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Response of summer blackgram (*Vigna mungo* L. Hepper) to planting geometry and weed management under Nagaland condition

A. Thongni • L. Tzudir* • S. Kumari

Department of Agronomy, SASRD, Nagaland University, Medziphema-797106, Nagaland, India

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ABSTRACT

In the present study, an attempt has been made to investigate the effect of planting distance and weed management practices on weed flora, growth and yield of summer black gram under mid hill conditions of Nagaland. Three planting distance i.e. 20 x 10 cm^2 (S_1), 30 x 10 cm^2 (S_2) and 40 x 10 cm^2 (S_3) and four weed management practices viz., Weedy check (W_1), Two hand weedings at 20 DAS and 40 DAS (W_2), Pendimethalin @ 1 kg a.i ha^{-1} + Imazethapyr @ 100 g ha^{-1} at 30 DAS (W_3) and Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS (W_4), were evaluated and compared. Planting distance 40 x 10 cm^2 recorded the highest growth attribute and found to be at par with 30 x 10 cm^2. Plant height and CGR however recorded to be highest at 20 x 10 cm^2. Weed management with Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded lowest weeds, weed dry weight, highest weed control efficiency, growth and yield attributes and this treatment was found to be at par with two hand weedings at 20 DAS and 40 DAS. Combination of 30 x 10 cm^2 and Pendimethalin @ 1 kg a.i ha^{-1}+ one hand weeding at 30 DAS recorded highest B:C ratio (1.32) among all the treatments and found to be an economically achievable treatment for summer blackgram.

1. Introduction

Black gram (*Vigna mungo* L. Hepper) is an important drought resistance pulse crop grown throughout the country in all three seasons. It is a self-pollinated annual crop of fabaceae family. The stem is covered with brown hairs and much branched from the base. The leaves are large, hairy and trifoliate. The inflorescence consists of a cluster of 5-6 flowers at the top of a peduncle. The pods are about 4-6 cm in length with 4-10 seeds inside which are generally black or very dark brown in colour. It is a nutrient rich crop with about 24% protein and has significant quantities of vitamin B_1, $B_2$and niacin (Tiwari and Shivhare, 2016). It is commonly used as dal and is also consumed in a variety of ways in preparation of different dishes and snacks like dosa, idli, vada, papad, halwa and imarti in combination with other food grains. Being leguminous, it demands less nitrogenous fertilizers and it fits well in different crop rotation systems to maintain the fertility level of the soil (Nazir, 1994). Blackgram is mainly distributed in the tropical to sub-tropical countries like India, Pakistan, Sri-Lanka, Burma and some countries of South East Asia. India is the world's largest producer as well as consumer and accounts of 29.03 m ha with production of 23.40 Mt at 806 kg ha^{-1} yield level (Directorate of Economics and Statistics, Govt. of India, 2019). In the North Eastern Region of India, the average productivity of pulses is 848 kg ha^{-1} which is higher than the national average (764 kg ha^{-1}) thus indicates the potential of pulse production in this region. In Nagaland, the area under blackgram is about 830 ha with a total production of 680 Mt. The largest portion of the crop is grown in Dimapur and it leads both in area and production of black gram in the state with about 170 ha and 140 Mt respectively. It is followed by Peren, Phek and Wokha districts. (Directorate of Economics and Statistics, Govt. of Nagaland, 2020). Planting distance contribute substantially to the seed yield of blackgram. Many researchers obtained different response in blackgram to planting distance (Singh *et al.,* 1994; Nagaraju *et al.,* 1995). It is necessary to maintain optimum plant population by maintaining proper inter and intra row spacing. Maximum or minimum plant density may reduce the yield of blackgram causing different changes in the physiology of the plant. Maintaining optimum plant population is an important aspect

*Corresponding author: lanunola@nagalanduniversity.ac.in

in the production of blackgram for maximizing the yield. Simultaneously weed infestation is considered as a major aspect in reducing the yield of black gram (Rao *et al*., 2010). The magnitude of losses largely depends upon the composition of weed flora, the period of crop-weed competition and also its intensity. In general, yield loss ranges from 27 to 100 % (Mansoori *et al.,* 2015). Unchecked weeds have been reported to cause a considerable reduction in the grain yield of blackgram, which could be 41.2 and 41.6 % in case of summer and Kharif blackgram respectively (Singh, 2011). The critical period of crop-weed competition is initial 30 days after sowing in case of summer blackgram which in certain situations could be 30-45 days after sowing (Rana *et al.,* 2008). The crop is not a very good competitor against weeds (Choudhary *et al*., 2012). Therefore, for proper crop growth, particularly in the early growth stages, weed control initiatives are essential. Therefore, keeping in mind the importance of maintaining an optimum plant population by adopting proper plant spacing to increase the productivity as well as the importance of weed management the following study was conducted.

2. Materials and Methods

The experiment was conducted during the summer (*Zaid*) season of 2021 at the research farm of the Department of Agronomy, SASRD, Nagaland University, Medziphema Campus. It is located at an altitude of 310 metres above mean sea level with the geographical location at $25^{o}45^{'}43^{"}$ N latitude and 95^{o} $53^{'}$ $04^{"}$ E longitude. The experiment consisted of 12 treatments having three planting distance i.e. 20 x 10 cm^2, 30 x 10 cm^2 and 40 x 10 cm^2 and four weed management practices viz., Weedy check, Two hand weedings at 20 DAS and 40 DAS, Pendimethalin @ 1 kg a.i ha^{-1} + Imazethapyr @ 100 g ha^{-1} at 30 DAS and Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS, replicated 3 times. The experiment was laid out in a randomized completed block design. The soil of the experimental field was sandy loam in texture with high levels of organic carbon (1.2%) and medium in available nitrogen (263.42 kg ha^{-1}), available phosphorus (25.64 kg ha^{-1}) and available potassium (163.10 kg ha^{-1}), with a *p*H of 4.7. Recommended doses of N, P and K in the ratio of 20:40:40 kg ha^{-1} were applied as basal doses. Blackgram cv. 'SBC-40' was sown after seed treatment with Carbendazim (2g kg^{-1}) of seeds. Herbicides, pendimethalin @ 1 kg a.i ha^{-1} as pre-emergence and imazethapyr @ 100 g ha^{-1} as post emergence were used to control the weeds. Pendimethalin was sprayed 2 days after sowing while Imazethapyr was applied 30 days after sowing. The amounts of herbicides required for individual plot was calculated and mixed with water to get the desired concentration of the herbicidal spray. The weed-control efficiency was calculated by using the following formula (Mani *et al*., 1981).The data were statistically analyzed as procedures given by Gomez and Gomez (1976).

3. Results and Discussion

Weed growth and weed control efficiency (WCE)

Data presented in Table 1 depicts that there was significant difference between the treatments. The weed count for grasses (9.75), broad leaf (9.12), sedge (1.88), total weed count (13.78) and total weed dry weight (4.50) was recorded to be lowest under 20 x 10 cm^2 planting distance. These findings are in conformity with Daramola *et al.* (2019) who found that weed density increases significantly with increasing row spacing while reducing planting distance leads to significant reduction in the weed biomass. Treatment Pendimethalin @ 1kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the lowest weed count for grasses (7.32), broad leaf (7.70), sedge (1.82) and lowest total weed dry weight (3.58) while lowest total weed population (10.79) was observed under the treatment Pendimethalin @ 1kg a.i ha^{-1} + one hand weeding at 30DAS. These treatments were found be significant over all the other treatments. The findings were in close conformity with the findings of Kumar *et al*. (2006) and Singh (2011). The findings of Weed Control Efficiency are in accordance with Tomar and Singh (2016), who reported that all types of weed flora were effectively managed by application of pendimethalin followed by hand weeding at 20 and 40 DAS.

Table 1. Effect of planting distance and weed management practices on weed growth and weed-control efficiency in black gram at 60 DAS

Treatment	Weed count (No./m^2)				Total weed dry weight (g/m^2)	Weed control efficiency (%)
	Grass	broad leaf	Sedges	Total		
Planting distance (S)						
S1 - 20 x 10 cm^2	9.75 (115.67)	9.12 (88.83)	1.8 (3.17)	13.7 (207.67)	4.50 (21.41)	46.19
S2 - 30 x 10 cm^2	10.24 (124.75)	9.76 (99.67)	2.0 (3.67)	14.4 (228.08)	4.71 (23.50)	43.03
S3 - 40 x 10 cm^2	12.94	11.59	2.4	17.5	5.50	37.05

	(175.17)	(138.33)	(5.83)	(319.3)	(31.45)	
SEm±	0.68	0.39	0.09	0.51	0.09	1.91
CD (p=0.05)	2.01	1.15	0.27	1.48	0.26	5.62
Weed management (W)						
W1 - Weedy check	15.64 (250.33)	12.75 (163.56)	2.4 (5.78)	20.3 (419.67)	6.64 (43.88)	0
W2 - Two hand weedings at 20 and 40 DAS	7.84 (71.78)	9.01 (84.22)	1.8 (3.11)	12.4 (159.11)	3.80 (14.12)	67.81
W3 - Pendimethalin @ 1 kg a.i ha^{-1} + Imazethapyr @ 100 g a.i ha^{-1} at 30 DAS	13.1 (172.22)	11.16 (127.33)	2.3 (5.11)	17.3 (304.67)	5.59 (31.29)	28.96
W4 - Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS	7.32 (59.78)	7.70 (60.67)	1.8 (2.89)	10.7 (123.33)	3.58 (12.54)	71.58
SEm±	0.79	0.45	0.11	0.58	0.1	2.21
CD (p=0.05)	2.32	1.32	0.31	1.71	0.3	6.48

Growth attributes

The data on effect of planting distance and weed management practices on the growth attributes of summer black viz., plant height, no. of primary branches $plant^{-1}$, no. of leaves $plant^{-1}$ and leaf area index (LAI) is presented in Table 2. Data indicates that there was no significant effect of planting distance and weed management practices on plant height, no. of primary branches $plant^{-1}$, no. and leaf area index at 25 DAS. At 25 and 65 DAS, the highest number of leaves (1.87, 16.94) was observed under planting distance 40 x 10 cm^2 and was found to be statistically at par with 30 x 10 cm^2. Treatment Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the highest number of leaves $plant^{-1}$ with (2.00, 19.90) at 25 and 65 DAS which was found to be at par with two hand weedings at 20 DAS and 40 DAS. Significantly highest plant height (23.82 cm) was recorded under 20 x 10 cm^2 at 65 DAS. This could be due to competition between the plants for light and due to less space for the plants to grow horizontally. This finding is in line with that of Mansoor *et al*. (2010) and Easha (2014). Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the significantly highest plant height (25.93 cm) and it is in line with that of Kavad *et al*. (2016). At 65 DAS, the number of primary branches $plant^{-1}$ and leaf area index was significantly highest (2.25, 1.79) under 40 x 10 cm^2 and also found to be statistically at par with 30 x 10 cm^2. Bhatt (2020) also recorded higher number of branches at wider spacing which was at par with the intermediate spacings and lowest at closed spacing. Treatment Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the significantly highest number of primary branches $plant^{-1}$and leaf area index (2.78, 1.87) at 65 DAS. Increase in growth attributes might be due to reduction in weed competition with the crops which favoured better environment for growth and development (Kaur *et al*., 2009). Pongen and Nongmaithem (2017) also witnessed greater value of leaf area index with application of Pendimethalin + hand weeding on 25 DAS.

Table 2. Effect of planting distance and weed management practices on growth attributes of summer blackgram

Treatment	Plant height (cm)		Primary branches/plant		Leaves/plant		Leaf area index (LAI)	
	25 DAS	65 DAS	25 DAS	65 DAS	25 DAS	65 DAS	25 DAS	65 DAS
Planting distance (S)								
S1 - 20 x 10 cm^2	5.29	23.82	0.92	1.96	1.68	14.59	1	1.25
S2 - 30 x 10 cm^2	5.26	22.65	0.92	2.18	1.85	16.9	0.98	1.54
S3 - 40 x 10 cm^2	5.21	21.97	0.92	2.25	1.87	16.94	1	1.79
SEm±	0.15	0.32	0.08	0.05	0.05	0.31	0.05	0.09
CD (p=0.05)	NS	0.93	NS	0.13	0.16	0.92	NS	0.28
Weed management (W)								
W1 - Weedy check	4.98	19.66	0.67	2.03	1.49	11.13	0.89	1.1
W2 - Two hand weedings at 20 and 40 DAS	5.4	24.55	1	2.69	1.91	18.93	1.02	1.73
W3 - Pendimethalin @ 1 kg a.i ha^{-1}	5.02	21.12	1	2.11	1.8	14.61	0.97	1.4

+ Imazethapyr @ 100 g a.i ha^{-1} at 30 DAS								
W4 - Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS	5.60	25.93	1	2.78	2	19.9	1.13	1.87
SEm±	0.17	0.37	0.1	0.05	0.06	0.36	0.06	0.11
CD (p=0.05)	NS	1.08	NS	0.15	0.18	1.06	NS	0.32

Shoot dry weight, CGR and RGR

The data pertaining to Shoot dry weight, CGR and RGR was recorded at different stages and is presented in the Table 3. The data shows that there was no significant effect of treatments on plant shoot dry weight at 25 DAS. At 45 and 65 DAS, planting distance 40 x 10 cm^2 recorded the significantly highest shoot dry weight (1.32 and 2.45 g plant^{-1}) and found to be statistically at par with 30 x 10 cm^2 (1.30 and 2.41 g plant^{-1}). The result was similar with the findings of Kabir and Sarkar (2008). At 45 and 65 DAS, significantly highest shoot dry weight was observed under treatment pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS (1.50 and 2.81 g plant^{-1}). At 25-45 and 45-65 DAS, the planting distance 20 x 10 cm^2 recorded the highest crop growth rate (2.78 and 2.51 g m^{-2} day^{-1}). It could be due to higher plant population as reported by Biswas *et al*. (2002) and Tungoe *et al*. (2018). The treatment Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the highest crop growth rate (2.44 and 2.31 g m^{-2} day^{-1}) followed by the treatment two hand weedings at 20 DAS and 40 DAS (2.21 and 2.03 g m^{-2} day^{-1}) at 25-45 DAS and 45-65 DAS respectively. Similar result was witnessed by Pongen and Nongmaithem (2017). Data on the relative growth rate was not significantly affected by planting distance and weed management practices at both the time intervals under observation. Easha (2014) also reported non-significant effect of spacing and weed management treatments on relative growth rate.

Table 3. Effect of planting distance and weed management practices on shoot dry weight, crop growth rate (CGR) and relative growth rate (RGR) of summer blackgram

Treatment	Shoot dry weight (g plant^{-1})			CGR (g m^{-2} day^{-1})		RGR (g g^{-1} day^{-1})	
	25 DAS	45 DAS	65 DAS	25 -45 DAS	45- 65 DAS	25 -45 DAS	45- 65 DAS
Planting distance (S)							
S1 - 20 x 10 cm^2	0.12	1.23	2.23	2.78	2.51	0.117	0.03
S2 - 30 x 10 cm^2	0.12	1.3	2.41	1.97	1.85	0.121	0.031
S3 - 40 x 10 cm^2	0.11	1.32	2.45	1.51	1.41	0.124	0.031
SEm±	0.01	0.01	0.02	0.02	0.04	0.0026	0.0004
CD (p=0.05)	NS	0.02	0.05	0.05	0.11	NS	NS
Weed management (W)							
W1 - Weedy check	0.1	1.09	1.98	1.76	1.59	0.119	0.03
W2 - Two hand weedings at 20 and 40 DAS	0.12	1.35	2.5	2.21	2.03	0.122	0.031
W3 - Pendimethalin @ 1 kg a.i ha^{-1} + Imazethapyr @ 100 g a.i ha^{-1} at 30 DAS	0.11	1.19	2.17	1.93	1.77	0.119	0.03
W4 - Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS	0.13	1.5	2.81	2.44	2.31	0.123	0.031
SEm±	0.01	0.01	0.02	0.02	0.04	0.003	0.0005
CD (p=0.05)	NS	0.02	0.06	0.05	0.13	NS	NS

Yield attributing characters

Data pertaining to yield attributing characters is presented in the Table 4. The data revealed that planting distance of 40 x 10 cm^2 recorded the significantly highest number of pods (29.36) and was statistically at par with 30 x 10 cm^2 (28.50). Increased number of pods $plant^{-1}$ in a wider spacing is attributed to lower plant population and more growth resources and because of an increase in branches that initiate more pod bearing space on the crop plant (Gutu and Dabasa, 2021). Treatment Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS recorded the highest number of pods (30.74) and found at par with the treatment two hand weedings at 20 DAS and 40 DAS (29.96). The result was similar with Patel *et al*. (2017). Integrating pre-emergence herbicide and hand weeding enhanced the number of pods $plant^{-1}$ (40 %) over the weedy plot (Choudhary *et al*., 2012). There was no significant effect on the length of pods due to planting distance and weed management practices. Achakzai and Panizai (2007) and Tungoe *et al*. (2018) reported that pod length did not respond significantly in relation to different row spacing. There was no significant effect of treatments on the number of seeds pod^{-1} and the result was similar with the findings of Nadeem *et al*. (2004) and Rashmitha *et al*. (2021). No significant effect of treatments was observed on the test weight of blackgram. The result is similar with the finding of Najibullah and Chinnusamy (2017).

Seed and stover yield

From the observations recorded at harvest, it is revealed that planting distance and weed management treatments significantly affected the seed and stover yield of blackgram and the data is presented in Table 4. The crop under planting distance 30 x 10 cm^2 recorded the highest seed yield (663.27 kg ha^{-1}) and stover yield (2007.70 kg ha^{-1}) and it was observed to be statistically at par with 20 x10 cm^2 with seed yield (654.60 kg ha^{-1}) and stover yield (1958.16 kg ha^{-1}). Higher grain yield in food legumes under narrow spacing could be due to increased number of plant population that compensated for the decrease of yield components (Shamsi, 2010). Increase in stover yield of blackgram was observed by (Bhatt, 2020) at closer spacing might be due to more plant population per unit area which contributed to more crop biomass and hence highest over yield. Weed management treatment shad significant effect on seed and stover yield. Highest seed yield (738.73 kg ha^{-1}) and stover yield (2068.25 kg ha^{-1}) was observed under treatment pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS and found at par with the treatment two hand weedings at 20 DAS and 40 DAS. Application of pre-emergence herbicide supplemented with hand weeding produced upper most economic and biological yield which was on par with hand weeding twice. Similar findings were also noted by Patel *et al*. (2017).

Harvest Index

The data on the effect of planting distance and weed management treatments on harvest index of summer blackgram was recorded and presented in Table 4. The data revealed that treatments had significant effect on harvest index. Planting distance of 30 x 10 cm^2 and 20 x 10 cm^2 were at par with each other and recorded the highest harvest index as compared to 40 x 10 cm^2. Highest harvest index was observed under treatment Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS and found at par with the treatment two hand weedings at 20 DAS and 40 DAS.

Table 4. Effect of planting distance and weed management practices on Yield attributing characters and Yield of summer blackgram

Treatment	No. of pods $plant^{-1}$	Length of pods	No. of seeds pod^{-1}	Test Weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Planting distance (S)							
S1 - 20 x 10 cm^2	24.31	4.4	6.52	36.31	654.6	1958.16	24.86
S2 - 30 x 10 cm^2	28.5	4.49	6.67	37.05	663.27	2007.7	24.63
S3 - 40 x 10 cm^2	29.36	4.49	6.55	36.31	570.43	1927.75	22.6
SEm±	0.31	0.07	0.15	1.05	3.57	17.23	0.16
CD (p=0.05)	0.92	NS	NS	NS	10.47	50.53	0.47
Weed management(W)							
W1 - Weedy check	22.44	4.27	6.38	34.21	452.59	1772.91	20.32
W2 - Two hand weedings at 20 and 40 DAS	29.96	4.55	6.6	37.73	728.23	2033.02	26.37

W3 - Pendimethalin @ 1 kg a.i ha^{-1} + Imazethapyr @ 100 g a.i ha^{-1} at 30 DAS	26.41	4.45	6.47	36.55	598.18	1983.96	23.14
W4 - Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS	30.74	4.58	6.87	37.74	738.73	2068.25	26.31
SEm±	0.36	0.08	0.17	1.21	4.12	19.89	0.18
CD (p=0.05)	1.06	NS	NS	NS	12.09	58.34	0.54

4. Conclusion

It can be concluded from the present experiment that maintaining a closer planting geometry of 30 x 10 cm^2 or 20 x10 cm^2 and application of Pendimethalin @ 1 kg a.i ha^{-1} + one hand weeding at 30 DAS which is a combination of mechanical as well as chemical treatments proved to be the best treatment for producing higher seed and stover yield as well as for controlling the weeds of summer blackgram under Nagaland condition.

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