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Response of Green Gram (*Vigna radiata* L.) to Different Levels of Phosphorus and Potassium

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A B S T R A C T

The experiment was conducted to study the response of green gram varieties to different levels of phosphorus and potassium. The experiment was laid out in factorial randomized block design (FRBD) with 12 treatments replicated thrice. Three different green gram varieties *viz.*, V_1: IPM 02-3, V_2: SGC-20 and V_3: SGC-16 were used along with four levels of phosphorus and potassium *i.e.*, N_1: control, N_2: 40 kg ha^{-1} P_2O_5 + 40 kg ha^{-1} K_2O, N_3: 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O and N_4: 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O. The study showed that different varieties and application of phosphorus and potassium had major influence on crop growth, yield attributes and yield. The variety IPM 02-3, was found to perform better than the other varieties and recorded the highest seed yield at 548.08 kg ha^{-1}. Application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O resulted in maximum growth attributes such as plant height, branches plant^{-1}, Leaf area index (LAI), crop growth rate (CGR) and yield attributes and seed yield.

Introduction

Green gram (*Vigna radiata* L.), often known as mung bean or golden gram, is a popular short-term pulse crop in India. With the chromosome number 2n=22, it belongs to the Fabaceae family. More than 70% of the world's green gram output comes from India. After chickpea and pigeon pea, green gram is the third most widely cultivated pulse in India. In the year 2019-2020, around 31.15 lakh ha was covered under green gram (Directorate of Economics and Statistics).

To achieve optimum development and output, every crop requires adequate fertilisation. Because leguminous plants can fix their own atmospheric nitrogen from the soil, nitrogen is required in less amounts than phosphorus(P). Phosphorus is a key nutrient that the plant needs in sufficient amounts for optimal development and reproduction. Phosphorus is essential in almost every activity that requires energy transfer. Because P is necessary for energy transformation in nodules, phosphorus improves biological nitrogen fixation in legumes. Additionally, P is important for root formation, nutrient absorption, and legume crop growth.

Potassium is another essential nutrient/substance for plant growth and development. Because of its influence on photosynthesis, water usage efficiency, and plant resistance to diseases, drought, and cold, not only that it also makes a balance between proteins and carbohydrates, sufficient quantities of K are necessary for enhancing the production and quality of various crops. Therefore, the objective of the experiment was to study the effect of phosphorus and potassium fertilization of the growth and yield attributes of different green gram varieties.

Materials and Methods

The experiment was carried out at the experimental farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema campus, during the summer season (April -July) of 2021. The farm is situated at an attitude of 310 meters above the mean sea level with the geographical location of 25° 45 ′ 4′ ′ North latitude and 95° 53 ′0′ East longitude. The maximum day temperature was observed in the month of June (35.6°C) and highest rainfall was received in the month on July (47.5mm). The soil condition was found to be well drained and sandy loam in texture with initial pH 4.6. Available soil Phosphorus and Potassium at the start of the experiment was 32.81 kg ha^{-1} P_2O_5 and 144.64 kg $ha^{-1}K_2O$.The field was laid out in factorial randomized block design and divided into three equal blocks which were further divided into 12 equal plots each measuring 3×2 m. Spacing of 1 m was maintained between block to block and 0.5 m between the plots. A total of 36 plots were made and the treatments were distributed in a random fashion. The treatment consisted of combination of three green gram varieties *viz.,* V_1: IPM 02-3, V_2: SGC-20 V_3: SGC-16 along with four levels of phosphorus + potassium; N_1: control, N_2: 40 kg ha^{-1} P_2O_5 + 40 kg ha^{-1} K_2O, N_3: 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O and N_4: 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O.

Results and Discussion

Growth Attributes

Plant height (cm)

The plant height was influenced by the application of phosphorus and potassium. Treatment N_4 *i.e.,* 60kg ha^{-1} P_2O_5 + 60kg ha^{-1} K_2Orecorded the highest plant height (8.27and 54.87 cm) at 20 DAS and harvest which was statistically at par with application of 50kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O (8.22and 54.37 cm). The increase in plant height with increased level of P&K fertilization can be due to increased cell division and cell expansion resulting in increasing positive effect in crop height. These observations are in accordance with the findings of Awomi *et al.,* (2012). Treatment combination V_1N_4 (IPM 02-3 and 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O) recorded the highest plant height (8.43and 56.45 cm) at 20DAS and harvest and was found to be at par with V_1N_3.

Leaf area index (LAI)

Application of 60 kg ha^{-1} P_2O_5 + 60 kg ha $^{-1}$ K_2O showed the highest leaf area index (0.76and 1.21) at 30and 60 DAS, followed by application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O (N_3) (0.71and 1.07). The increase in LAI with increase in levels of P&K can be attributed to the role of phosphorus and potassium in enhancing cell division and cell growth leading to increased leaf area of the plant, as well as crop canopy. These observations are in accordance with the findings of Singh *et al.,* (2019).The interaction effect of varieties and levels of phosphorus and potassium on LAI was found significant. V_1N_4 recorded the highest LAI at 30 DAS (0.80). However, at 60 DAS the highest LAI was recorded in treatment combination of V_1N_3 (1.28).

Dry matter production (g)

The influence of phosphorus on dry matter production has been reported by Abbasi *et al.,* (2012). Application of 50 kg ha^{-1} P_2O_5 + 50kg ha^{-1} K_2O (N_3) recorded significant increase on dry matter production over control (N_1) and N_2 (40 kg ha^{-1} P_2O_5 + 40kg ha^{-1} K_2O). The highest dry matter production (19.15 and143.82 g m^{-2}) at 30and 60 DAS was recorded in application of N_3 then followed by application of P&K at 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O(N_4). N_3 and N_4 were found to be at par with each other. The influence of phosphorus and potassium in enhancing the plant height, leaf area and branches plant^{-1} can be credited to the increase in dry matter production. The observed data is in line with the report from the work of Khairnar and Gunjal (2012). The interaction effect varieties and levels of phosphorus and potassium on dry matter production was found significant. The highest dry matter production at 30and 60 DAS (19.22and144.72 g m^{-2} respectively) was recorded in the combination of IPM 02-3 and 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O (V_1N_3).

Crop growth rate (CGR)

Application of phosphorus and potassium at different levels, significantly influenced the crop growth rate over control. At 30-45 DAS, application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O gave significantly higher CGR followed by application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O. At 45-60 DAS, the application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O gave higher CGR and was statistically at par with application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O. Phosphorus and potassium play a major role in plant photosynthesis, which enhances plant vigour and accelerates leaf development thereby increasing the CGR with increase in levels of P&K. The results are in accordance with the results of Saxena *et al.,* (1996) where application of 60 kg ha^{-1} P_2O_5 reported significant increase in CGR in green gram.

The lowest CRG at 30-45 DAS and 45-60 DAS (4.64, 2.33 g m^{-2} day^{-1}) was observed in control (N_1).The interaction effect of varieties and levels of phosphorus and potassium on CGR was found significant. The treatment combination V_1N_4 *i.e.,* IPM 02-3 and 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O recorded maximum CGR (5.47 and 3.18 g m^{-2} day^{-1}) at 30-45 DAS and 45-60 DAS respectively.

Yield attributes

Pods plant^{-1}

Application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O (N_3) reported the maximum number of pods plant^{-1} (15.17) and was significantly higher over control (N_1) and N_2 (40 kg ha^{-1} P_2O_5 + 40 kg ha^{-1} K_2O). Number of pods plant^{-1} with application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O (N_4) was at par with application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O. The increase in pods plant^{-1} may be due to the enzymatic activities triggered by the application of phosphorus and potassium, which controls flowering and pod formation (Khan *et al.,* 1999). The results are in accordance with the results of Khairnar and Gunjal (2012). The interaction effect of varieties and levels of phosphorus and potassium on the number of pods plant^{-1} was found significant. Treatment combination V_1N_4 *i.e.,* IPM 02-3 and 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O recorded the highest number of pods plant^{-1} (8.33).

Test weight (g)

The application of phosphorus and potassium did not have any significance on test weight. The interaction effect of varieties and levels of phosphorus and potassium on test weight was found non-significant.

Table.1 Effect of phosphorus and potassium on plant growth attributes of different green gram varieties

Treatment	Plant Height (cm)		LAI		Dry Matter Production (g)		CGR (g m^{-2})	
	20 DAS	harvest	30 DAS	60 DAS	30 DAS	60 DAS	30-45 DAS	45-60 DAS
V_1	7.47	53.09	0.72	1.10	18.00	137.98	5.14	2.89
V_2	7.27	51.93	0.68	1.05	18.01	136.93	5.06	2.88
V_3	7.21	51.79	0.66	1.02	17.92	136.14	5.02	2.87
S.Em ±	0.089	0.672	0.004	0.004	0.040	0.336	0.0251	0.0307
CD (P=0.05)	NS	NS	0.014	0.015	NS	1.143	0.0854	NS
N_1	5.66	44.56	0.63	0.96	15.45	120.38	4.64	2.33
N_2	7.14	53.08	0.67	0.99	18.21	140.42	4.94	2.96
N_3	8.22	54.37	0.71	1.07	19.15	143.82	5.28	3.14
N_4	8.27	54.87	0.76	1.21	19.08	143.46	5.44	3.13
S.Em ±	0.103	0.776	0.005	0.005	0.046	0.388	0.0290	0.0354
CD (P=0.05)	0.350	2.641	0.017	0.017	0.158	1.130	0.0986	0.1204

Table.2 Effect of phosphorus and potassium on yield attributes of different green gram varieties

Treatment	Pods $Plant^{-1}$	Test Weight (g)	Seed Yield (Kg ha^{-1})
V_1	13.61	28.00	548.08
V_2	13.39	27.01	508.76
V_3	12.89	26.60	437.90
S.Em ±	0.263	0.188	2.988
CD (P=0.05)	NS	0.639	10.165
N_1	10.16	25.26	386.08
N_2	13.07	26.47	447.69
N_3	15.17	27.61	574.29
N_4	14.77	29.47	584.94
S.Em ±	0.303	0.217	3.450
CD (P=0.05)	1.032	NS	11.737

Table.3 Interaction effect of varieties and levels of phosphorus and potassium on green gram

Treatment	Plant height		LAI		DRY MATTER PRODUCTION (g)		CGR (g m^{-2})		PODS $PLANT^{-1}$	TEST WEIGHT (g)	SEED YIELD (Kg ha^{-1})
	20 DAS	harvest	30 DAS	60 DAS	30 DAS	60 DAS	30-45 DAS	45-60 DAS			
V_1N_1	5.83	48.73	0.65	0.96	15.66	121.47	4.76	2.27	6.00	25.80	412.42
V_1N_2	7.27	53.33	0.71	1.02	18.00	141.13	5.01	2.98	6.78	27.09	503.65
V_1N_3	8.36	53.87	0.75	1.28	19.22	144.72	5.33	3.12	7.33	27.95	637.94
V_1N_4	8.43	56.45	0.80	1.15	19.12	144.61	5.47	3.13	8.33	31.16	638.33
V_2N_1	5.57	41.07	0.63	0.96	15.40	120.08	4.62	2.33	5.11	25.07	395.29
V_2N_2	7.13	53.80	0.66	1.00	18.33	140.17	4.94	2.96	5.78	26.30	442.16
V_2N_3	8.17	54.80	0.71	1.05	19.19	143.96	5.25	3.12	6.65	27.81	587.59
V_2N_4	8.23	54.54	0.74	1.20	19.11	143.52	5.46	3.13	7.33	28.86	610.00
V_3N_1	5.57	43.87	0.62	0.95	15.30	119.60	4.56	2.38	4.66	24.92	350.52
V_3N_2	7.03	52.10	0.65	0.96	18.30	139.95	4.88	2.94	5.33	26.01	397.27
V_3N_3	8.13	54.43	0.68	1.03	19.05	142.77	5.26	3.09	5.75	27.07	497.33
V_3N_4	8.13	53.61	0.72	1.16	19.02	142.26	5.41	3.08	6.22	28.38	506.49
S.Em (±)	0.178	1.345	0.008	0.009	0.080	0.606	0.0502	0.0613	0.526	0.376	5.976
CD (P=0.05)	0.606	NS	0.0296	0.031	0.274	2.283	0.170	0.2086	1.788	NS	20.330

Seed yield (kg ha^{-1})

Phosphorus and potassium significantly increased the seed yield. Application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O recorded highest seed yield (584.94 kg ha^{-1}), which was followed by application of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O and was found to be at par with each other.

The increase in yield parameters such as number of pods $plant^{-1}$, number of seeds pod^{-1} eventually leads to increase in seed yield with increased levels of P&K fertilization. Also, the role of phosphorus and potassium in translocation of photosynthates to fruiting zone and also due to increased nodulation that in turn fixes more N which is utilised during grain formation stage may attribute to higher seed yield.

The observations are in line with the results of Singh *et al.*, (2019), where phosphorus application had a significant effect on seed yield up to 60 kg ha^{-1} P_2O_5. Influence of potassium on seed yield was reported by Singh (2017).

The interaction effect of varieties and levels of phosphorus and potassium on seed yield revealed that treatment combination V_1N_4 (IPM 02-3 with 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O) and V_1N_3 (IPM 02-3 with 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O) are statistically at par with each other. The highest seed yield was recorded in V_1N_4 (638.33 kg ha^{-1}).

In conclusion, the application of 60 kg ha^{-1} P_2O_5 + 60 kg ha^{-1} K_2O produced the highest plant height, leaf area index, CGR, test weight and seed yield. The interaction effect of V_1N_4 produced maximum plant height, CGR, pods $plant^{-1}$, test weight and seed yield. However, it was found to be at par with V_1N_3 in almost all attributes in question. Thus, combination of IPM 02-3 with of 50 kg ha^{-1} P_2O_5 + 50 kg ha^{-1} K_2O can be used to maximize productivity in the study area. However, for recommendation of nutrient level and variety for the area in study, repeated experiment has to be conducted for more years.

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