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Evaluation of herbicide efficacy and its impact on growth and yield components of green gram (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during February–April, 2024 at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, to evaluate the efficacy of herbicides on growth and yield components of green gram. The experiment consisted of Eleven treatments laid out in a randomized block design with three replications. Among the herbicidal treatments, the sequential application of Pendimethalin @ 1 kg a.i. ha^{-1} at 3 DAS (pre-emergence) followed by propaquizafop @ 50 g a.i. ha^{-1} at 20 DAS (post-emergence) (T8) recorded the highest values for plant height (44.59 cm), leaf area index (2.95 at 45 DAS and 2.74 at harvest), crop dry matter production (1699 kg ha^{-1}), number of pods plant-1 (9.06), number of grains pod-1 (8.57), pod length (6.05 cm), hundred grain weight (2.30 g), grain yield (522 kg ha^{-1}), and haulm yield (1472 kg ha^{-1}). The lowest values for growth and yield attributes, grain yield, and haulm yield were recorded under the unweeded control (T1). Hence, the sequential application of pendimethalin followed by propaquizafop proved to be the most effective weed management strategy for enhancing the growth and productivity of green gram.

Keywords: Green gram, growth, herbicides, weed management, yield

1. Introduction
Pulses are the pod bearing plant belonging to the fabaceae family. Pulses are cheaper than meat and often known as poor man's meat. It occupy a special place in human nutrition with 20-25 per cent protein, 55-60 per cent carbohydrates, 10-15 per cent fibre, 1-2 per cent fat, it also contains 2- 4 mg zinc, 6-8 mg iron and 38 mg beta-carotene in 100 grain-1 (Fukagawa, 2022) [1]. Pulses are a magnificent gift of nature with the unique ability of biological nitrogen fixation, mobilize insoluble soil nutrients, have a deep root system and bringing qualitative changes in soil properties which make them known as "soil fertility restorers" (Kumar *et al.*, 2018) [2]. Green gram [*Vigna radiata* (L.) Wilczek], also known as mung bean belongs to the family fabaceae. It is the fourth most widely produced pulse crop in India after chickpea, pigeonpea and black gram. It can be grown during both rainy and summer seasons. It can play a major role in nitrogen fixation from 20-80 kg ha^{-1}. 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) [3]. Weed are the major factor which affect the yield of green gram. The maximum crop weed competition in green gram was observed during the period of 15 to 30 days after sowing. It is specific period for crop development cycle, where weeds must be managed to avoid yield losses. Therefore, weeding operation in green gram is tedious, expensive and time-consuming when carried out manually and mechanically. It is necessary to switch from expensive manual- mechanical weed control to an alternative weed control which consumes less time and cost. In such cases, chemical weed management may be a feasible and cost-effective option for green gram. Herbicides are effective at right dosage in controlling weeds (Kumar *et al*., 2019) [4].

2. Materials and Methods

A field experiment was conducted at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar during February to April, 2024 for "Evaluation of herbicide efficacy and its impact on growth and yield components of green gram". The experimental field was located at 11˚ 24' N latitude, 79˚44' E longitude and at an altitude of +5.79 m above mean sea level. The soil of the experimental field was clay loam in texture, moderately drained with pH of 7.8 (alkaline). The soil was low in nitrogen, medium in available phosphorus and high in available potassium. 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 recommended dose of 25:50:25 kg ha^{-1} N, P_2O_5, and K_2O was applied as basal before sowing. Each treatment plot size is
5.1 m × 4 m. The experimental field was laid out in randomized block design with three replications and eleven treatments. The treatments consisted of: T1 - Unweeded control, T2 – Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre), T3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre), T4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @50 g a.i. ha^{-1} on 15 DAS (EPoE), T7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE), T8 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE), T9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE), T10 - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE) (Tank mix) and T11 – Hand weeding twice at 15 and 30 DAS. Growth parameters were measured at suitable intervals during the experiment, while yield parameters were assessed at harvest, including plant height, LAI, number of pods per plant, number of grains per pod, pod length, 100-grain weight, grain yield, and haulm yield. All the recorded data were statistically examined as applicable to RBD.

3. Results and Discussion

3.1 Effect of weed management practice on growth parameters of green gram

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) (T8) registered significantly taller plant height (44.59 cm at harvest), higher LAI (2.95 at 45 DAS & 2.74 at harvest) and DMP at harvest (1699 kg ha^{-1}) (Table 1). It 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) (T6) 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) (T4). The reason behind the higher growth parameters of the green gram under these treatments is due to the effective control of weeds which might have reduced the competition for nutrients, moisture, space and radiant energy providing favorable conditions during and better utilization of other resources which eventually led to an increase in the rate of photosynthesis and metabolic activities, thereby enhancing all the necessary growth factors. Similar findings were reported by Kumar *et al*. (2022) [5]. Unweeded control (T1) recorded lowest growth parameters. This might be due to high competition by weeds and suppression of growth due to lesser availability of growth contributing factors to plants thus reducing the growth to greater extent. The results were in conformity with the findings of Sivanantha *et al*. (2024) [6].

3.2 Effect of weed management practice on yield attributes and yield of green gram

The highest yield attributes and yield of green gram were significantly influenced by the herbicidal treatments over unweeded control were presented in Table 2. From the field experiment, all the yield contributing characters and yield were significantly recorded highest values *viz.*, number of pods plant-1 (9.06), number of grains pod-1 (8.57), pod length (6.05 cm), hundred grain weight (2.30 g), grain yield (522 kg ha^{-1}) and haulm yield (1472 kg ha^{-1}) with the treatment application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T8). 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) (T6) 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) (T4). This could be attributed to the fact that reduced weed population created a more favorable environment for the crop, minimizing competition for resources and allowing for optimal growth. This might be attributed to reduced crop–weed competition under effective weed management treatments, which enhanced crop productivity compared to the weedy environment through the cumulative improvement in 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 Madhusree *et al*. (2023) [7]. The lowest grain and haulm yield (252 kg ha^{-1} & 943 kg ha^{-1}) was recorded under unweeded control (T1). This is due to severe weed infestation creates higher crop-weed competition, results in crop plants unable to express their genetic potential. This similar with the reports of Chhodavdia *et al*. (2024) [8].

Table 1: Evaluation of herbicides on growth parameters of green gram

Treatments	Plant height (cm) at harvest	Leaf area index		Crop dry matter production (kg ha^{-1}) at harvest
		45 DAS	At harvest	
T1 - Unweeded control	24.43	1.47	0.98	998
T2 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre)	30.24	1.80	1.50	1166
T3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)	29.54	1.76	1.39	1134
T4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	42.73	2.81	2.52	1618
T5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	33.32	2.09	1.89	1303
T6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	43.87	2.87	2.69	1664

T7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	34.45	2.17	2.03	1308
T8 - Pendimethalin @1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	44.59	2.95	2.74	1699
T9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	35.02	2.22	2.09	1363
T10 - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (Tank mix) (EPoE)	38.90	2.51	2.31	1492
T11 - Hand weeding twice at 15 and 30 DAS	47.73	3.25	2.98	1825
S. Ed	1.48	0.13	0.10	59
CD(p=0.05)	3.10	0.28	0.20	125

Table 2: Evaluation of herbicides on yield attributes and yield of green gram

Treatments	Number of pods plant-1	Number of grains pod-1	Pod length (cm)	Hundred grain weight (g)	Grain yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T1 - Unweeded control	6.34	6.16	4.12	2.22	252	943
T2 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre)	6.97	6.75	4.64	2.28	305	1090
T3 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre)	6.91	6.70	4.56	2.27	295	1064
T4 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	8.89	8.46	5.96	2.20	489	1419
T5 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Quizalofop ethyl @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	7.56	7.29	5.06	2.26	354	1195
T6 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	8.95	8.50	6.01	2.30	508	1451
T7 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (EPoE)	7.60	7.35	5.17	2.25	357	1197
T8 - Pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	9.06	8.57	6.05	2.30	522	1472
T9 - Isoproturon @ 0.5 kg a.i. ha^{-1} on 3 DAS (Pre) + Propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE)	7.75	7.38	5.20	2.30	374	1234
T10 - Quizalofop ethyl @ 50 g a.i. ha^{-1} + Imazethapyr @ 50 g a.i. ha^{-1} on 15 DAS (Tank mix) (EPoE)	7.32	7.92	5.58	2.29	433	1329
T11 - Hand weeding twice at 15 and 30 DAS	9.64	9.14	6.44	2.25	559	1561
S. Ed	0.26	0.25	0.17	0.08	17	42
CD(p=0.05)	0.56	0.53	0.37	NS	36	88

4. Conclusion

From this study, it is found that the productivity of green gram could be improved by application of pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T8). It was found to be most effective and economically feasible herbicide treatment in controlling complex weeds flora. Therefore, pendimethalin @ 1 kg a.i. ha^{-1} on 3 DAS (Pre) + propaquizafop @ 50 g a.i. ha^{-1} on 20 DAS (PoE) (T8) can be recommended as a reliable weed management strategy for maximizing the productivity of green gram.

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