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Effect of plant geometry and weed management on yield and yield attributes of summer mungbean (*Vigna radiata* L.)

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Abstract
A field experiment was carried out during *kharif* season of 2017 at research farm of TCA Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar) to study the "Effect of plant geometry and weed management on yield and yield attributes of summer mungbean (*Vigna radiata* L.)" The experiment was laid out in randomised block design with three replications. The treatment comprised of three plant geometry *i.e.*, 20 x 10 cm, 25 x 10 cm and 30 x 10 cm and five weed management practices *i.e.*, weedy check, hand weeding at 15 and 30 DAS, Pendimethalin 0.75 kg/ha (pre-emergence), Quizalofop-ethyl 60 g/ha at 15 DAS and Imazethapyr 60 g/ha at 15 DAS. Number of pods per plant, pod length and test weight were not significantly influenced by plant geometry. Among the weed management practices, hand weeding twice recorded significantly higher number of pods per plant, number of grains per pod and pod length than Quizalofop-ethyl and Pendimethalin. Closer row spacing of 20 × 10 cm recorded significantly higher grain yields than row spacing of 25 × 10 cm and 30 × 10 cm. Hand weeding twice although produced higher grain yield but was at par with Imazethaypr and significantly surpassed over Quizalofop-ethyl and Pendimethalin. Harvest index was unaffected by plant geometry and weed management practices.

Keywords: mungbean, plant geometry, weed management practices, yield and yield attributes

Introduction
Mungbean [*Vigna radiata* (L.) Wilczek] is one of the important pulse crop grown in India. It is a short duration pulse crop which can be grown as catch crop during *kharif* season. The production potential of this crop during *summer* can be fully explored using short duration and photo insensitive varieties. The crop in this season is raised under controlled conditions and there is less infestation of insects, pests, diseases. The sky remains clear and duration of sunshine hours is also more which may result in more photosynthetic efficiency of this crop subsequently more grain yield with good quality grains. It occupies 30.53 lakh hectare area and contributes 15.09 lakh tonnes in pulse production in the country (Statistical year book India, 2016) [7]. It is highly nutritious with protein, carbohydrates, minerals and vitamins. Plant geometry plays an important role in the dominance and suppression of weed during the process of competition. Ideal plant geometry is precious and important for better and efficient utilization of available plant growth resources in order to get maximum productivity in crops. The productivity of this crop is very low compared to its potential yield owing to many reasons but infestation of weeds is felt one of the most serious reasons for limiting the productivity. Weeds cause severe losses in greengram due to its short stature and may causes losses up to 40-68 per cent (Tamang *et al.*, 2015) [8]. 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 mungbean. There was an urgent need to sort out a broad-spectrum efficient post-emergence herbicide including quizalofop ethyl and imazethapyr for effective control of weeds in summer greengram to optimize productivity.

Material and Methods
The field experiment was conduct during summer season of 2017 at research farm of Tirhut College of Agriculture Farm, Dholi (Muzaffarpur), a campus of Dr. Rajendra Parsad Central Agricultural University, Pusa (Samastipur), Bihar. Farm is situated on the southern bank of the river *Burhi Gandak* at an altitude of 52.18 meter above mean sea level and lies at 25^{0}39' N latitude and 85^{0}40' E longitude. The soil of the experimental plot was alluvial and calcareous in nature. The soil of the experimental plot was low in organic carbon, available nitrogen, available P_2O_5 and medium in available K_2O which indicate that the soil was low in fertility.

The treatment consists of three plant geometry *i.e.*, 20 x 10 cm, 25 x 10 cm and 30 x 10 cm and five weed management practices *i.e.*, weedy check, hand weeding at 15 and 30 DAS, Pendimethalin 0.75 kg/ha (pre-emergence), Quizalofop-ethyl 60 g/ha at 15 DAS and Imazethapyr 60 g/ha at 15 DAS. The experiment was laid out in randomized block design and replicated twice.

A plot having uniform fertility and even topography was selected for experimental trial. The field was given a pre sowing irrigation before field preparation to obtained proper germination and establishment of the crop. Mungbean variety 'HUM 16' was sown in the summer season of 2016 using the seed rate of 25 kg/ha. Seed was treated with fungicide, Thiram @ 2 g/kg of seed before sowing against fungal diseases. Plant to plant distance of 10 cm was maintained by thinning after 15 days of sowing. One irrigation was given at 20 DAS to the crop. The recommended dose of fertilizer (20:40:0 kg N: P_2O_5: K_2O/ha) was applied. Pendimethailn was applied on next day of sowing while imazethapyr and quizalofop ethyl were applied at 15 days after sowing. These herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using 600 litres of water per hectare. Hand weeding operations was performed at 15 and 30 DAS. Two pickings were done by hand for complete harvest of mature pod per plot. The weight of grains and straw were recorded treatment wise and converted into quintal per hectare.

Length of pods in cm in sampled five plants were recorded from base of pod to the tip of the pod with the help of metre scale and then averaged out. Number of pods in sampled five plants were counted. The average number were computed and expressed as number of pods per plant. A representative sample of 1000-grains of mungbean was sundried at 15% moisture level from each plot and weighed in gram.

Grain yield after threshing, cleaning and sun drying were taken and finally recorded in quintal per hectare. After picking the pods, the remaining portion of the plant was harvested. The straw yield was calculated after the plant was completely dried. For obtaining the final straw yield, weight of straw of the observational plants were also added in the corresponding figures. The yield was then converted into quintal per hectare. 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.

$$\text{H.I}\,(\%) = \frac{\text{Grain yield (kg/ha)}}{\text{Grain + Straw yield (kg/ha)}} \times 100$$

Result and Discussion
Yield attributes

A close scrutiny of data revealed that there was no significant effect of planting geometry on pod length, number of pods per plant. However, the maximum number of pods per plant and highest pod length was recorded under wider plant spacing of 30 × 10 cm. Number of grains per pod significantly increased with the increase in the plant spacing. Wider plant geometry of 30 × 10 cm recorded significantly higher number of grains per pod (7.08) than closer plant spacing 25 × 10 cm (6.46) and 20 × 10 cm (5.55). 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 × 10 cm indicates higher test weight (35.84) followed by 20 × 10 cm (34.85) and 25 × 10 cm (35.47). 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) [3] in red gram 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 (13.24). A look on the result from the data indicated that higher number of pods per plant (18.15) was recorded under hand weeding twice (18.15) which was statistically alike to Imazethapy(17.35) 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 (5.71) in respect of number of grains per pod. Among the weed control treatments, hand weeding twice (7.09) recorded similar to Imazethapyr (6.70) but significantly recoded over Quizalofop-ethyl (6.30) and Pendimethalin (6.01). The chemical weeding had no marked effect on number of grains per pod, it was higher in Imazethapyr (6.70) followed by Quizalofop-ethyl (6.30) and Pendimethalin (6.01). Weed management practices registered a significant enhancement in pod length over weedy check (5.12). Maximum pods length (8.02 cm) was noticed when weeds were controlled by hand weeding which was significantly superior over chemical done by Quizalofop ethyl (7.26 cm) and Pendimethalin (6.95 cm) but was found at par to Imazethapyr (7.58 cm). Among the chemical weeding, Imazethapyr recorded highest pod length (7.58 cm) which was at par with Quizalofop ethyl (7.26 cm) and Pendimethalin (6.95 cm). Similarly, the test weight of greengram was also not significantly influenced by all weed management practices. However, the highest test weight was recorded under hand weeding twice (36.78) and the lowest was noticed under weedy check (33.82). 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 mungbean. Yield attributes of mungbean, namely, number of pods per plant, number of seeds per pod and test weight were significantly influenced by the weed management practices. Maximum values of all these yield contributing characters were recorded under hand weeding twice that were found to be at par with Imazethapyr and significantly higher over Quizalofop-ethyl and Pendimethalin except test weight. Test weight did not varied significantly among the weed management practices. Numbers of pod and length of pod did not varied significantly among the chemical weeding. 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) [2], Dungarwal *et al.* (2003) [1] and Malliswari *et al.* (2008) [4].

Grain yield

Data pertaining to the grain yield elucidated that grain yield was significantly influenced by different plant spacing. The highest grain yield was recorded under closest plant spacing of 20 × 10 cm (12.53) which was significantly higher grain yield over wider spacing of 30 × 10 cm (9.17). The increase in grain yield at closer row spacing was possible due to more number of plants per unit area. The results are in agreement with the findings of Singh *et al.* (2011).

Data on grain yield at harvest revealed that weed management practices turned out to be significant over weedy check (7.19). Among the weed control treatments, hand weeding produced higher grain yield (13.92) but was at par with Imazethapyr (12.97) and significantly higher over Quizalofop ethyl (11.62) and Pendimethalin (9.10 q/ha). Among the chemical weeding, though it was higher in Imazethapyr (12.97) and was at par with Quizalofop ethyl (11.62 q/ha) and both recorded significantly higher grain yield over Pendimethalin (9.10 q/ha). Excessive weed growth and severe crop-weed competition drastically reduced crop yield in unweeded control. The increase in grain yield in weed control treatments may be mainly due to maintenance of weed free environment, at critical growth stages, reduce crop weed competition helped in better growth and development of yield indices resulting in higher grain yield. Singh *et al*. (1999) [6] also reported 67.7% reduction in grain yield due to uncontrolled weeds. These observations get support from those of Malliswari *et al.* (2008) [4].

Straw yield

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 20 × 10 cm (22.23) which significantly reduced with widening the row spacing. The remarkable increase in straw yield at closer plant geometry was mainly due to increased plant population per unit area. The results are in accordance with findings of Yadav *et al*. (1992) [9] in soybean.

Hand weeding although recorded higher straw yield (23.87) but was found at par with Imazethapyr (22.83) and significantly enhanced over Quizalofop ethyl (21.15) and Pendimethalin (17.08 q/ha). Among the chemical weeding, higher straw yield was recorded under Imazethapyr (22.83) and Quizalofop ethyl (21.15) which was at par and both significantly surpassed over Pendimethalin (17.08 q/ha). All the weed management practices recorded significantly higher straw yield than weedy check (14.05). 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.

Harvest index

Data on harvest index indicated that row spacing did not produce significant effect on harvest index. However, the maximum value of harvest index was registered under closer row spacing of 20 × 10 cm (35.84) whereas the lowest under wider row spacing of 30 × 10 cm (34.85).

Weed management practices did not affect harvest index significantly. However, the maximum harvest index was observed under hand weeding (36.78) while the lowest was associated with weedy check (33.83). The weed free environment although recorded higher harvest index than weedy check but differences was not found to be significant. 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: Effect of plant geometry and weed management on yield attributes of summer mungbean

Treatment	Yield attributes			
	No. of pod/plant	**No. of grains/pod**	**Length of pod (cm)**	**Test weight (g)**
Plant geometry				
20 x 10 cm	15.80	5.55	6.74	34.85
25 x 10 cm	16.65	6.46	6.98	35.47
30 x 10 cm	16.93	7.08	7.24	35.84
SEm±	0.34	0.13	0.17	0.83
CD (P=0.05)	NS	0.38	NS	NS
Weed Management				
Weedy check	13.24	5.71	5.12	33.82
Hand Weeding 15 and 30 DAS	18.15	7.09	8.02	36.78
Pendimethalin 0.75 kg /ha at pre-emergence	16.73	6.01	6.95	34.72
Quizalofop-ethyl 60 g /ha (15 DAS)	16.83	6.30	7.26	35.42
Imazethapyr 60 g /ha (15 DAS)	17.35.	6.70	7.58	36.18
SEm±	0.43	0.17	0.22	1.07
CD (P=0.05)	1.26	0.49	0.63	NS

Table 2: Effect of plant geometry and weed management on grain yield, straw yield and harvest index of summer mungbean

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
Plant geometry			
20 x 10 cm	12.53	22.23	35.84
25 x 10 cm	11.19	20.17	35.47
30 x 10 cm	9.17	16.99	34.85
SEm±	0.26	0.60	1.01
CD (P=0.05)	0.77	1.77	NS
Weed Management			
Weedy check	7.19	14.05	33.83
Hand Weeding 15 and 30 DAS	13.92	23.87	36.78
Pendimethalin 0.75 kg /ha at pre-emergence	9.10	17.08	34.72
Quizalofop-ethyl 60 g /ha (15 DAS)	11.62	21.15	35.42
Imazethapyr 60 g /ha (15 DAS)	12.97	22.83	36.19

SEm±	0.34	0.78	1.31
CD (P=0.05)	0.99	2.28	NS

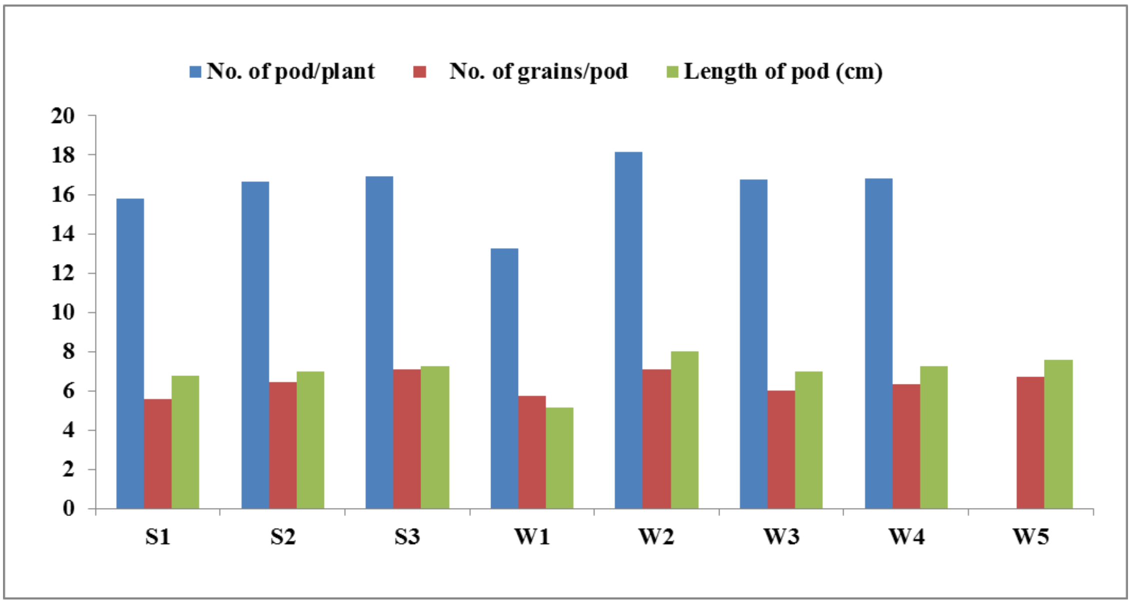

Fig 1: Effect of plant geometry and weed management on yield attributes of summer mungbean

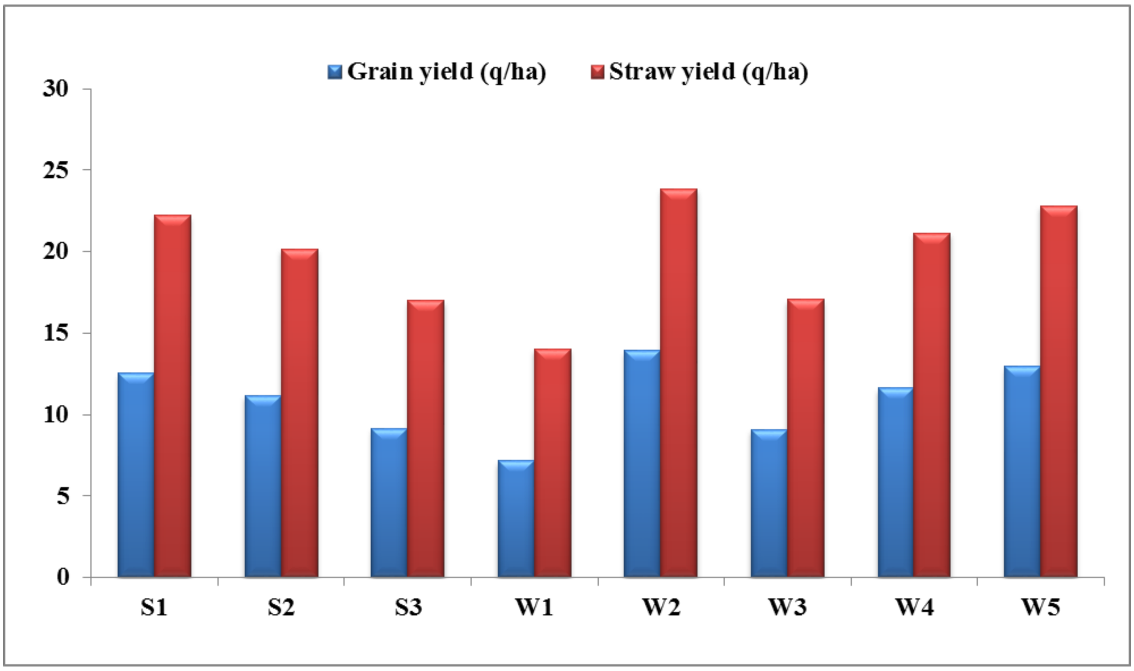

Fig 2: Effect of plant geometry and weed management on grain yield and straw yield of summer mungbean

Conclusion

It was concluded that closest plant spacing of 20 × 10 cm was found effective for produced significantly higher grain and straw yield than wider row of 25 × 10 cm and 30 × 10 cm. But the maximum value of yield attributing characters were found in wider row spacing of 30 × 10 cm compared to closer row spacing. Hand weeding produced higher grain and straw yield but was found at par with Imazethapyr. The yield attributing characters were also found maximum in hand weeding.

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