IMPACT OF PRE AND POST-EMERGENCE HERBICIDES ON WEED DYNAMICS AND YIELD PERFORMANCE OF GREEN GRAM (*Vigna radiata* L.)

Abstract

A field experiment was conducted in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during February - April, 2024 to study the impact of pre and post-emergence herbicides on weed dynamics and yield performance of green gram. The experiment consists of eleven treatments were laid out in randomized block design with three replications. Among the herbicidal treatments, sequential application of Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) resulted in lower total weed density, weed dry weight and higher weed control efficiency (WCE). This treatment also led to maximum grain yield (522 kg ha^{-1}), haulm yield (1472 kg ha^{-1}), net income (Rs. 24628 ha^{-1}) and benefit cost ratio (BCR) (2.03) indicating superior weed suppression and economic feasibility. In contrast, the unweeded control exhibited maximum weed growth and the lowest yield and economic returns. Therefore, it is suggested that the sequential application of herbicides is a promising strategy for effective weed management and optimal productivity of green gram.

Keywords: Economics, Grain yield, Green gram, Propaquizafop, Weed control efficiency.

1. Introduction

Green gram (*Vigna radiata* L.) is one of the most important pulse crops in India, ranks third in production. It can be grown in all the seasons of the year *viz., kharif, rabi* and *summer*. The area under green gram in India is 3.78 million hectares with a production of 2.91 million tonnes and productivity of 670 kg ha^{-1}. The total area under green gram in Tamil Nadu is 1.48 lakh hectares with a production of 0.45 lakh tonnes and productivity of 306 kg ha^{-1} (Anonymous, 2024)[1]. Growth and productivity of green gram affected by many biotic and abiotic factors like nutritional deficiency, water scarcity, pest and disease etc. Weeds infestation is one of the major factors limiting the productivity of green gram. Yield loss in green

gram due to weeds to the tune of 60-80%. Weeds pose a serious threat to the growth and yield of green gram because of more competition for nutrients, water, space and sunlight. Weed management is an important factor in enhancing the productivity of green gram. The traditional practice of hand weeding require dependence on the increased number of labours during the peak period of sowing and harvesting are becoming expensive. The combination of pre-emergence and post- emergence herbicides or some ready-mix herbicide formulations reduces the crop weed competition and effectively manages the weed flora in green gram. Under such circumstances, the best possible means to control the new flush of weeds through the combined use of pre and post-emergence or early post-emergence herbicides (Madhusree *et al*., 2023)[2].

2. Materials and Methods

A field investigation was carried out at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, during February to April, 2024. The experiment was laid out in a Randomized Block Design (RBD) comprising eleven treatments, each replicated three times. The treatment details are as follows: T_1 - Unweeded control, T_2 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre), T_3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre), T_4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T_5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)+ Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T_6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS(Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T_7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T_8 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizofop @ 50 g a.i. ha^{-1} on 20 DAS (PoE), T_9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)+ Propaquizofop @ 50 g a.i. ha^{-1} on 20 DAS (PoE), T_{10} - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} (EPoE) (Tank mix) on 15 DAS, T_{11}- Hand weeding twice at 15 DAS and 30 DAS.

Field was prepared after the paddy harvest with the help of cage wheel, after the excess water has been drained, the green gram variety ADT-3 was chosen and broadcasted. The fertilizer was applied as per the recommended dose of 25:50:25 kg ha^{-1} N, P_2O5 and K_2O were applied as basal application. The herbicides were sprayed as per the treatments schedule with the help of knapsack sprayer by using a spray volume of 500 l ha^{-1}. Total weed count and weed dry weight were recorded using 0.25 m^2 quadrate at four places randomly in each plot at 30 and 45 DAS (days after sowing), sun dried and oven dried at 80°C for 72 h and expressed in g m^{-2}. Weed control efficiency (WCE) was calculated using the formula as suggested by

Mani *et al.* (1973)[3]. Data on weed count and weed dry weight were subjected to square root transformation $\sqrt{(X + 0.5)}$. All the data were statistically examined.

3. RESULT AND DISCUSSION

3.1. Weed flora

The field was infested with seven weeds *viz., Cynodon dactylon, Echinochloa colonum* in grasses, *Cyperus rotundus* in sedge*, Cleome chelidonii, Commlenia benghalensis, Eclipta alba,* and *Phyllanthus niruri* in broad-leaved weeds were the predominant weed species found in the experimental field.

3.2. Effect of weed management practices on total weed count

The different pre-emergence and post-emergence (PoE) herbicide treatments significantly influenced the total weed count (Table 1). At 30 DAS, among the herbicidal treatments, tank mix application of quizalofop ethyl @ 50 g a.i. ha^{-1} + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_{10}) (23.70 no. m^{-2}) was found to significantly recorded the lowest total weed count at 30 DAS. This was on par with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8). The reduction in total weed count was attributed to the combined application of two herbicides, imazethapyr and quizalofop ethyl, which together offer broad-spectrum weed control. Imazethapyr, effectively targets annual grasses and certain broad-leaved weeds by inhibiting the acetolactate synthase (ALS) enzyme, thereby disrupting protein synthesis and ultimately leading to weed mortality and quizalofop ethyl, belonging to the aryloxyphenoxypropionate (AOPP) group, specifically controls narrow-leaved (grass) weeds by inhibiting acetyl-CoA carboxylase (ACCase), a key enzyme in fatty acid synthesis, to which grass weeds are particularly sensitive (Mukherjee, 2024)[4].

At 45 DAS, among the herbicidal treatments, an application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) (27.50 no. m^{-2}) was found to significantly recorded the lowest total weed count. This was on par with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_6) and pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_4). This might be due to pendimethalin controls annual grasses and some of broad-leaved weed at germination stage and it inhibits root and shoot growth by distrupting cell division. Propaquizafop, a post-emergence herbicide, inhibits the ACCase enzyme, which is essential for fatty acid and phospholipid biosynthesis,

key components of lipid membranes and cuticular waxes in narrow-leaved weeds. Its action leads to chlorosis in young leaves and reddening or purpling in older ones. It effectively controls a wide range of grassy and broad-leaved weeds (Singh *et al.*, 2018)[5]. The maximum total weed count was observed in unweeded control (T_1) at 30 DAS and 45 DAS.

3.3. Effect of weed management practices on total weed dry weight

Total Weed dry weight was also significantly affected by treatments. At 30 DAS, Among the herbicidal treatments, the tank mix application of quizalofop ethyl @ 50 g a.i. ha^{-1} + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_{10}) (15.88 g m^{-2}) was found to significantly recorded the lowest weed dry weight. This was on par with application of pendimethalin @ 1 kg a.i. ha^{-1}on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) was significantly recorded as the least weed biomass. This might be due to better performance of combination herbicides and synergistic effect between the two herbicides reducing the population as well as dry matter accumulation of different weed species. Similar to the findings of Muduli *et al*. (2023)[6].

At 45 DAS, among the herbicidal treatments, the treatment with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) (19.25 g m^{-2}) was significantly recorded as the least weed dry weight (Table 1). This was on par with an application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_6) and pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_4). This is due to combined application of pre-emergence herbicide of pendimethalin and post-emergence herbicide of propaquizafop effectively controlled the annual grasses and wide range of broad-leaved weeds, it leads to lowest total weed dry weight. The results were in conformity with the findings of Panda *et al*. (2021)[7]. The maximum weed dry weight of weeds was observed in unweeded control (T_1) at 30 DAS and 45 DAS.

3.4. Effect of weed management practices on weed control efficiency

Among the herbicidal treatments, the higher weed control efficiency 62.32 % was recorded in tank mix application of quizalofop ethyl @ 50 g a.i. ha^{-1} + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_{10}) at 30 DAS. Among the herbicidal treatments, the higher weed control efficiency of 69.95 % at 45 DAS was registered with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS

(PoE) (T_8) (Table 1). This might be due to effective control of first flush of weeds by pre-emergence herbicide and subsequent flushes by post-emergence herbicide, which was found effective against all kind of weeds resulting in reduced particular weed count ultimately enhanced the weed control efficiency (Sangwan *et al.*, 2018)[8]. The lowest weed control efficiency of 22.4 % at 45 DAS was recorded under the treatment with a sole application of isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (pre).

3.5. Effect of weed management practices on grain and haulm yield

Among the herbicidal treatments, the application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) produced higher grain yield (522 kg ha^{-1}) and haulm yield (1472 kg ha^{-1}) (Table 2). It was comparable with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_6) and application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_4). This might be due to the crop weed competition under weed management treatments enhanced productivity of crop over weedy environment due to cumulative effect of yield attributes. Further, better weed control associated with decrease in weed population and increase in herbicide efficiency index ultimately reflected in overall yield as compared to weedy check. Also, the better initial growth induced more flower and pod production with timely supply of resources led to a positive source-sink gradient of photosynthates. The results are in accordance with the findings of Jain *et al.* (2025)[9]. Unweeded control (T_1) recorded significantly lower grain yield and haulm yield compared to other treatments due to severe weed infestation creates higher crop-weed competition, results in crop plants unable to express their genetic potential.

3.6. Effect of weed management practices on economics

The higher net return of Rs. 24628 ha^{-1} and benefit cost ratio (BCR) of 2.03 were obtained with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) (Table 2). It was followed by the treatment with application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_6) and application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (T_4). The better net return and benefit cost ratio in herbicidal treatment were mainly due to minimum cost of cultivation compared to hand weeding (Shilurenla *et al.*, 2022)[10]. The lower net returns of Rs. 3314 ha^{-1} and benefit cost

ratio of 1.16 were recorded in unweeded control (T_1). This might be due to severe reduction of yield because of weed competition throughout the cropping period.

4. Conclusion

The study concluded that the application of herbicides at different growth stages is broaden the weed free environment and was a viable option to manage the weeds and enhanced the crop productivity. Among the herbicidal treatments, application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T_8) proved to be most effective. This approach not only minimized total weed count, weed dry weight, higher weed control efficiency, grain yield, net return and benefit cost ratio. Consequently, this method stands out as a sustainable and economically viable strategy for green gram cultivation.

Table 1. Impact of herbicides on weed dynamics of green gram

Treatments	Total weed count (no. m^{-2})		Total weed dry weight (g m^{-2})		WCE %	
	30 DAS	**45 DAS**	**30 DAS**	**45 DAS**	**30 DAS**	**45 DAS**
T_1 - Unweeded control	(62.89) 7.96	(91.50) 9.59	(42.19) 6.53	(59.48) 7.74	0.00	0.00
T_2 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre)	(43.99) 6.67	(55.38) 7.48	(30.42) 5.56	(38.90) 6.28	30.05	39.48
T_3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)	(46.06) 6.82	(59.15) 7.72	(32.24) 5.72	(40.22) 6.38	26.76	35.36
T_4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	(29.69) 5.49	(31.40) 5.65	(20.41) 4.57	(21.59) 4.69	52.79	65.68
T_5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	(38.03) 6.21	(47.05) 6.90	(25.85) 5.13	(33.40) 5.82	39.53	48.58
T_6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	(28.96) 5.43	(29.50) 5.48	(19.86) 4.51	(20.07) 4.54	53.95	67.76
T_7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	(37.26) 6.14	(45.62) 6.79	(24.95) 5.04	(30.55) 5.57	40.75	50.14
T_8 - Pendimethalin @1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	(24.88) 5.04	(27.50) 5.29	(16.42) 4.11	(19.25) 4.44	60.44	69.95
T_9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	(35.05) 5.96	(45.04) 6.75	(24.54) 5.00	(31.03) 5.62	44.27	50.78
T_{10} - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (Tank mix) (EPoE)	(23.70) 4.92	(38.05) 6.21	(15.88) 4.05	(25.87) 5.13	62.32	58.42
T_{11} - Twice hand weeding at 15 and 30 DAS	(19.77) 4.50	(20.27) 4.56	(12.23) 3.57	(13.60) 3.75	68.56	77.85
S. Ed	**0.18**	**0.22**	**0.18**	**0.21**		
CD(p=0.05)	**0.38**	**0.46**	**0.39**	**0.43**		

Table 2. Impact of herbicides on yield and economics of green gram

Treatments	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Net return (Rs ha^{-1})	BCR
T_1 - Unweeded control	252	943	3314	1.16
T_2 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3DAS (Pre)	305	1090	5748	1.25
T_3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)	295	1064	6077	1.28
T_4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	489	1419	21050	1.87
T_5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	354	1195	9962	1.43
T_6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	508	1451	23300	1.98
T_7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	357	1197	10657	1.47
T_8 - Pendimethalin @1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	522	1472	24628	2.03
T_9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	374	1234	12325	1.54
T_{10} - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (Tank mix) (EPoE)	433	1329	17838	1.80
T_{11} - Twice hand weeding at 15 and 30 DAS	559	1561	19566	1.61
S. Ed	**17**	**42**		
CD(p=0.05)	**36**	**88**		

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