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Impact of Various Levels of Nitrogen, Potassium, Phosphorus and Biochar on Soil Physico-chemical Properties and Yield of Black gram (*Vigna mungo* L.) *Var:* Shekhar-2

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

At the “Central Research Farm, Soil Science and Agricultural Chemistry Department, SHUATS, Prayagraj”, an experiment titled "Impact of various levels of Nitrogen, Potassium, Phosphorus and Biochar on Soil Physico-chemical Properties and Yield of Black gram(*Vigna mungo* L.)*Var*: Shekhar-2" was carried out during the Zaid season of 2023–2024. A randomized block design was used, consisting of three variables and three levels of NPK (at 0, 50, and 100% ha^{-1}) and biochar (at 0, 50, and 100% ha^{-1}). An excavated soil specimen from the experimental site prior to the start of study activities showed that the soil had a sandy loam texture, a neutral to alkaline reaction, and significantly higher treatment levels.

Keywords: Biochar; NPK; Black gram; soil; growth; yield.

1. INTRODUCTION

A healthy life is built on healthy soils. The capacity of soil to provide environmental quality, plant ,animal health, and biological productivity is referred to as soil health. Conservation and deliberate management of soil health principles are necessary to maintain soil health. But it's worth it. Because life depends on soil, bad soils have a negative influence on plant, animal, and human health. Five tasks carried out by good soil support clean air, water, and living things. According to these five roles include controlling water flow, maintaining plant and animal life, filtering and absorbing any contaminants, cycling nutrients, and offering support and stability physically.

Black gram (*Vigna mungo L*.), is one of the most important pulse crop. A healthy fertilization program is necessary to increase black gram yield. It can symbiotically repair atmospheric nitrogen to suit its nitrogen needs. The two nutrients that require attention are sulfur and phosphorus. Black Gram reacts strongly to sulfur treatment. Both sulfur and phosphorus can enhance the yield and quality of the pulses. Thus, the goal of the current investigation was to determine how black gram reacted to different amounts of application of PSB, sulfur, and phosphorus. Since black gram is a leguminous crop and can fix nitrogen from the atmosphere, it is also utilized as a green manuring crop. Additionally, it aids in halting soil erosion. Given its short lifetime and offseason plasticity, it works well in many intensive crop rotations.

Vigna mungo L. Hepper, or uradbean, is one of the main pulses farmed in the nation throughout the summer and wet seasons. Legume that self-pollinates, it has a 24 percent protein content, 60 percent carbohydrate content, 1.30% fat content, 3.20% minerals, 0.9% fiber content, 154 mg calcium, 9.1% iron, and a negligible quantity of vitamin B complex. It works effectively in a variety of multiple and intercropping systems because it is a short-duration crop. Plant’s can utilized high-quality of green manure or wilted feed after the pods are removed. As a legume, it fixes atmospheric nitrogen, which further enriches the soil.

About 13% of the overall area and 10% of the pulses produced in our nation come from uranium. It is produced in the nation on 3.06 million hectares of land, yielding 1.70 million t of yield and 555 Kg ha-1 of productivity over 70% of the world's production, India is currently the leading producer of black grams. Pakistan and Myanmar come after India. Black gram coverage in India during the 2019–20 kharif is 37.52 lakh ha. India's top producers of black gram during Kharif are Andhra Pradesh (0.11 lakh ha) and Karnataka (0.687 lakh ha). (*4th Advance Estimates, Directorate of Economics and Statistics (DES), 2019–20). it may be cultivated on any kind of soil, from sandy loam to heavy clay except alkaline and salty soil. On heavier soils, such as black soils, which have high water holding capacity, it performs well.

2. MATERIALS AND METHODS

An investigation was carried out in the field at the “Central Research Farm, Soil Science and Agricultural Chemistry Department, SHUATS, Prayagraj”. Normally, this region is part of Uttar Pradesh's subtropical belt, which is located in the southeast and experiences warm summers and cold winters. The minimum and maximum temp. recorded between 4°C or5°C and rise to 46°C or 48°C. There was relative humidity ranging from 20 to 94%. An average of 1100 mm of precipitation falls in this area each year.

The soil at the experimental site is situated at latitude 25^0 57'N and longitude 81^0 59'E, 98 meters higher then sea level. The soil in the experiment area has a sandy loam texture and is categorized as Inceptisol (62.71% sand, 23.10% silt, and 14.1% clay). Utilizing a RBD, 9 treatment combination and 3 NPK level (0, 50, and 100%) and Biochar level (0, 50, and 100%) doses were used in the setup of the experiment. The treatment has been made three times. In all, there were 27 plots. During the Zaid season, black gram is sown with a 30 x 10 cm spacing between each plant in 2 × 2 m squares.

Using a soil auger, specimens of the soil were obtained from each plot both before and after the experiment, at a depth of 0–15 cm is denominated as d_1 depth to 15-30 cm is denominated as d_2 depth. The various properties were assessed after the soil specimens were allowed to air dry and sieved by 2 mm screen. A pH meter given by M.L. Jackson [1] was used to determine the pH of the soil, while a conductivity meter was used by Wilcox [2] to determine the electrical conductivity (EC). The methods by Subbiah and Asija [3], Olsen et al. [4], and Toth and Prince [5] were utilized to compute the available nitrogen (N), phosphorus (P), and potassium (K).We used the Walkley and Black method to identify soil organic carbon (SOC).

3. RESULTS AND DISCUSSION

3.1 Physical Property

a. Bulk density (Mg m^{-3}) (BD)

It was shown that there was no statistically significant relationship between the bulk density of soil and the quantities of NPK and biochar. In T_1, the lowest BD of soil was measured at 1.233 Mg m^{-3} at d_1 depth and 1.249 Mg m^{-3} at d_2 depth respectively. In T_9, the highest BD of soil was measured at 1.284 Mg m-3 at d_1 depth and 1.286 Mg m^{-3} at d_2 depth. In T_8, the subsequent two greatest BD were 1.280 Mg m^{-3} at d_2 depth and 1.282 Mg m^{-3} at d_1 depth. Additionally, it was noted that when the dosage of various NPK and biochar levels grew, the BD of the soil steadily increased as well. Kumar et al. [6], Reddy et al.,[7] and Bhattacharya et al. [8] have all reported similar results.

b. Particle density (Mg m^{-3}) (PD)

It was shown that there was no statistically significant difference in the soil's reaction PD to NPK and biochar levels. In T_1, the lowest soil PD was measured at 2.465 Mg m^{-3} at d_1 depth and 2.472 Mg m^{-3} at d_2 depth. In T_9, the highest PD of soil was measured at 2.518 Mg m^{-3} at d_1 depth and 2.522 Mg m^{-3} at d_2 depth. Then, in T_8, 2.504 Mg m^{-3} at d_1 depth and 2.512 Mg m^{-3} at d_2 depth was measured. Additionally, it was noted that when the dosage of various NPK and biochar levels grew, the soil's PD progressively increased. Hussain et al., [9],Chintha et al.,[10] and Dangi et al., [11] have all reported results that are similar.

C. Pore space (%) (PS)

It was discovered that the reaction PS of soil to NPK and biochar levels was considerable. In T_1, the minimum PS of the soil was measured at 41.6% at d_1 depth and 37.40 % at d_2 depth, respectively. The highest percentage of soil PS was observed in $T_9$46.6 at d1 depth and 42.20 % at d_2 depth. This was followed by T_8 at 45.60% at d_1 depth and 41.50% at d_2 depth. Also, as the dosage of various NPK and biochar levels was raised, it was noted that the PS of the soil steadily expanded. Amurta et al. [12], Azadi et al. [13], and Kumawat et al.[14] have all reported similar results.

d. Water holding capacity (%) (WHC)

It was discovered that the amount of NPK and biochar in the soil significantly affected its ability to retain water. The greatest WHC of the soil was found to be 40.3% at d_1 depth and 38.7% at d_2 depth in T_9. This was followed by therapy T_8 at 39.5% at d_1 depth and 37.9% at d_2 depth. In T_1, the lowest WHC of the soil was measured 34.5% at d_1 depth and 32.4% at d_2 depth.Also, it was noted that when the dosage of various NPK and biochar levels rose, the soil's WHC (%) grew steadily. Amurta et al. [12], Azadi et al. [13], and Kumawat et al. [14] have all reported similar results.

3.2 Chemical Property

a. pH of soil w/v (1:2.5)

It was discovered that the pH of the soil responded significantly to NPK and biochar levels. The lowest soil pH was observed in T_1, respectively, 6.55 at d_1 depth and 6.61 at d_2 depth. The highest pH of the soil was measured in T_9 respectively, at 7.09 d_1 depth and 7.15 at d_2 depth. This was followed by T_8 6.99 at d_1 depth and 7.01 at d_2 depth. Additionally, it was noted that when the dosage of various NPK and biochar levels grew, the pH of the soil steadily increased. Sohel et al.,[15] Chandrakar, [16], and Jha et al.,[17] have all reported similar results.

Table1. Effect of NPK and Biochar on soil physical properties

Treatment	BD(Mg m^{-3})		PD(Mg m^{-3})		Pore space (%)		WHC (%)	
	d_1 depth	d_2 depth	d_1 depth	d_2 depth	d_1 depth	d_2 depth	d_1 depth	d_2 depth
T1-NPK@0 % + Biochar@0 %	1.243	1.249	2.475	2.476	41.6	37.4	33.5	32.4
T2-NPK@0 % + Biochar@50 %	1.238	1.245	2.470	2.477	41.9	37.6	35.1	33.6
T3-NPK@0 % + Biochar@100 %	1.244	1.252	2.476	2.482	42.4	39.1	36.0	35.4
T4-NPK @ 50 % + Biochar @ 0 %	1.260	1.258	2.483	2.487	42.2	38.1	35.8	35.2
T5-NPK @ 50 % + Biochar @ 50 %	1.255	1.264	2.499	2.501	43.8	39.7	36.5	35.9
T6-NPK @ 50 % + Biochar @ 100 %	1.262	1.268	2.485	2.498	44.2	40.5	37.2	36.3
T7-NPK @ 100 % + Biochar @ 0 %	1.266	1.275	2.501	2.510	44.6	41.1	38.9	36.1
T8-NPK @ 100 % + Biochar @ 50 %	1.282	1.280	2.504	2.512	45.6	41.5	39.5	37.9
T9-NPK @ 100 % + Biochar @ 100 %	1.284	1.286	2.518	2.522	46.6	42.2	40.3	38.7
F-Test	NS	NS	NS	NS	41.6	37.4	33.5	32.4
S.Ed. (±)	-	-	-	-	0.65	0.36	0.67	0.66
CD at 0.5%	-	-	-	-	1.98	1.10	2.02	1.99

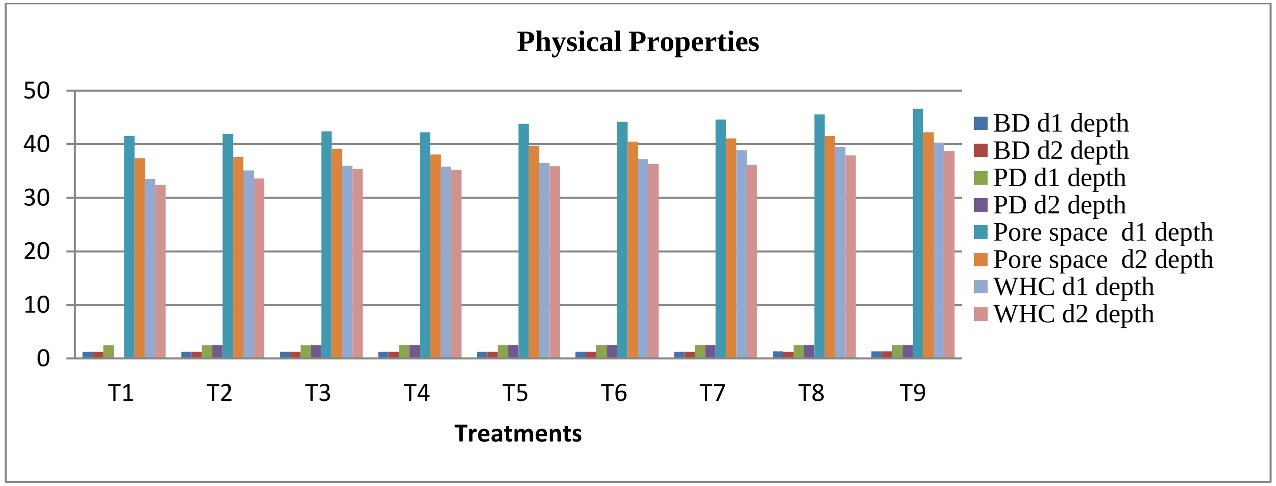

Fig. 1. The impact of varying NPK and biochar levels on the water-holding capacity, PD (Mg m^{-3}), PS (%), and BD (Mg m^{-3}) of soil at depths of 0–15 cm (d_1 depth) and 15–30 cm (d_2 depth)

Table 2. Effect of NPK and Biochar on soil chemical properties

Treatment	pH		EC (dS m^{-1})		Organic carbon (%)	
	d1 depth	d2 depth	d1 depth	d2 depth	d1 depth	d2 depth
T1-NPK @ 0 % + Biochar @ 0 %	6.58	6.61	0.442	0.451	0.375	0.367
T2-NPK @ 0 % + Biochar @ 50 %	6.59	6.68	0.451	0.455	0.379	0.376
T3-NPK @ 0 % + Biochar @ 100 %	6.75	6.78	0.458	0.461	0.388	0.377
T4-NPK @ 50 % + Biochar @ 0 %	6.69	6.72	0.453	0.458	0.383	0.373
T5-NPK @ 50 % + Biochar @ 50 %	6.81	6.87	0.461	0.465	0.391	0.380
T6-NPK @ 50 % + Biochar @ 100 %	6.86	6.91	0.466	0.472	0.394	0.385
T7-NPK @ 100 % + Biochar @ 0 %	6.94	6.97	0.462	0.474	0.397	0.389
T8-NPK @ 100 % + Biochar @ 50 %	6.99	7.01	0.475	0.479	0.402	0.392
T9-NPK @ 100 % + Biochar @ 100 %	7.09	7.15	0.471	0.484	0.406	0.395
F-Test	**S**	**S**	**NS**	**NS**	**S**	**S**
S.Ed. (±)	**0.08**	**0.08**	**-**	**-**	**0.004**	**0.003**
C.D. at 0.5%	**0.24**	**0.25**	**-**	**-**	**0.01**	**0.01**

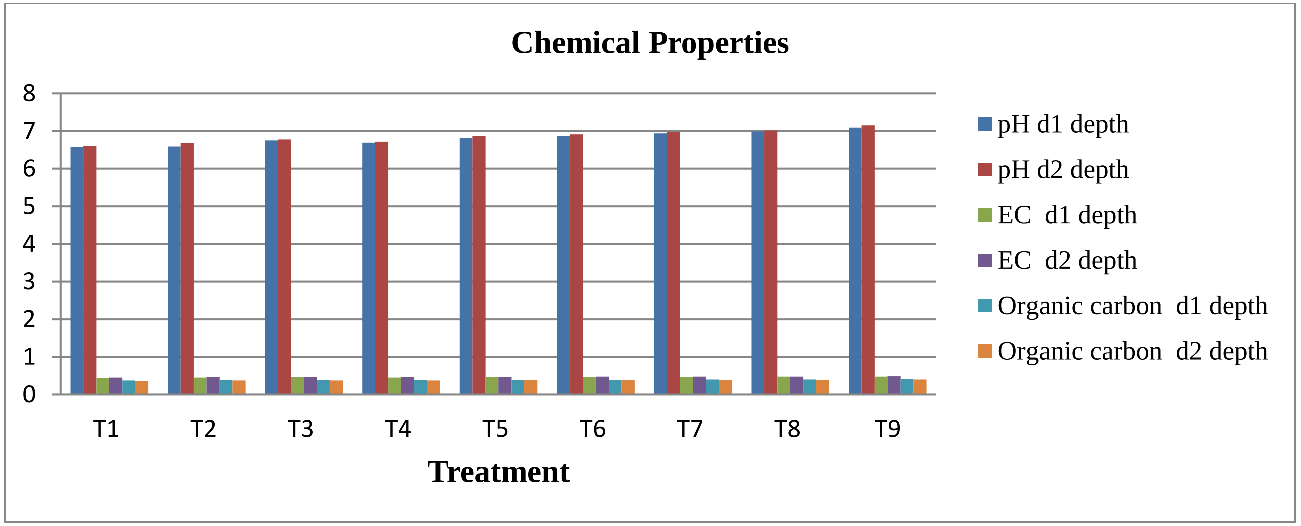

Fig. 2. Effect of varying quantities of NPK and Biochar on pH, EC (dS m^{-1}), Organic carbon (%) of soil depth0-15 cm (d_1 depth) and 15-30 cm (d_2 depth)

Table 3. Effect of NPK and Biochar on soil chemical properties

Treatment	Available Nitrogen (Kg ha^{-1})		Available Phosphorus (Kg ha^{-1})		Available Potassium (Kg ha^{-1})	
	d_1 depth	d_2 depth	d_1 depth	d_2 depth	d_1 depth	d_2 depth
T1-NPK @ 0 % + Biochar @ 0 %	292.6	287.3	16.41	17.45	185.24	178.5
T2-NPK @ 0 % + Biochar @ 50 %	292.5	288.1	18.17	17.31	184.5	179.42
T3-NPK @ 0 % + Biochar @ 100 %	294.4	290.9	17.36	16.8	186.1	181.46
T4-NPK @ 50 % + Biochar @ 0 %	298.7	292.6	19.02	18.12	188.3	184.02
T5-NPK @ 50 % + Biochar @ 50 %	301.6	295.3	19.1	17.59	193.7	187.80
T6-NPK @ 50 % + Biochar @ 100 %	305.8	299	18.84	17.08	197.8	191.56
T7-NPK @ 100 % + Biochar @ 0 %	311	305.2	20.01	19.20	202.3	196.25
T8-NPK @ 100 % + Biochar @ 50 %	318.3	311.3	20.4	19.43	206.4	202.74
T9-NPK @ 100 % + Biochar @ 100 %	322.6	317.5	20.64	19.81	210.3	207.62
F-Test	S	S	S	S	S	S
S.Ed. (±)	5.80	5.28	0.33	0.31	2.67	3.26
C.D. at 0.5%	17.48	15.90	1.02	0.93	8.04	9.83

Table 4.Impact of various cost-benefit ratios (C:B) for various black gram treatment combinations

Treatment	Yield (q ha^{-1})	SellingPrice(₹ q^{-1})	Gross return(₹ ha^{-1})	Total cost of cultivation(₹ ha^{-1})	Net profit (₹ ha^{-1})	Benefit Cost ratio (B: C)
T1-NPK @ 0 % + Biochar @ 0 %	7.9	9700.00	76630.00	42250.00	34380.00	1: 1.81
T2-NPK @ 0 % + Biochar @ 50 %	9.1	9700.00	88270.00	44716.00	43554.00	1: 1.97
T3-NPK @ 0 % + Biochar @ 100 %	9.63	9700.00	93411.00	47182.00	46229.00	1: 1.97
T4-NPK @ 50 % + Biochar @ 0 %	9.78	9700.00	94866.00	44759.00	50107.00	1: 2.11
T5-NPK @ 50 % + Biochar @ 50 %	10.4	9700.00	100880.00	47225.00	53655.00	1: 2.13
T6-NPK @ 50 % + Biochar @ 100 %	10.9	9700.00	105730.00	49691.00	56039.00	1: 2.12
T7-NPK @ 100 % + Biochar @ 0 %	11	9700.00	106700.00	47268.00	59432.00	1: 2.25
T8-NPK @ 100 % + Biochar @ 50 %	11.6	9700.00	112520.00	49734.00	62786.00	1: 2.26
T9-NPK @ 100 % + Biochar @ 100 %	12.4	9700.00	120280.00	52200.00	68080.00	1: 2.30

The following table illustrates the economics of the various treatments: - With a cost-benefit ratio of 1:2.30, therapy T_9 [NPK @ 100% + Biochar @ 100%] yields the highest net profit of ₹ 68080.00. Nonetheless, treatment T1)] showed a minimum net profit of ₹ 34380.00, with a B:C ratio of 1:1.81

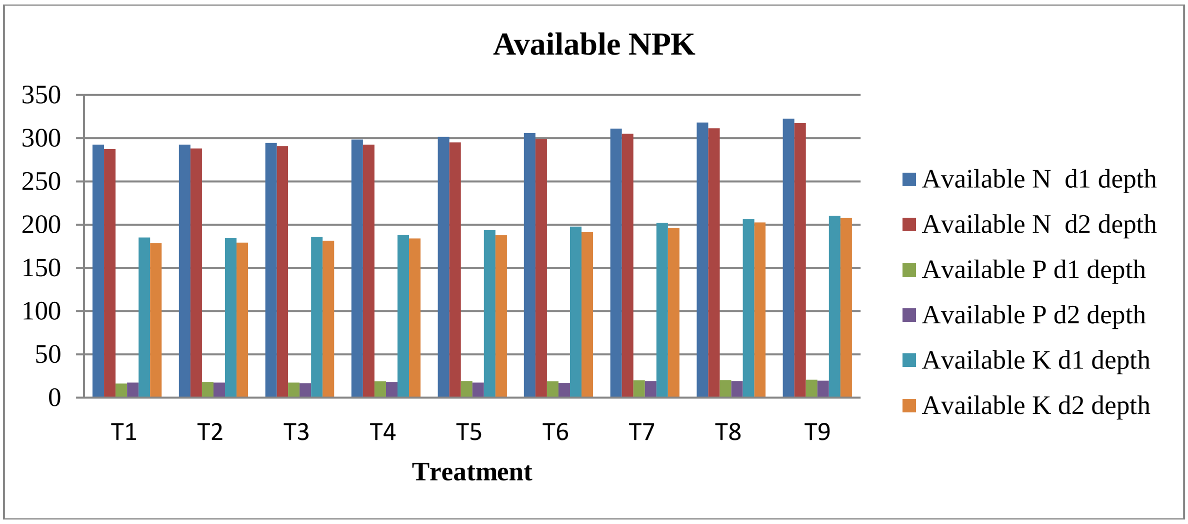

Fig. 3. Effect of different levels of NPK and Biochar on Available N (Kg h^{-1}), P (Kg h^{-1}), and K (Kg h^{-1}), of soil depth 0-15 cm (d_1 depth)and 15-30 cm (d_2 depth)

b. Electrical Conductivity (dS m^{-1}) (EC)

It was discovered that the response of soil electrical conductivity to NPK and biochar levels was not statistically significant. The results indicate that highest EC of the soil was measured at 0.471 dS m^{-1} at d_1 depth and 0.484 dS m^{-1} at d_2 depth in T_9, followed by 0.475 dSm^{-1} at d_1 depth and 0.479 dSm^{-1} at d_2 depth in T_8 and the lowest EC was measured at 0.443 dS m^{-1} at d_1 depth and 0.451 dS m^{-1} at d_2 depth in T_1, respectively. Additionally, it was noted that the addition of more NPK and biochar to the soil caused a gradual rise in EC. Meena and Ram, [18], Habib et al., [19] and Sahu et al., [20] have followed all results.

c. Organic Carbon (OC)

It was discovered that the soil's OC response to NPK and biochar levels was not statistically significant. The results indicate that the highest OC of the soil was measured 0.406 %at d_1 depth and 0.395 % at d_2 depth in T_9, followed by 0.402 % at d_1 depth and 0.392 % at d_2 depth in T_8 and the lowest OC of the soil was measured 0.373 % at d_1 depth and 0.367 % at d_2 depth in T_1, respectively. It was also noted that when the amount of NPK and biochar in the soil rose, the amount of OC in the soil steadily increased. Meena and Ram, [18], Habib et al., [19] and Sahu et al., [20] have followed all results.

d. Available Nitrogen (Kg ha^{-1}) / Available N

It was discovered that the amount of NPK and biochar significantly affected the soil's response to available N. The results indicate that the highest available N of the soil was recorded at 322.6 Kg ha^{-1} at d_1 depth and 317.5 Kg ha^{-1} at d_2 depth in T_9, followed by 318.3 Kg ha^{-1} at d_1 depth and 311.3 Kg ha^{-1} at d2 depth in T_8 whereas the lowest available N of the soil was recorded at 291.6 Kg ha-^{1} at d_1 depth and 287.3 Kg ha^{-1} at d_2 depth in T_1.In addition to providing nutrients for plant growth and enhancing drought tolerance, N treatment could boost a plant's yield. Sammauria [21] has observed similar findings.

e. Available Phosphorus (Kg ha^{-1}) / Available P

It was discovered that the amount of NPK and biochar significantly affected the soil's response to available P. The results indicate that the highest available P of the soil was found at 20.64 Kg ha^{-1} at d_1 depth and 19.81 Kg ha^{-1} at d_2 depth in T_9, then come 20.04 Kg ha^{-1} at d_1 depth and 19.43 Kg ha^{-1} at d_2 depth in T_8 whereas the lowest available P of the soil was recorded at 17.95 Kg ha^{-1} at d_1 depth and 17.45 Kg ha^{-1} at d_2 depth in T_1, correspondingly. Comparable results have been published by Sammauria [21], Javeed et al. [22], and Sharma et al. [23].

f. Available Potassium (Kg ha^{-1}) / Available K

It was discovered that the soil's response to available K was substantial in terms of NPK and biochar levels. The lowest available K was founded at 183.32 Kg ha^{-1} at d_1 depth and 178.25 Kg ha^{-1} at d_2 depth in T_1, respectively. The highest available K of soil was found at 210.3 Kg ha^{-1} at d_1 depth and 207.62 Kg ha^{-1} at d_2 depth in T_9. This was followed by 206.38 Kg ha^{-1} at d_1 depth and 202.74 Kg ha^{-1} at d_2 depth

T_8. Comparable results have been published by Sammauria [21], Javeed et al. [22], and Sharma et al. [23].

4. CONCLUSION

It was concluded that T_9 gave the best result followed by T_8. T_9 gave the highest net profit (68080.00 Rs ha^{-1}) and highest B:C ratio (1:2.30)

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Jackson ML. Soil chemical analysis Prentice Hall of India Ltd. New Delhi. 1958;219-21.
2. Wilcox LV. Electrical conductivity. Water Works Assoc. 1950;42(8):775-6.
3. Subbiah BV, Asiija EC. A rapid procedure for estimation of available nitrogen in soil. Current Science. 1956;25(8):259-60.
4. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate ($NaHCO_3$). Dairy Australia [Circular]. 1954; 939:1-19.
5. Toth SJ, Prince AL. Estimation of cation exchange capacity and exchangeable Ca, K and Na content of soil by flame photometer technique. Soil Sci. 1949;67 (6):439-46.
6. Kumar J, Sharma P, Meena S. Physicochemical properties of the soil, under the two forest plantation stands around Varanasi (U.P.), India; 2008.
7. Reddy, S., Jitendra, K. M., Thenua, O.V.S. and Jat, H.S. (2005) Effect of phosphorus and bio-fertilizer on productivity nutrient uptake and economics of black gram. Legume Res., 36(1): 41-48.
8. Bhattacharya VP, Mani AK, Thilagvathi T. Effect of sources and levels of phosphorus and P solubilizers on yield and nutrient uptake in rainfed green gram. Annals of Arid Zone. 2004;40:43-8.
9. Hussain M, Tahir M, Majeed MA. Effect of zinc sulphate as soil application and seed treatment on black gram (*Vignamungo* L.). Pakistan Journal Life Society Science. 2022;12(2):87-91.
10. Chintha, P., Alka, Y., Choudhary, B. L. and Puniya, M.M. (2021) Response of integrated phosphorus management on nodulation and productivity of mungbean on Typic Ustipsamment. Green Farming, 5: 222-225.
11. Dangi A, Kumar S, Singh S, Omkar, Singh BP. Effect of phosphorus and sulphur fertilization on productivity and nutrient uptake of black gram. Ann Agric Res New S. 2020;35(1):54-7.
12. Amruta N, Devaraju PJ, Mangalagowri Kiran SP, Ranjitha HP, Kalavati P. Effect of integrated nutrient management and spacing on seed quality parameters of black gram cv. Lbg-625 (rashmi). Journal of Applied and Natural Science. 2017;8(1):340-345.
13. Azadi E, Rafiee M, Hadis N. The effect of different nitrogen levels on seed yield and morphological characteristic of mungbean in the climate condition of Khorramabad. Annals of Biological Research. 2013;4(2):51-5.
14. Kumawat, N., Sharma, O. P. and Kumar, R. (2013) Effect of Organic Manures, PSB and Phosphorus Fertilization on Yield and Economics of Mungbean (Vigna radiata L.)Environment & Ecology. 27(1): 5-7.
15. Sohel, M. H., Miah, M. R., Mohiuddin, S. J., Islam, A. K. M. S., Rahman, M. M. and Haque, M. A. (2017) Correlation and path coefficient analysis of Black gram (Vignamungo L.). Journal of Bioscience and Agriculture Research. 07(02): 621-629.
16. Chandrakar K, Verma SK, Dubey S, Kesari R. Yield gap analysis of black gram through front line demonstration under rainfed condition. Int J Chem Stud. 2018;6(4):3173-6.
17. Jha DP, Sharma SK, Amarawat T. Effect of organic and inorganic sources of nutrients on yield and economics of black gram (*Vignamungo*) grown during Kharif. Agric Sci. 2015;35(3):224-8.
18. Meena BL, Ram B. Integrated Nutrient Management in black gram under Rainfed

Condition. Int J Recent Sci Res. 2016;7(10):13875-94.

19. Habib A, Ali A, Akhtar J, Yasin M. Effects of phosphorus in combination with rhizobium inoculation on growth and yield parameters of black gram (*Vignamungo* L.). Crop Environ. 2018;1:53-6.
20. Sarvade S, Gautam DS, Upadhyay VB, Sahu RK, Shrivastava AK, Kaushal R et al. Agroforestry and soil health: an overview. J Int Dev, I, Agroforestry for Climate Resilience and Rural Livelihood Jodhpur, India: Scientific Publishers India. 2019: 275-97.
21. Sammauria, R. and Yadav, R.S. (2008) Effect of phosphorus and zinc application of growth and yield of Black gram and their residual effect on succeeding pearl millet (Pennisetum graucum) under irrigated conditions of North West Rajasthan. Indian Journal of agricultural Sciences, 78: 61-64.
22. Javeed A, Gupta M, Gupta V. Effect of graded levels of NPK on growth, yield and quality of black gram under subtropical conditions. *SSARC* International Journal of Management. 2017;3(1):1-8.
23. Sharma SN, Prasad R, Shivay YS, Dwivedi MK, Kumar S, Kumar D. Effect of rates and sources of phosphorus on productivity and economics of black gram as influenced by crop-residue incorporation. Indian Journal of Agronomy. 2009;54(1):42-6.

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