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Effect of tillage and weed management practices on performance of maize-sunflower

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ABSTRACT

Field experiment was conducted during *kharif* and *rabi* seasons of 2005-2006 to study the growth and productivity in maize-sunflower cropping system as influenced by tillage and weed management methods. The result revealed that growth attributes *viz.*, plant height and dry matter production were increased by continuous conventional tillage with hand weeding on 20 and 40 DAS. Similarly yield attributes and yield were also significantly higher with continuous conventional tillage with hand weeding on 20 and 40 DAS.

Key words : Tillage, Growth, Yield, Maize, Sunflower.

INTRODUCTION

Intense weed competition is one of the major constraints in productivity of crops. Weeds constitute a major component among the bottlenecks for successful crop production. Tillage helps in controlling weeds by burying the weed seeds and emerged weed seedlings leaving a rough surface to hinder weed seed germination and expose underground parts of perennial weeds leading to desiccation. Adoption of conservation tillage practices can lead to shifts in weed communities. Weed management techniques like manual and herbicidal methods are found to be effective in controlling different groups of weeds in cropped fields. Maize is the third most important cereal grain crop in India after wheat and rice. As the crop is heavily fertilized and sparsely grown, severe weed infestation is experienced, resulting in drastic reduction of grain yield.

Yield losses due to weeds varied from 28 to 93 per cent depending on the type of weed flora and their intensity, stage, nature and duration of crop-weed competition (Sharma and Thakur, 1998). Sunflower is an important oil seed crop of India. Wide row spacing and slow initial growth of sunflower provide enough room for weeds to establish and to take advantage of slower initial growth of the crop. Uninhibited growth of weeds cause enormous loss of nutrients which in turn reduce the yield of sunflower up to 64 per cent (Legha *et al*., 1992). Cropping system influences the weed control as it results in weed population shifts due to various practices *viz.*, land preparation, organic and fertilizer nutrient application and herbicidal application or other means of weed management.

The information on the influence of tillage and different weed management methods on the productivity of crops in a system and their interactive effects on the cropping system productivity are seldom available. Hence, a field experiment was programmed to develop information on efficient and economic tillage and weed management methods for maize-sunflower cropping system under irrigated conditions.

MATERIALS AND METHODS

Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *kharif* and *rabi* seasons of 2005 and 2006 to study crop growth and productivity in maize – sunflower cropping system as influenced by tillage and weed management methods. The experiments were laid out in split plot design with four replications. Main plot treatment consisted of four tillage methods *viz.*, zero tillage- zero tillage, zero tillage-conventional tillage, conventional tillage - zero tillage and conventional tillage - conventional tillage for maize-sunflower cropping system. Three weed management methods *viz.*, hand weeding on 20 and 40 DAS, pre-emergence herbicide (atrazine 0.5 kg ha^{-1} for maize and pendimethalin 1.0 kg ha^{-1} for sunflower) application followed by hand weeding on 40 DAS, along with an unweeded check for both the crops consisted the sub plot treatments. The first crop of maize was raised during *kharif* (June-Sep) 2005 and 2006 and the second crop of sunflower during *rabi* (Oct-Dec) 2005 and 2006. Maize variety Co-1 with duration of 105-110 days and sunflower variety Co-4 with duration of 85-90 days were selected for the study. In zero tillage the seeds are dibbled in the stubbles of the previous crop without any tillage or soil disturbance, except that which is necessary to place the seeds at the desired depth. One mould board plough / disc plough was given as the primary tillage operation

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followed by one secondary tillage with a disc harrow for conventional tillage treatment. The recommended dose of 135: 62.5: 50 and 40:20:20 kg NPK ha^{-1} was applied in the form of urea, single super phosphate and muriate of potash by the side of seed rows for maize and sunflower, respectively.

RESULTS AND DISCUSSION

Effect of treatment on growth attributes:

Tillage methods failed to influence the plant height of first year maize at all stages except at 20 DAS (Table 1 and 2). During second year onwards continuous conventional tillage (T_4) and conventional tillage (T_3 for maize; T_2 for sunflower) resulted in taller plants. Whereas, conventional tillage followed by zero tillage (T_2 for maize; T_3 for sunflower) reflected their poor efficiency by recording shorter plants among different tillage methods. Tillage methods produced more or less similar plant dry matter at all stage of maize during the first year of study. But during second year maize, increased dry matter was recorded with continuous conventional tillage (T_4) and conventional tillage (T_3 for maize; T_2 for sunflower). Zero

Table 1 : Effect of tillage and weed management practices on growth attributes of maize –sunflower cropping system-I

Treatments	Maize				Sunflower			
	Plant height (cm)	Dry matter (kg ha^{-1})	LAI	Root volume (cm^3)	Plant height (cm)	Dry matter (kg ha^{-1})	LAI	Root volume (cm^3)
T_1	282.2	9667	2.05	71.9	154.9	7887	2.20	20.7
T_2	280.8	9594	2.40	71.2	167.9	8473	2.51	33.6
T_3	290.9	10082	2.96	91.3	145.5	7708	2.06	22.3
T_4	297.2	10215	3.04	91.8	172.2	8701	2.67	36.7
S.E. $\pm$	8.7	288.6	0.11	3.4	5.4	338.7	0.08	1.4
C.D. (P=0.05)	NS	NS	0.25	7.6	12.2	766.1	0.18	3.1
W_1	308.7	10718	3.19	88.5	166.2	9267	3.10	33.2
W_2	290.3	10249	2.75	83.4	161.8	8557	2.31	28.8
W_3	264.3	8701	1.89	72.7	152.4	6753	1.68	22.9
S.E. $\pm$	6.7	239.3	0.09	2.4	3.7	198.9	0.08	0.8
C.D. (P=0.05)	13.9	493.8	0.19	4.9	7.7	410.5	0.16	1.6
T at W - S.E.$\pm$	14.0	485.8	0.19	5.2	8.1	469.2	0.15	1.9
T at W - C.D. (P=0.05)	NS	NS	0.40	NS	NS	NS	0.32	NS
W at T- S.E. $\pm$	13.4	478.5	0.18	4.8	7.4	397.8	0.15	1. 6
W at T- C.D. (P=0.05)	NS	NS	0.38	NS	NS	NS	0.32	NS

T_1- T_4- Tillage practices, W_1-W_3- Weed management methods NS-Non significant

Table 2: Effect of tillage and weed management practices on growth attributes of maize –sunflower cropping system-II

Treatments	Maize				Sunflower			
	Plant height (cm)	Dry matter (kg ha^{-1})	LAI	Root volume (cm^{-3})	Plant height (cm)	Dry matter (kg ha^{-1})	LAI	Root volume (cm^{-3})
T_1	207.6	9425	2.61	78.6	153.9	5308	1.67	21.6
T_2	186.7	8479	2.17	56.6	182.0	7252	2.85	32.7
T_3	215.2	11050	2.87	87.4	167.6	6687	2.53	28.8
T_4	224.5	11733	3.03	93.8	187.5	7537	2.92	34.2
S.E. $\pm$	10.2	411.8	0.08	3.5	5.3	248.6	0.13	1.2
C.D. (P=0.05)	23.2	931.5	0.18	7.9	12.1	562.4	0.23	2.8
W_1	223.2	11675	2.99	88.4	183.6	7675	2.80	34.3
W_2	217.8	11244	2.86	82.8	173.5	6789	2.68	29.3
W_3	186.9	7596	2.15	65.9	161.2	5624	1.99	24.4
S.E. $\pm$	8.1	317.7	0.07	2.2	3.6	174.4	0.07	0.8
C.D. (P=0.05)	16.7	655.7	0.14	4.5	7.5	359.9	0.14	1.7
T at W - S.E.$\pm$	16.7	662.4	0.14	4.98	8.0	378.0	0.17	1.81
T at W - C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	0.37	NS
W at T- S.E. $\pm$	16.2	635.4	0.14	4.4	7.3	348.7	0.14	1.6
W at T- C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	0.28	NS

T_1- T_4- Tillage practices, W_1-W_3- Weed management methods NS-Non significant

tillage (T_2 for maize; T_3 for sunflower) recorded lower plant dry matter due to increased weed competition for available inputs.

Effective weed control with pre-emergence application of atrazine 0.5 kg ha^{-1} followed by hand weeding on 40 DAS (W_2) resulted in taller plants at 20 DAS of maize due to good control of dicot and monocot weeds which reduced the weed competition from germination stage of crop. Hand weeding on 20 and 40 DAS (W_1) resulted in better growth of maize with taller plants at later stages. Better efficacy of hand weeding in controlling the weeds at critical crop-weed competition (up to 40 DAS) in maize is the reason for better growth (Arti Khare and Jain, 1995). Higher plant dry matter production was recorded with pre-emergence application of atrazine 0.5 kg ha^{-1} followed by hand weeding on 40 DAS (W_2) at 20 DAS. But in later stages, hand weeding twice (W_1) recorded higher plant dry matter and it was comparable with herbicide application (W_2) at 60 DAS and at harvest stage. Sinha (2000) reported that, nutrient depletion by weeds was minimum under hand weeding in calcareous soils of North Bihar. Poonghuzhalan (1992) also observed that hand weeding and herbicidal application recorded taller plants than unweeded control due to reduction in competition offered by weeds for nutrients and moisture.

Effect of treatment on yield attributes:

Yield attributes were not significantly influenced by tillage treatment during first year maize (Table 3 and 4). After wards, yield attributes *viz*., cob length, grains per cob and test weight for maize and diameter of the capitulum, number of seeds per capitulum and test weight of sunflower were significantly influenced by tillage practices. During second year maize, higher yield attributing characters were recorded by treatments those received conventional tillage (T_4 and T_3). Zero tillage (T_3) during first year and continuous zero-tillage (T_1) during second year recorded lower values due to least weed control efficiency and reduced nutrient availability and utilization by the crop.

Heavier and longer cobs with more number of grains and higher test weight of maize and bigger capitulum with more seeds per capitulum and higher test weight of sunflower were obtained with hand weeding on 20 and 40 DAS (W_1) which was comparable with atrazine 0.5 kg ha^{-1} followed by hand weeding on 40 DAS (W_2). Unweeded control obviously due to heavy weed competition resulted in low nutrient uptake and reduced growth and yield contributing components (Sivakumar, 2000).

Effect of treatment on yield of crops:

Tillage treatments failed to influence the yield of maize significantly during first year because all tillage practices produced similar and comparable yields (Table 5). According to Wilhelm and Wortmann (2004), the soybean yield obtained under no-tillage was similar to yields with other tillage practices. During second year, treatments those received conventional tillage (T_4 and T_3) produced higher and comparable grain and stover yield which is an indication for higher efficiency of deep tillage

Table 3 : Effect of tillage and weed management practices on yield attributes of maize –sunflower cropping system-I

Treatments	Maize					Sunflower			
	Cob lenth (cm)	Cob girth (cm)	Cob weight (g)	No. of seeds cob^{-1}	Test weight (g)	Cap dia.m (cm)	Cap weight (g)	No. of seeds cap^{-1}	Test weight (g)
T_1	14.5	13.6	79.7	387.7	274.0	15.0	48.4	893.7	40.82
T_2	14.2	12.9	78.7	383.3	268.3	15.7	51.9	982.7	43.77
T_3	15.3	13.7	84.6	397.7	281.7	14.4	45.6	882.0	41.24
T_4	15.4	13.8	84.9	400.3	288.3	16.1	54.3	990.3	44.85
S.E. $\pm$	0.5	0.4	2.4	11.2	8.2	0. 5	1.6	29.0	1.0
C.D. (P=0.05)	NS	NS	NS	NS	NS	1.0	3.6	65.7	2.2
W_1	15.6	14.1	89.0	429.3	309.3	17.4	58.9	998.5	45.11
W_2	14.8	13.5	86.0	421.3	297.5	15.6	56.1	957.0	44.05
W_3	14.0	12.9	70.9	326.3	227.5	12.9	35.1	856.0	38.86
S.E. $\pm$	0.3	0.3	2.0	9.3	6.8	0.4	1.544	21.0	0.9
C.D. (P=0.05)	0.7	0.6	4.2	19.3	13.9	0.8	3.2	43.3	1.9
T at W - S.E.$\pm$	0.7	0.6	4.1	18.9	13.7	0.8	3.0	44.9	1.8
T at W - C.D. (P=0.05)	NS	NS	NS	NS	NS	1.63	NS	NS	NS
W at T- S.E. $\pm$	0.7	0.6	4.0	18.7	13.5	0.7	3.1	41.9	1.7
W at T- C.D. (P=0.05)	NS	NS	NS	NS	NS	0.86	NS	NS	NS

NS-Non significant

Table 4 : Effect of tillage and weed management practices on yield attributes of maize –sunflower cropping system-II

Treatments	Maize					Sunflower			
	Cob length (cm)	Cob girth (cm)	Cob weight (g)	No. of seeds cob^{-1}	Test weight (g)	Cap. dia.m (cm)	Cap. weight (g)	No. of seeds cap^{-1}	Test weight (g)
T_1	14.2	13.4	82.3	389.3	282.3	11.6	38.7	613.7	34.88
T_2	12.3	11.8	69.0	284.7	260.0	14.7	57.7	904.3	42.46
T_3	15.6	14.1	88.0	405.0	292.7	13.6	50.6	832.7	41.15
T_4	16.4	14.8	92.0	408.7	299.0	14.9	63.5	921.3	45.28
S.E. $\pm$	0. 7	0.4	3.6	17.6	11.1	0.4	2.4	32.2	1.4
C.D. (P=0.05)	1.5	0.9	8.2	39.7	25.1	1.0	5.4	72.8	3.1
W_1	16.1	14.4	91.5	417.7	306.2	14.8	59.4	913.5	43.6
W_2	15.2	13.5	84.5	404.5	296.7	14.2	56.5	873.2	42.8
W_3	12.6	12.6	72.5	293.5	247.5	12.0	41.7	667.2	36.5
S.E. $\pm$	0.5	0.3	2.7	13.6	9.2	0.3	1.4	21.7	1.0
C.D. (P=0.05)	1.1	0.6	5.6	28.2	19.1	0.7	2.8	44.9	2.1
T at W - S.E.$\pm$	1.1	0.6	5.7	28.4	18.7	0.7	3.3	47.9	2.1
T at W - C.D. (P=0.05)	NS	NS	NS	60.7	NS	1.63	NS	103.2	NS
W at T- S.E. $\pm$	1.0	0.6	5.4	27.3	18.5	0.6	2.7	43.5	2.0
W at T- C.D. (P=0.05)	NS	NS	NS	56.3	NS	0.86	NS	89.8	NS

T_1- T_4- Tillage practices, W_1-W_3- Weed management methods NS-Non significant

Table 5 : Effect of tillage and weed management practices on yield of maize –sunflower (kg ha^{-1})

Treatments	Maize –sunflower-I			Maize –sunflower-II		
	Maize		Sunflower	Maize		Sunflower
	Grain yield	Stover yield	Seed yield	Grain yield	Stover yield	Seed yield
T_1	4293	7494	1383	4642	7558	948
T_2	4258	7454	1608	3067	6479	1518
T_3	4482	7862	1272	5133	8850	1234
T_4	4519	7901	1710	5362	9533	1551
S.E. $\pm$	118.4	219.7	52.3	204.1	309.9	57.5
C.D. (P=0.05)	NS	NS	118.3	461.8	701.1	130.0
W_1	4796	8931	1785	5613	9800	1586
W_2	4641	8032	1715	5434	9043	1509
W_3	3727	6070	981	2606	5471	844
S.E. $\pm$	105.9	200.1	42.6	169.6	271.6	37.5
C.D. (P=0.05)	218.5	412.9	88.1	350.2	560.6	77.5
T at W - S.E.$\pm$	209.5	393.8	87.1	344.1	541.1	84.0
T at W - C.D. (P=0.05)	NS	NS	186.1	NS	NS	NS
W at T- S.E. $\pm$	211.7	400.2	85.3	339.3	543.2	75.1
W at T- C.D. (P=0.05)	NS	NS	176.2	NS	NS	NS

T_1- T_4- Tillage practices, W_1-W_3- Weed management methods NS-Non significant

over a longer cropping period. Higher grain and stover yield of maize with conventional tillage are highly supported with improved growth and yield attributes (Bakhsh *et al.*, 2000). Zero tillage (T_2) resulted in minimum grain and stover yields of maize. Lower grain (42 per cent yield reduction) and stover (32 per cent yield reduction) yields of maize were due to poor growth parameters like shorter plants, lesser dry matter and leaf area as well as yield attributes. Higher grain and stover yields of maize obtained with hand weeding on 20 and 40 DAS (W_1) during first and second year, respectively was due to efficient control of weeds and increased root growth (Sharma *et al.*, 1988).

Higher seed yield of sunflower was obtained with continuous conventional tillage (T_4) during both the years. Comparable yields of sunflower were obtained with conventional tillage (T_2) to that of continuous conventional tillage due to better weed control and favourable soil environment. Raj and Yadav (1979) obtained higher grain yield in sunflower with deep cultivation without stubble

mulching, due to improved root development and soil water use. The lowest seed yield obtained with zero tillage (T_3) was due to higher weed competition during first year. During second year of the experiment, continuous zero tillage (T_1) recorded lowest seed yield with higher weed index (48.2 per cent) due to heavy competition for nutrients, space and light offered by annual and perennial grasses. Among the weed management practices, higher seed yield of sunflower obtained with hand weeding on 20 and 40 DAS (W_1) during both the years was due to better growth and yield parameters as a result of efficient weed control by hand weeding at critical crop weed competition. Comparable seed yield of sunflower was obtained with pre-emergence application of pendimethalin 1.0 kg ha^{-1} followed by hand weeding on 40 DAS (W_2) due to early application of broad spectrum selective herbicide which controlled and increased the seed yield of sunflower. Jat and Giri (2000) also reported the advantage of pendimethalin in controlling weeds and increasing the yield of sunflower.

Conclusion:

Growth and yield attributes and yield were higher with conventional tillage. Increased growth and yield attributes and yield of maize and sunflower were recorded by hand weeding on 20 and 40 DAS and also with pre-emergence herbicide (atrazine 0.5 kg ha^{-1} for maize and pendimethalin 1.0 kg ha^{-1} for sunflower) followed by hand weeding on 40 DAS.

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