

## Evaluation of Efficacy of Different Herbicides for Efficient Weed Control in Sunflower [*Helianthus annuus* L.]

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### ABSTRACT

A field experiment was conducted during kharif, 2013-14 at Student Farm, College of Agriculture, Rajendranagar, Hyderabad, Acharya N. G. Ranga Agricultural University to find out the effect of different weed management practices in sunflower. Weed spectrum of the experimental field consisted of three groups of weeds like prominent weed species observed in experimental site were grasses viz., *Cynodon dactylon* and *Dactyloctenium aegyptium*, sedges viz., *Cyperus rotundus* and broadleaved weeds viz., *Celosia argentea*, *Digera arvensis*, *Trianthema portulacastrum*, *Commelina benghalensis*, and *Parthenium hysterophorus*. At 60DAS significantly lower weed density, weed dry matter and higher weed control efficiency were recorded with weed free (HW from 15DAS to harvest at 15 days interval) treatment. Hand weeding twice at 20 and 40DAS and application of oxyfluorfen @ 150 g a.i ha<sup>-1</sup> as PE with one hand weeding at 25DAS treatments were on par each other. Higher weed density, weed dry matter and lower weed control efficiency recorded with weedy check.

**Key words:** Sunflower, Oxyfloufen, Pendimethalin, Quizalofop-p-ethyl, Fenoxaprop-p-ethyl, Paraquat, Hand weeding, Net returns.

### INTRODUCTION

Agriculture is the backbone of Indian economy as nearly 60 per cent of the total population depends directly or indirectly on agriculture. Agriculture and allied sectors are providing 52 per cent of the gainful employment in India. Much of the acreage under coarse cereals (85%), pulses (83%) and oilseeds (70%), substantial area under rice (42%) and nearly 65 per cent of the cotton area is under rainfed conditions<sup>13</sup>. Sunflower (*Helianthus annuus* L.), by virtue of its short duration, wider

adaptability to different soil types, photo-insensitivity and availability of promising hybrids and varieties, has stabilized its area and production in India. Sunflower is the oil of preference among the consumers world-wide due to its health appeal and in India too, sunflower oil is the largest selling oil in the branded oil segment. It is also a crop of choice for farmers due to its wider adaptability, high yield potential, shorter duration and profitability.

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Our country accounted for 3.26 per cent (1044 thousand mt) of total world production of sunflower in 2011 with average productivity of 610 kg ha<sup>-1</sup>, which is very much lower than the world average of 1356 kg ha<sup>-1</sup> (FAO,2011), indicating wider scope for improving the yield potential.

There are several constraints in sunflower production, amongst them weed infestation is one of the major constraints to be addressed for increasing productivity. One of the major constraints in sunflower production is weed competition. The weeds are the major threat resulting in a seed yield loss upto 45 to 55% obtained by Wanjari *et al*<sup>14</sup>. The possibility of enhancing the productivity in sunflower has increased significantly with the discovery of several selective herbicides and also opened up new opportunities efficient weed management. Sunflower is a poor competitor with weeds on account of its slow growth in the initial stage. It has now been well established that losses from weeds are far more than due to infestation of insect pests and diseases. Weeds compete with crop plants for nutrients, soil moisture, space and sunlight causing poor growth and yield losses. Legha *et al*<sup>5</sup> reported that uncontrolled weed growth caused enormous loss of nutrients, which in turn reduced the yield of sunflower crop to an extent of 64 per cent. Reduction in yield depends on various aspects like weed density, time and duration of weed competition, weed spectrum etc<sup>1</sup>.

#### MATERIALS AND METHODS

A field experiment was conducted during *kharij*, 2013-14 at Student Farm, College of Agriculture, Rajendranagar, Hyderabad, Acharya N.G.Ranga Agricultural University to study the effect of different weed management practices in sunflower. The experiment was laid out in randomized block design with three

replications and thirteen treatments *viz.*, T<sub>1</sub>-pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE, T<sub>2</sub>-oxyflourfen @ 150 g *a.i* ha<sup>-1</sup> as PE, T<sub>3</sub>-pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE + HW at 25DAS, T<sub>4</sub>-oxyflourfen @ 150 g *a.i* ha<sup>-1</sup> as PE + HW at 25DAS, T<sub>5</sub>-pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE + quizalofop-p-ethyl @ 50 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS, T<sub>6</sub>-oxyflourfen @ 150 g *a.i* ha<sup>-1</sup> as PE + quizalofop-p-ethyl @ 50 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS, T<sub>7</sub>-pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE + fenoxaprop-p-ethyl @ 56.25 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS, T<sub>8</sub>-oxyflourfen @ 150 g *a.i* ha<sup>-1</sup> as PE + fenoxaprop-p-ethyl @ 56.25 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS, T<sub>9</sub>-pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE + paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS (directed spray), T<sub>10</sub>-oxyflourfen @ 150 g *a.i* ha<sup>-1</sup> as PE + paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE at 15-20DAS (directed spray), T<sub>11</sub>-hand weeding at 20 and 40DAS, T<sub>12</sub>-weed free (HW from 15DAS to harvest at 15 days interval) and T<sub>13</sub>-control (weedy check). A uniform dose of 60-40-30 kg N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O ha<sup>-1</sup> in the form of urea (46 % N), single super phosphate (16 % P<sub>2</sub>O<sub>5</sub>) and muriate of potash (60 % K<sub>2</sub>O) respectively were applied. Entire quantity of P and K was applied as basal, whereas N was applied in two splits, one half at the time of sowing as band placement, 5 cm away from seed row at a depth of about 5 cm, maintaining 60 cm row spacing and between the plants 30 cm. The sunflower cultivar DRSH-1 was sown on 5 July, 2013 adopting the recommended seed rate of 5 kg ha<sup>-1</sup> and harvested on 10<sup>th</sup> October, 2013. Standard procedures were adopted for recording the data on various growth and yield parameters. Plants enclosed in an area of 0.25m<sup>2</sup> from the destructive sampling area were removed at 30, 60DAS and at harvest the plant samples so collected were sun dried and later oven dried at 60°C till a constant weight is obtained.

Weed index (WI) was calculated by using the following formula as given by Gill and Kumar<sup>3</sup>.

$$WI = \frac{\text{Yield from best treatment} - \text{Yield from treated plot}}{\text{Yield from best treatment}} \times 100$$

Weed control efficiency (WCE) was calculated by using the formula suggested by Umrani and Boi<sup>12</sup>.

$$WCE = \frac{[\text{Dry matter of weeds in unweeded plot (g m}^{-2}\text{)}] - [\text{Dry matter of weed in treated plot (g m}^{-2}\text{)}]}{\text{Dry matter of weeds in unweeded plot (g m}^{-2}\text{)}}$$

The data was computed and expressed in kg/ha. Five heads were taken randomly to determine the number of seeds/head. Average number of seeds per head was calculated. 1000 seeds were taken from each plot and were weighed. Plants were threshed manually; seed yield of each plot was recorded and converted into kilograms/hectare.

## RESULTS AND DISCUSSION

### Effect on weeds

The weed flora associated with experimental crop consisted of grasses viz., *Cynodon dactylon*, *Dactyloctenium aegyptium* sedges viz., *Cyperus rotundus* and broad leaved weeds viz., *Celosia argentea*, *Digera arvensis*, *Trianthema portulacastrum*, *Commelina benghalensis* and *Parthenium hysterophorus*. Among all weed sps, *Cynodon dactylon*, *Cyperus rotundus* and *Parthenium hysterophorus* were the most dominant ones. Renukaswamy et al<sup>8</sup> also observed similar weed flora associated with sunflower. Weed population, weed dry matter and weed control efficiency in sunflower field differed significantly with the different weed management practices both at 30 and 60 days

after sowing (DAS). The weed density recorded at 30 and 60DAS are presented in Table 1. At 30 DAS, application of oxyfluorfen @ 150 g a.i ha<sup>-1</sup> as PE fb hand weeding at 25DAS and pendimethalin @ 580 g a.i ha<sup>-1</sup> as PE fb hand weeding at 25 DAS were equally effective and recorded significantly lower weed number over all other treatments because of hand weeding at 25DAS and these treatments were on par with pendimethalin @ 580 g a.i ha<sup>-1</sup> as PE fb paraquat @ 600 g a.i ha<sup>-1</sup> as PoE at 15-20DAS (directed spray) and oxyfluorfen @ 150 g a.i ha<sup>-1</sup> as PE fb paraquat @ 600 g a.i ha<sup>-1</sup> as PoE at 15-20DAS (directed spray) compared to other treatments and higher number of grasses, sedges, broad leaved weeds and total weeds (20.0, 25.00, 19.00 and 64.00 respectively) were observed in weedy check (control). Pre-emergence application of pendimethalin (580 g a.i ha<sup>-1</sup>) or oxyfluorfen (150 g a.i ha<sup>-1</sup>) either alone or coupled with PoE of quizalofop-p-ethyl (50 g a.i ha<sup>-1</sup>) or fenoxaprop-p-ethyl (56.25 g a.i ha<sup>-1</sup>) were not effective in controlling the sedges and broad leaved weeds at 30DAS.

**Table 1: Effect of different integrated weed control treatments on weed density (no. m<sup>-2</sup>) in sunflower at 30 DAS & 60DAS during kharif, 2013**

T. No	Weed density (Number per m <sup>2</sup> )								Weed dry matter (g/ m <sup>2</sup> )	
	30DAS				60DAS				30DAS	60DAS
	Grasses	Sedges	BLW'S	Total weeds	Grasses	Sedges	BLW'S	Total weeds		
T <sub>1</sub>	3.08 (9.0)	3.08 (9.00)	2.73 (7.00)	5.05 (25.00)	4.64 (21.00)	4.95 (24.00)	4.94 (24.00)	8.34 (69.0)	3.16 (10.21)	5.76 (33.10)
T <sub>2</sub>	2.35 (5.0)	2.73 (7.00)	2.91 (8.00)	4.53 (20.10)	4.40 (19.00)	4.52 (20.00)	4.74 (22.00)	7.84 (61.0)	2.74 (7.10)	5.67 (32.20)
T <sub>3</sub>	1.22 (1.0)	1.22 (1.00)	1.22 (1.00)	1.86 (3.00)	2.08 (4.00)	3.24 (10.00)	3.67 (13.00)	5.24 (27)	1.38 (1.40)	3.81 (14.21)
T <sub>4</sub>	1.22 (1.0)	1.22 (1.00)	1.22 (1.00)	1.86 (3.00)	2.12 (4.00)	3.08 (9.00)	3.52 (12.00)	5.05 (25.0)	1.30 (1.20)	3.39 (11.10)
T <sub>5</sub>	1.58 (2.0)	2.91 (8.00)	3.53 (12.00)	4.74 (22.00)	2.47 (5.67)	3.81 (14.00)	4.30 (18.00)	6.20 (38.0)	2.92 (8.10)	4.30 (18.00)
T <sub>6</sub>	1.58 (2.0)	2.50 (5.77)	2.90 (8.00)	4.06 (16.00)	2.34 (5.00)	3.81 (14.00)	4.06 (16.00)	5.96 (35.0)	2.35 (5.01)	4.18 (17.11)
T <sub>7</sub>	1.96 (3.3)	3.24 (10.00)	3.08 (9.00)	4.85 (23.00)	2.74 (7.00)	4.18 (17.00)	4.53 (20.00)	6.60 (43.0)	3.08 (9.02)	4.74 (22.14)
T <sub>8</sub>	1.87 (3.0)	2.91 (8.00)	2.54 (6.00)	4.18 (17.00)	2.34 (5.00)	4.26 (17.67)	4.27 (18.00)	6.44 (41.0)	2.56 (6.04)	4.53 (20.07)
T <sub>9</sub>	1.53 (1.8)	1.58 (2.00)	1.22 (1.00)	2.48 (5.67)	2.90 (8.00)	3.39 (11.00)	4.40 (19.00)	6.20 (38.0)	1.41 (1.50)	4.18 (17.07)
T <sub>10</sub>	1.41 (1.5)	1.58 (2.00)	1.22 (1.00)	2.42 (5.37)	2.90 (8.00)	3.24 (10.00)	3.93 (15.00)	5.79 (33.0)	1.41 (1.50)	4.06 (16.00)
T <sub>11</sub>	2.12 (4.0)	1.22 (1.00)	2.34 (5.00)	3.24 (10.00)	2.53 (6.00)	1.86 (3.00)	2.73 (7.00)	4.06 (16.0)	1.58 (2.00)	2.74 (7.00)
T <sub>12</sub>	2.68 (6.7)	1.56 (2.00)	2.54 (6.00)	3.89 (14.7)	2.12 (4.00)	1.58 (2.00)	2.35 (5.00)	3.39 (11.0)	2.12 (4.01)	1.58 (2.00)
T <sub>13</sub>	4.53 (20.0)	5.05 (25.00)	4.41 (19.00)	8.03 (64.00)	5.70 (32.00)	6.12 (37.00)	5.33 (28.00)	9.87 (97.0)	5.43 (29.04)	7.18 (51.42)
	0.13	0.12	0.17	0.25	0.15	0.20	0.17	0.18	0.21	0.22
	0.39	0.36	0.49	0.72	0.44	0.59	0.49	0.53	0.67	0.68

**Original values are given in parentheses, which were transformed to  $\sqrt{x+0.5}$** 

At 60DAS, significantly lower number of grasses (4.00), sedges (2.00), broad leaved weeds (5.00) and total number of weeds (11.00) were recorded with weed free (HW from 15DAS to harvest at 15 days interval) condition and superior over all other treatments. Hand weeding twice at 20 and 40DAS also recorded significantly lower weeds *viz.*, grasses, sedges, broad leaved and total weeds over rest of the treatments. Next best treatments, application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE with one hand weeding at 25DAS (4.00, 9.00, 12.00 and 25.00, respectively) and pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* hand weeding at 25DAS being at par also recorded lower weeds over all other treatments. Significantly higher grasses (32.00), sedges (37.00), broad leaved weeds (28.00) and total number of weeds (97.00) were recorded in weedy check compared to all other treatments. These results indicate that hand weeding continued its effect on weeds which resulted in lower weed density at 60DAS. At 30DAS, application of pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* hand weeding at 25DAS and oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* hand weeding at 25DAS were significantly superior with lower dry matter of weeds (1.40 and 1.20, respectively) over other treatments and these treatments remained on par with pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE (directed spray) at 15-20DAS (1.50 g m<sup>-2</sup>) and oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE (directed spray) at 15-20 DAS (1.50 g m<sup>-2</sup>) were found to be equally effective in recording lower weed dry matter and was on par with hand weeding twice at 20 and 40DAS (2.00 g m<sup>-2</sup>) while higher weed dry matter (5.43 g m<sup>-2</sup>) recorded with weedy check. At 60DAS, in contrast to 30DAS significantly lower weed dry matter (2.00 g m<sup>-2</sup>) was recorded by maintaining weed free conditions over all other treatments. Next best treatments were hand weeding twice at 20 and 40DAS (7.00 g m<sup>-2</sup>) was on par with application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* hand weeding at 25DAS (11.10 g m<sup>-2</sup>) while these two were significantly superior to other treatments but closely followed by

pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* hand weeding at 25DAS (14.21 g m<sup>-2</sup>) while the highest weed dry matter (51.42 g m<sup>-2</sup>) was recorded with weedy check. The pre-emergence herbicides when supplemented with one hand weeding caused a reduction in weed dry matter production and these treatments were found to be better as compared to the herbicides applied alone. At 30DAS the higher weed control efficiency (95.9%) was obtained by the application of pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS, oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS (95.3%), pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE or oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE in combination with paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE (directed spray) at 15-20 DAS performed better whereas adoption of weed free (HW from 15DAS to harvest at 15 days interval) treatment recorded WCE of 93.1 per cent. At 60DAS the highest WCE (96.1) was recorded by adoption of weed free treatment (HW from 15DAS to till harvest at 15 days interval) followed by practicing hand weeding twice at 20 and 40DAS. Next best treatments was application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS which has recorded a weed control efficiency of 78.4 and 71.3 per cent at 60DAS and at harvest respectively. Similar results were obtained by Kumar *et al*<sup>4</sup> and Nagamani *et al*<sup>6</sup>. Higher weed control efficiency in case of the treatments where in hand weeding and oxyfluorfen was due to reduced weed growth during the early stage of crop growth period. At 60DAS and at harvest higher WCE was observed in hand weeding twice followed by oxyfluorfen and pendimethalin integrated with one hand weeding. A weed index of 0 (zero) was obtained when the field was kept weed free (HW from 15DAS to harvest at 15 days interval) and practicing hand weeding twice 20 and 40DAS (4.5%), followed by application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS (7.8%) and pendimethalin @ 580 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS (15.5%). Whereas the higher weed index was recorded with weedy check (66.01%). Weed index is an indicator of the efficiency of weed control treatments, the lower values of weed index indicate better efficiency. Higher weed index was recorded with unweeded check.

**Effect on crop**

The observations on plant height of sunflower were recorded at 60DAS and yield (Table 2). Data shows that all the growth stages was significantly influenced by different weed control treatments. At 60DAS, the highest plant height (155.4 cm) was recorded with weed free treatment (HW from 15DAS to harvest at 15 days interval) and it was on par with the plant height due to hand weeding twice at 20 and 40DAS, application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE *fb* HW at 25DAS (151.0 cm) and pendimethalin @ 580 g *a.i* ha<sup>-1</sup> *fb* one hand weeding at 25DAS (149.3 cm) while the lower plant height recorded with weedy check (111.4 cm). The highest seed yield of 1840 kg ha<sup>-1</sup> was recorded in weed free conditions was

significantly superior to all other treatments and remained on par with practicing hand weeding twice at 20 and 40DAS (1757 kg ha<sup>-1</sup>), application of oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> as PE with one hand weeding at 25DAS (1697 kg ha<sup>-1</sup>). Nagamani *et al*<sup>6</sup> have reported maximum seed yield with herbicide followed by one hand weeding. Next best treatment pendimethalin @ 580 g *a.i* ha<sup>-1</sup> with hand weeding at 25DAS produced 1555 kg ha<sup>-1</sup> it was on par with oxyfluorfen @ 150 g *a.i* ha<sup>-1</sup> *fb* paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE (directed spray) at 20DAS (1493 kg ha<sup>-1</sup>) and pendimethalin @ 580 g *a.i* ha<sup>-1</sup> *fb* paraquat @ 600 g *a.i* ha<sup>-1</sup> as PoE (directed spray) at 20DAS (1490 kg ha<sup>-1</sup>) while the lower seed yield (625 kg ha<sup>-1</sup>) was recorded with weedy check.

**Table- 2: Effect of different integrated weed control treatments on weed control efficiency (%), weed index (%) and yield in sunflower**

T.No	Weed control efficiency (%)	WI (%)	Plant height (cm)	Seed yield (kg ha <sup>-1</sup> )
	60DAS		60DAS	
T <sub>1</sub>	35.9	50.3	138.3	914
T <sub>2</sub>	37.9	44.5	140.2	1021
T <sub>3</sub>	72.5	15.5	149.3	1555
T <sub>4</sub>	78.4	7.8	151.0	1697
T <sub>5</sub>	64.7	30.4	142.9	1281
T <sub>6</sub>	66.7	27.2	144.4	1340
T <sub>7</sub>	56.9	32.5	141.3	1243
T <sub>8</sub>	60.8	31.3	142.2	1264
T <sub>9</sub>	66.7	24.8	145.6	1490
T <sub>10</sub>	68.6	19.0	146.3	1493
T <sub>11</sub>	86.3	4.5	153.9	1757
T <sub>12</sub>	96.1	0.0	155.4	1840
T <sub>13</sub>	0	66.0	111.4	625
SEm±	-	-	2.1	53
CD(P=0.05)	-	-	6.1	154

The late hand weeding increased the aeration and enhanced root growth of crop. This might have augmented the absorption of nutrient and moisture from the soil resulting in higher yield. It might be due to control of weeds from the initial growth of sunflower, as appeared from drastic reduction in density and dry matter of weeds in weed free condition, which helped in better growth of the crop resulting in significant seed yield of sunflower, The factors that contributed to higher crop dry matter production might have resulted in higher stalk

yields in the treatments where weeds were controlled efficiently. These results corroborate those of Kumar *et al*<sup>4</sup>, Siva Sankar and Subramanyam<sup>10</sup> and Nagamani *et al*<sup>6</sup>.

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