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Effect of Non-chemical Weed Management Practices on Weed Characteristics, Yield and Quality in Organically Grown Sunflower

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ABSTRACT

Field experiment was conducted at Tamil Nadu Agricultural University Coimbatore to study the effect of non chemical weed management practices on weed characteristics, yield and quality in organically grown sunflower with 12 treatments. The results revealed that the lower total weed density and group wise (grasses, sedges and broad leaved weeds) and weed dry weight at harvest was recorded with hand weeding twice at 25 DAS and 45 DAS. This treatment also recorded highest seed yield (1250 kg ha^{-1}), oil yield (488.8 kg ha^{-1}) and protein yield (1027.8 kg ha^{-1}). Corresponding treatment also resulted in significantly higher WCE (75.6%) and lower WI (5.8%). However, it was on par with manually operated weeder at 25 DAS followed by hand weeding at 45 DAS.

Key words: Sunflower, Quality, Weed, Weed control efficiency, Weed index, Yield

Organic farming is gaining momentum in the recent past due to the farmer's movement and consumer choice and promotion from the policy makers not only in India but also across different parts of the world. Growing awareness of health and environmental issues in agriculture has demanded production of organic food which is emerging as an attractive source of rural income generation (Bhattacharyya and Chakraborty 2005). Sunflower is one of important source of edible oil and bulk of the production of sunflower seed at global and national level go almost exclusively to oil extraction. Presently, sunflower is cultivated on an area of 0.72 million ha with production of 0.5 million tonne in India. However, the yield of 692 kg ha^{-1} is the lowest among the major sunflower producing countries in the world (Anonymous 2012). Weeds drain the nutrient from the soil and cause huge reduction in the yield of the sunflower crop. The weeds cause drastic reduction in seed yield of sunflower which goes upto 83% if the weeds are left uncontrolled throughout the season (Legha *et al*. 1992). Most of the weeds species that are abundant in organic fields are common in the conventional fields with greater diversity in the vegetation and seed bank of weed species observed in organic than in conventional fields (Frick 2005). Chemical intervention is not permitted for weed control purposes in organic farming systems. Thus, concerns about the potential increase in weed population without the use of herbicide have limited the scope of organic farming. Non chemical weed control and high labour requirement for the hand weeding are considered as the major constraints for the conversion of fields to ecological system. Many of the potential weed problems can be averted through management activities and agronomic practices that diversify the cropping system and the weed environment. Common weed management practices in organic system include, stale seedbed technique, crop rotation, use of the green manures and cover crops, forages, mulches, intercropping, use of highly competitive crops, crop cultivars, use of the allelopathic crops and matching crops to fertility (Bond and Grundy 2001). Manual weeding is always not possible, because of greater demand for labour. Hence an attempt was made to study the effect of the non chemical weed management practices on the performance of the organically grown sunflower crop.

MATERIALS AND METHODS

The experiment was conducted at Eastern Block, Tamil Nadu Agricultural University, Coimbatore during *rabi* under irrigated conditions. The soil of the experimental site was calcareous black soil, which belongs to *Vertic Ustropept* with slightly alkaline pH (8.68), low in organic carbon (0.60%) and available nitrogen (173.6 kg ha^{-1}) and high in available phosphorus (40 kg ha^{-1}) and potassium (740 kg ha^{-1}). The experimental site was under the organic cultivation for past three years before initiation of the experiment. The experiment was laid out in randomized block design with three replication comprising 12 treatments including weed free and weedy check. The sunflower seed (variety Co-4) were dibbled at spacing of 60 cm between the rows and 20

cm within the rows. A seed rate of 12 kg ha^{-1} was adopted. Organic source of well decomposed thoroughly mixed and powdered Phosphorus enriched FYM (P source-rock phosphate) inoculated *Pseudomonas*, *Azospirillum*, *Phosphobacteria* cultures were used as nutrient source. Weed population groupwise (grasses, sedge and broad leaved weeds) in each plot were recorded by using quadrate (0.5 × 0.5 m) in two places at random and expressed as No m^{-2}. The weeds removed from each treatment plot were air dried and then oven dried to obtain a constant weight at 66° ± 2°C and expressed as kg ha^{-1}. Weed control efficiency (WCE) and weed index (WI) was calculated as per the standard procedure and expressed in percentage.

$$WCE\ (\%) = \frac{WDC - WDT}{WDC} \times 100$$

Where, WDC- dry weight of the weeds in the control plot (kg ha^{-1}) and WDT - dry weight of the weeds in the treated plot (kg ha^{-1})

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

Where X- yield from the minimum weed competition plot (kg ha^{-1}) and Y- yield from treated plot (kg ha^{-1}).

The seed and stalk yield for the net area was recorded and expressed in kg ha^{-1}. The oil content of the sunflower seed was estimated with the Nuclear Magnetic Resonance (NMR) instrument and expressed in percent. The oil yield was worked out by multiplying the oil content with seed yield and expressed in kg ha^{-1}. The seeds were analysed for total N content by Micro-kjeldahl method (Yoshida *et al*. 1971) and this N fraction was multiplied by the factor 6.25 to arrive at the crude seed protein content. The observed data on weeds and test crop were statistically analyzed based on the procedure given by Gomez and Gomez (1984) to find out the treatment differences. The data on weed count and weed dry weight that showed higher variation and were subjected to log transformation before statistical analysis. Critical differences were worked out at 5% probability level.

RESULTS AND DISCUSSION

Weed flora

Analysis of relative density of the individual weed species revealed that the weed flora of the experimental field (unweeded control) was dominated by the grassy weeds (64.3%) comprising of *Dactyloctenium aegyptium* Beauv., *Cynodon dactylon* L. Pers., *Dinebra retroflexa*, *Echinochloa colona*, *Chloris barbata* (Sw), *Panicum flavidum* and *Panicum repens*. The only sedge *Cyperus rotundus* L. recorded 16.3 percent of the total weed flora. The broad leaved weeds constituted 20.0 percent of the total weed flora which comprised of *Digera arvensis* Forsk., *Trianthema portulacastrum* L. and *Parthenium hysteroporus* L. Similar weed species were observed by Nalayini (1990).

Weed density

In situ green manuring with sunhemp at 45 DAS (T_5) registered relatively lower grassy weed density of 37.3 m^{-2} at harvest among the cultural methods of weed control employed mainly on account of the physical removal of the weed of the emerged weeds at the time of incorporation. HW twice at 25 and 45 DAS (T_1) recorded significantly lower grassy weeds density of 35.3 m^{-2} which was followed by manually operated weeder twice at 25 and 45 DAS (T_2) (42.7 m^{-2}) and manually operated weeder at 25 DAS + HW at 45 DAS (T_3) (48.7 m^{-2}) treatment. The effective control might be achieved due to the physical removal of the weeds at the early stage in comparison to the other treatments which mainly emphasized on the suppression of the weeds. The results are in corroboration with the findings of Wanjari *et al*. (2001) who reported the importance of the early weed control in sunflower. Intercropping coriander (T_6), mulching with weed residues at 5 t ha^{-1} (T_8) *in situ* green manuring with sunhemp (T_5), showed lower sedge density (4.0, 4.7 and 6.0 m^{-2}, respectively) in comparison to other treatments. This might be attributed to reduction in the light radiation reaching the soil surface, selective suppression and inability of the sedges to thrive above the residues. While, significant lower broad leaved weed density in intercropping with coriander (T_6) (1.3 m^{-2}), *in situ* green manuring with sunhemp at 45 DAS (T_5) (2.0 m^{-2}) and eucalyptus oil spray (T_{10}) (3.3 m^{-2}) was observed. Whereas, the total weed density at harvest indicated *in situ* green manuring with sunhemp at 45 DAS (T_5) significantly reduced the late season weeds followed by HW twice (T_1) with 45.3 and 50.7 m^{-2}, respectively. Eucalyptus oil spray at 0.1 percent at 3 DAS (T_{10}) (74.7 m^{-2}), stale seed bed technique (T_9) (76.7 m^{-2}) and mulching with crop residues at 5 t ha^{-1} (T_7) (80.7 m^{-2}) did not exhibit significant weed control. The in effectiveness might be attributed to the lower concentration of the allelopathic principle in inhibition of the weeds. The results obtained are in line with findings of Saravanane (2000).

Weed dry weight

Hand weeding (HW) twice (T_1) registered significantly lower grassy weed dry weight (325.0 kg ha^{-1}) followed by the manually operated weeder at 25 DAS + HW at 45 DAS (T_3) (462.0 kg ha^{-1}). Whereas, manually operated weeder twice (T_2) (40 kg ha^{-1}) and intercropping with coriander (T_6) (58.0 kg ha^{-1}) recorded lower sedge weed dry weight. Invariably reduction in broad leaved weeds (BLW) dry weight was observed in all the treatments. Intercropping with coriander (T_6) recorded lower BLW dry weight (46.66 kg ha^{-1}). Unweeded control (T_{12}) accounted for the highest BLW dry weight of 259.9 kg ha^{-1}. Hand weeding (HW) twice (T_1) was best treatment in reducing the total weed dry weight (598.3 kg ha^{-1}). These findings were also observed by Kandasamy and Chandrashekar (1998) in comparative study weed treatments in maize.

Yield and quality

Weed management treatments had significant influence on the yield of the sunflower. The highest seed yield of 1327 kg ha^{-1} was recorded in weed free (T_{11}). HW twice (T_1) (1250 kg ha^{-1}) and manually operated weeder at 25 DAS + 45 DAS HW (T_3) (1230 kg ha^{-1}) produced higher and comparable yield. Effective physical removal of the weed at the early stage paved way for less competition among the

crop and the weeds facilitating adequate resources, nutrients for crop utilization resulting in improved yield. Similarly, weed free treatment (T_{11}) produced significantly superior stalk yield of 4111 kg ha^{-1} followed by HW weeding twice (T_1) (3748 kg ha^{-1}). Manually operated weeder + HW at 45 DAS (T_3) (3583 kg ha^{-1}) and manually operated weeder twice (T_2) (3432 kg ha^{-1}) treatment stalk yield were next best treatment and did not differ statistically among themselves. The increased yield may be ascribed to the better weed control with congenial environment for the crop growth. Increased growth attributes and the yield attributes on account of better utilization of the available resources by the plant for the photosynthesis and translocation of photosynthates. Similar results were recorded by Jat and Giri (2000).

Table 1 Effect of different non chemical weed control treatments on weed group wise, weed density No.m^{-2} and dry weight (kg ha^{-1}) in organically grown at harvest

Treatment	Weed density No.m^{-2}				Weed dry weight (kg ha^{-1})			
	Grasses	Sedge	BLW	Total	Grasses	Sedge	BLW	Total
T_1: Hand weeding twice at 25 and 45 DAS	1.57 (35.3)	1.10 (10.7)	0.82 (4.7)	1.72 (50.7)	2.52 (325.0)	2.19 (153.3)	2.09 (120.0)	2.78 (598.3)
T_2: Manually operated weeder twice at 25 and 45 DAS	1.65 (42.7)	0.78 (4.0)	0.90 (6.0)	1.71 (52.7)	2.81 (643.3)	1.62 (40.0)	2.14 (137.3)	2.92 (820.7)
T_3: Manually operated weeder at 25 DAS + hand weeding at 45 DAS	1.71 (48.7)	1.00 (8.0)	0.90 (6.0)	1.80 (62.7)	2.67 (462.0)	2.13 (132.2)	2.39 (214.0)	2.91 (808.2)
T_4: *In situ* green manuring – cowpea incorporation at 45 DAS	1.65 (42.7)	1.03 (8.7)	0.82 (4.7)	1.76 (56.0)	2.76 (528.0)	2.06 (111.3)	2.40 (185.0)	2.92 (824.3)
T_5: *In situ* green manuring – sun hemp incorporation at 45 DAS	1.60 (37.3)	0.90 (6.0)	0. 60 (2.0)	1.67 (45.3)	2.79 (612.0)	1.98 (94.0)	1.87 (72.0)	2.89 (778.0)
T_6: Intercropping with coriander	1.74 (52.7)	0.78 (4.0)	0.52 (1.3)	1.78 (58.0)	3.07 (1165.0)	1.78 (58.0)	1.69 (46.66)	3.09 (1223.0)
T_7: Mulching with crop residues – maize stalks at 5 t ha^{-1}	1.70 (48.0)	1.45 (26.0)	0.94 (6.7)	1.92 (80.7)	2.83 (680.0)	2.46 (285.0)	2.37 (233.0)	3.08 (1198.0)
T_8: Mulching with weeds (composite, broad leaved weeds) at 5 t ha^{-1}	1.78 (58.0)	0.82 (4.7)	0.82 (4.7)	1.84 (67.3)	3.04 (1082.0)	2.01 (100.0)	2.16 (141.3)	3.12 (1323.3)
T_9: Stale seed bed –techniques	1.80 (61.3)	1.03 (8.7)	0.94 (6.7)	1.90 (76.7)	3.10 (1256.0)	2.05 (110.0)	2.36 (228.0)	3.20 (1594.0)
T_{10}: Spray of Eucalyptus oil at 0.4% at 3 DAS	1.85 (68.7)	1.05 (12.0)	0.73 (3.3)	1.89 (74.7)	3.26 (1815.0)	2.12 (130.0)	1.87 (72.0)	3.31 (2017.0)
T_{11}: Weed free	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)	0.30 (0.0)
T_{12}: Weedy check/control	1.88 (74.0)	1.15 (12.0)	1.08 (10.0)	1.98 (93.3)	3.31 (2026.7)	2.23 (169.3)	2.42 (259.9)	3.39 (2456.0)
SEd	0.081	0.208	0.171	0.070	0.077	0.177	0.398	0.110
$CD_{p=0.05}$	0.169	0.431	0.355	0.145	0.160	0.368	0.825	0.229

DAS- days after sowing, BLW- broad leaved weeds, *Values in the parenthesis are the original values

Weed free (T_{12}) was found to be superior to other treatments and it produced the highest crude protein content of 18.9 percent followed by HW twice (T_1) (18.5%). The lowest crude protein content was registered with the weedy check (T_{12}) (15.8%). Results observed are in line with findings of Thanki *et al.* (2004). While, weed free treatment (T_{11}) resulted in superior crude protein yield (1027.8 kg ha^{-1}) followed by HW twice (T_1) (924.6 kg ha^{-1}). Higher protein content coupled with the dry matter production of the crop resulted in higher protein yield. The lowest crude protein yield of 512.6 kg ha^{-1} was registered with unweeded check (T_{12}). Weed free (T_{11}) recorded higher oil content (39.5 %) followed by manually operated weeder at 25 DAS + HW at 45 DAS (T_1) (39.2%). The lowest oil content was observed in weedy check (T_{12}) (37.9%). Oil yield which is product of the oil content and the seed yield was significantly influenced by weed management treatments. Influence of the weed treatments on the oil content observed in the present investigation is in line with findings of Singh *et al.* (1997). Among the different treatment, weed free treatment (T_{11}) resulted in higher oil yield (524.4 kg ha^{-1}) over the other treatments. This was followed by HW twice (T_1) (488.8 kg ha^{-1}), manually operated weeder at 25 DAS and HW at 45 DAS (T_3) (482.2 kg ha^{-1}) but these treatments were comparable with each other. The results obtained are concomitant with the findings of Jat and Giri (2000).

The highest weed control efficiency of 75.6 percent at harvest was registered in the treatment of hand weeding (HW) twice (T_1). The manually operated weeder at 25 DAS + HW at 45 DAS (T_3) was the second superior treatment in the control of the weeds accounting for 67.1 percent of the WCE. The lowest WCE was recorded in the treatment of the eucalyptus oil spray of 0.4 percent spray at 3 DAS (17.9). Hand weeding twice (T_1) recorded superior weed infestation (WI) value of 5.8 followed by manually operated weeder twice (T_3) which shown weed infestation (WI) of 7.3. The

treatment of the eucalyptus oil spray at 0.4 percent at 3 DAS was inefficient in controlling the weeds and accounted for the higher weed infestation (WI) value (26.1). Observations recorded are in confirmation with the findings of Idapuganti *et al.* (2005) who also observed lower weed infestation (WI) in twice hand weeded treatment.

Table 2 Effect of different non chemical weed control treatments in organically grown sunflower on yield, quality, weed control efficiency (WCE) and weed index (WI)

Treatment	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Protein content (%)*	Crude protein yield (kg ha^{-1})	Oil content (%)*	Oil yield (kg ha^{-1})	WCE (%)	WI (%)*
T_1	1250	3748	18.5	924.6	39.1	488.8	75.64	5.8
T_2	1140	3432	17.1	781.9	38.9	443.5	66.59	14.1
T_3	1230	3583	17.2	828.0	39.2	482.2	67.09	7.3
T_4	1083	3148	17.8	753.1	38.7	419.1	66.44	18.4
T_5	1024	2983	17.6	705.2	38.4	393.2	68.32	22.8
T_6	990	2699	16.1	594.0	38.1	377.2	50.20	25.4
T_7	1085	3256	16.3	707.7	38.9	422.1	51.22	18.2
T_8	1036	2957	15.8	630.9	38.2	395.8	46.12	21.9
T_9	1006	2911	16.2	634.6	38.1	383.3	35.10	24.2
T_{10}	980	2858	16.1	618.0	38.4	376.3	17.87	26.1
T_{11}	1327	4111	18.9	1027.8	39.5	524.2	100.00	0.0
T_{12}	845	2399	15.8	512.6	37.9	320.3	-	36.3
SEd	32.1	131.1	-	36.38	-	16.43		-
$CD_{p=0.05}$	67.8	271.9	-	75.46	-	34.07		-

*Not statistically analyzed

Early removal of the weed in sunflower organic ecosystem through physical means facilitated progressive development of the crop and reduced weed interface. Hand weeding twice at 25 days after sowing (DAS) and 45 DAS controlled the weeds effectively and resulted in superior yield and quality of the organically grown sunflower. Manually operated weeder at 25 DAS and hand weeding (HW) at 45 DAS is also a viable option.

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