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Weed parameters as influenced by herbicide mixtures in rabi greengram (*Vigna radiata* L.)

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ABSTRACT

A field experiment on "weed parameters as influenced by herbicide mixtures in *rabi* greengram (*Vigna radiata* L.)" was conducted during *rabi,* 2023-24 at Regional Agricultural Research Station, Lam, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India. The experiment was laid-out in a randomized block design with twelve weed management practices and replicated thrice on clay loam soils. The results revealed that among all the weed management practices, the lowest density and dry weight of all the categories of weeds *viz.*, grasses, sedges and broad-leaved weeds including total weed were recorded with hand weeding twice at 20 and 40 DAS (W_{11}) and closely followed by PoE application of fomesafen + fluziafop-p-butyl 222 g ha^{-1} (W_7) and sodium-aciflourfen + clodinafop-propargyl 185 g ha^{-1} (W_9), applied at 20 DAS. The same weed management practices resulted in higher weed control efficiency, higher drymatter production,seed yield ,haulm yield, net returns and benefit –cost ratio for broad spectrum of weed control in greengram grown on clay loam soils of Krishna Zone of Andhra Pradesh.

Key words : *Greengram, Herbicide mixtures , Seed yield , Weed intensity and Weed control efficiency*

Greengram (*Vigna radiata* L.) is grown widely for use as a human food, largely consumed as dal in India. It is supposed to be easily digestible. It contains about 25 per cent proteins, 60 per cent carbohydrate, 1.3 per cent fat and several essential amino acids including lysine which is generally found deficient in cereals and providing protein rich diet. It is also rich in vitamin A, B_1, B_2 calcium, phosphorus and potassium.It plays an important role not only in human diet, but also in improving the soil fertility through biological nitrogen fixation with rhizobium (Upadhyay *et al.,* 1999).

The potential yield of most of the greengram varieties ranges from 1200-1600 kg ha^{-1}, but the productivity is far less than the potential yield. The lower productivity of greengram is mainly due to non-adoption of good crop husbandry practices by the farming community. Among the several factors, proper weed management plays a vital role in enhancing productivity of greengram. Being a short duration crop and relativity slow initial growth, *rabi* greengram is subjected to heavy infestation of weeds posing a considerable threat to obtain expected yield. Weed infestation is one of the major constraints in greengram cultivation and causes 50 to 90 per cent yield loss. The extent of yield loss due to heavy weed infestation in *rabi* greengram is about 80 per cent (Algotar *et al.,* 2015).

Initial weed free situations are essential for greengram as the critical period of crop-weed competition is upto 20-30 DAS (Singh *et al*., 2015). Greengram is severely infested by various grasses, sedges and broad leaved weeds. Due to shortage of human labour, weed control through manual weeding is not feasible and also uneconomical. In spite of the pre-and-post emergence of herbicides recommendations are available for control of weeds in greengram, there is large variation in weed intensity and weed flora in *kharif* and *rabi* greengram due to rainfall pattern or irrigation schedule adopted. Significantly lower weed density and weed dry weight with higher benefit-cost ratio were obtained with pre-emergence application of pendimethaline + imazethapyr 1.0 kg ha^{-1} and higher benefit cost-ratio as compared to hand weeding (Kumar *et al.*, 2019).

Pendimethalin and imazethapyr at recommended doses failed to control certain weed species like *Phyllanthus maderaspatensis,* *Cardiospermum helicacabum* and *Chrozophora rotteleri* in greengram and blackgram. This might be due to late emergence of weeds or development of certain resistance mechanism in the weeds to these herbicides. In the recent years, new herbicide molecules or ready mix herbicides are available in the market to control the weeds in greengram, but the performance is varied to control the weed flora associated with crop. These new generation and low dose high efficiency herbicides have better selectivity coupled with broad-spectrum weed control as well as low mammalian toxicity. There is a need to evaluate new generation pre- emergence and post-emergence herbicide mixtures, alternative to pendimethalin and imazethapyr for broad-spectrum weed control in greengram on black cotton soil of Krishna Zone of Andhra Pradesh.

MATERIALS AND METHOD

A field experiment was conducted at Regional Agricultural Research Station, Lam campus of Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India during *rabi,* 2023-24. The experiment was laid out in a randomized block design with twelve treatments and replicated thrice.The treatments details were pre-emergence application of pyroxasulfone 125 g ha^{-1} (W_1),Pre-emergence application of diclosulam 20 g ha^{-1} (W_2),Pre-emergence application of metolachlor 1200 g ha^{-1} (W_3), Pre-emergence application of pendimethalin 1000 g ha^{-1} (W_4), imazethapyr 50 g ha^{-1} + clethodim 125 g ha^{-1} (TM) at 20 DAS (W_5),imazethapyr 50 g ha^{-1} + haloxyfop-R-butyl 125 g ha^{-1} (TM) at 20 DA S(W_6),fomesafen + fluziafop-p-butyl 222 g ha^{-1} (RM) at 20 DAS(W_7), imazethapyr + imazamox (RM) 75 g ha^{-1} at 20 DAS (W_8),sodium-aciflourfen + clodinafop-propargyl (RM) 185 g ha^{-1} at 20 DAS (W_9),Pre-emergence application of pendimethalin 1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} at 20 DAS(W_{10}) ,Two hand weedings at 20 and 40 DAS (W_{11}),Un-weeded check (W_{12}). The gross plots size was 4.8 m × 4.0 m and spacing was 30 cm × 10 cm. The test variety used in the present experiment was LGG- 607. The required quantities of pre-emergence herbicides *viz.*, pyroxasulfone, diclosulam, metolachlor, pendimethalin and post-emergence herbicides *viz.*,imazethapyr + clethodim (TM), imazethapyr + haloxyfop-R-butyl (TM),fomesafen + fluziafop-p-butyl (RM), imazethapyr + imazamox(RM) and sodium-aciflourfen +clodinafop-propargyl(RM) were applied at one and 20 DAS, respectively by using spray fluid 500 L ha^{-1} with the help of knapsack sprayer fitted with flat fan nozzle as per the treatments. The data on weed density, weed dry weight, drymatter, seed yield ,haulm yield ,net returns and cost –benefit ratio was recorded at harvest .

RESULTS AND DISCUSSION

Weed Density

Among the weed management practices tested, significantly lower density of total weeds was recorded with hand weeding twice at20 and 40 DAS (W_{11}) which was at par with PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1}(W_7), sodium aciflourfen+clodinafop-propargy l18 g ha^{-1}(W_9) and PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} at 20 DAS (W_{10})(Table 1). All the above weed management practices were significantly lesser than rest of the weed management practices studied with regards to weed density . This might be due to better control of all categories of weeds with above herbicides, particularly ready mix herbicide due to dual mode of action. These results are in conformity with the findings of Jetendra *et al.* (2023) in soybean and Kalyani *et al*. (2023). Post-emergence application of imazethapyr 50 g ha^{-1} +clethodim125g ha^{-1} (W_5) was considered as next best treatment which was at par with imazethapyr 50 g ha^{-1}+haloxyfop–R-butyl 125 g ha^{-1} (W_6) which in turn at par with imazethapyr+imazamox 75 g ha^{-1} (W_8) in ascending order of total weed density. Pre-emergence application of pyroxasulfone125 g ha^{-1} (W_1), diclosulam 20 g ha^{-1}(W_2), pendimethalin1000 g ha^{-1} (W_4) were at par with each other in reducing the density total weeds in increasing order. The highest density of total weeds was recorded with unweed check (W_{12}) which was significantly higher than rest of the weed management practices .

Weed Dry Weight

Among the weed management practices investigated, the lowest dry weight of total weeds was obtained with PoE application of fomesafen+fluziafop-p-buty l222 g ha^{-1} at 20 DAS(W_7), sodium aciflourfen+clodinafop-propargy l185 g ha^{-1} (W_9) and PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} at 20 DAS (W_{10})(Table1). All the above weed management practices were significantly lesser than rest of the weed management practices in obtaining dry weight of total weeds. This might be due to better control of all categories of weeds with above herbicides, particularly ready mix herbicide application. These results are in conformity with the findings of Prameelarani and Venkateswarlu (2022),Punia *et al.*(2018) and Panda *et al* (2022). Post-emergence application of imazethapyr 50 g ha^{-1} +clethodim125 g ha^{-1} at 20DAS (W_5) was considered as next best treatment, which was at par with imazethapyr 50 g ha^{-1}+haloxyfop-R-methyl 125 g ha^{-1} (W_6) which intun at par with hand weeding twice at20 and 40 DAS (W_{11}) in ascending order of total weed dry weight.Pre-emergence application of diclosulam 20 g ha^{-1} (W_2) pyroxa sulfone 125gha^{-1}(W_1), pendimethalin 1000 g ha^{-1} (W_4) were at par with each other in recording total dry weight of weeds in increasing order. The highest dry weight of total weeds was recorded with unweed check (W_{12}) which was significantly higher than rest of the weed management practices.

Weed Control Efficiency (%)

Weed control efficiency computed at harvest was altered due to different weed management practices tried in greengram (Table 1).At harvest, POE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1} (W_7) registered higher weed control efficiency followed by sodium aciflourfen+clodinafop-propargy l185 g ha^{-1} (W_9) and PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} at 20 DAS (W_{10}). However, higher weed control efficiency was computed with two hand weedings (W_{11}) at 40 and 60 DAS. The maximum weed control efficiency in the above treatments mainly due to dual mode of action of ready mix herbicides application resulted in broad-spectrum weed control. These results are in accordance with the findings of Singh *et al.* (2018) and Harisha *et al.* (2021). Among all the PE herbicides, maximum weed control efficiency was registered with diclosulam 20 g ha^{-1}(W_2) followed by pyroxasulfone 125 g ha^{-1}(W_1) and pendimethalin1000 g ha^{-1} (W_4).The lower weed control efficiency was obtained with PE application of metolachlor 1200 g ha^{-1} (W_3) due to its poor performance in controlling mixed weed flora associated with greengram lead to higher dry matter accumulation of weeds and thereby reduced weed control efficiency.

Drymatter Production

Different pre- and post-emergence herbicides altered the drymatter production of greengram at various growth stages. The drymatter production of greengram was increased gradually at an increasing rate from sowing to harvesting stage. (Table 1). At harvest stage**,** significantly higher drymatter production was produced with hand weeding twice at 20 and 40 DAS(W_{11}) which was at par with PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1}(W_7), sodium-aciflourfen+clodinafop-propargyl 185 g ha^{-1} (W_9) and PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} (W_{10}).These weed management practices offered broad-spectrum weed control from initial days of crop growth that lead to increased plant height, number of branches $plant^{-1}$and higher number of leaves due to increased availability of growth resources. These results are in accordance with the findings of Singh *et al*.,(2018) and Srijani *et al.,*(2020).Pre-emergence application of diclosulam 20 g ha^{-1} (W_2), pyroxasulfone125 gha^{-1} (W_1), pendimethalin 1000 g ha^{-1} (W_4) and metolachlor1200 g ha^{-1} were at par with each other in recording drymatter production in decreasing order. The lowest drymatter production was obtained with unweeded check (W_{12}) which was significantly lesser than rest of the weed management practices due to severe competition offered by weeds on crop.

Seed Yield

Different pre-and post-emergence herbicides significantly influenced the seed yield of greengram(Table.1).The highest seed yield of greengram was recorded with hand weeding twice at 20 and 40 DAS (W_{11}) which was comparable with PoE application of fomesafen+fluziafop-p-butyl 222gha^{-1}(W_7)andsodium-aciflourfen+clodinafop-propargyl 185 g ha^{-1} (W_9) and latter treatment was at par with PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} (W_{10}). This might be due to increased yield components *viz.,* number of pods $plant^{-1}$, seeds pod^{-1} and 100-seed weight as a result of broad spectrum of weed control obtained in the above treatments during the critical period of crop growth and thereby enhanced the better translocation of photosynthates from source to pods and then to seeds. Due to maintenance of weed free environment in the above said treatments facilitated favorable environment for increased number of branches plant-

Table:1 Weed density, dry weight and yield of greengram as influenced by Pre- and post –emergence herbicides .

SNo	Treatments	Weed density (No.m^{-2})	Weed dry weight (gm^{-2})	WCE (%)	Dry matter (kg ha^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Net Returns (Rs)	Benefit – Cost Ratio
1	W_1 : Pre-emergence application of pyroxasulfon 125 g ha^{-1}	8.80 (77.00)	6.75 (45.12)	45.20	19.08	764	1222	34184	1.95
2	W_2 : Pre-emergence application of diclosulam 20 g ha^{-1}	10.05 (104.33)	6.57 (42.67)	48.18	18.36	785	1256	38536	2.15
3	W_3 : Pre-emergence application of metolachlor 1200 g ha^{-1}	11.22 (127.67)	8.46 (71.17)	13.57	19.4	712	995	23036	1.67
4	W_4 : Pre-emergence application of pendimethalin 1000 g ha^{-1}	10.21 (104.00)	7.70 (58.96)	28.40	18.48	710	1136	31778	1.95
5	W_5 : Imazethapyr 50 g ha + clethodim 125 g ha^{-1} (TM) at 20 DAS	6.28 (39.00)	4.86 (23.21)	71.81	18.13	885	1368	43723	2.26
6	W_6 : Imazethapyr 50 g ha + haloxyfop-R-methyl 105 g ha^{-1} (TM) at 20 DAS	6.91 (47.00)	5.30 (27.66)	66.40	17.6	810	1296	38426	2.07
7	W_7 : Fomesafen + fluziafop-p-butyl 222 g ha^{-1} (RM) at 20 DAS	5.14 (26.00)	3.99 (15.40)	81.30	21.12	1074	1675	64465	2.90
8	W_8 : Imazethapyr + imazamox 75 g ha^{-1} at 20 DAS	7.87 (61.67)	5.99 (35.52)	56.86	18.27	801	1282	38877	2.12
9	W_9 : Sodium-aciflourfen + clodinafop-propargyl 185 g ha^{-1} at 20 DAS	5.21 (26.67)	4.03 (15.52)	80.82	20.3	1032	1651	61006	2.81
10	W_{10} : Pre-emergence application of pendimethalin 1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} at 20 DAS	5.73 (32.33)	4.15 (16.76)	79.65	18.99	954	1526	52678	2.51
11	W_{11} : Two HW at 20 and 40 DAS	4.41 (19.00)	5.02 (24.70)	70.00	22.53	1154	1710	59550	2.29
12	W_{12} : Unweeded check	11.60 (134.00)	9.10 (82.34)	-	17.33	426	805	8000	1.25
	CD (P = 0.05)	1.63	0.50		1.89	143	284	3438	0.53

[1] and pod development which in turn increased the number of pods plant^{-1} and there by higher seed yield.

The seed yield of greengram was increased by 63.08,60.35,58.72 per cent with hand weeding twice at 20 and 40 DAS(W_{11}),PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1} (W_7) and sodium-aciflourfen+clodinafop-propargyl185gha^{-1} (W_9), respectively, compared to unweeded check (W_{12}).These results are in agreement with results of Gopakumar and Menon (2022) and Panda *et al.* (2022). Among the PE herbicides tested, diclosulam 20 g ha^{-1} (W_2) resulted in higher seed yield which was at par with pyroxasulfone125 g ha^{-1} (W_1) and the latter treatment (W_1) was in turn comparable with pendimethalin1000 g ha^{-1} (W_4) and metolachlor1200 g ha^{-1} (W_3) in the descending order of seed yield. The lowest seed yield of greengram was obtained with unweeded check (W_{10}), which was significantly lesser than rest of the weed management practices due to severe competition offered by weeds for growth resources right from the crop germination to harvest and in turn reduced the growth and yield components lead to decreased seed yield.

Haulm Yield

Haulm yield of greengram was significantly influenced by different weed management practices(Table.1).The highest haulm yield of greengram was recorded with hand weeding twice at 20 and 40 DAS (W_{11}) which was comparable with PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1}(W_7) and sodium-aciflourfen+clodinafop-propargy l185 g ha^{-1} (W_9)and latter treatment (W_9) was at par with PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} (W_{10}).This might be due to increased growth parameters *viz.,* plant height, branches plant^{-1}and drymatter production as well as seed yield as a result of weed free environment maintained in these treatments. These results are in agreement with findings of Prameelarani and Venkateswarlu (2022) and Harisha *et al.* (2021).Pre-emergence application of diclosulam 20 g ha^{-1} (W_2) resulted in higher haulm yield followed by PE application of pyroxasulfone125 g ha^{-1} (W_1) and pendimethalin1000 g ha^{-1} (W_4) in decreasing order. The lowest haulm yield of greengram was obtained with un-weeded check (W_{10}), which was significantly lesser than rest of the weed management practices due to heavy weed infestation that lead to decreased stature of plants, reduced branching and lower biomass accumulation which ultimately resulted in reduced haulm yield.

Net Returns

The different weed management practices in greengram significantly influenced the net returns (Table.1).The highest net returns of greengram cultivation was obtained with PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1} (W_7) which was significantly higher than rest of the weed management practices due to increased seed and haulm yield as well as reduced cost of weeding in this treatment. Post-emergence application of sodium-aciflourfen+clodinafop-propargyl 185 g ha^{-1} (W_9) and two hand weddings at 20 and 50 DAS (W_{11}) were at par with each other in obtaining higher netreturns.This might be due to increased economic yield and reduced cost of herbicide treatments. Pre-emergence application of pendimethalin 1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} (W_{10}) realized higher net returns than PoE application of imazethapyr 50g ha^{-1} +clethodim125 g ha^{-1} (W_5). Among the PE herbicides studied, diclosulam 20 g ha^{-1} (W_2) resulted in higher net returns than rest of the PE herbicides while the lowest was obtained with metolachlor1200 g ha^{-1} (W3).The lowest net returns were obtained with un-weeded check(W_{12}),which were significantly lesser than rest of the weed management practices due to reduced seed and haulm yield.

Benefit-Cost Ratio

Different weed management practices in greengram significantly influenced the benefit-cost ratio of greengram cultivation (Table.1).Among the weed management practices tried in the present filed experiment, the highest benefit-cost ratio was computed with PoE application of fomesafen+fluziafop-p-butyl 222 g ha^{-1} (W_7) which was statistically at par with sodium-aciflourfen+clodinafop-propargyl185 g ha^{-1} (W_9) and PE application of pendimethalin1000 g ha^{-1} *fb* imazethapyr 50 g ha^{-1} (W_{10}).This might be due to increased economic yield and low cost associated with weed management in these treatments. Benefit-cost ratio obtained with hand weeding twice at 20 and 40 DAS (W_{11}) was lag behind than former two best weed management practices W_7andW_9 due to increased cost of weeding. Among the herbicidal treatments, the lowest benefit-cost ratio was calculated with metolachlor 1200 g ha^{-1}(W$_3$) followed by pyroxasulfone 125 g ha^{-1}(W$_1$) due to reduced seed yield as a result of poor weed control. The lowest benefit-cost ratio was computed with unweeded check (W$_{12}$) due to severe competition offered by weeds for growth resources right from the crop germination to harvest and in-turn reduced the growth and yield components lead to decreased seed yield.

From these results it can be inferred that highest seed yield and gross returns as well as broad-spectrum weed control in greengram were obtained with hand weeding twice at 20 and 40 DAS(W$_{11}$) which was comparable with PoE application of fomesafen+fluziafop-p-butyl 222g ha^{-1}(W$_7$)and sodium-aciflourfen + clodinafop-propargyl 185g ha^{-1} (W$_9$) applied at 20 DAS, however the highest net returns and benefit-cost ratio were obtained with latter two weed management practices on clay loam soils of Krishna Zone of Andhra Pradesh.

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