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Effect of planting geometry and weed management practices on yield attributes and yield of green gram (*Vigna radiata* L. Wilczek)

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Abstract
A field experiment was carried out to study the "Effect of planting geometry and weed management practices on weed dynamics, growth and productivity of greengram" at Instructional Farm, Alesur, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, Chhattisgarh. The experiment was laid out in split plot design with three replications. The treatment comprised of three plant geometry i.e., 20 cm × 10 cm, 30 cm × 10 cm and 40 cm × 10 cm and five weed management practices i.e., weedy check, Pendimethalin 30 EC + Imazethapyr 2 EC (Pre-mix) @ 0.75 kg a.i. ha-1 (PE) fb 1 Hand weeding at 20 DAS, Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 10% SL @ 100 g a.i. ha-1 at 20 DAS, Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 35 WG+ Imazamox 35 WG @ 70 g a.i. ha-1 (Pre-mix) at 20 DAS and Weed free. Number of seeds per pod and test weight were not significantly influenced by plant geometry. Among the weed management practices, Pendimethalin + Imazethapyr (Pre-mix) fb 1 Hand weeding at 20 DAS recorded significantly higher number of pods per plant, number of grains per pod and test weight than Pendimethalin fb Imazethapyr + Imazamox (Pre-mix) Closer row spacing of 30 cm × 10 cm recorded significantly higher grain yields than row spacing of 40 cm × 10 cm and 20 cm × 10 cm. Pendimethalin + Imazethapyr (Pre-mix) fb 1 Hand weeding at 20 DAS although produced higher grain yield.

Keywords: Greengram, planting geometry, weed management, weed dynamics, yield and yield attributes

Introduction
Mungbean (*Vigna radiate* L. Wilczek), alternatively known as the moongbean, greengram, belongs to the family Fabaceae. In India pulses is grown in an area of 29.16 mha with production and productivity of 22.08 and 757 kgha-1 respectively (Anonymous, 2020) [1]. Inspite of being the largest producer in the world, our country has to import pulses to the tune of two million tonnes every year to meet its domestic requirement; the increment in the production being not able to maintain the pace with population growth. It is an excellent source of protein (25%) with high lysine content (460 mgg-1) and tryptophan (60 mgg^{-1}). It also has remarkable quantity of ascorbic acid when sprouted and also bears riboflavin and minerals.

Spacing plays an important role in contributing to the high yield because dense plant population will not get proper light for photosynthesis and poses high risk of diseases incidence. On the other hand, very low plant population will also reduce the yield. Hence, the optimum plant population is necessary for obtaining the higher yield. Plant geometry plays an important role in the dominance and suppression of weeds during the process of competition. Various works on spacing of greengram cultivation showed that optimum plant spacing gave maximum yield (Mansoor *et al*., 2010) [10]. Weeds cause severe losses in green gram due to its short stature and may causes losses up to 40-68 per cent (Tamang *et al*., 2015) [13]. The magnitude of loss as a result of crop weed competition depends on type of weed species associated with crop, their densities and duration of competition with crops. In green gram, weeds are normally controlled by hand weeding. However, hand weeding is laborious, time consuming, costly and tedious. With increase in labour cost and constraints in availability on time, manual weed control is no more an economical in green gram. Pendimethalin, a pre-emergence herbicide is used to control initial flush of weeds in moong since last many years. However, sole application of pendimethalin is not sufficient to control the diverse group of weed flora in moong. Hence, there was an urgent need to sort out a broad-spectrum efficient post-emergence herbicide including Imazethapyr and Imazamox (Pre-mix) for effective control of weeds in Rabi green gram to optimize productivity.

The present investigation on effect of plant geometry and weed management practices on weed dynamics, growth and productivity of green gram was planned with the objectives to determine the optimum planting geometry and better weed management practices to maximise grain yield at the same environment of row spacing in Chhattisgarh condition.

Material and method

The field experiment was conducted in *Rabi* season 2021 at the Research Cum Instructional Farm, Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, Chhattisgarh during *Rabi* season 2021 in split plot design (SPD) and replicated thrice. The treatment comprised of three plant geometry i.e., 20 cm × 10 cm, 30 cm × 10 cm and 40 cm × 10 cm and five weed management practices i.e., weedy check, Pendimethalin 30 EC + Imazethapyr 2 EC (Pre-mix) @ 0.75 kg a.i. ha-1 (PE) fb 1 Hand weeding at 20 DAS, Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 10% SL @ 100 g a.i. ha-1 at 20 DAS, Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 35 WG + Imazamox 35 WG @ 70 g a.i. ha-1 (Pre-mix) at 20 DAS and Weed free. IPM 4103 (Shikha) variety of green gram was used. The field with homogenous fertility and uniform textural make-up was selected for this purpose. The soil of the experimental plot was *Vertisol*. Observation on yield attributes and yield number of pod plant-1, number of seed pod-1, pod length, test weight, seed yield, straw yield, biological yield and harvest index. The harvest index was calculated as the ratio of economic yield (grain) to biological yield (grain + straw). Its value was expressed in percentage, using the following formula.

$$\text{HI}\,(\%) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Grain + straw yield (kg ha}^{-1})} \times 100$$

Results and Discussion

Yield attributes

A close scrutiny of data revealed that there was no significant effect of planting geometry on number of grains per pod and test weight. However, the maximum number of pods per plant and highest pod length was recorded under wider plant spacing of 30 cm × 10 cm. Whereas the maximum number of pod plant-1 was observed at (18.56) 30 cm × 10 cm spacing followed by 40 cm × 10 cm spacing and minimum number of pods per plant was observed at (15.15) 20 cm ×10 cm on mung bean. Yayeh *et al*. (2014) [16]. The highest pod length (7.48 cm) was obtained from 30 cm×10 cm spacing followed by 40 cm×10 cm whereas, the lowest (6.07 cm) was observed from 20 cm×10 cm spacing. Foysalkabir *et al*. (2016) [5]. Among the various parameters contributing towards final yield of a crop, test weight is of prime importance. Data revealed that test weight of grains was not significantly influenced by different plant geometry. Data showed that wider row spacing 30 cm × 10 cm indicates higher test weight (38.18 g) followed by 40 cm × 10 cm (38.18 g) and 20 cm × 10 cm (38.04 g). The maximum number of pods per plant and seeds per pod in wider row spacing may be attributed to relatively less inter-plant competition due to more space availability to individual plants which in turn contributed towards vigorous growth of plant. This ultimately was reflected in better development of these yield indices. These findings are substantiated with the reports of Laxminarayana (2003) [8] in greengram with respect to pods per plant, number of seeds per pod and test weight. Application of various weed management practices tended to increase number of pods per plant significantly over weedy check (12.70). A look on the result from the data indicated that higher number of pods per plantwas recorded under Pendimethalin + Imazethapyr (pre-mix) fb 1 Hand weeding at 20 DAS (18.88) which was statistically alike to Pendimethalin (PE) fb Imazethapyr + Imazamox (Pre-mix) at 20 DAS (18.27) and significantly surpassed over other herbicidal treatments. Number of pods per plant did not varied significantly among the herbicidal treatments. Weed management proved were significantly superior over weedy check (7.65) in respect of number of grains per pod. Among the weed control treatments, Pendimethalin + Imazethapyr (pre-mix) fb 1 Hand weeding at 20 DAS (8.88) recorded similar to Pendimethalin (PE) fb Imazethapyr + Imazamox (Pre-mix) at 20 DAS (8.26) but significantly recoded over Pendimethalin (PE) fb Imazethapyr (8.75).Weed management practices has no significant effect on pod length. Similarly, the test weight of greengram was significantly influenced by all weed management practices. However, the highest test weight was recorded under Pendimethalin + Imazethapyr (pre-mix) fb 1 Hand weeding at 20 DAS (38.79) and the lowest was noticed under weedy check (37.03). Yield per hectare is a product of number of plants per hectare and the yield per plant. Yield per plant depends on the number of pods per plant, number of grains per pod and 1000-seed weight, in case of greengram. The lower value of yield indices in weedy plot might be due to more competition by weeds for resources, which made the crop plant inefficient for take up more moisture, nutrients and ultimately growth by affected by due to less supply of nutrients and carbohydrate. Contrary on other hand weed free environment under weed free control treatments, enjoying growth resources more efficient, resulting in better growth of plant which lead towards an increase in yield indices. These observations get support from those of Khaliq *et al*. (2002) [7], Dungarwal *et al*. (2003) [4] and Malliswari *et al*. (2008) [9].

Yield

The highest grain yield was recorded under closest row spacing of 30 cm × 10 cm (1044 kgha-1) which was significantly higher over wider row spacing of 40 cm × 10 cm (901 kgha-1) and 20 cm × 10 cm (833 kgha-1). This result is in accordance with the findings of maximum grain yield of greengram was recorded in treatments having 30 cm of row spacing by having maximum grain yield. Mansoor *et al*. (2010) [10] Grain yield due to weed management practices turned out to be significant over weedy check (756 kgha-1) Among the weed control treatments, Pendimethalin + imazethapyr (ready mix)(PE) fb 1 Hand weeding at 20 DAS(977 kgha-1) followed by Pendimethalin (PE) fb Imazethapyr + Imazamox (Pre-mix) at 20 DAS while the lowest at Pendimethalin (PE) fb Imazethapyr. Grain yield was recorded highest with weed free treatment (1100 kgha-1). Whereas lowest seed yield recorded with weedy check plot (756 kgha-1). This result is in accordance with the findings of Pendimethalin 30 EC + imazethapyr 2 EC (Vellore 32) @ 1.0 kg ha-1 (PE) + manual weeding at 25-30 DAS recorded significantly the higher yield during the year 2016. Significantly the lowest seed yield was recorded in weedy check during all the years. Pendimethalin and hand weeding was superior in controlling weeds and increasing the seed yield reported by Chaudhari (2016) [2] Chhodavadia (2014) [3]

and Jha (2013). The data indicated that there was significant variation in straw yield among different plant geometry. The higher straw yield was recorded under closer row spacing of (1777 kgha-1) in 30 cm × 10 cm followed by 40 cm × 10 cm and lowest at (1532 kgha-1) in 20 cm × 10 cm. The highest values of straw yield was observed at spacing 30 cm × 10 cm followed by spacing at 40 cm × 10 cm and lowest values was recorded at spacing 20 cm × 10 cm. Reported that the Rasul (2012) [11] and Yadav (2004) [14]. Significant differences were recorded due to weed management practices on the straw yield. Weed free although recorded higher straw yield (1950 kgha-1). Among the chemical weeding, higher straw yield was recorded under Pendimethalin + imazethapyr (ready mix) (PE) fb 1 Hand weeding at 20 DAS (1749 kgha-1) followed by Pendimethalin (PE) fb Imazethapyr + Imazamox (Pre-mix) at 20 DAS (1618 kgha-1) while the lowest at Pendimethalin (PE) fb Imazethapyr (1588 kgha-1) All the weed management practices recorded significantly higher straw yield than weedy check (1557 kgha-1). The reduction in straw yield due to weed infestation was obviously because of the reduced growth and development of vegetative attributes and reduced dry matter production by crop plants under intense weed competition. Significant differences were recorded due to the spacing of biological yield. However the maximum biological yield was observed in spacing (2881 kgha-1) in 30 cm × 10 cm followed by 40 cm × 10 cm and minimum (2365 kgha-1) in 20 cm × 10 cm. The findings showed that mung bean types differed in terms of straw and biological production. Plant spacing of 20 cm × 10 cm and 40 cm × 10 cm were statistically equal, however plant spacing of 30 cm × 10 cm was significantly greater than 20 cm × 10 cm. Plant geometry biological yield showed a similar trend. Sarkar *et al*. (2004) [12] also discovered differences in straw and biological yield. Biological yield of greengram was significantly influenced by different weed management practices. However the highest biological yield was recorded with weed free treatment (3050 kgha-1). Among the herbicidal treatment Pendimethalin 30 EC + imazethapyr 2 EC (ready mix) 0.75 a.i. kgha-1 (PE) fb 1 Hand weeding at 20 day after sowing (2693 kg ha-1) and lowest biological yield recorded with weedy check plot (2313 kgha-1). Weed free recorded the highest biological yield and grain yield. Weedy check treatment recorded the lowest biological yield and grain yield, which might be due to more weed density and dry weight of weeds and poor nodulation. Data on harvest index indicated that row spacing did not produce significant effect on harvest index. However, the highest value of harvest index was registered under closer row spacing of (36.24%) harvest index was observed at 30 cm × 10 cm spacing followed by 20 cm × 10 cm spacing and lowest harvest index (34.06%) was observed at 40 cm × 10 cm on mung bean**.** The recommended 30 cm inter row and 10 cm intra row spacing for maximum seed yield and harvest index. This result is in accordance with the findings of Yadev *et al*. (2014) [14]. Weed management practices significantly affect harvest index. However the maximum harvest index was observed Pendimethalin 30 EC + imazethapyr 2 EC (ready mix) 0.75 kg a.i. ha-1 (PE) fb 1 Hand weeding at 20 day after sowing (36.26%) and lowest Harvest index recorded with weedy check plot (32.61%). This was probably due to better availability of growth resources resulting in enhanced sink capacity and higher grain yield under weed control treatments.

Table 1: Yield attributes of green gram as influenced by planting geometry and weed management practices

Treatment	No. of pod plant-1	No. of seed pod-1	Pod length (cm)	Test weight (g)
Planting geometry				
20 cm × 10 cm	15.15	8.14	6.07	38.04
30 cm × 10 cm	18.56	9.48	7.48	38.29
40 cm × 10 cm	17.25	8.78	6.85	38.18
S.Em±	0.27	0.33	0.14	0.08
CD (*P*=0.05)	1.11	NS	0.56	NS
Weed management practices				
Weedy check	12.70	7.65	6.70	37.03
Pendimethalin 30 EC + imazethapyr 2 EC (ready mix) 0.75 kg a.i. ha-1 (PE) fb 1 Hand weeding at 20 DAS	18.88	8.88	6.81	38.79
Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 10% SL @ 100 g a.i. ha-1 at 20 DAS	15.46	8.75	6.73	37.34
Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 35 WG + Imazamox 35 WG @ 70 g a.i. ha-1 (Pre-mix) at 20 DAS	18.27	8.26	6.77	38.39
Weed free	19.64	9.46	7.00	39.31
S.Em±	0.32	0.30	0.25	0.39
CD (*P*=0.05)	0.95	0.90	NS	1.16

Table 2: Yield of green gram as influenced by planting geometry and weed management practices

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Planting geometry				
20 cm × 10 cm	833	1532	2365	35.10
30 cm × 10 cm	1044	1777	2881	36.24
40 cm × 10 cm	901	1769	2642	34.06
S.Em±	5.80	29.29	19.93	0.17
CD (*P*=0.05)	23.41	118.10	80.35	0.70
Weed management practices				
Weedy check	756	1557	2313	32.61

Pendimethalin 30 EC + imazethapyr 2 EC (ready mix) 0.75 kg a.i. ha-1 (PE) fb 1 Hand weeding at 20 DAS	977	1749	2693	36.26
Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 10% SL @ 100 g a.i. ha-1 at 20 DAS	853	1588	2442	34.98
Pendimethalin 30 EC @ 1.0 kg a.i. ha-1 (PE) fb Imazethapyr 35 WG + Imazamox 35 WG @ 70 g a.i. ha-1 (Pre-mix) at 20 DAS	944	1618	2650	35.75
Weed free	1100	1950	3050	36.05
S.Em±	5.52	33.26	42.20	0.62
CD (*P*=0.05)	16.22	97.65	123.91	1.82

Conclusion

From the experiment it is clear that closer plant spacing of 30 cm × 10 cm was found effective for produced significantly maximum value of yield attributing character and yield. Though the highest yield was recorded with Pendimethalin + Imazethapyr (Pre-mix) followed by one hand weeding. The yield attributing characters were also found maximum in Pendimethalin + Imazethapyr (Pre-mix) followed by one hand weeding.

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