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Evaluation of Efficacy of Different Pre and Post Emergence Herbicides for Efficient Weed Control in Green Gram (*Vigna radiata* L.)

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Abstract A field experiment was conducted during *kharif* of 2013-14 to find out the effect of different weed management practices in greengram. Weed spectrum of the experimental field consisted of three groups of weeds like grasses, sedges and broad leaved weeds. Grasses viz., *Cynodon dactylon, Dactyloctenium aegyptium* and *Celotia argentia,* sedges viz., *Cyperus rotundus* and broad leaved weeds viz., *Digera arvensis, Trianthem aportulacastrum, Commelina bengalensis, Parthenium hysterophorus, Euphorbia hirta* and *Hemidismus indica*. Weed free (hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS) treatment and hand weeding at 20 and 40 DAS recorded the lowest weed density, weed dry matter and the highest weed control efficiency compared to other treatments at all the stages of crop growth. Among the integrated weed treatments, application ofimazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS and pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS were found effective in limiting weed growth.

Keywords Greengram, Hand weeding, Imazamox, Imazethapyr, Pendimethalin Quizalofop-pethyl.

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Introduction

Pulses are the most important food crops after cereals. Constitute the major source of dietary protein of large section of vegetarian population of the world. Among the grain legumes, greengram [*Vigna radiata* (L.) Wilczek], one of the most important pulse crops. In India, Green gram [*Vigna radiata* (L.) Wilczek] is the third important pulse crop of India after chickpea and pigeonpea. It is quite versatile crop grown for seeds, green manure and forage, as a mixed or sole crop either on residual moisture of the previous crop or as a catch crop to make use of the land left idle

between two main season crops. One of the major constrains in greengram production is weed competition. The loss of greengram yield due to weeds ranges from 65.4% to 79.0% [1, 2]. Besides causing crop losses, weeds are also responsible for reducing crop quality, nutrients status of soil. The conventional methods of weed control (hoeing or hand weeding) are labor intensive, expensive, insufficient and may cause damage to the crop. Chemical weed control is not common as the use of herbicides may be uneconomical due to low yield potential of green gram [3].

The possibility of enhancing the productivity in green gram has increased significantly with the discovery of several selective herbicides and also opened up new opportunities efficient weed management. This situation coupled with acute labor shortage and higher costs involved in hiring of labor has necessitated identification suitable integrated/chemical weed management strategy in green gram. In spite of availability of several herbicides for weed management in green gram data pertaining to the efficiency of herbicide and their combinations, economics of varies weed management practices with respect to Andhra Pradesh conditions in lacking. Keeping the above idea in view, the present research work was carried out with the objective to evaluate efficacy of different pre and post emergence herbicides for efficient weed control in green gram.

Materials and Methods

The field experiment was conducted during *kharif* 2013–2014 at student's farm, College of Agriculture Rajendranagar, Hyderabad, Acharya N. G. Ranga Agricultural University to study the efficacy of different pre and post emergence herbicides for efficient weed control in green gram. The soil of the experimental field was sandy loam in texture with pH of 7.8. The soil was low in available nitrogen (230 kg ha^{-1}), low in available phosphorus (23.42 kg ha^{-1}) and medium in available potassium (409.2 kg ha^{-1}) contents. A medium duration cultivar MGG-295 was used as a test variety. The experiment was laid out in a randomized block design with twelve treatments, pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence, imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence, pendimethalin 30% EC @ 1.0 kg ai ha^{-1} + imazethapyr 10% SL @ 50 g ai ha^{-1} as pre-emergence, pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS, imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS, imazethapyr 10% SL @ 75 g ai ha^{-1} at 15 DAS as post-emergence, imazethapyr 10% SL + imazamox 35% WG @ 70 g ai ha^{-1} at 15–20 DAS as post-emergence, pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + Quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, imazethapyr 10% SL @ 100 g ai ha^{-1} + Quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, weed free (hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS), hand weeding at 20 and 40 DAS and weedy check and replicated thrice. The rate of N, P_2O_5 and K_2O were applied @ 20:50:0 kg ha^{-1} in the form of urea and single super phosphate, respectively. The entire dose of fertilizer was applid as basal, and then they were thoroughly mixed with the soil. The seeds were sown @ 20 kg ha^{-1} at a depth of 2–3 cm, maintaining 30 cm row spacing, followed by covering with soil. Weed control efficiency (WCE) was calculated at harvest using the following formula and expressed in percentage [4].

Where, DWC: dry weight of weeds in unweeded control plot; and DWT: dry weight of weeds in weed control treatment plot. The weed index (WI) was calculated for different treatments using the formula as suggested by Gill and Kumar [5].

$$WI\ (\%) = \frac{(X - Y)}{X} \times 100$$

Where, X = Grain yield from weed free check or maximum yield treatment Y = Grain yield from treatment. The data obtained on different parameters were analyzed statistically using Fisher's method of analysis of variance as suggested by Panse and Sukhatme [6]. The original data on weed densities were transformed to $\sqrt{X + 0.5}$ transformations.

Results and Discussion

Effect on weeds

In this study, the important weed flora observed in the experimental site were *Cynodon dactylon,*

Table 1. Effect of different integrated weed control treatments on various classes of weed population (no. m^{-2}) and weed drymatter (g m^{-2}) at 30 and 45 DAS in greengram during *kharif*, 2013-14. Original values are given in parentheses, which were transformed to $\sqrt{x+0.5}$.

	Weed population (no. m^{-2})							
Tr.	30 DAS				45 DAS			
No.	Grass	Sedge	BLW	Total	Grass	Sedge	BLW	Total
T_1	3.49 (11.67)	4.49 (19.67)	5.70 (32.00)	7.99 (63.33)	4.38 (18.67)	5.79 (33.00)	7.18 (51.00)	10.16 (103.0)
T_2	3.49 (11.67)	4.45 (19.33)	5.85 (33.67)	8.07 (64.67)	4.30 (18.00)	5.76 (32.67)	7.31 (53.00)	10.21 (103.6)
T_3	3.34 (10.67)	4.30 (18.00)	5.46 (29.33)	7.65 (58.0)	4.14 (16.67)	5.64 (31.33)	7.03 (49.00)	9.87 (97.00)
T_4	1.46 (1.67)	1.93 (3.33)	2.96 (8.33)	3.71 (13.33)	2.68 (6.67)	4.70 (21.67)	5.05 (23.00)	7.33 (52.33)
T_5	1.34 (1.33)	1.86 (3.00)	2.73 (7.00)	3.44 (11.33)	2.54 (6.00)	4.63 (21.00)	4.84 (23.00)	7.10 (50.00)
T_6	1.87 (3.00)	3.98 (15.33)	3.53 (12.00)	5.55 (30.33)	2.61 (6.33)	5.30 (27.67)	6.01 (35.67)	8.38 (69.67)
T_7	1.68 (2.33)	3.94 (15.00)	2.66 (6.67)	4.95 (24.00)	2.26 (4.67)	5.24 (27.00)	5.61 (31.00)	7.95 (62.67)
T_8	1.17 (1.00)	3.85 (14.33)	4.78 (22.33)	6.17 (37.67)	1.68 (2.33)	5.21 (26.67)	6.28 (39.00)	8.28 (68.00)
T_9	0.88 (0.33)	3.76 (13.67)	4.38 (18.67)	5.76 (26.67)	1.68 (2.33)	5.15 (26.00)	6.04 (36.00)	8.03 (64.33)
T_{10}	1.95 (3.33)	3.48 (11.67)	4.02 (15.67)	5.58 (30.67)	1.86 (3.00)	4.48 (19.67)	4.56 (20.33)	6.56 (43.00)
T_{11}	1.58 (2.00)	1.93 (3.33)	2.97 (8.33)	3.76 (13.67)	1.17 (1.00)	1.68 (2.33)	1.17 (1.0)	2.18 (4.33)
T_{12}	4.56 (20.33)	5.46 (29.33)	7.27 (52.67)	10.12(102.33)	5.15 (26.00)	6.34 (50.00)	8.44 (76.00)	11.72 (152.0)
SEm±	0.11	0.14	0.17	0.18	0.11	0.15	0.17	0.25
CD (*p*= 0.05)	0.34	0.42	0.50	0.53	0.34	0.44	0.50	0.72

Table 1. Continued.

	Weed dry matter (g m^{-2})							
Tr.	30 DAS				45 DAS			
No.	Grass	Sedge	BLW	Total	Grass	Sedge	BLW	Total
T_1	2.39 (5.25)	2.53 (5.90)	4.22 (17.28)	5.38 (28.43)	3.51 (11.80)	3.78 (13.86)	5.79 (33.11)	7.70 (58.77)
T_2	2.40 (5.25)	2.51 (5.80)	4.32 (18.18)	5.45 (29.38)	3.45 (11.38)	3.77 (13.72)	5.87 (34.19)	7.73 (59.28)
T_3	2.30 (4.80)	2.43 (5.40)	4.04 (15.84)	5.15 (26.04)	3.32 (10.53)	3.69 (13.16)	5.66 (31.61)	7.47 (55.30)
T_4	1.11 (0.75)	1.22 (1.00)	2.23(4.50)	2.59 (6.25)	2.17 (4.21)	3.10 (9.10)	4.08 (15.13)	5.47 (28.44)
T_5	1.04 (0.60)	1.18 (0.90)	2.07 (3.78)	2.40 (5.28)	2.07 (3.79)	3.05 (8.82)	3.91 (14.84)	5.29 (27.45)
T_6	1.36 (1.35)	2.26 (4.60)	2.64 (6.48)	3.59 (12.43)	2.12 (4.00)	3.48 (11.62)	4.85 (23.01)	6.24 (38.63)
T_7	1.23 (1.05)	2.24 (4.50)	2.01 (3.60)	3.10 (9.15)	1.85 (2.95)	3.44 (11.34)	4.53 (20.00)	5.90 (34.28)
T_8	0.96 (0.45)	2.19 (4.30)	3.54 (12.06)	4.16 (16.81)	1.40 (1.47)	3.42 (11.20)	5.06 (25.16)	6.18 (37.83)
T_9	0.80 (0.15)	2.14 (4.10)	3.25 (10.08)	3.85 (14.33)	1.40 (1.47)	3.37 (10.92)	4.87 (23.22)	6.00 (35.61)
T_{10}	1.41 (1.50)	2.00 (3.50)	2.99 (8.46)	3.73 (13.46)	1.54 (1.90)	2.96 (8.26)	3.68 (13.12)	4.87 (23.27)
T_{11}	1.17 (0.90)	1.22 (1.00)	2.22 (4.50)	2.62 (6.40)	1.03 (0.63)	1.21 (0.98)	1.04 (0.65)	1.65 (2.26)
T_{12}	3.11 (9.15)	3.05 (8.80)	5.38 (28.44)	6.84 (46.39)	4.11 (18.43)	4.15 (19.80)	6.80 (50.80)	8.89 (88.77)
SEm±	0.08	0.07	0.10	0.12	0.08	0.10	0.14	0.19
CD (*p*= 0.05)	0.24	0.21	0.28	0.35	0.25	0.30	0.40	0.55

Dactyloctenium aegyptium and *Celotia argentia,* sedges viz., *Cyperus rotundus* and broad leaved weeds viz., *Digera arvensis, Trianthem aportulacastrum, Commelina bengalensis, Parthenium hysterophorus, Euphorbia hirta* and *Hemidismus indica*.

Weed population, weed dry matter and weed control efficiency in greengram field differed significantly with the different weed management practices both at 30 and 45 days after sowing (DAS). At 30 DAS imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS recorded singificantly lower number and weed dry matter of grasses, sedges and broadleaved weeds compared to other treatments, but it was on par with the next

Table 2. Effect of different integrated weed control treatments on weed control efficiency (%), weed index (%), yield and yield attributesin greengram. T_1. Pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence, T_2. Imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence, T_3. Pendimethalin 30% EC @ 1.0 kg ai ha^{-1} + imazethapyr 10% SL @ 50 g ai ha^{-1} as pre-emergence, T_4. Pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS, T_5. Imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS, T_6 Imazethapyr 10% SL @ 75 g ai ha^{-1} at 15 DAS as post-emergence, T_7. Imazethapyr 10% SL + imazamox 35% WG @ 70 g ai ha^{-1} at 15–20 DAS as post-emergence, T_8. Pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + Quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, T_9. Imazethapyr 10% SL @ 100g ai ha^{-1} + Quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, T_{10}. Weed free (hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS), T_{11}. Hand weeding at 20 and 40 DAS, T_{12}. Weedy check.

Tr. No.	Weed control efficiency (%) 30 DAS	45 DAS	Weed index	No. of plants per m^{-2}	No. of pods per plant	No. seeds per pod	100 seed weight (g)	Grain yield (kg/ha)	Haulm yield (kg/ha)	HI (%)
T_1	38.72	33.80	63.27	26.67	6.37	7.37	3.11	4.22	8.47	33.2
T_2	36.99	33.22	40.38	31.00	9.15	8.17	3.42	6.85	11.53	37.3
T_3	43.87	37.70	39.99	31.70	8.50	8.23	3.45	6.89	11.60	37.3
T_4	86.53	66.84	59.46	27.33	6.50	7.50	3.15	4.65	8.80	34.6
T_5	88.62	69.08	9.95	32.30	11.00	9.97	3.58	10.40	15.68	39.8
T_6	73.21	56.48	29.32	32.32	9.23	8.50	3.50	8.12	13.77	37.1
T_7	80.28	61.38	19.66	32.32	9.70	8.80	3.51	9.23	14.14	39.5
T_8	63.76	57.38	62.34	27.00	6.47	7.73	3.03	4.32	8.77	32.9
T_9	69.11	59.89	25.90	32.33	9.27	8.70	3.50	8.51	14.05	37.8
T_{10}	70.99	73.79	0.00	33.33	11.23	10.10	3.63	11.49	16.70	40.7
T_{11}	86.20	97.45	5.60	32.78	11.10	10.00	3.60	10.85	15.75	40.7
T_{12}	0.00	0.00	60.76	29.94	6.87	8.10	3.17	4.51	9.06	33.1
SEm±	–	–	–	0.90	0.47	0.40	0.10	39	47	–
CD (p=0.05)	–	_	_	2.66	1.39	1.17	0.30	1.10	138	–

best treatments viz., pendimethalin 38.7% CS @ 580 g ai ha^{-1}as pre-emergence + hand weeding at 20 DAS and hand weeding at 20 and 40 DAS which also significantly recorded lower number and weed dry matter of grasses sedges and broadleaved weeds. Application of post emergence herbicides viz., imazethapyr 10% SL + imazamox 35% WG @ 70 g ai ha^{-1} at 15–20 DAS as post-emergence, imazethapyr 10% SL @ 100 g ai ha^{-1} + quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, imazethapyr 10% SL @ 75 g ai ha^{-1} at 15 DAS as post-emergence and pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence continued their effect on weeds which resulted in lower weed density and weed dry matter values at 30 DAS compared to that of weedy check. At 45 DAS significantly lower number and weed dry matter of grasses, sedges and broad leaved weeds were recorded with hand weeding at 20 and 40 DAS compared to rest of the treatments. Application of imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS significantly recorded lower number and weed dry matter of total weeds than other treatments but remained at par with pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS. There results indicate that hand weeding at 20 and 40 DAS continued its effect on weeds which resulted in lower weed density and weed dry matter at 45 DAS. However, application of pendimethalin 38.7% CS and imazethapyr 10% SL as pre emergence alone has 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 found that one hand weeding is essential at 20 DAS for effective control of weeds. These results are in conformity with Rathi et al. [7] and Raj et al. [8].

At 30 DAS, the highest weed control efficiency viz., was observed with imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS followed by pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS, hand weeding at 20 and 40 DAS treatments since first weeding was done on 20th day after sowing. Application of

post emergence herbicides viz., imazethapyr 10% SL + imazamox 35% WG @ 70 g ai ha^{-1} at 15–20 DAS as post-emergence, imazrthapyr 10% SL @ 100 g ai ha quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence, imazethapyr 10% SL @ 75 g ai ha^{-1} at 15 DAS as post-emergence and pendimethalin 38.7% CS @ 580g ai ha^{-1} as pre-emergence + quizalofop 5% EC @ 50 g ai ha^{-1} at 15–20 DAS as post-emergence continued their effect on weeds which resulted in higher weed control efficiency value at 30 DAS compared to that of weedy check. The findings confirm the results of Bhandari et al. [9]. Idapuganti et al. [10] and Chhodavadia et al. [11]. These results indicate that whenever 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 might be due to the removal of weeds that emerged at later stages of crop growth by hand weeding or application post emergence herbicides at 15–20 days after sowing. The data on weed control efficiency at 45 DAS revealed that highest weed control efficiency was observed under hand weeding at 20 and 40 DAS. The next best treatment in recording the highest weed control efficiency was hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS and followed by imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS and pendimethalin 38.7% CS @ 580 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS.

The lowest weed index was recorded with weed free (hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS treatment, hand weeding at 20 and 40 DAS and imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS was due to control of all grasses, sedges and broad leaved weeds and thereby providing favorable environment for the growth and yield of greengram crop under the weed stress free environment.

Effect on crop

Seed yield of greengram was significantly influenced due to different weed management treatments. All the weed control treatments recorded significantly higher seed yield than weedy check (except T_1, T_4 and T_8). The highest seed yield was recorded in weed free (hand weeding from 15 DAS at 15 days interval 15, 30 and 45 DAS) treatment, which remained on par with hand weeding at 20 and 40 DAS and application of imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS. These three treatments were found significantly superior to rest of the treatments. This significant increase in seed yield was due to effective weed control and also high yield parameters like number of seeds per pod, number of pods per plant and hundred seed weight. Next best treatments in registering higher seed yield were application of imazethapyr 10% SL + imazamox 35% WG @ 70 g ai ha^{-1} at at 15–20 DAS as post-emergence treatment, which remained on par with application of imazethapyr 10% SL @ 100 g ai ha^{-1} + quizalofop 5% EC @ 50 g ai ha^{-1} 15–20 DAS as post-emergence and imazethapyr 10% SL @ 75 g ai ha^{-1} at 15 DAS as post-emergence. The reduction of yield in T_1, T_4 and T_8 treatments because of phytotoxicity of pendimethalin 38.7% CS @ 580 g ai ha^{-1} on greengram crop. The maximum seed yield production by weed free (hand weeding from 15 DAS at 15 days interval; 15, 30 and 45 DAS) treatment followed by hand weeding at 20 and 40 DAS and application of imazethapyr 10% SL @ 75 g ai ha^{-1} as pre-emergence + hand weeding at 20 DAS due to effectiveness of hand weeding in controling weeds and improvement in the growth and development of crop and higher yield attributed of greengarm crop. The increase in yield attributes and yield under these treatments may be attributes 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 agreements with the findings of Rathi et al. [7], Raj et al. [8] and Chhodavadia et al. [11].

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