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Role of planting patterns and weed control treatments on growth and development of black gram

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Abstract
The field experiment entitled "Role of planting patterns and weed control treatments on growth and development of Black gram" (*Vigna mungo* L.) was conducted during the spring season of 2022 on the research farm of the School of Agriculture, Lovely Professional University, Phagwara (Punjab). The experiment was laid out in Split-Plot Design with four replications. Three main plot treatments (planting pattern) viz., M1: Row sowing, M2: Bed sowing, and M3: Cross sowing and four weed control treatments in subplots viz., T1: Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em, T2: Stomp 30 EC (pendimethalin 0.45 kg /ha), T3: One hand weeding at 25 days after sowing, T4: Unweeded (control) were kept. The experiment was laid out in Split-Plot Design with four replications. Among planting patterns total weed count and dry matter was observed to be at par among bed planting and cross sowing and both these techniques produced significantly higher weed count and their dry matter than row sowing. Significantly low weed count and dry matter accumulation by weed control treatments was obtained under one hand weeding at 25 DAS, Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em., Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em. and as compared to unweeded (control). Dry matter of weeds recorded at the time of harvest was found to be at par among bed planting and cross sowing and significantly less than flat sowing. All weed control treatments significantly reduced weed dry matter than control. The plant height was significantly more under cross sowing than row sowing and bed sowing. Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. recorded the significantly highest plant height among all weed control treatments. The dry matter accumulation by plant was found to be more in control which was significantly better than Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em., one hand weeding, Stomp 30 EC (pendimethalin 0.75 kg /ha). All the growth and yield attributes were found to be significantly higher in bed planting and cross among main plots and in pendimethalin (0.75 and 0.45 kg/ha) and one hand weeding than control among sub plots. Significantly higher seed yield was recorded under the bed sowing (9.12 q/ha) method of planting pattern than cross (9.11 q/ha) and row sowing method (8.11 q/ha). The yield under bed sowing was 10 percent higher than cross sowing and flat sowing techniques. In different weed control treatments, the higher seed yield was recorded under Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. (11.12 q/ha) and lowest seed yield was observed under unweeded control (6.47 q/ha) which was significantly less than other weed control treatments.

Keywords: Planting patterns, weed control, black gram

Introduction
Black gram (*Vigna mungo* L.) grows well on loamy to clay loam soils with good moisture holding capacity and with a neutral pH. Its growth and development is very poor on low organic matter soils which are sandy in texture. It is vulnerable to soil that are flooded with water.It is known as "poor man's meat" since it is a less expensive source of protein. Being leguminous crop, it fixed atmospheric nitrogen for its nitrogen requirements and also this crop improves soil fertility. According to FAO/WHO recommendations, 85 grams of pulses per capita per day are necessary to satisfy protein requirements, however pulses are currently available in India at barely 40 grams per capita per day.

The largest user and producer of black gram in the world are both in India. With 46.7 lakh hectares of land, it generates roughly 23.4 lakh tonnes of black gram annually, with an average yield of 501 kg per hectare in 2020-2021. (agricoop.nic.in). About 15.7% of India's total pulse acreage and 9.09% of the country's total pulse production are made up of black gram area. The three states with the largest areas for growing black gram are Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh.

India is the largest producer and consumer of mung bean in the world. Other producing countries are Myanmar, Thailand, Pakistan, Sri Lanka, Japan, Bangladesh, Canada, the Islamic Republic of Iran, Greece and East African countries.

It reveals that Andhra Pradesh occupied 555 thousand hectares (18 percent) of area and the largest producer of Black gram accounting for 30 percent (390 thousand tonnes) of the total production, during 2000-2001 in country, followed by Maharashtra, 574 thousand hectares (19 percent) with production 205 thousand tonnes (16 percent). The area under Black gram in Uttar Pradesh was 385 thousand hectares (13 percent) with production 163 thousand tonnes (13 percent), whereas in Tamil Nadu, the area and production was 276 thousand hectares (9 percent) and 127 thousand tonnes (10 percent) respectively.

Crop losses due to weeds may depend upon their type and intensity. Weed have been observed to reduce black gram yields by 27 to 90 percent, depending on the kind and degree of weed flora. Weeds are a significant issue during the rainy (*Kharif*) season. In black gram, losses as high as 50 to 60 percent (Yadav 1992) [12] have been reported as a result of weed competition. One hand weeding at 20 days after sowing (DAS) and a second hand weeding at around 40 DAS are mechanical ways to manage weeds. However, manual hand weeding is time-consuming and labor-intensive, and it does not guarantee weed elimination at a crucial stage of crop-weed competition. Even the high cost of labour and lack of availability during a vital period call for a practical and cost-effective weed management strategy. So, chemical control of weeds is very economical, sure and effective method of weeding control in this crop.

Different planting patterns plays important role for controlling weeds, saving irrigation water and hence seed yield. Plant growth and development as well as sensitivity to insect, pest and diseases also depend upon variable planting pattern. Patel (2020) [5] reported that narrow spacing (30cm) produced higher seed yield of moong bean where as wider row to row spacing (45cm) recorded highest number of branches per plant. Cross sowing/bidirectional sowing is very helpful for smothering weeds due to more uniform crop stand and hence providing less space for weed growth. Alternatively bed sowing protects the crop from excess rainfall, less weed seed germination due to their deep burial and less attack of insects and diseases due to proper aeration of crop canopy raised on beds. Moreover, there is saving of irrigation water by 20 to 25% with bed planting technique as compared to flat sowing.

Material and methods

The experiment was conducted at a research farm, Department of Agronomy, Lovely Professional University, Phagwara Punjab during spring season of 2022. In summer temperature of Punjab is very high and accordingly cooler in winters. The summer starts mostly from the April month of the year up to mid-September, the highest temperature rises up to 47 degree Celsius in the month of June. The Punjab regions receives monsoon from the end of June up to September. The amount of rainfall received is optimum for the crop growth period. The month of July receives the highest rainfall in the whole year and the highest temperature is experienced in May and June. Extremely cold weather is experienced during December and January it lowers down to even 0 °C.

Chemical properties of the soil of experimental field were Electrical Conductivity (ds/m) (0.16), Soil pH (7.2), Organic carbon (0.352), Available Nitrogen (kg/ha) (379.9), Available Phosphorous (kg/ha) (24), Available Potassium (kg/ha) (227). The field was normal in pH and EC and low in organic carbon and medium in phosphorus and potash. The experiment was carried out with twelve treatments using Split Plot Design which consists three main plots and four subplots with four replications. Main plot consists of three (Planting patterns) M1-Row sowing (22.5 cm row to row spacing) M2- Bed sowing (Bed size:- 67.5 cm, Bed top:-37.5cm, Furrow:-30cm Two rows of Mash crop were sown per bed. M3-Cross sowing (22.5cm x 22.5cm) and four Sub plots (weed control treatments) T1- Stomp 30 EC (pendimethalin 0.75 kg a.i /ha) pre em, T2 - Stomp 30 EC (pendimethalin 0.45 kg a.i /ha) pre em, T3- One hand weeding at 25 DAS, T5 - Unweeded (control). The size of the experimental plot was 5m x 3m. MASH 1137 variety of black gram was used in this experiment. The recommended seed rate for sowing black gram variety was 50 kg/ha. The seeds of black gram variety were sown manually in the field on 8th April, (2022). The depth of sowing was 2 to 3 cm. After proper field preparation, lay out and sowing was done. A recommended dose of 12.5 kg N/ha and 25.0 Kg P_2O_5 kg/ha was uniformly applied to all the plots as per the recommendation. Urea was used as a source of nitrogen and single super phosphate as a source of phosphorous. Entire dose of phosphorous and half dose of nitrogen was applied at the time of sowing after field preparation. The remaining dose of nitrogen was applied 25 DAS as top dressing by using urea fertilizer. As per the treatment of pre- emergence we used to different doses of pendimethalin 0.75 kg a.i/ha, pendimethalin 0.45 kg a.i/ha, within 24 hours of sowing. Hand weeding was performed 25 DAS. The last treatment was under control, so no weed control measures were taken. Irrigations were applied 5-6 times. The quadrat of 30cm x 30cm was thrown twice randomly per plot and the number of weed plants and their dry matter was noted. The plant height was recorded for the 5 plants/plot in centimeters from the ground level to the tip of growing point of plants with the help of scale. The term weed control efficiency is expressed in % and calculated at harvest. It refers to reduction of weed growth due to weed control treatments. Net plot harvested was 2.0 sq.m. area.

Weed control efficiency (WCE): To judge the effect of weed control treatments in controlling weeds, WCE is worked out.

$$WCE = \frac{DMC\text{-}DMT}{DMC} \times 100$$

DMC- Dry matter of weeds in control (unweeded) treatment
DMT- Dry matter of weeds in a treatment

Result and Discussion

Table 1: Influence of planting pattern and different weed control treatments on periodic weed count per square meter, dry weight of weeds (q/ha) and weed control efficiency.

Treatments	Total weed count (sq/m) at harvest	Dry matter of weed (q/ha) at harvest	WCE (%) at harvest
Main plot treatments (Planting patterns)			
M1- Row sowing (22.5 cm)	33.62	9.15	64.17
M2- Bed sowing (Two/rows)	21.52	6.61	74.11
M3- Cross sowing (22.5cm x 22.5 cm)	22.02	6.26	75.48
CD 5%	2.82	0.81	-
Sub plot treatments (Weed control treatments)			
T1-Pendimethalin 0.75 kg/ha, pre-em.	13.57	0.46	98.19
T2-Pendimethalin 0.45 kg/ha, pre-em.	21.81	1.17	95.41
T3-One hand weeding (25 DAS)	5.77	2.18	91.46
T4-Control (Unwedded)	61.72	25.54	-
CD 5%	3.86	0.91	-
C.D. Interactions	6.88	1.64	-

The total weed count per sq.m. at harvest was found to be significant among planting patterns and bed sowing (21.52 m^{-2}) and it was significantly less in cross sowing (32.02 m^{-2}) than flat sowing method (33.62), however differences in the former planting patterns being at par unweeded (control) recorded significantly higher weed count than all other treatments. Among sub plot treatments total weed count was found to be significant among weed control treatments, the total weed count in unweeded control was (61.72 m^{-2}) which was significantly highest than other treatments. In one hand weeding, total weed count was lowest (5.77 m^{-2}) which was significantly less as compared to other weed control treatments Stomp 30 EC pendimethalin 0.75 kg/ha, pre em. (13.57 m^{-2}) which was significantly better than Stomp 30 EC pendimethalin 0.45 kg/ha, pre em. (21.81 m^{-2}). The result obtained are similar to the findings of Komal *et al.* (2015) [3] at Rajasthan in which total weed count was found to be highest in control and lowest among herbicide and integrated weed control treatments.

At harvest, significantly higher dry weight of weeds was recorded under the flat sowing method i.e. (9.15 q/ha) than with bed sowing (6.61 q/ha) (Table 1) and cross sowing. Among sub plots, cross sowing (6.26 a/ha) significantly highest dry matter accumulation by weeds was observed in unweeded (control) (25.54 q/ha) than all other weed control treatments. Similar reading was observed by Yadav et al. (1992) [12]. The lowest weed dry matter accumulation was recorded under Stomp 30 EC pendimethalin 0.75 kg/ha, pre em. (0.46 q/ha) which was at par with the application of Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em. (1.17 q/ha), and one-hand weeding at 25 days after sowing (2.18 q/ha). Dry matter by weeds was significantly more in unweeded (control) than all other weed control treatments. The results obtained are similar to the findings of Kumar *et al.* (2006) [4].

The data revealed that among planting patterns the highest weed control efficiency was observed in cross sowing which were followed by bed sowing and row sowing being respectively (Table 1). Among weed control treatments the highest weed control efficiency was achieved by Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. (98.19%) which was followed by Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em. (95.41%). The lowest weed control efficiency recorded in one hand weeding at 25 days after sowing was observed (91.46%). Similar results were recorded by Rai *et al.* (2016) [6].

Growth parameter

Table 2: Influence of planting pattern and different weed control treatments on plant height (cm), dry matter per plant(g), number of branches per plant.

Treatments	Plant height (cm) at harvest	Dry matter per plant (gm) at harvest	No. of branches per plant at harvest
Main plot treatments (Planting patterns)			
M1- Row sowing (22.5 cm)	33.55	29.74	8.49
M2- Bed sowing (Two/rows)	35.02	35.11	8.91
M3- Cross sowing (22.5cm x 22.5 cm)	33.34	36.1	9.08
CD 5%	0.73	3.84	N/S
Sub plot treatments (Weed control treatments)			
T1-Pendimethalin 0.75 kg/ha, pre-em.	37.29	32.07	9.18
T2-Pendimethalin 0.45 kg/ha, pre-em.	33.71	44.04	9.12
T3-One hand weeding (25 DAS)	33.95	41.26	9.10
T4-Control (Unwedded)	30.92	17.23	7.92
CD 5%	0.76	2.26	0.64
C.D. Interactions	1.38	8.59	1.17

Plant height (cm) at harvest was significantly influenced by planting patterns and different weed control treatments as shown in (Table 2). Under different planting patterns, the highest plant height was observed in bed sowing (35.02 cm) which was significantly more than row sowing (33.55 cm) and cross sowing (33.34 cm) method of planting. The significantly lowest height was recorded in un-weeded (control) (30.92 cm) than other weed control treatments.

Stomp 30 EC pendimethalin 0.75 kg/ha, pre em. (37.29 cm) recorded significantly more height than Stomp 30 EC pendimethalin 0.45 kg/ha, pre em. (33.71 cm) and one hand weeding at 25 days after sowing (33.95 cm). The lowest plant height in unweeded treatment may be due to severe crop weed competition for the resources, which resulted in lower uptake of moisture and nutrient which adversely affected plant height. Rathore *et al.* (2010) [7] observed that different seed densities and fertilizer concentrations have an impact on plant height in black gram crop.

At harvest the dry matter accumulation by plants was significant in different planting patterns and weed control treatments as shown in (Table 2). Under different planting patterns, the highest plant dry matter (g) was recorded in cross sowing (36.10) and bed sowing (35.11) which was significantly higher than row sowing (29.74) significantly lowest plant dry matter was recorded in un-weeded (control) (17.23) than all other weed control treatments. The application of Stomp 30 EC (pendimethalin 0.75 kg/ha), pre em. recorded significantly more plant dry matter than all other weed control treatments. The lowest plant dry matter was observed in unweeded (control) than all weed control treatments due to poor crop growth because of weed competition in this treatments as compared to all other weed control. Similar findings were observed by Verma *et al.* (2020) [11].

The number of branches per plant at harvest were non-significantly influenced by planting pattern. In the weed control treatments, the highest number of branches per plant in Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. and pre em. application of (pendimethalin 0.45 kg/ha) and in one hand weeding were significantly more than unweeded (control) treatments.

Table 3: Influence of planting pattern and different weed control treatments on length of pod (cm), number of pods per plant, number of grains per pod and test weight (g).

Treatments	Length of pod (cm)	No. of pods/plant	No. of grains/pod	Test weight (g)
Main plot treatments (Planting patterns)				
M1- Row sowing (22.5 cm)	3.29	14.00	10.43	36.45
M2- Bed sowing (Two/rows)	3.34	14.57	10.67	37.64
M3- Cross sowing (22.5cm x 22.5 cm)	3.52	14.95	10.52	36.93
CD 5%	N/S	N/S	N/S	N/S
Sub plot treatments (Weed control treatments)				
T1-Pendimethalin 0.75 kg/ha, pre-em.	3.63	16.92	11.31	40.67
T2-Pendimethalin 0.45 kg/ha, pre-em.	3.05	14.22	11.15	38.27
T3 One hand weeding (25 DAS)	3.54	16.51	10.42	35.97
T4-Control (Unwedded)	3.35	10.37	9.28	33.12
CD 5%	0.20	0.99	0.48	0.93
C.D. Interactions	N/S	1.86	N/S	N/S

A perusal of data (Table 3) indicated that length of pod (cm), no.of pods/plant, no.of grains/pod, test weight at harvest were observed as non-significant among planting patterns. In weed control treatments, the highest values for these yield attributes were recorded in Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. than (pendimethalin 0.45 kg /ha), pre em. and one hand weeding at 25 days after sowing were observed than unweeded (control).

Table 4: Influence of planting pattern and different weed control treatments on seed yield (q/ha) and straw yield (q/ha).

Treatments	Seed yield (q/ha)	Straw yield (q/ha)
Main plot treatments (Planting patterns)		
M1- Row sowing (22.5 cm)	8.11	13.25
M2- Bed sowing (Two/rows)	9.12	14.18
M3- Cross sowing (22.5 cm x 22.5 cm)	9.11	14.30
CD 5%	0.25	0.26
Sub plot treatments (Weed control treatments)		
T1-Pendimethalin 0.75 kg/ha, pre-em.	11.12	16.24
T2-Pendimethalin 0.45 kg/ha, pre-em.	9.89	15.01
T3-One hand weeding (25 DAS)	7.64	12.81
T4-Control (Unwedded)	6.47	11.61
CD 5%	0.27	0.24
C.D. Interactions	0.49	0.45

Among planting patterns, significantly highest seed yield was recorded under the bed sowing method of planting (9.12 q/ha) and in cross method (9.11 q/ha) which was significantly higher than The yield under cross sowing technique (9.11 q/ha) was at par with row sowing (8.11 q/ha) technique. Higher yield in bed sowing may be due to better weed control (Table 1) better growth parameters (Table 2) and better yield attributes (Table 3). Among sub plot treatments significantly higher seed yield was recorded in (pendimethalin 0.75 kg/ha), pre em. than all other treatments. Higher seed yields in Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. may be due to the maintenance of the weed-free environment, especially during the critical growth period of black gram, which resulted into more plant height (Table 2), more dry matter/plant (Table 2) and more yield attributes (Table 3), more number of grains per pod, more number of pod/plant as compared to control. The yield under weed control treatments was observed significantly higher in Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em (11.12 q/ha), Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em., (9.89 q/ha), one hand weeding at 25 days

after sowing (7.64 q/ha) and unweeded control treatment. The unweeded control recorded significantly less seed yield (6.47) q/ha) than other weed control treatments. Subbulakshmi *et al.* (2021) [9].

Among planting patterns, the highest straw yield was recorded under the cross sowing method of planting (14.30 q/ha) and bed sowing (14.18 q/ha) which was significantly more than bed and row sowing method (Table 4) The straw yield under bed sowing technique (14.18 q/ha) was at par with cross sowing technique. The straw yield under weed control treatments was observed significantly higher in Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. (16.24 q/ha), Stomp 30 EC (pendimethalin 0.45 kg /ha), pre em. (15.01 q/ha), one hand weeding at 25 days after sowing (12.81 q/ha) and unweeded control were obtained very less (11.61 q/ha) as compared to other weed control treatments respectively unweeded control recorded significantly less straw yield than other weed control treatments. Similar results were found by Jhakar *et al.* (2015) [2] found that the uncontrolled weeds reduced seed yield 34% two hand weedings at 20 and 40 DAS also recorded 14% less yield than only pendimethalin applied plots.

Conclusion

From the experimental results the present study it can be concluded that in black gram, among planting patterns, bed sowing and cross sowing technique significantly improved the growth, yield attributes, yield and productivity of black gram as compared to better with other methods. Pre-em. application of pendimethalin at 0.75 kg/ha was found to be significantly superior to other herbicidal treatments with respect to seed yield. The combination of Stomp 30 EC (pendimethalin 0.75 kg /ha), pre em. with bed sowing planting pattern was also found to be most effective in controlling the weeds in black gram under well irrigated conditions.

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