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Influence of Weed Management Practices on Weed Density, Growth and Yield of Greengram (*Vigna radiata*)

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ABSTRACT

A field experiment was conducted during spring season of 2021 to study the effect of herbicides on weed control efficiency and yield attributes in greengram. The experiment consisting of seven treatments comprising four herbicide treatments (Pendimethalin 30 EC @ 500 g a.i./ha, pendimethalin 30 EC @ 1000 g a.i./ha, imazethapyr 10% SL @ 50 g a.i./ha and imazethapyr 10% SL @ 75 g a.i./ha) compared with hand weeding, weed free check and unweeded control. The weed species observed in experimental farm were *Digitaria*, *Dactyloctenium aegyptium*, *Cyperus iria*, *Cyperus rotundus* (Nut grass), *Cyperus difformis* and *Cyperus compressus*, *Chenopodium album*, *Parthenium hysterophorus*, *Medicago polymorpha* and *Anagallis arvensis*. The results showed that the grasses were predominant weed species followed by broadleaf weeds and sedges. Significantly lower weed density (2.27/m^2) and weed dry weight/m^2 (3.20 g) were recorded in weed free plot. The highest weed control efficiency (91%) was obtained with imazethapyr 10% SL @ 50 g a.i./ha. The maximum plant height (55 cm), number of branches per plant (16), number of leaves per plant (94.33), pod length (9.57 cm), number of pods per plant (24), number of seeds/pod (11.67), 1000-grain weight (44 g), grain yield (1100 kg/ha), straw yield (2116.67 kg/ha) and harvest index (36.45%) were recorded in weed free plots followed by hand weeding plot. The control plot produced the maximum number of weeds and the minimum plant height, number of branches/plant, number of leaves/ plant, pod length (cm), number of pods/plant, number of seeds/pod, 1000-grain weight, grain yield, straw yield and harvest index.

Key words : Weed free check, imazethapyr, pendimethalin, yield

INTRODUCTION

Pulses play an important role in Indian agriculture, as they improve soil physical and chemical condition and provide nutrition food and fodder to human and animals. India is a world's largest producer of pulses (Singh *et al.,* 2015). Increasing yield of pulse crops should be the top priority to fill up the existing gap in the requirement and availability of pulses. This will not only ensure food security but will also provide nutritional security, particularly to the large vegetarian population of our country (Nagender *et al.,* 2017). Greengram, also known as mungbean, belongs to Fabaceae family, is the fourth most widely produced pulse crop in India after chickpea, pigeonpea and blackgram. It can be grown during both rainy and summer seasons. Being a short duration crop, it fits well in traditional rice-wheat cropping systems and provides farmers with additional income (Singh *et al.*, 2018). Being a leguminous crop, it can play a major role in nitrogen fixation from 20-80 kg/ha (Patel *et al.*, 2016), thus improving system sustainability. Mungbean is the highest pulse crop for protein supplement in sub-tropical zones of the world. Greengram contains 51% carbohydrate, 24-26% protein, 4% minerals and 3% vitamin (Tamang *et al.,* 2015). Greengram is consumed as a good source of vitamin C and used for making some products like snacks, deserts and bean sprouts. However, one of the major constraints in mungbean production is weed competition. The losses of moonbeam yield due to weeds range from 65.4 to 79.0%. Gharde *et al.* (2018) reported that besides causing crop losses, weeds creating competition for nutrients, space, water, etc. reduced the crop yield and the quality of produce, hence, reduced the market value of the produce. The critical

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period of crop-weed competition in summer greengram is 15-30 days after sowing. Yield loss in greengram due to weeds is 31-58% under the irrigated conditions of Punjab (Kaur *et al.*, 2016). Some of the major weed species dominant in the greengram field are *Convolvulus arvensis, Amaranthus viridis, Chenopodium album, Physallis minima* and *Datura stramonium*, *Cynodon dactylon, Sorghum halepense, Conyza* spp., *Matricaria* spp., *Poa* spp. and *Cyperus rotundus* (Chauhan *et al.,* 2017). For the success of mungbean production in India, the role of weeding needs to be emphasized. The manual and mechanical weeding are laborious, time consuming and costly. Herbicides inhibit weed growth for considerable period after their application. Therefore, there is an urgent need to move from costly manual-mechanical weed control to an integrated weed control. Under such circumstances, chemical control of weeds may be the viable and cost-effective alternative for this crop (Verma *et al.,* 2017). Effective herbicide at appropriate rate may prove as an effective weed control method and replace conventional methods of weed control. But little information is available regarding the herbicide's that is suitable for either pre-sowing or post-sowing application in mungbean (Komal *et al.,* 2015). Looking into an urgent need of time, the present study was carried out to find out the suitable herbicides for controlling weeds associated with mungbean by pre-or post-sowing application and to evaluate the relative efficacy of herbicides on growth, yield and profitability of mungbean.

MATERIALS AND METHODS

The experiment was conducted at Research Farm of Agronomy at Lovely Professional University, Phagwara, during summer season 2021. Greengram variety SML 668 released by Punjab Agricultural University (PAU), Ludhiana was used as experimental material for this research. The experiment comprising seven treatments (Table 1) was laid out in randomized block design (RBD) with three replications. The crop was grown on ridges and the line sowing method was followed at 30 × 10 cm spacing. Crop was sown in summer season (Feb. to April 2021). All the cultural practices were followed as per Package & Practices of PAU, Ludhiana. The soil of experimental site was loamy sand in texture with pH 7.9. Recommended dose of fertilizer (12.5 kg N and 40 kg P_2O_5/ha) was applied at the time of land preparation through urea and SSP. Herbicides were applied as per the treatments. Pre-emergence herbicides were applied within 48 h of sowing and post-emergence herbicides were applied on 20th day after sowing. Intercultural operations, irrigation and spray of insecticides were applied as and when needed. Weed samples were taken from 1 m^2 area in each plot using quadrate method and weed population was recorded. Weed dry weight was recorded after oven drying at 65±5°C. Weed control efficiency (WCE) denoting the magnitude of weed reduction due to weed control treatments was expressed in percentage. Weed index was defined as the magnitude yield reduction due to presence of weeds in comparison with weed free check. In other words, weed index expressed the competition offered by weeds measured by % reduction in yield owing to their presence in the field. The growth and yield attributes viz., plant height, number of leaves/ plant, number of branches/plant, number of pods/plant, pod length and number of seeds/ pod were recorded at harvest.

Table 1. The seven weed treatments applied in the experimemt

Treatments	Combinations
T_0	Control (weedy check)
T_1	Hand weeding 20, 40 DAS
T_2	Pendimethalin 30 EC @ 500 g a.i./ha
T_3	Pendimethalin 30 EC @ 1000 g a.i./ha
T_4	Imazethapyr 10% SL @ 50 g a.i./ha
T_5	Imazethapyr 10% SL @ 75 g a.i./ha
T_6	Weed free

RESULTS AND DISCUSSION

The major weed flora observed in the experimental site were : *Echinochloa crusgalli, Celosia argentia, Phyllanthus niruri, Setaria glauca, Acrachne racemosa* and *Cynodon dactylon* (seen as grasses) and *Commelina benghalensis, Digera arvensis* and *Eragrostis* spp. as major broad-leaved weeds. The sedge, *Cyperus rotundus* was the most problematic weed in the experiment. The density of grassy weeds in greengram in different plots was recorded at 30, 45 and 60 days after sowing (DAS). Useful variation was observed in case of weed density of grasses under different

treatments at different durations. The data at 30 DAS indicated that weed free and hand weeding reduced the density of weeds as 2.93, 3.31/m^2 as compared to T_0–Control (4.50). T_6–Weed free, T_5–Imazethapyr 10% SL @ 75 g a.i./ha, T_2–Pendimethalin 30 EC @ 500 g a.i./ha, T_3–Pendimethalin 30 EC @ 1000 g a.i./ha and T_0–Control were statistically similar having no significant difference between them. At 45 DAS, there was significant variation in number of grassy weeds under different treatments. It was evident from the data that highest reduction (2.22/m^2) in the density of grassy weeds over control was recorded in case of T_6–Weed free. T_2 (Hand weeding) showed much superiority in the reduction of grassy weeds. On the other hand, T_3–Pendimethalin 30 EC @ 1000 g a.i./ha and T_5–Imazethapyr 10% SL @ 75 g a.i./ha showed comparable result to pendimethalin and imazethapyr in which density of grass weeds was 3.24 and 3.26/m^2. The maximum number of grassy weeds was (4.50) recorded under T_1 (Control). All treatments showed significantly better result over control. At 60 DAS, lowest number of grassy weeds (1.78/m^2) was observed in weed free. Nevertheless, the highest number of grasses (5.45/m^2) was recorded in control (T_1). The weed density of sedges was studied at 30, 45 and 60 DAS. At 30 DAS, minimum number of sedges (5.29/m^2) was recorded in T_7–Weed free and maximum number of sedges (7.52/m^2) in T_1–Control and T_5 (7.18/m^2).

At 45 DAT, a remarkable variation was observed in density of sedges/m^2 under different treatments (Table 2). The sedges density varied from 3.71-8.28 m^{-2}. The lowest density of sedges (3.71/m^2) was recorded in case of T_2–Hand weeding, followed by 3.81, 3.96 and 4.23/m^2 in T_6–Weed free, T_5–Imazethapyr 10% SL @ 75 g a.i./ha and T_3–Pendimethalin 30 EC @ 1000 g a.i./ha). At 60 DAT, there was significant reduction in density of sedges. The number of sedges/m^2 ranged from 2.73-9.91/m^2. The lowest number of sedges (2.73/m^2) was observed in case of T_7–Weed free which was at par with T_5–Imazethapyr 10% SL @ 75 g a.i./ha (2.94/m^2) followed by Imazethapyr 100%/ha. The maximum number of sedges (9.91/m^2) was recorded under control. The best results were shown by weed free and imazethapyr as compared to others.

The density of broadleaf weeds was recorded at 30, 45 and 60 DAS. At 30 DAS, the broadleaf weed density ranged from 2.73-4.45/m^2. The lowest density (2.73/m^2) was observed in T_2 (hand weeding) followed by T_6 (weed free). Maximum density (4.45/m^2) was observed in case of control. All treatments were significantly superior over control. At 45 DAS, the best result in case of the density of broadleaf weeds (2.49/m^2) was recorded in T_2 (hand weeding). The maximum number of broadleaf weeds (4.54/m^2) was recorded under T_1 (Control). At 60 DAS, there was a remarkable variation in density of broadleaf weeds. The density of broadleaf weeds/m^2 varied from 1.64-4.89/m^2. Lowest density (1.64/m^2) of

Table 2. Effect of herbicides on density of weeds at 30, 45 and 60 DAS (number/m^2)

Treatments	Grasses (No./m^2)			Sedges (No./m^2)			Broadleaf weeds (No./m^2)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T_0–Control	4.50 (16)^{a}	4.89 (19.33)^{a}	5.45 (24.67)^{a}	7.52 (49.33)^{a}	8.28 (60.67)^{a}	9.91 (88.67)^{a}	4.45 (15.67)^{a}	4.54 (16.33)^{a}	4.89 (19.33)^{a}
T_1–Hand weeding 20, 40 DAS	3.31 (8)^{b}	2.64 (4.67)^{c}	2.22 (3)^{de}	5.56 (25.67)^{cd}	3.71 (10.33)^{d}	4 (12.33)^{b}	2.73 (5)^{c}	2.49 (4)^{d}	2.22 (3)^{c}
T_2–Pendimethalin 30 EC @ 500 g a.i./ha	4.35 (18)^{a}	3.24 (7.67)^{b}	2.49 (4)^{cd}	6.13 (31.67)^{bcd}	4.23 (14)^{d}	3.26 (7.67)^{cd}	4.10 (13)^{ab}	2.73 (5)^{cd}	2.13 (2.67)^{c}
T_3–Pendimethalin30 EC @ 1000 g a.i./ha	4.37 (15)^{a}	3.76 (10.67)^{b}	2.88 (5.67)^{bc}	6.24 (6.40)^{bc}	5.52 (25.33)^{b}	4.10 (13)^{b}	4.33 (14.67)^{ab}	3.66 (10)^{b}	2.88 (5.67)^{b}
T_4–Imazethapyr 10% SL @ 50 g a.i./ha	3.96 (12)^{a}	3.26 (7.67)^{b}	2.13 (2.67)^{de}	7.18 (7.42)^{a}	3.96 (12)^{d}	2.94 (6)^{d}	3.91 (11.67)^{b}	2.82 (5.67)^{cd}	1.88 (2)^{cd}
T_5–Imazethapyr 10% SL @ 75 g a.i./ha	4.28 (13)^{a}	3.81 (11)^{b}	3.08 (6.67)^{b}	6.76 (6.63)^{ab}	4.85 (19)^{c}	3.60 (9.67)^{bc}	4 (12.33)^{ab}	3.26 (7.67)^{bc}	2.73 (5)^{b}
T_6–Weed Free	2.93 (4)^{b}	2.22 (3)^{c}	1.78 (1.67)^{e}	5.30 (4.47)^{d}	3.81 (11)^{d}	2.73 (5)^{d}	3 (6.33)^{c}	2.79 (5.33)^{cd}	1.64 (1.33)^{d}

Figures in parentheses are original values as observation, while without parentheses are transformed ($\sqrt{x+0.5}$) values.

broadleaf weeds was observed in T_6 (weed free). It was statistically superior over all other treatments. The maximum number of broad-leaf weeds (4.89/m^2) was noticed under control. The results indicated that hand weeding at 20 and 40 DAS continued its effect on weeds which resulted in lower weed density and weed dry matter. However, application of pendimethalin and imazethapyr as pre-emergence alone had failed to control weeds at later stages due to heavy rains after 30 DAS. These findings showed that adoption of either hand weeding at 20 and 40 DAS or pre-emergence application of herbicides followed by one hand weeding at 20 DAS was essential at 20 DAS for effective control of weeds.

The weeds were collected at 30 DAS to record their dry weight. The variation in weed dry weight was significant. The weed dry weight ranged from 2.92-4.91 g/m^2. Lowest weed biomass (2.92 g/m^2) was recorded in weed free treatment. However, significantly highest weed biomass (4.91 g/m^2) was recorded in control followed by T_1, T_4 and T_3 as 4.81, 4.74 and 4.69 g/m^2. All the treatments showed significantly better results as compared to control but weed free proved best in reducing the weed biomass. At 60 DAS, a noticeable reduction in dry weight of weeds was recorded. The lowest weed biomass (2.18 g/m^2) was recorded in T_3 (Imazethapyr 10% SL @ 50 g a.i./ha), followed by T_6 (weed free) (2.27). The maximum weed biomass (6.34 g/m^2) was recorded in case of control.

Weed control efficiency (WCE) was calculated to measure the effectiveness of weed control treatment to eradicate weeds (Table 3). The WCE varied from 0-69.63%. At 30 DAS, significantly highest (69.63%) WCE was recorded in weed free. However, lowest weed control efficiency (4.76%) was recorded in T_3 (Pendimethalin 30 EC @ 1000 g a.i./ha) followed by T_4 (Imazethapyr 10% SL @ 50 g a.i./ha) and T_5 (Imazethapyr 10% SL @ 75 g a.i./ha). The treated plots showed significantly better results over control. At 60 DAS, significantly highest WCE (91.59%) was recorded in imazethapyr 10% SL @ 50 g a.i./ ha followed by T_6 (weed free) (78.90%). Lowest weed control efficiency (18.62%) was recorded in T_2 (Pendimethalin 30 EC @ 500 g a.i./ha). Lowest weed control efficiency and highest weed index % were recorded in weed free, which might be due to elimination of weeds by manual weeding and herbicides. The findings confirmed the results of Verma *et al.* (2017). These results indicated that between 15 - 20 DAS any treatment viz., either hand weeding or imposition of some post-emergence herbicide will improve the weed control efficiency of crops. This was due to the removal of weeds that emerged at later stages of crop growth by hand weeding or application of post-emergence herbicides at 15-20 DAS. Effect on dry weight of weeds and seed yield under these treatments might have been responsible for excellent weed indices in various situations with different pulse crops. The lowest weed index values were found in T_6 (0.00) followed by T_1 (2.91) and T_3 (9.09). However, T_0 treatment recorded highest weed index (46.16).

In the T_1 hand weeding significantly recorded the highest plant height (55 cm) followed by T_6 (53 cm) and the lowest plant height was recorded in T_0 (36 cm). The crop was adversely affected by weeds in un-weeded control due to heavy competition with crop for nutrients, moisture, space and light, which suppressed crop growth. In different treatments T_6 and T_4

Table 3. Effect of herbicides on weed dry weight, weed control efficiency, weed index and weed control index

Treatments	Weed dry weight (%)		Weed control efficiency (%)		Weed index (%)	Weed control index (%)
	30 DAS	60 DAS	30 DAS	60 DAS		
T_0–Control	4.91 (19.53)^a	6.34 (34.13)^a	0	0	46.36	0
T_1–Hand weeding 20, 40 DAS	3.34 (8.10)^{bc}	2.71 (5)^{cd}	58.52	85.35	2.91	46.2
T_2–Pendimethalin 30 EC @ 500 g a.i./ha	4.81 (18.60)^a	2.99 (6.27)^{bc}	4.76	18.62	14.82	30.6
T_3–Pendimethalin 30 EC @ 1000 g a.i./ha	3.62 (9.77)^b	3.53 (9.30)^b	49.77	72.75	31.82	36.4
T_4–Imazethapyr 10% SL @ 50 g a.i./ha	4.69 (17.63)^a	2.18 (2.87)^d	9.72	91.59	9.09	38.9
T_5–Imazethapyr 10% SL @ 75 g a.i./ha	4.74 (18.07)^a	3.19 (7.30)^{bc}	7.47	78.61	28.45	29.5
T_6–Weed free	2.92 (5.93)^d	2.27 (3.20)^d	69.63	78.90	0	53.9

recorded the highest number of branches (15) followed by T_2 (14.6) and T_0 control recording lower number of branches (11). The data on number of pods per plant indicated significant differences due to influence of treatments and crop weed competition (Table 4). The number of pods/plant was significantly higher in T_1 and T_6 (24 and 23.33) followed by T_3 (22.33). However, the lowest number of pods was recorded in T_0 (13.33). Seed yield in greengram was significantly influenced due to different weed management treatments. All the weed control treatments recorded significantly higher seed yield than weedy check. The highest seed yield (1100 and 1068 kg/ha) was recorded in T_6 (weed free) and T_1 (hand weeding) treatment. These treatments were found significantly superior to rest of the treatments. This significant increase in seed yield was due to effective weed control and high yielding parameters like number of seeds/pod, number of pods/plant and 100-seed weight. The next best treatment registering higher seed yield was application of imazethapyr 10% SL @ 75 g a.i./ha. The increase in yield attributes and yield under these treatments may be attributed to concomitant reduction in weed dry matter, which accounted for reduction in crop-weed competition, and provided congenial environment to the crop for better reproductive potential. The results are in agreement with the findings of Patel *et al.* (2016).

Table 4. Effect of herbicides on growth and yield parameters in greengram

Treatments	Plant height (cm)	Branches/ plant	Pod length (cm)	Pods/ plant	Seeds/ pod	1000-seed weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T_0–Control	36.00±1.63^{d}	11.00±0.82^{d}	5.70±0.45^{e}	13.67±1.25^{d}	6.00±0.82^{d}	25±2.45^{d}	590±29.44^{e}	1113.33±33.99^{e}	31.22
T_1–Hand weeding 20, 40 DAS	55.00±1.63^{a}	16.00±0.82^{a}	9.57±0.66^{a}	24.00±1.63^{a}	10.67±0.94^{ab}	42±1.63^{a}	1068±22.48^{a}	2056.67±33.00^{a}	34.92
T_2–Pendimethalin 30 EC @ 500 g a.i./ha	45.33±2.05^{b}	14.33±0.47^{b}	8.43±0.65^{b}	20.00±0.82^{b}	9.00±0.82^{bc}	34±1.63^{bc}	937±12.47^{c}	1736.67±2 6.25^{c}	32.55
T_3–Pendimethalin 30 EC @ 1000 g a.i./ha	40.33±1.25^{c}	12.33±0.47^{C}	6.80±0.29^{c}	17.00±1.63^{c}	7.33±1.25^{cd}	31±1.63^{c}	750±32.66^{d}	1390.00±8.16^{d}	31.90
T_4–Imazethapyr 10% SL@ 50 g a.i./ha	50.67±2.49^{a}	15.00±0.82^{a}	8.13±0.34^{b}	22.33±1.25^{ab}	10.67±1.25^{ab}	36.67±2.05^{b}	1000±16.33^{b}	1950.00±40.82^{b}	33.80
T_5–Imazethapyr 10% SL 75 g a.i./ha	43.67±2.05^{bc}	11.33±1.25^{c}	5.83±0.25^{cd}	16.67±1.70^{c}	8.00±1.63^{cd}	31.33±1.70^{c}	787±20.55^{d}	1413.33±26.25^{d}	33.10
T_6–Weed free	53.00±2.16^{a}	15.00±0.82^{a}	8.53±0.39^{b}	23.33±1.25^{a}	11.67±0.47^{a}	44±2.1 6^{a}	1100±8.16^{a}	2116.67±102.74^{a}	36.45

CONCLUSION

All the herbicides irrespective of mode of application reduced the weed density over control. The best results were obtained in weed free or hand weeding but it proved a costly method. This study showed that as an alternative with respect to yield of greengram, weed control, as well as benefit : cost ratio gave comparable result to weed free. However, there is need for further investigation on this aspect.

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