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EFFECT OF DIFFERENT HERBICIDES AND CULTURAL PRACTICES ON WEED DYNAMICS AND PRODUCTIVITY OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) GROWN ON A*LFISOLS* OF EASTERN DRY ZONE OF KARNATAKA

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ABSTRACT
An experiment was carried out at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru with an objective to evaluate the sequential application of pre and post emergence herbicides along with cultural practices on weed dynamics and productivity of Sunflower. The experiment was conducted in *kharif* 2015 and was laid out in RCBD design with three replications. Pendimethalin was used as pre-emergent herbicide, whereas, Quizalofop – ethyl, Propaquizafop, fenoxoprop-ethyl were used as directed post-emergence spray. All herbicides used were safe for sunflower crop as no adverse effect on sunflower crop growth was noticed. Pendimethalin @ 1.0 kg a.i / ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray on weeds at 15-20DAS recorded reduced total weed population and dry weight compared to all other treatments with higher Weed Control Efficiency (80.38%) and thus considered for weed management options in sunflower. Across all the treatments seed yield did not differ significantly, but higher seed yield was recorded with Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray + Intercultivation at 30-35 DAS (T9) coinciding with top dressing (1679 kg/ha). The study revealed the existence of treatment variation in response to herbicides application and application of pre-emergent as well post emergent herbicides application in Sunflower resulted in higher seed yield without any phytotoxic effects.

KEY WORDS*:* Pre and post emergent herbicides, Sequential application, Phytotoxicity, Seed yield.

INTRODUCTION

Sunflower (*Helianthus annus* L.) is one of the important oilseed crops of India. It is known for its wider adaptability to varied agro-climatic conditions and soil types. Photo insensitivity and short duration nature makes Sunflower to fit into different types of cropping systems. Productivity of Sunflower in India is very low (791 kg/ha) as compared to the world average (1495kg/ha) indicating wider scope for improving the yield potential. Wide row spacing and slow initial growth of Sunflower provide enough space for weeds to establish well and affect seed yield of Sunflower. Uncontrolled growth of weeds reduces the yield of sunflower to an extent of 64% (Legha *et al.*, 1992). Thus, Weed management assumes significant importance for attaining higher yields and better quality in Sunflower. Conventional methods of weed control are labor intensive and are not being taken up in right time owing to varied reasons. To obtain maximum seed yield, it is imperative to keep sunflower fields free of weeds for first 4-6 weeks after sowing (Krishnegowda *et al.*,1985). Pre-emergent herbicides provide a weed free environment during the early stages of crop growth, but are not much efficient from the point of their selective nature for different weeds. Rather than pre or post –emergence herbicide application alone, use of both pre and post–emergence herbicides sequentially along with cultural practices may be viable option to control the weeds effectively right from the sowing to harvesting and to enhance the productivity of sunflower. Keeping these points in view, the present experimental study was undertaken to evaluate the integrated weed management practices and relative efficiency of sequential application of pre emergent herbicide (pendimethalin) followed by post emergence herbicides *viz.,* Quizalofop Propaquizapop, Fenoxaprop on weed growth and productivity of Sunflower.

MATERIALS & METHODS

The present experiment was undertaken during the *Kharif* 2015 at Zonal Agricultural Research Station, University of Agricultural Sciences, Bangalore. The soil of the experimental site was red sandy loam in texture. The total rainfall received during the crop growth period (August to November) was 703.80mm with 31 rainy days. Sunflower crop was sown at a spacing of 60 cm X 30 cm. The hybrid used for the study was KBSH – 53 which is of 100-110 days duration and moderately resistant to powdery mildew. Gross and net plot size was 5.4 m X 4.8m and 4.8 m X 3.6 m, respectively. The experiment was laid out in Randomized Complete Block Design with three replications. Farm yard manure was applied @7.5t/ha two weeks before sowing. Nitrogen, Phosphorus and

Potassium (NPK) nutrients were provided as per the recommended dose (90:90:60 kg NPK/ha). Seeds treated with imidacloprid @ 5g /kg of seeds were used for sowing as protection against vector thrips and to avoid spread of necrosis virus disease.

Pendimethalin 38.7 EC at 0.75 kg a.i /ha and at 1.0 kg a.i /ha as per the treatments was sprayed one Day After Sowing (DAS) as pre-emergence application with the help of hand operated knapsack sprayer with a spray volume of 750 liters /ha using WFN 78 nozzle. Sufficient soil moisture was ensured at the time of herbicide application. Quizalofop – ethyl 10EC, Propaquizafop at 62 g a.i /ha, fenoxoprop-ethyl at 38.52g a.i /ha were sprayed as directed post-emergence spray as per the treatments schedule between 15-20 DAS by using a spray volume of 750 liters /ha with WFN 40 nozzle. Inter-cultivations at 20 and 40 DAS and hand weeding at 30 DAS were carried out as per the treatments schedule. Earthing up operation was taken up at 35 DAS and at the same time 50% of nitrogen was also top dressed. Protective irrigation was provided as when required to avoid moisture stress.One plant protection spray using Confidor was undertaken at 30 days after sowing to control leaf spot disease.

Visual observations were recorded after spraying of herbicides to know the extent of toxicity caused by herbicides on crop by using phytotoxicity rating zero (no toxicity) to ten (100% toxicity) scale (Anon.,1981). Observation on the weed population were recorded at 30, 60 DAS and at harvest in 1m2 area at 3 places/plot and mean weed population/m2 was worked out. Weed dry weight was recorded at harvest and Weed Control Efficiency (WCE) was worked out as per the formula suggested by Patel *et al.,* (1987).

Growth, yield and other ancillary parameters were recorded periodically and at harvest. In computing the economics, different variable cost items were considered. The experimental data collected on various growth and yield components was subjected to Fischer's method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (1984).

RESULTS & DISCUSSION

Visual observation indicated that no adverse effect on sunflower crop growth due to use of post-emergence herbicides indicating that all the herbicides are safe for sunflower crop. No abnormality was recorded in any herbicidal treatment pertaining to growth, crop color and luster and also crop showed no phytotoxicity.

Weed flora and dynamics

The prominent weeds present were *Celosia argentea* (L.), *Amaranthus viridis*, *Phyllanthus niruri* (amarus), *Argemone mexicana* (Linn.), *Acanthospermum hispidum* (starburr) and *Alternanthera sessilis* with a mean number of 0.67-4.73 / m2. About 40% of the dicot (broad leaf) weeds were recorded before application of post-emergence herbicides. Among them, *Amaranthus viridis* and *Phyllanthus niruri* were dominant with a mean value of 2.70 / m2 (Table 1). Similar weed species in Sunflower crop are also reported by Krishne Gowda *et al*.,(1985), Basavarajappa (1992) and Poonguzhalan (1993).

TABLE 1: Dicot weed count (no./m^2) in weed control treatments after 30DAS, 60DAS and at harvest

Treatments	Dicots (no./m^2)		
	30 DAS	60 DAS	At harvest
T_1: Pendimethalin @ 0.75 kg a.i/ha (38.7 CS new molecule) as PE	1.1	1.0	1.0
T_2: Pendimethalin @ 0.75 kg a.i/ha as PE + One intercultivation at 30 DAS followed by hand weeding at 40 DAS	1.1	1.2	1.1
T_3: Pendimethalin @ 1.0 kg a.i/ha as PE + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha as POE	1.0	1.0	1.2
T_4: Pendimethalin @ 1.0 kg a.i/ha as PE + Propaquizofop (Agil) @ 62 g a.i/ha as POE	0.8	1.0	1.1
T_5: Pendimethalin @ 1.0 kg a.i/ha as PE + Fenoxoprop Ethyl (White super) @ 37.5 g a.i/ha as POE	1.2	1.2	1.1
T_6: Farmers practice (Two IC at 20 & 40 DAS + One HW at 30 DAS)	1.5	1.5	1.2
T_7: Weed free (Three hand weedings at 15, 30 & 45 DAS)	1.3	1.4	1.0
T_8: Unweeded control	1.3	1.7	1.2
T_9: T_3 + Intercultivation at 30-35 DAS coinciding with top dressing	1.2	1.2	1.2

Note: PE- pre-emergence spray and POE- post-emergence spray at 15 – 20 DAS

TABLE 2: Total weed dry weight (g/m^2) and weed control efficiency (%) in different weed control treatments at harvest

Treatments	Total Dry weight of weeds (g/m^2)	WCE (%)
T_1: Pendimethalin @ 0.75 kg a.i/ha (38.7 CS new molecule) as PE	5.80	77.11
T_2: Pendimethalin @ 0.75 kg a.i/ha as PE + One intercultivation at 30 DAS followed by hand weeding at 40 DAS	6.10	75.92
T_3: Pendimethalin @ 1.0 kg a.i/ha as PE + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha as POE	4.97	80.38
T_4: Pendimethalin @ 1.0 kg a.i/ha as PE + Propaquizofop (Agil) @ 62 g a.i/ha as POE	5.44	78.53
T_5: Pendimethalin @ 1.0 kg a.i/ha as PE + Fenoxoprop Ethyl (White super) @ 37.5 g a.i/ha as POE	5.73	77.38
T_6: Farmers practice (Two IC at 20 & 40 DAS + One HW at 30 DAS)	6.20	75.53
T_7: Weed free (Three hand weedings at 15, 30 & 45 DAS)	5.24	79.32
T_8: Unweeded control	25.34	-
T_9: T_3 + Intercultivation at 30-35 DAS coinciding with top dressing	4.98	80.34

Note: PE- pre-emergence spray and POE- post-emergence spray at 15 – 20 DAS

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TABLE 3: Growth, seed yield and economic parameters of sunflower hybrid as influenced by weed control treatments

Treatments	Head Diameter (cm)	Stem girth (cm)	100 seed weight (g)	Volume Weight (cc/100ml)	Seed Yield (kg/ha)	Net Returns (Rs/ha)	B:C ratio
T_1: Pendimethalin @ 0.75 kg a.i/ha (38.7 CS new molecule) as PE	15.87	2.39	3.64	40.2	1521	37053	2.79
T_2: Pendimethalin @ 0.75 kg a.i/ha as PE + One intercultivation at 30 DAS followed by hand weeding at 40 DAS	15.40	2.17	3.87	40.2	1399	30427	2.34
T_3: Pendimethalin @ 1.0 kg a.i/ha as PE + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha as POE	15.73	2.28	3.88	39.2	1595	38909	2.79
T_4: Pendimethalin @ 1.0 kg a.i/ha as PE + Propaquizofop (Agil) @ 62 g a.i/ha as POE	15.47	2.20	3.98	42.1	1373	30049	2.36
T_5: Pendimethalin @ 1.0 kg a.i/ha as PE + Fenoxoprop Ethyl (White super) @ 37.5 g a.i/ha as POE	15.00	2.11	3.80	41.3	1315	28241	2.30
T_6: Farmers practice (Two IC at 20 & 40 DAS + One HW at 30 DAS)	16.00	2.41	3.98	41.7	1676	40143	2.71
T_7: Weed free (Three hand weedings at 15, 30 & 45 DAS)	15.80	2.38	3.85	42.1	1720	40813	2.66
T_8: Unweeded control	15.00	2.12	3.57	40.0	1251	27998	2.43
T_9: T_3 + Intercultivation at 30-35 DAS coinciding with top dressing	15.80	2.35	3.56	41.0	1679	41613	2.87
SEm±	0.248	0.084	0.183	1.141	109.84	4172	0.186
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS

Note: PE-pre-emergence spray and POE-post-emergence spray at 15–20 DAS

Total weed dry weight recorded at harvest was found to be less in all the treatments compared to unweeded control plot (Table 2). Pendimethalin @ 1.0 kg a.i / ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray on weeds at 15-20DAS recorded lesser total weed dry weight (4.97 g/ m2) and it was on par with Pendimethalin @ 1.0 kg a.i/ha as PE + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha as POE + Intercultivation at 30-35 DAS coinciding with top dressing (4.98 g/ m2). The reduction in total weed population and dry weight in these treatments was mainly due to effective control of weeds at all stages of crop growth period which resulted in lower weed density and dry weight at harvest. The results are in conformity with the findings of Siva Sankar and Subramanyam (2011).

Weed Control Efficiency is a measure of the efficiency of weed control methods in restricting the weed growth. Among the different weed management practices, Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray (80.38%) (Table 2) which was closely followed by Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray + Intercultivation at 30-35 DAS coinciding with top dressing (80.34%) and thus indicates that above treatments can be considered for weed management options in sunflower. The higher Weed Control Efficiency in T3 and T9 is due to better control of weeds during crop growth period which lowered the weed population and its dry weight. These results are in conformity with the findings of Narkhede (2000), Rajanand Hiremath *et al.*,(2013) and Sylvestre Habimana *et al.*, (2013).

Seed yield and Economics

Across all the treatments seed yield did not differ significantly (Table 3). Weed free treatment (three hand weedings at 15, 30 & 45 DAS) recorded highest seed yield of 1720 kg/ha compared to all other treatments. Whereas, Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray + Intercultivation at 30-35 DAS (T9) coinciding with top dressing (1679 kg/ha) and Farmers practice (two IC at 20 & 40 DAS + One HW at 30 DAS) recorded similar seed yield (1676kg/ha). Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha at 15 – 20 DAS as directed post-emergence spray on weeds also recorded higher seed yield of 1595 kg/ha and these treatments were non-significant to unweeded control.

The higher yield obtained with T9: Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray + Intercultivation at 30-35 DAS coinciding with top dressing (1679 kg/ha) and T6: Farmers practice (Two IC at 20 & 40 DAS + One HW at 30 DAS) (1676kg/ha) was mainly attributed to improved yield components such as head diameter (15.80 and 16.00cm), 100 seeds weight (3.98 and 3.56 g) and volume weight (41.7 and 41.0 cc / 100ml). the reason for increased yield components might be due to efficient and broad spectrum wed management achieved by the above treatments resulting in increased availability of nutrients and moisture throughout the crop growth. This inturn have created favorable condition – competition free environment. These yield attributing parameters were adversely affected in unweeded control treatment due to severe weed competition exerted by weeds for space, light, moisture and nutrients throughout the crop growth period. the increase in 100 seed weight is due to availability of more amount of photosynthates and better partitionoing of dry weight. Similar comparable reports have been reported by Hafeez Ullah et al., (2001) and Young *et al.*, (2003).

Net returns and B:C ratio was highest with with T9: Pendimethalin @ 1.0 kg a.i/ha as pre-emergence spray + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha post-emergence spray + Intercultivation at 30-35 DAS coinciding with top dressing (Rs.41613/ ha and 2.87).

CONCLUSION

The experimental data collected suggests that treatment variation exist in response to herbicides application and application of pre-emergent as well post emergent herbicides application in sunflower results in higher seed yield without any phytotoxic effects.

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