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Weed Control, Nutrient Studies and Greengram Performance with New Molecules of Pre and Post Emergence Herbicides

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ABSTRACT: Herbicide use is increasingly being adopted around the world due to non-availability and high wages of labour. As greengram is a short duration crop with slow initial growth faces severe weed infestation. So there is a dire need to identify the new molecules of herbicides. Based on the problem identified, a field experiment was conducted during *rabi* season 2020-21 at Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad to study the bioefficacy of new generation herbicides on *rabi* greengram. Herbicidal effect was evaluated on weed control, nutrient studies and crop performance in greengram. Based on the observations recorded, application of Diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE(pre emergence) and Diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE *fb* Imazethapyr 10 % SL @ 75 g a.i ha^{-1} as PoE (post emergence) at 20 days after sowing (DAS) recorded higher weed control efficiency. On the contrary the weed index was high due to phytotoxic effect on the crop which resulted in severe yield loss. Apart from the diclosulam treated plots, Imazethapyr 10 % SL + Quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS has recorded higher control of weeds, nutrient uptake, higher yield by the crop which was found on par with weed free check.

Keywords: Greengram, nutrient removal, nutrient uptake, pre and post emergence herbicides, weed control.

INTRODUCTION

Greengram (*Vigna radiata* L.) is an important pulse crop in India grown in all the seasons' *viz*., *kharif, rabi* and summer. The potential yield of most of the varieties ranges from 1200-1600 kg ha^{-1}, but the productivity is far less than the potential yield. There are many constraints for this low yield *i.e.* loss caused by weed, cultivation on poor and marginal lands and inadequate fertilization, but weed infestation is one of the main constraints. It faces severe weed competition due to its initial slow growth and lack of effective weed control measures. The weed interference in greengram can be effectively managed by practices like hand weeding and intercultivation. But, these traditional methods have become costly, tedious, labor intensive which requires more time to keep the crop weed free.

One of the possible courses of action for controlling weeds would be through herbicides at appropriate level. The progressive modernization of agriculture involving intensive use of herbicides is acquiring popularity in recent years due to lower cost, easy and timely application and efficiency in controlling weeds. Keeping in view all the points, the present study was taken up.

MATERIAL AND METHODS

A field experiment was conducted during *rabi*, 2020-2021 at College farm, Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad, Telangana state. The soil of experimental site was sandy loam in texture and slightly alkaline in reaction (pH 7.96), low in organic carbon (0.39 %) and available nitrogen (235.8 kg/ha), high in available phosphorous (45.5 kg/ha) and potassium (384.6 kg/ha) with electrical conductivity of 0.41 dS/m. The experiment was laid out in randomized complete block design having three replications with ten treatments. Greengram variety MGG-347 was sown on 6th November 2020 with a spacing of 30 × 10 cm. Basal application of 20:50:20 kg ha^{-1} NPK was done. PE herbicides was applied one day after sowing the crop and PoE herbicides was applied at 20 days after sowing (DAS). The weed samples and crop samples collected at flowering stage and at harvest were sundried for two days and then dried in hot air oven at 60°C to a constant weight were used for analysis after grinding by using the Willey mill and this powder was used for estimation of N, P and K to work out uptake of major nutrients. The treatment details include:

Treatment	Details
W_1	Diclosulam 84 % WDG @ 26 g a.i ha^{-1} as Pre emergence (PE)
W_2	Pendimethalin 30 % EC + Imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE
W_3	Imazethapyr 35 % + Imazamox 35% WG combination @ 70 g a.i ha^{-1} as post emergence (PoE)
W_4	Imazethapyr 3.75 % + Propaquizafop 2.5 % w/w ME @ 125 g a.i ha^{-1} as PoE
W_5	Sodium acifluorphen 16.5 % EC + Clodinafoppropargyl 8 % EC @ 250 g a.i ha^{-1} as PoE
W_6	Diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE *fb*Imazethapyr 10 % SL @ 75 g a.i ha^{-1} as PoE
W_7	Imazethapyr 10 % SL + Quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE
W_8	Intercultivation at 20 DAS with power weeder
W_9	Unweeded check
W_{10}	Weed free check

Weed control efficiency (WCE) was calculated based on the following formula, (Mani *et al.*, 1973).

1. $$\boldsymbol{WCE}\ (\%) = \frac{DM_C - DM_T}{DM_C} \times 100$$

2. $$Weed\ index\ (\%) = \frac{X - Y_T}{X} \times 100$$ (Gill and Vijaykumar, 1969)

3. $$\text{HEI} = \frac{Y_T - Y_C}{Y_T} \times \frac{DM_C}{DM_T}$$ (Krishnamurthy *et al.*, 1975)

Where, WCE = Weed Control Efficiency (%)

HEI =Herbicide efficiency index

DMc = Dry matter of weeds in the unweeded check (control)

DM_T = Dry matter of weeds in the treatment imposed plot

X: grain yield from weed free check or maximum yield treatment

Y_T: grain yield from treatment for which weed index is to be calculated

Y_C= Yield of control (unweeded) plot

RESULTS AND DISCUSSION

A. Nutrient Studies in Crop and Weed

Nutrient uptake by crop (kg ha^{-1}). Nutrient uptake by plant was significantly influenced by different herbicide combinations at flowering and harvest stage of the crop. At flowering stage of the crop, significantly higher uptake of Nitrogen (N), Phosphorous (P) and Potassium (K) was recorded with weed free check. Among the herbicides, imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.iha^{-1} as PoE at 20 DAS registered significantly higher uptake of nutrients which was at par with weed free check. Higher uptake of N, P and K in seed and haulm was registered with weed free check. Significantly higher values of N, P and K in seed and haulm were recorded under weed free check followed by imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS which were at par with each other. This was followed by pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE and sodium acifluorphen 16.5 % EC + clodinafoppropargyl 8 % EC @ 250 g a.i ha^{-1} as PoE at 20 DAS. The growth of the weeds was suppressed with the herbicide combinations which reduced the weed dry matter accumulation. The better weed control efficiency in those treatments led to vigorous growth of the plants resulting in higher biological yield due to higher uptake of nutrients. This was coupled with more transfer of nutrients to the seed, which was the ultimate sink. Due to phytotoxicity of herbicide, diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE and diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE fbimazethapyr 10 % SL @ 75 g a.i ha^{-1} as PoE at 20 DAS recorded lower uptake of N, P and K than unweeded check at flowering and harvest stage of the crop. Similar findings were reported by Jinger *et al.* (2016).

Nutrient removal by weeds. Nutrient removal by weeds at flowering differed significantly among the treatments and highest was recorded under unweeded check and the lowest uptake was seen with diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE followed by imazethapyr 10 % SL @ 75 g a.iha^{-1} as PoE at 20 DAS and diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE which was at par with weed free check. This was followed by imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.iha^{-1} as PoE at 20 DAS. The results disclosed that all the herbicide combinations resulted in lower depletion of nutrients by the weeds when compared to unweeded check. Similar trend was followed at harvest. The highest removal of nutrients in unweeeded check might be due to more density and growth of weeds. Whereas, least values of nutrient depletion by weeds was observed with herbicidal combinations as they have effectively controlled weeds which made more amount of nutrients available to the crop. This has led to lower removal of nutrients by weeds due to competition from the crop plants. Komal *et al*. (2015), Poornima *et al.* (2018) in greengram and Bhimwal *et al*. (2019) in soybean were of similar opinion.

B. Weed control efficiency, Weed index and Herbicide Efficiency Index

Higher weed control efficiency was observed with diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE *fb* imazethapyr 10 % SL @ 75 g a.i ha^{-1} as PoE at 20 DAS which was followed by diclosulam 84 % WDG @ 26 g a.i ha^{-1} as pre-emergence application and imazethapyr 10 % SL + quizalofopethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS (Table 2). Lower weed index and higher herbicide efficiency index was recorded with imazethapyr 10 % SL + quizalofop ethyl 5% EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS and pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE. Lower herbicide efficiency index was encountered with diclosulam treated plots (W_1 and W_6) as they have shown phytotoxic effects on the crop resulting in low yields even though the weed control efficiency of diclosulam was superior. The results are analogous to those obtained by Singh *et al.* (2016); Adhikary (2018) in blackgram.

C. Seed yield (Kg ha^{-1}), Haulm yield (Kg ha^{-1}) and Harvest index (%

Different weed control treatments have shown significant variation in seed yield (Table 2). Higher seed yield was registered with weed free check (1430) but the herbicide combinations i.e, imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS (1375) and pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE (1244) were on par with weed free check which has shown 53.01 % more increment in seed yield over the unweeded check. The findings are analogous to those obtained by Poornima *et al*. (2018); Singh *et al*. (2021) in greengram.

Table 1: Effect of herbicides on nutrient removal by weeds and uptake by greengram.

Treatment	Nutrient removal by weeds at flowering (kg ha^{-1})			Nutrient removal by weeds at harvest (kg ha^{-1})			Nutrient uptake by rabi greeengram at flowering (kg ha^{-1})			Nutrient uptake (kgha^{-1}) by seed			Nutrient uptake (kgha^{-1}) by haulm		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
W_1	0.40	0.06	0.37	1.71	0.28	1.78	6.13	0.27	4.24	4.69	0.58	1.60	6.74	1.02	12.87
W_2	2.38	0.28	1.71	7.85	1.44	8.23	23.85	1.50	16.55	37.96	6.44	16.41	29.26	5.32	55.11
W_3	3.62	0.75	3.27	11.97	2.17	11.12	18.29	0.98	12.67	31.37	4.85	13.37	24.24	2.95	45.32
W_4	2.78	0.56	2.56	10.60	1.94	10.70	21.91	1.30	15.16	31.84	5.25	13.68	27.28	5.04	51.79
W_5	2.18	0.41	1.99	9.37	1.67	9.63	22.47	1.33	15.51	37.47	6.28	16.16	27.39	5.02	51.57
W_6	0.25	0.05	0.24	1.43	0.22	1.49	6.25	0.30	4.34	4.50	0.55	1.56	6.68	1.13	12.99
W_7	1.13	0.12	1.10	7.54	1.26	7.73	25.04	1.65	17.37	41.85	7.07	17.94	30.54	5.51	57.07
W_8	3.14	0.65	2.95	11.24	2.11	11.79	19.79	1.10	13.64	25.21	3.76	9.55	24.25	4.41	49.38
W_9	12.60	2.05	11.21	20.69	3.93	19.60	13.54	0.58	9.73	19.27	2.57	6.82	18.57	2.14	35.91
W_{10}	0.00	0.00	0.00	0.00	0.00	0.00	26.87	1.77	18.63	43.37	7.46	19.80	30.62	5.71	59.41
SEm±	0.21	0.04	0.18	0.51	0.11	0.52	0.80	0.05	0.53	2.56	0.40	1.05	1.49	0.22	2.51
CD (P=0.05)	0.62	0.11	0.54	1.52	0.33	1.55	2.38	0.13	1.59	7.60	1.18	3.13	4.42	0.66	7.46

Table 2: Effect of herbicides on weed control, yield and economics of rabi greengram.

Treatment	Weed parameters			Seedyield (kg ha^{-1})	Haulmyield (kg ha^{-1})	H.I (%)	Net Returns (Rs ha^{-1})	B:C ratio
	WCE (%)	WI (%)	HEI (%)					
W_1	90.59	88.57	-33.04	164	591	21.54	-16495	0.41
W_2	56.98	13.01	1.07	1244	2418	33.93	59014	3.06
W_3	39.47	40.44	0.35	852	2108	28.77	31878	2.13
W_4	44.77	25.24	0.67	1069	2292	31.62	47005	2.66
W_5	49.98	14.64	0.90	1207	2382	33.63	56819	3.01
W_6	92.15	88.25	-38.20	168	593	22.95	-17917	0.40
W_7	59.47	3.83	1.26	1375	2503	35.43	67308	3.27
W_8	42.71	31.03	-	987	2201	30.76	39769	2.34
W_9	0.00	53.02	-	672	1786	27.41	20588	1.77
W_{10}	100.0	0.00	-	1430	2570	36.02	67053	2.98
SEm±				69	116	1.45	-16495	0.41
CD (P=0.05)				205	344	4.30	59014	3.06

Higher haulm yield was registered with weed free check (2570) which was at par with imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.iha^{-1}as PoE at 20 DAS (2503), pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE (2418), imazethapyr 3.75 % + propaquizafop 2.5 % w/w ME @ 125 g a.iha^{-1} as PoE at 20 DAS (2292) and sodium acifluorphen 16.5 % EC + clodinafoppropargyl 8 % EC @ 250 g a.i ha^{-1} as PoE at 20 DAS (2282). On the contrary, diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE (164) and diclosulam 84 % WDG @ 26 g a.i ha^{-1} as PE fbimazethapyr 10 % SL @ 75 g a.i ha^{-1} as PoE at 20 DAS recorded lower seed and haulm yield due to phytotoxicity of the crop resulting in poor accumulation of photosynthates. Similar trend was followed for harvest index. The higher yield is due to better expression of yield attributes. The enhanced yield attributes and yield might be due to poor density and growth of weeds. Consequently the crop was able to compete with the weeds for all the necessary growth factors. The superior values of yield attributing characters were the outcome of these effects. The findings are analogous to those obtained by Singh *et al*. (2017); Lata and Kushwaha (2019).

D. Economics

Higher net returns and B: C ratio was realized with imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS and pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE. The least was observed with diclosulam treated plots as the herbicide has shown phytotoxicity which led to yield loss. Similar results were obtained by Tamang *et al.* (2015); Arvind and Roshan (2020) in greengram.

CONCLUSION

From the results it can be concluded that application of imazethapyr 10 % SL + quizalofop ethyl 5 % EC (tank mix) @ 125 g a.i ha^{-1} as PoE at 20 DAS or pendimethalin 30 % EC + imazethapyr 2 % EC combination @ 960 g a.i ha^{-1} as PE can be recommended for fetching higher yield and net returns in *rabi* greengram.

FUTURE SCOPE

There is a need to further study the influence of herbicidal combinations on soil microbial activity and lower dosage of diclosulam may be tested on greengram.

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