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Response of different levels of phosphorus and zinc on soil health after harvesting Clusterbean (*Cyamopsis tetragonoloba* L.) *VAR*. Selection 220

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Abstract

The study was conducted at the Research Field of the Department of Soil Science and Agricultural Chemistry, Naini Agricultural Institute, SHUATS, during the *Zaid* season of 2021 to assess the effect of different levels of Phosphorus and Zinc on soil health. Inceptisol was the order of the soil in the experimental location. The experiment was set up using a Randomized Block Design, which consisted of nine treatment combinations that were replicated three times and had three levels of zinc (0,10 and 20 kg ha^{-1}) and phosphorus (0, 25 and 50 kg ha^{-1}). Individual or combined applications of Zinc and Phosphorus have a considerable impact on the physical and chemical properties of soil. Bulk density, particle density, soil pH and available Zinc increased as the depth of the soil increased, whereas pore space, electrical conductivity, organic carbon, available Nitrogen, Phosphorus and Potassium decreased. The soil was slightly alkaline in nature, with a normal EC, a medium range of organic carbon, available Nitrogen and Potassium and a high range of available Phosphorus and a low range of available Zinc. All the soil parameters found best in treatment T_9 (@ 100% $ZnSO_4$ + @ 100% P_2O_5 + RDF).

Keywords: Clusterbean, zinc, phosphorus, pH, EC, OC

Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub], sometimes known as 'Guar,' is a common legume crop that belongs to the *Leguminaceae* family and is believed to promote soil fertility. During the *kharif* season, it thrives well in rainfed conditions in dry and semiarid regions, and prefers well-drained sandy loam soil with a pH of 7.5 to 8.0. Bacterial nodulation is impeded in heavy soil, and it requires a long day for growth and a short day for flowering to begin. Clusterbean is unlike any other legume crop in terms of hardiness and drought tolerance [1]. It promotes soil fertility by fixing atmospheric nitrogen, with a capacity of 37-196 kg of nitrogen per hectare per year [2]. It is sometimes used to reclaim saline and alkaline soils [3]. India is the world's leading guar producer, accounting for roughly 75 to 80% of global total production (7.5 to 10 lakh tones) [4]. Rajasthan has the most area under cultivation (82.1%), followed by Haryana (8.5%), Gujarat (8.1%), and Punjab (1.0%), with average productivity of 272 kg ha^{-1} in Rajasthan, 881 kg ha^{-1} in Haryana, 522 kg ha^{-1} in Gujarat, and 748 kg ha^{-1} in Punjab, respectively [5]. When sprayed to legumes like clusterbean, phosphorus causes early root development, growth, and blooming, as well as assisting in seed generation. Phosphorus has a beneficial and considerable effect on crop nodulation [6], as well as allowing rhizobia in root nodules to function [7]. Phosphorus is more significant than nitrogen for legume crops since the latter is fixed by rhizobium through symbiosis. Hand book of Agriculture by ICAR, (2010). Cluster bean is likewise a micronutrient-responsive crop. Zinc is required for the creation of chlorophyll, protein, and the regulation of water absorption. It is necessary for plant growth and also functions as an enzyme activator, assisting in the induction of alkalinity tolerance in crops by increasing the Na/K and Na/Ca ratio. Zinc is involved in carbohydrate metabolism and is directly involved in the biosynthesis of growth regulators such as auxin, which promote the production of more plant cells and biomass, which is stored in plant organs, particularly seeds, and its deficiency is one of the main reasons for low yield in light texture soils [8].

Materials and Methods

During *Zaid* 2021, the experiment was carried out at the Research Farm of the Department of Soil Science and Agricultural Chemistry, Naini Agriculture Institute, SHUATS, which is located at $25^{0}57'$ N latitude and $81^{0}57'$

E longitude at a mean elevation of 98 m above mean sea level. It was designed using a Randomized Block Design, with nine treatment combinations replicated three times and fertilizer doses applied in each plot according to the treatment combinations listed in Table 1.

Soil samples were taken with a soil auger from depths of 0-15 and 15-30 cm from each experimental plot. The soil samples were air dried, and all impurities were removed. Clods were broken with a wooden mallet, and the sample was sieved with a 2mm stainless steel sieve before being stored in polythene bags. The methods listed in Table 2 were used to examine various physical and chemical properties of the soil.

Table 1: Treatment Combinations

Treatment	Treatment combination
T_1	Control
T_2	@ 0% $ZnSO_4$ + @ 50% P_2O_5 + RDF
T_3	@ 0% $ZnSO_4$ + @ 100% P_2O_5 + RDF
T_4	@ 50% $ZnSO_4$ + @ 0% P_2O_5 + RDF
T_5	@ 50% $ZnSO_4$ + @ 50% P_2O_5 + RDF
T_6	@ 50% $ZnSO_4$ + @ 100% P_2O_5 + RDF
T_7	@ 100% $ZnSO_4$ + @ 0% P_2O_5 + RDF
T_8	@ 100% $ZnSO_4$ + @ 50% P_2O_5 + RDF
T_9	@ 100% $ZnSO_4$ + @ 100% P_2O_5 + RDF

RDF: N- 25 kg ha^{-1}, P- 50 kg ha^{-1}, K- 50 kg ha^{-1}

Table 2: Soil Analysis Methods

Parameters	Methods	Scientist
Bulk density (Mg m^{-3})	Graduated Measuring Cylinder	Muthuval *et al.*, (1992)
Particle density (Mg m^{-3})		
Pore space (%)		
Soil pH	pH meter	Jackson, 1958
EC (dSm^{-1})	Conductivity meter	Wilcox, 1950
Organic Carbon	Wet Oxidation Method	Walkley and Black, 1947
Available Nitrogen (kg ha^{-1})	Alkaline Permanganate Method	Subbiah and Asija, 1956
Available Phosphorus (kg ha^{-1})	Photoelectric Colorimeter	Olsen *et al.*, 1954
Available Potassium (kg ha^{-1})	Flame Photometer	Toth and Prince, 1949
Available Zinc (mg kg^{-1})	DTPA-extraction	Lindsay and Norvell,1978

The method of analysis of variance (ANOVA) was used to analyses all of the acquired data, as defined by Fischer. The significance and non-significance of treatment were determined using the 'f' variance ratio test. With the use of standard error for the differences of two treatments mean and tabulated value of 't' at 5% level of significance and error degree of freedom, the critical difference of all the characters was calculated to compare the means of two treatments.

Result and Discussion

Physical Properties of Soil

Table 3 shows the effects of various levels of Zinc and Phosphorus on soil physical parameters following clusterbean harvesting. For bulk density and particle density of soil, statistical examination of data was determined to be non-significant. Bulk density (Mg m^{-3}) and Particle density (Mg m^{-3}) increase with soil depth, whereas Percentage Pore space decreases, as 0-15cm soil depth includes Bulk density 1.266 Mg m^{-3}, Particle density 2.412 Mg m^{-3}, and Pore space 44.93%, whereas 15-30 cm soil depth includes Bulk density 1.269 Mg m^{-3}, Particle density 2.418 Mg m^{-3}, and Pore space 44.44%. For both depths, the treatment T_9 ($ZnSO_4$ @ 20 kg + P_2O_5 @ 50 kg ha^{-1}) had the best results. The findings are consistent with those of [10, 11, 12].

Chemical Properties of Soil

Table 4 shows the effects of various levels of Zinc and Phosphorus on soil chemical parameters following clusterbean harvesting. In the case of soil pH, statistical analysis revealed that it was not significant. The chemical properties of samples collected from 0-15cm and 15-30cm show that pH and available Zinc increase with soil depth, while EC (dSm^{-1}), OC (%), available Nitrogen, Phosphorus, and Potassium (kg ha^{-1}) decrease. For example, the 0-15cm soil depth includes pH 7.440, EC 0.591 (dSm^{-1}),Organic carbon 0.569%, available Nitrogen 275.35 kg ha^{-1}, available Phosphorus 33.96 kg ha^{-1}, available Potassium 154.43 kg ha^{-1} and available Zinc 0.410 mg kg^{-1} whereas sample collected from 15-30cm soil depth includes pH 7.446, EC 0.587(dSm^{-1}), Organic carbon 0.568%, available Nitrogen 275.23 kg ha^{-1}, available Phosphorus 33.85 kg ha^{-1}, available Potassium 154.34 kg ha^{-1} and available Zinc 0.417 mg kg^{-1}. For both depths, the treatment T_9 ($ZnSO_4$ @ 20 kg + P_2O_5 @ 50 kg ha^{-1}) had the best results. The findings are consistent with those of [13, 14, 15, 11].

Table 3: Effect of different levels of Phosphorus and Zinc on physical properties of post harvest soil sample of 0-15 and 15-30 cm depth.

Treatments	D_b (Mg m^{-3})		D_p (Mg m^{-3})		Percent pore space	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	1.392	1.397	2.412	2.418	42.33	41.74
T_2	1.390	1.395	2.423	2.429	42.83	42.71
T_3	1.384	1.389	2.426	2.430	43.05	42.92
T_4	1.383	1.388	2.431	2.436	43.38	43.29
T_5	1.381	1.386	2.435	2.439	43.61	43.54
T_6	1.375	1.379	2.442	2.446	43.82	43.68
T_7	1.372	1.377	2.443	2.446	44.16	43.94
T_8	1.371	1.376	2.443	2.447	44.75	44.13
T_9	1.364	1.368	2.444	2.449	44.93	44.44
SE.D	NS	NS	NS	NS	0.04	0.31
CD at 5%	_	_	_	_	0.09	0.67

D_b – Bulk density, D_p- Particle density

Table 4: Effect of different levels of Phosphorus and Zinc on chemical properties of post harvest soil sample of 0-15 and 15-30 cm depth.

Treatment	pH		EC (dS m^{-1})		OC (%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})		Available Zn (mg kg^{-1})	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
T_1	7.480	7.484	0.537	0.531	0.566	0.566	254.25	254.13	24.57	24.41	131.28	131.19	0.310	0.318
T_2	7.474	7.479	0.549	0.543	0.566	0.565	258.46	258.34	27.73	27.62	135.20	135.11	0.324	0.330
T_3	7.472	7.476	0.548	0.542	0.567	0.566	262.95	262.83	28.53	28.39	138.65	138.56	0.332	0.339
T_4	7.465	7.469	0.556	0.550	0.566	0.566	264.24	264.12	28.82	28.70	142.72	142.63	0.340	0.348
T_5	7.463	7.467	0.567	0.562	0.567	0.567	266.12	266.01	29.86	29.22	146.77	146.68	0.343	0.351
T_6	7.453	7.459	0.578	0.572	0.568	0.567	269.92	269.80	29.86	29.73	146.87	146.59	0.365	0.372
T_7	7.452	7.457	0.586	0.581	0.568	0.568	270.18	270.06	31.15	31.04	148.68	148.47	0.371	0.377
T_8	7.451	7.455	0.589	0.584	0.569	0.568	273.46	273.44	32.28	32.16	150.56	150.30	0.392	0.399
T_9	7.440	7.446	0.591	0.587	0.569	0.568	275.35	275.23	33.96	33.85	154.43	154.34	0.410	0.417
F-test	NS	NS	S	S	S	S	S	S	S	S	S	S	S	S
SE.D	_	_	0.01	0.01	0.01	0.01	0.114	0.139	0.008	0.007	0.034	0.035	0.001	0.001
CD at 5%	_	_	0.002	0.002	0.002	0.002	0.244	0.298	0.018	0.016	0.072	0.074	0.002	0.002

EC- Electrical conductivity, OC – Organic carbon, AN- Available Nitrogen, AP- Available Phosphorus, AK- Available Potassium, AZn – Available Zinc

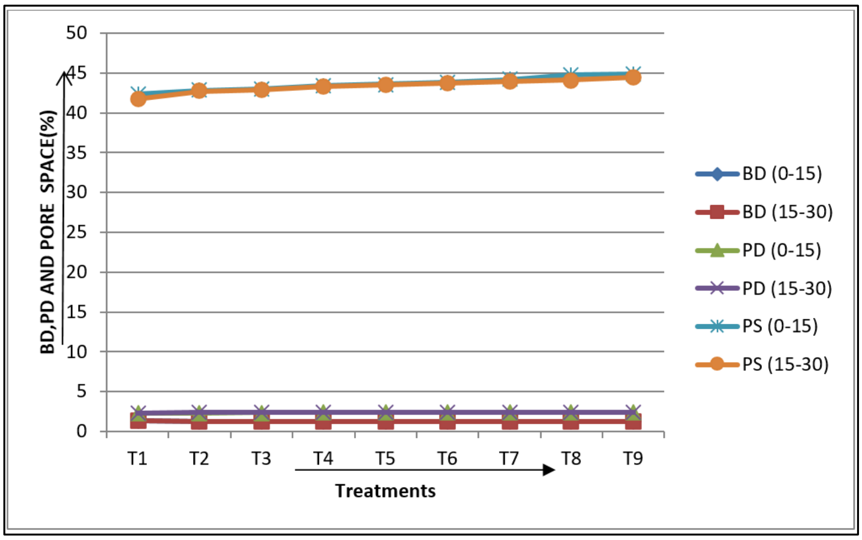

Fig 1: Effect of different levels of Phosphorus and Zinc on physical properties of post harvest soil sample of 0-15 and 15-30 cm depth.

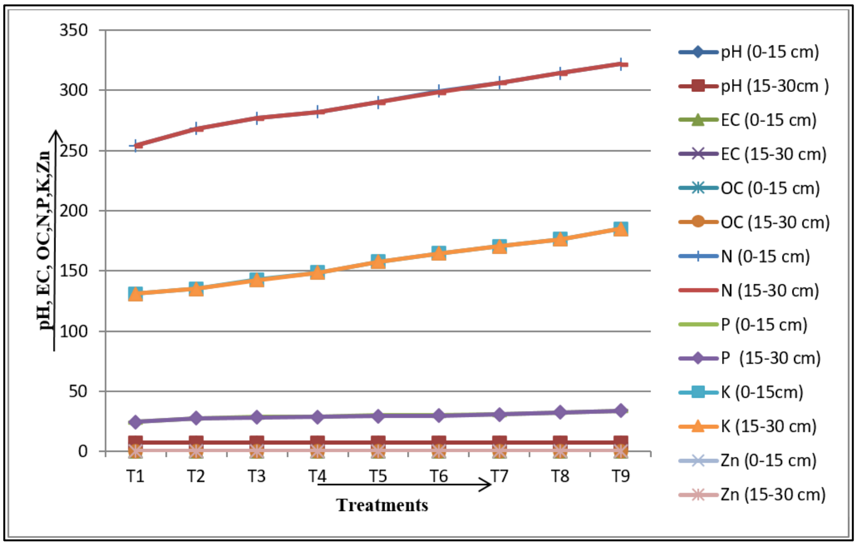

Fig 2: Effect of different levels of Zinc and Phosphorus on chemical properties of post harvest soil sample of 0-15 and 15-30 cm depth.

Conclusion

As a result, all soil-related indicators were determined to be at their highest in treatment T_9 (@100% $ZnSO_4$+ 100% P_2O_5+ RDF), whereas they were at their lowest in treatment T_1 (control). It has been discovered that if we apply Zinc and Phosphorus fertilizers at a specific dose, our soil health improves, but if we apply a high amount of Phosphorus in comparison to Zinc, there is a Zinc deficiency in the soil because they have an antagonist effect, so a well- balanced fertilizer supply is critical for maintaining soil fertility.

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Conflict of Interest: None

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