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Efficacy of Post Emergence Herbicides in Groundnut

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ABSTRACT

Background: Groundnut encounters severe infestation of weed especially during the early stages of growth due to less crop canopy which allows higher weeds growth and thus crop becomes more susceptible to weed competition. During rainy season, effective and economical weed control is not possible through manual and mechanical weeding due to unfavorable soil conditions and also the unavailability of costly labours. Herbicides have been accepted as cost effective tool to manage weed menace in groundnut. The current study aims to study the efficancy of different post-emergence and pre-mix combination of post-emergence herbicides on weeds, growth and yield of groundnut.

Methods: The field experiment was conducted at AICRP Weed Management Field, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during three consecutive *Kharif* seasons of 2015-2017. The experiment was laid out in randomized block design with ten treatments replicated thrice. The treatments comprised of one pre emergence and five different post emergence herbicides and compared with weed free and weedy check.

Result: The results revealed that weed free was found most effective to control weeds in groundnut with lowest weed count, weed dry matter of weeds and maximum gross monetary returns (Rs. 117641/ha), net monetary returns (Rs. 80894/ha). Among the herbicides, application of Imazethapyr + Imazomox 0.10 kg/ha POE 20 DAS produced less weed count and weed dry matter and highest weed control efficiency (80.68%) and lower weed index (6.71%) as well as maximum growth, yield attributes and pod yield in groundnut over all the other herbicidal treatments *viz*. plant height (30.25), dry matter accumulation (18.11 g), number of pods/plant (32.35) and pod yield (2448 kg/ha) and highest pooled B:C ratio (3.74).

Key words: Imazethapyr + Imazomox, Pre-mix, Propaquizofop, Post-emergence, Weed free.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important edible oilseed crop extensively cultivated in the world. It is called as the king of the oilseeds. Groundnut is also called as wonder nut and poor men's cashew nut. It is a low-priced commodity, but valuable sources of all the nutrients. The oil content of the groundnut seed varies from 44 to 50 per cent depending on the varieties and agronomic practices. India occupies the first place with regards to the area and production in the world. During the year 2015-2016, there was a production of 71.80 lakh tones of groundnut from an area of 44.45 lakh ha with a productivity of 1753 ka/ ha (Anonymous, 2015). In India, groundnut production and productivity has exhibited wide fluctuations in recent years, mainly due to changing rainfall patterns and stiff competition with other cash crop and availability and preference for cheaper edible oils. Groundnut is grown mainly in *kharif* season in India, where it encounters severe infestation of weed especially during the early stages of growth. During initial growth of crop there is relatively less crop canopy which allows higher weeds growth and thus groundnut crop becomes more susceptible to competition with weeds in the earlier growth period of the crop. Jat *et al*. (2011) reported that, groundnut-weeds comprise diverse plant species from grasses to broad-leaf weeds and sedges and cause substantial yield losses (15-75%) which are more in rainfed Spanish bunch type than in irrigated Virginia type groundnut. The weeds emerge fast and grow rapidly competing with the crop severely for the resources *viz.,* nutrients, light and space and transpire lot of valuable conserved water from the soil. Season long weed competition reduces the yield as high as 24 to 70 per cent in groundnut. (Wani *et al*., 2010). Weeds when allowed to compete till harvest depleted nearly 162.8 kg N, 21.7 kg P_2O_5, 141.8 kg K_2O per ha (Singh *et al*., 2017). The first three-four weeks of crop growth period are critical for weed control in groundnut (Mulik *et al*., 2010). Thus, weed control during initial stage is essential to get optimum crop yield.

During rainy season, effective and economical weed control is not possible through manual and mechanical weeding due to unfavourable soil conditions and the unavailability of costly labours in time. Herbicides have been accepted as cost effective tool to manage weed menace in groundnut.There are number of pre-emergence herbicides

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such as pendimethalin, oxyflurofen, fluchloralin etc. which are being used for weed control in groundnut. However, they often fail to control weeds emerging during early vegetative phase of the crop. Nowadays, many broad spectrum post emergence herbicide molecules like Imazethapyr and pre-mix combination of Imazethapyr + Imazomox are available which controlled both grassy and broad leaved weeds in groundnut during the critical period of crop weed competition. Keeping all the above facts in view, an attempt was made to asses the efficancy of different post-emergence and pre-mix combination of post-emergence herbicides on weed flora, growth and yield of groundnut.

MATERIALS AND METHODS

The study was conducted at AICRP Weed Management field, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during three consecutive *Kharif* season of the year 2015-2016, 2016-17 and 2017-18 under rainfed condition. However, protective irrigation was given as and when required at critical growth stages. The investigation was carried out to study the efficiency of different post emergence herbicides against weed complex and their effect on growth and productivity of groundnut. The experiment was laid out in RBD design replicated thrice having ten different treatments of weed management practices. It includes Pendimethalin 1.0 kg/ha P.E, Propaquizofop 0.10 kg/ha POE, Quizolofop ethy l 0.10 kg/ha POE, Imazethapyr 0.10 kg/ha POE, Imazethapyr + Imazomox 0.10 kg /ha POE, Imazethapyr 0.10 kg/ha POE *fb*Quizolofop ethyl 0.10 kg/ha, Imazethapyr 0.10 kg/ha + Quizolofop ethyl 0.10 kg/ha (Tank mixed), Oxyflurofen 0.20 kg /ha POE, Weed free and weedy check. The experimental site was low in nitrogen, medium in phosphorous and rich in potash and slightly alkaline in reaction. The groundnut variety TAG-24 was sown on 19thJune, 23rd June and 20th June at a spacing of 30×10 cm with 20:50:00 NPK kg/ha and the crop was harvested on 13th October, 17th October and 21st October during the year 2015-16, 2016-17 and 2017-18 respectively. The pre-emergence herbicide was sprayed on next day of sowing and all the post-emergence herbicides were sprayed at 20 Days after Sowing (DAS). The application of herbicide was done as per the treatments with manually operated knapsack sprayer attached with a flat fan nozzle. After calibrating the sprayer, water volume used was 700 lit. per ha. for Pre. E and 500 lit. per ha. for Post. E. The observations on weed density and weed biomass were taken at 20 days interval up to harvest from four randomly selected spots by using a quadrate of 50 cm × 50 cm from net plot area of 8 sq.m. The entire weeds inside the quadrate were uprooted and cut close to the transition of root and shoot in each plot and collected for dry matter accumulation. Then weeds were grouped as monocot species and dicot species. The samples were first dried in sun and later kept in oven at 70±2°C. The dried samples were weighed and expressed as dry biomass (g/m^2). Square root transformation was done for weed density and weed biomass to normalize their distribution (Gomez and Gomez, 1984). Weed control efficiency (WCE) and weed index (WI) was calculated by using standard formula suggested by Mani *et al*. (1973). Phytotoxicity symptoms due to herbicides on crop was recorded by using a visual score scale of 0-10 scale method as proposed by Rao (2000). Visual assessment of herbicide toxicity on crop was monitored 10 days after application of herbicide in respective treatment. Cost of cultivation, gross returns and BCR for each treatment were calculated by taking into consideration of total costs incurred and returns obtained. Data on various growth and yield attributing characters were statistically analysed as per the standard procedure.

RESULTS AND DISCUSSION

Weed flora

The experimental field was absolutely invaded with mixed population of weed flora consisting of both dicots and monocots. Among the total weeds, dicots (76%) were more prominent than the monocot weeds (24%). The major dicot weed flora during *Kharif* season in groundnut crop was dominated by *Digera arvensis, Lagasca mollis, Euphorbia geniculata, Tridexprocumbense, Parthenium hysterophorus, Celosia argentea, Alysicarpus monolifer, Alternanathera triandra, Portulaca oleracae, Amaranthis viridis, Acalyphaindica*, *Cardiospermum helicarpium*, *Ipomoea reniformis*, *Corchorus acutangulus, Phyllanthus niruri*, *Abutilon indicum*, *Abelmoschus moschatus, Boerhavia diffusa*, *Calotropis gigantea*, *Ageratum conyzoides*, *Bidens pilosa*, *Mimosa pudica*, *Xanthium strumarium, Datura stramonium* and among the monocots weeds *Cynodon dactylon, Cyperus rotundus, Commelina benghalensis, Ischaemum pilosum*, *Digitaria sanguinalis, Dinebra retroflexa, Poa annua, Cyanotis axillaris Roem* were the weeds observed in the experimental field. Similar observations on weed flora in *kharif* groundnut was also reported by Pawar *et al.* (2018).

Crop phytotoxicity

The herbicide toxicity on crop stand and growth was recorded at 10 days after application of herbicide in respective treatment by using visual score scale of 0-10. Phytotoxicity rating revealed that,only post emergence application of Oxyflurofen 0.20 kg/ha at 20 DAS showed phytotoxicity symptoms (Score-4) on the leaves of groundnut due to higher dose of Oxyflurofen where severe scorching was observed and it affects the final plant stand of groundnut crop. Similar phytotoxicity was also reported earlier by Kalaichelvi *et al.* (2015). Other post emergence herbicides does not shown any adverse effect on groundnut crop.

Effect on weed density and dry weight of weeds

The pooled analysis of data (Table 1) revealed significant reduction in all the weed control treatments with respect to weed density and dry weed biomass over the unweeded control. The highest reduction in weed density and dry matter of weeds were recorded under weed free treatment

Table 1: Phytotoxicity rating, weed density (no./m^2), weed dry matter (g/m^2) at harvest, weed control efficiency and weed index as influenced by different weed control treatments (pooled over three years).

Treatments	Crop phytotoxicity visual rating score	Weed density (No./m^2) (Monocot + Dicot)				Weed dry matter (g/m^2) (Monocot + Dicot)				WCE (%)	Weed Index (%)
		2015-16	2016-17	2017-18	Pooled	2015-16	2016-17	2017-18	Pooled		
T_1: Pendimethalin 1 kg/ha Pre. E	0-No injury	7.62	7.65	7.58	7.62	7.70	7.84	7.80	7.78	67.47	22.83
		(58.43)	(60.99)	(57.04)	(58.82)	(59.89)	(64.01)	(60.53)	(61.48)		
T_2: Propaquizofop 0.10 kg/ha Post. E 20 DAS	0-No injury	5.72	6.02	5.92	5.89	5.97	6.75	6.70	6.47	77.39	9.34
		(33.09)	(38.56)	(34.61)	(35.42)	(36.06)	(47.93)	(44.45)	(42.81)		
T_3: Quizolofop ethyl 0.10 kg/ha Post. E 20 DAS	0-No injury	6.68	6.81	6.73	6.74	6.95	7.27	7.23	7.15	72.57	17.98
		(45.09)	(48.83)	(44.88)	(46.27)	(48.69)	(55.2)	(51.72)	(51.87)		
T_4: Imazethapyr 0.10 kg/ha Post. E 20 DAS	0-No injury	6.44	6.67	6.58	6.56	6.88	7.13	7.09	7.03	73.44	17.26
		(41.89)	(46.79)	(42.84)	(43.84)	(47.73)	(53.2)	(49.72)	(50.22)		
T_5: Imazethapyr+Imazomox 0.10 kg/ha Post. E 20 DAS	0-No injury	5.38	5.74	5.64	5.59	5.76	6.10	6.05	5.97	80.68	6.71
		(29.36)	(35.33)	(31.38)	(32.02)	(33.53)	(39.78)	(36.30)	(36.54)		
T_6: Imazethapyr 0.10 kg/ha Post. E fbQuizolofop ethyl 0.10 kg/ha 20 DAS	0-No injury	6.99	7.11	7.03	7.04	7.16	7.51	7.46	7.38	70.82	22.26
		(49.26)	(52.96)	(49.01)	(50.41)	(51.63)	(58.7)	(55.22)	(55.18)		
T_7: Imazethapyr 0.10 kg ha +Quizolofop ethyl 0.10 kg/ha Post. E 20 DAS	0-No injury	6.85	6.98	6.90	6.91	7.03	7.40	7.36	7.26	71.68	20.62
		(47.33)	(51.06)	(47.11)	(48.50)	(49.79)	(57.16)	(53.68)	(53.54)		
T_8: Oxyflurofen 0.20 kg/ha Post. E 20 DAS	4-Moderate injury with scorching of leaves	6.55	6.70	6.62	6.62	6.88	7.31	7.26	7.15	72.57	38.94
		(43.36)	(47.29)	(43.34)	(44.66)	(47.66)	(55.73)	(52.25)	(51.88)		
T_9 : Weed free	0-No injury	2.31	2.44	2.21	2.32	2.17	2.14	1.99	2.10	97.26	-
		(5.73)	(8.33)	(4.38)	(6.15)	(5.11)	(6.97)	(3.49)	(5.19)		
T_{10} : Weedy check	0-No injury	12.35	12.29	12.25	12.30	13.52	13.83	13.81	13.72	-	59.58
		(153.09)	(158.63)	(149.68)	(153.80)	(183.16)	(193.59)	(190.11)	(188.95)		
SEm ±	-	0.17	0.16	0.15	0.18	0.14	0.17	0.16	0.20	-	-
CD (P= 0.05)	-	0.50	0.47	0.44	0.56	0.43	0.52	0.48	0.59	-	

Figures in parenthesis are original values.

(6.15 no./m^2 and 5.19 g/m^2) due to complete and effective removal of the weeds during the experimentation. Similar results were also reported by Singh *et al*. (2019) who reported that weed free was found most effective to control weeds in groundnut and recorded lowest weed count and weed dry matter of both broad leaved and grassy weeds. Among the herbicides, of Imazethapyr + Imazomo × 0.10 kg a.i. /ha POE found more superior treatment in curtailing the weed population and dry weight of weeds (32.02 no./m^2, 36.54 g/m^2) followed by Propaquizofop 0.10 kga.i /ha POE (35.42 no./m^2, 42.81 g/m^2) as compared to unweeded control and both remain at par with each other. Pre-mix combination of Imazethapyr + Imazomox 0.10 kg a.i./ha provided excellent control of weeds. This post emergence herbicide combination applied at 20 DAS was able to control the further infestation of weed in groundnut crop. Further the crop covers the soil surface and smothers and suppress the growth of weeds result into least number of weed at harvest (Malunjkar *et al.*, 2012). The significant reduction in weed density and weed dry matter as compared to weedy check might be due to combination of both herbicides that have longer effect on controlling weed population. These results are in agreement with the results reported by Dixit (2012) and Kar *et al*. (2015).

Effect on weed control efficiency and weed index

Weed control efficiency (WCE) in groundnut was significantly influenced by weed management treatments, where all the treatments resulted in increased per cent of weed control efficiency over the weedy check. The highest value of WCE (97.26%) was obtained from weed free check treatment. Adhikary *et al*. (2016) earlier also reported treatment receiving hand weeding twice recorded lowest weed biomass and highest WCE (85.09%) which was significantly higher over other treatments. Amongst herbicides, the maximum value of WCE was achieved by of Imazethapyr + Imazomox 0.10 kg/ha (80.68%) followed by Propaquizofop 0.10 kg (77.39%). The application of pre-emergence herbicide pendimethalin @1.0 kg/ha and other post emergence herbicides registered less WI. Similarly data on weed index as indicated in Table 1 showed the least yield reduction (6.71%) inImazethapyr + Imazomox followed by Propaquizofop 0.10 kg (9.34%). Where as yield reduction varied from 6.71 per cent to 38.94 per cent in the herbicide applied plots as compared to weed free treatment. The WI was lower in all the treatments as compared to weedy check. Lower is the weed index in chemical treatments, better the efficiency of that herbicide in controlling weeds, which provided favourable conditions for crop growth which ultimately increased the grain yield of groundnut crop as compared to weedy check treatment. Similar trend of weed control efficiency and weed index were recorded during study from 2015-16 to 2017-18. Similar results were also reported by Kushwah and Vyas (2005); Malunjkar *et al.* (2012) and Datta *et al*. (2001).

Effect on growth and yield

Pooled data of growth and yield attributing parameters showed that, maximum plant height (33.35 cm) at harvest was recorded in weed free method which was at par with pre-mix post emergence herbicide Imazethapyr + Imazomox @ 0.10 kg/ha. This might due to the least weed population observed in the treatments, which reduced the crop weed competition. Significant reduction in plant height was noticed in unweeded control treatment which might be due to the competition between crop and weeds for soil moisture, plant nutrients, solar radiation and space during active growth period. These results are in accordance with the results reported by Mishra *et al*. (2013). Different weed management practices had significant positive impacts on yield attribute and yield of groundnut crop. Significant lowest values ofdry matter, pods/plant, 100 kernel weight were recorded under weedy check and the highest values for these parameters were recorded under weed free treatment. Higher level of these parameters could be attributed due to low crop-weed competition under this treatment. Among herbicidal treatment, Imazethapyr + Imazomox @ 0.10 kg/ha efficiently increased dry matter per plant (18.11 g) over weedy check (8.86 g). The increase in the dry matter of groundnut was attributed to the decreased weed population and lesser dry weight of weeds thus resulted in decreased competition by weeds to moisture, light and nutrients. The effect of which can be traced back to increased dry matter accumulation in stem, leaves and pods. Murthy *et al.* (1992) and Kumar and Sharma (1996) have reported significant reduction in the dry matter accumulation and lower pod yield in groundnut under weedy check. The dry matter production and its accumulation in reproductive parts depends upon the photosynthetic ability of the plant and can be analysed through leaf area and dry matter accumulation in leaves, which in turn influence the photosynthetic ability, performance and yield of the crop. The results corroborate with the findings of Kumar and Sharma (1997) and Yadav *et al.* (2014). Propaquizofop 0.10 kg/ha POE 20 DAS as post emergence was next best molecule for increasing dry matter, pods/plant kernel weight. This might be due to minimizing the competition of weeds with main crop for resources *viz*. space, light, nutrients and moisture with adaption of effective weed control methods. Singh and Giri (2001) also concluded that proper weed control was responsible for increase in plant height and dry matter production in groundnut. However, incase of other herbicidal treatments, Quizolofop ethyl 0.10 kg/ha ,Imazethapyr 0.10 kg/ha, Imazethapyr 0.10 kg/ha *fb* Quizolofop ethyl 0.10 kg, Imazethapyr 0.10 kg/ha + Quizolofop ethyl 0.10 kg/ha (Tank mix) and Oxyflurofen 0.20 kg/ha recorded higher yield and yield attributes of groundnut compared to weedy check but remained at par with each other.

Pooled analysis exhibited that different weed control treatments registered significant increase in dry pod yield of groundnut compared to weedy check during all the three years of study. Weed free treatment recorded highest pod yield of 2614 kg/ha which might be due to the fact that weed free environment in crop facilitated better peg initiation and development at the critical growth stages of groundnut which

Table 2: Growth, yield attributes, dry pod yield (kg/ha), GMR, NMR (Rs./ha.) and B:C ratio as influenced by weed control treatments in groundnut (pooled over three years).

Treatments	Plant height (cm)	Plant matter dry (g)	No. of pods per plant	100 Kernel weight (g)	Dry pod yield (kg/ha)				GMR (Rs/ha)	NMR (Rs/ha)	B:C ratio
					2015-16	2016-17	2017-18	Pooled			
T_1: Pendimethalin 1 kg/ha Pre.E.	24.93	14.54	27.69	42.54	2108	2057	1940	2035	91400	62025	3.11
T_2: Propaquizofop 0.10 kg/ha Post. E 20 DAS	29.69	17.74	31.85	46.16	2455	2374	2280	2370	107012	77110	3.58
T_3: Quizolofop ethyl 0.10 kg/ha Post. E 20 DAS	27.32	15.96	29.40	42.24	2238	2182	2060	2160	97307	66464	3.15
T_4: Imazethapyr 0.10 kg/ha Post. E 20 DAS	28.43	16.82	31.32	43.09	2253	2196	2080	2176	98041	68598	3.33
T_5: Imazethapyr + Imazomox 0.10 kg /ha Post. E 20 DAS	30.25	18.11	32.35	44.43	2527	2468	2350	2448	109873	80530	3.74
T_6: Imazethapyr 0.10 kg/ha Post. E fbQuizolofop ethyl 0.10 kg/ha 20 DAS	28.02	16.28	29.14	43.44	2130	2052	1960	2047	92569	59536	2.80
T_7 : Imazethapyr 0.10 kg/ha + Quizolofop ethyl 0.10 kg/ha Post. E 20 DAS	28.77	16.53	29.81	43.48	2168	2118	2000	2095	94541	62098	2.91
T_8: Oxyflurofen 0.20 kg /ha Post. E 20 DAS	26.12	15.57	25.52	39.82	1696	1636	1530	1620	72997	43386	2.47
T_9 : Weed free	33.35	21.21	35.74	48.60	2718	2614	2510	2614	117641	80894	3.21
T_{10}: Weedy check	21.43	8.86	16.59	38.53	1209	1110	990	1103	50514	23261	1.85
SEm ±	0.78	0.66	0.94	1.07	67	44	50	58	2440	2440	-
CD (P= 0.05)	2.35	1.95	2.80	3.22	197	131	150	172	7251	7251	-

tends to increase in number of pods/plant and pod yield/ hectare. Higher profitable pod yield of summer groundnut was also reported by Raj *et al.*(2008) and Singh *et al.* (2018) with keeping the crop in weed free condition.Among the herbicides, the higher value of dry pod yield in the individual years and over the pooled was obtained with application ofImazethapyr + Imazomox @ 0.10 kg/ha (2448 kg/ha.) closely followed by Propaquizofop 0.10 kg (2370 kg/ha.). Pooled data showed that both these treatments recorded 54.94% and 53.45% increase in dry pod yield over weedy check.Better expression of yield attributes due to reduced weed infestation through these treatments might have helped the crop plants to accumulate more dry matter through greater nutrient uptake that might have provided more quantity of photosynthates to developing sink in crop plants produced more yield. The grain yield improvement and weed control has already been reported by Malligawad *et al.* (2000) and Kalhapure *et al.* (2013).

Economics of weed control

As indicated in Table 2, all the weed control treatments tended to significantly surpass weedy check in terms of gross returns,net returns and B:C ratio. Although, weed free recorded the maximum pod yield, maximum gross monetary returns and net monetary returns was registered in weed free treatment (Rs.117641/ha and Rs.80894/ha) followed by pre-mix herbicide combination of Imazethapyr+ Imazomox 0.10 kg /ha (Rs.109873/ha and Rs.80530/ha), however highest pooled B:C ratio (3.74) was registered in application of Imazethapyr + Imazomox followed by Propaquizofop 0.10 kg /ha (3.58). The differences in B:C ratio is due to the cost of herbicides, labours required and productivity of the crop. Though the weed free treatment resulted in highest seed yield (2616 kg/ha) owing to 97.26% weed control efficiency but could not found as profitable as herbicidal treatment due to higher expenditure incurred on engaging labours. Annadurai *et al.* (2010) also reported that weed management is the need of the day through the introduction of herbicides to meet labor shortage to effect early weed control and reduce the cost of weeding. Similar results were also obtained by Mishra *et al.* (2013), Vaghasia and Nadiyadhara (2013) and Dixit *et al.* (2016).

CONCLUSION

It is concluded from the three years study on Herbicide Weed control in groundnut that, post emergence application of Imazethapyr + Imazomo × 0.10 kg/ha as Post. E on 20 DAS produced best results in reducing the weed density and dry weight and found to be more effective in getting higher weed control efficiency, yield and economic returns of groundnut.

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