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Response of green gram (*Vigna radiata* L.) to major nutrients following omission approach under diverse dates of sowing

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ABSTRACT

A field experiment was carried out at Agriculture Research Station, Brinjhagiri, Siksha O Anusandhan Deemed to be University; Odisha during Summer 2022 entitled "Response of Green Gram (*Vigna radiata* L.) to major nutrients following omission approach under diverse dates of sowing" to find out most suitable time for sowing in summer season with relation to major nutrients. For this a split plot design was opted with the main plot consisting of 3 dates of sowing viz. 22nd January, 12th February & 5th March. And the sub plot consisted of 8 treatments with all the three major nutrients following omission approach viz. $N_1P_1K_1$, $N_1P_1K_0$, $N_1P_0K_1$, $N_1P_0K_0$, $N_0P_1K_1$, $N_0P_1K_0$, $N_0P_0K_1$ & $N_0P_0K_0$. A recommended fertilizer dose of 20-40-20 kg of nitrogen, phosphorous and potassium per ha was applied. The following experiment showed that growth parameters and yield attributing characters varied significantly. Under nutrient treatments those that received all three major nutrients showed maximum values such as the plant height(45.10 cm), leaf number (25.83), dry matter accumulation(373.97 g/m^2), CGR(3.12) and protein content (24.46). The maximum crop yield attributes were recorded for those sown on 12th February (7th SMW). The maximum seed yield of 936.9 kg/ha and stover yield of 2366.22 kg/ha was recorded from $N_1P_1K_1$ treatments. The nutrient content and uptake was also found to be maximum for those under $N_1P_1K_1$ treatment and the D2 (12th February, 7th SMW) sowing date. Regarding the economics of the various treatment combination, the treatment that received all three major treatments $N_1P_1K_1$ fetched the highest net return of 30784 and maximum B:C ratio of 1.82 while those sown on D2 showed the highest return of 28631 and B:C ratio of 1.80.

Key words: *Green gram, Sowing dates, Major nutrients, Omission approach*

Introduction

Pulses as a candidate crop, contributes immensely towards doubling farmers' income through diminishing cost of production, scaling per unit productivity, efficient marketing networks and successful technology delivery mechanisms by giving emphasis sustainable intensification and crop diversification, climate resilient production technologies backed with strong research outputs in pulses can contribute towards doubling the farmers' income (Singh, 2007).

In India, the pulses were cultivated in an area of 28.83 million hectares with production of 25.72 mil-

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lion tonnes during 2020-21. India contributes more than 70% of world's green gram production with Rajasthan ranking 1st in terms of area and Madhya Pradesh ranking 1st in production.

Green gram is mainly a rainy season crop but with the development of early maturing varieties, it proved to be a suitable crop for spring and summer season. This in turn helped to increase the farmers' household income while simultaneously combating malnutrition and sustaining agricultural production.

Sowing time affects plant physiological and morphological specifications like effect on vegetative and reproductive periods, harvest time, yield and its quality. So in order to achieve good yield crop must be sown at suitable time. Sarkar *et al.* (2004) observed that early planted crops produced higher yield compared to late planted crops. Major nutrients play an important role for obtaining higher crop production. Though green gram can fix atmospheric nitrogen, application of 15 to 20 kg nitrogen per hectare as basal dose at time of sowing will be good for crop growth. Application of phosphorushelps in development of root system leading to more nodulation. But inadequate and imbalanced fertilizer application has lead to decline in pulse production.

Materials and Methods

The present experiment was conducted at Agricultural Research Station, Brinjhagiri, Chhatabar of Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar (Odisha) during summer season of 2022. The experimental area having fairly uniform topography, normal fertility status and soil homogeneity.

The site is situated in Khordha district of Odisha at the latitude of 20° North and longitude of 85° East at altitude of 58m above mean sea level. The weekly meteorological data viz., rainfall, temperature, relative humidity and number of rainy days during crop season were recorded in meteorological observatory of ARS Chatabar, Bhubaneswar. The general climatic condition of the experimental site is hot and humid. The annual mean temperature is 27.4 °C. the summer season (March to June) remains hot and humid, with temperature ranging from 30-40 °C. The humidity is normally higher during this period, thereafter it decreases with increased sunshine hours. Winter last here for a short period (Mostly December and January), only for ten weeks. During this short winter span, the average temperature ranges between 15-28 °C. May and January are the hottest and coolest month with an average temperature range of 32-42 °C and 15-26° C respectively (Acharya *et al.*, 2020).

The composite surface (0-15cm) soil samples collected in all treatments during the cropping period, i.e, before sowing and after harvest. The soil of the experimental site was sandy clay in nature having slight acidic pH of 6.0, with low in available N (187.4 kg/ha) and medium in available P and K 18.48 and 113.6 kg/ha respectively.

The experiment was laid out in Spilt plot design with three replications. Treatments comprised of three date of sowing in main plot D_1: 22nd January, D_2: 12th February & D_3: 5th March with 8 nutrient management treatment combinations viz. $N_1P_1K_1$, $N_1P_1K_0$, $N_1P_0K_1$, $N_1P_0K_0$, $N_0P_1K_1$, $N_0P_1K_0$, $N_0P_0K_1$ and $N_0P_0K_0$ in sub plot. Urea, SSP and MOP were used as a source of major nutrients towards providing 20 kg nitrogen, 40 kg phosphorous and 20 kg potassium per hectare the gross and net plot size viz. 6.0 m × 3.0 m and 5 m × 2 m respectively. The test variety was Virat (IPM 205-7). Seeds were inoculated with Rhizobium before sowing; the seeds were sown at a distance of 25 cm apart between rows and 10 cm plant to plant.

Nitrogen, phosphorus and potassium content and uptake were assessed in the laboratory after the harvest of the crop. The total nitrogen content in plant was determined by micro kjeldahl and distillation method (Jackson, 1973). The total phosphorus content of plant materials was determined by Triple acid extraction and Vanadomolybdo phosphoric acid yellow colour method (Jackson, 1973). Potassium content of the plant material was evaluated by Triple acid extraction and flame photometry (Piper, 1966).

Nitrogen content in the grain of greengram was estimated by Kjeldahl's method (AOAC, 1999), and the protein per cent in the grain was calculated by multiplying the nitrogen content with a factor 6.25.

After harvesting of greengram, grain and stover yield were calculated by drying the seed under the sun to standard moisture condition. Aside from this growth attributes like pods/plant, seeds/pod, plant height, dry matter and branches per plant was also recorded.

Results and Discussion

Growth parameters: The result revealed that due to different sowing dates the growth parameters significantly varied. The plant height, number of leaves per plant and number of branches per plant data (Table 1) varied significantly under different sowing dates and nutrient management. The plants sown under the treatment D_2 with nutrient management $N_1P_1K_1$ showed higher plant height, number of leaves per plant and number of branches per plant compared to all other treatments.Dry matter accumulation was the highest for plants sown in D_2 and $N_1P_1K_1$ nutrient management compared with all other dates of sowing and treatments. The crop growth rate was observed to be the highest for $N_1P_1K_1$ which was at par with $N_0P_1K_0$, $N_0P_1K_1$ and $N_1P_0K_0$ at all observations. The lowest CGR was observed in $N_0P_0K_0$ treatment.

Protein content: The protein content in seed was also found to be highest in D_2(22.13%) which is at par with those of D3(21.89%). It was also observed that $N_1P_1K_1$ treatment had highest protein content of 24.46% in the seeds.

Yield attributes and Yield: Noting the yield attributing character and yield of greengram it is understood that under different sowing dates significant differences were observed in pods per plant (Table 2). The highest pods were counted (15.94) in the 2nd date of sowing, i.e, 12th February which was also at par with the third date of sowing counting 14.95 pods. Among different nutrient management practices at the same time the highest number of pods were counted in treatment $N_1P_1K_1$ which was 18.21. Among interaction between sowing and nutrient management the highest number of pods per plant was also results significant variations in the treatment combination $N_1P_1K_1$ under D_2 counting 19.39. This was also at par with treatment $N_1P_1K_0$ at D_2 and treatment $N_1P_1K_1$ at D_3. Sarkar *et al* 2004 and Adhikari 2021 also observed similar type of results.

Similarly, the number of seeds per pod showed (Table 3) significant variations under different sowing dates and nutrient management. The highest seeds per pod was observed in D_2 at treatment $N_1P_1K_1$ of 12.9 This was at par with treatment $N_1P_1K_1$ at D_3 counting 12.8.

The highest seed yield was acquired under the treatment $N_1P_1K_1$which was 878.1 kg/ha and D_2 which was 1006 kg/ha among nutrient management and date of sowing respectively. The lowest seed

Table 1. Growth parameters and protein content of greengram as affected by different treatments

Treatments	Days after sowing					
	Plant height (cm)	Number of leaves/ plant	No of branches/ plant	Dry matter (g/m^2)	CGR ($g/m^2/day^{-1}$)	Protein content in seed (%)
Date of Sowing						
D_1 (22nd January)	41.23	23.4	4.60	279.23	3.218	21.19
D_2 (12th February)	44.09	24.2	4.93	314.24	2.124	22.13
D_3 (5th March)	43.33	24.0	4.79	294.06	2.177	21.89
SEm±	0.535	0.242	0.038	3.457	0.443	0.259
CD (P=0.05)	1.485	0.673	0.105	9.598	1.231	0.711
Nutrient Management						
$N_1P_1K_1$	45.10	25.83	5.53	373.97	3.12	24.46
$N_1P_1K_0$	44.47	25.09	5.39	345.95	2.34	23.21
$N_1P_0K_1$	43.75	24.66	5.06	329.07	5.07	22.32
$N_1P_0K_0$	41.98	23.49	4.91	256.89	1.14	21.68
$N_0P_1K_1$	43.26	24.46	4.84	306.22	2.78	21.71
$N_0P_1K_0$	41.11	22.54	4.41	270.60	2.30	21.16
$N_0P_0K_1$	42.84	23.86	4.20	279.45	1.86	20.64
$N_0P_0K_0$	40.56	21.95	3.83	204.63	1.41	18.75
SEm±	0.671	0.743	0.162	14.659	1.004	1.258
CD (P=0.05)	1.354	1.50	0.327	29.583	2.026	2.540
Interaction D × N						
SEm±	1.162	1.287	0.281	25.39	1.739	2.180
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table 2. No of pod per plant as influenced by different sowing dates and nutrient management practices of greengram

Date of Sowing	Nutrient management practices								
	$N_1P_1K_1$	$N_1P_1K_0$	$N_1P_0K_1$	$N_1P_0K_0$	$N_0P_1K_1$	$N_0P_1K_0$	$N_0P_0K_1$	$N_0P_0K_0$	Mean
D1	17.05	16.23	15.45	12.07	14.89	12.18	15.07	10.04	**14.12**
D2	19.39	18.24	18.09	14.38	16.27	12.95	17.49	10.72	**15.94**
D3	18.20	16.08	16.80	14.55	16.07	11.04	17.20	9.66	**14.95**
Mean	18.21	16.85	16.78	13.67	15.74	12.06	16.59	10.14	
		Main plot			Sub plot			Interaction (D ×N)	
SEm±		0.233			0.404			0.701	
CD (P=0.05)		0.649			0.817			1.415	

Table 3. Seed per pod as influenced by different sowing dates and nutrient management practices of greengram

Date of Sowing	Nutrient management practices								
	$N_1P_1K_1$	$N_1P_1K_0$	$N_1P_0K_1$	$N_1P_0K_0$	$N_0P_1K_1$	$N_0P_1K_0$	$N_0P_0K_1$	$N_0P_0K_0$	Mean
D1	12.4	12.2	11.8	11.3	11.9	11.1	11.2	9.5	11.42
D2	12.9	12.4	12.2	11.7	12.3	11.7	11.50	10.4	11.88
D3	12.8	11.8	11.5	11.9	11.6	11.3	11.5	9.9	11.64
Mean	12.7	12.16	11.83	11.61	11.9	11.39	11.4	9.93	
		Main plot			**Sub plot**			**Interaction (D × N)**	
SEm±		0.046			0.132			0.229	
CD (P=005)		0.127			0.267			0.462	

yield obtained under the treatment $N_0P_0K_0$ amounting to 482 kg/ha and D_1 sowing date yielding to 684.9 kg/ha (Table 4).

Nutrient Uptake: The highest Nitrogen uptake in seeds of 30.9 (kg ha^{-1}) was calculated in crops sown on 12thFebruary, similarly the highest nitrogen uptake of 29.1 (kg ha^{-1}) in stover was also noted in D_2 (table 5) but this was found statistically at par with D_3 in terms of N uptake by stover. Again the very same pattern of observations were grasped with phosphorus and potassium uptake both by seed and stover, when the crop sown during 12th February (D_2) shown the highest uptake values and also found to be at par with the uptake values of P & K under sowing date D_3 (Table 5). Between different nutrient management combinations under $N_1P_1K_1$ the maximum accumulation of nitrogen, phosphorus and potassium by seed with 36.85 (kg ha^{-1}), 2.75(kg ha^{-1}) and 15.2 (kg ha^{-1}) respectively were calculated. Harish *et al* 2023 also reported similar observation.

Temperature and yield

Seed yield under different date of sowing directly influenced by average temperature for that period (Fig 1). The study clearly showed a positive significant correlation between yield and average temperature. The result revealed higher seed yield logged under a favourable mean temperature range of 30 °C. Similar type of observation also reported by Rakavi *et al.,* 2019.

Economics: The cost of cultivation varied due to dif-

Table 4. Seed Yield (kg/ha) as influenced by different sowing dates and nutrient management practices of greengram

Date of Sowing	Nutrient management practices								Mean
	$N_1P_1K_1$	$N_1P_1K_0$	$N_1P_0K_1$	$N_1P_0K_0$	$N_0P_1K_1$	$N_0P_1K_0$	$N_0P_0K_1$	$N_0P_0K_0$	
D1	847.33	785.0	776.33	698.33	671.67	586.33	632.33	482.0	684.9
D2	1006.0	973.0	962.33	847.0	924.33	822.0	884.33	606.0	878.1
D3	965.33	903.0	736	833.0	879.33	732.33	839.67	558.33	805.9
Mean	939.56	887	824.89	792.78	825.11	713.56	785.44	548.78	
		Main plot			Sub plot			Interaction(D ×N)	
SEm±		11.483			27.024			46.807	
CD (P=0.05)		31.881			54.537			94.462	

Table 5. Nutrient uptake in seed & stover (kg/ha) as influenced by different sowing dates and nutrient management practices of greengram

Treatments	Nutrient uptake in seed and stover (kg/ha)					
	Nitrogen (N)		Phosphorus (P)		Potassium (K)	
	Seed	Stover	Seed	Stover	Seed	Stover
Date of Sowing						
D1 (22nd January)	23.5	18.5	1.7	0.78	7.2	18.5
D2 (12th February)	30.9	29.1	2.3	1.19	11.6	29.1
D_3 (5th March)	29.3	28.2	2.2	1.18	10.3	28.2
SEm±	1.419	0.343	0.143	0.088	1.2	0.343
CD (P=0.05)	3.942	0.953	0.397	0.244	3.331	0.953
Nutrient management						
$N_1P_1K_1$	36.85	36.16	2.75	1.57	15.22	36.16
$N_1P_1K_0$	32.58	32.99	2.44	1.29	10.09	30.39
$N_1P_0K_1$	29.93	26.93	2.08	1.03	11.07	30.93
$N_1P_0K_0$	26.34	24.53	1.84	0.89	8.24	24.53
$N_0P_1K_1$	29.00	23.61	2.25	1.07	10.60	23.61
$N_0P_1K_0$	25.23	20.61	1.95	0.96	8.25	20.61
$N_0P_0K_1$	26.72	20.37	1.98	0.90	9.86	20.37
$N_0P_0K_0$	16.49	17.14	1.25	0.69	4.05	17.14
SEm±	2.384	2.419	0.191	0.159	1.127	2.419
CD (P=0.05)	4.811	4.882	0.386	0.321	2.275	4.882
Interactions D X N						
SEm±	4.129	4.190	0.331	0.275	1.952	4.190
CD (P=0.05)	NS	NS	NS	NS	NS	NS

ference in input cost such as manures, biofertilizers and fertilizers which in turn lead to variation in cost of cultivation. The net return form D2 (12th February, 7 SMW) was found to be highest (Fig. 3). Under nutrient management treatment $N_1P_1K_1$ fetched the highest gross return. Similar case was seen for B:C ratio with crops sown on D2 and $N_1P_1K_1$ treatment being highest.

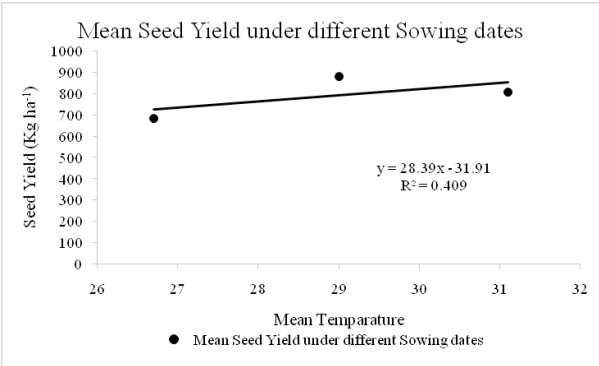

Fig. 1. Correlation between seed yield and mean temperature under different sowing dates

This variation in yield under different sowing dates may be due to variation in weather parameters like temperature and relative humidity during its growing period. The maximum, minimum and average temperature was low during the initial growth stage of greengram when it was sown early (Fig. 2). During 4th, 5th, 6th and 7th SMW maximum temperature raised between 27.5-28.9 °C However the minimum temperature remains 14.7-16.9 °C during the initial crop establishment period under 1st date of sowing. When the crop was sown 12th of February the maximum and minimum temperature begins to raises up. The maximum temperature raised between 28.9 °C -34.7 °C during 7th-10th meteorologi-

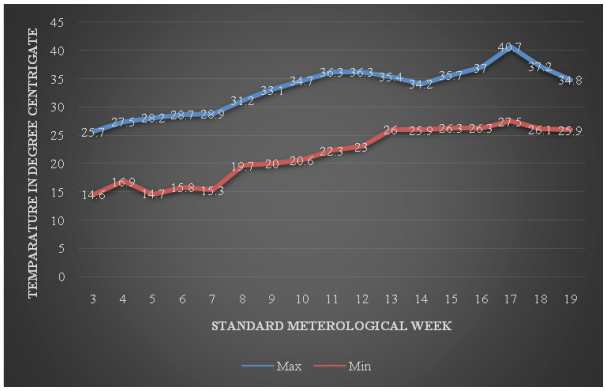

Fig. 2. Maximum and minimum temperature during experimental period

cal weeks whereas the minimum temperature also increases during this period. Further the temperature raises more ranging from 34.7 °C – 35.4 °C (maximum) during 10th- 13th standard meteorological week, the minimum temperature raises when the 3rd sowing dates arrives that's why the crop under 2nd and 3rd sowing date get a favorable condition for initial growth and development which reflects into their yield attributes which leads to higher yield in comparison to when the crop sown early. This is in support by the statement given by Varaprasad *et al*., 2001; Rakavi *et al*., 2019; Harsant *et al*., 2013 and Adhikari, 2021. This may be due to during the first fortnight of January the temperature difference between day and night. Especially the relative low night temperature in compare to 2nd and last sowing dates provides a unfavorable condition for the seed germination and emergence. From 2nd week of February the temperature difference reduces which gives a promising condition for growth and development. Similar observations are also reported by Adhikary *et al* 2022.Again when the crop was sown in the month of March it matures early because of high temperature at later stage i.e. late April onwards. Singh *et al*. (2007), Adhikari (2021) also reported similar results.

For different nutrient management practices it is quite simple that the treatment receives nutrient by various sources from the sowing time itself have a healthy plant stand and low mortality. Dry matter production in above ground parts is contributed by stem, branches, leaves, pods and grains inside the pods. Now, temperature and soil moisture directly influenced the dry matter production. Thus, the crop sown 2nd week of February have a favourable climatic condition for growth and development. Under late sown condition due to scorching heat and dry soil resulted in more flower senesces. This leads to low dry matter accumulation due to low individual plant weight. When the crop sown early due to very low temperature the germination and initial vegetative growth hampers, thus it took a longer time to complete its life cycle. This was true for all the stages of observation (Adhikari *et al.*, 2022). Favourable climatic condition in timely sowing might be responsible for higher dry matter over of early sowing.

The variation in seed yield is clearly due to omission of major nutrients either N or P or K in single or in combination, when the treatments receive all the major nutrients the highest yield was recorded with omission of any one major nutrients from the treatment shows declining in seed yield. The treatment $N_1P_0K_1$, $N_1P_1K_0$, $N_0P_1K_1$ are found at par between themselves. These three treatments are also at par with $N_1P_1K_1$ which produce the highest yield, whenever two major nutrients omitted from the treatment yield further declines. Similar observation also reported by Harish *at al.* 2023.

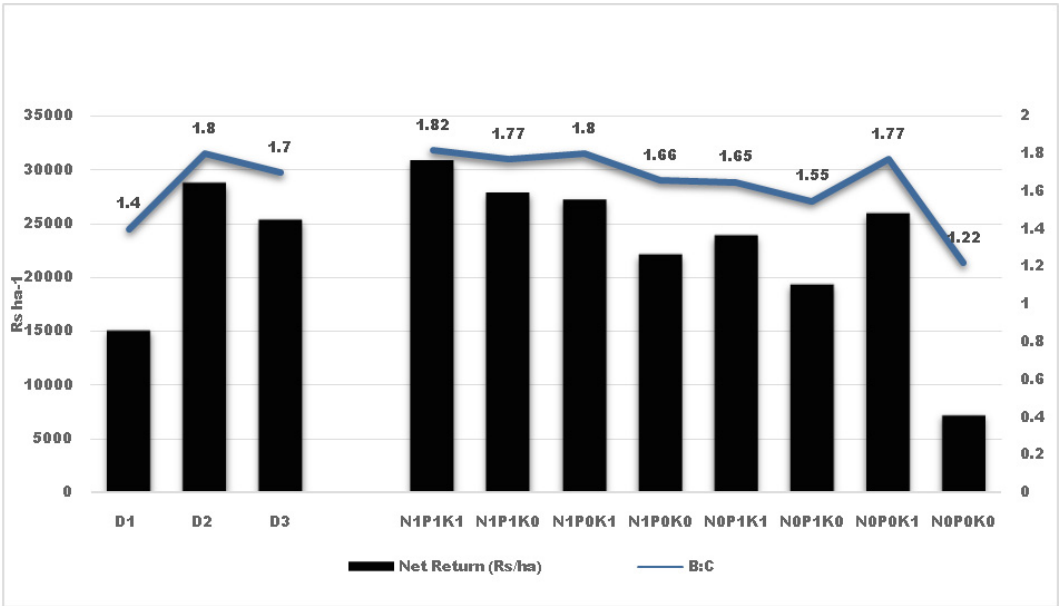

Fig. 3. Economics of greengram as influenced by sowing dates and nutrient management practices

Conclusion

So it can be concluded that the growth, yield and productivity of green gram was found to be maximum when the treatment contained all three major nutrients such as nitrogen, phosphorus and potassium with the recommended dose being 20-40-20 kg/ha respectively. The growth, yield and productivity of greengram was also found to be maximum when the crop was sown in the second week of February (12th Feb, 7thSMW). Though the treatment costs were less in the treatments which received only two major nutrients in combination, due to higher variation in seed yield the treatment which received all three major nutrients was found to be the best.

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Conflict of Interests

The authors declare that there is no conflict of interest related to this article.

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