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Influence of sowing dates on yield of black gram varieties under rainfed condition

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ABSTRACT

A field experiment was conducted during rabi season from 2013 to2016, at Agricultural Research station, Kovilpatti to identify the best time of sowing and suitable blackgram varieties for rainfed black soil. The experiment was laid out in split-plot design and replicated thrice. The treatments were pre-monsoon (39th standard week), monsoon (41st standard week) and post- monsoon sowing (43rd standard weeks) respectively in main plot with four varieties viz., Vamban (Bg) 6 and Vamban (Bg) 7, NUL 7 and CO 5 in the sub plot. The results revealed that sowing during 39th (pre- monsoon) and 41st standard week (monsoon) registered increased growth and yield parameters viz., plant height (24.2and 22.3 cm), dry matter production (2111 and 2106 kg ha-1), leaf area index (3.73 and 3.73), number of pods plant-1 (18.3 and 17.9), number of seeds pod-1 (5.1 and 5.0), and 100- seed weight (4.6 and 4.5 g) and increased grain yield (616 and 601 kg ha-1), respectively. Similarly, among the varieties, CO 5 registered higher growth and yield attributes which reflected on increased grain yield (608 kg ha-1).

***Keywords*:** Blackgram, rainfed, sowing date, varieties and yield

Blackgram is an important protein-rich food which contains about 26% protein, almost three times that of cereals. Blackgram constitute an integral part of human diet and are potential source of protein for the millions of people. Dietary allowance recommended for adult male is 60 gm day^{-1} and for adult female it is 55 gm day^{-1} (Directorate of pulses Development, 2016). However, the per capita availability is only 42 gm day^{-1}. Hence, it is necessary to increase the per capita availability of pulses. And also, the average yield level of pulses in India is 650 kg ha^{-1} against the world average of 909 kg ha^{-1}. In Tamil Nadu, black gram (46%) and green gram (25%) are the major pulse crops accounting for about 71 percent of the area under pulses and the average yield level of blackgram is far below the national average (464 kg ha^{-1}). Hence, efforts are needed to increase the productivity of blackgram.

Amongst all the factors of crop production, timely sowing is important in all crops and in all seasons as time of sowing will influence the yield and growth of crops to the most by determining time of flowering, seed set and seed yield. Biotic and abiotic needs of crops vary from each other for it's own growth and development. Favourable environment will be achieved only when crop is sown at correct time. Singh and Uttam (1999) reported that reduction in yield @ 39 kg ha^{-1} per day due to delay in sowing from apt time of sowing. Qasim *et al.* (2008) found that timely sowing of wheat increased growth and yield attributes and grain yield. Delayed sowing reduces the yield due to decrease in number of tillers, number of grains per spike and weight of wheat (Poudel and Poudel, 2020).

At present, many high yielding varieties are out dated. Selection of pipe line varieties to cope up with changing environmental condition is necessary to get higher yield (Tahir *et al.*, 2009). The value of stable and high yielding cultivars has been universally recognized as an important factor for boosting crop production (Sharma *et al.*, 2018). Optimum time of sowing of blackgram may vary from variety to variety and season to season due to variation in conditions. Thus, keeping the above facts in view, the present investigation was conducted to study the effect of varieties and date of sowing on growth, yield and economics of black gram.

MATERIALS AND METHODS

Research trial was conducted during 2013-16 at Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti, (Kovilpatti is situated between 8°48' and 9°20' North latitude and 78 ° 25' east longitude at 90 MSL). The trial was laid out in split-plot design and replicated thrice. The treatments were D_1- pre-monsoon (39th standard week), D_2 - monsoon (41st standard week) and D_3 - post- monsoon sowing (43rd standard week) in main plots with four different black gram varieties *viz*., V_1- Vamban (Bg) 6,V_2- Vamban (Bg) 7, V_3- NUL 7 andV_4- CO 5 in the sub plots. The plot size was 5 x 4 m. The soil was clay in texture with sub angular blocky in structure with WHC of 65%, EC 0.32

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dSm^{-1}, pH 8.45, available N 140 kg ha^{-1}, available P 15.5 kg ha^{-1}, available K 340 kg ha^{-1}. Sowing of four blackgram varieties were taken as per treatment schedule.

Application of fertilizers @ 12.5: 25: 12.5: 10 kg NPKS ha^{-1} was done all the years. Blackgram was sown with the spacing of 30 × 10 cm. For controlling weeds, pre-emergence application of pendimethalin @ 2.5 lit ha^{1} followed by one hand weeding at 30-35 days after sowing was done. Data on plant height, leaf area index (LAI),dry matter production (DMP), number of pods $plant^{-1}$, number of seeds pod^{-1}, 100-seed weight and seed yield (kg ha^{-1}) were recorded replication wise. The seed yield obtained from the net plot area was shade dried, weighed as kg $plot^{-1}$ and then expressed in kilogram $hectare^{-1}$. The data obtained were subjected to statistical analysis and were tested at a five per cent level of significance to interpret the treatment differences as suggested by Gomez and Gomez (1984). The data on growth and yield attributes and yield were statistically analyzed using AGRES software. Treatment means were compared using a partition of the sum of squares. Analysis of variance was used to describe the data. The Meteorological data regarding rainfall (RF), maximum temperature (Max T), minimum temperature (Min T), morning relative humidity (RH I), Evaporation (EVP) and sunshine hours (SSH) were collected from meteorological observatory located near crop field at Agricultural Research Station, Kovilpatti. Observed and derived weather parameters like Growing Degree Day (GDD), Accumulated Growing Degree Day (AGDD), Helio Thermal Unit(HTU), Accumulated Helio Thermal Unit (AHTU)and Photo Thermal Unit (PTU) were worked out by using following formula and presented in Table 1.

Thermal time or growing degree days were calculated according to the equation of Mali *et al*. (2000)

$$GDD = \frac{Tmax + Tmin}{2} - Tb$$

where, Tmax - maximum temperature (°C) during a day, Tmin - minimum temperature (°C) during a day, T_b - base temperature of 10.0 °C

Heliothermal units (HTU), the product of GDD and corresponding actual sunshine hours for that day, were computed on daily basis as follows:

HTU = GDD × Actual sunshine hours

Photothermal units (PTU), the product of GDD and corresponding day length for that day, were computed on daily basis as follows:

PTU = GDD × Day Length

where, day length refers to maximum possible sunshine hours.

RESULTS AND DISCUSSION

Growth and yield attributes

The results of the experiment revealed that sowing during 39th (pre-monsoon) and 41st standard week (monsoon) registered significantly increased growth and yield parameters *viz.,*plant height (24.2 and 22.3 cm), dry matter production (2111 and 2106 kg ha^{-1}), leaf area index (3.73 and 3.73), number of pods $plant^{-1}$ (18.3 and 17.9), number of seeds pod^{-1} (5.1 and 5.0), and 100-seed weight (4.6 and 4.5 g) respectively, (Table 2). Higher growth and yield attributes observed in the pre-monsoon and monsoon sown crop (Table 1) might be due to early sowing of blackgram received well distributed high rainfall (234.1 and 211.1 mm), Accumulated Growing Degree Day (AGDD) (1185 and 1158) and Accumulated Helio Thermal Unit (AHTU) (6966 and 6729) which resulted in higher biomass and enhanced the accumulation of more photosynthates than 43rd standard week (post- monsoon) sown blackgram. Reddemma *et al*. (2019) also found the same results.

Post-monsoon sown blackgram produced lower plant height (18.9 cm), dry matter production (1589 kg ha^{-1}), leaf area index (3.14), number of pods $plant^{-1}$ (13.9), number of seeds pod^{-1} (4.0), 100- seed weight (4.0 g). Jahan and Adam (2015) found that November 14 sown wheat produced maximum 1000-grain weight and there was a gradual decreasing trend with delayed sowing. Decrease in test weight is also due to shortening of grain filling duration in delayed sowing, which ultimately reduces grain weight (Poudel *et al.*, 2020).

Among the varieties, CO 5 registered significantly increased growth and yield parameters *viz*., plant height (25.7 cm), dry matter production (2062 kg ha^{-1}), leaf area index (3.68), number of pods $plant^{-1}$ (18.3 nos), number of seeds pod^{-1}(5.1nos), 100- seed weight (4.9 g) which was followed by variety NUL 7. Higher yield might be due to favorable growing environment received by CO 5. Lower growth and yield attributes of blackgram was recorded by variety Vamban(BG) 6. Genetic inheritance of varieties also plays a major role in deciding yield of variety (Poudel *et al.,*2020).

Weather variables Vs sowing dates and variety

Pre-monsoon sown blackgram received higher maximum temperature during germination, vegetative, pod development and maturity stages than post-monsoon sown crop (Fig.1). Germination, photosynthesis, transpiration, respiration and flowering are influenced by the temperature. Increase in temperature (up to a point), increases the transpiration, respiration and photosynthesis. Sunshine hours is very important during vegetative to pod development stage for producing more photosynthates. Pre-monsoon sown

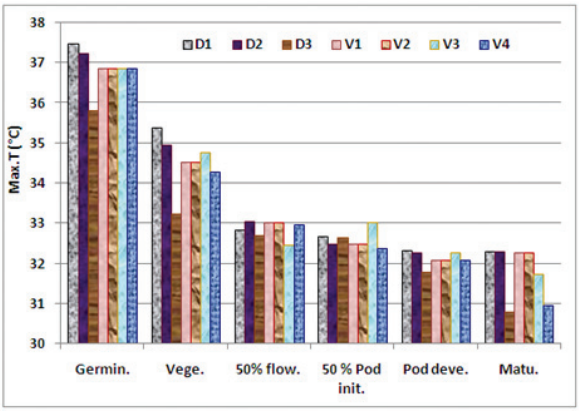

Fig. 1. Maximum temperature (°C) received during different phenological stages of blackgram

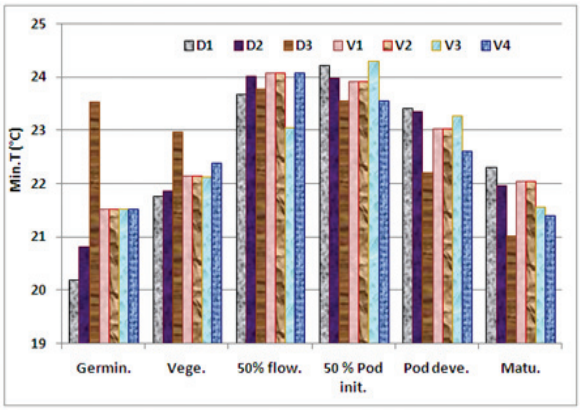

Fig. 2. Minimum temperature (°C) received during different phenological stages of blackgram

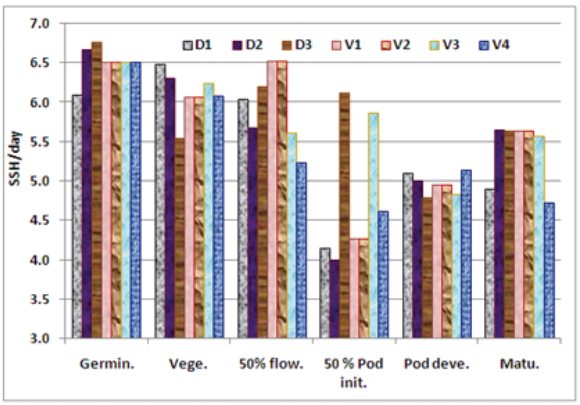

Fig. 3. Sunshine hours (hrs day^{-1}) received during different phenological stages of blackgram

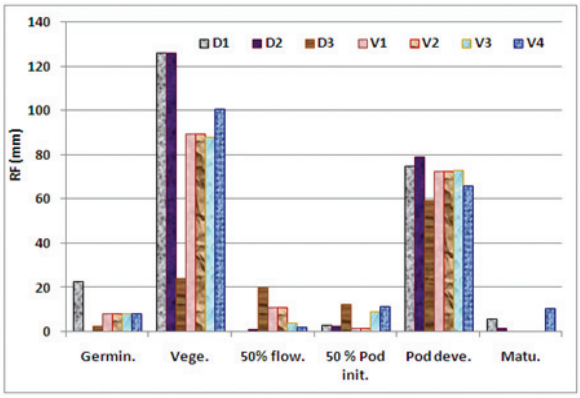

Fig. 4. Rainfall (mm) received during different phenological stages of blackgram

blackgram received higher amount of sun shine hours during vegetative and pod development stage (Fig. 3) which may lead to higher grain yield. High rainfall in pre-monsoon sown crop especially during germination, vegetative and grain development stage (Fig. 4) plays a vital role in deciding crop yield. Among the varieties, CO 5 received high rainfall during vegetative stage and low rainfall during flowering stage which may be the reason for getting higher yield in this variety. The varieties Vamban (Bg) 6 and 7 are matured in 65- 70 days and the variety NUL 7 is matured in 60-65 days and the duration of CO 5 is 70- 75 days. Longer the duration, the plant automatically receives more rainfall, AGDD and AHTU. Rainfall received during flowering stage is highly detrimental to yield of blackgram. High sunshine hours day^{-1} received during pod development stage, higher amount of total rainfall, AGDD and AHTU (Table 1) received (due to duration of variety *i.e.* 7-8 more number of days utilized by this variety) by the variety CO 5 helped the plant to produce more photosynthates and that may be the reason for getting higher yield in this variety (Table 2). Even higher maximum temperature was received by the variety NUL 7 during vegetative and pod development stage, but due to higher rainfall during flowering stage might reduce the yield of NUL 7 than CO 5.

Correlation analysis

Correlation of weather parameters with yield showed positive correlation with maximum temperature during all the stages except pod initiation stage. Hence, pre-monsoon sown crop received higher maximum temperature helped the plant to get higher yield. Minimum temperature at vegetative and germination stage has negative correlation and at pod development stage has positive correlation with yield. Blackgram sown during 43rd standard week received higher minimum temperature during germination and vegetative stage and 39th and 41st standard week sown

Table 1: Observed and derived weather parameters during the cropping period

Treat-ments	MaxT (°C)	MinT (°C)	Sun Shine (hrs day^{-1})	RH I (%)	Wind velocity (km hr^{-1})	Evaporation (mm)	PTU	Rainfall (mm)	AGDD	AHTU
D_1	33.8	22.6	5.5	84	4.5	4.9	215	234.1	1185	6966
D_2	33.7	22.7	5.6	84	4.9	4.9	215	211.1	1158	6729
D_3	32.8	22.8	5.8	87	4.6	4.6	211	119.2	1074	5985
V_1	33.5	22.8	5.7	85	4.7	4.8	214	183.9	1120	6473
V_2	33.5	22.8	5.7	85	4.7	4.8	214	183.9	1120	6473
V_3	33.5	22.6	5.8	85	4.7	4.8	213	183.9	1092	6318
V_4	33.3	22.6	5.4	85	4.5	4.7	212	200.6	1225	6977

Notes: Max T- maximum temperature, Min T- minimum temperature, RH I- morning relative humidity, PTU- photo thermal unit, AGDD- accumulated growing degree day, AHTU- accumulated helio thermal unit

Table 2: Effect of treatments on growth and yield attributes and yield of blackgram

Treat-ments	Plant height (cm)		Dry matter production (kg ha^{-1})		Leaf area index		Number of pods plant^{-1}	Number of seeds pod^{-1}	100- seed wt. (g)	Yield (kg ha^{-1})
	Flowering	Maturity	Flowering	Maturity	Flowering	Maturity				
Date of sowing										
D_1	20.7	24.2	1243	2111	3.73	1.54	18.3	5.1	4.6	616
D_2	19.5	22.3	1239	2106	3.73	1.53	17.9	5.0	4.5	601
D_3	16.2	18.9	991	1589	3.14	0.93	13.9	4.0	4.0	469
SEm (±)	**1.0**	**1.1**	**59**	**99**	**0.18**	**0.07**	**0.9**	**0.2**	**0.2**	**29**
LSD(0.05)	**2.7**	**3.2**	**163**	**276**	**0.49**	**0.21**	**2.4**	**0.7**	**NS**	**81**
Varieties										
V_1	14.8	17.7	1102	1872	3.31	1.13	15.0	4.4	3.9	520
V_2	16.5	19.1	1113	1847	3.39	1.21	15.9	4.4	4.0	542
V_3	22.2	24.7	1202	1962	3.74	1.48	17.5	4.8	4.8	578
V_4	21.6	25.7	1213	2062	3.68	1.51	18.3	5.1	4.9	608
SEm (±)	**0.8**	**0.9**	**45**	**76**	**0.14**	**0.05**	**0.7**	**0.2**	**0.2**	**22**
LSD (0.05)	**1.6**	**1.8**	**95**	**159**	**0.29**	**0.11**	**1.4**	**0.4**	**0.4**	**47**
M at S*[1]-										
SEm (±)	**1.50**	**1.7**	**90**	**151**	**0.27**	**0.11**	**1.3**	**0.4**	**0.3**	**44**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
S at M										
SEm (±)	**1.30**	**1.5**	**79**	**131**	**0.24**	**0.09**	**1.1**	**0.3**	**0.3**	**38**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

*[1]- M at S is Interaction of main plot at sub plot and vice versa

Table 2a: Effect of treatments on yield of blackgram (an interaction table)

Treatment	D_1	D_2	D_3	Mean
V_1	565	550	445	520
V_2	600	595	430	542
V_3	625	620	490	578
V_4	675	640	510	608
Mean	616	601	469	562
	M	S	M at S*	S at M*
S.Ed.	**29**	**22**	**44**	**38**
CD	**81**	**47**	**106**	**81**

*- M at S is Interaction of main plot at sub plot and vice versa

crop received higher minimum temperature during pod development stage (Fig. 2) which may be the reason for lower and higher yield in post-monsoon and pre-monsoon sown treatments respectively. Sunshine hours (SSH) during vegetative and pod development stage has positive correlation with yield. In present study also 39th and 41st standard week sown crop received higher sunshine hours during this stage and 43rd standard week sown crop received higher sunshine hours during 50% flowering and pod initiation stage leading to higher and lower yield in these treatments respectively. Wind velocity and RH has positive correlation with yield during all the stages except germination and maturity stage. Rainfall has negative correlation during 50% flowering and pod initiation stage and evaporation

Table 3: Correlation coefficient value at different phenophases of blackgram

Phenophases	Weather parameters/ agrometeorological indices						
	Max T	Min T	SSH	RH-I	WV	RF	EVP
Germination stage	0.999*	-0.996	-0.677	-0.191	-0.634	0.491	0.460
Vegetative stage	0.995	-1.000*	0.996	-0.914	0.964	0.996	0.997
50% flowering stage	0.7267	0.111	-0.668	0.804	0.997*	-0.998*	-0.559
50% Pod initiation stage	-0.251	0.964	-0.988	0.326	0.981	-0.991	0.789
Pod development stage	1.000*	0.999*	0.981	0.994	0.994	0.955	1.000**
Maturity stage	0.995	0.986	-0.567	-0.203	-0.970	0.789	-1.000*

* Significant at 0.05 level

Notes: Max T- maximum temperature, Min T- minimum temperature, RH I- morning relative humidity,SSH- Sunshine hours day$^{-1,}$ WV- Wind velocity, RF- rainfall, EVP- evaporation

Table 4: Effect of dates of sowing and varieties on the economics of blackgram (kg ha ^{1})

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B : C ratio
D_1V_1	*14425	*25425	*11000	*1.76
D_1V_2	14425	27000	12575	1.87
D_1V_3	14425	28125	13700	1.95
D_1V_4	14425	30375	15950	2.11
D_2V_1	14425	24750	10325	1.72
D_2V_2	14425	26775	12350	1.86
D_2V_3	14425	27900	13475	1.93
D_2V_4	14425	28800	14375	2.00
D_3V_1	14425	20025	5600	1.39
D_3V_2	14425	19350	4925	1.34
D_3V_3	14425	22050	7625	1.53
D_3V_4	14425	22950	8525	1.59

data not statistically analysed

(EVP) has negative correlation during 50% flowering and maturity stage. 43rd standard week sown crop received higher rainfall during these stages may be the reason for low yield in this treatment (Table 3).

Yield

Dates of sowing and varieties significantly influenced the yield of blackgram. The higher grain yield of 616 and 601 kg ha^{-1} was recorded by blackgram sown during 39th(pre-monsoon) and 41st standard week (monsoon). Increased growth and yield attributes might be the reason for higher yield in these treatments (Table 2 and 2a). Significantly lower grain yield of 469 kg ha^{-1} was recorded by seeds sown during 43rd standard week (post-monsoon sown) (Table 2 and 2a). Percentage of yield increase by pre-monsoon sown blackgram was 31 % than post- monsoon sown blackgram. Adam and Jahan (2019) also reported that reduction in grain yield due to delay in sowing.

The variety NUL 7 performed better up to flowering stage, after that the variety CO 5 performed better than other varieties because of drought tolerant capacity of later variety. The variety CO 5 registered higher grain yield (608 kg ha^{-1}) due to better moisture availability and temperature, AGDD, AHTU (Table 1) and favourable weather condition (Fig. 1-4.) which leads to increased nutrients uptake from the soil for root and shoot development which in turn leads to better growth, yield attributes and yield. This result was in line with the findings of Ketan Patidar and Singh (2018).

Economics

Higher gross return (Rs. 27731 ha^{-1}), net return (Rs. 13306 ha^{-1}) and B: C (1.92) ratio were recorded by sowing of blackgram during 39th standard week (pre-monsoon sowing) which was followed by sowing of blackgram during 41st standard week (monsoon). Among the varieties tried, the variety CO 5 registered higher gross return (Rs. 27375 ha^{-1}), net return (Rs. 12950 ha^{-1}) and B: C (1.90) ratio due to higher grain yield (Table 4).

From the study it can be concluded that sowing of blackgram variety CO 5 during 39th standard week (pre-monsoon) is recommended for getting higher yield and

economics even under intermittent drought and deficit rainfall condition.

Author's contribution

Dr. S. Subbulakshmi designed the research plan, performed experimental works, collected the required data and analysed the data, prepared and finalized the manuscript. Final form of manuscript was approved by the author.

Conflict of Interest

The author declares that there is no conflict of interest with present publication. This data has not been published or is not being considered or for publication in other journal.

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