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M Jitendra
Department of Agronomy, Agricultural College, ANGRAU, Hyderabad, Telangana, India

K Srinivasulu
Department of Agronomy, Agricultural College, ANGRAU, Hyderabad, Telangana, India

PVN Prasad
Department of Agronomy, Agricultural College, ANGRAU, Hyderabad, Telangana, India

M Ravi Babu
Department of Crop Physiology, Agricultural College, ANGRAU, Hyderabad, Telangana, India

Corresponding Author:
M Jitendra
Department of Agronomy, Agricultural College, ANGRAU, Hyderabad, Telangana, India

Pre-emergence and Post-emergence weeds management in groundnut crop using selective herbicides

M Jitendra, K Srinivasulu, PVN Prasad and M Ravi Babu

Abstract
A field experiment was undetaken during *rabi* season, 2020–21 on a sandy loamy soil at the agricultural college farm, Bapatla to investigate the effect of different weed management practices on the growth and yield of groundnut. The experiment was laid out in randomized block design with nine treatments and three replications. The results of the experiment revealed that the lowest weed density, weed dry weight and the highest weed control efficiency were recorded at 60 days after sowing (DAS) with hand weeding at 20 and 40 DAS (12.87 No. m^{-2}, 5.61 g m^{-2} and 93.84%, respectively), which was on a par with alachlor 1.5 kg a.i ha^{-1} as pre-emergence followed by (PE *fb*) hand weeding at 30 DAS (23.67 No. m^{-2}, 15.94 g m^{-2} and 82.48%, respectively) and Fomesafen 110g + fluazifop-p-butyl 110 g a.i ha^{-1} as post emergence (PoE) at 20 DAS (22.78 g m^{-2} and 74.96%, respectively). Crop growth parameters like plant height, dry matter production and leaf area index were found superior with hand weeding at 20 and 40 DAS, which was on par with alachlor 1.5 kg a.i ha^{-1} as pre-emergence followed by hand weeding at 30 DAS and propaquizafop 50 g + imazethapyr 75 g a.i ha^{-1} as post emergence at 20 DAS. Highest number of pods/plants, pod yield, kernel yield and shelling per cent were recorded with hand weeding at 20 and 40 DAS (8.2, 2287 kg ha^{-1}, 1630 kg ha^{-1} and 71.2%, respectively), which was on a par with alachlor @ 1.5 kg a.i ha^{-1} as pre-emergence.

Keywords: Groundnut, herbicides, weed management, growth and yield

1. Introduction
Groundnut is the 4th most oilseed crop and 13th crucial food crop of the world. China and India are huge producers of groundnut, accounting for over 41% and 18% of total world's production, respectively. It occupies an area of 27.96 m ha in the world with a production of 47.09 m t and productivity of 1680 kg ha^{-1} (FAOSTAT, 2018-19). Whereas in India, it is cultivated to an extent of 4.88 m ha with a production of 9.25 m t and productivity of 1893 kg ha^{-1} (www.indiastat.com, 2017-18) [3] and it occupies a predominant position among all the oil seeds. Groundnut cultivation is associated with several constraints of which weed interference is the major bottle neck for achieving high yield. They are the certain class of pests which can limit the production of major crops and cause serious losses of about 33% on an average (DWR-ICAR, 2015) [1]. They pose a severe competition for all the resources such as light, moisture and space when they are limited. They can remove about 30-40% of applied nutrients. Due to short stature and initial slow growth, groundnut is highly susceptible to weed preponderance. Weed infestation can reduce the yield of *kharif* groundnut by 15 to 75% (Priya *et al*. 2013) [6]. The age-old practice of controlling weeds in groundnut by cultural practices (hand weeding an inter cultivation), which although much effective is time consuming, expensive and laborious. Application of selective pre-emergence herbicides like oxyfluorfen or metolachlor or Alachlor and pre-emergence followed by one hand weeding are common practices for managing weeds during early stages. This allows emergence of weeds at later stages particularly in groundnut where most of the research work confirm the same. Post-emergence herbicides offer a great scope to tide over these situations. This warrants development of post-emergence herbicides in order to manage the late emerging weeds potentially. In this context, there is a need to find out new generation post-emergence herbicide mixtures for effective control of broad-spectrum weeds in groundnut. With this view, the present study is conducted to find out the best post-emergence herbicide for the management of weeds in groundnut crop and for the benefit of farmers.

2. Materials and Methods
A field experiment was conducted during *rabi*, 2020–21 at the agricultural college farm,

Bapatla, which is located in the Krishna agro-climatic zone of Andhra Pradesh, geographically situated between 15º 55' N latitude and 80º 28' E longitude with an altitude of 5.49 meters above the mean sea level. The experiment was laid out in randomized block design with nine treatments *viz.*, T_1: Weedy check, T_2: Hand weeding at 20DAS and 40DAS, T_3: alachlor 1.5 kg a.i ha^{-1} as pre-emergence followed by hand weeding at 30 DAS, T_4: imazethapyr 50 g a.i ha^{-1} as post-emergence, T_5: quizalofop ethyl 50 g a.i ha^{-1} as post-emergence, T_6: alachlor 1.5 kg a.i ha^{-1}as pre-emergence followed by hand weeding at 30 DAS, T_7: propaquizafop 50g + imazethapyr 75 ga.i ha^{-1} as post-emergence at 20 DAS, T_8: acifluorfen 160g + clodinafop propargyl 80 g a.i ha^{-1} as post-emergence at 20DAS, T_9: fomesafen 110 g + fluazifop-p-butyl 110 g a.i ha^{-1} as post-emergence at 20 DAS and three replications. Groundnut variety "DHARANI" was sown at spacing of 22.5 cm x 10 cm. Application of nutrients was done as per the recommendation, 30 kg N, 40 kg P_2O_5 and 50 kg K_2O ha^{-1} in the form of urea, single super phosphate (SSP) and muriate of potash (MOP) respectively. 20 kg of nitrogen, and entire dose of phosphorous and potassium were applied as basal, remaining 10 kg of nitrogen was top dressed at 25 DAS. Gypsum was applied at the rate of 500 kg ha^{-1} at 30 DAS in the podding zone through band placement. Field operations such as irrigation and plant protection measures were taken as per requirement. The data on weed density (No. m^{-2}), weed dry weight (g m^{-2}), weed control efficiency (%), plant height (cm), dry matter production (kg ha^{-1}), leaf area index, number of pods plant^{-1}, number of kernels pod^{-1}, test weight (g), pod yield (kg ha^{-1}), kernel yield (kg ha^{-1}) and shelling per cent (%) were recorded as per standard procedures. Data were analyzed using ANOVA and the significance was tested by Fisher's least significance difference (p=0.05).

3. Results and Discussion

The predominant weed species observed in experimental plot were grasses like *Cynodon dactylon*, *Digitaria sanguinalis* and *panicum repens*, sedge *Cyperus rotundus* and broad-leaved weeds like *Trichodesma indica*, *Cleome viscosa*, *Indigiofera hirsuta* and *Phyllanthus niruri*. Significantly lower weed density and dry weight were observed with all weed management practices over the weedy check (Table.1). At 60 DAS, the lowest density and dry weight of weeds (12.87 No. m^{-2}, 5.61 g m^{-2}, respectively) were recorded with hand weeding at 20 and 40 DAS (T_2). However, it was on a par with alachlor 1.5 kg a.i ha^{-1}as pre-emergence followed by hand weeding at 30 DAS (23.67 No. m^{-2}, 15.94 g m^{-2}, respectively). Among the post-emergence herbicides studied, fomesafen 110g + fluazifop-p-butyl 110 g a.i ha^{-1} at 20 DAS (22.78 g m^{-2}) performed better throughout the crop growth period than other treatments. The highest weed control efficiency (93.84%) was recorded with hand weeding at 20 and 40 DAS (T_2), which was at par with alachlor 1.5 kg a.i ha^{-1}as pre-emergence followed by hand weeding at 30 DAS (82.48%). Among the post-emergence herbicides studied, the highest weed control efficiency (74.96%) was recorded with fomesafen 110g + fluazifop-p-butyl 110 g a.i ha^{-1} at 20 DAS (T_9). This might be due to effective weed control obtained under hand weeding, pre- and post-emergence application of herbicides at initial and early growth stage, which resulted into the lowest weed density and finally reduced the total dry weight of weeds and higher weed control efficiency. Similar findings were observed by Venkateswarlu (2011) [9], Kundu *et al*. (2011) [4] and Shah and Pramanik (2020). Furthermore, phytotoxic symptoms like discoloration of leaves, reduction in leaf area and stunted growth were observed with the application of acifluorfen + clodinafop propargyl (T_8) and fomesafen + fluazifop-p-butyl (T_9). However, crop recovered from the phytotoxic effect by 14 days after spraying (Table. 2).

The highest plant height, leaf area index and dry matter production across the growth stages were observed with hand weeding at 20 and 40 DAS (T_2), which was on a par with alachlor 1.5 kg a.i ha^{-1}as pre-emergence followed by hand weeding at 30 DAS (T_6) (Table.3). Among the post-emergence herbicides studied, propaquizafop 50g + imazethapyr 75 g a.i ha^{-1} as post-emergence at 20 DAS (T_7) recorded the highest plant height, leaf area index and drymatter production. This might be due to timely and effective control of all the categories of weeds during the critical stage which might have increased availability of resources to the crop plants, thereby increased plant height which in turn resulted in production of a greater number of large size leaves, which resulted in increased leaf area index and dry matter production. Similar results were reported by Sumachandrika *et al*. (2002) [8], Sandil *et al*. (2015) [7] and Divymani *et al*. (2018). Moreover, the highest number of pods plant^{-1}, pod yield, kernel yield and shelling per cent (8.2, 2287 kg ha^{-1}, 1630 kg ha^{-1} and 71.2%, respectively), were found with hand weeding at 20 and 40 DAS (T_2) (Table 4). Among the post-emergence herbicides studied, propaquizafop 50 g + imazethapyr 75 g a.i ha^{-1} as post-emergence at 20 DAS (T_2) recorded comparable number of pods plant^{-1}, pod yield, kernel yield and shelling per cent (8.0, 1986 kg ha^{-1}, 1398 kg ha^{-1} and 70.4%, respectively) with hand weeding at 20 and 40 DAS (T_2). This might be due less weed competition resulting in less competition for growth resources offered by weeds right from the crop establishment to harvest, which in turn lead to inflated stature of yield attributing characters and finally increased the pod and kernel yield. Similar results were reported Kundu *et al*. (2011) [4] and Patel *et al*. (2019) [5].

Table 1: Effect of weed management practices on weed density (No.m^{-2}), dry weight (g m^{-2}) and weed control efficiency (%) at 30, 45 and 60 DAS in groundnut

Treatments	Weed density (No.m^{-2})			Weed dry weight (g m^{-2})			Weed control efficiency (%)		
	30DAS	45DAS	60DAS	30DAS	45DAS	60DAS	30DAS	45DAS	60DAS
T_1: Weedy check	10.40 (107.67)	10.67 (113.33)	10.98 (120.00)	7.97 (63.01)	8.71 (75.28)	9.56 (90.96)	0.00	0.00	0.00
T_2: Hand weeding at 20 and 40 DAS	3.81 (14.00)	0.71 (0.00)	3.66 (12.87)	2.69 (6.75)	0.71 (0.00)	2.47 (5.61)	89.29	100.00	93.84
T_3: Alachlor @ 1.5 kg a.i ha^{-1} as PE	6.42 (40.67)	7.47 (55.33.)	8.17 (66.33)	5.49 (29.65)	6.19 (37.85)	6.58 (42.85)	53.02	49.72	52.89
T_4: Imazethapyr @ 50 g a.i ha^{-1} as PoE	6.52 (42.00)	6.92 (47.33)	7.22 (51.67)	5.11 (24.46)	5.53 (30.13)	5.95 (34.89)	61.18	60.02	61.64
T_5: Quizalofop ethyl @ 50 g a.i ha^{-1} as PoE	7.47	7.58	8.22	5.78	6.45	7.43	47.85	45.32	39.89

	(55.33)	(57.00)	(67.00)	(32.86)	(41.15)	(54.68)			
T_6: Alachlor @ 1.5 kg a.i ha^{-1}as PE *fb* hand weeding at 30 DAS	1.96 (3.33)	2.91 (8.00)	4.92 (23.67)	1.24 (1.05)	1.88 (3.01)	4.05 (15.94)	98.33	95.99	82.48
T_7: Propaquizafop @ 50 g + Imazethapyr @75 g a.i ha^{-1} as PoE at 20 DAS	5.96 (35.00)	5.79 (33.00)	6.10 (36.67)	4.14 (16.74)	4.59 (20.55)	4.91 (23.60)	73.43	72.70	74.05
T_8: Acifluorfen @ 160 g + Clodinafop propargyl @ 80 g a.i ha^{-1} as PoE at 20 DAS	5.67 (31.67)	6.28 (39.00)	7.25 (52.00)	4.76 (22.12)	5.13 (25.82)	4.90 (23.56)	64.89	65.70	66.40
T_9: Fomesafen @ 110 g + Fluazifop-p-butyl @ 110 g a.i. ha^{-1} as PoE at 20 DAS	5.64 (31.33)	5.79 (33.00)	5.70 (32.00)	3.92 (14.84)	4.30 (17.97)	4.82 (22.78)	76.45	76.13	74.96
S.Em±	0.64	0.69	0.49	0.91	0.25	0.92	7.93	6.51	7.61
CD (P=0.05)	1.92	2.09	1.48	2.74	0.74	2.76	24.38	19.74	22.84
CV (%)	17.12	18.18	16.40	19.48	15.22	21.35	21.06	17.50	22.09

The data transformed to square root transformation ($\sqrt{X+0.5}$). The figures in parenthesis are original values

Table 2: Phytotoxic effect of different herbicidal treatments on groundnut

Treatments	Pre-emergence spray		Post-emergence spray	
	7 DAS	14 DAS	7 DAS	14 DAS
T_1: Weedy check	-	-	-	-
T_2: Hand weeding at 20 and 40 DAS	-	-	-	-
T_3: Alachlor @ 1.5 kg a.i ha^{-1} as PE	0	0	-	-
T_4: Imazethapyr @ 50 g a.i ha^{-1} as PoE	-	-	0	0
T_5: Quizalofop ethyl @ 50 g a.i ha^{-1} as PoE	-	-	0	0
T_6: Alachlor @ 1.5 kg a.i ha^{-1}as PE *fb* hand weeding at 30 DAS	-	-	-	-
T_7: Propaquizafop @ 50 g Imazethapyr @ 75 g a.i ha^{-1} as PoE at 20 DAS	-	-	0	0
T_8: Acifluorfen @ 160 g + Clodinafop propargyl @ 80 g a.i ha^{-1} as PoE at 20 DAS	-	-	1	0
T_9: Fomesafen @ 110g + Fluazifop-p-butyl @ 110 g a.i. ha^{-1} as PoE at 20 DAS	-	-	1	0

*Rating 0= No symptoms
*Rating 1 = Slight stunting, injury/discolouration

Table 3: Effect of wed management practices on plant height (cm), leaf area index and dry matter production (kg ha^{-1}) at 40, 60 and 80 DAS and at harvest in groundnut

Treatments	Plant height (cm)				Leaf area index				Dry matter production (kg m^{-2})			
	40 DAS	60 DAS	80 DAS	At harvest	40 DAS	60 DAS	80 DAS	At harvest	40 DAS	60 DAS	80 DAS	At harvest
T_1: Weedy check	22.2	24.0	26.3	27.0	0.96	1.75	3.38	0.41	1667.4	2918.0	3184.7	3351.3
T_2: Hand weeding at 20 and 40 DAS	24.5	30.4	33.0	33.3	1.28	3.37	4.93	0.67	2277.7	4338.6	5113.3	5529.9
T_3: Alachlor @ 1.5 kg a.i ha^{-1} as PE	24.9	28.5	30.2	30.5	1.18	2.20	4.26	0.55	2096.4	3801.3	4405.5	4723.3
T_4: Imazethapyr @ 50 g a.i ha^{-1} as PoE	25.2	29.2	30.8	31.0	1.13	2.97	4.35	0.60	2194.5	3845.1	4493.4	4892.7
T_5: Quizalofop ethyl @ 50 g a.i ha^{-1} as PoE	24.0	29.1	30.5	30.8	1.12	2.94	4.31	0.60	2113.7	3814.3	4281.9	4871.8
T_6: Alachlor @ 1.5 kg a.i ha^{-1}as PE *fb* hand weeding at 30 DAS	26.3	31.0	32.3	33.2	1.28	3.17	4.86	0.66	2250.1	4217.4	4925.8	5465.7
T_7: Propaquizafop @ 50 g + Imazethapyr @75 g a.i ha^{-1} as PoE at 20 DAS	24.0	29.9	31.5	32.7	1.22	3.15	4.52	0.62	2209.9	4005.5	4676.7	5321.2
T_8: Acifluorfen @ 160 g + Clodinafop propargyl @ 80 g a.i ha^{-1} as PoE at 20 DAS	23.1	27.6	28.6	29.0	0.99	2.43	3.70	0.57	1904.1	3455.9	4012.1	4632.2
T_9: Fomesafen @ 110g + Fluazifop-p-butyl @ 110 g a.i. ha^{-1} as PoE at 20 DAS	22.4	27.7	28.7	29.1	1.02	2.67	3.83	0.60	1840.0	3409.8	4152.6	4717.4
S.Em±	0.80	0.72	0.83	0.92	0.06	0.15	0.16	0.03	110.46	191.84	119.70	159.87
CD (P=0.05)	2.41	2.16	2.48	2.77	0.18	0.44	0.47	0.08	331.17	575.16	358.86	479.30
CV (%)	5.78	5.37	5.76	5.18	9.29	9.30	7.11	8.01	9.28	8.85	5.30	5.70

Table 4: Effect of wed management practices on yield attributing characters, pod yield (kg ha^{-1}), kernel yield (kg ha^{-1}) and shelling per cent (%) of groundnut

Treatments	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Shelling per cent (%)
T_1: Weedy check	1171	707	60.4
T_2: Hand weeding at 20 and 40 DAS	2287	1630	71.2
T_3: Alachlor @ 1.5 kg a.i ha^{-1} as PE	1470	1002	68.2
T_4: Imazethapyr @ 50 g a.i ha^{-1} as PoE	1609	1083	67.3
T_5: Quizalofop ethyl @ 50 g a.i ha^{-1} as PoE	1681	1156	68.8
T_6: Alachlor @ 1.5 kg a.i ha^{-1}as PE *fb* hand weeding at 30 DAS	1998	1413	70.7
T_7: Propaquizafop @ 50 g + Imazethapyr @ 75 g a.i ha^{-1} as PoE at 20 DAS	1986	1398	70.4
T_8: Acifluorfen @ 160 g + Clodinafop propargyl @ 80 g a.i ha^{-1} as PoE at 20 DAS	1667	1136	68.2
T_9: Fomesafen @ 110g + Fluazifop-p-butyl @ 110 g a.i. ha^{-1} as PoE at 20 DAS	1785	1214	67.8
S.Em±	122.08	90.57	0.57
CD (P=0.05)	366.02	271.44	1.70
CV (%)	12.17	13.14	1.44

4. Conclusion

Overall, the study revealed that propaquizafop 50 g + imazethapyr 75 g a.i ha^{-1} as post-emergence at 20 DAS gave comparable pod yields (1986 kg ha^{-1}) and kernel yield (1398 kg ha^{-1}) of groundnut with hand weeding at 20 and 40 DAS (2287 kg ha^{-1} and 1630 kg ha^{-1}, respectively).

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