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Efficacy of Pre and Post-emergence Herbicides for Weed Management in Groundnut

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ABSTRACT

Background: Herbicides are used in agriculture to reduce the density of weeds and improve the crop yield. Pendimethalin 30% EC is widely used pre-emergent herbicide to control annual grasses and certain broad leaf weeds; is no longer effective against established weeds like *Cyperus* and *Commelina benghalensis*, *Acalypha indica* and *Phyllanthus spp*. that are dominant in groundnut crop. Combination of Pendimethalin 30% and Imazethapyr 2% EC is a broad-spectrum herbicide that controls most broadleaf weeds and some annual grasses. The current study aimed to improve the profitability of farmers by effectively and economically by controlling the targeted weeds.

Methods: A field experiment was conducted at Zonal Agricultural and Horticultural Research Station (ZAHRS), Babbur Farm, Hiriyur, Karnataka during *Kharif* 2018, 2019 and 2020, to study the efficacy of pre and post-emergence herbicides for weed management in groundnut. The trial comprised of nine treatments involving two pre-emergence herbicides [Pendimethalin 38.7 CS 1.0 kg/ha PE and Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)] alone and in combinations with post-emergence herbicides [quizalofop-p-ethyl 50 g/ha at 15-20 DAS (PoE)], along with pre-emergence herbicides super imposed with hand weeding at 30 DAS and compared with two inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows and weedy check.

Result: The experimental results revealed that, among the different herbicides treatments, the higher net return (Rs. 92,835/ha) and B:C ratio (2.70) were noticed in Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+manual weeding at 30 DAS as compared to control plot (Rs. 2620/ha and 0.96, respectively) this has effectively controlled most of the weed flora present in the experimental field.

Key words: Groundnut, Herbicides, Weed control efficiency, Weed index.

INTRODUCTION

Groundnut is an important oilseed crop of India with average productivity is about 1,436 kg/ha. In Karnataka, groundnut is grown in an area of 7.0 lakh ha with a production of 6.76 lakh tonnes and productivity of 966 kg/ha is lower as compared to national average (Anonymous, 2021). Groundnut being a *Kharif* crop is highly susceptible to weed infestation due to its slow growth and small foliage cover in the initial stages up to 40 days, further short plant height and underground pod bearing habit and higher weed infestation during *kharif* season due to congenial moisture which allows weeds to grow more luxuriantly than *Rabi*/ summer season. Besides, their competition for nutrient, water and light with the crop, weeds hinder pegging, compete for underground space and make harvesting of groundnut cumbersome. Depending on the severity of infestation and yield losses caused by weeds, it is most critical factor for groundnut cultivation and unless a good control of weed is achieved, substantial yield losses up to 70 per cent may occur which are more in rainfed Spanish bunch type than in irrigated Virginia type groundnut (Jat *et al*., 2011). Thus weed management is essential to get optimum crop yield. At present several herbicidal formulations are available in the market used as pre- and post-emergence herbicides for controlling weed complex. On an average, the loss of groundnut production in the country due to weeds has been estimated as 54 to 71 per cent (Agasimani *et al*., 2010). Thus, weed management during the initial stage of crop growth is essential to achieve the optimum crop yield.

Pre-emergent herbicides prevent the germination of weed seeds in the beginning stages of the crop growth. Thus, there will be less weed infestation till the activity of herbicide present in the soil. An additional method to control weeds in later stages of crop growth is through the application of post-emergent herbicide which effectively controls matured weeds. So, post-emergent herbicides help in controlling the emerged weeds in later stages of groundnut crop where it is important to control the crop-weed competition at flowering and peg formation stages. Other than chemicals even

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physical and mechanical methods or the traditional methods are effective in controlling irrespective of weeds but these methods are time and labour consuming. However, mechanical and cultural methods help in loosening the soil which improves aeration, porosity, soil moisture conservation and easy peg penetration in soil. With the increasing labour scarcity, it is difficult to manage weeds by traditional method. Chemical weed management such as pre or post-emergent herbicide application gives a good result but couldn't control a broad spectrum of weeds. Hence integration of herbicides with manual weeding we can control a broad spectrum of weed population throughout the crop period.

Materials and Methods

A three year field trial was conducted during *Kharif* 2018, 2019 and 2020 at ZAHRS, Babbur Farm, Hiriyur, Chitradurga Dist. Karnataka, India. The experimental site is situated between 13°57′ 32″ N latitude and 70° 37′ 38″ E longitude with an altitude of 606.1 meters above mean sea level. It comes under Central Dry Zone (Agro-climatic zone 4) of Karnataka. The soil was medium black with slightly alkaline in reaction and having medium soil fertility. The experiment was laid out in randomized complete block design replicated thrice and comprised of nine treatments, *viz.*, Pendimethalin 38.7 CS 1.0 kg/ha PE, Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix), Pendimethalin 38.7 CS 1.0 kg/ha PE+quizalofop -p- ethyl 50 g/ha at 15-20 DAS (PoE), Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+quizalofop-p-ethyl 50 g/ha at 15-20 DAS (PoE), Pendimethalin 38.7 CS 1.0 kg/ha PE+Imazethapyr 2 EC 75g/ ha at 15-20 DAS, Pendimethalin 38.7 CS 1.0 kg/ha PE+ manual weeding at 25-30 DAS, Pendimethalin 30 EC+ Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+manual weeding at 25-30 DAS, Inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows and weedy check. Groundnut local variety (TMV-2) was sown at 30 cm × 10 cm spacing. Recommended dose of fertilizer (25:50:25 kg of N:P:K/ha) along with gypsum 500 kg/ha and $ZnSO_4$ 25 kg/ha were applied at basal. Pre-emergence herbicide, Pendimethalin 38.7 CS 1.0 kg/ha was sprayed on the day of sowing. Total spray solution used was 500 l/ha. The knapsack sprayer fitted with flat fan nozzle was used for the herbicide spray. These treatments were compared with farmers practice of two inter cultivation operation at 15 and 30 DAS followed by one manual weeding for intra rows and weedy check. The weed density and weed biomass from one m^2 was recorded before herbicides spray and at 30, 60, 90 DAS and at harvest. For bio-efficacy observations, three spots were selected at random and marked with pegs in each plot. Total weed density of major weed species was recorded using 0.25 m^2 quadrant in peg marked areas before herbicide application. It was converted to number of weeds per m^2 area. Weed biomass was also recorded from each plot from 0.25 m^2 quadrant and computed to g/m^2 area. At the end of cropping season, yield was recorded from net plot area and computed to ha^{-1}. Cost of cultivation, gross returns, net returns and B:C ratio were calculated based on the prevailing market price of inputs and outputs. The weed density and weed biomass data were transformed square root.

Results and Discussion

The yield levels among the herbicide tests, Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg ha^{-1} PE (ready mix)+ manual weeding at 30 DAS recorded significantly higher pod yield (3128 kg/ha) and it was on par with inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows and increase in 33.10 per cent over Pendimethalin 38.7 CS 1.0 kg/ha PE (2,254 kg/ha) (Table 2). The results are in agreement with the findings of Annadurai *et al*. (2010) minimizing crop-weed competition at the early stages of groundnut and improve the yield by about 20-30 per cent. This is for the reason that the application of chemical along with cultural practice or post-emergent herbicide quizalofop-p-ethyl 50 g/ha 20 DAS the weeds which are escaped or left over from the initial operation will be controlled by the succeeding method of weed management and weeds which are resistance to herbicide will also be suppressed by the manual weeding, so that at early and later stages of crop growth weeds are reduced, thus it favours for better growth and development of reproductive parts *viz.,* flowering, pegging and pods development thus finally increases the pod yield. These findings were close conformity with Timsina *et al*. (2020).

Application of Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+manual weeding at 30 DAS (66.5,48.6,51.8 and 40.7 m^{-2} at 30, 60, 90 DAS and at harvest, respectively) recorded significantly lower total weed population over application of Pendimethalin 38.7 CS 1.0 kg/ha PE alone (117.4, 131.7, 126.2 and 111.3 m^{-2} at 30, 60, 90 DAS and at harvest, respectively) and it was on par with intercultivation at 15 and 30 DAS followed by manual weeding (40.6, 43.1, 46.8 and 37.8 m^{-2} at 30, 60, 90 DAS and at harvest, respectively) (Table 1), this indicates that there is no need to keep the groundnut field completely weed free condition. For better growth and development of the main crop, weeds should be controlled during the critical period of crop-weed competition and the value should be kept below the threshold level (Vishwanath, 2017). When pre-emergent spray (ready mix) was used, this controls the emergence of all types of weeds by inhibiting root and shoots growth at the emergence stage of weeds, while the combination of hand weeding at 30 DAS will completely eradicate all the left over weed species in the field, which resulted in lower total weed density over single application. This resulted better growth of groundnut and increased the yield components which reflected on improvement in pod yield. Imazethapyr is responsible for inhibition of acetolactate synthase (ALS) or actohydroxy acid synthase (AHAS) in broad leaved weeds which caused destruction of these weed growth (Smita *et al*., 2014).

Therefore, lesser the total weed population (66.5, 48.6, 51.8 and 40.7 number m^{-2} at 30, 60, 90 DAS and at harvest)

Table 1: Total weed density (number m^{-2}), weed dry weight (g m^{-2}) at different stages and weed indices of groundnut as influenced by weed management practices at different crop growth stages during 2018, 2019 and 2020.

Treatments		Total weed population (number m^{-2})				Total weed dry weight (g m^{-2})				WCE at harvest (%)	WI (%)
		30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest		
T_1	Pendimethalin 38.7 CS 1.0 kg/ha PE	117.1	131.7	126.2	111.3	10.8	20.2	39.6	48.3	34.5	25.2
T_2	Pendimethalin 30EC+Imazethapyr 2 EC @ 1.0 kg/ha PE(ready mix)	75.7	113.3	110.6	98.0	8.6	17.6	36.6	42.4	42.8	20.1
T_3	Pendimethalin 38.7 CS 1.0 kg/ha PE+ quizalofop-p-ethyl 50 g/ha at 15-20 DAS (PoE)	123.1	84.2	92.7	78.6	12.6	19.1	36.1	38.0	52.5	19.7
T_4	Pendimethalin 30EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+quizalofop- p- ethyl 50 g/ha at 15-20 DAS (PoE)	68.7	72.0	75.2	58.2	7.2	14.8	26.3	29.0	63.0	7.7
T_5	Pendimethalin 38.7 CS 1.0 kg/ha PE+ Imazethapyr 2 EC 75 g/ha at 15-20 DAS	126.4	82.4	92.5	79.4	12.4	18.9	37.6	39.2	50.8	17.0
T_6	Pendimethalin 38.7 CS 1.0 kg/ha PE+116.8 manual weeding at 30 DAS	60.4	65.9	55.0	9.4	14.3	28.5	28.9	63.8	15.2	
T_7	Pendimethalin 30EC+Imazethapyr 2 EC 1.0 kg/ha PE(ready mix)+manual weeding at 30 DAS	66.5	48.6	51.8	40.7	5.3	9.3	21.8	23.2	72.6	0.7
T_8	Inter cultural operation at 15 and 30 DAS followed bymanual weeding for intra rows	40.6	43.1	46.8	37.8	2.9	5.3	15.2	14.8	76.3	0.0
T_9	Weedy check	226.7	201.9	179.4	158.0	24.4	41.6	60.1	67.7	0.0	67.3

Table 2: Yield parameters and economics of groundnut as influenced by weed management practices.

Treatments	100 Kernel weight (g)	Number of pods	Pod yield (kg/ha)				Haulm yield (kg/ha)				Economics		
			2018	2019	2020	Pooled	2018	2019	2020	Pooled	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T_1 Pendimethalin 38.7 CS 1.0 kg/ha PE	30.4	33.9	2413	2254	2386	2350	4206	3552	4017	3925	112478	61755	2.25
T_2 Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)	31.5	34.7	2751	2333	2469	2517	4413	3710	4196	4106	120185	67493	2.30
T_3 Pendimethalin 38.7 CS 1.0 kg/ha PE+quizalofop -p- ethyl 50 g/ha at 15-20 DAS (PoE)	28.9	34	2383	2504	2650	2512	3566	4048	4578	4064	120556	67732	2.28
T_4 Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+quizalofop-p-ethyl 50 g/ha at 15-20 DAS (PoE)	31.6	37	3070	2738	2898	2902	4826	4206	4757	4596	138672	83797	2.53
T_5 Pendimethalin 38.7 CS 1.0 kg/ha PE+Imazethapyr 2 EC 75 g/ha at 15-20 DAS	31.5	34.7	2702	2487	2632	2607	4406	3925	4439	4256	124693	72014	2.38
T_6 Pendimethalin 38.7 CS 1.0 kg/ha PE+manual weeding at 30 DAS	31.7	36	2766	2540	2688	2664	4546	4167	4713	4475	127472	70885	2.25
T_7 Pendimethalin 30 EC + Imazethapyr 2 EC 1.0 kg/ha PE (ready mix) + manual weeding at 30 DAS	32.8	38.7	3422	2897	3066	3128	5160	4345	4914	4806	149284	92835	2.70
T_8 Inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows	33.6	41.6	3447	2976	3025	3149	5520	4623	5228	5123	150184	87541	2.40
T_9 Weedy check.	25.3	29.3	1086	975	1046	1035	2273	2053	2322	2215	49619	2620	0.96
S.Em±	1.2	2.2	244	165	172	179	309	281	304	310			
CD at 5%	3.7	6.6	726	494	512	534	929	844	912	931			

resulted in lower total weed dry weight in Pendimethalin 30 EC+Imazethapyr 2 EC @ 1.0 kg/ha PE (ready mix)+manual weeding at all the stages (5.3, 9.3, 21.8 and 23.3 g/m^2 at 30, 60, 90 DAS and at harvest) (Table 1). The lower weed dry weight in the above treatment was mainly due to lower weed density by effective control of weeds through Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} PE (ready mix)+manual weeding at 30 DAS. These results are in accordance with the findings of Mavarkar *et al*. (2015). Pre-emergent application of pendimethalin inhibits microtubule formulation in cells of susceptible monocot and dicot weeds, which is an important part for cell division process so that, it results in the restricted cell division, growth of weed emergence is prevented, arise in death of weeds due to lack of food reserves thus lowers the dry matter of weeds (Smita *et al*., 2014).

Unlike observed higher gross returns (Rs. 1,50,184/ha), in plots receiving inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows. The higher net returns (Rs. 92,835 /ha) and B:C ratio (2.70) were noticed in Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+manual weeding at 25-30 DAS (2.70) as compared to control plot (0.96) (Table 2).

In weed control efficiency (WCE), we considered the total weed density which includes different weed species. Therefore, it will not reveal the weed control efficiency of individual species. Among the treatments, as inter cultural operation at 15 and 30 DAS followed by manual weeding recorded the highest weed control efficiency followed by ready mix application of Pendimethalin 30 EC+ Imazethapyr 2 EC 1.0 kg/ha PE+manual weeding at 30 DAS and Pendimethalin 38.7 CS 1.0 kg/ha PE+manual weeding at 25-30 DAS, which recorded as 76.3, 72.6 and 63.8%, respectively (Table 1). The above results might be due to pre-emergent herbicide (ready mix) which prevents the emergence of grasses, sedges and broad-leaved weeds by inhibiting root and shoot growth so that there is less crop-weed competition at initial stages and by one hand weeding at 30 DAS all the weeds are manually removed, correspondingly manual weeding improves the soil aeration and increase nutrient availability to the crop through active mineralization and decomposition (Sangeetha *et al*., 2012), which favours peg initiation without any weed competition, in this case there is a higher WCE noted and there is a increases in yield through less weed density. These results were in line with the finding of Kalhapure *et al*. (2013).

Among the herbicidal treatments, Pendimethalin 30 EC +Imazethapyr 2 EC 1.0 kg ha^{-1} PE (ready mix)+manual weeding at 30 DAS recorded significantly lower weed index (0.7 %) over Pendimethalin 38.7 CS 1.0 kg/ha PE (25.2 %). The higher weed index is because of the single application of herbicide so that the weeds are controlled till the herbicide effect is present in the soil after that, the weeds start growing which compete with the main crop for natural resources. In this situation the crop lack with natural resources and there by growth reduces which correspondingly reduces the yield. Similar variation in weed density and total weed dry weight was also observed in the earlier studies conducted by Bolaji *et al*. (2015).

Conclusion

Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix)+manual weeding at 30 DAS recorded higher pod yield (3128 kg ha^{-1}) and it was on par with inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows and increase in 33.10 per cent pod yield over Pendimethalin 38.7 CS 1.0 kg/ha PE (2,254 kg/ha). Among the herbicidal treatments, Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE (ready mix) + manual weeding at 30 DAS recorded lower weed index (0.7%) over Pendimethalin 38.7 CS 1.0 kg ha^{-1} PE (25.2%). In weed control efficiency (WCE), as inter cultural operation at 15 and 30 DAS followed by manual weeding for intra rows recorded the highest weed control efficiency followed by ready mix application of Pendimethalin 30 EC+Imazethapyr 2 EC 1.0 kg/ha PE+manual weeding at 30 DAS and Pendimethalin 38.7 CS 1.0 kg/ha PE+manual weeding at 25-30 DAS, which recorded as 76.3, 72.6 and 63.8%, respectively.

Conflict of interest

All authors declared that there is no conflict of interest.

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