Short communication

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Effect of weed management on growth, yield and nutrient uptake of greengram

Komal, S.P. Singh* and R.S. Yadav

College of Agriculture Bikaner, SK Rajasthan Agriculture University, Bikaner, Rajasthan 334 006

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Greengram is one of the major pulse crops in India which is cultivated in arid and semi-arid region. It is cultivated in nearly 3.35 million hectare area with the production of 1.82 million tones and average productivity of 512 kg/ha. Lack of improved cultural practices, cultivation on marginal and sub marginal lands of poor fertility, inadequate fertilization, monsoon dependent cultivation, high sensitivity to pests and diseases and non-availability of suitable varieties are the major factors responsible for low yield of greengram. Along with these, weed infestation is one of the major constraints in greengram cultivation. Being a rainy season crop, it is invaded by a large number of fast growing weeds. The critical period of weed competition in greengram is during the first 30–40 days after sowing. Weeds grow quickly during this time taking the advantage of crops' slow initial growth.

Weeding and hoeing are common cultural and manual weed management methods for greengram. Manual weeding at right stage is difficult, time consuming and expensive due to intermittent rainfall during rainy season and scanty labour, therefore, farmers rarely adopt manual weeding for weed control. Under such situation, herbicides use with suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable do complete weed control because of their selective kill. Their use can be made more effective, if supplemented with hand weeding or hoeing *etc*. A judicious combination of chemical and cultural methods of weed control would not only reduce the expenditure on herbicides but would benefit the crop by providing proper aeration and conservation of moisture (Prakash *et al*. 1991). Thus, an experiment was conducted with an objective to identify a judicious combination of chemical and cultural methods for controlling weeds in greengram.

***Corresponding author:** spbhakar2010@gmail.com

The experiment was conducted during *Kharif* season of 2013 at Agriculture Research Station, SK Rajasthan Agricultural University, Bikaner, Rajasthan to identify the suitable integrated weed management method for managing weeds in greengram. The experiment was laid out in randomized block design with 16 treatments replicated thrice. The soil of the experimental field was loamy sand **(**84.1% sand, 7.5% silt and 8.0% clay) with poor in organic carbon (0.08), low in available nitrogen (78.0 kg/ha), medium in available phosphorus (22.0 kg/ha) and potassium (210.0 kg/ha). The soil was slightly alkaline in reaction with pH 8.22.

Experimental treatments comprised weedy check, weed free, pendimethalin 0.75 kg/ha as pre-emergence, pendimethalin 0.75 kg/ha as pre-emergence + one hand weeding at 30 DAS, imazethapyr 40 g/ha at 20 DAS as post-emergence, imazethapyr 50 g/ha at 20 DAS as post-emergence, imazethapyr 60 g/ha at 20 DAS as post-emergence , imazethapyr 40 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS, imazethapyr 50 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS, imazethapyr 60 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS, imazethapyr + imazamox 40 g/ha at 20 DAS as post-emergence, imazethapyr + imazamox 60 g/ha at 20 DAS as post-emergence, pendimethalin 0.75 kg/ha as pre-emergence + imazethapyr 40 g/ha at 20 DAS as post-emergence, imazethapyr + imazamox 40 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS, imazethapyr + imazamox 60 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS and pendimethalin 0.75 kg/ha as pre-emergence + imazethapyr + imazamox 40 g/ha at 30 DAS as post-emergence.

Greengram variety '*SML-668*' was sown with seed rate of 20 kg/ha and plant spacing of 30 × 10 cm. The recommended dose of fertilizer 20:40:40 kg/ha N, P_2O_5 and K_2O was applied as basal dose through

urea, single super phosphate and muriate of potash respectively. Protective irrigations were applied whenever it was necessary during the crop growth. Pendimethalin was applied one day after sowing as pre emergence whereas imazethapyr was applied 20 and 30 DAS as post emergence as per the treatment with knapsack sprayer. Weed free was achieved by two hand weedings at 20 and 40 DAS. Randomly five plants were selected from each plot and regular biometric observations of crop and weed parameters were recorded from 30 DAS upto harvest. Weed density(no./m^2) was recorded by putting a quadrate of 0.25 m^2 at two random spots in each plot and after drying them in hot air oven (65^0 C for 48 hours) weed dry weight (g/m^2) was recorded. Weed density was subjected to $\sqrt{x+0.5}$ transformation. Weed control efficiency was estimated on the basis of reduction in weed weight in comparison with unweeded control and expressed as an index taking weed free as 100% efficiency. Weed index refers to reduction in yield due to presence of weeds in comparison to the weed free treatment plot yield. The experimental plot size was 3.40 x 2.40 m^2. Yields were harvested from net plot. For economic study, prevailing market price was used for different outputs and inputs.

Weed flora

Predominant weeds in experimental greengram field were: *Amaranthus spinosus*, *Digera arvensis*, *Trianthema portulacastrum*, *Gisekia poredious*, *Euphorbia hirta*, *Aristida depressa*, *Portulaca oleracea*, *Cenchrus biflorus*, *Cleome viscosa*, *Tribulus terrestris*, *Corchorus tridense*, *Cyperus rotundus*, *Eleusine verticillata*, *Eragrastris tennela* and *Aerva tomentosa*.

All the treatments were responsible for significant reduction in weed density and dry weight of weeds over control. Weed free treatment resulted in lowest weed density and dry weight of weeds. However, treatment pendimethalin 0.75 kg/ha as pre emergence + imazethapyr + imazamox 40 g/ha at 30 DAS as post-emergence and imazethapyr + imazamox 60 g/ha at 20 DAS as post-emergence + hand weeding at 40 DAS were found to be at par with each other and recorded significantly least number of weed and weed dry matter. Pendimethalin 0.75 kg/ha as pre emergence + imazethapyr + imazamox 40 g/ha at 30 DAS as post-emergence was found next superior treatment after weed free in respect of all weed parameters. This might be due to control of weeds during early growth stage by pre-emergence application of pendimethalin which prevented emergence of monocot and grassy weeds by inhibiting root and shoot growth, while post emergence application of imazethapyr + imazamox was responsible for inhibition of acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) in broad-leaved weeds which caused destruction of these weeds at 3-4 leaf stage.

The treatment combination of pre- and post-applied herbicide after sowing and 30 DAS was able

Table 1. Effect of different weed management practices on weed parameters in greengram at harvest

Treatment	Weed density (no/m^2)	Weed dry weight (g/m^2)	Weed control efficiency (%)	Weed index (%)
Pendimethalin 0.75 kg/ha	2.81 (7.42)	6.33	89.0	14.1
Pendimethalin 0.75 kg/ha + HW 30 DAS	1.04 (0.59)	0.54	98.8	2.40
Imazethapyr 40 g/ha 20 DAS	1.90 (3.15)	5.60	93.8	19.1
Imazethapyr 50 g/ha 20 DAS	1.88 (3.09)	5.70	94.0	16.4
Imazethapyr 60 g/ha 20 DAS	1.87 (3.00)	5.72	94.1	16.8
Imazethapyr 40 g/ha 20 DAS + HW 40 DAS	1.10 (0.71)	1.49	98.3	12.1
Imazethapyr 50 g/ha 20 DAS + HW 40 DAS	1.00 (0.50)	1.15	98.5	10.3
Imazethapyr 60 g/ha 20 DAS + HW 40 DAS	1.17 (0.86)	2.13	98.6	9.82
Imazethapyr + issmazamox 40 g/ha 20 DAS	0.96 (0.43)	0.29	99.4	15.4
Imazethapyr + imazamox 60 g/ha 20 DAS	0.91 (0.32)	0.21	99.5	14.6
Pendimethalin 0.75 kg/ha + imazethapyr 40 g/ha 20 DAS	0.90 (0.31)	0.30	99.5	2.88
Imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	0.83 (0.19)	0.39	99.6	7.51
Imazethapyr + imazamox 60 g/ha 20 DAS + HW 40 DAS	0.75 (0.06)	0.15	99.8	6.07
Pendimethalin 0.75 kg/ha + imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	0.75 (0.06)	0.06	99.8	4.79
Weedy check (W_1)	8.14 (65.8)	46.9	-	50.6
Weed free (W_2)	0.71 (0.00)	0.00	100.0	-
LSD (P=0.05)	0.17	0.46		

HW= Hand weeding; DAS=Day after sowing

to control the further infestation of weeds in greengram crop. Further the crop covers the soil surface and smothers the growth of weeds results into least number of weeds at harvest.

Highest weed control efficiency and lowest weed index percentage were observed in weed free treatment. Besides weed free, treatments pendimethalin 0.75 kg/ha as pre-emergence + imazethapyr + imazamox 40 g/ha at 30 DAS as post-emergence, imazethapyr + imazamox 60 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS and imazethapyr + imazamox 40 g/ha at 20 DAS as post-emergence + one hand weeding at 40 DAS recorded lower weed index 4.79, 6.07 and 7.51 and

Table 2. Effect of different weed management practices on growth and yield parameters in greengram

Treatment	Plant height (cm)	Branches /plant	Dry matter accumulation (g/plant)	Dry weight of nodules at 50 DAS (mg/plant)	Pods/ plant (no.)	Seeds / pod (no.)
Pendimethalin 0.75 kg/ha	64.5	4.16	14.4	25.5	26.1	5.61
Pendimethalin 0.75 kg/ha + HW 30 DAS	64.7	4.17	14.5	27.4	27.5	5.89
Imazethapyr 40 g/ha 20 DAS	59.1	3.77	12.8	25.6	25.4	5.50
Imazethapyr 50 g/ha 20 DAS	59.2	3.80	13.2	26.2	25.5	5.65
Imazethapyr 60 g/ha 20 DAS	59.6	3.81	13.0	26.4	25.7	5.57
Imazethapyr 40 g/ha 20 DAS + HW 40 DAS	61.0	3.98	13.4	26.5	26.4	5.65
Imazethapyr 50 g/ha 20 DAS + HW 40 DAS	61.4	4.01	13.8	26.5	26.6	5.69
Imazethapyr 60 g/ha 20 DAS + HW 40 DAS	61.5	4.03	14.1	27.0	26.6	5.71
Imazethapyr + issmazamox 40 g/ha 20 DAS	60.2	3.87	13.3	27.7	25.9	5.59
Imazethapyr + imazamox 60 g/ha 20 DAS	60.5	3.90	13.2	27.8	26.0	5.60
Pendimethalin 0.75 kg/ha + imazethapyr 40 g/ha 20 DAS	60.7	3.93	13.2	25.8	27.5	5.87
Imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	62.1	4.06	14.1	28.1	27.0	5.75
Imazethapyr + imazamox 60 g/ha 20 DAS + HW 40 DAS	62.3	4.10	14.2	28.2	27.1	5.81
Pendimethalin 0.75 kg/ha + imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	63.4	4.12	14.3	27.2	27.1	5.83
Weedy check (W_1)	46.6	2.97	7.90	20.2	19.2	4.52
Weed free (W_2)	65.2	4.21	14.8	29.5	27.8	5.94
LSD (P=0.05)	7.40	0.50	2.62	3.05	3.24	0.50

HW= Hand weeding; DAS=Day after sowing

Table 3. Effect of different weed management practices on yield and economics in greengram

Treatment	Seed yield (t/ha)	Straw yield (t/ha)	Gross return (x10^3 `/ha)	Net returns (x10^3 `/ha)	B:C ratio
Pendimethalin 0.75 kg/ha	1.08	2.82	64.15	40.70	2.74
Pendimethalin 0.75 kg/ha + HW 30 DAS	1.22	3.11	72.76	47.99	2.94
Imazethapyr 40 g/ha 20 DAS	1.01	2.74	60.48	37.82	2.67
Imazethapyr 50 g/ha 20 DAS	1.05	2.81	62.43	39.69	2.74
Imazethapyr 60 g/ha 20 DAS	1.04	2.76	62.16	39.32	2.72
Imazethapyr 40 g/ha 20 DAS + HW 40 DAS	1.10	2.90	65.60	41.62	2.74
Imazethapyr 50 g/ha 20 DAS + HW 40 DAS	1.12	2.95	66.96	42.88	2.78
Imazethapyr 60 g/ha 20 DAS + HW 40 DAS	1.13	2.95	67.30	43.13	2.78
Imazethapyr + imazamox 40 g/ha 20 DAS	1.06	2.82	63.18	40.69	2.81
Imazethapyr + imazamox 60 g/ha 20 DAS	1.07	2.83	63.76	41.17	2.82
Pendimethalin 0.75 kg/ha + imazethapyr 40 g/ha 20 DAS	1.22	3.11	72.43	48.11	2.98
Imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	1.16	3.01	69.01	45.19	2.90
Imazethapyr + imazamox 60 g/ha 20 DAS + HW 40 DAS	1.18	3.03	70.06	46.14	2.93
Pendimethalin 0.75 kg/ha + imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	1.19	3.08	71.02	46.86	2.94
Weedy check	0.62	1.69	36.97	15.19	1.70
Weed free	1.25	3.18	74.54	50.10	3.05
LSD (P=0.05)	0.24	0.58		10.40	0.53

HW= Hand weeding; DAS=Day after sowing

higher weed control efficiency 99.8, 99.8, 99.6 and 98.6%. This might be due to elimination of weeds by manual weeding and interculturing or by herbicides. The integrated effect on dry weight of weeds and seed yield under these treatments might have been responsible for excellent weed indices. These findings are akin to report of Bhandari *et al.* (2004). Lowest weed control efficiency and highest weed index percentage were recorded in weed free.

Weed free treatment recorded significantly taller plants and higher dry matter production and seed yield/ha over all the other treatments (Table 2 and 3). This was followed by treatment pendimethalin 0.75 kg/ha as pre-emergence + hand weeding at 30 DAS. However in respect of pods/plant and seed/pod weed free and pendimethalin 0.75 kg/ha as pre-emergence + hand weeding at 30 DAS were found at par with each other. This might be due to minimizing the competition of weeds with main crop for resources *viz.* space, light, nutrients and moisture with adaption of effective weed control methods. Thus, reduced crop- weed competition resulted into overall improvement in crop growth as reflected by plant height and dry matter accumulation consequently resulted into better development of reproductive structure and translocation of photosynthates to the sink. The results corroborate with the findings of Singh *et al*. (1994) and Yadav *et al*. (2014). Significantly lower value of growth parameters *viz.* plant height, dry weight of nodules and number of branches/plant and yield attributing characters *viz.* pods/plant, seeds/pod seed yield and straw yield were recorded in treatment weed free. This might be due to severe competition by weeds for resources, which made the crop plant inefficient to take up more moisture, nutrients and ultimately growth was adversely affected due to less supply of carbohydrates. Similar findings was observed by Panwar *et al.* (1982), Singh and Chaudhary (1992) and Malliswari *et al.* (2008).

The monetary returns were found to be significantly influenced by different weed control treatments (Table 3). The maximum gross returns of ` 74,544/ha, net returns of ` 50,102/ha and benefit: cost ratio (3.05) was obtained with weed free treatment. Among herbicide weed control treatments maximum gross return (` 72,764/ha) was recorded with treatment pendimethalin 0.75 kg/ha as pre-emergence + hand weeding at 30 DAS whereas maximum net returns (` 48,108/ha) and benefit : cost ratio (2.98) were recorded with treatment pendimethalin 0.75 kg/ha as pre-emergence + imazethapyr 40 g/ha at 30 DAS as post-emergence. This might be due to the cost of cultivation of greengram crop was increased in treatment pendimethalin 0.75 kg/ha as pre-emergence + hand weeding at 30 DAS due to the higher need of human labours and their higher wages. This cost was reduced in treatment pendimethalin 0.75 kg/ha pre-emergence + imazethapyr 40 g/ha at 30 DAS as post-emergence by using herbicides to effective control of weeds with minimizing human labours. These

Table 4. Effect of different weed management practices on nutrient uptake by crop and weeds in greengram

Treatment	Nutrient uptake (kg/ha)					
	Crop			Weeds		
	N	P	K	N	P	K
Pendimethalin 0.75 kg/ha	79.5	10.5	79.7	8.68	1.68	7.01
Pendimethalin 0.75 kg/ha + HW 30 DAS	94.2	12.1	91.6	0.73	0.14	0.59
Imazethapyr 40 g/ha 20 DAS	74.2	9.86	75.8	6.73	1.33	5.60
Imazethapyr 50 g/ha 20 DAS	76.9	10.2	78.3	6.84	1.36	5.66
Imazethapyr 60 g/ha 20 DAS	76.4	10.1	77.2	6.85	1.24	5.13
Imazethapyr 40 g/ha 20 DAS + HW 40 DAS	81.8	10.8	82.0	1.76	0.37	1.53
Imazethapyr 50 g/ha 20 DAS + HW 40 DAS	84.3	11.0	84.1	1.36	0.29	1.21
Imazethapyr 60 g/ha 20 DAS + HW 40 DAS	85.2	11.1	84.7	2.55	0.54	2.29
Imazethapyr + imazamox 40 g/ha 20 DAS	78.4	10.3	78.9	0.39	0.08	0.32
Imazethapyr + imazamox 60 g/ha 20 DAS	79.3	10.5	79.5	0.28	0.05	0.22
Pendimethalin 0.75 kg/ha + imazethapyr 40 g/ha 20 DAS	94.0	12.2	90.9	0.37	0.07	0.31
Imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	88.6	11.4	86.9	0.47	0.10	0.40
Imazethapyr + imazamox 60 g/ha 20 DAS + HW 40 DAS	90.4	11.6	87.8	0.17	0.04	0.17
Pendimethalin 0.75 kg/ha + imazethapyr + imazamox 40 g/ha 20 DAS + HW 40 DAS	91.1	11.8	89.3	0.08	0.02	0.07
Weedy check	45.0	6.02	46.3	61.9	12.1	51.3
Weed free	97.2	12.6	94.6	0.00	0.00	0.00
LSD (P=0.05)	19.1	2.36	16.7	0.62	0.12	0.64

HW = Hand weeding; DAS = Day after sowing

findings are in close vicinity with those reported by Sardana *et al.* (2006), Kalhapure *et al.* (2013) and Yadav *et al.* (2014). Weedy check recorded lowest gross monetary return (` 36,974/ha), net monetary return (` 15,188/ha) and benfeit: cost ratio (1.70).

All weed control treatments were almost equally important in controlling weeds and improving crop yield. Weed free treatment was superior most with respect to yield (1.25 t/ha), yield attributes, quality and net profit (` 50,102/ha) and B: C ratio (3.05). The next best treatment with respect to net returns (` 48,108/ha) and B:C ratio (2.98) was found pendimethalin 0.75 kg/ha as pre-emergence + imazethapyr 40 g/ha at 20 DAS as post-emergence.

Significant decrease in total N, P and K uptake by weeds were recorded due to all weed management practices over weedy check (Table 4). The nil uptake of N, P and K by weeds was recorded with weed free which was at par with pendimethalin at 0.75 kg/ha as pre-emrgence + imazethapyr + imazamox at 40 g/ha at 30 DAS as post-emergence. Reduced nutrient uptake by weeds under the influence of different weed control measures had been also reported by Chhokar *et al.* (1995) and Chhodavadia *et al.* (2013)

All weed control treatments significantly increased N, P and K uptake by seed and straw of greengram over weedy check. Weed free treatment resulted in significantly highest total uptake of N (97.16 kg/ha), P (12.56 kg/ha) and K (94.56 kg/ha) by the crop compared to weedy check (44.97, 12.56 and 94.56 kg/ha), respectively.

SUMMARY

A field experiment was conducted during *Kharif* of 2013 at Agriculture Research Station, SK Rajasthan Agricultural University, Bikaner, Rajasthan, India with combination of 16 weed control treatments in three replications. Weed free check (two hand weeding at 20 and 40 DAS) was found most effective to control weeds in greengram and recorded lowest weed density, weed dry matter and weed index and highest weed control efficiency. It was also recorded significantly highest growth and yield attributes in greengram over all the other treatments, *viz*. plant height, dry weight of nodules, dry matter accumulation, number of pods/plant, seeds/pod and seed yield/ha. The maximum net return of ` 50,102/ ha and B: C ratio (3.05) was recorded under weed free treatment. Among the different herbicides, pre-emergence application of pendimethalin 0.75 kg/ha + post-emergence application of imazethapyr 40 g/ha at 30 DAS recorded significantly higher net returns of ` 48,108/ha and B:C ratio (2.98).

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