

Effect of different level of NPK and Rhizobium on Soil Physico-chemical Properties and Yield attribute of Black gram (*Vigna mungo* L.) Var: Shekhar-2

ABSTRACT

An experiment was conducted on “to determine the effect of different level of NPK and Rhizobium on soil physico-chemical properties and yield attribute of black gram (*Vigna mungo* L. var. Shekhar-2) during Zaid season 2023-2024 at the Research farm Department of Soil Science and Agricultural Chemistry, Naini Agriculture Institute, SHUATS, Prayagraj. The design applied was 3x3 factorial randomized complete block design having three factors with three levels of NPK @ 0, 50, and 100 % ha⁻¹, and three levels of Rhizobium @ 0, 50 and 100 % ha⁻¹ respectively. The excavated soil samples from experimental site before conducting research operation, mentioned revealed that, soil is of sandy loam texture with neutral to alkaline in reaction and significantly highest in treatment (specify what treatment?). The treatment combinations were replicated three times, were allocated at random in each replication. The results show that application of different levels combination of inorganic fertilizers increased growth, yield (take note, since you have mentioned the growth and yield, please provide a table in the results and discussion section) of black gram and improved soil chemical properties. **Keywords:** Black gram, Soil, NPK, Rhizobium, Growth and Yield, etc,

INTRODUCTION

Soil is a natural body consisting of layers (soil horizon) of mineral constituents of variable thickness which differ from the parent material in their morphological, physical, chemical and mineralogical characteristics. (brady et al., 2016) The annual production of black gram is about 24.5 lakh tonnes from about 4.6 million hectares of area, with an average productivity of 533 kg ha⁻¹ in 2021-22. It is a drought resistant crop grown both as a summer and kharif crop. (directorate of pulses development, 2022).

After cereals and oilseeds, pulses occupy an important place in Indian agriculture. The total world acreage under pulses is about 85.40 Mha with production of 87.40 Mt at productivity 1023 kg ha⁻¹ production with 34 and 26% respectively with average productivity of 835 kg ha-

(Agricultural Statistics Division, Directorate of Economics and Statistics, 2019). 70% of the total world's black gram and green gram production comes from India, of which black gram constitutes 1.65 Mt with the share of 12.4 % (Elzebroek and Wind, 2008). Pulses are excellent source of high quality protein, essential amino acids, fatty acids, fibers, minerals and vitamins. The protein level of black gram is quite high *i.e.* about 24 % with nutritional value of 10.9 % moisture, 1.4 % fats, 60.3 % carbohydrates and 3.4 % ash (Shroti *et al.*, 2018). It improves soil health by enriching nitrogen status and also maintains sustainability of the cropping systems.

Nitrogen is vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compound of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life. Phosphorus plays key roles in many plant processes such as energy metabolism, nitrogen fixation, synthesis of nucleic acids and membranes, photosynthesis, respiration and enzyme regulation. Phosphorus is critical to black gram yield because it is reported to stimulate growth, initiate nodule formation as well as influence the efficiency of the *Rhizobium* legumes symbiosis (Ndakidemi and Dakora, 2007).

According to Oti *et al.* (2004), phosphorus decrease zinc concentration in the black gram grain, thereby affecting its nutritional quality. It is required for the physiological processes of protein synthesis and energy transfer in plants. Application of phosphorus has been reported by several authors to improve yield of black gram. Seed yield is, therefore, governed by number of factors which have a direct or indirect impact. Among these factors are yield components such as number of pods per plant, number of seeds per pod and 100-seed weight over a given land area.

Potassium play important role in formation of protein and chlorophyll and it provide much of osmotic "pull" that draw water into plant roots. Potassium produces strong stiff straw in maize and reduce lodging in maize. Potassium imparts increase vigor and disease resistance to plant (Cobbinah *et al.*, 2011).

Rhizobia are symbiotic diazotrophs (prokaryotic organisms that carry out di-nitrogen fixation) that form a symbiotic association with legumes. This association is symbiotic in that both the plant and rhizobia benefit. The plant supplies the rhizobia with energy in the form of amino acids and the rhizobia fix nitrogen from the atmosphere for plant uptake. The reduction of atmospheric di nitrogen into ammonia is the second most important biological process on earth after photosynthesis (Singh, 2008). Keep these things, the present investigation is "Effect of

Different Level of NPK and Rhizobium on Soil Physico-Chemical Properties and Yield Attribute of Black Gram (*Vigna mungo* L.) Var. Shekhar-2" done.

MATERIALS AND METHODS

A field experiment to study the "Effect of Different Levels of NPK and Rhizobium on Soil Health in Black Gram (*Vigna mungo* L.)" was conducted at central research farm department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj. This area normally falls under the subtropical belt in the southeast of Uttar Pradesh, where the summers are quite hot and the winters are moderately chilly. The location's highest temperature occasionally drops below 4⁰C or 5⁰C and can reach up to 46⁰C to 48⁰C. Between 20 to 94% the relative humidity was present. Around 1100 mm of rain precipitation occurs yearly on average in this region. The experimental site is located 98 meters above sea level at 25⁰57'N latitude and 81⁰59'E longitude. The soil in the experimental region is classified as Inceptisol, and its texture is sandy loam (sand content: 62.71%; silt content: 23.10%; clay content: 14.1%). The experiment was set up using a randomized block design (RBD), which included nine treatments and three doses of NPK (0, 50, and 100%) and Rhizobium (0, 50, and 100%). Three replicates of the treatment have been made. There were 27 plots in total. Black gram sowing in 2 x 2 m plots during the *Zaid* season, with a spacing of 30 x 10 cm. Soil samples were taken from each plot both before and after the experiment at a depth of 0-15 to 15-30 cm by using a soil auger. The soil samples were air dried, put through a 2 mm screen, and then had their different soil qualities examined. M.L. Jackson (1958) assessed the soil pH with a pH meter, and Wilcox (1950) measured the electrical conductivity (EC) with a conductivity meter. The available nitrogen (N) was calculated using the Subbiah and Asijam method (1956), the phosphorus (P) was calculated using the Olsen et al. method (1954), the potassium (K) was calculated using the Toth and Prince method (1949). The soil organic carbon (SOC) was estimated using the Walkley and Black method.

RESULT AND DISCUSSION

Bulk density (Mg m^{-3})

The response bulk density of soil was found to be non-significant in levels of NPK and Rhizobium. The maximum bulk density of soil was recorded 1.293 Mg m^{-3} at 0-15 cm and 1.294 Mg m^{-3} at 15-30 cm in treatment T₉ (NPK @ 100% + Rhizobium @ 100%) followed by 1.291

Mg m⁻³ at 0-15 cm and 1.289 Mg m⁻³ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum bulk density of soil was recorded 1.241 Mg m⁻³ at 0-15 cm and 1.251 Mg m⁻³ at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. It was also observed the bulk density of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Kumar *et al.*, 2008; Reddy *et al.*, 2005 and Bhattacharya *et al.*, 2004.

Particle density (Mg m⁻³)

The response particle density of soil was found to be non-significant in level of NPK and Rhizobium. The maximum particle density of soil was recorded 2.515 Mg m⁻³ at 0-15 cm and 2.525 Mg m⁻³ at 15-30 cm in treatment T₉ (NPK @ 100% + Rhizobium @ 100 %) followed by 2.509 Mg m⁻³ at 0-15 cm and 2.521 Mg m⁻³ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum particle density of soil was recorded 2.473 Mg m⁻³ at 0-15 cm and 2.481 Mg m⁻³ at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0%)] respectively. It was also observed the particle density of soil was gradually increased with an increase in dose of different level of NPK and Rhizobium. Similar result has been recorded by Hussain *et al.*, 2022; Chintha *et al.*, 2021 and Dangi *et al.*, 2020.

Percent Pore space (%)

The response pore space of soil was found to be significant in level of NPK and Rhizobium. The maximum pore space of soil was recorded 48.65 % at 0-15 cm and 47.75 % at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 48.11 % at 0-15 cm and 47.20 % at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum pore space of soil was recorded 44.12 % at 0-15 cm and 40.75 % at 15-30 cm in treatment T₁ [control (NPK @ 0% + Rhizobium @ 0 %)] respectively. It was also observed the pore space of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Kumawat *et al.*, 2013; Azadi *et al.*, 2013 and Amurta *et al.*, 2017.

Water holding capacity (%)

The response water holding capacity of soil was found to be significant in levels of NPK and Rhizobium. The maximum water holding capacity of soil was recorded 46.31 % at 0-15 cm and 44.72% at 15-30 cm in treatment T₉ (NPK @ 100% + Rhizobium @ 100%) followed by 45.09% at 0-15 cm and 43.07% at 15-30 cm in treatment T₈ (NPK @ 100% + Rhizobium @ 50%) and minimum water holding capacity of soil was recorded 40.47 % at 0-15 cm and 37.08 % at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. It was also observed the water holding capacity (%) of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Kumawat *et al.*, 2013; Azadi *et al.*, 2013 and Amurta *et al.*, 2017.

pH of soil w/v (1:2.5)

The response pH of soil was found to be non-significant in levels of NPK and Rhizobium. The maximum pH of soil was recorded 7.20 at 0-15 cm and 7.21 at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 7.21 at 0-15 cm and 7.22 at 15-30 cm in treatment T₈ (NPK @ 100% + Rhizobium @ 50%) and minimum pore space of soil was recorded 7.29 at 0-15 cm and 7.31 at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. It was also observed the pH of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Sohe *et al.*, 2017; Chandrakar, 2018 and Jha *et al.*, 2015.

Electrical Conductivity (dSm⁻¹)

The response Electrical Conductivity of soil was found to be non-significant in levels of NPK and Rhizobium. The maximum Electrical Conductivity of soil was recorded 0.475 dSm⁻¹ at 0-15 cm and 0.480 dS m⁻¹ at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 0.471 dSm⁻¹ at 0-15 cm and 0.475 dSm⁻¹ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50%) and minimum EC of soil was recorded 0.443 dSm⁻¹ at 0-15 cm and 0.446 dSm⁻¹ at 15-30 cm in treatment T₁ [control (NPK @ 0% + Rhizobium @ 0%)] respectively. It was also observed the pH of soil was gradually increased with an increase in dose of different level of NPK and Rhizobium. Similar result has been recorded by Sohe *et al.*, 2017; Chandrakar, 2018 and Jha *et al.*, 2015.

Organic Carbon (%)

The response organic carbon of soil was found to be non-significant in levels of NPK and Rhizobium. The maximum organic carbon of soil was recorded 0.407% at 0-15 cm and 0.409% at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100%) followed by 0.406 % at 0-15 cm and 0.403 % at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum organic carbon of soil was recorded 0.385 % at 0-15 cm and 0.378 % at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. It was also observed the pH of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Sohel *et al.*, 2017; Chandrakar, 2018 and Jha *et al.*, 2015.

Available Nitrogen (kg ha⁻¹)

The response Available Nitrogen of soil was found to be significant in levels of NPK and Rhizobium. The maximum Available Nitrogen of soil was recorded 331.45 kg ha⁻¹ at 0-15 cm and 327.18 kg ha⁻¹ at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 325.17 kg ha⁻¹ at 0-15 cm and 320.62 kg ha⁻¹ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum available nitrogen of soil was recorded 297.15 kg ha⁻¹ at 0-15 cm and 291.32 kg ha⁻¹ at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. It was also observed the pH of soil was gradually increased with an increase in dose of different levels of NPK and Rhizobium. Similar result has been recorded by Sohe *et al.*, 2017; Chandrakar, 2018 and Jha *et al.*, 2015.

Available Phosphorus (kg ha⁻¹)

The response available phosphorus of soil was found to be significant in level of NPK and Rhizobium. The maximum available phosphorus of soil was recorded 29.14 kg ha⁻¹ at 0-15 cm and 24.31 kg ha⁻¹ at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 27.82 kg ha⁻¹ at 0-15 cm and 22.57 kg ha⁻¹ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum available phosphorus of soil was recorded 18.42 kg ha⁻¹ at 0-15 cm and 14.15 kg ha⁻¹ at 15-30 cm in treatment T₁ [control (NPK @ 0 % + Rhizobium @ 0 %)] respectively. Similar result has been recorded by Sharma *et al.*, 2009; Javed *et al.*, 2017 and Sammauria, 2007.

Available Potassium (kg ha⁻¹)

The response available potassium of soil was found to be significant in levels of NPK and Rhizobium. The maximum available potassium of soil was recorded 221.29 kg ha⁻¹ at 0-15 cm and 217.62 kg ha⁻¹ at 15-30 cm in treatment T₉ (NPK @ 100 % + Rhizobium @ 100 %) followed by 216.38 kg ha⁻¹ at 0-15 cm and 212.74 kg ha⁻¹ at 15-30 cm in treatment T₈ (NPK @ 100 % + Rhizobium @ 50 %) and minimum available potassium of soil was recorded 192.32 kg ha⁻¹ at 0-15 cm and 188.25 kg ha⁻¹ at 15-30 cm in treatment T₁ [control (NPK @ 0% + Rhizobium @ 0%)] respectively. Similar result has been recorded by Sharma *et al.*, 2009; Javeed *et al.*, 2017 and Sammauria, 2007.

UNDER PEER REVIEW

Fig.1.EffectofdifferentlevelsofNPKandRhizobiumonBD(Mgm⁻³),PD(Mgm⁻³),PS(%),andWHC(%)ofsoildepth (0-15 cm).

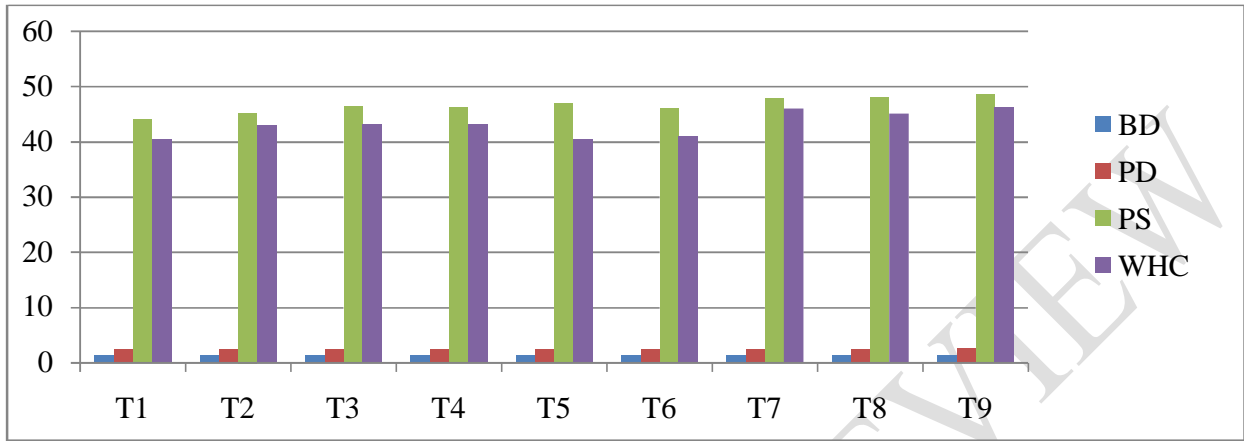


Table1.EffectofNPKandRhizobiumonsoilphysicalproper

Treatment	BD(Mgm ⁻³)		PD(Mgm ⁻³)		Pore space(%)		WHC(%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK@0%+Rhizobium@0%	37.08	37.08	37.08	37.08	44.12	40.75	40.47	37.08
NPK@0%+Rhizobium@50%	37.21	37.21	37.21	37.21	45.22	44.19	42.94	37.21
NPK@0%+Rhizobium@100%	39.29	39.29	39.29	39.29	46.39	44.89	43.16	39.29
NPK@50%+Rhizobium@0%	39.62	39.62	39.62	39.62	46.19	45.09	43.21	39.62
NPK@50%+Rhizobium@50%	40.38	40.38	40.38	40.38	46.90	45.54	40.42	40.38
NPK@50%+Rhizobium@100%	40.63	40.63	40.63	40.63	46.10	45.55	41.03	40.63
NPK@100%+Rhizobium@0%	42.97	42.97	42.97	42.97	47.90	45.54	46.07	42.97
NPK@100%+Rhizobium@50%	43.07	43.07	43.07	43.07	48.11	47.2	45.09	43.07
NPK@100%+Rhizobium@100%	44.72	44.72	44.72	44.72	48.65	47.75	46.31	44.72
F-Test	NS	NS	NS	NS	S	S	S	S
S.Ed.(±)	-	-	-	-	0.60	0.70	0.65	0.50
C.D.at0.5%	-	-	-	-	1.81	2.71	1.97	1.51

(Please note that if the result is significant, please proceed to post hoc analysis then assign letter to each mean)

Fig.2.EffectofdifferentlevelsofNPKandRhizobiumonBD(Mgm⁻³),PD(Mgm³),PS (%), andWHC(%)ofsoildepth(15-30cm).

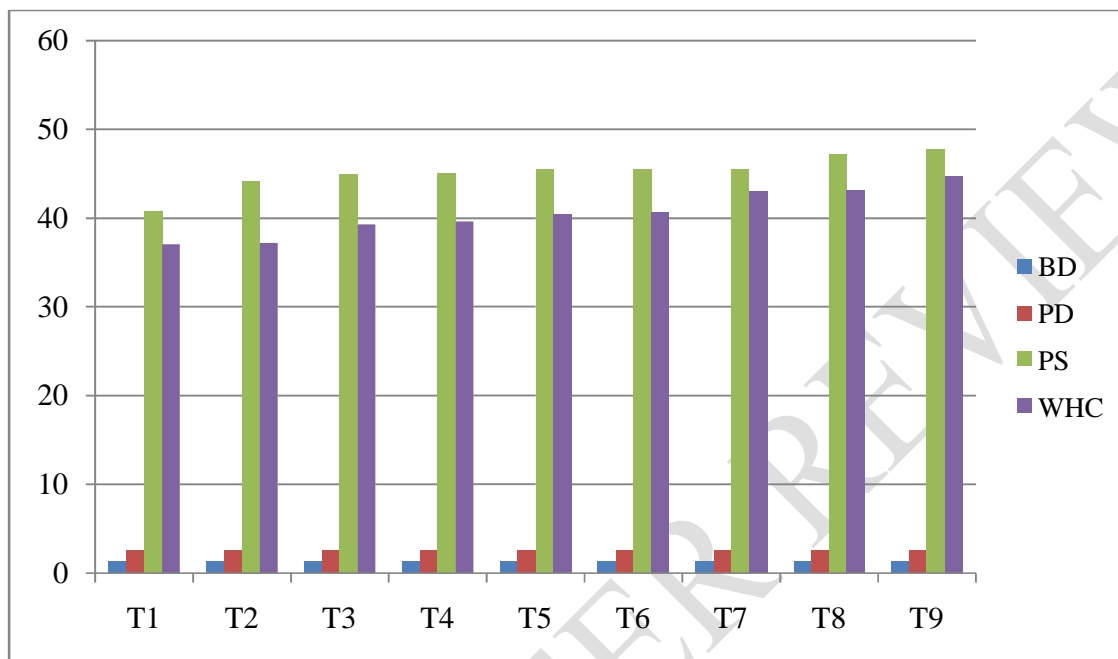


Table2.EffectofNPKandRhizobiumonsoilchemicalproperties

Treatment	pH		EC(dSm ⁻¹)		Organic carbon (%)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
NPK@0%+Rhizobium@0%	7.29	7.31	0.443	0.446	0.385	0.378
NPK@0%+Rhizobium@50%	7.26	7.27	0.448	0.449	0.39	0.382
NPK@0%+Rhizobium@100%	7.25	7.26	0.452	0.453	0.394	0.386
NPK@50%+Rhizobium@0%	7.24	7.26	0.455	0.456	0.399	0.389
NPK@50%+Rhizobium@50%	7.25	7.25	0.459	0.463	0.402	0.391
NPK@50%+Rhizobium@100%	7.23	7.24	0.463	0.467	0.405	0.396
NPK@100%+Rhizobium@0%	7.22	7.23	0.461	0.471	0.405	0.403
NPK@100%+Rhizobium@50%	7.21	7.22	0.471	0.475	0.406	0.403
NPK@100%+Rhizobium@100%	7.20	7.21	0.475	0.480	0.407	0.409
F-Test	NS	NS	NS	NS	NS	NS
S.Ed.(±)	-	-	-	-	-	-
C.D.at0.5%	-	-	-	-	-	-

Fig.3.EffectofdifferentlevelsofNPKandRhizobiumonAvailableN(kgh⁻¹),P(kgh⁻¹),andK (kgh⁻¹),ofsoildepth(0-15 cm).

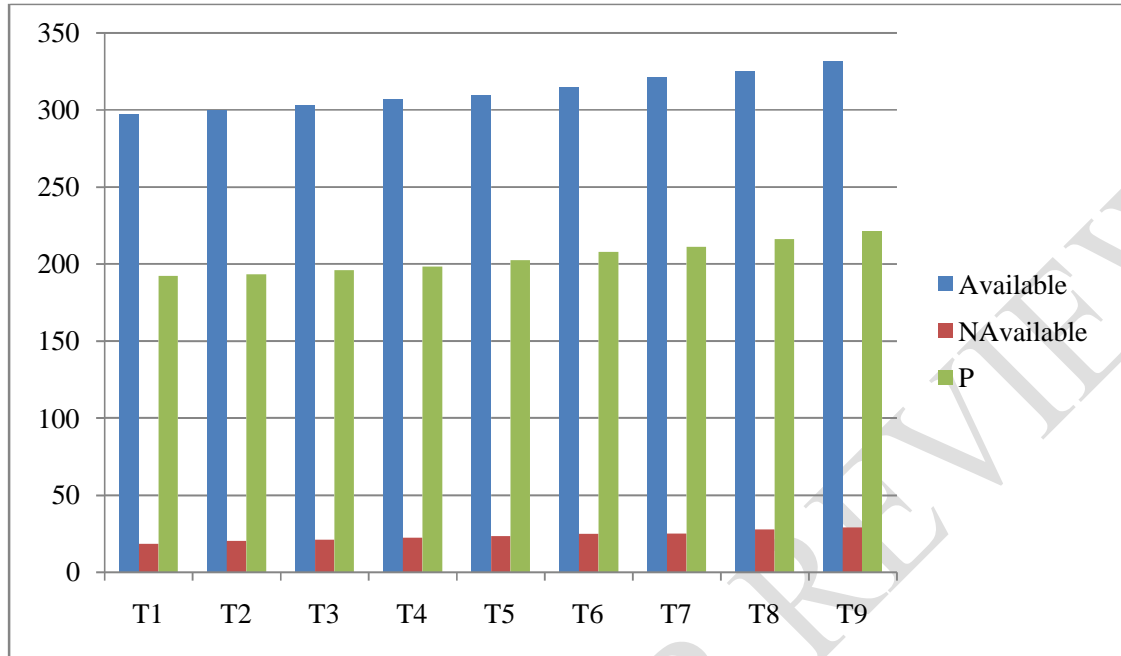
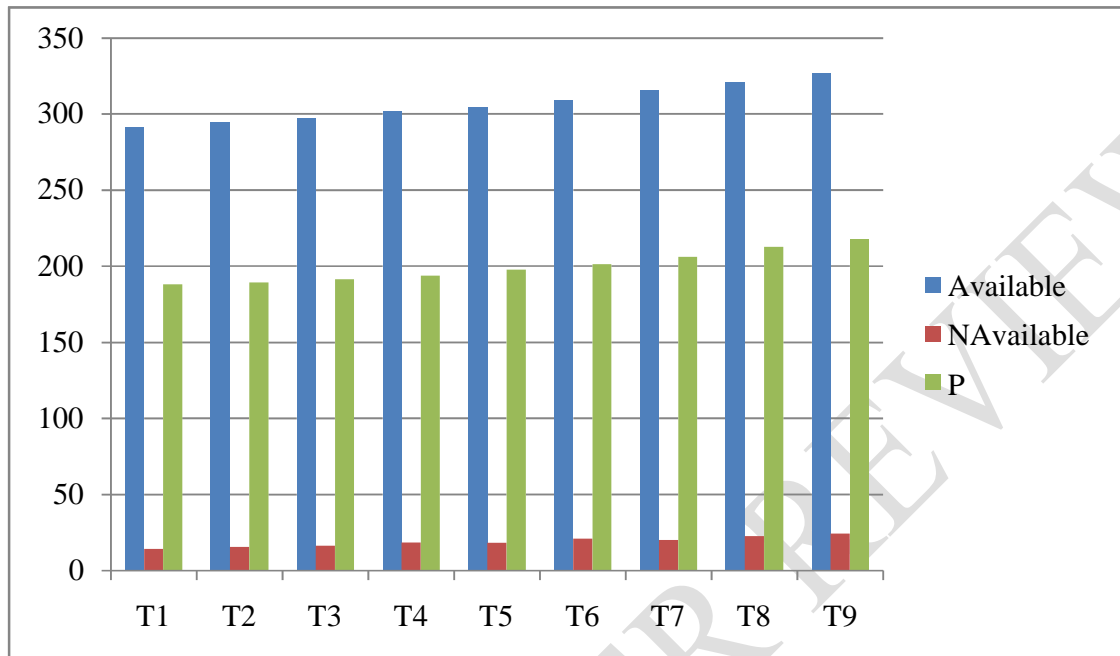


Table3.EffectofNPKandRhizobiumonsoilchemicalpropertie

Treatment	AvailableNitrogen(kgh ⁻¹)		AvailablePhosphorus(kgh ⁻¹)		AvailablePotassium(kgh ⁻¹)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	15-30 cm	15-30 cm
NPK@0%+Rhizobium@0%	297.15	291.32	18.42	14.15	192.32	188.25
NPK@0%+Rhizobium@50%	299.68	294.54	20.36	15.27	193.54	189.42
NPK@0%+Rhizobium@100%	303.42	297.35	21.27	16.46	196.05	191.46
NPK@50%+Rhizobium@0%	306.72	302.28	22.52	18.33	198.38	194.02
NPK@50%+Rhizobium@50%	309.46	304.6	23.48	18.24	202.65	197.8
NPK@50%+Rhizobium@100%	315.08	309.32	24.96	20.97	207.82	201.56
NPK@100%+Rhizobium@0%	321.36	315.45	25.05	20.13	211.25	206.25
NPK@100%+Rhizobium@50%	325.17	320.62	27.82	22.57	216.38	212.74
NPK@100%+Rhizobium@100%	331.45	327.18	29.14	24.31	221.29	217.62
F-Test	S	S	S	S	S	S
S.Ed.(±)	4.42	5.05	0.40	0.222	2.92	3.43
C.D.at0.5%	13.31	15.21	1.23	0.67	8.79	10.35

Fig..4.EffectofdifferentlevelsofNPKandRhizobiumonAvailableN(kgh⁻¹),P(kgh⁻¹),andK (kgh⁻¹),ofsoil depth(15-30 cm).



Conclusion

From trial it was concluded that the various level of NPK and Rhizobium used from different sources fertilizers [*i.e.* Urea (46 % N), + SSP (16 % P₂O₅) + MOP (60 % K₂O) + Rhizobium] in the experiment gave the best result in the treatment T₉ (NPK @ 100% + Rhizobium @ 100 %) followed by treatment T₈, in T₉ the soil health parameters retained the suitable soil properties, yield attributes and yield of black gram and gave highest net profit of 68080.00 ₹ ha⁻¹ with highest cost benefit ratio is 1:2.30. Therefore, it can be recommended for farmers to obtain best combination Treatment (T₉) for higher farmer income and sustainable agriculture.

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