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Integrated weed management in maize-sunflower cropping system

R. Baskaran* and R. Kavimani
Cotton Research Station, Tamil Nadu Agricultural University, Veppanthattai, Perambalur, Tamil Nadu 621 116

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ABSTRACT

A field experiment was conducted during *Rabi and Kharif* season of 2012 and 2013 at Veppantattai to study the effect of tillage and weed management methods on weeds dynamics and yield of maize–sunflower cropping system. Results revealed that conventional tillage with disc plough followed by cultivator tillage twice and pre-emergence herbicide (atrazine 0.5 kg/ha for maize and pendimethalin 1.0 kg/ha for sunflower), followed by hand weeding on 40 DAS kept the weed density and weed dry weight below the economic threshold level and increased the productivity, net returns and benefit : cost ratio of maize-sunflower cropping system in clay loam soils under irrigated condition.

Key words: Maize, Sunflower, Tillage, Weed management, Weed density, Yield

In India, maize is grown in an area of 8.26 million ha with a production of 20.03 million tones. Sunflower is cultivated over an area of about 1.48 million ha with a production of 0.90 million tones. The productivity of sunflower is quite low compared to other sunflower growing countries. Uninhibited growth of weeds caused enormous loss of nutrients, which in turn reduced the yield of sunflower up to 64% (Legha *et al*. 1992). Continuous use of herbicides over a prolonged time leads to development of resistance in weeds making them difficult to control. The combination of herbicides with mechanical weeding is effective in controlling major weeds. The herbicide controls weeds in-row, whereas mechanical weeding removed weeds between the rows. The information on the influence of preparatory tillage methods on weed population and productivity of crops in a system approach are seldom available. Hence, a field experiment was conducted to develop information on weed population dynamics in maize-sunflower cropping system as influenced by preparatory tillage and weed management methods under irrigated condition.

MATERIALS AND METHODS

A field experiment was conducted during 2012 and 2013 at N block of Cotton Research Station, Veppantattai. The soil of the experimental farm is clay loam in texture with low in N, medium in P and K. The experiment was laid out in strip plot design with three replications. Main plot treatment consisted of three tillage methods, *viz.* conventional tillage, minimum tillage and zero tillage. Five weed management methods, *viz*. pre-emergence application of herbicide (atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower) followed by hand weeding on 40 DAS, pre-emergence application of herbicide (atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower) followed by power weeding on 40 DAS, hand weeding twice on 20 and 40 DAS, power weeding on 20 and 40 DAS along with an unweeded check for both the crops were the sub-plot treatments. The maize '*NK 6240*' and sunflower hybrid '*Sunbred*' were sown on 60 x 25 cm and 60 x 30 cm, respectively. Conventional tillage involved one disc ploughing, followed by two cultivator operations. One pass of cultivator ploughing and ridger operation were used for minimum tillage. In zero tillage, the seeds were dibbled in the stubbles of the previous crop without any tillage. For manual weeding treatments, two hand weeding were done on 20 and 40 DAS. Herbicide treated plots were applied with atrazine 0.5 kg/ha for maize as pre-emergence spray on third day after sowing, followed by a hand weeding on 40 DAS. Pendimethalin 1.0 kg/ha was applied in sunflower as pre-emergence spray on third day after sowing, followed by a hand weeding on 40 DAS. For power weeding plots, two weeding were given on 20 and 40 DAS with 'Garuda' power weeder in between rows and within the rows weeds were removed manually.

***Corresponding author:** rbaski73@gmail.com

RESULTS AND DISCUSSION

Effect on weeds

Dominant weed species were: *Dinebra retroflexa, Cynodon dactylon, Panicum repens, Chloris barbata, Cyperus roundus, Trianthema portulacastrum,*

Parthenium hysterophorus and *Digera arvensis*. Both tillage and weed management methods significantly influenced the weed dry weight (Table 1). The lower weed density, weed dry weight were observed with conventional tillage due to the inversion of surface soil and burial of weed seeds by disc ploughing. Zero tillage was found to record higher total weed density and weed dry weight mainly due to the higher densities of both grasses and broad-leaved weeds resulted in deposition of more seeds and propagules of predominant annual and perennial weeds near the soil surface. Greater deposition of weed seeds at the soil surface with zero tillage and minimum tillage than conventional tillage was reported by Clements *et al.* (1996). Lower weed density and weed dry weight were recorded by conventional tillage in sunflower. Higher weed density and weed dry weight were recorded by zero tillage due to deposition of weed seeds in the upper layer of the soil. Increase in perennial and some annual weed species due to reduced tillage was also reported by Hume *et al.* (1991).

Lower density and dry weight of weeds were observed with pre-emergence application of atrazine 0.5 kg/ha for maize and pendimethalin 1.0 kg/ha for sunflower followed by hand weeding at 40 DAS. Application of herbicides was found to control grassy and broad-leaved weeds effectively. Unweeded control resulted in higher grasses, sedge and broad-leaved weeds. Interaction between tillage and weed management methods was found to be significant in altering the densities and dry weight of weeds. Pre-emergence application of herbicides combined with conventional tillage reduced the weed density and dry weight of weeds. It was due to better exposure of weeds to herbicides and manual removal in well distributed soil layers due to deep tillage. Higher weed density and weed dry weight were recoded with zero tillage combined with pre-emergence herbicide application due to the plant residues on the soil surface which might have intercepted the penetration of herbicides into the soil (Yenish *et al*. 1992).

Effect on crop yield

Grain yield of maize was significantly influenced by tillage and weed management methods (Table 2). Conventional tillage resulted in significantly higher yield compared with minimum and zero tillage, which is an indication for higher efficiency of deep tillage

Table 1. Effect of tillage and weed management practices on weed density and dry weight at 40 DAS in maize-sunflower cropping system

Treatment	Weed growth in maize				Weed growth in sunflower			
	Density (no./m^2)		Dry weight (kg/ha)		Density (no./m^2)		Dry weight (kg/ha)	
	2012	2013	2012	2013	2012	2013	2012	2013
Tillage								
Conventional tillage	6.8 (53.7)	6.8 (55.1)	13.1 (184.4)	13.8 (202.4)	13.0 (178.6)	5.0 (29.6)	13.0 (178.6)	13.6 (194.2)
Minimum tillage	7.5 (65.6)	7.6 (67.9)	15.5 (255.8)	13.5 (184.2)	14.5 (228.2)	5.9 (38.4)	14.5 (228.2)	14.8 (236.2)
Zero tillage	8.46 (82.8)	8.5 (84.5)	15.87 (276.0)	14.7 (236.2)	15.1 (252.6)	6.5 (47.3)	15.1 (252.6)	15.9 (277.2)
LSD (P=0.05)	0.53	0.19	0.49	0.19	0.34	0.17	0.34	0.45
Weed control								
Atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower + hand weeding at 40 DAS	5.2 (27.6)	5.4 (29.6)	11.8 (141.3)	11.9 (145.0)	11.1 (126.0)	4.0 (16.1)	11.1 (126.0)	11.6 (137.3)
Atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower + power weeding at 40 DAS	5.7 (33.3)	5.9 (35.09)	12.7 (164.6)	12.6 (160.7)	11.8 (140.6)	4.6 (21.8)	11.8 (140.6)	12.6 (160.6)
Hand weeding twice on 20 and 40 DAS	6.3 (40.6)	6.4 (41.5)	13.3 (180.0)	13.2 (176.0)	12.9 (169.6)	5.1 (27.0)	12.9 (169.6)	13.4 (181.6)
Power weeding at 20 and 40 DAS	7.1 (50.9)	7.01 (49.4)	14.3 (208.0)	13.9 (196.7)	13.8 (192.6)	5.7 (33.5)	13.8 (192.6)	14.4 (211.0)
Unweeded check	13.4 (184.4)	13.7 (190.8)	22.1 (499.6)	18.4 (359.7)	21.4 (470.0)	9.6 (93.6)	21.4 (470.0)	21.8 (488.6)
LSD (P=0.05)	0.48	0.35	0.89	0.56	0.58	0.58	0.58	0.82

Figures in parentheses are original values

Table 2. Effect of tillage and weed management practices on yield of maize-sunflower cropping system

Treatment	Maize				Sunflower seed yield (t/ha)	
	Grain yield (t/ha)		Stover yield (t/ha)			
	2012	2013	2012	2013	2012	2013
Tillage						
Conventional tillage	5.98	4.98	8.94	8.26	1.62	1.53
Minimum tillage	5.46	4.72	8.51	8.13	1.50	1.42
Zero tillage	504	4.35	7.87	7.60	1.28	1.21
LSD(P=0.05)	0.27	0.11	0.32	0.19	0.11	0.11
Weed control						
Atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower + hand weeding at 40 DAS	6.23	5.30	9.25	8.76	1.64	1.56
Atrazine 0.5 kg/ha for maize and pendimenthalin 1.0 kg/ha for sunflower + power weeding at 40 DAS	5.96	5.08	8.65	8.28	1.54	1.38
Hand weeding twice at 20 and 40 DAS	5.70	4.86	8.43	8.03	1.46	1.45
Power weeding at 20 and 40 DAS	5.54	4.73	8.07	7.63	1.38	1.23
Unweeded check	4.03	3.44	7.79	7.28	1.33	1.24
LSD (P=0.05)	0.41	0.17	0.29	0.27	0.09	0.08

over a long cropping period. Higher grain yield of maize with conventional tillage was also reported by Bakhsh *et al*. (2000). Zero tillage resulted in lower grain yield due to poor growth parameters like shorter plants, lesser dry matter production and leaf area index and yield attributes. The compact layer of soil along with the greater competition of weeds was responsible for reduced root development and ultimately yield reduction (Cavalaris and Gemtos 2002). Higher grain yield of maize obtained with pre-emergence application of atrazine 0.5 kg/ha followed by hand weeding at 40 DAS was due to efficient control of weeds, higher weed control efficiency coupled with lower depletion of nutrients by weeds (Sharma *et al.* 1988).

Conventional tillage recorded higher yield of sunflower due to deep ploughing and pulverization of plough sole depth of soil layers. Raj and Yadav (1979) found higher grain yield in sunflower due to improved root development. The lower seed yield obtained with zero tillage was due to higher weed competition for nutrient, space and light offered by weed flora.

Higher seed yield of sunflower obtained with pre-emergence application of pendimethalin 1.0 kg/ha followed by hand weeding at 40 DAS was due to efficient weed control and increase in growth and yield parameters. Unchecked weed growth resulted in more weed density and thus reduced the seed yield of sunflower.

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