Plant Archives Vol. 16 No. 2, 2016 pp. 715-718 *ISSN 0972-5210*

EFFECT OF SOIL AMELIORATION, BIO-FERTILIZATION AND INORGANIC APPLICATION ON YIELD, SOIL HEALTH AND NUTRIENT UTILIZATION OF SNOW PEA (*PISUM SATIVUM* L. VAR. *MACROCARPON*)

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Abstract

A field experiment was conducted during *rabi* season 2011-12 and 2012-13 to assess the effects of soil amelioration, bio-fertilization and inorganic application on growth, yield and quality of snow pea (*Pisum sativum* L. var. *macrocarpon*) in college of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha (India) by taking two levels of chemical fertilizers, vermicompost, bio-fertilizers and lime in different combinations. The highest yield of snow pea was recorded in 100% NPK + bio-fertilizer + vermicompost + lime followed by 75% NPK + bio-fertilizer + vermicompost + lime over control, which recorded yield (11.30%) increase on former treatment over the latter. Application of lime along with 100% NPK gave better result than lone application of 100% NPK. The least growth and yield was noticed in control treatment. The pod yield (12.99 t ha^{-1}) and dry matter production of vine (53.60 q ha^{-1}) and pod (19.98 q ha^{-1}) increased significantly due to maximum utilization of N, P and K nutrients from different sources in the treatment T_6 (100% NPK + bio-fertilizer + vermicompost + lime). The combined effect of inorganics and organics along with bio-fertilizers in presence of lime on soil available NPK, NPK uptake apparent recovery of nutrients in pod was found significantly higher as compared to other treatments.

Key words : Soil health, nutrient utilization, snow pea, intensive cultivation.

Introduction

Snow/Chinese peas (*Pisum sativum* var *macrocarpon* L.) cv. Swarna Tripti is an edible podded pea. 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. The crop can be grown from October to March in the eastern region of the country. Snow peas feature comparatively lesser calories than green-shelling peas. 100 g pods provide just 42 calories against 81 calories of green peas. However, the pods are rich in vitamins, minerals and other plant nutrients than the traditional shelling peas. When consumed whole, they provide relatively high content of dietary fiber. Fiber diet helps reduce blood cholesterol levels, obesity, and constipation. Fresh pods contain 150% more amounts of vitamin C than in garden peas. Besides maintaining soil fertility through biological nitrogen fixation in association with symbiotic rhizobium prevalent in their root nodules and thus play a vital role in sustainable agriculture (Negi *et al*., 2006).

Chemical fertilizers are needed to get good crop yields, but their abuse can be harmful for the environment (Bobade *et al*., 1992). The increased use of chemicals under intensive cultivation has not only contaminated the ground and surface water but has also distributed 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 the parts of chemical fertilizers. A judicious use of organic manures and bio-fertilizers may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizers of crop (Jaipaul *et al.*, 2011).

The acid soils are abundant in phytotoxic Al, Fe, Mn. Pea dose not thrive well in acidic soil thus addition of lime slightly increased NO_3-N and bulk density of soil, lowered exchangeable stability. Reduced soil acidity and exchangeable Al, in conjunction with increased NO_3-N

and P contributed to increased crop yield by liming.

Literatures on the effect of bio-fertilizers on Snow pea/snap pea crop in Odisha is scanty. No systematic package of practice has been generated scientifically till now for this crop. Keeping the above background in view the present study "Effect of soil amelioration, bio-fertilization and inorganic application on growth, yield and quality of snow pea (*Pisum sativum* L. var. *macrocarpon*)" was undertaken in the campus of College of Agriculture, Odisha University of Agriculture& Technology, Bhubaneswar during *Rabi* season of 2011-12 & 2012-13 consecutively to study the effect of integration of bio-inoculation with chemical fertilization on yield, nutrient uptake and their recovery by snow pea and post-harvest soil properties.

Materials and Methods

The present investigation was done with snow pea var. Swarna Tripti during the year 2011-12 and 2012-13 in the research plots of Department of Soil Science and Agricultural Chemistry, College of Agriculture, O.U.A.T., Bhubaneswar which is located on $22^0$15' North latitude, $80^0$22' 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^{o}C (2011-2012) and 37.8^{0}C (2012-2013).

The experiment was conducted on sandy loam soil with pH 5.78, organic carbon 0.59%, available N, P and K 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 (only FYM was given), **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 @ 4Kg ha^{-1}), **T_6**-100% NPK + Lime + Vermicompost + Bio-fertilizer, **T_7**- 75% NPK + lime + Vermicompost (5 t ha^{-1}), **T_8**-75% NPK + lime + Bio-fertilizer (Azotobactor + Azospirillum + PSB + Rhizobium @ 4Kg ha^{-1}) and **T_9**-75% NPK + Lime + Vermicompost + Bio-fertilizer. The culture of bio-fertilizer 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}), dry matter content, nutrient uptake and apparent recovery of nutrient by the pod and post harvest soil properties were recorded in each replication of all the treatments in both the years.

Results and Discussion

Pod yield

Maximum yield of 12.99 t ha^{-1} (pooled) was obtained by using 100% recommended dose of chemical fertilizers along with vermicompost and bio-fertilizers in presence of lime was significantly higher than other treatments including control. The increase in yield might be due to the better performance of yield attributes as these attributes have a positive influence on the yield. The possible reason for this increase may be the solubilization effect of nutrient as well as chelating effect of bio-fertilizers and organic source on metals, thereby the availability of nutrients to the plant got increased.

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 (bio-fertilizers) 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 bio-fertilizers, which might have helped in the plant metabolic activity, resulting in early vegetative growth. The increased vegetative growth, balanced C/N ratio and increased synthesis of carbohydrates, in turn increased the crop yield.

Similar results has been reported by Negi *et al.* (2006), Ganie *et al.* (2O09), El-Shaikh *et al.* (2010), Jaipaul *et al*. (2011) in pea.

Dry matter content

The dry matter as observed in course of experimentation was maximum when the snow pea received nutrient sources in an integrated manner at optimal recommended dose**.** maximum dry matter content of vine was also recorded in **T_6** (53.60 q ha^{-1}), which was significantly superior then other treatments tried in the experiments and the lowest value was recorded in control *i.e.* **T_1** (32.07 q ha^{-1}), maximum dry matter content of pod was recorded in **T_6** (19.98 q ha^{-1}), which was also significantly superior to other treatments. The variation in dry weights of the studied pea seedlings treated with different nutrient sources may be due to higher availability and increased uptake by pea seeds (Haroun and Hussen, 2003). It was observed that biologically fixed nitrogen played an important role in higher uptake where biofertilization were added. The increment in dry weight

Table 1 : Effect of soil amelioration, bio-fertilization and inorganic application on yield, dry matter content, nutrient uptake, apparent recovery and post harvest available soil nutrients in snow pea (pooled data of 2011-12 & 2012-13).

	Treatments	Yield (t ha^{-1})	Dry matter content (q ha^{-1})		Uptake of nutrients (Kg ha^{-1})			Apparent recovery of nutrients by pods(%)			Post harvest available soil nutrients (Kg ha^{-1})		
			Vine	Pods	N	P	K	N	P	K	N	P	K
T_1	Control (only FYM was given)	3.84	32.07	4.73	37.39	2.88	73.40	0.00	0.00	0.00	240.00	40.35	198.00
T_2	100% RDF (50:60:40 kg ha^{-1})	5.67	40.14	6.85	55.17	5.11	96.71	13.51	1.91	8.07	268.17	43.82	226.50
T_3	100% RDF+ lime	6.94	44.01	8.88	68.34	7.56	113.15	31.91	3.82	15.40	280.00	46.47	220.79
T_4	100% RDF + vermicompost+ lime	10.39	50.69	15.59	122.73	15.77	158.05	55.70	9.14	27.02	323.95	58.18	238.44
T_5	100% RDF + Bio-fertilizer	7.85	49.58	13.56	110.63	14.70	145.09	85.00	9.19	37.12	311.09	54.69	248.84
T_6	100% RDF + Vermicompost + Bio-fertilizer + lime	12.99	53.60	19.98	166.63	25.62	184.21	87.33	18.80	47.16	366.95	66.35	266.69
T_7	75% RDF + Vermicompost+ lime	8.44	45.83	11.71	94.70	10.64	123.18	38.87	8.41	19.61	290.92	49.89	241.87
T_8	75% RDF + Bio-fertilizer + lime	7.37	45.14	9.93	82.33	9.06	121.86	48.66	10.04	26.46	302.86	50.34	245.22
T_9	75% RDF + Vermicompost + Bio-fertilizer + lime	11.93	51.06	17.98	147.30	19.34	171.10	87.98	20.34	46.12	345.24	61.78	260.84
	SEm±	0.08	0.32	0.10	0.94	0.17	0.87	1.59	0.30	0.53	3.24	0.59	1.35
	CD(0.05)	0.25	0.97	0.30	2.81	0.51	2.61	4.78	0.89	1.58	9.72	1.77	4.05

of different plant organs of snow pea was directly related to increment in vegetative growth in different treatments. The increase in plant growth may be attributed to the beneficial effects of nitrogen on stimulating the meristematic activity for producing more tissues and organs, since N played major roles in the synthesis of structural proteins and other several macro-molecules, in addition to its vital contribution towards several biochemical processes in the plant related growth (Marschner, 1995). The results obtained were in harmony with those reported by Srivastava and Ahlawat (1995), Mishra *et al*. (2010) in pea.

Snow pea removes large quantity of N, P and K from soil. The highest amount of NPK uptake was observed with the supply of 100% NPK recommended dose through chemical fertilizers along with bio-fertilizer and vermicompost at all the stages of the crop growth in all the plant parts (vine and pods). This might be due to greater availability of these nutrients with extended root system, coupled with increased seed and resulting in higher uptake of these nutrients.

Nutrient uptake, with 100% NPK of recommended dose applied through chemical fertilizers and bio-fertilizers with vermicompost as an organic source in limed plot gave the maximum uptake value in the vine as well as in pod and total uptake of N (168.60 kg ha^{-1}), P (25.62 kg ha^{-1}) and K (184.21 kg ha^{-1}) followed by 75% NPK + vermicompost + bio-fertilizer on limed plot. This might be due to the favourable effect of inorganic, organic and biological sources for increasing the total uptake of N, P and K causing enhancement of plant growth parameters and dry weight per hectare and higher N, P and K concentration in different plant organs (pod and vine) and this in turn increased total uptake of N, P and K by snow pea plant.

The results obtained are in harmony with those reported by Srivastava and Ahlawat (1995) and El-Mansi *et al.* (2000) inoculated pea with bio-fertilizers and found that higher values of total N, P and K uptake of pea plants were observed when seeds were inoculated with *Rhizobium* compared with check.

Apparent recovery of nutrients

In intensive agriculture nutrient recovery through crop is of paramount importance, because the cost intensive input-fertilizers should be properly utilized for economic benefit of farmer and stability of cropping system by maintaining soil productivity. Inoculating the crop with bio-fertilizers increases the recovery of nutrients considerably and more particularly in N and P. Maximum recovery was obtained when the crop

was applied with vermicompost and bio-fertilizer. The recovery of nutrient further increased with integration of chemical fertilizer with bio-fertilizers and vermicompost.

However, integrating bioinoculants and vermicompost with 75% RDF resulted in nitrogen recovery at par with 100% recommended dose while Phosphorus recovery recorded 8.19% more in 75% recommended dose of fertilizer than 100% of RDF. On the contrary the trend of potash recovery in pod was at par under both 75% and 100%recommended dose of fertilizer.

Post harvest soil properties

There is an increasing trend of potash, nitrogen and phosphorus content of the soil with the combined use of chemical fertilizers, vermicompost and bio-fertilizers of different doses in the soil. Soil nitrogen was increased and the values were recorded in the range from 240.00 to 366.95 kg ha^{-1}. Similar trend was also marked in case of phosphorus (range from 40.35 to 66.35 kg ha^{-1}.) and potash (range from 198.00 to266.69 kg ha^{-1}), where the highest amount was recorded by applying 100% NPK along with bio-fertilizers and vermicompost. The increase in the nutrient content might be due to the application of vermicompost and bioinoculants along with the chemical fertilizers which in turn influenced the nutrient uptake significantly and converted the unavailable form which was reflected in the post-harvest soil properties.

These results confirmed the findings of Jeon e*t al*. (2003), Gopinath *et al*. (2008) in pea and Bhat *et al*. (2013) in field pea.

Conclusion

Finally, it is concluded that not only chemical fertilizers can produce a good yield but application of organic manure like vermicompost along with bio-fertilizers can also achieve the yield target under better management practices. Simultaneously, the organic manures are locally available, eco-friendly and helpful to sustain the soil health. The optimal or sub optimal dose of chemical fertilizers along with vermicompost and bio-fertilizers in presence of lime resulted in higher pod yield besides increasing soil available nutrients and total N,P and K in plants than control and 100%NPK alone. Therefore, integrated management of inorganics and organic application along with biofertilization can be used to boost the production of snow pea and at the same time enrich the soil with residual nutrients so as benefit the succeeding crop, thus help to maintain the soil fertility.

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