Effect of different levels of Macronutrients and Rhizobium on Soil Health and yield attributes of Field Pea (Pisum Sativum L.)

Abstract

The field experiment was carried out at the central research farm ~~of~~ in the~~department~~ Department of ~~soil~~ Soil ~~science~~ Science and ~~agricultural~~ Agricultural ~~chemistry~~Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Rabi season 2023-24. The soil texture ~~of the soil~~ in the experimental region was sandy loam. The design was set up using randomized block design, with two levels of sulphur (50 ~~&~~and100%), Rhizobium, and NPK (20:60:40) at different levels. The treatment T9 (@100% NPKS +@100% Rhizobium+ 100% Sulphur) gave the best results in terms of plant height, number of pods plant-1, and total Field Pea yield. It also showed a slight decrease in pH, bulk density, and particle density; however, there was a significant increase in pore space, water holding capacity, EC, organic carbon, available nitrogen, phosphorus, and potassium, as well as plant growth and yield attributes. There was no discernible difference in the growth and production of Field Pea under control. The use of Biofertilizer, as well as their blend with complete NPK and S, significantly ~~increases~~ increasedthe characteristics of growth and total yield attributes of Field Pea.

Comment [CA1]: State purpose before mentioning the treatments

Keywords: Field Pea, NPK, Sulphur, Rhizobium

INTRODUCTION

Pea (Pisum sativum L.) is the most important legume crop, which had its origin in Ethiopia.One of the main pulse crops is field pea, a grain legume that belongs to the Leguminosae family. Due to its high protein, carbohydrate, vitamin C, calcium, and phosphorus content, it is a staple food that is enjoyed by people all over the world (Diveky-Ertsey et al. 2022). Notably, lysine and tryptophan are also abundant in field peas (Sharma et al. 2023).Symbiotic Rhizobium bacteria within its root nodules enable nitrogen fixation, a process critical to soil fertility preservation (Zhong et al. 2023). ~~Pea (Pisum sativum L.) is the most important legume crop, which had its origin in Ethiopia.~~ Peas are commonly small spherical seeds present inside the pod. Each pod contains several seeds, which develop from the ovary of the flower and can be green or yellow in color. It is used as a fresh vegetable or can even be canned or processed. Pea occupies an area of 5,49,000 hectares with an annual production of 56,80,000 metric tons in India (NHB, 2021-22). In Himachal Pradesh, it occupies an area of 22,855.17 hectares with an annual production of 2,88,994 metric tons (DOA, Shimla 2021-2022).

Long term sustainability of agriculture is a matter of today's agriculture. The most intensive agriculture shows signs of soil deterioration in the quality and quantity of soil nutrients as well as physical soil properties, which is associated to stagnation and yield decline. Imbalance use of inorganic fertilisers and lack of organic fertilization are the related causal factors for decline of their properties (Beshir and Abdulkerim., 2017). The use of organic manures along with chemical fertilizers on a regular basis is usually thought to be useful in the long run for maintaining and increasing fertility of the soil. Organic manures improve soil quality indicators such as physical, chemical, and biological as well as provide plant nutrients (Arshad and Martin, 2002).

Rhizobium is a genus of Gram-negative soil bacteria that fix nitrogen. Rhizobium species from an endosymbiotic nitrogen-fixing association with roots of legumes and other flowering plants. The bacteria colonize plant cells within root nodules, where they convert atmospheric nitrogen into ammonia using the enzyme nitrogenase and then provide organic nitrogenous compound such as glutamine or ureides to the plant. The beneficial effects of Rhizobium inoculation on cluster bean grain yield resulting in saving of 13.37 to 21.73kg/ha nitrogen and an enhanced seed yield ranging from 2.34 to 8.05q/ha along with nitrogen application compared to control.

Phosphate solubilizing bacteria (PSB) are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compound. P-solubilization ability of rhizosphere microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition. PSB have been introduced to the Agricultural community as phosphate Biofertilizer. Phosphorus is one of the major essential macronutrients for plants and is applied to soil in the form of phosphate fertilizers. However, a large portion of soluble inorganic phosphate which is applied to the soil as chemical fertilizer is immobilized rapidly and becomes unavailable to plants. PSB have attracted the attention of agriculturists as soil inoculums to improve the plant growth and yield. Many different strains of these bacteria have been identified as PSB, including Pantoeaagglomerans(P5), Microbacteriumlaevaniformans (P7) strains are highly efficient insoluble phosphate solubilizers.

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Materials and Methods

The research work was carried out at the Soil Science Research Farm, Department of Soil Science and Agricultural Chemistry Sam Higginbottom University of Agriculture, Technology and Sciences, Naini Agricultural Institute, Prayagraj, during Rabi Season of 2023-2024. Agroclimatically, Prayagraj district represents the subtropical belt of the South East of Uttar Pradesh, and is endowed with extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^0C-48^0C and seldom falls as low as 4^0C -5^0C. The relative humidity ranged between 20 to 94 percent. The average rainfall of this area is around 1100mm annually. The experiment was carried out in a Randomized Block Design (RBD) with three levels of inorganic fertilizer N, P, K (40, 80, 40 ha-1), Levels of sulphur and ~~Levels~~ levels of Rhizobium, the treatments were replicated three times. Treatments were T_1 -(control), T_2-RDF @ 0% + S @ 0% + @ Rhizobium 50%, T_3-RDF @ 0% + S @ 0% + @ Rhizobium 75%, T_4-RDF @ 0% + S @ 0% + @ Rhizobium 100%, T_5-RDF @ 50% + S @ 0% + @ Rhizobium 50%, T_6-RDF @ 50% + S @ 50% + @ Rhizobium 75%, T_7 -RDF @ 50% + S @ 50% + @ Rhizobium 100%, T_8 -RDF @ 100% + S @ 100% + @ Rhizobium 75% and T_9 -RDF @ 100% + S @ 100% + @ Rhizobium 100%. During the experimentation, growth and yield characters were recorded. The source of inorganic nutrients was Urea, SSP, MOP, micronutrient and rhizobium respectively.

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Results and Discussions

After harvesting the shows that soil bulk density was found to be non significant by organic and inorganic. The maximum soil bulk density at 0-15 to 15-30 cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%] which was 1.32 and 1.33 Mg m-3 and minimum soil bulk density was recorded in T_1[(Control)] which was 1.24 and 1.25 Mg m-3. The maximum bulk density was recorded in treatment T9. Similarfindingswererecorded byVerma andBaigh,(2012), Kumar*et al.* (2008). The maximum soil particle density at 0-15 to 15-30 cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%], which was 2.51and 2.52 Mg m-3 and minimum soil particle density was recorded in T_1[(Control)], which was 2.43 and 2.44 Mg m-3. Similarfindingswere recordedby Kumar*et al.* (2008),Reddy*et al.* (2005),Gupta*et al.* (2000). The maximum soil %porespace at 0-15 to 15-30 cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%], which was 46.63and 41.98%and minimum soil %porespace was recorded in T_1[NPK @ 0% + S @ 0% + @ Rhizobium 0%], which was 41.10and 36.80%. The maximum soil

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waterholdingcapacity(%)at 0-15 to 15-30 cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%], which was 40.96and 36.71% and minimum soil waterholdingcapacity(%)was recorded in T_1[(Control)], which was 35.55and 31.48% ThetableshowstheinteractionbetweenNPKfertilizersinconjunctionwith*Rhizobium*onwaterholdingcapacityinsoilwassignificant..SimilarfindingswererecordedbyKumar*etal.*(2008),Reddy*etal.*(2005). ThemaximumsoilpHw/v(1:2.5) at 0-15 to 15-30 cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%], which was 7.12 and 7.16 and minimum soil pH was recorded in T_1[(Control)], which was 6.71 and 6.75. The maximum soil pH was recorded 7.35 in treatment T0(control) Similar findingswererecorded byVerma andBaigh,(2012), Takase*et al.* (2011).The maximum soil EC (dS m^{-1}) at 0-15cm soil depth was recorded in T_9[NPK @ 100% + S @ 100% + @ Rhizobium 100%], which was 0.43 and 0.42 Mg m^{-1} andminimum was recorded inT_1[(Control)], which was 0.29 and 0.26 Mg m^{-1}.The maximum EC of the soil was recorded in treatment T9 [RDF @ 100% + S @100%+@Rhizobium100%].SimilarfindingswererecordedbyTakase*etal.*(2011),Kumar,(2008)Gupta*et al.* (2000).

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Table 1: Physical properties of soil sample after harvesting of Pea (Pisum sativum L.)

Treatment combination		Bulk density (Mg m-3)		Particle density (Mg m-3)		Pore Space (%)		Water Holding Capacity(%)		pH w/v (1:2.5)		EC (dS m-1)	
		0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth
T1	(Control)	1.24	1.25	2.43	2.44	41.10	36.8	35.55	31.48	6.71	6.75	0.29	0.26
T2	NPK @ 0% + S @ 0% + @ Rhizobium 50%	1.24	1.25	2.44	2.45	41.56	37.43	35.97	31.7	7.23	7.27	0.31	0.28
T3	NPK @ 0% + S @ 0% + @ Rhizobium 75%	1.25	1.26	2.45	2.46	42.18	38.46	36.07	32.18	7.25	7.29	0.33	0.3
T4	NPK @ 0% + S @ 0% + @ Rhizobium 100%	1.26	1.26	2.45	2.46	42.43	39.21	36.84	32.72	6.80	6.84	0.37	0.34
T5	NPK @ 50% + S @ 0% + @ Rhizobium 50%	1.26	1.27	2.46	2.47	43.38	39.87	37.61	33.92	7.27	7.31	0.38	0.35
T6	NPK @ 50% + S @ 50% + @ Rhizobium 75%	1.28	1.29	2.47	2.48	43.98	40.06	38.3	34.22	7.28	7.32	0.38	0.35
T7	NPK @ 50% + S @ 50% + @ Rhizobium 100%	1.29	1.3	2.48	2.49	44.5	40.86	38.84	35.09	7.16	7.20	0.39	0.36
T8	NPK @ 100% + S @ 100% + @ Rhizobium 75%	1.3	1.31	2.51	2.52	45.48	41.67	40.51	35.85	6.73	6.77	0.43	0.42
T9	NPK @ 100% + S @ 100% + @ Rhizobium 100%	1.32	1.33	2.51	2.52	46.63	41.98	40.96	36.71	7.12	7.16	0.43	0.42
F- test		NS	NS	NS	NS	S	S	S	S	NS	NS	NS	NS
S. Ed. (±)		-	-	-	-	0.62	0.48	0.68	0.55	-	-	-	-
C. D. (P = 0.05)		-	-	-	-	1.32	0.99	2.06	1.65	-	-	-	-

The data recorded on % organic carbonwasrecorded at0-15and 15-30cmsoildepth.Theresultofthedatashowsthatsoil %organiccarbon was found to be significant by organic and inorganic. The maximum soil % organiccarbon at 0-15and 15-30cmsoildepth was recorded in T9 [NPK @ 100% + S @ 100% + @ Rhizobium 100%] which was 0.53 and 0.44 minimum was recorded in T1[(Control)] which was 0.30 and 0.28.Similarfindingswererecordedby VermaandBaigh,(2012),Kumar*etal.* (2008)andReddy*et al.* (2005).The maximum soil Available Nitrogen (kg ha^{-1}) at 0-15and 15-30cmsoildepth was recorded in T9 [NPK @ 100% + S @ 100% + @ Rhizobium 100%] which was 285.42 and283.93 minimum was recorded in T1[(Control)] which was 258.15 and 256.82.Similar findings have been reported by Malav*et al.* (2018),Patel*et al.* (2018),Patel *et al.* (2010), Manohar*et al.* (2018).The maximum soil AvailablePhosphorus(kgha^{-1}) at 0-15and 15-30cmsoildepth was recorded in T9 [NPK @ 100% + S @ 100% + @ Rhizobium 100%] which was 25.01and24.08 minimum was recorded in T1[(Control)] which was 12.25 and 11.32.Thesefindingscorroboratewiththeresultsreportedby Katkar*etal.*,2011.Moharana*etal.*,(2012)alsofoundthemaximumincreaseinavailablephosphorusinthesurface soil withtheincorporation ofPSBalong with NPK through chemicalsovercontrol.The maximum soil AvailablePotassium(kgha^{-1})at 0-15and 15-30cmsoildepth was recorded in T9 [NPK @ 100% + S @ 100% + @ Rhizobium 100%] which was 218.10and216.17 minimum was recorded in T1[(Control)] which was 184.41 and 182.48. The lowest available potassium was recorded in thetreatment T0 which might be due to continuous cropping and no addition of organic and inorganic fertilizersinthesoil(Katkar*etal.*,2011).Inthesub-surfacelayer(15-30cm),theavailablepotassiumwasfoundlowascompared to the surface soil but the pattern was same. This might be due to lower SOM and higher fixationofpotassium ions inthesub surface soil. Similarfindingswere reported by Moharana*et al.*, (2012).

Table 2: Chemical properties of soil sample after harvesting of Pea (Pisum sativum L.)

Treatment combination		Organic Carbon (%)		Available Nitrogen (kg ha-1)		Available Phosphorous (kg ha-1)		Available Potassium (kg ha-1)	
		0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth	0 – 15 cm Depth	15 – 30 cm Depth
T1	(Control)	0.30	0.28	258.15	256.82	12.25	11.32	184.41	182.48
T2	NPK @ 0% + S @ 0% + @ Rhizobium 50%	0.37	0.35	260.97	259.64	12.93	12.00	189.33	187.51
T3	NPK @ 0% + S @ 0% + @ Rhizobium 75%	0.39	0.37	268.65	267.32	16.21	15.28	192.85	190.12
T4	NPK @ 0% + S @ 0% + @ Rhizobium 100%	0.42	0.40	273.18	271.72	16.22	15.29	193.19	191.26
T5	NPK @ 50% + S @ 0% + @ Rhizobium 50%	0.43	0.41	274.91	273.58	16.93	16.00	196.83	194.90
T6	NPK @ 50% + S @ 50% + @ Rhizobium 75%	0.47	0.45	282.05	280.26	17.97	17.04	201.15	199.22
T7	NPK @ 50% + S @ 50% + @ Rhizobium 100%	0.52	0.50	282.26	280.93	19.96	19.03	205.83	203.90
T8	NPK @ 100% + S @ 100% + @ Rhizobium 75%	0.43	0.51	284.59	283.26	20.65	19.72	212.83	210.90
T9	NPK @ 100% + S @ 100% + @ Rhizobium 100%	0.53	0.44	285.42	283.93	25.01	24.08	218.10	216.17
F- test		NS	NS	S	S	S	S	S	S
S. Ed. (±)		-	-	2.18	1.8	1.10	0.68	1.75	1.41
C. D. (P = 0.05)		-	-	4.42	3.62	2.23	1.40	3.28	1.85

CONCLUSION

From trial it was concluded that the various level of Nitrogen, Phosphorous, Potassium, Sulphur andRhizobiumusedintheexperimentgavethebestresultinthetreatmentT9(NPK@100%+S@100% +Rhizobium@100%)andthesoilhealthparametersretainedthesuitablesoilproperties,yield attributesandyield of Field Pea.Therefore, it can be recommended for farmers to obtain best combination Treatment (T9) for higher farmincome.

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