



Effect of land configuration and weed management on productivity of greengram (*Vigna radiata*)

GURIQBAL SINGH, HARPREET KAUR VIRK and VEENA KHANNA

Punjab Agricultural University, Ludhiana, Punjab 141 004, India

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ABSTRACT

A field experiment was conducted to study the effect of different land configuration and weed management treatments in greengram (*Vigna radiata* L.). The raised bed and ridge sown crop recorded significantly lower dry matter of weeds and significantly higher weed control efficiency (WCE) (78.4% and 78.1%, respectively) than flat sown crop (68.5%). Raised bed sowing provided higher grain yield to the tune of 4.0 and 16.1% over ridge and flat sowing, respectively and gave significantly higher gross returns, net returns and B:C ratio than ridge and flat sowings. Application of pendimethalin @ 0.75 kg/ha as pre-emergence (PE) + imazethapyr @ 55 g/ha as post-emergence (POE) 15-20 days after sowing (DAS) and imazethapyr @ 55 g/ha (POE) 15-20 DAS recorded significantly lower dry matter of weeds and significantly higher WCE than pendimethalin @ 0.75 kg/ha (PE). The application of herbicides (pendimethalin as PE and imazethapyr as POE) had no adverse affect on symbiotic parameters. Pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS provided significantly higher grain yield than the other treatments and gave the highest gross returns, net returns and B:C ratio. It can be concluded that sowing of greengram on raised bed land configuration along with application of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS was found to be effective for controlling weeds as well as improving the grain yield and providing higher net returns and B:C ratio.

Key words: Greengram, Imazethapyr, Pendimethalin, Raised bed, Symbiotic parameters

Greengram (*Vigna radiata* L.), also known as mungbean, is grown during rainy (*Kharif*) and summer seasons in many parts of India. In rainy season, the most limiting factors in successful greengram production are waterlogging due to heavy rains, and infestation of weeds. In rainy season, the raised bed and ridge planting systems, the furrows act as drainage channels, resulting in significant benefits of these methods. Moreover, water is a scarce input and needs to be used judiciously. The ridge planting (Patel *et al.* 2009) and furrow irrigated raised bed planting (Dhindwal *et al.* 2006) can save considerable amount of irrigation water and increase water productivity. The raised bed planting increases the availability of nutrients to crop roots, results in better crop establishment and weed management, and reduces soil compaction.

Weeds grow luxuriantly and compete for nutrients, water, light and space with the crop plants and reduce grain yields considerably (Singh *et al.* 2017). Therefore, weeds need to be controlled at appropriate time using suitable method(s). Management of weeds through hand weeding

requires a lot of labour and is very costly. Herbicides may have negative effects on symbiosis (Singh *et al.* 2017). However, some reports revealed no such adverse effects (Khanna *et al.* 2012). Pre-emergence application of pendimethalin has been recommended in greengram for controlling weeds. However, there is a need to find out some safe and effective post-emergence herbicide for controlling weeds in greengram when sown under different planting systems. Therefore, an experiment was planned to study the effect of different land configurations and weed management treatments on weeds, nodulation, growth, productivity and economics of greengram.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* (rainy season) 2015-16 at the research farm of Punjab Agricultural University, Ludhiana (30° 54'N, 75° 48'E, altitude 247 m), Punjab. Soil of the experimental site was loamy sand (80.3% sand, 14.3% silt and 5.4% clay), having pH 7.3, organic carbon 0.38%, available P 29.2 kg/ha and available K 107.5 kg/ha. A total of 254.2 cm (12 rainy days) and 217.5 cm (14 rainy days) rainfall was received during the crop growing seasons in 2015-16, respectively.

The experiment comprising three land configurations (raised bed, ridge and flat bed methods) and four weed

*Corresponding author e-mail: singhguriqbal@rediffmail.com

management treatments [Weedy check, pendimethalin 30 EC @ 0.75 kg/ha as pre-emergence (PE), imazethapyr 10% SL @ 55 g/ha as post-emergence (POE) at 15-20 days after sowing (DAS) and pendimethalin 30 EC @ 0.75 kg/ha (PE) fb imazethapyr 10% SL @ 55 g/ha at 15-20 DAS] was conducted in a strip plot design by keeping land configuration in main plot and weed management in sub-plot with four replications. Raised beds and ridges were formed using a raised bed planter and a ridger, respectively. The total width of each raised bed was 67.5 cm (bed top 37.5 cm and furrow 30 cm) and on the bed top two rows were sown at a row spacing of 20 cm. In case of ridge sowing, ridges were formed at a spacing of 60 cm and one row of greengram was sown at the top of the ridge. In case of flat bed sown crop, sowing was done on flat beds at a row spacing of 30 cm. In all the treatments, uniform seed rate of 20 kg/ha was used to maintain equal plant population. Each plot measured 10.0 m × 2.7 m for flat bed and raised bed methods and 10.0 m × 2.4 m for ridge method during both the years. Pendimethalin was sprayed as pre-emergence in the evening on the day of sowing of crop, whereas imazethapyr was sprayed at 15-20 DAS. These herbicides were sprayed using 500 litres of water per hectare with a knapsack sprayer fitted with a flat fan nozzle. In case of weedy check plots, the weeds were allowed to grow during the whole crop growing season.

After pre-sowing irrigation, at optimum soil moisture, the field was ploughed twice followed by planking. The crop was sown on 21 July, 2015 and 20 July, 2016. The sowing of cultivar PAU 911 in 2015 and ML 818 in 2016 was done using a seed rate of 20 kg/ha. Nutrient dose of 12.5 kg N and 40 kg P₂O₅/ha was applied through urea and single superphosphate, respectively uniformly in all the treatments at sowing. The crop was harvested on 2 October, 2015 and 7 October, 2016.

Data on weed species count were recorded 55 DAS from a randomly selected area measuring 50 cm × 50 cm from each plot and then converted to weed species count/m² area. At 55 DAS, all weed species after taking the weed count data were dried together plot-wise and the data converted to dry matter of weeds in kg/ha. During 2015 and 2016, at harvest, weeds from the whole plot were harvested, dried and data converted into kg/ha. Weed control efficiency (WCE), at harvest, was calculated as per the following formula:

$$\text{WCE (\%)} = \frac{(\text{Dry weight of weeds in unweeded plot} - \text{Dry weight of weeds in the treated plot}) \times 100}{\text{Dry weight of weeds in unweeded plot}}$$

Data on symbiotic parameters, viz. number and dry weight of nodules were recorded 40 DAS. Five plants/plot were randomly selected for number and dry weight of nodules, and then average worked out. Data on plant height, number of branches/plant and number of pods/plant were recorded from randomly selected five plants from each plot, and number of seeds/pod from randomly selected 20 pods at maturity. Biological yield and grain yield were recorded on the basis of whole plot area and converted into kg/ha. From

the produce of each plot, 100 seeds were taken for 100-seed weight data. Harvest index (HI) was also calculated. Economic analysis was done using prevailing prices of inputs and minimum support price (MSP) of output (grain yield). All data were subjected to analysis of variance. Two-year pooled analysis was done.

RESULTS AND DISCUSSION

Effect on weeds: The major weed flora were *Cyperus rotundus* (Purple nut sedge), *Dactyloctenium aegyptiacum* (Crow's foot grass), and *Commelina benghalensis* (Day flower). Different treatments of land configuration and weed management did not influence the weed density significantly. However, weed density was lower in raised bed and higher in flat sowing treatment. Pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS recorded the lowest number of weeds followed by imazethapyr @ 75 g/ha. The post-emergence herbicide, i.e. imazethapyr @ 75 g/ha, controlled *Cyperus rotundus* more effectively than pendimethalin.

Dry matter of weeds was significantly influenced by land configuration and weed management treatments (Table 1). At 55 DAS, the crop sown on raised bed significantly reduced the dry matter of weeds to the tune of 10.9 and 13.4% over ridge and flat sowing, respectively. At harvest, the raised bed and ridge sown crop recorded significantly lower dry matter of weeds than flat sown crop, which was 23.8 and 21.6% lower, respectively. This could be due to better crop growth in these treatments over the flat sowing. Weed control efficiency (WCE) was significantly higher in raised bed (78.4%) and ridge (78.1%) sowing than flat sown crop (68.5%).

As compared to weedy check, all herbicide treatments resulted in significantly lower dry matter of weeds, possibly due to not only by reducing the weed number but also the growth of weeds. Non-significant effect on weed count could be due to appearance of weeds at later stages, which were, however, not so vigorous in growth. At 55 DAS and harvest, application of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS recorded significantly lower dry matter of weeds than the other treatments and at par with imazethapyr @ 55 g/ha 15-20 DAS. Amongst the herbicide treatments, pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS recorded the lowest dry matter of weeds and it was followed by imazethapyr @ 75 g/ha. Imazethapyr has been reported to provide effective control of weeds in greengram (Singh *et al.* 2014, Singh *et al.* 2017), blackgram (Veeraputhiran *et al.* 2008, Aggarwal *et al.* 2014) and soybean (Virk *et al.* 2018). WCE was significantly higher in the treatment of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS (88.7%) and imazethapyr @ 55 g/ha 15-20 DAS (82.5%) than pendimethalin @ 0.75 kg/ha (53.8%). Similarly, Fayaz *et al.* (2017) also reported WCE of 83.6% and 81.0% with the application of pendimethalin 30 EC @ 1.0 kg/ha (PE) fb imazethapyr 10% SL @ 55 g/ha at 15-20 DAS and imazethapyr 10% SL @ 55 g/ha at 15-20

Table 1 Weed dry matter, weed control efficiency, nodulation (40 DAS) and growth (at harvest) of greengram as influenced by different land configuration and weed management treatments (pooled mean of two years)

Treatment	Dry matter of weeds		Weed control efficiency at harvest (%)	Number of nodules/ plant	Dry weight of nodules (mg/plant)	Plant height (cm)	Branches/ plant
	55 DAS (g/m ²)	At harvest (kg/ha)					
Land configuration							
Raised bed	114.3	1026	78.4	21.6	23.2	63.4	5.12
Ridge	128.4	1056	78.1	21.5	22.3	65.1	5.12
Flat	132.1	1347	68.5	20.6	20.8	59.7	4.54
CD (P=0.05)	13.9	116	5.0	NS	NS	1.2	0.35
Weed management							
Pendimethalin @ 0.75 kg/ha (PE)	85.3	1315	53.8	23.1	23.4	63.9	5.26
Pendimethalin @ 0.75 kg/ha (PE) + Imazethapyr @ 55 g/ha (POE) 15-20 DAS	15.7	244	88.7	22.2	23.9	61.9	5.00
Imazethapyr @ 55 g/ha (POE) 15-20 DAS	24.1	306	82.5	21.2	20.4	61.7	4.92
Weedy check	374.7	2707	-	18.6	20.6	63.5	4.52
CD (P=0.05)	15.5	182	7.4	2.2	NS	1.6	NS

DAS, respectively. Pendimethalin does not control *Cyperus rotundus* and *Commelina benghalensis* effectively (Virk *et al.* 2018) that is why in the present study, due to the presence of these weed species, pendimethalin showed poor WCE.

Symbiotic parameters: The different treatments of land configuration did not affect the number and dry weight of nodules/plant significantly (Table 1). However, the number and dry weight of nodules/plant were higher in raised bed and ridge sowings than in flat sowing. The different treatments of weed management significantly affected the number of nodules/plant (Table 1). The application of pendimethalin @ 0.75 kg/ha recorded the highest nodule number/plant, which was significantly higher than weedy check but at par with other treatments. However, the nodule dry weight/plant was non-significant. Therefore, it can be assumed that the herbicides had no adverse effect on symbiotic parameters.

As *Rhizobium* infects plant roots through root hairs and thus it is hypothesized that herbicides affecting root hair development might interfere with nodulation. Raghavendra and Gundappagol (2017) reported that herbicides application had no significant variation in rhizobial population in the soil. Imazethapyr at 25, 40 and 75 g/ha showed negative effect on different symbiotic parameters such as nodule number, nodule dry weight and leghaemoglobin content as compared to two hand weeding in greengram (Singh *et al.* 2015). No negative effect of imazethapyr on symbiotic parameters in the present study could be due to more rainfall received (254.2 cm and 217.5 cm in two years) than in the study of Singh *et al.* (2015) (68.8 cm and 45.4 cm).

Effect on crop: The plant height, branches/plant (Table 1) and pods/plant (Table 2) were significantly influenced by different treatments of land configuration. These were recorded significantly higher in raised bed and ridge sowings than flat sowing treatment, which might be due to higher light interception in the crop canopy. However, seeds/pod and 100-seed weight were non-significantly affected by

different treatments of land configuration.

Treatments of land configuration influenced the biological yield, grain yield (except in 2015) and harvest index significantly (Table 2). Sowing of greengram on raised beds and ridges recorded significantly higher biological yield than flat sowing, which might be due to more growth in terms of plant height and number of branches. Raised bed and ridge sowings recorded significantly higher grain yield than flat sowing which could be due to improvement in the number of pods/plant. Further, raised bed sowing provided higher biological yield and grain yield than ridge sowing, possibly due to better distribution of plants, thereby causing less intra row competition among plants for various resources. Higher grain yield of crop sown on raised beds was reported by many researchers in pigeonpea (Kantwa *et al.* 2006) and greengram (Singh *et al.* 2011, Ram *et al.* 2018). Raised bed sown crop recorded the lowest harvest index, which might be due to higher biological yield.

The plant height (Table 1), pods/plant and seeds/pod (Table 2) were significantly influenced by weed management treatments. However, branches/plant and 100-seed weight were non-significantly influenced by weed management treatments. The plant height was recorded significantly higher in treatments of pendimethalin @ 0.75 kg/ha and weedy check than the treatments of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS and imazethapyr @ 55 g/ha 15-20 DAS. Higher plant height in pendimethalin @ 0.75 kg/ha and weedy check treatments could be due to more weed density and weed dry matter (Table 1) which resulted in more competition among the plants for sunlight. The pods/plant was recorded significantly higher in treatment of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS than treatments of weedy check and imazethapyr @ 55 g/ha 15-20 DAS, which was, however, at par with pendimethalin @ 0.75 kg/ha.

Weed management treatments influenced the biological

Table 2 Influence of different land configurations and weed management treatments on the yield attributes, biological yield, grain yield, harvest index and economics of greengram (pooled mean of two years)

Treatment	Pods/ plant	Seeds/ pod	100-seed weight (g)	Biological yield (kg/ha)	Grain yield (kg/ha)			Harvest index (%)	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
					2015	2015	Mean					
Land configuration												
Raised bed	15.7	11.4	3.33	4128	972	946	959	23.2	26687	57542	30854	2.14
Ridge	15.7	11.5	3.38	3780	932	912	922	24.4	26687	55346	28659	2.06
Flat	13.7	11.2	3.29	3391	852	799	826	24.3	24312	49547	25234	2.03
CD (P=0.05)	0.6	NS	NS	123	NS	65	27	0.2		2421	2421	0.09
Weed management												
Pendimethalin @ 0.75 kg/ha (PE)	16.9	11.4	3.28	4234	998	948	973	23.2	26108	58392	32284	2.23
Pendimethalin @ 0.75 kg/ha (PE) + Imazethapyr @ 55 g/ha (POE) 15-20 DAS	17.3	11.4	3.36	4011	1190	1041	1116	28.3	26933	66952	40019	2.48
Imazethapyr @ 55 g/ha (POE) 15-20 DAS	15.5	11.5	3.40	3681	868	932	900	24.4	25683	54022	28339	2.09
Weedy check	10.4	11.1	3.29	3141	619	621	620	19.9	24858	37212	12354	1.50
CD (P=0.05)	0.9	0.2	NS	267	136	109	97	2.8		5845	5845	0.22

yield; grain yield and harvest index significantly (Table 2). Application of pendimethalin @ 0.75 kg/ha recorded the highest biological yield, which was significantly higher than imazethapyr @ 55 g/ha 15-20 DAS and weedy check and at par with pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS. In 2015 and on mean basis, application of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS provided significantly higher grain yield than the other treatments. Higher grain yield in pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS was due to higher number of pods/plant, which might have been resulted due to better control of weeds as reflected in lower weed count and lower dry matter of weeds and higher WCE (Table 1). Fayaz *et al.* (2017) also reported that pendimethalin 30 EC @ 1.0 kg/ha (PE) + imazethapyr 10% SL @ 55 g/ha at 15-20 DAS recorded significantly higher grain yield of greengram than imazethapyr 10% SL @ 55 g/ha at 15-20 DAS, pendimethalin 30 EC @ 0.75/1.0 kg/ha (PE) and weedy check. Treatment of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS recorded significantly higher harvest index than the other treatments.

Interaction effects between land configuration and weed management treatments with respect to the grain yield were non-significant. However, raised bed and ridge sowings provided superiority over flat sowing under all weed management treatments.

Economic analysis: Greengram sown on raised bed gave the highest gross returns, net returns and B:C ratio, which was, however, statistically at par with ridge sowing but significantly higher than flat sowing (Table 2). Pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS gave the maximum gross returns, net returns and B:C ratio, which were significantly higher than the other treatments. Higher returns in these treatments were due to higher grain yields.

It can be concluded that sowing of greengram on raised bed land configuration along with application of pendimethalin @ 0.75 kg/ha (PE) + imazethapyr @ 55 g/ha 15-20 DAS was found to be effective for controlling weeds as well as improving the grain yield and providing higher net returns and B:C ratio.

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