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Response of black gram cultivar on yield, economics and heat unit under different sowing windows

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Abstract
Crop growth and development are strongly associated with thermal energy parameter which directly influence its yield and economics. Hence, experiment was conducted on response of black gram cultivar on yield, economics and heat unit under different sowing windows during *kharif* 2024-25 at Agronomy Farm, College of Agriculture, Nagpur. The experiment was laid out in split plot design with three sowing windows *i.e* 25th MW, 26th MW and 27th MW as main plot treatment and four varieties *i.e.* PDKV Blackgold, TAU-1, PKV Urd-15 and Local as sub plot treatment and replicated thrice. Result revealed that 26th MW recorded significantly superior seed yield, straw yield, gross monetary return, net monetary return, B: C ratio as compare to the 25th MW and 27th MW and accumulated growing degree days highest in 25th MW decreases with dealy in sowing. Among the cultivars TAU-1 recorded highest seed and straw yield, economic returns, B: C ratio and GDD accumulation in comparison with PDKV Blackgold, PKV Urd-15 and Local variety.

Keywords: Black gram, sowing window, varieties, GDD

Introduction
Black gram, commonly known as Urd or Udid in India, is one of the most vital pulse crops and belongs to the Fabaceae family. It is often referred to as a "mini-fertilizer factory" due to its ability to improve and sustain soil fertility by fixing atmospheric nitrogen (Pratibha and Vats, 2013) [9]. After harvesting the pods, the remaining plant material can be used as livestock fodder or incorporated into the soil as green manure to enhance soil organic content.

Nutritionally, black gram is a key part of the Indian diet. It is rich in protein (25g per 100g), contains 1.3% fat, 3.2% minerals, 0.9% fiber, and 59.6% carbohydrates. It helps in reducing cholesterol levels and is a good source of calcium (138mg per 100g), iron (7.57mg per 100g), essential amino acids, and various vitamins.

India cultivates black gram on 4.63 million hectares area, producing 2.78 million tons yield with productivity 600 kg ha^{-1}. Madhya Pradesh leads in area, followed by Uttar Pradesh and Maharashtra, while Andhra Pradesh records the highest yield (915 kg ha^{-1}) (Anonymous, 2023). In Maharashtra, black gram is grown on 3.68 lakh hectares area, yielding 2.34 lakh tons yield about 7% of India's total yield with a productivity of 635 kg ha^{-1} (Anonymous, 2024). India is a largest producer of pulses however the availability of pulses $capita^{-1}$ in the country is lesser than recommendations of WHO (80 g $capita^{-1}$) hence there is need to increase average productivity of pulses crop to meet the protein requirement of population.

Optimum date of sowing varies from variety to variety and season to season due to variation in agro-ecological conditions. Therefore sowing time is most important factor influencing the yield of backgram (Patidar and Singh, 2018) [8]

Recent observations suggest that rising temperatures are contributing to a decline in black gram production. Since the crop's growth and yield depend heavily on when it is sown, choosing the right sowing time is essential for maximizing productivity (Adhikari *et al.*, 2022) [2]. Weather plays a vital role in crop performance, as it affects both the physiological traits and genetic potential of plants. Factors like sunlight, temperature, soil moisture, humidity, and sunshine duration directly impact the crop's growth cycle.

Hence, based on the above considerations, the experiment was conducted to study the response of black gram cultivar on yield, economics and heat unit under different sowing windows.

Materials and Methods

A field experiment was conducted at Agronomy Farm, College of Agriculture, Nagpur during *kharif* season 2024. Soil of experiment is clayey in texture, low in available nitrogen, phosphorus and rich in available potash. Organic carbon content was medium and soil reaction was slightly alkaline. An experiment was laid out in split plot design with 12 treatments replicated in thrice with three sowing windows *i.e.* 25th MW, 26th MW and 27th MW as a main plot treatment and four varieties of black gram *i.e.* PDKV Blackgold, TAU-1, PKV Urd-15 and Local variety as a sub plot treatments. The gross plot and net plot size was 3.6 m X 4.8 m and 3.0 m X 4.2 m respectively. Black gram was sown manually with 30 cm spacing between row to row according to meteorological week based treatments and harvesting occurred when crop reached to full maturity. Observations were recorded from net plot area and then adjusted to ha^{-1} value using hectare factor conversion. Statistical analysis was applied to data and cost of cultivation was estimated by using prevailing market price of black gram.

Growing degree days for different phenophases were determined as per Nuttonson (1955) [7] and calculated by using equation.

$$GDD = \frac{T_{max} + T_{min}}{2} - T_{base}$$

Where,

T_{max}-maximum temperature

T_{min}-minimum temperature

T_{base}-base temperature as 10 °C

Results and Discussion

Seed yield

The data on seed yield (Table 1) indicated that the seed yield of black gram was significantly superior in 26th MW (1035 kg ha^{-1}) as compare to the other sowing windows followed by 25th MW (1000 kg ha^{-1}). The significantly lowest seed yield was recorded by 27th MW (948 kg ha^{-1}). This might be due to suitable agro-climatic condition for healthy crop and development that enhanced number of pods plant^{-1}, weight of seed plant^{-1} in 26th MW that ultimately gave higher seed yield. Similar reports were recorded by Ahmad *et al.* (2014) [1].

Among the evaluated black gram varieties, TAU-1 variety produced significantly highest seed yield which was superior over PKV Urd-15 and Local variety and found at par with PDKV Blackgold variety. This might be due to higher number of pods plant^{-1}, weight of seed plant^{-1} and test weight by TAU-1 variety. Similar results reported by Yadahalli and Palled (2004) [10].

Interaction effect of sowing windows and variety for seed yield was found to be non-significant.

Straw yield

The highest straw yield was recorded when crop was sown in 26th MW which was significantly higher than other sowing windows and was found at par with 25th MW. Least straw yield recorded for the crop sown in 27th MW. The increase in straw yield might be due to higher dry matter production which could be result of greater translocation of food material to reproductive parts. Similar results reported by Zanjurne (2012) [11].

Among the varieties, TAU-1 recorded significantly highest straw yield over other two varieties i.e. PKV Urd-15 and Local variety but was at par with PDKV Blackgold. The increase straw yield in TAU-1 variety might be due to increase plant height, number of branches plant^{-1} and dry matter production plant^{-1}. Similar results were finding by Madane *et al.* (2004) [6].

Interaction effect of sowing windows and varieties found to be non-significant for straw yield of black gram.

Economics

Black Gram crop sown during 26th MW recorded significantly highest Gross monetary return (Rs. 78598 ha^{-1}), Net monetary return (Rs. 50406 ha^{-1}) and Benefit: Cost ratio (2.79) over other sowing windows. Reduction of economic returns in early sowing due to dealyed in onset of monsoon. While, sowing on 27th MW recorded least GMR (Rs. 71967 ha^{-1}), NMR (Rs. 43775 ha^{-1}) and B: C ratio (2.55).

In case of varieties, TAU-1 gave significantly superior in Gross monetary return (Rs. 85975 ha^{-1}), Net monetary return (Rs. 57783 ha^{-1}) and B: C ratio (3.05) over other three varieties PDKV Blackgold, PKV Urd-15 and Local variety

Interaction effect of sowing windows and varieties in economic returns was found to be non-significant.

Accumulated growing degree days

In the *kharif* 2024 cropping period, the accumulated growing degree days (°C day) recorded for three sowing windows were 25th MW (1437.1 °C day), 26th MW (1375.5 °C day) and 27th MW (1357.6 °C day). A consistent decline in accumulated GDD was recorded from 25th MW to 27th MW. Generally, this reduction in GDD with delayed sowing could be attributed to the prevailing maximum air temperature at the time of sowing. Similar results were found by Kingra and Kaur (2012) [5].

Among all cultivars, maximum accumulated GDD were found in variety TAU-1 (1343.5 °C day) followed by PDKV Blackgold (1294.6 °C day), PKV Urd-15 (1278.0 °C day) and Local variety (1244.5 °C day). It might be due to genotypical differences in crop duration.

Table 1: Effect of sowing windows and varieties on yield, economics and heat unit of black gram.

Treatments	Yield		Economics			Heat unit
	Seed Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B: C ratio	GDD (°C day)
Main plot treatments-sowing windows						
W_1-25th MW	1000	1987	76012	4782	2.70	1437.1
W_2-26th MW	1035	2020	78598	50406	2.79	1375.5
W_3-27th MW	948	1927	71967	43775	2.55	1357.6
SE (m)±	7.45	14.47	566	566	-	-
C.D. at 5%	29.25	56.78	2221	2221	-	-
Sub plot treatments-varieties						
V_1-PDKV Blackgold	1079	2269	82024	53832	2.91	1294.6
V_2-TAU-1	1131	2314	85975	57783	3.05	1343.5
V_3-PKV Urd-15	990	2131	75166	46974	2.67	1278.0
V_4-Local	778	1664	58936	30744	2.09	1244.5
SE (m)±	16.88	31.76	1281	1281	-	-
CD at 5%	52.02	97.88	3948	3948	-	-
Interaction effect						
SE (m)±	29.24	55.02	2219	2219	-	-
CD at 5%	NS	NS	NS	NS	-	-
GM	994	2044	75525	47333	2.68	1332.9

Conclusion

Based on the results of the field experiment, it was concluded that sowing during 26th MW was most suitable for obtaining significantly higher seed yield and straw yield along with economic returns and GDD decreases with delayed in sowing. Among the varieties tested, TAU-1 performed best in higher seed yield, straw yield and economic returns and GDD accumulation.

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