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Research Paper

Effect of post-emergence herbicides on yield of *Kharif* groundnut

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Abstract: A field experiment was conducted to investigate the most appropriate post - emergence herbicides for the maximum weed control and yield enhancement in groundnut (*Arachis hypogaea* L.). The experiment in a RCBD with three replicates was conducted during *Kharif* season (June to October) 2013 and 2014 at the Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.), India. The crop variety AK 159 was sown at a spacing of 30 cm (between rows) x 10 cm (within row). Nine treatments including six post-emergence herbicides applied at 2-4 leaf stage of weeds, a pre-emergence herbicide, and a weedy and weed-free (hand weeding) control. The recommended mixture of fertilizer 25:50 N, and P (kg/ha) was applied as a basal dressing using Urea (46 % N) and SSP (16% P_2O_5), respectively. Among the herbicidal treatments, the lowest weed index (3.26%) was observed under post-emergence herbicides Propaquizafop 10 EC (100 g/ha) followed Quizalofop ethyl 5 EC (100 g/ha) with a weed index of 9.74%. The minimum weed dry weight was also recorded in these treatments, which was significantly lower ($p<0.05$) than all other treatments. The lowest weed control efficiency (81.6%) was recorded in plots with the pre-emergence application of Pendimethalin 30 EC (1000 g/ha). The highest dry pods yield (2,927 kg/ha) was recorded in the weed free control (hand weeding 20 and 40 Days after emergence) and the lowest (1,520 kg/ha) was under un-weeded control. The post-emergence herbicides Propaquizafop 10 EC (100 g/ha) recorded the highest gross and net monetary returns, which were at par ($p>0.05$) with Quizalofop ethyl 5 EC (100 g/ha) but significantly higher ($p<0.05$) as compared to other herbicidal treatments. Application of post--herbicides effectively controlled weeds, and resulted in a considerably lower cost of cultivation compared with hand weeding. The benefit:cost ratio was the highest with post emergence herbicides Propaquizafop 10 EC (100 g/ha) followed by Quizalofop ethyl 5 EC (100 g/ha) compared to other treatments.

Keywords: Groundnut yield, post emergence herbicides, weed control

Introduction

Groundnut (*Arachis hypogaea* L.) is grown mainly in the *Kharif* season (June-October) in India. It encounters severe weed infestation especially in the early stages of growth, as the crop seedling emerges seven to ten days after sowing coupled with the slow growth in the initial stages. The weeds emerge faster and grow rapidly competing with the crop severely for the resources namely, nutrients, light, and space and also transpire conserved water from the soil. On an average, the loss of groundnut production in the country due to weeds has been estimated as 33-70% (Dotray *et al*., 2012). Thus, weed control during initial stage of crop growth is

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essential to achieve the optimum crop yield. Though, physical methods of weed control are effective, the non-availability of labor during peak growing period, high labor cost, and unfavorable environmental conditions such as rainfall are among the major limitations in achieving successful results. Under such conditions, the chemical weed control plays an important role in groundnut and substantially enhances the crop yield (Patil *et al.*, 2012). Hence, an experiment was designed to elucidate the success of weed management in groundnut with the use of several post-emergence herbicides.

Materials and Methods

A field experiment was conducted during *Kharif* (June to October) season in 2013 and 2014 at the Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) in India. Groundnut (*Arachis hypogeae* L.) variety AK 159 was sown at a spacing of 30 cm (between rows) x 10 cm (within row) in a randomized complete block design (RCBD) with three replicates having nine treatments namely, T_1: Weeded check (un-weeded), T_2: Weed-free check (Clean plot), T_3: Propaquizafop 10 EC (100 g a.i./ha), T_4: Quizalofop ethyl 5 EC (50 g a.i./ha), T_5: Quizalofop ethyl 5 EC (100 g a.i./ha), T_6: Imazethapyr 10% SL (50 g a.i./ha), T_7: Imazethapyr 10% SL (100 g a.i./ha), T_8: Imazethapyr+Imazamox 70% WG (100 g a.i./ha) and T_9: Pendimethalin 30 EC (1000 g a.i./ha). The treatments T_3-T_8 were post-emergence herbicides applied at 25-30 days after crop emergence (DACE), where the weeds were at 2-4 leaf stage. The T_9 is a pre-emergence herbicide. Hand weeding (control, T_2) was done at fortnightly intervals until crop harvest. The herbicides were sprayed using a knapsack sprayer fitted with a flat fan nozzle, with spray volume of 500 L/ha. The gross and net plot sizes were 3.6 m x 3 m and 3 m x 2.8 m, respectively. The recommended fertilizer 25:50 N:P was used as a basal dressing using Urea (46% N) and SSP (16% P_2O_5), respectively.

The weed index (WI %), weed control efficiency % (visual observation compared to the weedy check) and weed dry weight/m^2 were determined at 60 days after weed emergence. The dry pod yield and haulm yield were obtained at harvest. The N (Kjeldhal method), P (Olsen-P) and K (Flame photometric method) uptake of weeds and crop were measured at the time of harvest. The gross monetary return (GMR, Indian Rs/ha), net monetary return (NMR; Indian Rs/ha), cost of cultivation (Indian Rs/ha) and the benefit:cost ratio of the treatments were calculated. Data of the two experiments were pooled for statistical analysis. Mean separation was done using critical difference at p=0.05.

Results and Discussion

The weeds observed in experiment site are given in Table 1. The experimental plots were dominated by broadleaf weeds followed by grasses.

Table 1. Weeds observed in the experimental site

Weed species	Common name	Family
	Grasses	
Cynodon dactylon (L.) Pers.	Doob grass	Poaceae
Ischaemum pilosum (Klein ex Willd.)	Kunda grass	Poaceae
Digitaria sanguinalis (L.) Scop.	Crab grass	Poaceae
Panicum spp.	Fall panicum	Poaceae
	Broadleaf weeds	
Achyranthus aspera Linn.	Prickly chaff flower	Amaranthaceae
Celosia argentia Linn.	Cock comb	Amaranthaceae
Commelina benghalensis L.	Day flower	Commelianaceae
Convolvulus arvensis L.	Bind weed	Convolvulaceae
Digera arvensis Forssk.	Amaranthus	Amaranthaceae
Euphorbia hirta L.	Spurge	Euphorbiaceae
Euphorbia geniculate Ortega.	Spurge	Euphorbiaceae
Parthenium hysterophorus L.	Rag weed	Compositeae
Phyllanthus niruri L.	Niruri	Euphorbiaceae
Tridax procumbens L.	Tridex	Compositeae
	Sedges	
Cyperus rotundus L.	Nut sedge	Cyperaceae

All herbicidal treatments significantly influenced ($p<0.05$) the weed index (WI) dry matter production of weeds (Table 2). The lowest WI (3.26%) was observed in the plots treated with Propaquizafop 10 EC (100 g a.i./ha) followed by (*fb*) Quizalofop ethyl 5 EC (100 g a.i./ha). The post-emergence application of Imazethapyr 10% SL (100 g a.i./ha), Imazethapyr+Imazamox 70% WG (100 g a.I./ha) and Quizalofop ethyl 5 EC (50 g a.i./ha), and the pre-emergence application of Pendimethalin 30 EC (1000 g a.i./ha) and the un-weeded check showed similar WIs ($p>0.05$) and were significantly higher ($p<0.05$) over the rest of the treatments. The maximum weed control efficiency (96.4%) was recorded with the post-emergence application of Propaquizafop 10 EC (100 g a.i./ha) *fb* Quizalofop ethyl 5 EC (100 g a.i./ha), Imazethapyr 10% SL (100 g a.i./ha), Imazethapyr+Imazamox 70% WG (100 g a.i./ha) and Quizalofop ethyl 5 EC (50 g a.i./ha). The lowest weed control efficiency was recorded with the pre-emergence application of Pendimethalin 30 EC (1000 g a.i./ha).

The lowest weed density and weed dry weight were recorded in the weed-free plots. Among the herbicidal treatments, Propaquizafop 10 EC (100 g a.i./ha) recorded the lowest weed density and dry weight ($p<0.05$) than the other herbicidal treatments. The plots with pre-emergence application of Pendimethalin 30 EC (1000 g a.i./ha) and the un-weeded check showed similar ($p>0.05$) but higher weed densities ($p<0.05$) over the rest. These results are in conformity with the findings of Patil *et al.* (2012) and Attarde *et al.* (2001) suggesting that the herbicides used have longer effect on weed controlling with significant reduction in weed dry matter as compared to un-weeded check.

Table 2. Weed growth, yield and economics of *Kharif* groundnut as influenced by different weed control treatments

Treatments[1]	Weed Index (%)	Weed control efficiency (%)	Weed density (No./m^2)	Weed dry matter (g/m^2)	Dry pod yield (kg/ha)	Haulm yield (kg/ha)	GMR[2] (Rs/ha)	COC[3] (Rs/ha)	NMR[4] (Rs/ha)	B:C[5] Ratio
T_1: Un-weeded check (control)	48.1	0.0	132.4	914.6	1520	3129	48640	24738	23902	1.97
T_2: Weed-free check	0.0	100.0	1.0	1.00	2927	3919	93674	32513	61161	2.88
T_3: Propaquizafop 10 EC (100 g a.i./ha), post-emergence	3.3	96.4	9.9	46.5	2832	3543	90624	27814	62810	3.26
T_4: Quizalofop ethyl 5 EC (50 g a.i./ha), post-emergence	17.1	87.3	14.2	70.5	2444	3297	78192	27325	50867	2.86
T_5: Quizalofop ethyl 5 EC (100 g a.i./ha), post-emergence	9.7	94.6	11.9	56.5	2689	3377	86048	27728	58320	3.10
T_6: Imazethapyr 10% SL (50 g a.i./ha), post-emergence	14.2	89.8	34.0	170.7	2546	3351	81472	27413	54059	2.97
T_7: Imazethapyr 10% SL (100 g a.i./ha), post-emergence	12.8	92.6	26.3	131.2	2603	3471	83285	27884	55401	2.99
T_8: Imazethapyr+Imazamox 70% WG (100 g a.i./ha), post-emergence	16.9	88.3	39.3	198.9	2486	3223	79552	27568	51984	2.89
T_9: Pendimethalin 30 EC (1000 g a.i./ha), pre-emergence	31.6	81.6	85.1	578.9	2141	3154	68522	27542	40980	2.49
SE(m)[6]	2.38	3.84	9.28	34.9	103	185	26523			
CD[7] at p=0.05	7.03	11.34	28.09	105.4	311	558	79934			
Grand Mean	17.07	81.17	39.35	240.9	2465.3	3384.8	78889	27836	51053	2.82

1 = Rates of herbicides are expressed as the amount of active ingredient (a.i.); 2 = gross monetary ratio in Indian Rs; 3 = net monetary ratio in Indian Rs.; 4 = cost of cultivation in Indian Rs.; 5 = benefit:cost ratio; 6 = standard error of the means; 7 = critical difference

The weed-free check recorded the highest dry pod yield of groundnut (2927 kg/ha) followed by ($p>0.05$) post-emergence application of Propaquizafop 10 EC (100 g a.i./ha) and Quizalofop ethyl 5 EC (100 g a.i./ha), but significantly higher ($p<0.05$) compared to the rest of the herbicide treatments (Table 2). The un-weeded check recorded the lowest pod yield (1520 kg/ha). The results are similar to those reported by Malunjkar *et al*. (2006), Sukhadia *et al*. (1998) and Virender *et al*. (2009). Walia *et al*. (2007) also reported yield losses in groundnut due to uncontrolled weed growth. Chaitanya *et al*. (2013) reported that the pre-emergence application of Pendimethalin (1000 g a.i./ha) along with Quizalofop ethyl (50 g a.i./ha) applied at 25 DACE has resulted in a higher growth and yield of *Kharif* groundnut compared to the farmer-practice and other weed management practices.

Among the herbicidal treatments, Propaquizafop 10 EC (100 g a.i./ha) recorded the maximum GMR and NMR, which was in par ($p>0.05$) with Quizalofop ethyl 5 EC (100 g a.i./ha), but significantly higher ($p<0.05$) compared to other treatments. The results supported the findings of Fayyaz and Azhar (2000), Majumder *et al*. (2009) and Malligawad *et al*. (2000). Herbicidal treatments incurred a lesser cost compared to hand weeding. The B:C ratio was the highest with Propaquizafop 10 EC (100 g a.i./ha) followed by Quizalofop ethyl 5 EC (100 g a.i./ha) than the rest of the treatments. Ghose *et al*. (2000) reported that the critical period for weed competition of the groundnut crop is during the first 50 to 60 days. In the preset study, weed competition during the first 30 days period of groundnut crop growth was found critical under *Kharif* rainfed condition.

Nutrient uptake by groundnut was higher in the weed-free treatment (Table 3), followed by post-emergence application of Propaquizafop 10 EC (100 g a.i./ha).

Table 3. Uptake of N, P and K by weeds (kg/ha) at crop harvest as influenced by various weed control treatments

Treatments[1]	N	P	K
	(kg/ha)		
T_1: Un-weeded check (control)	53.90	25.6	39.50
T_2: Weed-free check	0.00	0.00	0.00
T_3: Propaquizafop 10 EC (100 g a.i./ha), post-emergence	14.57	12.2	16.15
T_4: Quizalofop ethyl 5 EC (50 g a.i./ha), post-emergence	14.81	12.4	14.00
T_5: Quizalofop ethyl 5 EC (100 g a.i./ha), post-emergence	12.79	3.70	5.47
T_6: Imazethapyr 10% SL (50 g a.i./ha), post-emergence	13.82	11.1	11.82
T_7: Imazethapyr 10% SL (100 g a.i./ha), post-emergence	12.83	7.9	8.56
T_8: Imazethapyr+Imazamox 70% WG (100 g a.i./ha), post-emergence	14.10	11.8	12.64
T_9: Pendimethalin 30 EC (1000 g a.i./ha), pre-emergence	18.34	14.3	18.71
S.E. (m)[2]	1.19	0.7	0.94
C.D.[3] at p=0.05	3.57	2.1	2.84
Grand mean	17.24	11.0	14.09

1 = Rates of herbicides are expressed as the amount of active ingredient (a.i.); 2 = standard error of the means; 3 = critical difference

Weeds in the un-weeded control showed a significantly higher ($p<0.05$) nutrient uptake compared to the rest due to higher weed density in the former. Among the herbicidal treatment, post-emergence application of Quizalofop ethyl 5 EC (100 g a.i./ha) also produced better weed control and thus higher nutrient uptake by groundnut crop (Table 4) as reported by Dixit *et al*. (2012). The available N, P and K in soil would have been higher in the weed-free treatment thus resulting in higher crop uptake followed by the post-emergence application of Propaquizafop 10 EC (100 g a.i./ha) as observed by Chaitanya *et al.* (2013).

Table 4. Uptake of N, P and K by groundnut (kg/ha) at harvest as influenced by various weed control treatments

Treatments	N	P	K
	(kg/ha)		
T_1: Un-weeded check (control)	95.69	11.31	46.20
T_2: Weed-free check	195.27	34.03	112.53
T_3: Propaquizafop 10 EC (100 g a.i./ha), post-emergence	179.20	30.90	97.10
T_4: Quizalofop ethyl 5 EC (50 g a.i./ha), post-emergence	146.50	16.60	67.00
T_5: Quizalofop ethyl 5 EC (100 g a.i./ha), post-emergence	161.71	25.90	76.99
T_6: Imazethapyr 10% SL (50 g a.i./ha), post-emergence	148.69	20.37	75.39
T_7: Imazethapyr 10% SL (100 g a.i./ha), post-emergence	151.60	22.63	76.21
T_8: Imazethapyr+Imazamox 70% WG (100 g a.i./ha), post-emergence	140.89	18.47	69.82
T_9: Pendimethalin 30 EC (1000 g a.i./ha), pre-emergence	123.04	14.73	61.45
S.E. $(m)^2$	9.83	1.16	5.16
C.D.[3] at p=0.05	29.64	3.48	15.56
Grand mean	149.17	21.66	75.85

1 = Rates of herbicides are expressed as the amount of active ingredient (a.i.); 2 = standard error of the means; 3 = critical difference

Conclusion

Post-emergence application of Propaquizafop 10 EC (100 g a.i./ha) and Quizalofop ethyl 5 EC (100 g a.i./ha), were most effective for controlling weeds, and found to be profitable through improvement productivity of *Kharif* groundnut**.**

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