobium* + PSB (30.12 q/ha) and was at par with RDF + *Rhizobium* + PSB (29.10 q/ha) and RDF +PSB (27.99 q/ha). Similar finding was also reported by Chanda *et al.* (2002) and Mishra *et al*. (2010). Amongst various treatments lowest straw yield was found with 75% RDF + FYM + *Rhizobium* and was at par with control, which produced lest straw yield per unit area. Similar work related to the field pea was also done by Singh *et al*. (2011); Singh *et al*. (2014); Basaiwala *et al*. (2013) and Chaudhry *et al*. (2014).

Economics :

Economics revealed that application of 100% RDF + *Rhizobium* + PSB (Rs. 43,518/ha) gave maximum gross income, which was followed by 75 % RDF + vermicompost + *Rhizobium* + PSB Rs. 40,612/ha, and lowest was recorded with control (Rs. 30,276/ha) (Table 2). Net return was noted higher by a margin of Rs. 26,113/ha with 100% RDF + *Rhizobium* +PSB over Rs. 25,139 and 13,421/ha at 75% RDF + vermicompost + *Rhizobium* + PSB and control. The highest B:C ratio of 2.62 was

Table 2 : Effect of treatments on yield attribute, yield and economics of field pea (pooled data of 2 years)

Treatments	Yield attributes				Yield (q/ha)		Economics(Rs./ha)		
	Pod length (cm)	Pods/plant (no.)	Seeds/ pod	1000 grain weight (g)	Grain	straw	Gross income	Net return	B:C ratio
Control	4.07	10.72	4.13	121.11	11.36	15.02	30276	13421	1.70
RDF	5.71	17.93	5.91	167.43	22.89	24.11	41164	24284	2.43
75% RDF + vermicompost	6.71	14.98	5.63	112.93	15.91	20.98	38120	21784	2.33
75% RDF + farm yard manure	5.45	14.10	5.43	108.62	14.01	18.33	37109	17242	1.86
RDF + *Rhizobium*	7.36	14.36	6.01	168.41	23.71	24.11	42074	25019	2.46
RDF + PSB	5.46	15.12	6.46	159.42	21.11	27.99	42842	20084	1.88
RDF + *Rhizobium* + PSB	7.72	20.92	6.07	194.68	26.74	29.10	43518	26113	2.50
75% RDF + vermicompost+*Rhizobium*	4.99	16.08	5.36	166.11	22.71	22.71	38781	21912	2.29
75% RDF + vermicompost + PSB	4.36	18.36	4.96	151.33	19.05	22.70	39112	16921	1.76
75% RDF + vermicompost+*Rhizobium* + PSB	7.92	19.63	6.98	188.72	25.08	30.12	40612	25139	2.62
75% RDF + FYM+ *Rhizobium*	4.66	11.36	4.14	153.12	19.17	18.10	37943	19241	2.02
75% RDF + FYM + PSB	4.77	11.53	4.94	133.11	16.19	19.36	38121	14392	1.60
75% RDF + FYM + *Rhizobium* + PSB	5.10	16.32	5.76	162.25	19.81	21.09	39192	20914	2.14
S.E. ±	0.45	0.63	0.37	2.35	1.41	1.72			
C.D. (P=0.05)	1.32	1.82	1.09	6.86	4.11	5.01			

calculated under 75% RDF + vermicompost + *Rhizobium* + PSB followed by 2.50 and 1.70 at RDF + *Rhizobium* + PSB and at control, respectively Singh *et al.* (2014) and Chaudhary *et al.* (2014) .

Overall it can be concluded that obtaining maximum grain yield as well as profit from field pea (cv. VL 40), seed should be inoculated with *Rhizobium* + PSB before sowing, in addition to vermicompost along with the 75 per cent recommended dose of fertilizer.

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