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Research Article

EFFECT OF CHEMICAL WEED MANAGEMENT ON GROWTH TRAITS AND ITS INFLUENCE ON PERFORMANCE OF SUNFLOWER

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ABSTRACT
The early growth period is the most critical stage at which stress of any kind can affect the physiological growth parameters and in turn the economic yields of the crop. In sunflower, weed competition is one such important stress during this period. In this regard, a field trial was conducted during *kharif* season at main research station experimental farm, University of Agricultural Sciences, Dharwad. The experiment consisted of four pre-emergent herbicides such as Alachlor (2.0 l ha^{-1}), Metolachlor (1.50 l ha^{-1}), Clomazone (1.0 l ha^{-1}) and Pendimethalin (1.50 l ha^{-1}) and mixture of these herbicides with half of their concentrations. In addition, weed free check and un-weeded check were also included for comparison. The result revealed that among the herbicide treatments maximum increase in LA, LAI, LAD, AGR, CGR, RGR and NAR was observed in the Alachlor (1.0 l ha^{-1}) and Metolachlor (0.75 l ha^{-1}) combination during all the crop growth stages with lowest weed biomass of 106.90 kg ha^{-1} and a weed index of 3.18% with highest weed control efficiency of 78.20%. The seed yield of sunflower was significantly higher (1277 kg ha^{-1}) with application of these herbicide combinations which was on-par with the seed yield of weed free check (1319 kg ha^{-1}). In unweeded check the weed biomass was 489.40 kg ha^{-1} and weed index was 33.51 % which were significantly higher compared to herbicides treatment and the application of herbicides significantly increased the sunflower seed yield as compared to unweeded check (877 kg ha^{-1}).

Key Words: *Critical Stage, Herbicide,Kharif, Pre-emergent, Sunflower, Stress, Weed Control Efficiency, Weed Index*

INTRODUCTION
Sunflower (*Helianthus annuus* L.) has emerged as one of the important oil seed crops in India because of its photo-insensitivity, short duration, low water requirement and good quality oil. But the average productivity of sunflower is very low (610 kg/ha) as compared to worlds average (1356 kg/ha), indicating wider scope for improving the yield potential. There are several constraints in sunflower production and weed infestation is one of the major factor for loss in yield. Sunflower is a poor competitor with weeds on an account of its slow growth in the initial stage and it has now been well established that losses from weed are for more than due to infestation of insects pest and diseases. Weeds compete with crop plants for nutrients, soil moisture, space and sunlight causing poor growth and yield losses. Hand weeding and other cultural methods of weed control widely used by farmers are efficient but laborious, time consuming and also very expensive. However, unfavourable soil and climatic conditions, non availability of labourers and high rate of wages during peak period of farm operations often come in the way of timely operations of manual/cultural methods of weed control. Moreover, these methods are employed only after the crop has attained a certain stage of growth, by which time, the weeds would have also attained sufficient growth, depleting the available and applied nutrients and moisture. Krishnagowda et al., 1985 reported that keeping weed free for the first 60 DAS will produce maximum seed yield in sunflower and Fariza et al. 1980 reported that the crop weed competition in sunflower extends from the formation of the 9^{th} leaf to the beginning of flowering. There fore timely weed control is the main criterion in improving the productivity of sunflower.

Hence pre emergent chemical weed control appears to hold a great promise in dealing with timely and efficient weed suppression during the initial stage of growth which improves the crop growth traits and in

turn economic yield. Keeping this in view an experiment was conducted to study the Effect of Chemical Weed Management on Growth Traits and its Influence on performance of Sunflower.

MATERIALS AND METHODS

A field experiment was conducted to study the effect of herbicides and their combinations in sunflower (Cv. KBSH-1) at Dharwad agricultural university, main research station experimental farm during *kharif* season. The soil of the experimental plot was black cotton with 7.5 soil pH and 30% field capacity.

The treatments were laid out in a randomised block design with three replications. The experiment consisted of four pre-emergent herbicides Alachlor (2.0 l ha^{-1}), Metolachlor (1.50 l ha^{-1}), Clomazone (1.0 l ha^{-1}) and Pendimethalin (1.50 l ha^{-1}) and their combinations. The herbicide mixtures were made by adding half the concentration of two individual herbicides. The treatments were imposed immediately after sowing and all these treatments were compared with weed free check and unweeded check. The weed free check was maintained by removing the weeds as and when they emerged. Weeds in experimental block were collected from randomly selected one square meter area in the net plot at harvest. The weed biomass was oven dried at 80°C for 72 hours and the dry weight was recorded as g m^{-2}. The data on weed biomass were transformed using the formula log (X+2). Sunflower seed yield from net plot was collected and expressed in kg ha^{-1}.

Leaf area (LA) expressed in cm^2, leaf area index (LAI), leaf area duration (LAD) expressed in days, absolute growth rate (AGR) expressed as g $plant^{-1}$ day^{-1}, crop growth rate (CGR) expressed as g dm^{-2} land area day^{-1}, relative growth rate (RGR) expressed as g g^{-1} day^{-1}, net assimilation rate (NAR) expressed as g dm^{-2} leaf $area^{-1}$ day^{-1} and weed control efficiency (WCE) expressed in per cent was calculated by using the formula given by Scheinter (1978), Watson (1952), Power *et al.*, (1967), Radford (1967), Watson (1952), Blackman (1919), Gregory (1929) and Thakur (1994) respectively.

The weed index (WI) was calculated on seed yield basis by adopting the following formula,

$$WI\ (\%) = \frac{X-Y}{X} \times 100$$

Where,

X = seed yield from the weed free check plot

Y = seed yield from the treated plot for which WI is to be worked out

RESULTS AND DISCUSSION

The weed flora of the experimental field during the crop growth period predominantly comprised of *Cynodon dactylon, Commelina benghalensis, Digitaria marginata, Echinochloa crussgalli, Acanthospermum hispidum, Amaranthus aspera, Amaranthus viridis, Chenopodium album, Euphorbia hirta,Phyllanthus niruri, Parthenium hysterophorus* and *Cyperus rotundus* weed species.

Leaf area depends on the number of leaves, the rate of leaf expansion, light interception and temperature. Leaf area recorded at various growth stages indicated significant differences due to herbicide treatments. The weed free check recorded significantly maximum leaf area at 30, 60 DAS and at harvest with 7.24, 61.92 and 14.03 dm^2 respectively. Among the herbicides maximum leaf area was observed in Alachlor @ 1.00 l ha^{-1} in combination with Metolachlor @ 0.75 l ha^{-1} with 7.21, 60.54 and13.78 dm^2 followed by Alachlor @ 2.00 l ha^{-1} with 7.12, 58.23 and13.10 dm^2 and Metolachlor @ 1.50 l ha^{-1} with 7.06, 57.65 and12.65 dm^2 which were significantly higher then unweeded chech with 6.75, 46.74 and 6.77 dm^2 respectively at 30, 60 DAS and at harvest. Crop weed competition in unweeded check resulted in decreased number of leaves which in turn results in reduction in leaf area. Growth parameters help in understanding the importance of morphological changes during the crop growth and development. In general all the physiological growth parameters such as LAI, AGR, CGR, RGR and NAR increased up to 60 DAS and there after decreased towards maturity in all the treatments. Weed free check recorded higher LAI (5.16 and 1.17) followed

Table 1: Influence of herbicides and their mixtures on leaf area, LAI and LAD at different stages in sunflower

Herbicide treatments (l ha^{-1})	Leaf area (dm^2)			LAI			LAD (days)	
	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest	30-60 DAS	60 DAS to Harvest
Alachlor (2.0)	7.12	58.23	13.10	0.59	4.85	1.09	82	89
Metolachlor (1.5)	7.06	57.65	12.65	0.59	4.80	1.05	81	88
Clomazone (1.0)	6.53	48.52	7.31	0.54	4.04	0.61	69	70
Pendimethalin (1.5)	6.94	54.96	10.43	0.58	4.58	0.87	77	82
Alachlor (1.0) + Metolachlor (0.75)	7.21	60.54	13.78	0.60	5.05	1.15	85	93
Alachlor (1.0) + Clomazone (0.50)	6.78	51.83	9.24	0.57	4.32	0.77	73	76
Alachlor (1.0) + Pendimethalin (0.75)	7.02	56.81	11.95	0.59	4.73	1.00	80	86
Metolachlor (0.75) + Clomazone (0.50)	6.69	50.76	8.76	0.56	4.23	0.73	72	74
Metolachlor (0.75) + Pendimethalin (1.5)	6.79	52.71	9.85	0.57	4.39	0.82	74	78
Clomazone (0.50) + Pendimethalin (0.75)	6.62	49.15	8.02	0.55	4.10	0.67	70	71
Weed free check	7.24	61.92	14.03	0.60	5.16	1.17	86	95
Unweeded check	6.75	46.74	6.77	0.56	3.90	0.56	67	67
S.Em±	0.32	2.36	0.92	0.02	0.17	0.08	1.71	1.84
C.D. at 5%	0.94	6.91	2.69	0.05	0.49	0.22	5.00	5.40

Table 2: Influence of herbicides and their mixtures on physiological growth traits at different stages in sunflower

Herbicide treatments (l ha^{-1})	AGR (g $plant^{-1}$ day^{-1})		CGR (g dm^{-2} land area day^{-1})		RGR (g g^{-1} day^{-1})		NAR (g dm^{-2} leaf $area^{-1}$ day^{-1})	
	30-60 DAS	60 DAS to Harvest	30-60 DAS	60 DAS to Harvest	30-60 DAS	60 DAS to Harvest	30-60 DAS	60 DAS to Harvest
Alachlor (2.0)	17.48	1.20	14.57	1.00	5.70	0.18	7.19	0.40
Metolachlor (1.5)	17.22	1.12	14.35	0.93	5.67	0.17	7.15	0.38
Clomazone (1.0)	14.84	0.41	12.37	0.34	5.54	0.07	7.09	0.19
Pendimethalin (1.5)	16.50	0.85	13.75	0.71	5.61	0.14	7.11	0.32
Alachlor (1.0) + Metolachlor (0.75)	18.01	1.41	15.00	1.18	5.75	0.21	7.18	0.45
Alachlor (1.0) + Clomazone (0.50)	15.78	0.60	13.14	0.50	5.55	0.10	7.12	0.24
Alachlor (1.0) + Pendimethalin (0.75)	16.87	0.99	14.06	0.83	5.65	0.16	7.08	0.34
Metolachlor (0.75) + Clomazone (0.50)	15.45	0.52	12.87	0.43	5.52	0.09	7.10	0.22
Metolachlor (0.75) + Pendimethalin (1.5)	16.11	0.73	13.42	0.60	5.58	0.12	7.19	0.28
Clomazone (0.50) + Pendimethalin (0.75)	15.18	0.45	12.64	0.37	5.50	0.08	7.15	0.20
Weed free check	18.44	1.51	15.37	1.26	5.79	0.22	7.24	0.47
Unweeded check	14.00	0.30	11.67	0.25	5.20	0.06	6.77	0.14
S.Em±	0.54	0.16	0.30	0.24	0.12	0.07	0.11	0.13
C.D. at 5%	1.59	0.45	0.88	0.72	0.35	NS	0. 32	NS

Table 3: Influence of herbicides and their mixtures on weed parameters and seed yield in sunflower

Herbicide treatments	Weed biomass at harvest	Weed control efficiency	Weed index	Seed yield
(l ha^{-1})	(kg ha^{-1})	(%)	(%)	(kg ha^{-1})
Alachlor (2.0)	2.12 (128.50)*	73.76	9.55	1193
Metolachlor (1.5)	2.17 (146.10)	70.16	11.15	1172
Clomazone (1.0)	2.18 (149.80)	69.40	22.52	1022
Pendimethalin (1.5)	2.25 (174.30)	64.40	13.95	1135
Alachlor (1.0) + Metolachlor (0.75)	2.04 (106.90)	78.20	3.18	1277
Alachlor (1.0) + Clomazone (0.50)	2.28 (188.90)	61.40	16.83	1097
Alachlor (1.0) + Pendimethalin (0.75)	2.22 (164.70)	66.40	13.34	1143
Metolachlor (0.75) + Clomazone (0.50)	2.29 (193.30)	60.05	18.12	1080
Metolachlor (0.75) + Pendimethalin (1.5)	2.27 (182.40)	62.80	14.71	1125
Clomazone (0.50) + Pendimethalin (0.75)	2.32 (207.00)	57.70	19.79	1058
Weed free check	0.3 (0.00)	100.00	----	1319
Unweeded check	2.69 (489.40)	----	33.51	877
S.Em±	0.12	7.37	2.70	49
C.D. at 5%	0.35	21.95	8.02	142

Figures in the parenthesis indicate the actual values

by combination of Alachlor @ 1.00 l ha^{-1} with Metolachlor @ 0.75 l ha^{-1} (5.05 and 1.15), Alachlor @ 2.00 l ha^{-1} (4.85 and 1.09) and Metolachlor @ 1.50 l ha^{-1} (4.80 and 1.05) which were significantly higher then

the unweeded check (3.90 and 0.56) at 60 DAS and at harvest respectively. LAD is the total amount of leaf area present over a particular period of plant growth and is an important growth parameter that influences the competition. Similar trend as that of LAI was observed in LAD with significantly higher LAD of 86 and 95 days in weed free check followed by 85 and 93 days in Alachlor @ 1.00 l ha^{-1} with Metolachlor @ 0.75 l ha^{-1} combination, 82 and 89 days in Alachlor @ 2.00 l ha^{-1} and 81 and 82 days in Metolachlor @ 1.50 l ha^{-1} as compared to unweeded check with 67days both at 30 to 60 DAS and 60 DAS to harvest respectively.

The growth traits such as AGR, CGR, RGR and NAR indicate the relative increase in crop growth per unit time. Due to herbicide treatments, the AGR and CGR differed significantly at both 30 to 60 DAS and 60 DAS to harvest. At both these stages weed free check recorded higher AGR and CGR followed by of Alachlor @ 1.00 l ha^{-1} with Metolachlor @ 0.75 l ha^{-1} combination, Alachlor @ 2.00 l ha^{-1} and Metolachlor @ 1.50 l ha^{-1} which were significantly higher then the unweeded check. Similarly, the same trend was observed in the RGR and NAR with significant difference due to herbicides only at 30to 60 DAS. The decrease in physiological growth traits such as AGR, CGR, RGR and NAR in unweeded check as compared to other treatments could be attributed to a significant reduction in leaf area which is the primary site of assimilation of photosynthates.

Bhanumurthy and Subramanin (1989) opined that weed biomass is a better parameter to measure the competition than weed number as it precisely measures the quantity of growth related factors utilized by weeds. All the herbicide treatments recorded significantly reduced weed dry weight when compared to unweeded check. Among the the herbicide treatments lowest weed biomass was recorded with Alachlor @ 1.00 l ha^{-1} in combination with Metolachlor @ 0.75 l ha^{-1} followed by Alachlor @ 2.00 l ha^{-1} and Metolachlor @ 1.50 l ha^{-1} (Table-2).Thus indicating the efficacy of these herbicides in control of weeds in sunflower. Several workers also reported significant reduction in dry weight of weeds due to the application of Alachlor and Metolachlor (Machado etal., 1989 and Malipatil, 1989).

The weed control efficiency (WCE) which reflects the efficiency of herbicides for controlling weeds was highest in Alachlor @ 1.00 l ha^{-1} in combination with Metolachlor @ 0.75 l ha^{-1} (78.2%) followed by Alachlor @ 2.00 l ha^{-1} (73.7%) and Metolachlor @ 1.50 l ha^{-1} (70.2%). This indicated that these herbicides can be used safely for the effective control of weeds in sunflower. Similarly, different studies also reported the use of Alachlor and Metolachlor in improving the weed control efficiency in sunflower (Suresh and Venkatareddy, 1994 Channappagouder et al., 2008 and Joshi et al., 1996 in soybean). The weed index (WI) values were lowest with Alachlor @ 1.00 l ha^{-1} in combination with Metolachlor @ 0.75 l ha^{-1} (3.18%) followed by Alachlor @ 2.00 l ha^{-1} (9.55%) and Metolachlor @ 1.50 l ha^{-1} (11.15%) and more with Clomazone @ 1.00 l ha^{-1} (22.52%), Clomazone @ 0.50 l ha^{-1} with Pendimethalin @ 0.75 l ha^{-1} (19.79%) and Metolachlor @ 0.75 l ha^{-1} with Clomazone @ 0.50 l ha^{-1} (18.12%) which suggests that Alachlor @ 1.00 l ha^{-1} in combination with Metolachlor @ 0.75 l ha^{-1} and Alachlor @ 2.00 l ha^{-1} can be efficiently used for higher weed control efficiency and lower weed index values.

The highest seed yield was found in weed free check (1319 kg ha^{-1}). Among herbicide treatments, Alachlor @ 1.00 l ha^{-1} and Metolachlor @ 0.75 l ha^{-1} combination (1277 kg ha^{-1}), Alachlor @ 2.00 l ha^{-1} (1193 kg ha^{-1}) and Metolachlor @ 1.50 l ha^{-1} (1172 kg ha^{-1}) showed significantly higher seed yield and it was lowest in unwedded check (877 kg ha^{-1}). From the present investigation it is very clear that the weed competition reduces the seed yield by 33.5 per cent.

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