Effect of Organic Nutrient Sources onSoil NutrientLevelinPea (*Pisumsativum* L.)

ABSTRACT

An experiment was undertaken during *rabi*season of the year 2020-21 to study the effect of bio-fertilizers and organic nutrient sources on residual soil nutrient status in pea. The study comprised of seventeen treatments with different combinations of bio-fertilizers viz., Rhizobium and Phosphate Solubilizing Bacteria (PSB) and organic manures viz., FYM and vermicompost.The investigation revealed that minimum soil pH (6.96), maximum soil organic carbon (0.76 %), available nitrogen (259.36 kg/ha) and available phosphorus (26.98 kg/ha) were obtained with treatmentT_{13} (Rhizobium+ PSB + FYM). The maximum soil electrical conductivity (0.208 dSm^{-1}) and available potassium (174.65 kg/ha) were obtained with treatment T_{17} [Recommended Dose of Fertilizer (25N: 60P:60K kg/ha)].

Keywords: Soil Nutrient Level, vermicompost, Fertilizer, vegetable crop

1. INTRODUCTION

"Pea is an important vegetable crop grown in India and world. It belongs to family Fabaceae and diploid chromosome numbers are 14. Pea is herbaceous, annual in habit and self-pollinated crop grown for its tender and immature pods. It is mainly utilized as vegetable, consumed as pulse, canned, processed or dehydrated. The green and dry foliage are used as cattle feed. Green peas are nutrient-dense containing high percentage of starch, dietary fibers, proteins, vitamin A & C and minerals like Ca& P. Heavy use of synthetic inputs like chemical fertilizers in order to increase food production and productivity has adverse effect on soil physical, chemical and biological properties. It also affects the sustainability of crop production, besides causing environmental pollution. So, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase in the usage of organics. Organic manures increase cation exchange capacity, water holding capacity and phosphate availability of the soil and reduces nitrogen loses due to slow release of nutrients”[1]. “Biofertilizers are low cost and renewable source of plant nutrients to supplement the chemical fertilizers. Judicious use of organic manures and biofertilizers is effective not only in sustainable crop production but also for improving soil health, human health, environment and to increase the population of beneficial microorganism in soil which provide different nutrients to the plants”[2]. “There are several reports, which show that the combined and sole application of organic manures and biofertilizers increase the yield and quality attributes in vegetables”[3]. “Vermicompost and FYM are highly efficient organic manures which can enhance production and improve the quality of vegetables. Vermicompost increase the growth and yield of plant and it could be best substitute to inorganic fertilizers” [4].“Whereas, Farmyard manure is precious organic manure that can improve soil health, increase microbial population due its high humus, macro and micronutrient contents. Pea being a leguminous crop, maintains soil fertility through biological nitrogen fixation in association with symbiotic Rhizobium prevalent in its root nodules and thus play an important role in fostering sustainable agriculture”[5].

“Rhizobium improves soil fertility and is a very cost-effective way of nitrogen management in leguminous crops and use of Phosphate Solubilizing Bacteria enhances phosphorus in soil and further its use by plants. Seeds when inoculated with Rhizobium and Phosphate Solubilising Bacteria produce more pod yield as compared to the un-inoculated. Rhizobium inoculation increase the root nodulation through better root development and enhance nutrient availability in soil, resulting in vigorous plant growth, better flowering, fruiting, pod formation and seed yield”[6]. “However, the fixed phosphorus in the soil can be solubilized by phosphate solubilizing bacteria which has the capacity to convert inorganic unavailable phosphorus form to available soluble forms in soil and make them available to plants. Besides organic manure and biofertilizers, Jeevamrut is also becoming prevalent in farming system and results in higher growth, yield and improve physico-chemical properties in soil”[7].

2. MATERIALS AND METHODS

2.1 Experimental Site

The study was conducted at the Experimental Farm of College of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh which located at latitude of 31° 41’47.6"

N and a longitude of 76° 28’06.3" E, and at an elevation of 650 meters above sea level. The soil at the research location was classified as sandy clay loam, with a composition of 58.60% sand, 14.60% silt, and 26.80% clay with pH of 7.10.

2.2 Experimental Design and Crop Management

Experiment was laid out in randomized complete block design(RCBD) with three replications at spacing of 60 x 10 cm in a plot size of 1.8 m x 1.0 m accommodating 30 plants in each plot. Planting was done in First week of November, 2020. The Experiment comprised of seventeen treatments viz., T_1 (FYM 200 q/ha), T_2 (Vermicompost 100 q/ha), T_3 (Jeevamrut drenching @ 10%), T_4 (Rhizobium), T_5 (Rhizobium + FYM), T_6 (Rhizobium + Vermicompost), T_7 (Rhizobium + Jeevamrut), T_8 (PSB), T_9 (PSB+ FYM), T_{10} (PSB + Vermicompost), T_{11} (PSB+ Jeevamrut), T_{12} (Rhizobium + PSB), T_{13} (Rhizobium + PSB+ FYM), T_{14} (Rhizobium + PSB+ Vermicompost), T_{15} (Rhizobium + PSB + Jeevamrut), T_{16} (RDF) and T_{17} (Control).Cultivar ‘Azad Pea-1’ was employed for the present study. Recommended dose of Nitrogen, Phosphorus and Potassium @ 25:60:60 kg/ha wereappliedin theform of Urea(54.35 kg/ha),SSP(375 kg/ha)andMOP(100 kg/ha)as pertreatments before planting of crop.Half dose of N along with full doses of P and K was appliedas basal dose. Remaining dose of N was divided in two equal splits and applied at monthlyinterval. While, FYM @ 200 q/ha and vermicompost @ 100 q/ha were broadcasted uniformlybefore plantingofcropas perthe treatments.

At the end of experiment, soil samples were collected from the top 15 cm of the treatment plots. These samples were air-dried, sieved through a 0.2 cm mesh, and stored in cloth bags for subsequent chemical analysis. The parameters assessed included soil pH, electrical conductivity (EC), organic carbon content, and the availability of nitrogen (N), phosphorus (P), and potassium (K). Soil pH and EC were measured using a digital pH meter and an electrical conductivity meter, respectively. “Organic carbon content was determined using the Chromic and Titration method proposed by” [8]. “The Alkaline Potassium Permanganate Method was employed to determine available N, while P levels were measured using the method outlined by Olsen” [9]. “Available K was quantified using the Normal Neutral Ammonium Acetate Method”[10]. “The mean data values underwent analysis of variance following the approach described by”[11] for a Randomized Complete Block Design.

2.3 Preparation of Jeevamut

Jeevamrut is prepared by mixing 10 kg of fresh cow dung**,** 10 liters of cow urine from a local breed, 1 to 2 kg of jaggery**,** 1 to 2 kg of gram flour**,** and a handful of fertile soil in a plastic drum. Thisconcoction is then mixed thoroughly. For the next 5 to 7 days**,** it should be stirred for at least ten minutes twice daily, moving in a clockwise direction with a wooden stick. Following this, 200 liters of water are added. Once these steps are completed, the Jeevamrut is ready to be used according to the specified treatment plan.

2.4 Seedtreatmentwithbiofertilizers

Seeds were inoculated with *Rhizobium* culture, Phosphate Solubilizing Bacteria cultureand *Rhizobium* + Phosphate Solubilizing Bacteria culture as per treatments. 100g of Jaggery wasdissolved in 100ml of warm water. Seeds were soaked in Jaggery solution for 15-20 minutes andseeds were dried under shade. Thereafter, these seeds were coated with *Rhizobium* culture @ 25g/kg and Phosphate Solubilizing Bacteria @ 25g/kg and with mixed culture of *Rhizobium* andPhosphate Solubilizing Bacteria as per the treatments. Treated seeds were dried in shade beforeplanting.

3. RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the treatments for soil parameters under study.Visualization of data presented in Table 1., revealed that the pH of the soil after harvesting decreased from the initial value (7.10). Soil pH varied from 6.89-7.08. Minimum soil pH (6.89) was recorded in T_{13}(Rhizobium+ PSB + FYM). Whereas maximum soil pH (7.08) was recorded in T_{17}(Control). Overall mean for soil pH was6.99. “The soil pH slightly decreased with the application of biofertilizers treated plots due to decrease in bulk density and increase in organic carbon and this altered the soil reaction towards neutral” [12,13,7 and 2]. Electrical conductivity of soil is essential, as it provides information about the concentration of soluble salts in soil. Range for electrical conductivity varied from 0.181-0.228 dSm^{-1}. Initial value for electrical conductivity was (0.235 dSm^{-1}) before planting of crop. Minimum electrical conductivity (0.181

dSm^{-1}) was recorded in treatment T_{13}(Rhizobium+ PSB + FYM) while, maximum (0.228 dSm^{-1}) was recorded in treatment T_{17}(Control). Overall mean for the character was 0.200 dSm^{-1}."Decrease in soil electrical conductivity with the addition of organic manure and biofertilizers can be attributed to leaching of insoluble salts"[13,2]. There was increase in the soil organic carbon in all the treatments from the initial value (0.66 %). Range varied from 0.64-0.91 %. The highest organic carbon (0.91 %) was recorded in T_{13}(Rhizobium+ PSB + FYM) and lowest (0.64%) in T_{17}(Control). Overall mean for organic carbon was 0.80%."Organic manures and biofertilizers application might have created environment favorablefor the formation of humic acid which stimulated the activity of soil microorganisms resulting in an increase in the organic carbon content of soil"[13] noticed significant increase in organic carbon with application of FYM + *Rhizobium* + PSB in pea"[12,14,2]. The data for available nitrogen is presented in Table 2. Range for available nitrogen varied from 194.43-279.10 kg/ha. Initial value for available nitrogen was 203.84 kg/ha before planting of crop. Significant maximum available nitrogen (279.10 kg/ha) was recorded in T_{13}(Rhizobium + PSB + FYM) and minimum (194.43 kg /ha) in T_{17}(Control) after harvesting of the crop. Overall mean for available nitrogen was 242.90 kg/ha."Fixation of atmospheric nitrogen by *Rhizobium* in rhizosphere and mineralization of organic manures might have increased the nitrogen and enhanced the uptake of nitrogen in plants"[7,15,2].Initial value for available phosphorus was 14.49 kg/ha before crop sowing. Available phosphorus ranged from 13.15-25.10 kg/ha. Maximum available phosphorus (25.10 kg/ha) was recorded in treatment T_{13}(Rhizobium + PSB + FYM) which was statistically *at par* with treatment T_{16}(RDF) observing value of 24.47 kg/ha and minimum (13.15 kg/ha) in treatmentT_{17}(Control)afterharvestingofthecrop.Overallmeanforavailablephosphoru swas 20.35 kg/ha. "An increase in available phosphorus over the initial value, indicated that addition of organic manures and biofertilizers specially Phosphate Solubilizing Bacteria, increased the solubility of phosphorus by producing certain organic acids and thereby increased the available phosphorus in the soil"[2,12,13]. Available potassium ranged from 133.65-191.89 kg/ha. Initial value for available potassium was 136.94 kg/ha before planting of crop. Maximum available K (191.89 kg/ha) was recorded in treatment T_{16}(RDF) and minimum

(133.65 kg/ha) was recorded in T_{17}(Control) after harvesting of crop. Overall mean for available potassium was 160.78kg/ha.“Greater availability of nutrients from inorganic sources might have increased available K in soil” [12,14,16].

Perusal of data given in Table 3, indicated that maximum gross income (Rs 2,57,760 /ha) was recorded in treatment T_{13} (Rhizobium + PSB + FYM) and minimum gross income (Rs1,20,880/ha) was observed in treatment T_{17} (Control) whereas, maximum total cost of cultivation (Rs1,45,040/ha) was recorded in treatment T_{14} (Rhizobium + PSB + Vermicompost) and minimum total cost of cultivation (Rs 44,140/ha) was recorded in treatment T_{17} (Control). Net income (Rs 1,76,720/ha) was recorded maximum in treatment T_{13} (Rhizobium + PSB + FYM) and minimum (Rs 30,080/ha) was recorded in treatment T_2 (Vermicompost). Highest benefit: cost ratio (2.18) was recorded in treatment T_{13} (Rhizobium + PSB + FYM) and minimum (0.20) was recorded in treatment T_2 (Vermicompost). Similar results were recorded by other authors[14 and16].

4. CONCLUSION

Application of Rhizobium, Phosphate Solubilizing Bacteria along with FYM resulted in maximum organic carbon, available nitrogen and available phosphorus in the soil.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

We hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have not been used during writing or editing of this manuscript.

Table1. Effect of biofertilizers and organic manures on pH, electrical conductivity (dSm^{-1}) and organic carbon (%) in soil

Treatment Code	Treatment	SoilpH	EC(dSm^{-1})	Organic Carbon (%)
T_1	FYM(200q/ha)	7.02	0.210	0.80
T_2	Vermicompost(100q/ha)	7.04	0.214	0.78
T_3	Jeevamrut(drenching@10%)	7.06	0.217	0.76
T_4	Rhizobium	7.05	0.204	0.77
T_5	Rhizobium+FYM (200 q/ha)	6.99	0.193	0.85
T_6	Rhizobium+Vermicompost(100 q/ha)	7.01	0.195	0.83
T_7	Rhizobium +Jeevamrut(drenching @ 10%)	7.00	0.197	0.80
T_8	PSB	7.01	0.206	0.79
T_9	PSB+FYM(100q/ha)	6.98	0.192	0.84
T_{10}	PSB+Vermicompost(100q/ha)	6.96	0.195	0.82
T_{11}	PSB+Jeevamrut(drenching@10%)	6.99	0.198	0.81
T_{12}	Rhizobium+PSB	7.00	0.186	0.79
T_{13}	Rhizobium+PSB+FYM (200 q/ha)	6.89	0.181	0.91
T_{14}	Rhizobium+PSB+Vermicompost(100q/ha)	6.91	0.184	0.87
T_{15}	Rhizobium+PSB+Jeevamrut(drenching @10%)	6.94	0.189	0.86
T_{16}	RDF(25N:60P:60Kkg/ha)	7.05	0.224	0.72
T_{17}	Control	7.08	0.228	0.64
	Mean	6.99	0.200	0.80
	C.D$_{(0.05)}$	0.00	0.000	0.01
	InitialValue	**7.10**	**0.235**	**0.66**

Table2.Effect of biofertilizers and organic manures on availablenitrogen (kg/ha),phosphorus (kg/ha)andpotassium (kg/ha)insoil

Treatment Code	Treatment	AvailableNitrogen(kg/ha)	Available Phosphorus(kg/ha)	AvailablePotassium(kg/ha)
T_1	FYM(200q/ha)	217.42	17.03	146.18
T_2	Vermicompost(100q/ha)	213.24	16.74	144.10
T_3	Jeevamrut(drenching@10%)	210.44	16.54	140.37
T_4	Rhizobium	234.15	18.71	153.06
T_5	Rhizobium+FYM (200 q/ha)	261.32	22.82	168.74
T_6	Rhizobium+Vermicompost(100 q/ha)	250.87	20.85	166.50
T_7	Rhizobium + Jeevamrut(drenching	246.69	20.08	157.54
T_8	PSB	222.65	18.14	150.74
T_9	PSB+FYM(100q/ha)	254.01	21.99	164.26
T_{10}	PSB+Vermicompost(100q/ha)	247.74	20.70	162.02
T_{11}	PSB+Jeevamrut(drenching@10%)	242.51	19.88	155.30
T_{12}	Rhizobium+PSB	256.10	22.42	159.78
T_{13}	Rhizobium+PSB+FYM (200 q/ha)	279.10	25.10	184.42
T_{14}	Rhizobium+PSB+Vermicompost (100q/ha)	265.51	23.96	180.69
T_{15}	Rhizobium+PSB+Jeevamrut(drenching@10%)	262.37	23.33	173.22
T_{16}	RDF(25N:60P:60Kkg/ha)	270.73	24.47	191.89
T_{17}	Control	194.43	13.15	133.65
	Mean	242.90	20.35	160.78
	C.D$_{(0.05)}$	4.92	0.11	1.73
	InitialValue	**203.84**	**14.49**	**136.94**

Table 3. Effect of organic sources of nutrients on economics of pea cultivation

Sr.no	Treatments	Total pod yield (q/ha)	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B:C ratio
T_1	FYM (200 q/ha)	88.00	80,140	1,76,000	95,860	1.19
T_2	Vermicompost(100 q/ha)	87.11	1,44,140	1,74,200	30,080	0.20
T_3	Jeevamrut(drenching @ 10%)	70.13	62,640	1,40,260	77,620	1.23
T_4	Rhizobium	70.22	44,640	1,40,440	95,800	2.14
T_5	Rhizobium + FYM (200 q/ha)	98.66	80,640	1,97,320	1,16,680	1.44
T_6	Rhizobium + Vermicompost(100 q/ha)	96.44	1,44,640	1,92,880	48,240	0.33
T_7	Rhizobium + Jeevamrut(drenching @ 10%)	93.77	63,640	1,87,540	1,24,400	1.97
T_8	PSB	69.33	44,540	1,38,660	94,120	2.11
T_9	PSB + FYM (100 q/ha)	94.66	80,540	1,89,320	1,08,780	1.35
T_{10}	PSB + Vermicompost(100 q/ha)	92.44	1,44,540	1,84,880	40,340	0.27
T_{11}	PSB + Jeevamrut(drenching @ 10%)	90.66	63,040	1,81,320	1,18,280	1.87
T_{12}	Rhizobium + PSB	71.11	45,040	1,42,220	97,180	2.15
T_{13}	Rhizobium + PSB + FYM (200 q/ha)	128.88	81,040	2,57,760	1,76,720	2.18
T_{14}	Rhizobium + PSB + Vermicompost(100 q/ha)	123.11	1,45,040	2,46,220	1,01,180	0.69
T_{15}	Rhizobium+ PSB + Jeevamrut(drenching @ 10%)	98.66	63,540	1,97,320	1,33,780	2.10
T_{16}	RDF (25 N:60P:60K kg/ha)	127.55	86,533	2,55,100	1,68,567	1.94
T_{17}	Control	60.44	38,640	1,20,880	76,740	1.00

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