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Performance of Blackgram (*Vigna mungo*) cultivars grown during the pre-monsoon season in Meghalaya

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ABSTRACT

A field experiment was carried out during the pre-monsoon season of 2021 at the experimental farm of the College of Post-graduate Studies in Agricultural Sciences, Barapani (CAU-Imphal) to ascertain an optimum sowing period for blackgram cultivars. The field experiment was laid out in split plot design under recommended package of practices. The treatment consisted of three sowing dates, from last week of February, the first week of March, and the second week of March, which have been taken under the main plot treatment. Four blackgram varieties, *viz.*, PU 1, PU 30, PU 31, and INDIRA, were taken under sub-plot treatment. Varietal significant differences were recorded for crop growth rate, relative growth rate, and net assimilation rate during the early growing stage of the crop. However, at a later stage, the difference was found to be non-significant. Sowing of PU-31 on the first week of March produced the highest grain, stover yield, harvest index, and benefit cost ratio among varieties *i.e.*, 0.96, 2.52 t ha^{-1}, 27.62%, 1.84, and sowing dates 0.96, 2.42 t ha^{-1}, 28.48%, 1.87, respectively. Results suggested that sowing blackgram during the first week of March is profitable for getting a significantly higher grain yield and benefit-cost ratio under pre-monsoon conditions.

1. Introduction

India contributes 25.79% of global pulses production and ranks first in world total pulse production. India is the largest producer and consumer of pulses and shares 28.99 Mha area with a productivity of 0.84 t ha^{-1} (DES, 2020-21). Blackgram (*Vigna mungo* L.) also known as urdbean, mash, muyo bean, black mapte *etc.*, grown as one of the principal short duration pulse crops in different parts of the India. From total pulses production black account 2.34 mt which contributes 13% in total pulses area and 10% in total production of India. Besides growing as sole crop, this crop can grow in cropping systems as a mixed crop, catch crop, inter crop under residual soil moisture conditions after the harvest of lowland rice (Das *et al.*, 2016; Dhivya and Ray, 2020). In dryland condition, this crop can also be grown before and after the harvest of summer crops. Blackgram seed are highly nutritious with protein (25-26%), carbohydrates, mineral and vitamins. It has multiple uses, where leaves and green stalks can be used as fodder, green pods are used as vegetable, dried seeds are consumed as dal and even used as a constituent in Papad, Idli, dosa and many other Indian cuisines (Prasad, 2002). Under North Eastern Region (NER) of India, the area planted under pulses expanded dramatically from 1,12,000 ha in 2000-01 to almost 2,17,000 ha in 2013-14 and the pulse productivity also enhanced due to various interventions from 647 to 848 kg ha^{-1}(Das *et al.*, 2016). The pulse requirement at national level is expected to increase from present 15 to 32 million tonnes, for which a growth rate

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of 4.2 % is necessary (Das *et al.*, 2016). On the contrary, under national scenario the pulse availability is following a decreasing trend (Roy *et al.,* 2017; Saikia *et al.*, 2018; John *et. al.*, 2021). Pulse availability dwindled from 69 g in 1961 to 37 g in 2016-17 which is a matter of serious concern, which is below the 50 g pulse per capita per day along with additional sources of protein (John *et. al.*, 2021). In North Eastern region (NER), the per capita availability of pulses is 20 g per day as against a requirement of 40 g per day (Gupta *et al.*, 1998). This region is almost 82% deficit in pulse production against its requirements as per Indian Council of Medical Research recommendation (Roy *et al.,* 2017).

The production and productivity can be increased by adopting appropriate package of practices, *viz.*, short-duration varieties, conservation tillage, mulching, adjustment of sowing time, integrated nutrient and pest management, *etc.* (Singh *et al.*, 2020). Pulses production depends on a number of factors among which "time of sowing" is one the most important non-monetary parameter. Optimum date of sowing helps in proper utilization of soil moisture and temperature, which leads to better growth, seed set and seed yield of pulses. In order to avoid heavy yield losses in *kharif* blackgram due to high insect-pest, diseases and less fruit setting, *rabi* and summer blackgram can be adopted with an optimum temperature of 25 to 35^{0}C. Short duration blackgram cultivation not only adds extra food to the food basket, it also enhances soil quality significantly (Ahmad*et al.,* 2014; Dhivya *et al.,* 2020). Therefore, keeping in view of these considerations, present investigations was attempted to optimize the suitable date of sowing for the higher yield.

2. Materials and methods

A field experiment was undertaken at experimental farm of College of Post-graduate Studies in Agricultural Sciences, Meghalaya, during summer season, 2021 to study the comparative performance of variable physiological and yield parameters of blackgram cultivars under different sowing dates. The experimental site was located at 091°54.72' E longitude and 25°40.886' N latitude and at an altitude of 950 m above the mean sea level (MSL) (Fig.1). The soil of research plot had high in organic carbon (1.16%), medium in nitrogen (243 kg ha^{-1}), medium in available phosphorus (16 kg ha^{-1}), medium in potash (221 kg ha^{-1}) and moderate acidic in reaction (5.01 pH). The experiment was laid out in Split Plot Design where main plots were assigned to three sowing dates, *viz.,* T_1: last week of February (25th February), T_2: first week of March (5th March), T_3: second week of March (13th March) and under sub-plots three varieties were assigned, *viz.*, V_1: PU 1, V_2: PU 30, V3: PU 31, V_4: INDIRA of blackgram and the treatment combinations were randomly replicated thrice. The seeds were line sown at 30 × 10 cm^2 spacing. Before sowing, the seed was treated with *Trichoderma* @ 10 ml per kg of seed followed by *Rhizobium* @ 100 ml per kg of seed. Recommended doses of N, P and K @ 20: 40: 40 NPK kg ha^{-1} were applied at the time of sowing. Similarly, other standard intercultural operations and management practices were followed as and when required during crop growth period. The growth observations, physiological parameters and yield were recorded at 30 days interval up to harvest whereas the yield attributing and yield observations were recorded at harvest by selected randomly five plants from each plot.

Different meteorological parameters were recorded on standard meteorological week (SMW) basis during the crop growing period from 8th to 25th SMW. A figure was plotted for these observed meteorological parameters and shown in Fig.2.The mean weekly maximum and minimum temperature during the cropping season was 27.58^{o}C and 16.19^{o}C, respectively. The mean weekly maximum and minimum relative humidity was recorded to be 83.44% and 59.79%, respectively. Mean weekly pan evaporation was 3.03 mm day^{-1} and mean weekly wind speed was 2.84 km hr^{-1}. In the entire cropping season, the total rainfall was 84.72 cm.

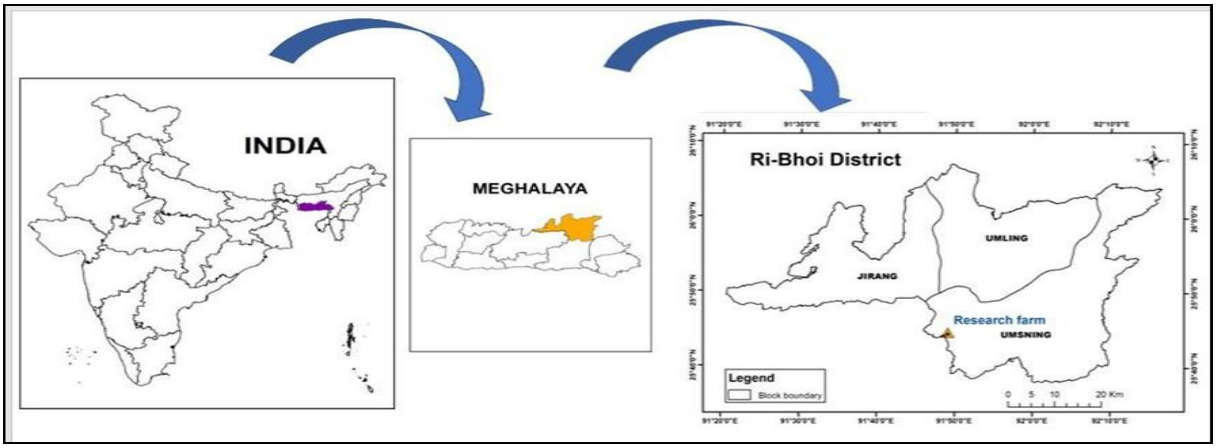


Figure 1. Location of the experimental site

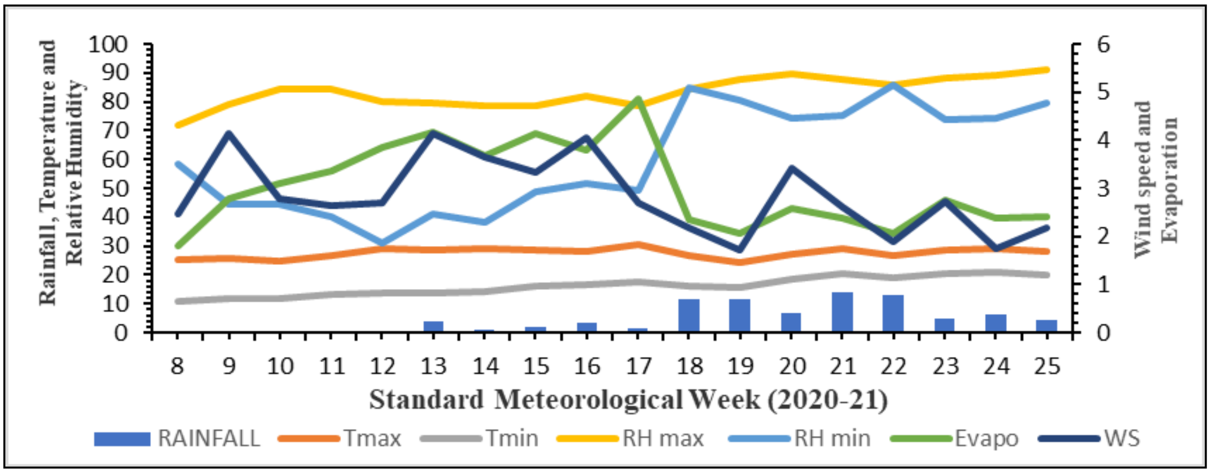


Figure 2. Variation of weather parameters during crop growing period

Various physiological parameters such as Crop Growth Rate (CGR), Relative growth rate (RGR) and Net Assimilation Rate (NAR) were also recorded at an interval of 30 days after sowing (DAS), harvest index (HI) and benefit cost ratio (BCR) were calculated after harvesting standard protocols.

Crop Growth Rate (CGR)

Crop growth rate was worked out between 30, 60, 90 DAS and at harvesting after sowing by using the formula (Eq.1) (Watson, 1947) expressed as g m^{-2} day^{-1}.

$$CGR = \frac{W2-W1}{t2-t1} \times \frac{1}{P} \quad ...(1)$$

Where, W_1 and W_2 are Dry matter production (g) per plant at time t_1 and t_2 respectively, P is ground area covered by plant (m^2).

Relative growth rate (RGR)

Relative growth rate was worked out between 30, 60, 90 DAS and at harvesting after sowing by using the formula (Eq.2) (Blackman, 1919) and expressed as mg g^{-1} day^{-1}.

$$RGR = \frac{\log W2 - \log W1}{t2-t1} \quad ...(2)$$

Where, W1 and W2 are dry weight production (g) of plant at time t1 and t2, respectively.

Net Assimilation Rate (NAR)

Net assimilation rate is a measure of increase of dry weight per unit leaf area. NAR was worked out between 30, 60, 90 DAS and at harvesting after sowing by using the formula (Eq.3) (Beadle, 1987) and expressed as mg cm^{-2} day^{-1}.

$$NAR = \frac{(W2-W1)(LogLA2-LogLA1)}{(t2-t1)(LA2-LA1)} \ldots(3)$$

Where, W_1 and W_2 are the dry matter accumulation (g), LA_1 and LA_2 are leaf area (cm^2) at time t_1 and t_2, respectively.

Different yield parameters, economical and biological yield for blackgram also estimated and later converted to per hectare basis, using standard protocols. Seed yield obtained from each net plot area was sun dried cleaned thoroughly, weighed and expressed as kg ha^{-1}. Similarly, stover yield obtained from each net plot area was thoroughly sun dried, until a constant weight and expressed as kg ha^{-1}.

Harvest Index (HI)

Harvest index value was also estimated, which is the relationship of economic yield to the total biological yield and expressed in percentage (Eq.4) (Donald, 1962).

$$\text{Harvest index } (\%) = \frac{\text{Economic yield } (t\ ha^{-1})}{\text{Biological yield } (t\ ha^{-1})} \times 100 \quad ...(4)$$

Benefit Cost Ratio (BCR)

The cost of cultivation for blackgram was estimated based on the prevailing market price, labour cost and charges for other miscellaneous activities. Similarly, the price of the produce was taken based on the Government of India Minimum Support Price (MSP)-2021. Accordingly, the benefit cost ratio (BCR) was quantified (Eq.5). The observed field experimental data were statistically analysed as per the method described by Gomez and Gomez (1984).

BCR = Gross return /cost of cultivation ...(5)

3. Results and Discussions

Various physiological, yield parameters and benefit cost ratio were estimated for blackgram crop during pre-monsoon season and presented under different sub-sections in a structured way.

Physiological parameters

Dates of sowing immensely affected on crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of the blackgram crop. The analysed values are presented in Table 1.

The different physiological parameters, *viz.*, CGR, RGR and NAR were progressively increased or by multi fold according to their successive increase on relative succession development in all treatment combinations, *i.e.,* from 30 to 90 DAS and maximum observed between 60 to 90 DAS, further increase in age of the crop it started decline up to harvest. This was might be due to leaf shedding, less light transmittance of upper leaves over the lower leaves, which reduces the rate and capacity of assimilate accumulation of lower leaves at physiological maturity stage. Similar findings reported by Banerjee *et al.* (2021), Banik *et al.* (2009), Sinclair and Muchow (1999). Highest CGR recorded with sowing date of first week of March, *i.e.*, 9.38g m^{-2} day^{-1} during 60-90 DAS and lowest was recorded with sowing date of second week of March, *i.e.*, 2.17 g m^{-2} day^{-1} during 0-30 DAS under main-plot treatment. Highest NAR was recorded with sowing date of first week of March, *i.e.*, 0.44mg cm^{-2} day^{-1} than sowing date of second week of March. This was might be due to early planting, which provided a long duration for their better reproductive growth, development and more production of functional leaves. However, short vegetation period was resulted to late planting causes a reduction in plant fresh weight, number of branches, leaf area, number of pods per plant, number of seeds per pod, ultimately it reduces the dry weight accumulation. These findings are in conformity with the findings of Rajput and Rajput (2017), Maruthupandi *et al.* (2016), Sritharan *et al.* (2015), Siddique and Bose (2015), Surendar *et al.* (2013), Mondal *et al.* (2012), Kumar *et al.* (2009), Hozayn *et al.*(2007), Sugui and Sugui (2002). Under the main plot, NAR was found to have a significantly higher value at the sowing date with the first week of March, *i.e.*, 0.34 mg cm^{-2} day^{-1} during 30-60 DAS than at the sowing dates with the second week of March and the last week of February, *i.e.,* 0.30 and 0.26 mg cm^{-2} day^{-1}, respectively.

Among different genotypes, highest CGR was recorded with PU 1, *i.e.,* 9.24 g m^{-2} day^{-1} during 60-90 DAS. Moreover, highest RGR recorded with INDIRA, *i.e.*, 28.57 mg g^{-1} day^{-1} during 30-60 DAS and highest NAR was recorded with PU 1, *i.e.,* 0.47 mg cm^{-2} day^{-1} during 60-90 DAS. CGR, RGR and NAR were significantly highest value recorded in PU 30, *i.e.*, 0.54g m^{-2} day^{-1}, INDIRA, *i.e.*, 28.57mg g^{-1} day^{-1} and PU 1, *i.e.*, 0.47 mg cm^{-2} day^{-1} during 0-30, 30-60 and 60-90 DAS, respectively. These could be the result of distinct genotypes' varying genetic potential as well as a lack of interaction between different sowing dates and blackgram varieties. Similar trend of observations reported byKumar and Kumar (2022), Subbulakshmi (2021), Poudel *et al.* (2020), Saikia *et al.* (2018), Ibrahimi *et al.* (2017), Meena and Ram (2016), Singh *et al.* (2013),Revanappa *et al.* (2012).

Yield Parameters

Grain, stover, biological yield, harvest index and benefit cost ratio (BCR) of blackgram is presented in Table 2. Similarly, the effect of different dates of sowing and varieties on yield parameters of blackgram is shown in Fig.3.

The grain, stover, biological yield and harvest index were recorded maximum for sowing date with first week of March, *i.e.*, 0.96 t ha^{-1}, 2.4 tha^{-1}, 3.3 t ha^{-1} and 28.48%, respectively and lowest at late planting after first week of March (11^{th} March), *i.e.*, 0.83 t ha^{-1}, 2.3 t ha^{-1}, 3.12 t ha^{-1} and 26.63%, under main-plot treatment. However,

Table 1. Effect of sowing dates on different physiological parameters of blackgram varieties

Treatments	CGR (gm^{-2} day^{-1})				RGR (mg g^{-1} day^{-1})			NAR (mg cm^{-2} day^{-1})		
DAS	0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	30-60 DAS	60-90 DAS	90 DAS-Harvest	30-60 DAS	60-90 DAS	90 DAS-Harvest
Main-plot treatments (T- Date of Sowing)										
T_0-25/02/2021	0.46	2.23	9.04	4.44	25.76	21.42	4.65	0.26	0.38	0.16
T_1-04/03/2021	0.47	2.52	9.38	4.50	26.81	20.65	4.52	0.34	0.44	0.18
T_2-11/03/2021	0.49	2.17	8.18	3.98	24.33	20.39	4.54	0.30	0.40	0.17
S.E.(m) ±	0.01	0.09	0.29	0.40	0.60	0.61	0.38	0.01	0.02	0.02
C.D. (P =0.05)	NS	NS	NS	NS	NS	NS	NS	0.03	NS	NS
Sub-plot treatments (V-Variety)										
V_1- PU 1	0.48	2.11	9.24	4.54	24.32	22.02	4.72	0.30	0.47	0.19
V_2- PU 30	0.54	2.14	8.80	4.19	23.22	21.10	4.55	0.28	0.42	0.16
V_3- PU 31	0.49	2.57	9.10	4.47	26.42	20.12	4.56	0.31	0.37	0.15
V_4- INDIRA	0.39	2.41	8.33	4.02	28.57	20.04	4.45	0.31	0.38	0.17
S.E.(m) ±	0.01	0.13	0.43	0.02	0.84	0.92	0.23	0.02	0.03	0.01
C.D.(P=0.05)	0.04	NS	NS	NS	2.5	NS	NS	NS	0.08	NS

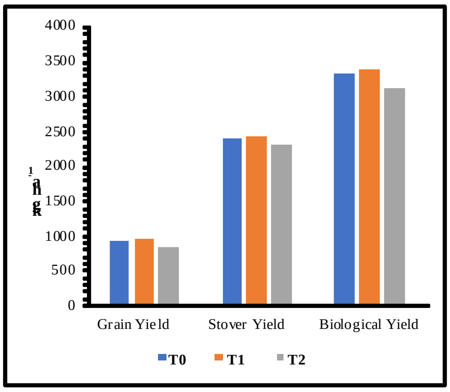
sowing date with first week of March produced significantly highest yield and BCR over sowing date with second week of March. This might be due to plants sown at early sowing dates had long growing periods and produced higher number of green leaves and leaf area. The amount of photosynthesis is a product of the solar radiation intercepted and the total leaf area of the plant. So, early sowing of crop leads to increase in accumulation of more photosynthates from source to sink; this result is in agreement with the works of Das *et al.* (2022), Reddemma *et al.* (2019), Dwivedi *et al.* (2018), Patidar and Singh (2018), Hossain *et al.* (2016), Jha *et al.* (2015), Ahmad *et al.* (2014), Reddy *et al.* (2014), Gangwar *et al.* (2012), Revanappa *et al.* (2012), Sharma *et al.* (2012), Rehman *et al.* (2009), Yoldas and Esiyok (2007), Yadahalli *et al.* (2006), Poehlman (1991), Ismail and Khalifa (1987). This was also might be due to the more suitable climatic factors, *i.e.*, availability of temperature, rainfall, humidity, sun-shine hours and GDD, similar findings have been reported by Rani *et al.* (2014), Srivastava *et al.* (2013), Antony *et al.* (2006), Malik *et al.* (2003), Biswas *et al.* (2002). Under sub-plottreatment, PU 31 recorded highest gain, stover and biological yield, *i.e.*, 0.96 t ha^{-1}, 2.5 tha^{-1} and 3.5 t ha^{-1} and INDIRA recorded lowest gain, stover and biological yield, *i.e.*, 0.84 t ha^{-1}, 2.2 t ha^{-1} and 3.05 tha^{-1}. These types of variations were might be due to variation of duration of flowering and maturity of genotypes is mainly governed by the genetic make-up of the genotypes. Similar findings were observed by Kumar and Kumar (2022), Subbulakshmi (2021), Poudel *et al.* (2020), Ibrahimi *et al.* (2017), Meena and Ram (2016), Singh *et al.* (2013), Dodwadiya and Sharma (2012), Singh *et al.* (2011) and Miah *et al.* (2009), Patra *et al.* (2000).

Benefit cost ratio (BCR)

Sowing during first week of March (4th March), recorded significantly highest BCR, *i.e.*, 1.87 over other dates of owing, under main-plot treatment (Fig.4), however, under sub-plot treatment, PU 31 recorded maximum BCR, *i.e.*, 1.84, over other varieties. This was might be due to higher grain, stover, biological yield and harvest index performance. Similar findings were also observed by Reddemma *et al.* (2019), Saikia *et al.* (2018), Kumar and Kumawat (2014), Jadhav *et al.* (2014).

Table 2. Effect of sowing dates on different yield parameters and BCR of blackgram varieties

Treatments	Grain Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Biological Yield(kg ha^{-1})	Harvest index (%)	BCR
Main-plot treatments (Date of sowing)					
T_0 – 25/02/2021	930.00	2381.83	3311.83	28.08	1.80
T_1 – 04/03/2021	963.58	2421.17	3384.75	28.48	1.87
T_2 – 11/03/2021	830.33	2289.58	3119.92	26.63	1.61
S.E.(m) ±	25.77	60.80	66.67	0.80	0.05
C.D.(P=0.05)	101.17	NS	NS	NS	0.20
Sub-plot treatments (V- Variety)					
V_1- PU 1	927.22	2413.44	3340.67	27.73	1.77
V_2- PU 30	895.56	2316.00	3212.56	27.90	1.76
V_3- PU 31	964.11	2523.22	3487.33	27.62	1.84
V_4- INDIRA	844.00	2204.11	3048.11	27.68	1.66
S.E.(m) ±	36.66	71.38	86.41	0.91	0.07
C.D.(P=0.05)	NS	212.05	256.71	NS	NS



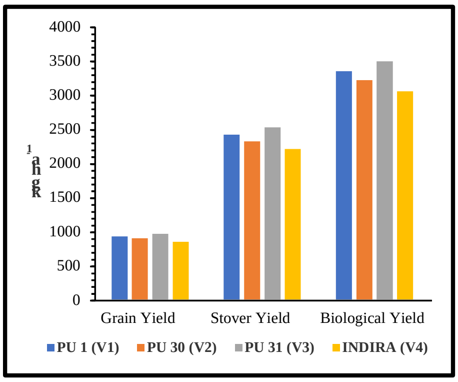


Figure 3. Effect of various sowing dates and varieties on yield parameters of blackgram

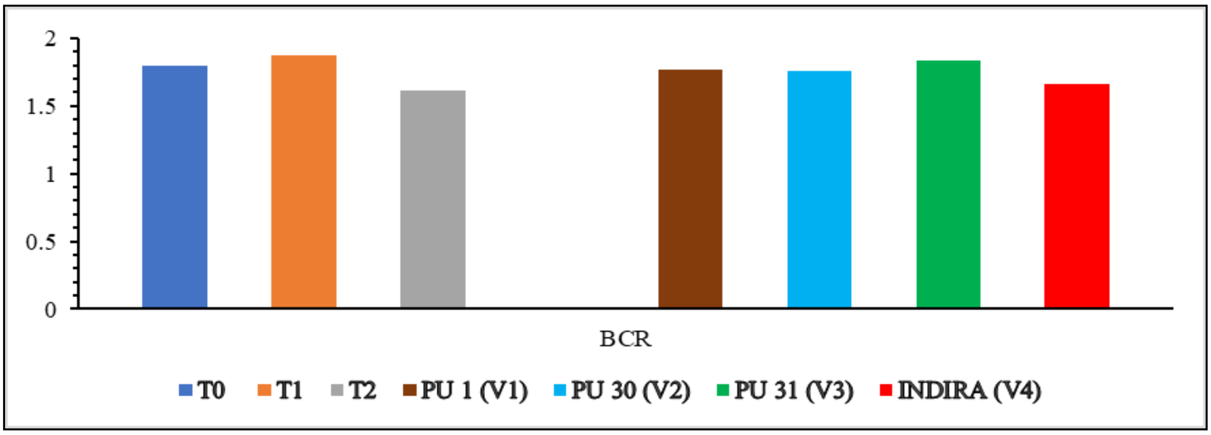


Figure 4. Effect of various sowing dates and varieties on BCR of blackgram

4. Conclusions

It can be inferred from the current field experiment conducted during the pre-monsoon season that sowing blackgram during the first week of March (4th March) provided a yield that was significantly higher than other sowing dates, *i.e.,* 936.58 kg ha^{-1}. Similar to this, there was no interaction between different sowing dates and blackgram variety, and PU 31 generated a higher yield, *i.e.*, 963.58 and 964.11 kg ha^{-1}, than other sowing dates and blackgram varieties, respectively. Blackgram, can be easily accommodated in the north eastern region during the pre-monsoon season. It will not only supply this region's food basket with nutrient-rich pulses, but it also looks after the quality of the soil.

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6. References

Ahmad HB, Amin MA, Hussian I, Rafique CM, Naveed M, Awais MA, Shafiq M, Aqeel M (2014). Effect of different sowing dates on yield contributing traits of mashbean (*Vigna mungo* L.). Int. J Agron Agri Res 5(6): 42-48.

Antony E, Chowdhury SR, Kar G (2006). Variations in heat and radiation use efficiency of green gram as influenced by sowing dates and chemical sprays. J Agromet 2003 5(2): 58-61.

Banerjee P, Venugopalan VK, Nath R, Althobaiti YS, Gaber A, Al-Yasi H, Hossain A (2021). physiology, growth, and productivity of spring–summer blackgram (*Vigna mungo* L. Hepper) as influenced by heat and moisture stresses in different dates of sowing and nutrient management conditions. Agronomy 11(11): 2329.

Banik C, Nath R, Chakraborty PK (2009). Effect of dates of sowing on growth and yield of groundnut crop. J Crop Weed 5(2): 59-62.

Beadle CL (1987). Plant Growth Analysis. Techniques in Bio-productivity and Photosynthesis, 2nd Ed: 21-23. Pergamon press, Oxford, New York.

Biswas M, Begum AA, Afzal AMFU, Hamid A (2002). Effect of sowing dates on the growth and yield of blackgram varieties. Pakistan j bio sci 5(3): 272-274.

Blackman VH (1919). The compound interest law and plant growth. Ann Bot 33: 353-36.

Das A, Babu S, Yadav GS, Ansari MA, Singh, Baishya LK, Rajkhowa DJ, Ngachan SV (2016). Status and strategies for pulses production for food and nutritional security in north-eastern region of India. Ind J Agron 61: 43-57.

Das D, Patel N, Biswasi, SK (2022). Weather effects on growth parameters of blackgram cultivars under different sowing dates during *rabi* in North Western Plateau zone of Odisha. J Pharmacognosy Phytochem 11(2), 258-260.

Dhivya RS, andRay LIP (2020). Performance of blackgram (*Vigna mungo* L. Hepper) with organic amendments. Ind J Hill Farm33(1): 10-18.

Dhivya RS, Ray LIP, Behera UK (2020). Organic amendments on soil nutrient balance under mid hills of Meghalaya. eplanet 18(1):29-38.

Director of economics and statistics (DES) (2020-21). Second advance estimates of production of food grains. director of economics and statistics, Ministry of agriculture and farmers welfare. Government of India. https://eands. dacnet.nic.in. (Accessed on 21st May 2021).

Dodwadiya KS, Sharma AR (2012). Effect of tillage and method of sowing on performance of greengram (*Vigna radiata*) varieties during summer and rainy seasons. Ind J Agric Sci 82 (5): 462-465.

Donald CM (1962). In search of yield. J. Austria Inst. Agri. Sci., 28: 171-178.

Dwivedi G, Mishra US, Pathak RK (2018). Study of different varieties and phosphorus level on yield attributes and economics greengram (*Vigna radiata* L.). J. Pharmacognosy Phytochem 7(6): 78-83.

Gangwar A, Jadhav TA, Sarvade S (2012). Performance of spring planted urdbean varieties as influenced by dates of planting. Env Ecology 30(4A): 1563-1566.

Gomez KA, Gomez AA (1984). Statistical procedures for agricultural research. John Wiley and Sons.

Gupta HS, Sarna BK, Sahay G (1998). Present status and prospects of pulse production in north eastern hill region. Ind J Hill Farm 11(1-2): 77-87.

Hossain MM, Mahbub MM, Shirazy BJ (2016). Growth and yield performance of mungbean varieties in summer cultivation. Scientia Agric 16(3): 79-82.

Hozayn M, Zeidan MS, Abd E1-Lateen EM, Abd EI-Salam MS (2007). Performance of some mungbean (*Vigna radiate* L. Wilckek.) Genotypes under late sowing condition in Egypt. Res J Agric Bio sci 3(6): 972-978.

Ibrahimi F, Rana KS, Choudhary AK, Dass A, Ehsan Q, Noorzai AU (2017). Effect of varieties and planting geometry on growth, yield and profitability of *kharif* mungbean (*Vigna radiata* (L.) W ilezek) in southern Afghanistan. Annals Agric Res New series 38(2):185-193.

Ismail AMA, Khalifa FM (1987). Irrigation, planting date and intra- row spacing effects on soybean grown under dry farming systems. Qatar University Sci 7:149-167.

Jadhav PB, Kamble DR, Jadhav KT, Gadpale DL (2014). Performance of blackgram (*Vigna mungo* (L.) Hepper) varieties to different sowing dates. Adv Res J Crop Improv 5(2): 166-171.

Jha DP, Sharma SK, Amarawat T (2015). Effect of organic and inorganic sources of nutrients on yield and economics of blackgram (*Vigna mungo* L.) grown during *kharif.* Agric Sci Digest 35(3): 224-228.

John AT, Makkar S, Swaminathan S, Minocha S, Webb P, Kurpad AV, Thomas T (2021). Factors influencing household pulse consumption in India: A multilevel model analysis. Global food security 29, 100534.

Kumar K, Kumar R (2022). Effect of different dates of sowing on growth, yield attributes and yield of various cultivars of *Kharif* blackgram (*Vigna mungo* L.) under Amritsar conditions. Agric Sci Digest-A Res J 42(1):84-87.

Kumar M, Lathwal OP, Kumar S (2009). Growth behaviour of mungbean genotypes under varying sowing time during summer season. Haryana J Agron 25(1&2): 79-81

Kumar R, Kumawat N (2014). Effect of sowing dates, seed rates and integrated nutrition on productivity, profitability, and nutrient uptake of summer mungbean in Eastern Himalaya. Archives Agron Soil Sci 60(9):1207–1227.

Malik MA, Saleem MF, Ali A, Rana AF (2003). Effect of sowing dates and planting patterns on growth and yield of mung bean (*Vigna radiata* L. Wilczek). J Agri Res 44(2):11-15.

Maruthupandi K, Veeramani A, Sanjevikumar A, Krisnaprabu N, Ramadas S (2016). Effect of methods and time of sowing on growth indices in rice fallow blackgram (*Phaseolus mungo* L.) under machine transplanted rice system. Adv J Crop Improv 7(1):129-133.

Meena BS, Ram B (2016). Effect of integrated nutrient management on productivity, soil fertility andeconomics of blackgram (*Vigna mungo*) varieties under rainfed condition. Legume Res 39(2):268-273.

Miah MAK, Anwar MP, Begum M, Juraimi AS, Islam MA (2009). Influence of sowing date on growth and yield of mungbean varieties. J Agric Social Sci 5(3):73-76.

Mondal MMA, Puteh AB, Malek MA, Ismail MR, Rafii MY, Latif MA (2012). Seed yield of mungbeen (*Vigna radiata* (L.) Wilczek) in relation to growth and developmental aspects. The Scientific World J ID 425168: 7.

Patidar K, Singh T (2018). Effect of varieties and dates of sowing on growth, yield and quality of blackgram (*Vigna mungo* L.). Annals of Plant and Soil Res 20(4):428-431.

Patra AK, Nayak BC, Mishra MM (2000). Performance of greengram (*Phaseolus radiatus*) varieties under different dates of sowing during winter season. Ind J Agron 45(1): 143-147.

Poehlman JM (1991). The mung bean. Oxford and IBH publishing Co Pvt Ltd New Dehli India.

Poudel PB, Jaishi UK, Poudel L, Poudel MR (2020). Evaluation of wheat genotypes under timely and late sowing conditions. Int J Applied Sci Biotech 8(2):161-169.

Prasad R (2002). Textbook of field crops production. Textbook of field crops production. https://www.cabdirect.org/cabdirect/abstract/20043005056.

Rajput BS, Rajput RL (2017). Effect of Genotypes and phosphorus levels on growth analysis parameters of greengram (*Vigna rediata* L.). Legume Res 40(2):331-335.

Rani N, Kumar P, Singh A (2014). Crop weather relationship of summer irrigated blackgram (*Vigna mungo*) at coastal areas of Karaikal. Technofarme- A J multidisciplinary Advance Res 3(2):01-09.

Reddemma K, Srinivasa Reddy M, Ramesh Babu PV, Umamaheswari P (2019). Effect of different sowing dates on yield and yield attributes of *rabi* blackgram (*Vigna mungo* L.) varieties in scarce rainfall zone of Andhra Pradesh. J Pharmacognosy Phytochem 8(4):2275- 2278.

Reddy GR, Dattatri K, Sudhakar N, Himabindu T, Osman M, Sharma KL (2014). Assessment of improved varieties under different climate vulnerabilities. Ind J Dryland Agri Res Dev 29(1):11-22.

Rehman A, Khalil SK, Nigar S, Rehman S, Haq I, Akhtar S, Khan AZ, Shah SR (2009). Phenology, plant height and yield of mungbean varieties in response to planting date. Sarhad J Agric 25(2):147-151.

Revanappa SB, Kamannavar PY, Vijaykumar AG, Ganajaxi M, Arunkumar B, Salimath PM (2012). Genotype X environment interaction and stability analysis for grain yield in blackgram. Legume Res 35(1):56-58.

Roy A, Singh NU, Tripathi AK, Yumnam A, Sinha PK, Kumar B, Das SK (2017). Dynamics of pulse production in north-east region of India-a state-wise analysis. Economic Affairs 62(4):655-662.

Saikia N, Nath KD, Chowdhary P (2018). Impact of cluster frontline demonstrations on popularization of blackgram var. PU 31 in Cachar district of Barak Valley region of Assam. J Pharmacognosy Phytochem 7(4):940-942.

Sharma P, Sekhon HS, Bains TS (2012). Performance and growth analysis in mash bean genotypes. World J Agril Sci 8(3):303-308.

Siddique A, Bose B (2015). Effect of seed invigoration with nitrate salts on morpho-physiological and growth parameters of wheat crop sown in different dates in its cropping season. Vegetos 28(1):76-85.

Sinclair TR, Muchow RC (1999). Radiation use efficiency. Adv Agron 65:215-265.

Singh G, Kaur H, Aggarwal N, Ram H, Gill KK, Khanna V (2013). Symbiotic efficiency, thermal requirement and yield of blackgram (*Vigna mungo*) genotypes as influenced by sowing time. Ind. J Agri Sci 83(9):953-958.

Singh G, Ram H, Sekhon HS, Gill KK, Khanna V (2011). Effect of time of planting on nodulation growth and seed yield of *kharif* Urdbean genotypes. J Food Legumes 25(2):125-127.

Singh R, Avasthe RK, Babu S (2020). No-till planting of blackgram for enhancing productivity in the NE Himalayas. Ind Farm 70(5):35-36.

Sritharan N, Rajavel M, Senthilkumar R (2015). Physiological approaches: Yield improvement in blackgram. Legume Res 38(1):91-95.

Srivastava P, Pandey A, Sinha DP (2013). Genetic diversity analysis in different varieties of blackgram using RAPD markers. Int J bio res 1(3):28-33.

Subbulakshmi S (2021). Influence of sowing dates on yield of blackgram varieties under rainfed condition. J Crop and Weed 17(3):41-46.

Sugui FP, Sugui CC (2002). Response of chickpea to dates of sowing in Ilocos Norte, Philippines. Int. Chickpea and Pigeonpea Newsletters,9-13.

Surendar KK, Vincent S, Vanagamudi M, Vijayaraghavan H (2013). Influence of plant growth regulators and nitrogen on leaf area index, specific leaf area, specific leaf weight and yield of blackgram (*Vigna mungo* L.). Plant Gene and Trait 4(1):26-29.

Watson DJ (1947). Comparative physiological studies in the growth of field crops: Variation in net assimilation rate and leaf area between species and varieties, and within and between years. Ann Bot 11:41-76.

Yadahalli GS, Palled YB, Hiremath SM (2006). Effect of sowing dates and phosphorus levels on growth and yield of blackgram genotypes. Karnataka J Agric Sci 19(3):682-684.

Yoldas F, Esiyok D (2007). Effects of sowing dates and cultural treatments on growth, quality and yield of processing beans. Pakistan J Bio Sci 10: 2470-2474.