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EFFECTS OF SOWING DATE AND N MANAGEMENT ON GROWTH AND YIELD OF GREEN GRAM (*VIGNA RADIATA* L.) OF ASSAM, INDIA

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Abstract

The field experiment was conducted at Tinsukia in Assam of India during *kharif* seasons of 2016-17 and 2017-18 to investigate the effect of sowing date and nitrogen (N) management practices on the growth and yield of green gram (*Vigna radiata* L.). Results indicate that the sowing date, S_2 (1st September) showed superiority in respect of the growth and yield of the crop, compared to other sowing dates for both years. Amongst the N management treatments, a significantly higher value of the growth parameters, yield attributes, and yields was observed in the treatment receiving 50% N as inorganic fertilizer along with vermi-compost @ 1.0 t/ha. Among the sowing dates, late sown crop (1st October) accumulated the lower heat units (GDD) and higher thermal time (HTU) at 50% flowering and maturity compared to the early sown crop (15th August or 1st September) causing a reduction in seed yield of green gram. The relationship between accumulated growing degree days (AGDD) and yield was positive for all the phenophases with a statistically significant result during PP2 (flowering to maturity). On the contrary, the correlation between AHTU and yield was negative for all the phenophases. The regression models for different phenophases of the crop indicate 86 - 98% of yield variation which can be explained by accumulated agrometeorological variables.

Introduction

Green gram (*Vigna radiata* L.) is an important pulse crop in India. The optimum sowing time ensures complete harmony between the vegetative and reproductive phases on one hand and the climatic rhythm on the other and helps in realizing the potential yield of the crop. Sowing of the crops at an optimum time therefore, plays a key role in obtaining higher seed yield (Rathore *et al*. 2010). In intensive agriculture, integrated nutrient management takes care of crops, nutritional needs as well as soil fertility, leading to enhanced yield output through judicious consumption of inorganic nutrients in the system. In recent years, organic farming has been recognized as a significant component of sustainable agriculture. The positive result of enriched compost as well as vermicompost in improving soil fertility and crop productivity is well documented (Borah *et al.*2014*).*Moreover, green gram is often grown on marginal land in Assam and is generally supplied with sub-optimal doses of fertilizers with local varieties, leading to low productivity of the crop. Balanced and efficient application of inorganic fertilizers, organic manures and biofertilizers along with the optimum time of sowing are essential for realizing higher yield and

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reducing the production cost in green gram. On the other hand, the available information on appropriate combination of organic and inorganic sources of nitrogen (N) in the *kharif* green gram is meagre in the sub-tropical humid conditions of Assam. In perception of the above, this study was conducted to find out a suitable sowing time and N management practices under the rainfed conditions of Assam.

Materials and Methods

The experiment was conducted at Krishi Vigyan Kendra, Tinsukia, Assam during the *kharif* season of 2016-17and 2017-18. Geographically, the area is situated at northern latitude 27°31$^{/}$10$^{//}$ and eastern longitude 95°21$^{/}$ 09$^{//}$ at an altitude of 147.83 m above mean sea level (msl).The soil of the experimental field was sandy clay loam with pH of 5.12 and 5.23, organic carbon of 0.85 and 0.90%, medium available N (298.75 kg/ha and 310.45 kg/ha) and P content (25.92 and 26.13 kg/ha) and very low available K (33.5 and 34.4 kg/ha)for 2016-17 and 2017-18, respectively. The experiment was arranged in factorial randomized block design with three replications. The treatments comprised four times of sowing (S_1-15th August, S_2- 1st September, S_3-15th September, S_4-1st October) and four N treatments (N_1: 100% RDF of N as inorganic fertilizer; N_2: 75% N as inorganic + 0.5 t/ha vermicompost (VC.); N_3: 50% N as inorganic + 1.0 t/ha VC.; N_4: 25% N as inorganic + 1.5 t/ha VC.), respectively. The recommended dose of nitrogen at 10 kg/ha through urea, phosphorus at 35 kg/ha through SSP and potassium at 10 kg/ha through MoP were applied. Full doses of N, P and K were applied at the time of sowing as per treatments. Before application, vermi-compost was incubated with *Rhizobium* and phosphorous solubilising bacteria (PSB) for 15 days @ 0.2% (w/w). The incubated vermi-compost was applied at a specified rate as per treatments. Seeds of green gram variety “Pratap” were inoculated with *Rhizobium* culture and sown @ 22 kg of seed/ha in lines. Plant to plant and row to row distance were maintained at 30 and 10 cm, respectively. Other agronomic practices and plant protection measures were followed as per recommendation. The phenological events like 50 % flowering and maturity of the crop were recorded. Observations on plant height, dry matter production, branches/plant, leaf area index (LAI), yield attributes, and yields were noted following standard procedure. The daily weather data on maximum temperature, minimum temperature, rainy days, rainfall and bright sunshine hours (BSSH) for the period of experimentation were collected from the nearby Agrometeorological Observatory. The accumulated growing degree day (GDD) or heat units for each day was calculated for different phenological events as per the equation suggested by Bharti *et al.* (2017), using a base temperature of 10°C. Heliothermal unit (HTU) was calculated as the product of GDD and corresponding BSSH for that day. Growing degree day and HTU was accumulated from the date of sowing to each date of observation *i.e.* 50% flowering and physiological maturity. Heat use efficiency (HUE) for grain yield was computed following the formula (Rajput, 1980)

$$\text{HUE} = \text{Seed yield/Accumulated heat units}$$

Results and Discussion

Marked variations in weather conditions were noticed in different dates of sowing in both years of experimentation (Table 1). The crop was exposed to a comparatively higher temperature regime when sown in the early as compared to late sown crop. Mean maximum and minimum temperatures during the growing period of green gram was 31.7 and 23.4°C on 15th August sown crop(S_1), whereas it was 29.2 and 15.5°C on 1st October sown crop (S_4), respectively in 2016-17. A similar trend was also observed in 2017-18. This might be the reason for lengthening the maturity period of the crop, with successive delays in sowing time. The crop grown in 2017-18 received a comparatively higher amount of rainfall on less number of rainy days than the crop grown in 2016-17. Comparatively, less BSSH was received by the crop, sown on 15th September (S_3) and 1st October (S_4) in 2017-18 due to the occurrence of more rainfall (Table 1). This might be the reason for considerably better performance of the crop in 2016-17 than in 2017-18.

Table 1. Variations in weather parameters and crop duration of green gram as affected by sowing dates in 2016-17 and 2017-18.

Weather parameters/ Crop duration	Sowing dates							
	2016-17				2017-18			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
Mean Tmax (°C)	31.7	30.8	30.1	29.2	32.5	31.2	30.5	29.0
Mean Tmin (°C)	23.4	21.1	18.9	15.5	23.2	21.5	19.2	16.4
Total Rainfall (mm)	496	440	168	98	459	490	303	176
Total Rainy days	32	24	17	12	20	19	11	7
Mean BSSH(hrs)	5.4	6.1	7.1	7.9	5.0	4.9	6.3	6.8
Crop Duration (Days)	61	65	69	74	61	66	72	75

All the growth parameters were significantly affected by sowing time and nitrogen treatments in both years of study (Table 2). A significantly higher value of maximum plant height, branches/plant, dry matter production, LAI at 45 and 60 DAS was recorded in the crop, sown on the 1st September (S_2) compared to other sowing dates (Table 2). Ransing *et al.* (2014) also reported maximum plant height, branches/plant, nodules/plant and their dry weight/plant in the 20th July sowing, which was a significantly higher than that in other dates of sowing i.e., 30th July and 9th August. They also observed a linear decline in plant height, branches/plant, nodules/plant and their dry weight /plant with delays in sowing. From the results, it indicates that the 15th August sowing of the *kharif* green gram resulted in better growth of plants due to favourable temperature and greater soil moisture as compared to low temperature and reduced soil moisture in the 1st October sowing (late sowing).

Amongst N management treatments, treatment receiving 50% urea-N as inorganic + 1.0 t/ha VC recorded a significantly higher plant height, dry matter production, branches/plant, LAI at 45 and 60 DAS (Table 2). These results clearly indicate the need for adding organic manure to soil conjunctive with inorganic fertilizers for prolonged availability of nutrients in soil leading to a positive effect on the growth of the plant. The present finding supports the results of Tyagi *et al.* (2014) who reported higher plant height, number of primary branches/plant and total dry matter accumulation in the treatment receiving 100% RDF + vermicompost @ 1.0 t/ha + *Rhizobium* as compared to other integrated nutrient management practices. Yield attributes, *viz.* pod/plant, seed/pod and 1000-grain weight were significantly affected by sowing dates and N management treatments in both years (Table 3). The crop, sown on the 1st September (S_2) produced significantly higher pods/plant than in other sowing dates. Similarly, a significantly higher seeds/pod was recorded in the crop, sown on 15th August (S_1)as compared to other sowing dates. However, the crop, sown on the 15th August (S_1) and 1st September (S_2) was statistically at par in respect of seeds/pod in both years. Thousand seed weight was found to be non-significant in both years of experimentation.

The treatment receiving 50% N as inorganic + vermi-compost (1.0 t/ha) produced higher yield attributes, which was significantly superior to the other N treatments. Amongst N management approaches, 1000-seed weight was found to be non-significant (Table 3). Application of inorganic along with organic sources of N had possibly improved the availability of nutrients to the plants,

Table 2.Effect of sowing date and N management on the growth parameters of green gram in 2016-17 and 2017-18.

Treatments	Plant height (cm)		Dry matter production (g/plant)		Branches /plant		LAI at 45 DAS		LAI at 60 DAS	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Sowing date (S)										
S_1 (15th August)	42.7	44.2	19.9	17.9	4.5	5.0	3.06	2.80	2.63	2.69
S_2 (1st September)	44.0	45.1	20.4	18.5	4.8	5.6	3.25	3.09	2.93	2.81
S_3 (15th September)	38.3	41.1	16.8	15.2	3.9	4.3	2.72	2.54	2.54	2.47
S_4 (1st October)	34.2	37.4	15.7	13.7	3.4	3.6	2.49	2.37	2.37	2.37
S.Em.(±)	0.3	0.2	0.2	0.2	0.04	0.03	0.03	0.02	0.02	0.02
CD (P=0.05)	0.7	0.8	0.3	0.3	0.1	0.1	0.09	0.06	0.07	0.06
Nitrogen management (N)										
N_1(100% N as Inorganic)	39.1	41.3	17.7	15.8	4.0	4.6	2.75	2.61	2.53	2.49
N_2 (75% N + 0.5 t/ha VC)	40.6	43.6	18.8	16.8	4.3	4.6	2.99	2.70	2.67	2.54
N_3 (50% N + 1.0 t/ha VC)	42.3	43.8	19.3	17.8	4.6	5.0	3.18	2.97	2.91	2.93
N_4 (25% N + 1.5 t/ha VC)	37.2	39.3	16.9	14.9	3.8	4.2	2.61	2.52	2.35	2.40
S.Em.(±)	0.3	0.2	0.2	0.11	0.04	0.03	0.03	0.02	0.02	0.02
CD (P=0.05)	0.7	0.8	0.3	0.32	0.11	0.10	0.09	0.06	0.07	0.06

Table 3. Effect of sowing date and N management on yield attributes, and yields of green gram in 2016-17 and 2017-2018.

Treatments	Pod/plant		Seed/pod		1000-seed weight (g)		Seed yield (q/ha)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Microclimatic regimes (M)								
S_1 (15th August)	17.20	15.40	8.91	8.73	30.27	29.34	8.45	8.10
S_2 (1st September)	18.70	17.80	8.88	8.65	30.23	28.98	8.57	7.98
S_3 (15th September)	15.83	14.62	8.22	8.15	29.85	28.67	7.89	6.97
S_4 (1st October)	14.02	13.67	7.43	8.07	29.18	28.20	6.45	6.71
S.Em.(±)	0.32	0.27	0.11	0.06	0.20	0.17	0.06	0.04
CD (P=0.05)	0.66	0.56	0.23	0.12	NS	NS	0.17	0.13
Nitrogen management (N)								
N_1(100% N as Inorganic)	15.90	15.89	8.23	8.52	29.80	28.62	8.07	7.44
N_2 (75% N + 0.5 t/ha VC)	17.76	17.76	8.76	8.71	30.38	29.44	8.01	7.71
N_3 (50% N + 1.0 t/ha VC)	18.44	18.40	8.89	8.83	30.42	29.34	8.48	7.72
N_4 (25% N + 1.5 t/ha VC)	13.61	13.61	7.55	7.48	28.94	27.79	6.81	6.90
S.Em.(±)	0.32	0.27	0.11	0.06	0.20	0.17	0.06	0.04
CD (P=0.05)	0.66	0.56	0.23	0.12	NS	NS	0.17	0.13

1quintal (q) = 100 kg.

The seed yield was influenced significantly by sowing dates in both years of study. A significantly higher seed yield (8.57 q/ha) was recorded in the crop sown on the 1st September (S_2) and it was at par with the crop sown on the 15th August (S_1) with seed yield of 8.45 q/ha in 2016-17 (Table 3). In 2017-18, a significantly higher seed yield (8.10 q/ha) was noted for the crop sown on the 15th August (S_1) which was at par with the seed yield of 7.98 q/ha for the crop sown on the 1st September (S_2). Higher seed yield was realized in the case of 15th August or 1st September sown crop, because of higher pods/plant and seeds/pod associated with greater sink. It was observed that the seed yield decreased gradually with delays in sowing time in both years of study. Under late sown condition, plants, however, cannot accumulate sufficient photosynthates due to poor vegetative growth (Singh *et al*. 2010).

Number of days to attain 50% flowering and maturity was more with delays in sowing time (Table 4). The crop, sown on the 15th August (S_1) took 37 and 62 days whereas the 1st October sowing (S_4) took 47 and 75 days to reach 50% flowering and maturity, respectively. This increase in duration of green gram on the 1st October (S_4) sowing was mainly attributed to the lower temperature compared to other microclimatic regimes which had led to lengthening of the maturity period in green gram. The present results corroborate the findings of Singh *et al.* (2010).

Table 4. Accumulated agrometeorological indices and heat use efficiency of green gram under different sowing dates and N management (Pooled data of 2 years).

Treatments	50% flowering			Maturity			Heat use efficiency (kg/ha/°C /day)
	Days	AGDD (°C day)	AHTU (°C day hr)	Days	AGDD (°C day)	AHTU (°C day hr)	
Microclimatic regimes (M)							
S_1 (15th August)	37	705	3616	62	1080	5763	0.76
S_2 (1st September)	40	698	3319	66	1057	5739	0.78
S_3 (15th September)	43	671	3922	71	1035	6803	0.72
S_4 (1st October)	47	661	4539	75	933	6769	0.70
S.Em.(±)	0.11	1.7	3.7	0.13	3.2	8.8	-
CD (P=0.05)	0.44	3.5	7.7	0.56	6.7	18.0	-
Nitrogen management(N)							
N_1 (100% N as Inorganic)	41	730	3820	68	1087	6428	0.71
N_2 (75% N + 0.5 t/ha VC)	41	733	3827	69	1088	6457	0.72
N_3 (50% N + 1.0 t/ha VC)	41	732	3819	69	1086	6445	0.74
N_4 (25% N + 1.5 t/ha VC)	40	722	3814	68	1072	6420	0.63
S.Em.(±)	0.11	1.7	3.7	0.13	3.2	8.8	-
CD (P=0.05)	NS	NS	NS	NS	NS	NS	-

The crop, sown on 15th August (S_1) availed more growing degree days (GDD) at 50% flowering and maturity and with every delay in sowing, the GDD decreased. So the crop, sown at early date absorbed sufficient amount of heat units in short time due to high temperature but the crop, sown at late(1st October) acquired more days to attain maturity and it resulted in accumulation of more GDD. The results are in agreement with the findings of Kaushik *et al.*

(2015) where they reported that the AGDD values decreased with the delays in sowing time in soybean. Accumulation of HTU from sowing to 50% flowering increased with delays in sowing. Highest AHTU on the 1st October sown crop, (S_4) might be due to higher BSSH and low temperature which delayed the maturity of green gram. To attain physiological maturity stage, the crop, sown on 15th September (S_3) accumulated more HTU while less on the 15th August (S_1). It was observed that the requirement of HTU to reach 50% flowering and maturity in early sown crop was lower than that of the late sown crop. This might be due to variations in BSSH which affected the magnitudes of the HTU though there was a record of higher GDD at advanced growth stages of the crop. The present results corroborate findings of Ransing *et al.* (2014). Results revealed that a comparatively higher HUE was observed in earlier sown crop compared to late sown crop. The higher HUE in the early sown crop might be due to higher temperature regimes as well as dry matter production. Influence of nitrogen management was found to be non-significant in the case of heat unit accumulation. However, the higher HUE was observed in 50% N as inorganic + 1.0 t/ha VC which might be due to higher dry matter production.

Results of pooled analysis showed that the correlation of pod yield with AGDD for all the phenophases was positive with statistically significant values for flowering to maturity (PP2) at 1% level. The correlation between AHTU and seed yield during PP1 and PP2 was negative. The correlations between seed yield and accumulated rainy days (ARD) and accumulated rainfall (ARF) for all the phenophases was positively and significantly correlated (Table 5). As rainfall is the most critical element in the rainfed ecosystem, therefore, its quantity as well as distribution might have played an important role in determining seed yield of green gram in the present study.

Table 5. Correlation coefficients and multiple regression equations between seed yield of green gram and sowing dates (Pooled of 2 years).

Phenophase	Correlation coefficients				Regression equation	R^2
	AGDD	AHTU	ARF	ARD		
PP1	0.076	-0.970	0.992*	0.953*	Y = 5.631+0.007*ARF	0.984
PP2	0.929*	-0.085	0.914*	0.904**	Y = 3.676+1.156*AGDD	0.862

* Significant at 5% level, ** significant at 1% level, PP1=Sowing to flowering, PP2= Flowering to maturity and Y =Yield (q/ha)

Multiple regression equation was developed following stepwise regression method between seed yield of green gram and AGDD, AHTU, ARD and ARF for different phenophases to find out the most important weather variables and phenophase in determining seed yield (Table 5). The regression models for different phenophases of the crop indicate that 86 to 98% of yield variations can be explained by agrometeorological variables. It was observed that the amount of rainfall (ARF) alone explained 98% during PP1 (sowing to flowering). Similarly, AGDD during PP2 (flowering to maturity) explained 86% of yield variations in green gram.

It may be concluded that the early sowing of the *kharif* green gram (1st September) along with combined application of 50% N as inorganic + 1.0 t/ha vermi-compost may be recommended to increase the productivity and heat use efficiency under the agro-climatic condition of the upper Brahmaputra valley zone of Assam.

References

Bharti T, Anita C, Vilas B and Sanjay K 2017.Phenology and heat unit requirement of summer green gram varieties under different sowing windows. Inter. J. Curr. Microbiol. Appl. Sci. **6**: 685-691

Borah N, Deka NC, Deka J, Barua IC, Nath DJ and Medhi BK 2014.Enrichment of compost through microbial inoculation-effect on quality. Inter. J. Curr. Res. **6**(8): 8026-8031

Kaushik DK, Patel SR, Chandrawanshi SK, Khavse R and Chaudhary JL 2015. Study on agrometeorological indices for soybean crop under different sowing dates in Chhattisgarh region of India. Indian J. Agric. Res. **49**(3): 282-285.

Rajput RP 1980. Response of soybean crop to climate and soil environments. Ph.D. Dissertation, IRRI, New Delhi. pp. 250

Ransing DM, Verma AK, Meshram MR and Paikra PR 2014.Nodulation, yield and thermal requirement of mungbean (*Vignaradiata*L.) genotypes as influenced by date of sowing. Int. J. Agric. Sci. **10**(2): 638-641.

Rathore SS, Dshora LN and Kaushik MK 2010. Effect of sowing time and fertilization on productivity and economic of urdbean genotypes. J. Food Legume.**23**:154-155.

Singh G, Sekhon HS, Ram H, Gill KK and Sharma P 2010. Effect of date of sowing on nodulation, growth, thermal requirement and grain yield of *kharif* mung bean genotypes.J. Food Legume. **23**(2): 132-134.

Tyagi PK, Upadhay AK and Raikwar RS 2014. Integrated approach in nutrient management of summergreengram. The Bioscan. **9**(4): 1529-1533.

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