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Correlation effect among the Physico-chemical properties of soil, morphological parameters and biological constituents after applying NPK with Rhizobium on Black gram (Vigna mungo L.) in Inceptisols of Prayagraj.

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Abstract-

A field study was conducted at the Department of Soil Science and Agricultural Chemistry research farm SHUATS in Prayagraj during the Kharif season 2018-2019. There were nine treatments in the trial, which was set up in a 3x3 randomized block design with three replications. The physicochemical parameters of the experimental field's soil revealed that it is an inceptisol given treatment T9 @ (100% NPK + 100% Rhizobium) was shown to be the best in post-harvest data based on mean performance. In terms of growth and yield there was a huge improvement. The correlation was observed between the physical and chemical properties of soil, physicochemical parameters with biochemical constituents and morphological parameters in which B.D represents a negative significant correlation with all other parameters and other parameters represent a positively significant correlation with each parameter.

Keywords: Correlation, Biological constituents, Morphological parameters, Physico-chemical properties

Introduction-

Pulses increase soil health by increasing nitrogen levels, long-term fertility, and cropping system sustainability. Pulse cultivation develops a system to fix atmospheric nitrogen in their root nodules, enabling them to meet their nitrogen requires to a large extent. It gets up to 80% of its nitrogen via symbiotic nitrogen fixation in the atmosphere. Despite being the world's largest pulse crop farming country, India's pulse production is little in compared to total cereal crop production. Pulse production in India is estimated to be around 22.4 million tonnes, with a poor average productivity of 765 kg ha-1. In India, black gram is the third most important pulse crop. It's an annual pulse crop that originated in Central Asia. It's also abundantly grown in the West Indies, Japan, and other tropical and subtropical regions. Black gramme seeds are rich in protein (24-26%) and are high in potassium, phosphorus, and calcium, with a moderate quantity of sodium. (Satish Kumar 2022) Symbiotic nitrogen fixation is a type of nitrogen fixation that uses a bacteria called Rhizobia as a main source to meet the majority of a plant's nitrogen needs.

This symbiotic nitrogen fixation is a significant source of nitrogen, with diverse legume crops and pasture species fixing 200 to 300 kg nitrogen ha-1. (Mahipal Choudhary 2019). Despite the fact that Rhizobia is an excellent source of symbiotic nitrogen fixation, nodulation and nitrogen fixation are not always successful due to a lack of Rhizobia and poor local Rhizobia. To maintain a healthy Rhizobia population in the soil. Various Rhizobium strains develop nodules on various leguminous plants, which promote in plant growth, nutrition, and soil fertility enhancement. Leghemoglobin synthesis in nodules is another key feature of nitrogen fixation, as it aids in the maintenance of the low oxygen concentration required for oxygen-sensitive nitrogenase activity (Shubha Tripathi 2021). Rhizobium's nitrogen fixation process allows legumes to require less chemical fertiliser than non-leguminous plants. The introduction of efficient rhizobia strains into diverse legumes resulted in a significant increase in plant biomass and grain yield. Due to their low nutritional quality, rhizobium alone does not result in a significant boost in crop yields. As a result of the aforementioned implications, black gram can now be grown using both inorganic and bio fertilisers. (Satish Kumar 2022)

Phosphorus is considered the pioneer plant nutrient required by leguminous crops for rapid and proper root growth, which later aids Rhizobium bacteria in greater nodulation. A sufficient supply of phosphorus to the plant stimulates maturation and speeds up nodulation and pod development. It is also found in essential compounds such as phospholipids and phosphor-protein. Application of phosphatic fertiliser to pulses enhances growth, nodulation, and yield since legumes are high phosphorus feeders. Phosphorus also gives shoots toughness, enhances the quality of photosynthesis, and regulates other physico-biochemical processes. The majority of phosphorus in soil is unavailable to plants, but it is made available by efficient microorganisms such as bacteria, fungus, and even cyanobacteria, which produce organic acid and increase phosphatase enzyme activity. Nitrogen is one of the most vital nutrients for plants across the world. (Harkesh Meena 2021) It's found in a variety of molecules that are necessary for plant growth, including chlorophyll, nucleotides, alkaloids, enzymes, hormones, and vitamins. Despite the fact that nitrogen is abundant in the atmosphere, it is the most limited nutrient for most crops and soils. This nutrient is not only scarce, but it also has a low usage efficiency, as much of the nitrogen added to the soil through fertilisers is lost through leaching, denitrification and volatilisation. As a result, there is a pressing need to create technology that can improve N use efficiency while also improving soil health. Fertilizer nitrogen has made a significant contribution to improving food production, however even with the finest agronomic practises, fertiliser nitrogen recovery is only 30-60%, because most of the applied nitrogen is leached and unavailable for plant use. A number of solutions for enhancing N usage efficiency have been developed in India and elsewhere, but none of them are equally efficient in varied conditions.As a result, an alternative way to addressing the problem of low N use efficiency is urgently required. Potassium is a significant macro element that is readily absorbed from the soil and is utilised as a catalyst, chlorophyll synthesis, respiration, photosynthesis, water regulation, and has a synergistic relationship with nitrogen and phosphorus. (M.P. Arya Gopinath 2018)

Materials and Methods-

The experiment was conducted during summer season of 2018-19 at research field of Department of Soil Science and Agricultural Chemistry at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The experimental site is located in the sub–tropical region with 250 24’23”N latitude 810 50’38”E longitudes and 98 meter above sea level altitudes with maximum temperature up to 460 C – 480 C and seldom falls as low as 40 C – 50 C. With semiarid climate rains generally from July to September, relative humidity ranged from 20 to 94 percent. The yearly rainfall is roughly 1100 mm in this area. The experiment was set up in a 3x3 RBD design, with nine treatments and three replicates for each of the three doses of NPK and Rhizobium. The treatment included nine different inorganic fertiliser combinations. T1 (@ 0% NPK + @ 0% Rhizobium), T2(@ 0% NPK + @ 50% Rhizobium), T3(@ 0% NPK + @ 100% Rhizobium), T4 (@50% NPK + @ 0% Rhizobium), T5(@ 50% NPK + @ 50% Rhizobium), T6(@ 50% NPK + @ 100% Rhizobium), T7(@ 100% NPK + @ 0% Rhizobium), T8(@ 100% NPK + @ 50% Rhizobium) and T9(@ 100% NPK + @ 100% Rhizobium). The sources of NPK and Rhizobium were as Urea, SSP, MOP and Rhizobium culture respectively. The total number of plots was 27 Black gram (Vigna mungo L.) with each plots size being 2 x 2 m in order of Inceptisol and is alluvial in nature. Random soil samples were collected at depth 0-15 cm and then analysis of the soil samples have been done under the following steps

Soil physical properties-Soil Textural class by Bouyoucos Hydrometer method (1952), Soil Colour by Munsell Colour Chart, Bulk density (Mgm-3) Particle density (Mgm-3) Pore Space (%) by Graduated Measuring Cylinder (Muthuvelet.al.,1992).

Soil Chemical properties-Soil pH - using digital pH meter (Jackson, 1958). Soil EC (dS m-1) using digital EC meter (Wilcox, 1950). Soil organic carbon (%) - Determined by rapid titration method as described by (Walkley and black, 1947). Organic matter (%) - By rapid titration method as described by (Walkley and black, 1934). Available nitrogen in soil (kg ha-1) - Determined through Kjeldahl apparatus (Subbiah and Asija 1956), Available phosphorus in soil (kg ha-1)Determined through Colorimeter (Olsen et al., 1954). Available potassium in soil (kg ha-1) - Determined by Flame Photometer (Toth and Prince, 1949).

Morphological Parameters-The plants per pot were removed from all samples after 30 days, 45 days, and 60 days of growth and examined for the following morphological parameters: Plant height (in cm), number of leaves (per plant), number of roots (per plant), shoot length (in cm), root length (in cm), root nodules (per plant), and seed yield were the variables.

Biochemical Contituents- Carbohydrate, Protein were estimated in 60th day treatment for combined inoculation.

Total carbohydrates were estimated by Anthrone method (Sadasivam and Manickam,1992)

[Protein content= Total Nitrogen x 6.25]

Statical Analysis and Interpretation of Data - The implemented design of experiment in the analysis was RBD (Randomised block design) and correlation in excel.

Results-

Table No. 1 Correlation between the Physical and chemical properties of soil

	BD	PD	%.PoreSpace	pH	E.C	O.C	N	P	K
BD									
PD	-0.631***								
%PoreSpace	-0.819***	0.814***							
pH	-0.526**	0.441*	0.495**						
E.C	-0.898***	0.695***	0.893***	0.581**					
O.C	-0.833***	0.692***	0.854***	0.625***	0.936***				
N	-0.815***	0.615***	0.874***	0.583**	0.868***	0.812***			
P	-0.851***	0.709***	0.899***	0.609***	0.946***	0.932***	0.852***		
K	-0.891***	0.654***	0.871***	0.594**	0.955***	0.921***	0.866***	0.961***	

*Correlation is significant at the 0.05 level
**Correlation is significant at the 0.01 level
***Correlation is significant at the 0.001 level

Table No. 2 Correlation between the Physico-chemical properties of soil and Biochemical constituents of Urd bean –

	BD	PD	%.PoreSpace	pH	E.C	O.C	N	P	K	Protein	Carbohydrate
BD											
PD	-0.631***										
%PoreSpace	-0.819***	0.814***									
pH	-0.526**	0.441*	0.495**								
E.C	-0.898***	0.695***	0.893***	0.581**							
O.C	-0.833***	0.692***	0.854***	0.625***	0.936***						
N	-0.815***	0.615***	0.874***	0.583**	0.868***	0.812***					
P	-0.851***	0.709***	0.899***	0.609***	0.946***	0.932***	0.852***				
K	-0.891***	0.654***	0.871***	0.594**	0.955***	0.921***	0.866***	0.961***			
Protein	-0.828***	0.633***	0.884***	0.526**	0.856***	0.796***	0.852***	0.868***	0.864***		
	-										

Carbohydrate	* **	0.671** *	0.845***	0.558* *	0.947** *	0.878** *	0.839** *	0.923** *	0.969** *	0.851** *	0.888

* Correlation is significant at the 0.05 level ** Correlation is significant at the 0.01 level
*** Correlation is significant at the 0.001 level

Discussion-

Correlation between the physical and chemical properties of soil –

Represented in Table no.1 soil physical chemical properties Bulk density with all the properties such as P.D, Percent pore space pH, E.C, O.C, N, P, K showed the negatively significant correlation p value at 0.001, 0.01, 0.005 level whereas other parameters like P.D, Percent pore space pH, E.C,O.C,N,P,K showed the positively significant correlation p value at 0.001, 0.01, 0.005 level with each parameters.

Correlation between the physico-chemical properties of soil and Biochemical constituents of Black gram-

Represented in Table no.2 correlation between the soil physico-chemical properties with the biochemical constituents of Black gram in that Bulk density with all the parameters like P.D, Percent pore space pH, E.C, O.C, N, P, K, Protein content and Carbohydrate content showed the negatively significant correlation p value at 0.001, 0.01, 0.005 level whereas other parameters like P.D, Percent pore space pH, E.C, O.C, N, P, K, Protein content and Carbohydrate content showed the positively significant correlation p value at 0.001, 0.01, 0.005 level with other parameters, Similarly reported by A.V. Chaudhari (2018)

Correlation between the physico-chemical properties of soil and morphological parameters of Black gram-

Represented in Table no.3 correlation between the soil physico-chemical properties with the Morphological Parameters of Black gram in which the Bulk density with parameters such as P.D, Percent pore space pH, E.C, O.C, N, P, K, Plant height at 30, 45, 60 days respectively, No. of leaves per plant at 30, 45, 60 days respectively, No. of nodules per plant at 30 60 days showed the negatively significant correlation p value at 0.001, 0.01, 0.005 level whereas all other parameters showed the positively significant correlation p value at 0.001, 0.01, 0.005 level with each parameters, earlier observed by Sohel et al., (2016)

Conclusion-

As per the research done concluded that the bulk density gave the negative impact on the other physical and chemical properties, Morphological parameters and Biochemical constituents as application of rhizobium influenced the nodule formation and nitrogen fixation significantly due to binding the soil tightly in the rhizosphere bulk density reduces as percent pore spaces increases. More aeration causes more microbial activity but reduces the bulk density of the soil The positive effect of N P

K on crop yield also be due to its requirement in carbohydrate and protein synthesis also due to improved yield attributing characters, shoot growth and nodulation.

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