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Efficacy of herbicides on weed management in green gram (*Vigna radiata* L.) in semi arid eastern plain zone of Rajasthan

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ABSTRACT

A field experiment was conducted continuously for three years during kharif season from 2013 to 2015 at Rajasthan Agriculture Research Institute, Durgapura Jaipur to evaluate the efficacy of herbicides for controlling weeds associated with green gram (RMG492). The nine treatments were tested under randomized block design with three replications. Weeds were collected at harvest stage from 1 m^2 area of each plot. Among the treatments, application of pendimethlin 30EC +Imazathapyar 2EC(ready mix) @1.0 kg ai ha^{-1}as pre emergence followed by one manual weeding at 25-30 days after sowing(T_7) produced significantly higher seed (655.5kg ha^{-1}) and stover (1078kg ha^{-1}) yield of green gram as compared to other treatments(T_1,T_2,T_3,T_4 and T_9) and however, it was found at par with treatments T_5,T_6 and T_8. The higher plant height (41.1cm), branches/plant (7.6), pods/plant (18.6), seeds/pod (9.3), test weight (37.9g) were also obtained with T_7 treatment along with higher weed control efficiency (90.45%). The lower weed counts (5.5per m2), weed dry matter (8.4g/ m^2), weed index and weed infestation along with higher net return (Rs21792) and B: C ratio (2.0) was also observed with this treatment (T_7).

INTRODUCTION

The pulses constitute an important group of crops in Indian Agriculture, as they improve physical condition of soil and provide nutritious food and fodder. India has a distinction of being world's largest producers of pulses. 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. Among the grain legumes, green gram ranks third after chickpea and pigeonpea in respect of production, and it can be grown throughout the year over a wide range of agro-climatic zones of the country. Mungbean (*Vigna radiata* L. Wilczek) covered an area of more than 3.0 million hectares with annual production of 1.60 million tons during 2015-16 growing season. It is a nutritious food item with high content of protein (20-25%), minerals (4%) and carbohydrate (46-51%). However, one of the major constraints in mungbean production is weed competition. The losses of moonbeam yield due to weeds ranges from 65.4% to 79.0% (Dungarwal *et al.* 2003). Arif *et al.*(2006)reported that besides causing crop losses, weeds creating competition for nutrients, space, water etc. reduce the crop yield and the quality of produce hence; reduce the market value of the produce. For the success 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. 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 actually suitable for either pre-sowing or post-sowing application in mungbean. Therefore, the present research work 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

A field experiment was conducted continuously for three years during kharif season from 2013 to 2015 at Rajasthan Agriculture Research Institute, Durgapura Jaipur. This Agricultural Research Institute is situated at 390

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meters above sea level on latitude 26'50^{o} N and longitude 75'47^{o} E. The experiment consisted of nine treatments i.e T_1 Pendimethalin @1kg ai ha^{-1} as pre emergence, T_2 Pendimethalin 30EC+Imazethapyr 2EC @1 kg ai ha^{-1}(redy mix) as pre emergence, T_3 Pendimethalin @1kg ai ha^{-1} as pre emergence+Quizalofopethyl@50g ai ha^{-1} at15-20 days after sowing,T_4 Pendimethalin 30EC+Imazethapyr 2EC @1 kg ai ha^{-1} as pre emergence+ Quizalofopethyl@50g ai ha^{-1} at15-20 days after sowing,T_5 Pendimethalin @1kg ai ha^{-1} as pre emergence+Imazethapyr@40g ai ha^{-1}15-20 days after sowing,T_6 Pendimethalin @1kg ai ha^{-1} as pre emergence +manual weeding at 25-30days after sowing, T_7 Pendimethalin 30EC+Imazethapyr 2EC(ready mix) @1 kg ai ha^{-1} pre emergence +manual weeding at 25-30days after sowing,T_8 Two manual weeding at 20 days and 35-40 days after sowing and T_9 unweeded (weedy check) . These treatment combinations were tested under randomized block design with three replications. The soil of experimental site was loamy sand in texture with pH 7.9, organic carbon 2.2 g kg^{-1}, available nitrogen 146-157 kg ha^{-1}, available P_2O_5 52-54 and K_2O 225-230 kg ha^{-1}. The variety RMG 492 was grown with fertilizer dose of 20:20:20:20 kg ha^{-1} N: P_2O_5:K_2O:S in the form of urea, single superphosphate, muriate of potash and gypsum, respectively as basal application. Seeds were sown in second week of July and harvested in third week of September during all the years. The seed were sown at 20 kg ha^{-1} in furrows at 30cm x 10 cm spacing. Herbicides were applied as per the treatments .Intercultural operations, Irrigation, and spray of insecticides were applied as and when needed .Weed samples were taken at harvest from 1m^2 area in each plot using quadrate and weed population were recorded. Weed dry weight were recorded after oven dry of weed samples at 65± 5 C .The weed control efficiency, weed infestation and weed index were calculated by using formula according to Kundu *et al.* (2009). Data on yield and yield attributing characters were recorded from three randomly selected plants from each plot and seed yield was recorded from the net plot. The cost of all type of variable was included to calculate the cost of cultivation and returns. Economic analysis with respect to gross margin was calculated to evaluate the profitability of different treatments.

RESULTS AND DISCUSSION

Weed flora

Several weed species were observed in experimental field; among them grasses, sedges one and remaining weed flora were from broad leaf category. The predominant weed species were *Cynodon dactylon*, *Cyperus rotundus Tribulus terestris*, *Digeria arvensis*, Amaranthus blitum, Amaranthus spinisus and *Amaranthus viridis*. Similar observation was also reported by Kundu *et al.* (2009)

RESULTS AND DISCUSSION

Effect on crop

Growth attributes

The plant height (Table1) was significantly higher (43.4 cm) with more number of branches per plant (8.3), in weed free treatment, which might be due to less competition by weeds for moisture and nutrients; consequently the plant growth was favorably affected. it was followed by pendimethalin 30 EC+Imazethapyr 2EC @1.0kg ha^{-1}(ready mix)+manual weeding at 25 to 30 days after sowing, Pendimethalin @1kg ai ha^{-1} as pre emergence +manual weeding at 25-30days after sowing, these treatments were significantly better than weedy check treatment and found at par with weed free treatment . The results are in agreement with the finding of Raj *et al.* (2010) and Chhodavadia *et al.* (2013).

Yield attributes

The number of pods/plant ranged from 8.6 in weedy check treatment to 19.3 in total weed free treatment (Table1). In weed free treatment maximum number of pods/plant (19.3) was obtained and it was followed by pendimethalin 30 EC+Imazethapyr 2EC @1.0kg ai ha^{-1}(ready mix)+manual weeding at 25 to 30 days after sowing(18.6), Pendimethalin @1kg ai ha^{-1} as pre emergence +manual weeding at 25-30days after sowing(18.0), Pendimethalin @1kg ai ha^{-1} as pre emergence+Imazethapyr @40g ai ha^{-1} 15-20 days after sowing(15.6).These treatments were significantly better than weedy check treatment and found at par with weed free treatment.

Table 1: Yield attributes and yield of green gram (mean of 3 years) as influenced by different weed management practices

Treatment	Initial P.P	Final P.P	Plant height (cm)	Branches /plant	Pods/ Plant	Seed/ Pod	Test weight (g)	Yield (kg ha^{-1})	
								Seed	Stover
T_1 Pendimethalin @ 1.0 kg/ha-PE	28.00	27.66	35.73	4.66	12.66	7.00	34.24	344.9	499.3
T_2 Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg/ha-PE	29.00	28.33	37.00	5.33	13.66	7.33	34.82	395.5	593.9
T_3 T_1+Quizalofopethyl@ 50 g/ha at 15-20 DAS	28.66	28.00	36.76	5.00	13.33	7.00	34.59	384.1	576.9
T_4 T_2+Quizalofopethyl@ 50 g/ha at 15-20 DAS	29.33	28.66	37.83	6.00	14.00	7.66	35.26	435.5	683.2
T_5 T_1 + Imazethapyr @ 40 g/ha-POE at 15-20 DAS	28.33	27.66	38.50	6.33	15.66	8.00	36.08	500.4	798.5
T_6 T_1 +Mannual weeding at 25-30 DAS	30.33	28.66	40.43	7.33	18.00	9.00	37.45	619.5	979.7
T_7 T_2 + Mannual weeding at 25-30 DAS	29.66	29.00	41.10	7.66	18.66	9.33	37.96	655.5	1078.0
T_8 Two manual weeding at 20 & 35-40 DAS (weed free)	29.00	28.33	43.40	8.33	19.33	9.66	38.49	685.5	1182.2
T_9 Weedy check	28.66	27.33	31.13	3.66	8.66	6.66	30.33	261.7	390.5
SEm±	1.15	1.19	1.48	0.82	1.45	0.61	1.38	52.2	60.01
CD at 5%	NS	NS	4.47	2.49	4.38	1.87	4.19	156.6	179.91
C.V %	6.88	7.34	6.74	23.64	16.88	13.45	6.76	19.02	13.79

Treatments T_1, T_2 and T_3 were statistically at par, but these three treatments produced significantly lower number of pods than other weed management treatments.. The results confirm the findings of Veeraputhiran (2009) **.**The weed management treatments had significant effect on number of seeds/pod. The number of seeds/pod varied from 6.6 in weedy check treatment to 9.6 in weed free treatment. The higher seeds/plant (9.6) was obtained with weed free treatment followed by pendimethalin 30 EC+Imazethapyr 2EC @1.0kg ai ha^{-1}(ready mix)+manual weeding at 25 to 30 days after sowing(9.3), Pendimethalin @1kg ai ha^{-1} as pre emergence +manual weeding at 25-30days after sowing(9.0), these treatments were significantly superior over weedy check(6.6) and found at par with weed free treatment. The weed management treatments had significantly effect on test weight of seed .Which might be due to remarkable reduction in weed population at different stages and less competition by weeds for moisture and nutrients. The application of pendimethlin 30EC +Imazathapyar 2EC 1.0 kgai ha^{-1} (Ready mix) + one manual weeding at 25-30 days after sowing gave significantly higher test weight (37.96g) however, it was found at par with two manual weeding at 20-25 and 35-40 days after sowing and pendimethalin @1.0kg ai ha^{-1} as pre emergence followed by one manual weeding at 25-30 days after sowing.

Yield

Weed free (hand weeding at 20-25 and 35- 40 DAS) although produced higher seed (685.5 kg ha^{-1}) and stover (1182.2kg ha^{-1}) yield but the B: C ratios were low (1.83) due to high cost of cultivation (Table 2). The weedy check treatment had the poor seed (261.7kg ha^{-1}) and stover (390.5kg ha^{-1}) yield. The tremendous weed infestation in weedy check treatment drastically reduced the yield of the crop. Similar findings were also reported by Kundu *et al.* (2009). The application of pendimethlin 30EC + Imazathapyar 2EC 1.0 kg ai ha^{-1} (ready mix) followed by one manual weeding at 25-30 days after sowing gave significantly higher seed (655.5kg ha^{-1}) and straw yield (1078 kg ha^{-1}) (Table 1) of green gram with highest B:C ratio (2.0)and higher weed control efficiency (90.45%). However, it was found at par with two manual weeding at 20-25 and 35-40 days after sowing and pendimethalin @1.0kg ai ha^{-}1 as pre emergence followed by one manual weeding at 25-30 days after sowing (Table 2).

Table 2: Weed parameters and economics of green gram (mean of 3 years) as influenced by different weed management practices (2013-2015)

Treatments	Weed Count/m^2	Weed Dry matter g/sq.m	WCE (%)	Weed Index (%)	Weed Infestation (%)	Net returns (Rs ha^{-1})	B:C ratio
T_1	21.86	26.37	62.24	49.69	44.14	4991.20	1.28
T_2	13.91	15.59	75.97	42.30	32.93	8255.60	1.46
T_3	20.45	24.22	64.68	43.97	42.21	6653.60	1.36
T_4	17.70	19.83	69.43	36.47	38.18	10012.80	1.53
T_5	8.36	11.25	85.56	27.00	23.21	14718.00	1.80
T_6	6.00	9.32	89.64	9.63	17.31	19388.80	1.89
T_7	5.53	8.41	90.45	4.38	16.02	21792.00	2.00
T_8	4.86	6.62	91.60	-	14.64	20858.80	1.83
T_9	57.90	67.27	0.00	61.82	67.93	264.00	1.02
SEm±	2.499	1.33					
CD at 5%	7.491	4.04					
C.V %	24.88	11.02					

Weed parameters

All weed management treatments significantly reduced the population of weeds as compare to weedy check. Among the different treatments tried, treatment weed free recorded significantly lowest number of weeds per m2 compared to rest of the treatments at harvest stage followed by application of pendimethlin 30EC +Imazathapyar 2EC(ready mix) 1.0 kg ai ha^{-1}+ one manual weeding at 25-30 days after sowing. The remarkable reduction in weed population at different stages might be due to effective weed control in respective treatments either manual or herbicidal control or both. These finding are confirm results of Raj *et al.* (2010). Among the different treatments, significantly the highest dry weight of total weeds was recorded under weedy check treatment (67.2g m^2). Among the different weed management treatments, weed free treatment recorded significantly minimum dry weight of weed i.e 6.6g m^2. Minimum weed dry weight in different weed management treatment with weed free condition might be due to effective weed control obtained under ,two hand weeding20-25 and35-40DAS and hand weeding with pre-emergence application herbicides at initial and early crop growth stage, which resulted into the lowest weed counts and finally reduced the total dry weight of weeds at harvest, ultimately the rapid growth of green gram crop, dense crop canopy might be suppressed weed growth as indicated by plant height and more number of branches per plant, which did not allow weeds to grow vigorously due to smothering effect (Table 2). These results confirm the finding of Rajib *et al.* (2014).

All the weed management treatments have better weed control efficiency (Table2). The highest weed control efficiency at harvest was recorded under weed free treatment(91.6%) followed by the T_7application of pendimethlin 30EC +Imazathapyar 2 EC 1.0 kg ai ha^{-1} (redymix) + one manual weeding at 25-30 days after sowing(90.4%) and T_6 pendimethalin @1.0kg ai ha^{-1} as pre emergence + one manual weeding at 25-30 days after sowing(89.6%). The higher weed control efficiency recorded under weed management treatments might be due to periodical removal of weeds by hand weeding, hand hoeing or herbicidal control resulted in remarkable reduction in weed population and ultimately less dry weight of weeds. These are in agreement with the findings of Malliswari *et al.* (2008). The weed index, which is the indicator of losses in seed yield due to presence of weeds, Weed free treatment is considered as base for calculating weed index. The lowest weed index was observed with (T_7) application of pendimethlin 30 EC + Imazathapyar 2 EC 1.0 kg ai ha^{-1}(redymix) + one manual weeding at 25-30 days after sowing(4.3%) and (T_6) pendimethalin @ 1.0kg ai ha^{-1} as pre emergence + one manual weeding at 25-30 days after sowing(9.6%). This might be due to effective weed control achieved under these weed management treatments, which resulted in reduction of weeds biomass ultimately, achieving higher weed control efficiency. The finding on weed dry weight, WCE and WI are in agreement with the result of Sultan and Baigh (2013) and Chhodavadia *et al.* (2013)

in green gram. The lowest weed infestation was observed with weed free treatment (14.6%) followed by the (T_7) application of pendimethlin 30EC +Imazathapyar 2EC 1.0 kg ai ha^{-1} (redymix) + one manual weeding at 25-30 days after sowing(16.0%) and(T_6) pendimethalin @ 1.0 kg ha^{-1} as pre emergence + one manual weeding at 25-30 days after sowing(17.3%).

From the result it can be concluded that all the weed control treatments effectively controlled weeds and significantly reduced their population and dry weight. However, pre emergence application of (T_7) Pendimethalin 30 EC + Imazethapyr 2 EC (redy mix) @ 1.00 kg a.i. ha^{-1} followed by one hand weeding at 25- 30 DAS was found most effective in reducing population and dry mass of weeds and producing maximum yield of green gram with highest economic returns (Rs. 21792) & B:C ratio (2.0).

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