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Effectiveness of herbicide mixture on weeds and yield of summer groundnut

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ABSTRACT

A field experiment was conducted during two consecutive summer season of 2018 and 2019 in loamy sand soil at B. A. College of Agriculture, Anand Agricultural University, Anand to study the effect of integrated weed management in summer groundnut. Results indicated that pre-emergence application of oxyfluorfen 180 g/ha PE *fb* interculturing (IC) + hand weeding (HW) at 40 DAS found to be effective for controlling weeds, and higher pod yield (3.99 t/ha) of groundnut, followed by oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE, IC *fb* HW at 20 and 40 DAS, oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (pre-mix) and fluazifop-p-butyl + fomesafen 250 g/ha ePoE (pre-mix) *fb* IC + HW at 40 DAS.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important edible oilseed crop of India popularly known as peanut or monkey nut belongs to the family leguminosae. Among all oilseed crops, groundnut accounts for more than 40-50% in area and 60-70% in production in the country. Gujarat is the largest producer contributing 25% of the total production of groundnut followed by Andhra Pradesh, Tamil Nadu and Karnataka (Sameer *et al.* 2014). Heavy weed infestation appears to be the most serious menace in groundnut production causing extensive losses. Because of its short stature and initial slow growth in comparison to fast growing weeds, weeds smother this crop at every stage by sharing water, nutrients, space, solar radiation and other resources resulting in yield losses ranging between 15-75% (Jat *et al.* 2011). Hence, for achieving potential yield, timely and effective weed control during the critical period of weed competition become necessary. Application of selective herbicides may control limited weed species but may not be effective on complex weed flora. Sometimes pre-emergence herbicides weed control for a limited period and therefore, late emerging weeds escape to applied herbicide. There is ample scope for controlling weeds by application of early post-emergence herbicides, herbicide mixtures or with integration of mechanical method. Moreover, recently many pre-mix herbicides are available in the market which provide effective control of weeds with less total active ingredient. Looking to this, an experiment was conducted to study the integrated weed management in summer groundnut under middle Gujarat conditions.

MATERIALS AND METHODS

A field experiment was conducted during summer season 2018 and 2019 in loamy sand soil at B.A. College of Agriculture, Anand Agricultural University, Anand. The soil of the experimental field was low in available nitrogen and medium in available phosphorous and high in potassium. Twelve weed management practices consisted of oxyfluorfen 180 g/ha pre-emergence (PE) *fb* interculturing (IC) + HW at 40 DAS, oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha post-emergence (PoE), oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (pre-mix), quizalofop-ethyl 50 g/ha early post-emergence (ePoE) *fb* interculturing (IC) + hand weeding (HW) at 40 DAS, imazethapyr 100 g/ha ePoE *fb* interculturing (IC) + hand weeding (HW) at 40 DAS, imazethapyr 150 g/ha PoE, imazethapyr + imazamox 70 g/ha PoE (pre-mix), imazethapyr + imazamox 70 g/ha ePoE (pre-mix) *fb* HW at 40 DAS, fluazifop-p-butyl + fomesafen 250 g/ha PoE (pre-mix), fluazifop-p-butyl + fomesafen 250 g/ha ePoE (pre-mix) *fb* interculturing (IC) + HW at 40 DAS, interculturing (IC) *fb* HW at 20 and 40 DAS and weedy check were laid out in a randomized block design with three replications. Groundnut cv. '*TG 37*' was sown on 20 and 6 February, 2018 and 2019, respectively keeping spacing of 30 x 10 cm by using seed rate of 120 kg/ha. The crop was harvested on 1 and 7 June, 2018 and 2019, respectively. Pre-and post-emergence herbicides were applied by using battery operated knapsack sprayer fitted with flat-fan nozzle by mixing in 500 litre of water/ha as per treatments. The crop was fertilizer with recommended rate of fertilizer with

25 kg N and 50 kg P/ha in the form of urea and single super phosphate, respectively as a basal dose.

Density and dry weight of weeds were recorded from randomly selected four spots by using 0.25 m^2 quadrate from net plot through destructive sampling at harvest. Weed control efficiency (WCE) was calculated on the basis of standard formulas suggested by Maity and Mukherjee (2011). The yield reduction (%) owing to the presence of weeds was estimated by using the formula suggested by Kumar and Gill (1969) and expressed as weed index (WI). Other growth and yield attributing observations were also recorded from net plot area. Seed index was worked out based on the counting of 100 seeds. Shelling percentage was calculated based on the following formula

$$\text{Shelling percentage (\%)} = \frac{\text{Weight of seed}}{\text{Weight of unshelled pods}} \times 100$$

Data of various observations during the experiment period were statistically analysed as per the standard procedure developed by Cochran and Cox (1957).

RESULTS AND DISCUSSION

Effect on weeds

Experimental field was infested with *Eleusine indica* (24.1%), *Dactyloctenium aegyptium* (15.0%), *Eragrostis major* (9.28%) and *Digitaria sanguinalis* (4.81%) in monocot weeds whereas, *Trianthema monogyna* (21.5%), *Phyllanthus niruri* (18.0%), *Digera arvensis* (2.40%) and *Amaranthus viridis* (2.18%) in dicot weed category. Density and dry biomass of total weeds (6.49/m^2 and 10.4 g/m^2, respectively) was recorded significantly lower under application of oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS at harvest (**Table 1**). Chandolia *et al*. (2010) also reported that application of oxyfluorfen along with hand weeding at 30 DAS was found more effective in controlling weeds at all the stages of crop growth. Among all the weed management practices, application of oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS stood first by providing maximum weed control efficiency followed by oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE, oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE and fluazifop-p-butyl + fomesafen 250 g/ha ePoE (premix) *fb* IC + HW at 40 DAS. Higher weed control

Table 1. Density and dry biomass of total weeds, WCE and weed index as influenced by weed management practices in summer groundnut

Treatment	Weed density at harvest (no./m^2)			Weed dry biomass at harvest (g/m^2)			Weed control efficiency (%)			Weed index (%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS	6.80^{d} (45.3)	6.19^{h} (37.3)	6.49^{h} (41.3)	10.7^{e} (114)	10.0^{e} (101)	10.4^{f} (107)	75.7	78.5	77.2	-	-	-
Oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE	7.34^{d} (53.3)	6.56^{fgh} (42.7)	6.95^{gh} (48.0)	10.9^{e} (119)	10.4^{e} (107)	10.6^{def} (113)	74.7	77.2	75.9	1.1	2.5	2.0
Oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (premix)	8.29^{cd} (68.0)	8.13^{defg} (66.7)	8.21^{def} (67.3)	11.7^{e} (136)	10.7^{e} (114)	11.2^{def} (125)	71.1	75.7	73.3	2.6	7.6	5.5
Quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS	8.11^{cd} (65.3)	6.67^{cdef} (74.7)	8.39^{de} (70.0)	12.1^{de} (146)	11.6^{e} (135)	11.9^{de} (141)	68.9	71.2	69.9	28.5	27.6	28.1
Imazethapyr 100 g/ha ePoE *fb* IC + HW at 40 DAS	8.10^{cd} (64.7)	6.69^{fgh} (44.0)	7.40^{efgh} (54.3)	11.9^{de} (142)	12.0^{de} (143)	12.0^{de} (142)	69.8	69.5	69.7	4.6	9.9	7.5
Imazethapyr 150 g/ha PoE	10.2^{ab} (104)	9.56^{bcd} (90.7)	9.90^{bc} (97.3)	15.6^{c} (242)	15.1^{c} (226)	15.3^{c} (234)	48.5	51.8	50.1	55.6	53.1	54.4
Imazethapyr + imazamox 70 g/ha PoE (premix)	11.1^{a} (121)	9.98^{bc} (98.7)	10.5^{ab} (110)	18.3^{b} (334)	19.7^{ab} (390)	19.0^{b} (362)	28.9	16.8	22.8	69.8	73.3	71.7
Imazethapyr + imazamox 70 g/ha ePoE (premix) *fb* HW at 40 DAS	9.08^{bc} (82.7)	8.76^{cde} (76.0)	8.92^{cd} (79.3)	12.9^{de} (167)	11.6^{e} (135)	12.3^{d} (151)	64.5	71.2	67.8	18.2	23.8	21.3
Fluazifop-p-butyl + fomesafen 250 g/ha PoE (premix)	10.7^{a} (113)	11.1^{ab} (124)	10.9^{ab} (119)	18.9^{b} (356)	18.8^{b} (355)	18.8^{b} (356)	24.2	24.3	24.1	74.3	73.1	73.7
Fluazifop-p-butyl + fomesafen 250 g/ha ePoE (premix) *fb* IC + HW at 40 DAS	7.57^{d} (57.3)	7.67^{efgh} (58.7)	7.62^{efg} (58.0)	11.4^{e} (130)	11.2^{e} (125)	11.3^{def} (128)	72.3	73.3	72.7	2.8	8.5	6.0
IC *fb* HW at 20 and 40 DAS	6.89^{d} (46.7)	7.80^{efgh} (60.0)	7.35^{efgh} (53.3)	13.8^{cd} (190)	14.0^{cd} (196)	13.9^{c} (193)	59.6	58.2	58.8	1.7	6.5	4.5
Weedy check	11.4^{a} (128)	11.9^{a} (141)	11.6^{a} (134)	21.7^{a} (470)	21.6^{a} (469)	21.6^{a} (469)	-	-	-	89.2	91.3	90.4
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	-	-	-	-	-	-
LSD (p=0.05)	8.5	11.0	9.5	7.0	8.7	7.9	-	-	-	-	-	-

Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. Treatment means with the letter/ letters in common are not significant by Duncan's New Multiple Range Test at 5% level of significance.

Table 2. Plant stand and plant height as influenced by weed management practices in summer groundnut

Treatment	Plant stand (no./m row length)						Plant height (cm)					
	15 DAS			At harvest			At 30 DAS			At harvest		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS	9.67	9.73	9.70	8.57^{ab}	8.73^{ab}	8.65^{ab}	10.1	7.08^{abc}	8.59	38.6^{d}	38.6^{f}	38.6^{de}
Oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE	9.33	9.80	9.57	8.17^{abcd}	9.07^{a}	8.62^{abc}	9.67	6.92^{abc}	8.30	41.3^{bcd}	43.0^{bcdef}	42.2^{cd}
Oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (premix)	10.3	9.53	9.93	9.10^{a}	8.60^{abc}	8.85^{a}	9.44	7.60^{a}	8.52	37.8^{d}	38.2^{f}	38.0^{de}
Quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS	9.80	9.67	9.73	8.50^{ab}	8.93^{a}	8.72^{ab}	9.03	6.88^{abc}	7.95	36.5^{d}	36.9^{f}	36.7^{e}
Imazethapyr 100 g/ha ePoE *fb* IC + HW at 40 DAS	10.3	9.80	10.1	9.07^{a}	8.80^{a}	8.93^{a}	9.49	7.31^{ab}	8.40	37.6^{d}	37.7^{f}	37.7^{de}
Imazethapyr 150 g/ha PoE	9.67	9.47	9.57	7.03^{cde}	8.40^{abc}	7.72^{bcde}	10.1	6.56^{bc}	8.34	50.7^{a}	52.8^{ab}	51.8^{b}
Imazethapyr + imazamox 70 g/ha PoE (premix)	10.0	9.87	9.93	7.37^{bcde}	6.73^{d}	7.05^{ef}	10.7	6.55^{bc}	8.63	53.5^{a}	59.0^{a}	56.3^{ab}
Imazethapyr + imazamox 70 g/ha ePoE (premix) *fb* HW at 40 DAS	9.67	9.87	9.77	8.40^{abc}	8.80^{a}	8.60^{abcd}	9.13	6.25^{c}	7.69	42.5^{bc}	44.5^{bcde}	43.5^{c}
Fluazifop-p-butyl + fomesafen 250 g/ha PoE (premix)	9.40	9.80	9.60	6.17^{e}	6.67^{d}	6.42^{f}	10.7	6.27^{c}	8.46	43.9^{b}	46.6^{bcd}	45.2^{c}
Fluazifop-p-butyl + fomesafen 250 g/ha ePoE (premix) *fb* IC + HW at 40 DAS	9.00	9.47	9.23	7.93^{abcd}	8.40^{abc}	8.17^{abcd}	9.27	6.67^{bc}	7.97	40.3^{bcd}	41.0^{f}	40.6^{cde}
IC *fb* HW at 20 and 40 DAS	10.0	9.93	9.97	8.87^{a}	8.87^{a}	8.87^{a}	9.53	6.45^{bc}	7.99	43.9^{b}	47.1^{bc}	45.5^{c}
Weedy check	9.33	9.53	9.43	4.37^{f}	4.80^{e}	4.58^{g}	10.4	6.17^{c}	8.27	54.7^{a}	60.8^{a}	57.7^{a}

efficiency with pre-emergence application of oxyfluorfen in groundnut was also reported by Priya *et al*. (2017).

Effect on crop and economics

The lowest plant stand (6.42/m) was observed under weedy check. Application of fluazifop-p-butyl + fomesafen 250 g/ha PoE (pre-mix) and imazethapyr + imazamox 70 g/ha PoE (pre-mix) both were at par with each other but recorded significantly lower plant stand as compared to other herbicidal treatments (**Table 2**). This may be due to phytotoxicity with fluazifop-p-butyl + fomesafen 250 g/ha PoE (pre-mix) and imazethapyr + imazamox 70 g/ha PoE (pre-mix) in terms of necrosis and epinasty and hyponasty symptoms on the leaves. Galon *et al*. (2018) also noted that fluazifop-p-butil + fomesafen caused low (less than 12%) phytotoxicity to the bean. Maximum plant height of 34.8 and 57.7 cm was measured under weedy check at 60 DAS and harvest, respectively. All the herbicidal treatments remained at par with each other with respect to plant height recorded at 60 DAS. At harvest, significantly higher plant height was measured under imazethapyr + imazamox 70 g/ha PoE as compared to rest of the treatment except imazethapyr 150 g/ha PoE. The higher plant height under said treatments may be due to maintenance of weed free environment which leads to better uptake of nutrient by the crops which help in increase in growth of plant in terms of plant height. Shelling percentage was non-significant but seed index was significant only in pooled results (**Table 3**). Significantly higher seed index (37.1 g) was recorded under weedy check as compared to oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS, oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE, imazethapyr 100 g/ha PoE *fb* IC + HW at 40 DAS, imazethapyr 150 g/ha PoE and fluazifop-p-butyl + fomesafen 250 g/ha ePoE (pre-mix) *fb* IC + HW at 40 DAS.

Yield reduction in weedy check due to presence of weeds was recorded maximum to the tune of 90.4% followed by fluazifop-p-butyl + fomesafen 250 g/ha PoE (73.7%), imazethapyr + imazamox 70 g/ha PoE (71.7%), imazethapyr 150 g/ha PoE (54.4%) and quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS. Minimum weed index of 2.00 % was recorded under oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE. Significantly higher pod yield (3.99 t/ha) was achieved under oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS as compared to quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS, imazethapyr 150 g/ha PoE, imazethapyr + imazamox 70 g/ha PoE (pre-mix), imazethapyr + imazamox 70 g/ha ePoE (pre-mix) *fb* HW at 40 DAS, fluazifop-p-butyl + fomesafen 250 g/ha PoE (pre-mix) and weedy check (**Table 3**). The higher pod yield under these treatments ascribed due to lower density and dry biomass of weeds prevent the crop-weed competition which facilitate the utilization of available nutrients, moisture, light and space than that of other treatments. These results were in accordance with the results of Priya *et al*. (2017). Further, oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS also recorded significantly higher haulm yield of 5.95 t/ha as compared to quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS, imazethapyr 150 g/ha PoE,

Table 3. Shelling, seed yield index and yields as influenced by weed management practices in summer groundnut

Treatment	Shelling (%)			Seed index (g)			Pod yield (t/ha)			Haulm yield (t/ha)			Net return (x10^3 ₹/ha)	B:C ratio
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled		
Oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS	66.6	67.2	66.9	33.3	34.8	34.0^{c}	3.51^{a}	4.46^{a}	3.99^{a}	5.36^{a}	6.55^{a}	5.95^{a}	142.81	3.22
Oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE	66.7	66.6	66.7	33.8	35.3	34.6^{bc}	3.47^{a}	4.35^{a}	3.91^{a}	5.25^{a}	6.34^{ab}	5.80^{a}	140.23	3.24
Oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (premix)	66.0	66.7	66.4	34.7	36.4	35.6^{abc}	3.42^{a}	4.12^{a}	3.77^{a}	5.11^{a}	6.18^{ab}	5.65^{a}	132.41	3.09
Quizalofop-ethyl 50 g/ha ePoE *fb* IC + HW at 40 DAS	67.2	67.7	67.5	34.8	36.0	35.4^{abc}	2.51^{bc}	3.23^{bc}	2.87^{bc}	4.16^{bc}	5.23^{bcd}	4.70^{bc}	83.94	2.28
Imazethapyr 100 g/ha ePoE *fb* IC + HW at 40 DAS	67.5	67.6	67.5	33.4	34.5	33.9^{c}	3.35^{ab}	4.02^{ab}	3.69^{ab}	4.89^{ab}	5.97^{abc}	5.43^{ab}	126.63	2.96
Imazethapyr 150 g/ha PoE	67.6	67.8	67.7	33.5	34.7	34.1^{c}	1.56^{d}	2.09^{d}	1.82^{d}	2.76^{d}	4.32^{cd}	3.54^{d}	35.38	1.58
Imazethapyr + imazamox 70 g/ha PoE (premix)	68.6	68.6	68.6	35.7	37.5	36.6^{ab}	1.06^{e}	1.19^{e}	1.13^{e}	1.70^{e}	2.68^{e}	2.19^{e}	-1.08	0.98
Imazethapyr + imazamox 70 g/ha ePoE (premix) *fb* HW at 40 DAS	68.4	68.3	68.3	35.5	37.3	36.4^{ab}	2.87^{bc}	3.40^{bc}	3.14^{bc}	4.25^{bc}	5.18^{bcd}	4.71^{bc}	97.80	2.50
Fluazifop-p-butyl + fomesafen 250 g/ha PoE (premix)	68.5	68.4	68.5	34.4	36.3	35.4^{abc}	0.903^{e}	1.20^{e}	1.05^{e}	1.23^{ef}	2.07^{e}	1.65^{e}	-6.22	0.90
Fluazifop-p-butyl + fomesafen 250 g/ha ePoE (premix) *fb* IC + HW at 40 DAS	66.9	67.0	67.0	34.0	35.8	34.9^{bc}	3.41^{a}	4.08^{a}	3.75^{a}	5.03^{a}	6.08^{ab}	5.55^{a}	129.51	2.99
IC *fb* HW at 20 and 40 DAS	68.6	68.5	68.5	34.3	36.1	35.2^{abc}	3.45^{a}	4.17^{a}	3.81^{a}	5.37^{a}	6.32^{ab}	5.84^{a}	127.94	2.86
Weedy check	67.4	67.0	67.2	36.0	38.2	37.1^{a}	0.380^{f}	0.39^{f}	0.385^{f}	0.793^{f}	1.02^{f}	0.905^{f}	-34.31	0.36
F test	NS	NS	NS	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	35.38	-
LSD (p=0.05)	3.3	3.2	3.2	3.3	6.1	4.97	10.1	11.4	10.9	10.1	12.9	12.0	-	-

Data subjected to $(\sqrt{x+1})$ transformation. Figures in parentheses are means of original values. Treatment means with the letter/ letters in common are not significant by Duncan's New Multiple Range Test at 5% level of significance.

imazethapyr + imazamox 70 g/ha PoE (pre-mix), imazethapyr + imazamox 70 g/ha ePoE (pre-mix) *fb* HW at 40 DAS, fluazifop-p-butyl + fomesafen 250 g/ha PoE (pre-mix). Application of oxyfluorfen as pre-emergence controlled broad-spectrum of weeds during initial stage of crop and later germinated weeds was manage by hand weeding and intercultivation which provide congenial environment for growth and development of the crop for a longer period which lead to improvement in yield of crop. Among different weed management practices, pre-emergence oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS was recorded higher net return (₹ 2,02,799/ha) followed by oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE. However, benefit cost ratio, of 3.24 and 3.22 were achieved under pre-emergence application of oxyfluorfen 180 g/ha PE *fb* imazethapyr 100 g/ha PoE and oxyfluorfen 180 g/ha PE *fb* IC + HW at 40 DAS, respectively. Further, IC *fb* HW at 20 and 40 DAS recorded lower BC ratio might be due to higher additional cost of cultivation.

Conclusion

In nutshell, pre-emergence application of oxyfluorfen 180 g/ha PE *fb* interculturing (IC) + hand weeding (HW) at 40 DAS effectively managed the weeds and also recorded higher pod yield, net return and B:C ratio followed by oxyfluorfen 180 g/ ha PE *fb* imazethapyr 100 g/ha PoE, IC *fb* HW at 20 and 40 DAS, oxyfluorfen 180 g/ha PE *fb* imazethapyr + imazamox 70 g/ha PoE (pre-mix) and fluazifop-p-butyl + fomesafen 250 g/ha ePoE (pre-mix) *fb* IC + HW at 40 DAS.

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