__Original Research Article__

Response of inorganic fertilizers, wheat residue and rhizobium on soil health and yield attributes of green gram (*Vigna radiata* L.) var. Samrat

ABSTRACT

An experiment was conducted on "Response of inorganic fertilizers, wheat residue and rhizobium on soil health and yield attributes of Green gram (*Vigna radiata* L.) var. Samrat" at research farm of Soil Science and Agricultural Chemistry, design laid out in randomized block design (RBD) with three replications. Green gram was taken for study with recommended doses of fertilizers (N, P_2O_5 and K_2O @ 20, 40 and 20 kg ha^{-1}) was applied with wheat residue and *rhizobium*. The variety of green gram is Samrat was taken for research trial. Bulk density (Mg m^{-3}) and particle density was maximum in T_1 - [NPK @ 0% + RZ @ 0% + WR @ 0%], soil pore space, water holding capacity, pH, EC**,** organic carbon, nitrogen, phosphorus and potassium were recorded maximum in T_9 - [NPK @ 100% + RZ @ 100% + WR @ 100%] respectively. In treatment T_9 the highest pod yield of green gram 55.12 q ha^{-1} was obtained with C:B ratio of 1:2.48. Use of T_9 - [NPK @ 100% + RZ @ 100% + WR @ 100%] on crop and analyzing the effect of T_9 treatment on soil physical as well as chemical properties of soil.

Keywords: Green gram, soil, yield, rhizobium, wheat residue, *etc.*

INTRODUCTION

Soil is a medium for plant growth. Crop production is largely based on soils. Some of the soil properties affecting plant growth include: soil texture (coarse fine), aggregate size, porosity, aeration (permeability), and water holding capacity, pH, bulk density, particle density. The rate of water movement into the soil (infiltration) is influenced by its texture, physical condition (soil structure and tilth), and the amount of vegetative cover on the soil surface. Organic matter tends to increase the ability of all soils to retain water, and also increases infiltration rates of fine textured soils **(Singh *et al.*, 2008).** Green gram is primarily a rainy season crop but with the development of early maturing varieties, it has also proved to be an ideal crop for spring and summer season. The grain (whole or split) is used as dal or to make flour. It is an excellent source of high-quality protein, the grain contains protein 24.5 %, iron 8.5 mg, mineral 3.5 %, fat 0.5 - 4.33, fibers 4.0 % and carbohydrates 59.9 %. The straw and husk are used as fodder for cattle. The germinated grains are also used as sprouts **(Afzal *et al.*, 2004).** Green gram also improves the soil physical properties. Moong bean having low productivity because cultivation of this crop on marginal and submarginal lands with inadequate fertilization and poor management practices. Moong bean gave low yield at farmers field due to less awareness of farmers about optimum date of sowing, Responsive weed control, balance use of fertilizers, pest management practices and proper planting pattern. Moong bean in delay planting results reduction in number of pods/plants, number of grains/pods, grain weight and ultimately grain yield. The time of sowing is the most important agronomic factor for realizing the yield potential of improved varieties, it helps in achieving complete harmony between vegetative and reproductive stages of the crop. Therefore, sowing of the crop at optimum time plays a key role in obtaining the high seed yields (**Rathore *et al*., 2010**). Green gram is capable of fixing atmospheric nitrogen, it responds to small quantity of nitrogenous fertilizers applied as starter dose. Application of 15-20 Kg Nha^{-1} has been found optimum to get better response. Application of higher dose of nitrogen may reduce nodule number and nodule growth and thus adversely affect the nitrogen fixation capacity **(Choudhary *et al.,* 2017).** Mungbean, nitrogen fixation potential ranged from 58-109 kg ha^{-1} par with others but more than Urdbean**.** Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. Deficient plants may have thin, erect and spindly stems and leaves turn into bluish green colour. Phosphorus is an essential constituent of majority of enzymes, which are of great importance in the transformation of energy, in carbohydrate metabolism, in fat metabolism and also in respiration of plants. It enhances the activity of Rhizobium and increased the formation of root nodules. Thus, it helps in fixing more of atmosphere nitrogen in root nodules **(Rajveer *et al.,* 2016).** Potassium is one of the seventeen elements which are essentialfor growth and development of plants. Potassium is required for improving the yield and quality of different crops because of its effect on photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between protein and carbohydrates **(Singh *et al.,* 2008).** The use of biofertilizers is more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen; biofertilizers enrich soil fertility and improves soil fertility of these biofertilizers, *Rhizobium* inoculants specific for different leguminous crop is the most important in India. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and *Rhizobium* species **(Meena *et al.,* 2016).** Wheat straw is a residue is a residue cum mulch material having C:N ratio of 100:1 and has wide application conserving soil depletion. It has very marginal amount of NPK *i.e.,* 0.05%, 0.02%, 0.05%. It has several benefits at the germination and seedling stage preventing crust formation and maintaining soil moisture at optimum level for plant mitigate moisture stress condition in case of irregular irrigation practices. crop residues contain carbon (40%-45%), nitrogen (0.6%-1%), phosphorus (0.45%-2%), potassium (14%-23%), and microelements, which are necessary for crop growth **(Wang XL *et al.*, 2020).**

MATERIALS AND METHODS

The exploratory led at the Soil Science Research Farm of SHUATS, Prayagraj, U.P., It is situated at $25^0$24’23” N latitude, $81^0$50’38” E longitude and at the altitude of 98 meter above the sea level. The soil of test region falls arranged by Inceptisol and in exploratory plots is alluvial soil in nature. The dirt examples haphazardly gather from five distinct locales in the trial plot before culturing activity from a profundity of 0-15 cm and 15-30 cm. The size of soil test diminishes by conning and quartering the composites the composites soil test is air dry and pass through a 2 mm strainer via setting up the example for physical and synthetic analysis. Agro climatically, Prayagraj addresses the subtropical belt of the south East of Uttar Pradesh, and is supplied with Tincredibly blistering summer and genuinely cool winter. The Maximum temperature of the area comes to up to 46ºC-49ºC and only occasionally falls as low as 4º c-5ºc. The general moistness ranges between 20-94%. The midpoints precipitation of this area is around 1100mm annually. It goes under subtropical environment getting the mean yearly precipitation of around 1100mm, significant precipitation from March to end May. Be that as it may, intermittent precipitation was additionally normal during winter. The cold weather months were cold while late spring months were extremely sweltering and dry. The base temperature during the harvest season w as to be 21.38℃ and the greatest is to be 37.82℃. The base moistness was to be 46.42% and most extreme was to be 96.85%.

Table 1: Physical parameters

Particulars	**Method**
Soil Colour	Munsell, 1971
Soil Texture (Sandy loam)	Bouyoucous, 1927
Bulk density(Mg m^{-3})	Muthuaval *et al*. 1992
Particle density(Mg m^{-3})	Muthuaval *et al*. 1992
Water Holding Capacity (%)	Muthuaval *et al*. 1992

Pore Space (%)	Muthuaval *et al*. 1992

Table 2. Chemical parameters

Particulars	**Methods**
Soil pH (1:2)	Jackson, 1967
EC (dS m^{-1})	Wilcox, 1950
Organic carbon (%)	Walkley and Black, 1947
Available Nitrogen (kg ha^{-1})	Subbaih and Asija, 1956
Available Phosphorus (kg ha^{-1})	Olsen *et al.*, 1954
Available Potassium (kg ha^{-1})	Toth and Prince, 1949

Table 3. Treatment Combinations of Green gram

Treatment	**Treatment combination**
T_1	Farmers Recommended Dose of Fertilizer (N P K)
T_2	[NPK @ 0 % + RZ @ 50 % + WR @ 50 % (wheat straw]
T_3	[NPK @ 0 % + RZ @ 100 %+ WR @ 100 %]
T_4	[NPK @ 50 % + RZ @ 0 %+ WR @ 0 %]
T_5	[NPK @ 50 % + RZ @ 50 %+ WR @ 50 %]
T_6	[NPK @ 50% + RZ @ 100 %+ WR @ 100 %]
T_7	[NPK @ 100 % + RZ @ 0 %+ WR @ 0 %]
T_8	[NPK @ 100% + RZ @ 50 %+ WR @ 50 %]
T_9	[NPK @ 100% + RZ @ 100 %+ WR @ 100 %]

Note: Recommended Dose of Fertilizer: 20:40:20 Nitrogen: Phosphorous: Potassium (kg ha^{-1}) *Rhizobium* (RZ) 20 g Kg seed, and wheat residue (WR) 2.5 t ha^{-1}.

RESULT AND DISCUSSION

Physical and Chemical properties

The maximum Bulk density (1.18 Mg m^{-3}) of soil after crop harvest was recorded in application of T_9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR and minimum (1.02 Mg m^{-3}) in T_1 Control. The maximum particle density of soil was recorded in T_9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR (2.50 Mg m^{-3}) and minimum (2.27 Mg m^{-3}) in T_1 Control. The maximum % Pore space (47.90%) of soil after crop harvest was observed by the application of T_9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR, minimum (46.29%) was observed in treatment T_1 Control.The maximum Water holding capacity (46.10) of soil after crop harvest was observed by the application of T9 @ 100 % (NPK) + @ 100 % R + WR @ 100 % minimum (43.30) was observed in treatment T1 Control. The maximum pH (7.5) of soil after crop harvest was observed by the application of T9 @ 100 % (NPK) + @ 100 % R+ @ 100 % WR, minimum (7.0) was observed in treatment T1 Control. The maximum EC (0.22) of soil after crop harvest was observed by the application of T9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR, minimum (0.04) was observed in treatment T1 Control. The maximum Organic carbon (0.45) of soil after crop harvest was observed by the application of T9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR minimum (0.39) was observed in treatment T1 Control. The maximum available Nitrogen (288.00) of soil after crop harvest was observed by the application of T9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR, minimum (251.50) was observed in treatment T_1 Control. The maximum available Phosphorus **(27.35)** of soil after crop harvest was observed by the application of T_9 @ 100 % (NPK) + @ 100 % R + @ 100 % WR minimum (21.08) was observed in treatment T_1 Control. The maximum available Potassium (210.31) of soil after crop harvest was observed by the application of T_9 @ 100 % (NPK) + @ 100 % R + @ 100 %WR minimum (181.38) was observed in treatment T_1 Control.

Table 4: Response of inorganic fertilizers, wheat residue and rhizobium on physical-chemical properties of Soil

Treatments	Depth (cm)	BD (Mg m^{-3})	PD (Mg m^{-3})	Pore Space (%)	WHC (%)	pH	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})

T_1	0-15	1.39	2.35	46.29	42.81	7.55	0.23	0.48	179.96	18.61	207.57
	15-30	1.47	2.42	44.29	40.35	7.52	0.20	0.32	148.22	15.73	175.79
T_2	0-15	1.28	2.25	47.16	44.16	7.44	0.25	0.48	191.88	22.65	211.28
	15-30	1.38	2.32	44.24	42.99	7.48	0.22	0.39	160.92	18.17	179.45
T_3	0-15	1.26	2.15	48.95	46.95	7.35	0.25	0.51	193.65	21.93	213.51
	15-30	1.39	2.21	45.22	43.86	7.39	0.22	0.51	151.36	18.79	176.61
T_4	0-15	1.33	2.29	44.17	42.17	7.42	0.24	0.51	196.55	26.26	217.77
	15-30	1.39	2.46	42.39	40.68	7.42	0.21	0.45	156.76	22.18	184.61
T_5	0-15	1.25	2.25	46.98	43.98	7.39	0.25	0.53	221.08	26.04	228.55
	15-30	1.39	2.31	43.32	41.09	7.55	0.23	0.45	181.37	21.96	182.62
T_6	0-15	1.11	2.15	47.18	45.18	7.30	0.26	0.57	242.55	28.77	230.60
	15-30	1.23	2.42	44.56	43.19	7.30	0.23	0.51	184.58	23.99	187.22
T_7	0-15	1.30	2.34	45.01	43.01	7.18	0.24	0.52	278.69	27.17	249.00
	15-30	1.41	2.40	43.37	41.34	7.10	0.21	0.44	244.20	23.18	171.76
T_8	0-15	1.28	2.24	46.18	43.18	7.16	0.24	0.52	288.42	30.07	252.45
	15-30	1.33	2.41	44.66	41.63	7.17	0.21	0.53	257.38	26.69	185.40
T_9	0-15	1.17	2.18	48.20	45.20	7.13	0.27	0.54	314.22	30.72	262.65
	15-30	1.28	2.20	46.68	42.44	7.07	0.24	0.56	268.98	27.25	196.20
F-Test		NS	NS	S	S	NS	NS	S	S	S	S
		NS	NS	S	S	NS	NS	S	S	S	S
S.Em.		-	-	0.40	0.59	-	-	0.01	5.43	0.62	4.44
(±)				0.65	0.38			0.03	5.04	0.44	2.80
C.D.		-	-	1.17	1.73	-	-	0.02	16.29	1.84	13.32
at 5%		-	-	1.95	1.10	-	-	0.07	15.11	1.32	8.40

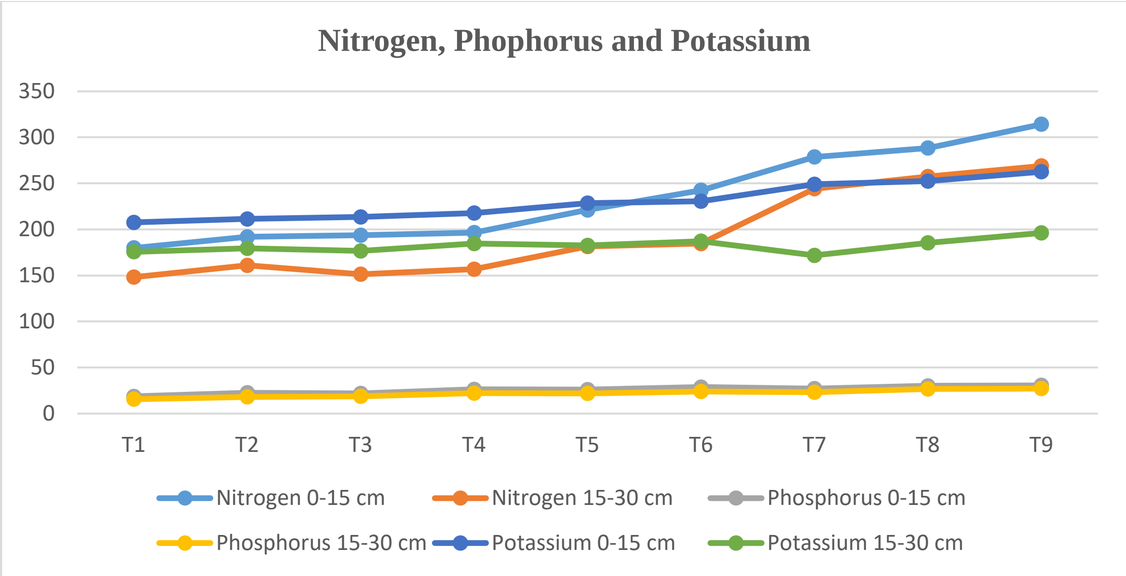

Fig 1: Response of inorganic fertilizers, wheat residue and rhizobium on different treatments on post- harvest Soil

Table 5: Response of inorganic fertilizers, wheat residue and rhizobium on growth and yield parameters of cluster bean

Treatments	Plant height (cm)			No. of Branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	Test weight (g)	pod yield (Kg ha^{-1})
	30 DAS	60 DAS	90 DAS					
T_1	15.5	22.1	30.0	6.7	11.03	6.20	30.15	583.200
T_2	16.5	23.6	31.9	6.8	14.98	7.09	32.04	713.983

T^3	18.2	26.4	35.2	6.9	14.77	7.15	33.31	753.087
T_4	16.5	23.4	31.5	6.9	14.93	7.03	30.84	841.560
T_5	19.3	29.6	39.6	7.0	15.80	7.16	32.30	861.887
T_6	19.6	33.4	44.5	7.4	16.68	8.01	33.54	931.447
T_7	18.5	25.7	35.7	6.8	15.01	7.10	31.29	944.023
T_8	19.2	30.5	40.4	7.2	16.20	7.90	32.42	1014.600
T_9	25.5	38.1	48.2	7.5	20.40	8.80	33.58	1352.807
F-Test	S	S	S	S	S	S	S	S
S. Em. (±)	1.01	1.28	1.11	0.13	0.55	0.26	1.14	1.99
C.D. at 5%	3.03	3.83	3.34	0.04	1.66	0.77	3.42	3.558

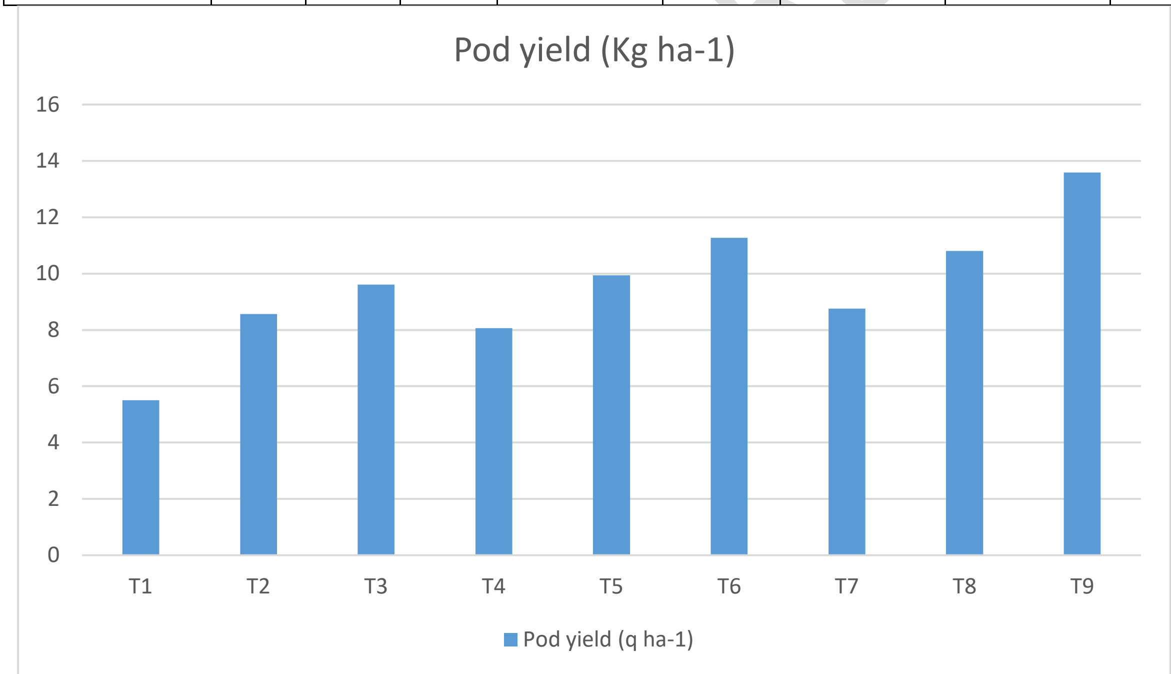

Fig 2: Total pod yield (Kg ha^{-1})

CONCLUSION

It is concluded from trail that experiment of T_9 [NPK @ 100% + R @ 100% + WR @ 100%] was best in terms of soil parameters and found to be significant. followed by T_1 [control] treatment T_9 also provide significantly highest vegetative growth as well as yield attributes and positive effect on net return up to ₹70439.07 ha^{-1} with C:B ratio of 1:2.12. therefore, it is suggested that application of T_9 [NPK @ 100% + R @ 100% + WR @ 100%] found most suitable dose for green gram to obtain higher yield (1358.6 Kg ha^{-1}) and for improvement of soil health.

Reference

Afzal, M. A., Bakr, M. A., Hamid, A., Haque, M. M. and Aktar, M. S. (2004) Green gram in Bangladesh. Lentil, black gram and green gram development pilot project. *Pulses Research Centre*, BARI, Gazipur- 1701.

Black, C.A. (1965) Methods of soil analysis **2**, Am. Soc, Agron.madison, Wisconsin, U.S.A.

Choudhary, R., Singh, K., Manohar, R. S., Yadav, A. K. and Sangwan, A. (2017) Response of different sources and levels of phosphorus on yield, nutrient uptake and net returns on mungbean under rainfed condition. *Indian Journal of Agriculture Research*. **35**: 263-268.

Jackson, M. L. (1958). Soil chemical analysis, Second edition Indian Reprint, prentice hall of India, New Delhi. Pp-498.

Meena, S. Swaroop, N. and Dawson, J. (2016) Effect of integrated nutrient management on growth and yield of green gram (*Vigna radiata* L.) *Agric. Sci. Digest.,* **36** (1) 2016: 63-65

Munsell, A. H. (1971). A Color Notation. Baltimore, MD: Munsell Color Company. ed.; **1(2)**:65.

Muthuval, P., Udaysoorian, C., Natesan, R., Ramaswami, P. P. (1992) Introduction to Soil analysis, Tamil Nadu Agricultural University, Coimbatore, 641002.

Rajveer, David A. A. and Khadda, B. S. (2016) assessment of integrated nutrient on crop growth parameters and yield of green gram (*Vigna radiata* L.). *Society for Scientific Development in Agriculture and Technology*. 6277-6279.

Rathore, B. S. (2010). Efficacy of streptocycline and plant extracts against bacterial leaf spot green gram. *J. Mycol and Plant Pathology*, **36**, 153-156.

Singh, R.S. and Yadav, M.K. (2008) Effect of phosphorus and biofertilizers on growth, yield and nutrient uptake of long duration mung under rainfed condition. *Journal of Food Legumes.* **21** (1):46-48.

Subbiah, B. V. and Asija, G. L. (1956) A rapid procedure for the estimate of *Available nitrogen in soil current sciences*, **2(5**): 259-260.

Toth, S. J., Prince, A. L. (1949) Estimation of Cation Exchange Capacity and exchangeable Ca, K and Na Content of Soil by Flame Photometer technique. *Soil Sci.*, **6 (7)**: 439-445.

Walkley, A. and Black, I. A. (1947) Critical examination of rapid method for determining organic carbon in soils, effect of variance in digestion conditions and of inorganic soil constituents. *Soil sci* pp. 632-251.

Wang, XL., Yang Z. and Liu X. (2020) The composition characteristics of different crop straw types and their multivariate analysis and comparison. Waste Manag.;**110**:87–97.