Different depths of tillage and weed management strategies effect on weed emergence in Sunflower

R. Narmadha[1*], P. Murali Arthanari[2], N. Sakthivel[3], A. Senthil[4], R. Shanmugasundaram[5], R. Jerlin[6]

[1]PhD Scholar, Department of Agronomy,TNAU, Coimbatore
[2]Professor (Agronomy), Agriculture Research Station, Sirugamani, Trichy
[3]Professor (Agronomy), Agriculture Research Station, Bhavanisagar,
[4]Professor (Crop physiology), [5]Professor (Soil science),
[6]Professor (Seed science technology),
[4,5,6] Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
*Corresponding Author email: narmadharaj97@gmail.com

Abstract

The field investigation was carried out in Sunflower during 2022-2023 at the Tamil Nadu Agricultural University in Coimbatore. To assess weed emergence in sunflower, 15 treatment combinations of tillage and weed management techniques were used in the experiment. Three replications of the split-plot design were used for the experiment. The data showed that, among the tillage techniques, the Mouldboard plough+ Cultivator+ Rotavator recorded lower total weed density and total dry weight with higher weed control efficiency, whereas with weed management techniques, hand weeding recorded lower weed density and dry weight with higher weed control efficiency which was on par with herbicide application. In the cultivator + rotavator in the unweeded treatment, higher total weed density and total weed dry weight with worse weed control effectiveness was noted. The relative density of the weed at 30, 60 and 90 DAS was recorded lower under MB plough *fb* cultivator *fb* rotavator. In the case of hand weeding and herbicide application, the relative weed density decreased after 30 DAS and increased during 90 DAS. Whereas in mulching, intercrop and unweeded check the relative density was increased after 30 DAS and decreased during 90 DAS.

Introduction

Sunflower (*Helianthus annuus L.*) is a globally important oilseed crop known for its versatility, nutritional value, and economic significance. However, the productivity of sunflower fields can be severely hampered by the presence of weeds, which compete with the crop for essential resources, ultimately leading to yield losses. Effective weed management is essential to ensure optimal sunflower growth, development, and yield. Among the key factors that influence weed dynamics in sunflower fields, tillage practices and weed management strategies play a pivotal role (Inuganti *et al.*, 2023)

Tillage is an age-old agricultural practice involving the mechanical manipulation of soil before planting. It has been traditionally employed to create a suitable seedbed, manage crop residues, and control weed growth. The choice of tillage method can significantly impact soil structure, moisture retention, temperature, and the distribution of weed seeds within the soil profile (Wang *et al.*, 2023). Conventional tillage, characterized by deep ploughing and extensive soil disturbance, can bury weed seeds at greater depths, potentially reducing their chances of germination and emergence (Crater and Mckyes, 2005). In contrast, reduced tillage or conservation tillage methods, which involve minimal soil disruption, may lead to shallower weed seed burial, resulting in higher emergence rates.

In recent decades, the focus of weed management has expanded beyond reliance solely on tillage. The adoption of herbicides revolutionized weed control by offering targeted and efficient means of reducing weed populations. Various methods such as hand weeding, herbicide application, mulching and intercropping have gained prominence. These strategies aim to disrupt the weed life cycle while minimizing the impact on the environment.

The emergence of weeds in sunflower fields is a dynamic process influenced by a multitude of factors, including soil type, climate, weed species, and agronomic practices (Stefanic *et al.*, 2023). Tillage and weed management practices can significantly alter the timing, density, and composition of weed emergence. Understanding these intricate interactions is crucial for devising effective strategies that can optimize weed control, enhance sunflower growth, and ultimately increase yield.

This study aims to provide a comprehensive exploration of the relationship between tillage practices, weed management strategies, and weed emergence dynamics in sunflower cultivation. By examining the effects of different tillage methods and weed management approaches on weed emergence patterns, we seek to uncover valuable insights into developing integrated strategies that promote sustainable weed management while supporting sunflower crop productivity. Through this research, the advancement of knowledge in weed science and agricultural practices, with practical implications for sunflower growers aiming to achieve optimal weed control and yield outcomes.

Materials and method

The field study was conducted in 2023 in the Eastern block, Department of Agronomy, Tamil Nadu Agricultural University, (11°00'54.3"N 76°56'12.4" E) Coimbatore. The soil was sandy clay loam. The total rainfall during the cropping period was 2.5 mm. The maximum temperature and the minimum temperature of 32^0C and 20^0C respectively. The experiment was laid out in a split-plot design with three replications. Main plot treatments viz., Disc plough *fb* cultivator *fb* Rotovator (M_1), Mouldboard plough *fb* Cultivator *fb* Rotovator (M_2) and Cultivator *fb* Rotovator (M_3) and subplot treatments four weed management practices viz., Two hand weeding at 20 and 40 DAS (S_1), Pre-emergence (PE) herbicide application of Pendimethalin and post-Emergence application of Quizalofop ethyl (S_2), crop residue mulching (S_3), Intercropping as cowpea (S_4) in and Unweeded (Control) (S_5). The sunflower hybrid COH3 was used with a seed rate of 5 kg ha^{-1} with 60 x 30 cm of spacing. The weed emergence was recorded at 30,60 and 90 DAS to calculate the total weed density (weeds m^{-2}) and its weed dry weight (g m^{-2}). The relative density of weeds and weed control efficiency using weed dry weight was worked out and the units were expressed in percentage (%). By using the quadrant of 0.25 m^{-2} at four random places in the net plot area of each treatment the weed density was noted at the interval of 30 days *viz.*, 30,60 and 90 DAS. The weeds were collected, shade dried and kept in a hot air oven at 80^0C until the constant weight was observed and expressed in g m^{-2}.

Statistical analysis

With respect to the observed parameter of weed, observations were analysed using the procedure from Gomez and Gomez (1984). To avoid the wide variations in the data of weed parameters like density and dry weight of the weeds the data were transformed before going for ANOVA using the square root transformation method $\sqrt{X} + 0.5$. The critical difference was calculated at a 5% probability level and the value of p was listed in case of significant difference whereas in treatments noted with the non-significant difference, it was denoted as NS

Result and discussion

Weed flora

The above ground weed species found in the experimental plot were thirteen species among which five species are broad-leaved weeds namely *Trianthema portulacastrum, Digeria arvensis, Boerhavia erecta, Amaranthus viridis, Parthenium hysterophorus, Echinochloa colona*, six species of grasses namely *Dactylactenium egyptium, Echinochloa colona, Dinebra retroflexa, Chloris barbata, Cynadon dactylon* and sedge namely *cyprus rotundus.*

Effect of tillage and weed management practices on total weed density in sunflower

The total weed density of sunflower as influenced by the tillage and weed management practices was presented in the table 1.

At 30 DAS among the different tillage treatments, the lower weed density was recorded under Mouldboard plough *fb* Cultivator *fb* Rotovator (77.47 weeds m^{-2}) and the higher weed density of 134.2 weeds m^{-2} was recorded in Cultivator *fb* Rotovator. Whereas among the weed management practices the lower weed density of 14.89 weeds m^{-2} was recorded in hand weeding at 20 and 40 DAS which was on par with herbicide application (16.33 weeds m^{-2}) and the higher weed density was recorded in unweeded control (297 weeds m^{-2}). The results are in accordance with Rashid *et al.,* 2017.

Table 1 Total Weed density (No m^{-2}) in sunflower as influenced by tillage and weed management practices @ 30, 60 and 90 DAS

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	12.17 (11.67)	16.83 (16.33)	17.17 (16.67)	**15.39 (14.89)**	3.58 (12.33)	2.91 (8.00)	4.38 (18.67)	**3.62 (13.00)**	4.52 (20.00)	3.62 (12.67)	5.39 (28.67)	**4.51 (20.44)**
S_2	25.17 (24.67)	10.50 (10.00)	14.83 (14.33)	**16.83 (16.33)**	4.67 (21.33)	3.66 (13.00)	5.51 (30.00)	**4.62 (21.44)**	5.57 (31.00)	4.65 (21.33)	6.23 (38.33)	**5.48 (30.22)**
S_3	38.17 (37.67)	30.83 (30.33)	61.83 (61.33)	**43.61 (43.11)**	8.50 (72.00)	7.61 (57.67)	9.90 (97.67)	**8.67 (75.78)**	7.98 (63.67)	6.64 (43.67)	8.77 (76.67)	**7.80 (61.33)**
S_4	162.50 (162.00)	107.83 (107.33)	195.17 (194.67)	**155.17 (154.67)**	16.07 (258.00)	13.33 (177.33)	18.58 (345.00)	**15.99 (260.11)**	13.23 (175.33)	11.60 (135.00)	14.54 (211.00)	**13.12 (173.78)**
S_5	284.17 (283.67)	223.83 (223.33)	384.50 (384.00)	**297.50 (297.00)**	17.43 (305.00)	15.61 (245.00)	19.65 (388.33)	**17.56 (312.78)**	15.09 (227.33)	14.06 (198.00)	17.58 (309.33)	**15.58 (244.89)**
Mean	**104.43 (103.93)**	**77.97 (77.47)**	**134.70 (134.20)**		**10.05 (133.73)**	**8.62 (100.20)**	**11.60 (175.93)**		**9.28 (103.47)**	**8.12 (82.13)**	**10.50 (132.80)**	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
SEd	0.19	0.29	0.48	0.46	0.24	0.45	0.74	0.63	0.31	0.32	0.58	0.64
CD(P=0.05)	0.45	0.57	0.98	0.85	0.56	0.90	NS	NS	0.71	0.63	NS	NS

At 60 DAS among the different tillage treatments, the lower weed density was recorded under Mouldboard plough *fb* Cultivator *fb* Rotovator (100.2 weeds m^{-2}) and the higher weed density of 175.9 weeds m^{-2} was recorded in Cultivator *fb* Rotovator. Whereas among the weed management practices the lower weed density of 13 weeds m^{-2} was recorded in hand weeding at 20 and 40 DAS which was on par with herbicide application (21.4 weeds m^{-2}) and the higher weed density was recorded in unweeded control (312.7 weeds m^{-2}).

At 90 DAS among the different tillage treatments, the lower weed density was recorded under Mouldboard plough *fb* Cultivator *fb* Rotovator (82.13 weeds m^{-2}) and the higher weed density of 132.8 weeds m^{-2} was recorded in Cultivator *fb* Rotovator. Whereas among the weed management practices the lower weed density of 20.4 weeds m^{-2} was recorded in hand weeding at 20 and 40 DAS and the higher weed density was recorded in unweeded control (244.8 weeds m^{-2}). The interaction effect of tillage and weed management practices showed a non-significant difference at 30,60 and 90 DAS. The lower weed density in mouldboard ploughing *fb* cultivator *fb* rotavator might be due to the inversion of the large surface portion of the soil to the deeper soil layer buries the weed seeds which present in the top layer. Seeds buried deep into the soil will not be able to emerge in the present season. The cultivator *fb* rotavator which mixes the soil layer at 10-15 cm gives the optimum condition for the weed seeds to germinate and emerge. Also, hand weeding at 20 and 40 DAS and pre-emergence and post-emergence herbicide application which controls the weed emergence to a higher level resulted in lower weed density when compared to the other treatments. The same results were in line with Subbulakshmi et al., 2009

Effect of tillage and weed management practices on total weed dry weight in sunflower

The total dry weight of sunflower as influenced by the tillage and weed management practices was presented in the table 2.

At 30 DAS among the different tillage treatments the lower weed dry weight of 26.10 gm^{-2} was recorded in Mouldboard plough *fb* Cultivator *fb* Rotovator and the higher weed dry weight of 52.57 gm^{-2} was recorded in unweeded check. Whereas among the weed management practices the lower dry weight of 2.5 gm^{-2} was recorded in hand weeding at 20 and 40 DAS and the higher dry weight was recorded in unweeded control (109.3 gm^{-2}). The interaction effect of tillage and weed management practices showed a significant difference and lower weed dry weight were recorded under M_1S_1 (1.05 gm^{-2}) which was on par with M_1S_2, M_2S_1 and M_2S_2 (Rashid *et al.*, 2017)

At 60 DAS among the different tillage treatments, the lower weed dry weight was recorded under Mouldboard plough *fb* Cultivator *fb* Rotovator (469.01 gm^{-2}) and the higher dry

Table 2 Total Weed dry weight (g m^{-2}) in sunflower as influenced by tillage and weed management practices @ 30, 60 and 90 DAS

Treatment	30 DAS				60 DAS				90 DAS			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.25 (1.05)	1.33 (1.28)	2.37 (5.17)	**1.65 (2.50)**	2.27 (4.68)	1.85 (2.97)	2.75 (7.10)	**2.29 (4.92)**	9.17 (84.34)	7.54 (56.99)	11.01 (121.48)	**9.24 (87.60)**
S_2	1.62 (2.16)	1.50 (1.75)	2.93 (8.25)	**2.01 (4.06)**	1.73 (2.54)	1.39 (1.46)	2.00 (3.54)	**1.71 (2.51)**	8.73 (77.65)	7.26 (52.74)	10.03 (100.55)	**8.67 (76.98)**
S_3	2.72 (7.00)	2.72 (6.95)	4.27 (17.87)	**3.24 (10.61)**	17.24 (297.49)	15.37 (237.06)	20.35 (414.27)	**17.65 (316.27)**	18.32 (338.79)	15.29 (234.73)	20.07 (403.96)	**17.89** (338.79)
S_4	5.91 (34.53)	6.02 (35.74)	8.57 (73.08)	**6.84 (47.78)**	35.65 (1273.82)	29.75 (884.84)	41.53 (1725.22)	**35.65 (1294.63)**	28.78 (834.49)	24.99 (628.11)	31.29 (979.26)	**28.35 (813.95)**
S_5	9.22 (84.67)	9.23 (84.77)	12.60 (158.45)	**10.35 (109.30)**	39.05 (1532.72)	34.76 (1218.74)	43.78 (1942.07)	**39.19 (1564.51)**	33.24 (1105.46)	30.53 (937.92)	38.25 (1463.81)	**34.00 (1169.06)**
Mean	**4.14 (25.88)**	**4.16 (26.10)**	**6.15 (52.57)**		**19.19 (622.25)**	**16.62 (469.01)**	**22.08 (818.44)**		**19.65 (488.15)**	**17.12 (382.10)**	**22.13 (613.81)**	
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
SEd	0.07	0.15	0.25	0.20	0.86	1.10	1.91	1.92	0.64	0.70	1.27	1.37
CD(P=0.05)	0.16	0.31	0.41	0.24	1.99	2.20	25.31	46.72	1.49	1.41	NS	NS

weight of 818.44 gm^{-2} was recorded in Cultivator *fb* Rotovator. Whereas among the weed management practices the lower dry weight of 2.51 gm^{-2} was recorded in herbicide application which was on par with hand weeding at 20 and 40 DAS (4.92 gm^{-2}) and the higher dry weight was recorded in unweeded control (1564 gm^{-2}). The interaction effect of tillage and weed management practices showed a significant difference and the lower weed dry weight was recorded under M_2S_2 (1.46 gm^{-2}) which was on par with M_1S_1, M_1S_2, M_2S_1, M_3S_1 and M_3S_2.

At 90 DAS among the different tillage treatments, the lower weed dry weight was recorded under Mouldboard plough *fb* Cultivator *fb* Rotovator (382.1 gm^{-2}) and the higher dry weight of 613.8 gm^{-2} was recorded in Cultivator *fb* Rotovator. Whereas among the weed management practices the lower dry weight of 76.98 gm^{-2} was recorded in herbicide application which was on par with hand weeding at 20 and 40 DAS (87.60 gm^{-2}) and the higher dry weight was recorded in unweeded control (1169 gm^{-2}). The interaction effect of tillage and weed management practices showed a non-significant difference. The lower weed density in the mouldboard *fb* cultivator *fb* rotavator and among weed management practices the hand weeding and herbicide application leads to the lower weed dry weight in the particular treatments. Without any management practices in unweeded check the dry weight of the weeds was higher. Baskaran *et al.,* 2014 also resulted in the same findings.

Effect of tillage and weed management practices on the relative density of weeds

The relative density of the sunflower at 30, 60 and 90 DAS was influenced by the tillage and weed management practices and was presented in the figure 1.

At 30,60 and 90 DAS among the tillage practices the lower relative density of 15.9%, 13.66% and 15.14% was recorded under the Mouldboard ploughing *fb* cultivator *fb* rotavator and the higher relative density was recorded under the cultivator *fb* rotavator (23.79%,26.81% and 25.35%). Among the weed management practices the lower relative weed density of 6%, 3.45% and 4.49% was recorded in hand weeding followed by herbicide application and mulching treatment. An unweeded check recorded the higher relative density in weed management practices. In the case of hand weeding and herbicide application, the relative weed density decreased after 30 DAS and increased during 90 DAS. Whereas in mulching, intercrop and unweeded check the relative density was increased after 30 DAS and decreased during 90 DAS. The hand weeding given at 20 DAS and herbicide application at 3 DAS and 25 DAS decreased the relative density of weeds at 60 DAS and it increased after 60

DAS in the above treatments whereas in mulching and intercrop at the early stage, it was lower and increased emergence of weed at 30 DAS increases the relative density of weeds. The observation was also made similar to the study conducted by varsha *et al.*, 2019

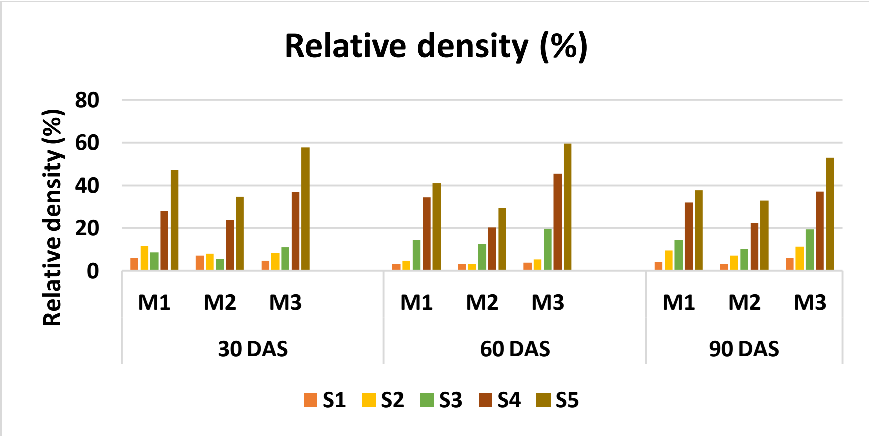

Fig 1. Effect of tillage and weed management practices on the relative density of weeds in sunflower

Effect of tillage and weed management practices on weed control efficiency

The weed control efficiency at 30,60 and 90 DAS was influenced by tillage and weed management practices and was represented in figure 2.

At 30,60 and 90 DAS among the tillage practices the higher weed control efficiency of 69.2%, 61.52% and 59.26% was recorded under the Mouldboard ploughing *fb* cultivator *fb* rotavator and the higher weed control efficiency was recorded under the cultivator *fb* rotavator (66.83%,57.86% and 55.84%). Among the weed management practices the higher weed control efficiency were recorded for hand weeding and herbicide application and in unweeded check no control of weeds was recorded. The deeper ploughing which made the soil inversion to the deeper layer records the higher weed control efficiency and weed management practices such that the hand weeding and herbicide application were effective against other treatments which record the higher weed control efficiency.

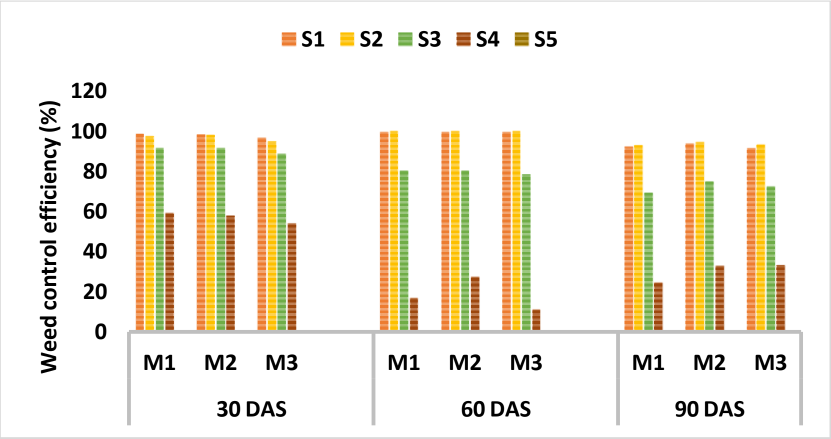

Fig.2 Effect of tillage and weed management practices on weed control efficiency in sunflower

Conclusion

From the study, it was concluded that weed control efficiency was higher under Mouldboard plough *fb* Cultivator *fb* Rotavator with hand weeding thus recorded the lower weed density and dry weight with the relative density was lower in sunflower. The above treatment was on par with the Mouldboard plough *fb* Cultivator *fb* Rotavator with herbicide application.

Reference

Carter, M. R., McKyes, E., & de Bellevue, S. A. (2005). Cultivation and Tillage. *Encyclopedia of Soils in the Environment. Elsevier, Oxford*, 356-361.

Inuganti, P., Praharaj, S., Lalichetti, S., Shankar, T., Mishra, G. C., Maitra, S., and Singh, S. (2021). Relative efficacy of different weed management practices on growth, yield and weed dynamics in sunflower. *International Journal of Agriculture, Environment and Biotechnology.*

Rashid, H. U., Khan, A., Hassan, G., Saeed, M., Khan, S. U., Khan, S. M., ... & Zamin, M. (2017). Integrated weed management in maize under different tillage regimes. *International journal of bioscience*, *10*(6), 223-231.

Stefanic, E., Rasic, S., Lucic, P., Zimmer, D., Mijic, A., Antunovic, S., ... & Stefanic, I. (2023). The Critical Period of Weed Control Influences Sunflower (Helianthus annuus L.) Yield, Yield Components but Not Oil Content. *Agronomy*, *13*(8), 2008.

Subbulakshmi, S., Subbian, P., and Prabhakaran, N. K. (2009). Influence of tillage and weed management practices on weed growth and yield of maize-sunflower cropping system. *International Journal of Agricultural Sciences*, *5*(1), 71-77.

Varsha, N., Madhavi, M., Ramprakash, T., & Devi, K. B. (2019). Relative density of weeds and weed indices as influenced by weed control options in cotton. *Indian journal of weed science*.51 (1), 86-91.

Wang, Y., Yang, S., Sun, J., Liu, Z., He, X., and Qiao, J. (2023). Effects of Tillage and Sowing Methods on Soil Physical Properties and Corn Plant Characters. *Agriculture*, *13*(3),600.