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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL PROPERTIES AND NUTRIENT CONTENT IN PEA (*PISUM SATIVUM* L.)

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ABSTRACT

A field experiment was conducted in the year 2010-2011 to evaluate the effect of Rhizobium, PSB and inorganic nutrient sources on soil properties and nutrient content under pea (*Pisum sativum* L.). A total of nine treatments including a control were replicated thrice in a Randomized Complete Block Design. The treatments consisted of Rhizobium and PSB with two levels of recommended dose of fertilizers (50 and 75%) and were compared with 100% RDF only (control). Seeds were sown in lines at a spacing of 60 × 7.5cm in 3.0m × 2.5m plots. Results indicated that application of Rhizobium isolate-2 + PSB + 50% N&P+ 100% K (T_9) significantly increase the available N (365.84 kg/ha), P (43.75 kg/ha) in soil and N content (4.21%) in the leaves. However, this treatment was found statistically at par with treatment T_7 (Rhizobium isolate -2 + PSB + 75% N & P + 100% K), which was the next best treatment for the other characters under study. Hence, the application of biofertilizers (*Rhizobium* and PSB) in combination with inorganic fertilizers at reduced doses (25-50%) can maintain and sustain a higher level of soil fertility and crop productivity.

INTRODUCTION

Pea is an important nutritive vegetable and is mainly cultivated as cool season crop throughout the globe. In hilly areas it is cultivated in summer as off-season crop. The increased crop output with the use of high amount of fertilizers and pesticides results in decreased food quality & soil fertility, degradation of cultivated land, water and air which threatens food safety and food security (Singh *et al*. 2014). Being a legume crop, pea have the inherent ability to obtain much of its nitrogen (N) requirement from the atmosphere by forming a symbiotic relationship with *Rhizobium* bacteria in the soil (Schatz and Endres, 2009). Average green pod yield in pea per unit area is quite low and injudicious use of chemical fertilizers is one of the major causes of the poor yield of the crop. The integrated use of chemical fertilizers, organic manures, bio-fertilizers and other organics is important to maintain and sustain a higher level of soil fertility and crop productivity. The integrated supply and use of plant nutrients from chemical fertilizers and organic manures has been shown to produce higher crop yields than when each nutrient is applied alone (Rai and Mauria, 2006). The essentiality of nitrogen as a major plant nutrient is well documented due to its role in improving photosynthetic efficiency and thus enhancing the yielding ability of crop. Phosphorus has a key role in the energy metabolism of all plant cells and particularly for N-fixation in legume crops (Erman *et al*., 2009). Potassium, unlike other vital nutrients does not become a part of chemical structure of plants but provide strength through thickness of cell wall. Furthermore, this element has a prominent role in photosynthesis through regulation of stomatal movements.

Chemical fertilizers play an important role to meet nutrient requirement of the crop but continuous use of these on lands will have deleterious effects on physical chemical and biological properties of soil, which in turn reflects on yield (Anitha *et al*., 2015). Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase the usage of organic manures which are known to improve physico-chemical properties of soil and supply the nutrients in available form to the plants. Similarly, usage of biofertilizers is very essential because the insoluble phosphate which is not directly available to plants usually comprises 95-99 percent of the total soil phosphorous. Integration of various organic manures with inorganic fertilizers and low cost bio-fertilizers inoculation not only reduces the fertilizer requirement but also an eco-friendly approach (Jeyabal *et al*., 2000). Further, biofertilizers are non- bulky and cheap sources of nutrients and may prove cost effective and eco-friendly supplementation especially in hill vegetable farming. Several attempts have been made in the past to increase the yield potential of pea crop, but they are concerned with use of chemical fertilizers. Hence, it is time to think not only to increase the production potential but also to improve the fertility status of soil by applying advancements in scientific production to meet the increasing demand and boost up the export earnings. Therefore, a study was undertaken with the objectives- to know the effect of *Rhizobium*, PSB and inorganic nutrient sources on soil properties and nutrient content under pea (*Pisum sativum* L.) crop.

MATERIALS AND METHODS

Investigation on the effect of Rhizobium, PSB and inorganic nutrient sources on soil properties and nutrient content under pea (*Pisum sativum* L.) crop was carried out at Vegetable Research Farm of the Department of Vegetable Science, Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. from November 2010 to April 2011. Before laying out the experiment, random soil samples were collected from the different spots at 0-15cm depth and the composite sample was prepared which was analyzed for various properties of the soil. The experiment was laid out in a randomized complete block design with three replications comprising nine treatments *viz*. T_1: Recommended dose of NPK (25:60:60 kg/ha); T_2 : Rhizobium isolate-1 +75% N + 100% P & K; T_3 : Rhizobium isolate-2 +75% N + 100% P & K; T_4 : Rhizobium isolate-1 +50% N + 100% P & K; T_5 : Rhizobium isolate-2 +50% N + 100% P & K; T_6 : Rhizobium isolate-1 + PSB + 75% N & P + 100% K; T_7 : Rhizobium isolate-2 + PSB + 75% N & P + 100% K;T_8 : Rhizobium isolate-1 + PSB + 50 % N & P + 100 % K; T_9 : Rhizobium isolate-2 + PSB + 50 % N & P+ 100 % K. Seeds were sown in lines at a spacing of 60 × 7.5 cm in 3.0 m × 2.5 m plots. Rhizobium isolates-1 and 2 were applied as seed treatment @ 200g/10 kg of seeds and PSB as soil treatment @ 5kg/ha. The observations were recorded on soil pH, EC (dSm^{-1}), organic carbon, available NPK in soil before start and after completion of experiment and nutrient content of plant.

Statistical analysis

The data recorded on various parameters were analyzed for RBD design as suggested by Gomez and Gomez (1983). The results have been interpreted on the basis of 'F' test value and critical difference (CD) was calculated at 5% level of significance.

RESULTS AND DISCUSSION

Soil pH, EC and organic carbon affected by *Rhizobium*, PSB and inorganic nutrients

Soil pH, EC and organic carbon (Table 2) did not influenced significantly by the combined application of biofertilizers and inorganic fertilizers. The soil pH slightly decreased under biofertilizers treated plots due to decrease in bulk density and increase in organic carbon and altered the soil reaction towards neutral. The present results are in accordance with the findings of Gopinath and Mina (2011) Jaipaul *et al.* (2011). The organic carbon content in the soil is slightly higher under combined application of biofertilizers and chemical fertilizers due to increased microbial and enzymatic activity and may have led to lower bulk density and subsequently increase in organic carbon content. These findings are in line with those of Datt *et al.* (2003) and (Kumari *et al.*, 2012)

Effect of *Rhizobium,* PSB and inorganic nutrients on available NPK in soil

The data pertaining to available N content in Table 2 was significantly influenced by different treatment combinations. The available N content was higher in Rhizobium isolate -2 +

Table 1: Physico-chemical properties of soil before sowing

Particulars	Value obtained 2010	Method Employed	Soil status
A. Mechanical analysis (%)			
1. Sand	42.95	International Pipette Method	
2. Silt	32.07		Sandy loam
3. Clay	23.98		
B. Chemical analysis			
1. Soil pH	6.87	Digital pH Meter	Neutral
2. Soil EC	0.65	Digital conductivity meter	Normal
3 Organic carbon(%)	0.95	Walkley and Black,1934	Medium
4. Available N (kg/ha)	263.42	Alkaline Potassium Permanganate Method (Subbiah and Asija, 1956)	Low
5. Available P (kg/ha)	35.17	Olsen Method (Olsen *et al.*,1954)	High
6. Available K (kg/ha)	132.98	Normal Neutral Ammonium Acetate Method (Merwin and Peech,1951)	Low

Table 2: Effect of different treatments on soil properties after the termination of experiment

TreatmentCode	SoilpH	Soil EC(dSm^{-1})	OrganicCarbon(%)	N (kg/ha)	% increase	P (kg/ha)	% increase	K (kg/ha)	% increase
T_1	7.12	0.69	0.99	296.87	12.69	38.38	9.122	146.35	10.54
T_2	6.77	0.65	1.04	328.23	24.60	39.35	11.88	148.59	11.73
T_3	6.85	0.68	1.13	349.14	32.54	40.77	15.92	151.20	13.70
T_4	6.81	0.66	1.12	326.14	23.80	39.08	11.11	147.09	10.69
T_5	7.02	0.63	1.11	344.96	30.95	40.03	13.81	149.33	12.29
T_6	6.88	0.66	1.17	353.29	34.11	43.23	22.91	152.69	14.82
T_7	6.84	0.69	1.20	363.77	38.09	42.93	22.06	160.53	20.71
T_8	6.92	0.65	1.19	330.32	25.39	41.69	18.53	159.79	20.16
T_9	6.76	0.63	1.23	365.84	38.88	43.75	24.39	157.55	18.47
Mean	6.86	0.66	1.13	339.84	-	41.02	-	152.56	-
$CD_{(0.05)}$	NS	NS	0.14	31.28	-	2.89	-	9.53	-

Table 3: Effect of different treatments on nutrient content (%) in pea

TreatmentCode	Treatments	NContent(%)	PContent(%)	KContent(%)
T_1	Control – 100 % RDF of NPK (25:60:60 kg/ha)	2.42	0.16	1.04
T_2	Rhizobium Isolate -1 + 75 % N + 100 % P & K	3.66	0.15	1.05
T_3	Rhizobium Isolate -2 + 75 % N + 100 % P & K	3.44	0.14	1.01
T_4	Rhizobium Isolate -1 + 50 % N + 100 % P & K	3.15	0.16	1.04
T_5	Rhizobium Isolate -2 + 50 % N + 100 % P & K	3.39	0.16	1.00
T_6	Rhizobium Isolate -1 + PSB + 75 % N & P +100% K	3.76	0.17	1.05
T_7	Rhizobium Isolate -2 + PSB + 75 % N & P + 100 % K	4.02	0.18	1.10
T_8	Rhizobium Isolate - 1 + PSB + 50 % N & P + 100 % K	4.17	0.17	1.09
T_9	Rhizobium Isolate - 2 + PSB + 50 % N & P + 100 % K	4.21	0.17	1.08
Mean		3.12	0.16	1.04
$CD_{(0.05)}$		0.94	NS	NS

PSB + 50% N and P + 100% K. In fact, treatment raised the available N by 38.8 % over the initial status. This may be due to atmospheric N fixation by *Rhizobium* resulting in higher accumulation of N in the soil, mineralization of native organic matter increased the N and also increased the uptake of N to the plant required for their growth and reproduction, Datt *et al.* (2003). Further, the favorable condition in the soil due to biofertilizers and higher organic matter leads to mineralization of soil N leading to build up of higher available N (Ansari and Kumar 2010 and Ansari and Sirpaul, 2011).

A perusal of data (Table 2) revealed the influence of different treatments on P content of soil indicated that treatment combination (T_9) Rhizobium isolate-2 + PSB + 50% N&P + 100% K registered maximum P content. Infect, this treatment raised the available P content by 24.39%. The biofertilizers specially PSB increase the solubility of phosphate by producing certain organic acids and there by increased the soil available phosphorous Jaipaul *et al.* (2011). Similar are the view of Gopinath and Mina (2011). Further, P status of soil increased with increasing level of fertilizers due to lower utilization of P by crop from applied sources Datt *et al.* (2003).

The study revealed that K content (table-2) in the soil was more in plot treated with Rhizobium isolate-2 + PSB + 75% N & P +100% K (T_7). Amount of available K content in the soil increased over the initial value. The enhanced status of soil K could be attributed to higher amount of potassium being added through muriate of potash and farmyard manure Datt *et al.* (2003). The maximum increase in K over the initial level was recorded in those treatments where combined application of biofertilizers and chemical fertilizers are used. Similar are the findings of Jaipaul *et al.* (2011) and Gopinath and Mina (2011).

Effect of *Rhizobium*, PSB and inorganic fertilizers on plant nutrient content

The N content increased significantly in different treatment combinations. Maximum N content was shown in table-3 obtained with the application of Rhizobium isolate-2 + PSB + 50% N & P + 100% K. This may be due to atmospheric nitrogen fixation by Rhizobium increased the availability of nitrogen in the soil and thereby increased the N content in the plants. These results are in line with the findings of Datt *et al.* (2003), Sharma and Chauhan (2011), Talukder *et al.* (2008) and Mishra *et al.* (2014). The P and K content did not show any statistically significant difference although maximum P content (0.18 %) and K content (1.10 %) were obtained with the application of Rhizobium isolate-2 + PSB + 75 % N & P +100 % K. This might be due to solubilization of applied and native P and possessing the ability of mobilizing unavailable form of nutrient element by PSB Sharma and Chauhan (2011). Similar are the findings of Habbasha *et al.* (2007) and Rudresh *et al.* (2005). Minimum P and K content were obtained under control.

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