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Bio-efficacy of Post-emergent Herbicides on Crop Growth, Yield and Economics of *kharif* Greengram (*Vigna radiata* L.)

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ABSTRACT

A field experiment was conducted during *kharif* 2018 to study the effect of post-emergent herbicides on weed growth and yield of greengram at the field unit of AICRP on Agro-forestry, University of Agricultural Sciences, GKVK, Bengaluru. The experiment consisted of 11 treatments replicated thrice in RBD design. Among the various herbicide treatments, significantly, higher seed yield was recorded with post emergent application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} (1058 kg ha^{-1}) and it was statistically on par with fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 252 + 78 g a.i. ha^{-1} (1007 kg ha^{-1}) and the same treatments has recorded higher crop growth parameters like, plant height, leaf area and total dry matter production. Economically, higher net income and BC ratio were recorded in post emergent application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} (Rs.51, 208 and 3.27, respectively) and was followed with the treatment receiving post emergent application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 252 + 78 g a.i. ha^{-1} (Rs.47,924 and 3.15, respectively).

Keywords : Greengram, Post-emergent herbicides, Fomesafen, Propaquizafop

GREENGRAM is the third most important pulse in India after chickpea and pigeonpea. It is a versatile crop grown as sole or mixed crop either on residual moisture of the previous crop or as a catch crop to make use of the land which is left idle between two main seasons.Indian pulses are genetically not much yielding and are also vulnerable to pests which are major hindrances to pulse production. Weed infestation is one of the major factors limiting growth and productivity of pulses (Dixit and Varshney, 2009). Weeds generally compete with crop for space, nutrients, water and light and reduce the grain yield of mungbean by 23.5 to 45.8 per cent (Punia *et al*., 2004). For *kharif* greengram, continuous rainfall during the rainy season hinders timely operations. Scarcity of labour is a major drawback for manual weeding. Mechanical methods are expensive and further more tedious. Therefore, chemical weed control serves as a best alternative to manual weeding and provide weed-free environment from emergence up to 24-45 days after sowing. Various pre emergence and post emergence herbicides are presently available in the market to control weeds in greengram. Pendimethalin is the most commonly used as pre-emergent herbicide which controls weeds during early growth stage of green gram. Pre-emergent herbicides are ineffective in controlling the lately emerged weeds. Due to rains during *kharif* greengram the application of pre-emergent herbicide becomes impossible. The lately emerging weeds competes with the crop and infest the land making it less productive in the successive seasons. Hence, post emergent herbicide becomes a possible alternative for wide range of weed control (Dhanpal *et al.,* 2019). In recent years many new molecules have been synthesized which exhibit high level of activity at low dose with shorter half-life, low mammalian toxicity and higher weed control efficiency. The herbicides like fomesafen and propaquizafop are characterized by broad spectrum weed control with broad window of application and an environmental advantage deriving from their very low application rates in grams rather than kilogram per

hectare which markedly reduce the chemical load in the environment. Keeping the above facts in view, an investigation was undertaken to study the bio-efficacy of post-emergent herbicides on crop growth, yield and economics of *kharif* greengram.

Material and Methods

A field experiment was conducted during *kharif* 2018 to study the bio-efficacy of post-emergent herbicides on weed growth and yield of greengram at the field unit of AICRP on Agro-forestry, University of Agricultural Sciences, GKVK, Bengaluru. Eleven treatments including the application of three post emergent herbicide molecules and their combinations (fomesafen, propaquizafop and imazethapyr) at 25 DAS, two hand weedings at 15 and 30 DAS, weed free check and unweeded control were replicated thrice in randomized complete block design. According to FAO classification, the soils of experimental site belong to ferric luvisols. The soil was red sandy loam in its texture with slightly acidic in reaction (p^H 6.2) with medium electrical conductivity (0.34 dS m^{-1}) and medium organic carbon content (0.55 %). Fertility status is low with respect to nitrogen (232.4 kg ha^{-1}) and high with phosphorus and potassium (34.14 kg ha^{-1} and 287.4 kg ha^{-1}, respectively) availability. The station has received actual mean annual rainfall of 727.8 mm. The average maximum air temperature ranged from 27.0 to 33.2ºC. Whereas, average minimum air temperature ranged between 14.1 to 20.8ºC. The mean monthly relative humidity ranged from 78 per cent in March to 94 per cent in August. The mean maximum and minimum wind speed were recorded in July and September months (9.9 and 5.0 km hr^{-1}, respectively).

Greengram variety KKM 3 was sown at a spacing of 30 x 10 cm and the recommended dose of fertilizer *i.e.*, 25:50:25 kg of N, P_2O_5 and K_2O was applied at the time of sowing. Rice crop was grown during the previous *summer* season of 2018. All the herbicides were applied as post-emergence spray to the weeds as per the treatment, at 25 days after sowing. The herbicides were applied using high volume sprayer. Crop growth parameters at harvest were recorded from the randomly tagged five plants in the net plot. First the border plants were harvested and separated. Later, the crop from each net plot was harvested and sun dried for three days, bundled, tagged, weighed and transported to threshing floor. Threshing was done for

Table 1

Crop growth parameters of *kharif* greengram at harvest as influenced by post-emergent herbicides

Treatments	Plant height (cm)	Leaf area (cm^2 $plant^{-1}$)	Total dry matter production (g $plant^{-1}$)
T_1 : Fomesafen 25 % SL (250 g a.i. ha^{-1})	29.6	879	9.39
T_2 : Propaquizafop 10 % EC (100 ga.i. ha^{-1})	28.1	860	9.38
T_3 : Imazethapyr 10 % SL (100 ga.i. ha^{-1})	31.4	803	8.86
T_4 : Fomesafen 18.8 % SL + propaquizafop5.83 % EC (168 + 52 g a.i. ha^{-1})	31.4	882	10.34
T_5 : Fomesafen 18.8 % SL + propaquizafop5.83 % EC (210 + 65 ga.i. ha^{-1})	34.1	892	10.43
T_6 : Fomesafen 18.8 % SL + propaquizafop5.83 % EC (252 + 78 g a.i. ha^{-1})	35.6	954	10.82
T_7 : Fomesafen 18.8 % SL + propaquizafop5.83 % EC (294 + 91 g a.i. ha^{-1})	36.2	958	10.91
T_8 : Propaquizafop 2.5 % EC + imazethapyr 3.7 % SL (50 + 75 g a.i. ha^{-1})	29.1	834	9.56
T_9 : Hand weeding @ 15 & 30 DAS	37.4	1014	11.36
T_{10}: Weed free check	38.0	1098	12.78
T_{11}: Unweeded check	20.5	447	5.21
S.Em±	0.82	25.57	0.29
C.D @ 5%	2.42	77.23	0.87

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TABLE 2
Yield and yield parameters of *kharif* greengram as influenced by post-emergent herbicides

Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	100 seed weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1 : Fomesafen 25 % SL (250 g a.i. ha^{-1})	21.80	6.32	4.92	728	1187.6
T_2 : Propaquizafop 10 % EC (100 ga.i. ha^{-1})	20.50	5.99	4.45	717	1172.7
T_3 : Imazethapyr 10 % SL (100 ga.i. ha^{-1})	19.40	5.81	4.27	681	1134.4
T_4 : Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (168 + 52 g a.i. ha^{-1})	24.00	6.87	5.31	937	1336.2
T_5 : Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (210 + 65 ga.i. ha^{-1})	24.90	7.04	5.40	959	1350.2
T_6 : Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (252 + 78 g a.i. ha^{-1})	25.50	7.07	5.72	1007	1400.3
T_7: Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (294 + 91 ga.i. ha^{-1})	26.90	7.08	5.83	1058	1437.8
T_8: Propaquizafop 2.5 % EC + imazethapyr 3.7 % SL (50 + 75 g a.i. ha^{-1})	22.30	6.61	4.94	844	1203
T_9: Hand weeding @ 15 & 30 DAS	27.90	7.11	6.02	1094	1476.8
T_{10}: Weed free check	28.60	7.22	6.12	1128	1525.3
T_{11}: Unweeded check	12.50	3.07	3.92	402	767.5
S.Em±	1.20	0.05	0.19	24.41	41.18
C.D @ 5%	3.5	NS	0.56	72.00	85.48

each plot and yield was computed to kg ha^{-1} basis. The data collected on different traits were statically analyzed using the standard procedure and the results were tested at five per cent level of significance as given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Crop Growth Parameters

Crop growth parameters as affected by different herbicide treatments are represented in Table 1. Among different herbicide treatments, T_7 *i.e.*, post emergent application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} recorded significantly higher plant height (36.2 cm), leaf area (958 cm^2 plant^{-1}) and total dry matter production (10.91 g plant^{-1}) and is on par with T_6 *i.e.*, fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 252 + 78 g a.i. ha^{-1} (35.6 cm, 954 cm^2 plant^{-1} and 10.82 g plant^{-1}, respectively). Higher crop growth parameters in T_7 and T_6 are due to lower competition by weeds during crop growth. Unweeded check recorded lowest of all parameters (20.5 cm, 447 cm^2 plant^{-1}and 5.21g plant^{-1}, respectively).

Yield and Yield Parameters

Significant differences were noticed in yield and yield components of greengram as a consequence of weed

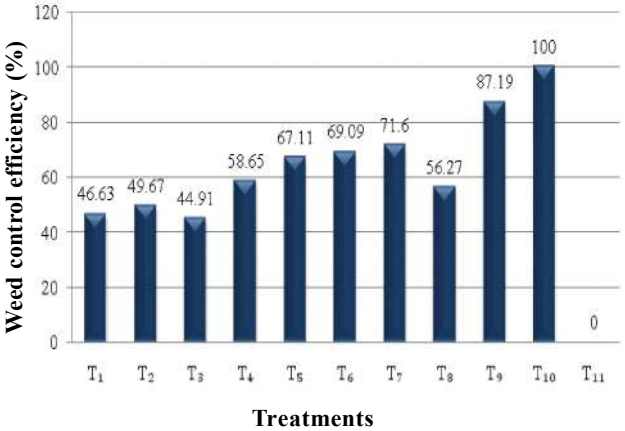

Fig.1: Weed control efficiency of treatments as influenced by weed management practice

TABLE 3

Economics of weed management practices in *kharif* greengram

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1: Fomesafen 25 % SL (250 g a.i. ha^{-1})	22165	50778	28113	2.24
T_2: Propaquizafop 10 % EC (100 ga.i. ha^{-1})	21665	50011	27846	2.26
T_3: Imazethapyr 10 % SL (100 ga.i. ha^{-1})	21065	47500	25935	2.20
T_4: Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (168 + 52 g a.i. ha^{-1})	21264	65356	43592	3.00
T_5: Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (210 + 65 ga.i. ha^{-1})	21538	66890	44852	3.04
T_6: Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (252 + 78 g a.i. ha^{-1})	21814	70238	47924	3.15
T_7: Fomesafen 18.8 % SL + propaquizafop 5.83 % EC (294 + 91 ga.i. ha^{-1})	22088	73796	51208	3.27
T_8: Propaquizafop 2.5 % EC + imazethapyr 3.7 % SL (50 + 75 g a.i. ha^{-1})	21665	58869	36704	2.66
T_9: Hand weeding @ 15 & 30 DAS	30165	76307	46142	2.53
T_{10}: Weed free check	32165	78678	46513	2.45
T_{11}: Unweeded check	20165	28040	7875	1.39

control treatments involving pre and post emergence application of herbicides (Table 2). All the herbicide treatments produced significantly higher seed yield compared to the unweeded check. Significantly, higher seed and haulm yield were recorded with T_7 *i.e.*, post emergent application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} (1058 and 1437.8 kg ha^{-1}, respectively) which was statistically on par with hand weeding at 15 and 30 DAS (1094 and 1476.8 kg ha^{-1}, respectively) followed by fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 252+78 g a.i. ha^{-1} (1007 and 1400.3 kg ha^{-1}, respectively). Significantly higher yield of greengram with T_7 and T_6 were attributed to higher weed control efficiency (71.6 and 69.09, respectively) (Fig. 1), significantly more number of pods plant^{-1} (26.9 and 25.5, respectively), higher number of seeds per pod (7.08 and 7.07, respectively) and higher test weight (5.83 and 5.72 g, respectively) resulted in significant higher pod yield plant^{-1}. Unweeded check has recorded lowest seed and haulm yield (402 and 767.5kg ha^{-1}, respectively) due to lower number of pods plant^{-1} (12.5), number of seeds per pod (3.07) and test weight (3.92 g). The results are in accordance with the findings of Gupta *et al.* (2013), Algotar *et al.* (2014) and Mamatha *et al.* (2017).

Economics

Significantly higher gross returns was realized in the treatment weed free check (Rs.78,678 ha^{-1}) follow by hand weeding at 15 and 30 DAS (Rs.76,307 ha^{-1}) as a result of higher seed yield and weed control efficiency (Table 3). Whereas, significantly higher net returns and BC ratio were obtained in T_7 *i.e.* post-emergence application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} (Rs.51,208 ha^{-1} and 3.27) followed by T_6 *i.e.* fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 252 + 78 g a.i. ha^{-1} (Rs.47,924 ha^{-1} and 3.15) was due to higher seed yields with lesser cost of weeding with herbicide application. The net returns and BC ratio from weed free (Rs.46,142 ha^{-1} and 2.53) and hand weeding at 15 and 30 DAS (Rs.36,704 ha^{-1} and 2.66) were lower compared to herbicidal treatments. Even though highest gross returns was recorded in weed free check and hand weeding at

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15 and 30 DAS, higher labour wages increased the cost of cultivation and lowered the BC ratio. Whereas, in herbicide treatments T_7 and T_6, lower cost of cultivation was due to lower labour requirement for herbicide application which decreased the cost of cultivation which further increased the BC ratio. Similar results were reported by Tamang *et al*. (2014); Komal *et al.* (2015); Biswal (2017); Mamatha (2017) and Nagarjun & Dhanpal (2018). Lowest gross return, net return and BC ratio was recorded for unweeded check (Rs.20,165 ha^{-1}, Rs.28,040 ha^{-1} and 1.39, respectively).

Post-emergence application of fomesafen 18.8 per cent SL + propaquizafop 5.83 per cent EC @ 294 + 91 g a.i. ha^{-1} recoded significantly higher dry matter production (10.91 g $plant^{-1}$), seed yield (1058 kg ha^{-1}), net returns (Rs.51208 ha^{-1}) and BC ratio (3.27) and was also found effective in controlling weeds. Combination of herbicides fomesafen and propaquizafop is more effective and can be used for profitable greengram cultivation under present labour constraint conditions, thereby increasing the farmer's income.

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