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Effect of soil amelioration, inorganic, organic and bio-fertilizer application on yield, quality and economics of snow pea (*Pisum sativum* L. var. *macrocarpon*)

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ABSTRACT

An experiment was conducted successively during rabi season of 2011-12 and 2012-13 to assess the effects of lime, vermicompost, two levels of inorganic fertilizers and bio-fertilizers on growth, yield and quality of Snow pea (Pisum sativum L. var. macrocarpon) in the College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar. The yield components and yield of snow pea were recorded highest in 100% NPK (RDF) + biofertilizer+ vermicompost+ lime (T_6) followed by 75% NPK + biofertilizer+vermicompost+lime (T_9) and the least was in control. There was 8.88% yield increase in T_6 over T_9. Application of lime along with 100% NPK gave better result than without lime. The least growth and yield was noticed in control. Although yield characters showed marked superiority in plants applied with 100% RDF integrated with vermicompost and biofertilizers in presence of lime but reducing 25% RDF and integrating with vermicompost and biofertilizers in presence of lime enhanced the quality parameters like T.S.S. (10.48° Brix) and total sugar content of pod (4.36%). A net profit of Rs.72712.50 per hectare from the snow pea over an investment of Rs.83107.50 with a benefit-cost ratio of 1.87: 1 was obtained with 100% RDF along with biofertilizers and vermicompost in presence of lime.

Keywords: Amelioration, bio-fertilizer, economics, quality, snow pea

Snow/Chinese peas (*Pisum sativum var macrocarpon* L.) cv. Swarna Tripti are edible podded peas. These nutritious and fibreless fresh green pods are consumed as sweet salad or as cooked vegetable. Thin-walled and fibreless (lack of parchment) green pods are harvested when they are sufficiently flat, but prior to seed development. As they consumed as a whole, they have relatively high content of dietary fiber. Fresh pods have 150% higher vitamin C content than the garden peas. Chemical fertilizers are needed to get good crop yields, but their abuse can be harmful for the environment and their cost cannot make economic agricultural products (Bobade *et al*.1992).The increased use of chemicals under intensive cultivation has not only contaminated the ground and surface water but has also disturbed the harmony existing among the soil, plant and microbial population (Bahadur *et al*.2006). Bio-fertilizers on the other hand are cost-effective and renewable source of plant nutrients to supplement partly chemical fertilizers. A judicious use of organic manures and biofertilizers may be effective for not only sustaining crop productivity and soil health, but also in supplementing chemical fertilizers of crop. (Jaipal *et al.* 2011, Roy and Hore , 2012).

The acid soils are abundant in Al, Fe, Mn. Pea dose not thrive well in acidic soils. Liming of acid soils increases crop yield through reducing the phytotoxicity of Al, Fe, Mn, increasing nitrogen and phosphorus availability and improving the overall environment of soil.

Thus, the present investigation aimed to assess the effect of integrated application of bio-fertilizer and inorganic fertilizer on Snow pea in terms of yield and quality parameters and to recommend a cost effective suitable combination of biofertilizers vis-à-vis inorganic fertilizer for greater economic return from Snow pea cultivation.

MATERIALS AND METHODS

The present investigation was done with snow pea var. Swarna Tripti during the year 2011-12and 2012-13 in the research plots of Department of Soil Science and Agricultural Chemistry, College of Agriculture, Orissa University of Agriculture and Technology (O.U.A.T.), Bhubaneswar, located on 22º15' North latitude, 80º22' East longitude and 25.5 m above sea level. The precipitation during the cropping period was about 101.4 mm and 209.3 mm which were received between October, 2011 to March, 2012 and October, 2012 to March, 2013 respectively. The maximum temperature observed during the cropping period was 37.4 °C (2011-2012) and 37.8 °C (2012-2013).

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The experiment was conducted on sandy loam soil with pH 5.78, organic carbon 0.59%, available N, P_2O_5 and K_2O was 272, 37 and 254 kg ha^{-1} respectively. The experiment consisting of nine treatments was laid in randomized block design with three replications in plot size of 3.96 m^2. The treatments included T_1 - control, T_2 - 100% NPK (50:60:40 kg ha^{-1}), T_3 - 100% NPK + lime (5q ha^{-1}), T_4 - 100% NPK + lime + vermicompost (5 t ha^{-1}), T_5 - 100% NPK + lime + Bio-fertilizer *(Azospirillum* + PSB + *Rhizobium* @ 4 kg each ha^{-1}), T_6 - 100% NPK + lime + vermicompost + biofertilizer, T_7 - 75% NPK + lime + cermicompost (5 t ha^{-1}), T_8 - 75% NPK + lime + bio-fertilizer (*Azospirillum* + PSB + *Rhizobium* @ 4 kg each ha^{-1}) and T_9- 75% NPK + lime + vermicompost + biofertilizer. The culture of biofertilizer were incubated in 100 kg of processed well decomposed FYM and applied to the plots after sowing of seeds as per the treatments. All the cultural operations were followed which were necessary to raise a good crop of snow pea.

Observations on characters like pod yield (t ha^{-1}), quality parameters and concentration of nutrients were recorded in each replication of all the treatments in both the years. Economics of the treatment was calculated as per prevailing market price of input and produce. Benefit-cost ratio, which represents the return per rupee invested, was worked out for different treatments by dividing the gross return with corresponding cost of cultivation.

RESULTS AND DISCUSSION

Pod yield

Maximum yield of 12.99 t ha^{-1} (pooled) was obtained (Table – 1) at 100% recommended dose of chemical fertilizers along with vermicompost and biofertilizers in presence of lime. This was significantly higher than other treatments including control (3.84 t ha^{-1}). The increase in yield might be due to the better performance of yield attributes as these have a positive influence on the yield. As regards the impact of integrated fertilizer management, it could be concluded that integrated application of inorganic (100% or 75% RDF), organic (vermicompost) and biological sources (biofertilizers) significantly increased the green pod yield per plant over the control and sole application of inorganic fertilizers. This might be attributed to the gradual and steady release of both macro and micro nutrients from vermicompost and biofertilizers, which might have helped in the plant metabolic activity, resulting in early vegetative growth. The increased vegetative growth of plant and balanced carbon to nitrogen ratio of soil and increased synthesis of carbohydrates, in turn increased the crop yield Similar results have been reported by Negi *et al.*, 2006, Ganie *et al.* (2009), El-Shaikh *et al.* (2010), Jaipaul *et al*.(2011) in pea.

Total Soluble Solids (T.S.S.) and Total sugar

Appreciable variation in the quality characters of snow pea pods was observed due to the application of different treatments combined with chemical fertilizers, bio-fertilizers, vermicompost and lime. Addition of vermicompost and bio-fertilizers improved the quality characters like total sugar and T.S.S. contents of the pod. The sugar content was found maximum (4.36 per cent) in T_9 (75% NPK + vermicompost + bio-fertilizer+lime) followed by T_6 (100% NPK + vermicompost + Bio-fertilizer + lime) and the lowest sugar content was found in control (3.77 per cent). Ramdan (1997) reported that the inoculation of pea seeds with *Rhizobium* significantly increased the carbohydrate and T.S.S. contents. Significant decrease in sugar content with increase in level of nitrogen was also marked by Mishra *et al.* (1990).

Crude protein (%)

The beneficial effects of bacterial inoculation on increased protein content and elemental nutrition might have been due to the supply of high amount of nitrogen available to the growing tissue and organs supplied by nitrogen fixing *Azotobacter*, *Azospirillum* and *Rhizobium*. The inorganic fertilization treatment produced the lowest crude protein content, when compared with other treatments. Chemical fertilizers had supplied higher amount of nitrate, phosphate and potash, which significantly increased the plant growth. The protein content of pod was maximum (30.47 per cent) in T_6 treatment (100 % RDF + vermicompost @5 t ha^{-1} + bio-fertilizer + lime). The inorganic source of NPK increases the metabolic activity. Similar observations were also reported by Ramadan (1997), Achakzai and Bangulzai (2006) and Susheela *et al.* (2007) for pea. The synergistic effect of phosphorus and organics which cause availability of more phosphorus, increasing root growth and nodulation resulting in increase in nitrogen and protein content in green pod.

Concentration of nutrients

The effects of inorganics, organics and bio-fertilizers on N, P, K, Ca and Mg contents of pea plants were presented in Table - 2. It was evident from the data that application of optimal dose of chemical

fertilizers with vermicompost and bio-fertilizers favoured significantly N, P, K, Ca and Mg contents in pea plants as compared to control.

Further it could be concluded that a marked superiority of N (4.88 per cent), P (0.80 per cent) and K (1.93 per cent) contents in pods are notable in 100% NPK and vermicompost used in conjunction with mixtures of three bio-fertilizers in limed plot which came in the first rank, followed by sub optimal dose of NPK + lime + vermicompost + inoculation with mixture of three biofertilizers. Sarg and Hassan (2003) and Solieman *et al.* (2003) reported that Nitrogen, Phosphorus and Potassium contents in leaves of pea significantly increased with *Rhizobium* as compared with the control.Results are further in harmony with those reported by EI- Neklawy *et al.* (1985), Abdel-Gafar Mohamed (1992), Ramadan (1997) and Ahmed (1999) for pea.

Economics

Integrated nutrient management practices with organics and bio-fertilizers exhibited noticeable influence in the economics of snow pea (Table - 3) cultivation comprising cost of cultivation, gross income, net income and B: C ratio during both the years of experimentation (2011-12 and 2012-13).

Maximum involvement of cost was marked when 100% recommended dose of inorganic fertilizers along with vermicompost and bio-fertilizers were applied in limed plot (Rs. 83107.50) and the lowest was in control (Rs. 44357.50) receiving neither chemical fertilizer nor organics. Combined use of 100% NPK with vermicompost and bio-fertilizers in limed plot recorded the highest gross return of (Rs.155820) where as the lowest gross return was obtained where no nutrients were applied (Rs. 46020). The higher gross return is mainly due to higher total green pod yield.

The highest net return of Rs. 72712.50 (mean of two years) was calculated by applying 100% NPK with vermicompost and biofertilizers in limed plot as compared to other treatments in the experiments. However, the lowest net return for both the years was calculated to be Rs.1662.50 (mean of two years in control). This might be due to application of chemical fertilizers alone. Thus the analysis indicated that application of 100% of recommended dose with inoculation of bio-fertilizers and vermicompost recorded significantly higher yield which resulted in higher economic return.

Chemical fertilizers can produce a good yield but application of inorganics along with organics like vermicompost and biofertilizers can also achieve the yield target under better management practices. Simultaneously, the organic manures are locally available, eco-friendly and helpful in sustaining the soil health. The optimal or sub optimal dose of

Table 1: Effect of soil amelioration, inorganic and bio-fertilizers on pod yield and quality of snow pea (pooled of two years)

	Treatments	Pod yield (t ha^{-1})	Quality parameters		
			T.S.S. (^{o}Brix)	Total sugar content of pods (%)	Crude protein content (%)
T_1	Control (only FYM given)	3.84	8.15	3.77	17.59
T_2	100% RDF	5.67	8.38	3.93	19.06
T_3	100% RDF + lime	6.94	8.55	4.00	19.59
T_4	100% RDF + vermicompost+ lime	10.39	9.05	4.12	25.63
T_5	100% RDF + bio-fertilizer	7.85	8.75	4.06	25.69
T_6	100% RDF + cermicompost + bio-fertilizer + lime	12.99	10.00	4.19	30.47
T_7	75% RDF + cermicompost+ lime	8.44	9.55	4.18	24.53
T_8	75% RDF + bio-fertilizer+ lime	7.37	9.28	4.14	20.69
T_9	75% RDF + cermicompost + bio-fertilizer + lime	11.93	10.48	4.36	29.53
	SEm(±)	**0.08**	**0.05**	**0.02**	**0.15**
	LSD(0.05)	**0.25**	**0.15**	**0.07**	**0.45**

Table 2: Effect of treatments on nutrient concentration of snow pea (pooled of two years)

	Treatments	Nutrient concentration in pod (%)					Nutrient concentration in vine (%)				
		N	P	K	Ca	Mg	N	P	K	Ca	Mg
T_1	Control (only FYM given)	2.82	0.37	1.18	0.019	0.07	0.75	0.04	2.12	0.75	0.11
T_2	100% RDF	3.05	0.43	1.29	0.033	0.09	0.86	0.06	2.19	0.99	0.14
T_3	100% RDF+ lime	3.14	0.46	1.32	0.039	0.11	0.92	0.08	2.31	1.03	0.16
T_4	100% RDF + vermicompost+ lime	4.11	0.48	1.48	0.048	0.15	1.16	0.12	2.55	1.24	0.23
T_5	100% RDF + bio-fertilizer	3.63	0.54	1.51	0.055	0.15	1.18	0.13	2.52	1.21	0.21
T_6	100% RDF + vermicompost+ bio-fertilizer + lime	4.88	0.80	1.93	0.081	0.26	1.33	0.19	2.76	1.32	0.31
T_7	75% RDF + vermicompost + lime	4.10	0.56	1.57	0.065	0.18	1.07	0.11	2.31	1.19	0.16
T_8	75% RDF + bio-fertilizer+ lime	3.31	0.48	1.36	0.061	0.21	1.10	0.10	2.40	1.16	0.16
T_9	75% RDF + vermicompost + bio-fertilizer + lime	4.73	0.62	1.85	0.073	0.23	1.20	0.14	2.72	1.25	0.26
	SEm(±)	**0.02**	**0.01**	**0.01**	**0.001**	**0.002**	**0.03**	**0.01**	**0.03**	**0.03**	**0.01**
	LSD(0.05)	**0.07**	**0.03**	**0.04**	**0.003**	**0.006**	**0.08**	**0.02**	**0.08**	**0.09**	**0.04**

chemical fertilizers along with vermicompost and biofertilizers in presence of lime resulted higher pod yield besides improving pod quality, concentration of nutrients in pods and economics of the crop than in control and 100%NPK alone. Therefore integrated use of organic manures and biofertilizers and inorganic fertilizers can be a tool to boost the production of snow pea.

Table 3: Economics of different treatments on snow pea cultivation pooled data over 2011-12 and 2012-13

	Treatments	Total expenditure* (Rs.)	Gross return (Rs.)	Net return (Rs.)	Benefit-cost ratio
T_1	Control (only FYM given)	44357.50	46020	1662.50	1.04
T_2	100% RDF	50187.50	68040	17852.50	1.36
T_3	100% RDF+ lime	52687.50	83220	30532.50	1.58
T_4	100% RDF + vermicompost+ lime	82687.50	124680	41992.50	1.51
T_5	100% RDF + bio-fertilizer	53107.50	93240	40132.50	1.76
T_6	100% RDF +vermicompost+ bio-fertilizer + lime	83107.50	155820	72712.50	1.87
T_7	75% RDF +vermicompost+ lime	81236.50	101280	20043.50	1.25
T_8	75% RDF + bio-fertilizer+ lime	51656.50	88380	36723.50	1.71
T_9	75% RDF + vermicompost+ bio-fertilizer+ lime	81656.50	143160	61503.50	1.75

** Cost of fertilizers and other inputs + Cost of cultivation excluding inputs (Labour cost)*

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