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***Research Article***

# SYNERGETIC EFFECTS OF HERBICIDE MIXTURES ON WEED MANAGEMENT IN SUNFLOWER

**N.S.Renukaswamy*, Prashant Kusagur and R. Jayaprakash**
*Department of Crop Physiology*
*University of Agricultural Sciences, Dharwad – 580 005, Karnataka, India*
** Author for Correspondence*

## ABSTRACT
An experiment was conducted to find out the synergetic effects of herbicide mixtures in sunflower 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 in unweeded check the weed biomass was 489.40 kg $ha^{-1}$ and with weed index of 33.51 % which were significantly higher and were reduced with the application of herbicides. Among the herbicide treatments Alachlor (1.0 l $ha^{-1}$) and Metolachlor (0.75 l $ha^{-1}$) combination recorded lowest weed biomass of 106.90 kg $ha^{-1}$ and a weed index of 3.18% with highest weed control efficiency (78.20%). The seed yield of sunflower was 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 $ha^{-1}$).

***Key Words:*** *Herbicide, Kharif, Sunflower, Synergetic Effects, Weed Control Efficiency*

## INTRODUCTION
In the present oil crisis, sunflower occupies a prime place as it is distinctly superior to most of the other oil seed crops. It is the main source of edible oil in several parts of the world as it has got more of poly unsaturated fatty acids (PUFA). In India it has gained importance in recent years however the average productivity in India is very low (610 kg $ha^{-1}$) as compared to the world average (1356 kg $ha^{-1}$) indicating wider scope for improving the yield potential. Among the oil seed crops sunflower has prominence owing to its wider adaptability to varying agro climatic conditions, higher oil production per unit area, short duration and photo-insensitivity. Apart from these factors low yields of sunflower could be attributed to a variety of factors. Among them the competition of weeds with the crop is one of the important factors. The cultural methods of weed control widely used by farmers are efficient but laborious, time consuming and expensive. Unfavourable soil and climatic conditions often come in the way of timely operations of 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. It has been reported that maximum yields were obtained when sunflower field was kept free of weeds for 4 to 6 weeks after planting (Krishnegowda et al., 1978).
Application of pre-emergent herbicides provides a weed free environment especially during the early stages of crop growth. Individual herbicides are not much efficient because of their selective nature for different weeds. Hence, herbicide combinations are presently used for effective and economic way of weed control. A mixture will broaden the spectrum of herbicidal action, in order to kill a greater variety of weeds which are difficult to control when individual herbicides are used.

## 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 15,30,45,60 days after sowing (DAS) and 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 $ha^{-1}$.

Weed control efficiency (WCE)

Weed control efficiency was worked out to evaluate the comparative efficacy of different herbicides and their combinations estimated by using the formula suggested by Thakur (1994).

$$WCE\ (\%) = \frac{W2-W1}{W1} \times 100$$

Where,

W1 = weed biomass of unweeded check plot

W2 = weed biomass of treated plot for which WCE is to be calculated

Weed index (WI)

The weed index 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.

The data recorded on total weed dry weight indicated significant differences at all crop growth stages. Significantly lowest weed dry weight was recorded with weed free check as these plots were maintained weed free at all stages of crop growth.

At 15 DAS, Clomazone @ 1.00 l $ha^{-1}$ recorded lowest weed dry weight (0.348) among herbicide treatments which was on par with weed free check (0.301) and mixture of Alachlor @ 1.00 l $ha^{-1}$ with Metolachlor @ 0.75 l $ha^{-1}$ (0.422) while all other treatments recorded significantly higher weed dry weight (Table-1). At 30 DAS also Clomazone @ 1.00 l $ha^{-1}$ recorded lowest weed dry weight (0.452) which was on par with mixture of Alachlor @ 1.00 l $ha^{-1}$ with Metolachlor @ 0.75 l $ha^{-1}$ (0.523) and Alachlor @ 1.00 l $ha^{-1}$ with Clomazone @ 0.50 l $ha^{-1}$ (0.525) and all other herbicide treatments were recorded significantly higher weed dry weight.

Alachlor @ 1.00 l $ha^{-1}$ with Metolachlor @ 0.75 l $ha^{-1}$ recorded lowest weed dry weight (0.733) at 45 DAS which was on par with Clomazone @1.00 l $ha^{-1}$ (0.758) Alachlor @ 2.00 l $ha^{-1}$ (0.769) and Metolachlor @ 1.50 l $ha^{-1}$ (0.779). while all other herbicide treatments were recorded significantly higher weed dry weight . At 60 DAS also, mixture of Alachlor @ 1.00 l $ha^{-1}$ with Metolachlor @ 0.75 l $ha^{-1}$ recorded significantly lower weed dry weight (0.798) as compared to mixtures of Clomazone @ 0.50 l $ha^{-1}$ with Pendimethalin @ 0.75 l $ha^{-1}$ (0.996) and Metolachlor @ 0.75 l $ha^{-1}$ with Clomazone @ 0.50 l $ha^{-1}$ (0.991) while all other herbicide treatments were on par with each other. Bhanumurthy and Subramanin (1989) opined that weed biomass is a better parameter to measure the competition than weed number as it

**Table 1: Influence of herbicides and their mixtures on weed biomass at different stages in sunflower**

| Herbicide treatments | Weed biomass at 15 DAS | Weed biomass at 30 DAS | Weed biomass at 45 DAS | Weed biomass at harvest |
|---|---|---|---|---|
| (l $ha^{-1}$) | (g $m^{-2}$) | | | |
| Alachlor (2.0) | 0.445 (0.786)* | 0.565 (1.672) | 0.769 (3.874) | 1.172 (4.870) |
| Metolachlor (1.5) | 0.449 (0.813) | 0.599 (1.968) | 0.779 (4.017) | 1.22 (5.925) |
| Clomazone (1.0) | 0.348 (0.231) | 0.452 (0.832) | 0.758 (3.725) | 1.23 (5.462) |
| Pendimethalin (1.5) | 0.46 (0.885) | 0.631 (2.278) | 0.871 (5.431) | 1.289 (6.521) |
| Alachlor (1.0) + Metolachlor (0.75) | 0.422 (0.643) | 0.523 (1.334) | 0.733 (3.402) | 1.103 (4.284) |
| Alachlor (1.0) + Clomazone (0.50) | 0.431 (0.698) | 0.525 (1.351) | 0.852 (5.104) | 1.32 (7.340) |
| Alachlor (1.0) + Pendimethalin (0.75) | 0.457 (0.864) | 0.62 (2.173) | 0.867 (5.357) | 1.276 (6.215) |
| Metolachlor (0.75) + Clomazone (0.50) | 0.434 (0.716) | 0.539 (1.458) | 0.882 (5.624) | 1.329 (7.795) |
| Metolachlor (0.75) + Pendimethalin (1.5) | 0.462 (0.897) | 0.659 (2.562) | 0.901 (5.963) | 1.306 (6.974) |
| Clomazone (0.50) + Pendimethalin (0.75) | 0.439 (0.749) | 0.605 (2.027) | 0.917 (6.257) | 1.356 (7.908) |
| Weed free check | 0.301 (0.000) | 0.301 (0.000) | 0.301 (0.000) | 0.301 (0.000) |
| Unweeded check | 0.598 (1.967) | 0.913 (6.184) | 1.283 (17.168) | 1.707 (20.184) |
| S.Em± | 0.026 | 0.029 | 0.038 | 0.069 |
| C.D. at 5% | 0.077 | 0.09 | 0.111 | 0.203 |

* - Figures in the parenthesis indicate the actual values

**Table 2: 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

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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