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Growth and yield of irrigated cotton *(Gossypium hirsutum)* as influenced by different chemical and non-chemical weed-management practices

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ABSTRACT

A field experiment was conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during the winter seasons (August to January) of 1998–1999 and 1999–2000, to develop efficient chemical and non-chemical weed-management practices for 'MCU 5' irrigated cotton *(Gossypium hirsutum* L.). Pre-emergence application of Cinmethylin at 0.6 kg/ha followed by hand-weeding 40 days after sowing gave excellent control of grasses, sedges and broad-leaved weeds, whereas the yield of seed cotton was reduced by initial phytotoxicity to cotton crop. However, Cinmethylin at 0.5 kg/ha + hand-weeding at 40 days after sowing increased the growth, yield parameters and seed-cotton yield of 1,878 and 1,781 kg/ha. Among the non-chemical weed-management practices, growing of greengram (*Phaseolus radiatus* L.) and cowpea [*Vigna unguiculata* (L.) Walp.] as smother crop effectively suppressed total weed population and enhanced growth, yield parameters and seed-cotton yield.

Key words : Cotton, Weed management, Cinmethylin, Pendimethalin, Smother crops

Cotton being an important commercial crop, earns valuable foreign exchange and provides employment to millions of people. Weeds in cotton crop are the major production constraint. Cotton is very sensitive to weed competition in the first 60 days of the crop growth. The recent awareness is to minimize the use of herbicides and adoption of eco-friendly approaches like cultural and biological methods for weed management. Hence an integrated approach was proposed to control weeds through manual and chemical weeding in addition to growing of smother crops as a biological means of weed management.

MATERIALS AND METHODS

A field study was conducted in irrigated cotton 'MCU5' during the winter seasons (August to January) of 1998–1999 and 1999–2000 at Agricultural College and

Research Institute, Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in randomized block design with 3 replications. The treatments tried were: T_1, control; T_2, hand-weeding (HW) twice at 20 and 40 days after sowing (DAS); T_3, Pendimethalin 1.0 kg/ha + HW at 40 DAS; T_4, Cinmethylin 0.5 kg/ha; T_5, Cinmethylin 0.5 kg/ha + HW at 40 DAS; T_6, Cinmethylin 0.6 kg/ha; T_7, Cinmethylin 0.6 kg/ha + HW at 40 DAS; T_8, *Parthenium* incorporation at 2 tonnes/ha ; T_9, *Parthenium* whole plant extract spray (10%); T_{10}, T_8 + HW at 40 DAS; T_{11}, T_9 + HW at 40 DAS; T_{12}, cowpea as smother intercrop up to 40 DAS; T_{13}, pearl millet as smother intercrop up to 40 DAS; and T_{14}, greengram as smother intercrop up to 40 DAS. The soil was sandy clay loam with low (187.6 kg/ha), medium (14.0 kg/ha) and high (420.1 kg/ha) in a available nitrogen, phosphorus and potassium respectively. The pH of the soil was 7.9 with the organic carbon content of 0.42% . Cinmethylin and Pendimethalin were applied as pre-emergence after sowing, followed by immediate irrigation. For applying herbicides, knapsack sprayer was used with a flat-fan nozzle. The cotton variety 'MCU5' was sown with 75 cm x 30 cm spacing and applied with the recommended dose of 80, 40 and 40 kg N, P and K kg/ha. The observation on total weed population, growth parameters like plant height, LAI, dry-matter production, bolls/plant and seed-cotton yield were recorded.

RESULTS AND DISCUSSION

Weed flora

Among the weed species the predominant weed species were *Dactyloctenium aegyptium* Beauv., *Echinochloa colonum* L., *Chloris barbata* SW and *Cynodon dactylon* (L.) Pers., among grasses; *Cyperus rotundus* among sedges; and *Digera arvensis* Forsk. and *Trianthema portulacastrum* L. among broad-leaved weeds.

Weed population

Different weed-control measures significantly influenced the weed density. The wide spectrum of weeds was reduced by Cinmethylin at 0.6 kg/ha + HW at 40 DAS which registered the lowest weed population of 16.64, 25.89, 14.09 and 10.17/m^2 at 20, 40, 80 and 120 DAS respectively. It was followed by Cinmethylin 0.5 kg/ha + HW. Cinmethylin at 0.6 kg/ha followed by hand-weeding at 40 DAS effectively controlled the weed population particularly the grasses and sedges (*Cyperus rotundus*) in both the crops. In second crop also, same trend was followed. This might be due to the fact that Cinmethylin is highly effective against grasses, sedges and its suppression activities on broad-leaved weeds (Table 2). In legume crops, similar result was observed by Wilson (1989).

Application of Pendimethalin 1.0 kg/ha followed by hand-weeding at 40 DAS reduced the weed population , particularly the grassy and broad-leaved weeds, but proved next to Cinmethylin at 0.6 kg/ha + HW. Ramamoorthy (1994) also reported that Pendimethalin was effective against grasses and broad-leaved weeds. In first crop, growing greengram as a smother crop with cotton recorded lower weed population which was on a par with the cowpea as

Table 1. Effect of weed-managment practices on total weed population (No./m²) in cotton

Treatment	First crop (1998–99)				Second crop (1999–2000)			
	20 DAS	40 DAS	80 DAS	120 DAS	20 DAS	40 DAS	80 DAS	120 DAS
T_1	171.33 (2.24)	222.3 (2.35)	188.47 (2.28)	130.11 (2.12)	186.45 (2.28)	247.36 (2.40)	205.10 (2.32)	145.40 (2.17)
T_2	165.66 (2.22)	31.28 (1.52)	18.51 (1.31)	14.46 (1.22)	181.19 (2.26)	38.96 (1.61)	20.36 (1.35)	27.33 (1.47)
T_3	26.21 (1.45)	30.02 (1.51)	21.64 (1.37)	20.74 (1.36)	30.42 (1.52)	35.08 (1.57)	29.33 (1.50)	23.73 (1.41)
T_4	18.01 (1.30)	28.47 (1.48)	31.16 (1.52)	26.42 (1.45)	20.24 (1.35)	31.77 (1.53)	41.71 (1.64)	32.40 (1.54)
T_5	17.48 (1.29)	28.92 (1.49)	18.28 (1.31)	15.04 (1.23)	20.09 (1.34)	31.93 (1.53)	24.07 (1.42)	16.29 (1.26)
T_6	17.32 (1.29)	25.63 (1.44)	30.92 (1.52)	28.45 (1.48)	18.31 (1.31)	28.27 (1.48)	38.91 (1.61)	33.28 (1.55)
T_7	16.64 (1.27)	25.89 (1.45)	14.09 (1.21)	10.17 (1.09)	19.03 (1.32)	28.45 (1.48)	16.62 (1.27)	12.63 (1.17)
T_8	150.55 (2.18)	62.44 (1.81)	61.44 (1.80)	52.94 (1.74)	156.02 (2.20)	67.45 (1.84)	67.31 (1.84)	59.66 (1.79)
T_9	132.88 (2.13)	58.11 (1.78)	52.12 (1.73)	46.01 (1.68)	138.48 (2.15)	63.11 (1.81)	57.32 (1.77)	42.85 (1.65)
T_{10}	158.73 (2.21)	61.75 (1.80)	55.66 (1.76)	73.50 (1.66)	163.97 (2.22)	66.82 (1.84)	60.96 (1.80)	49.85 (1.72)
T_{11}	129.32 2.12)	58.84 (1.78)	43.18 (1.65)	37.36 (1.60)	136.15 (2.14)	63.88 (1.82)	47.98 (1.70)	36.28 (1.58)
T_{12}	89.79 (1.96)	152.29 (1.74)	36.33 (1.58)	32.62 (1.54)	97.18 (2.00)	56.98 (1.77)	40.64 (1.63)	34.42 (1.56)
T_{13}	125.17 (2.10)	81.89 (1.92)	45.72 (1.68)	38.77 (1.61)	130.44 (2.12)	87.98 (1.95)	53.70 (1.75)	43.27 (1.66)
T_{14}	86.64 (1.95)	50.06 (1.72)	34.16 (1.56)	28.77 (1.49)	92.71 (1.98)	54.32 (1.75)	41.97 (1.64)	33.72 (1.55)
CD (P=0.05)	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03

Details of treatments are given in text
Figures in parentheses indicate log (x+2) value
DAS, Days after sowing

Table 2. Effect of weed-managment practices on population of grasses, sedges, broad-leaved weeds and weed dry-matter production at 120 days

Treatment	Grasses (No./m²)		Sedges (No./m²)		BLW (No./m²)		Weed dry matter at 120 days (kg/ha)	
	1998–99	1999–2000	1998–99	1999–2000	1998–99	1999–2000	1998–99	1999–2000
T_1	66.18 (1.83)	69.41 (1.85)	25.60 1.44)	29.22 (1.49)	38.33 (1.61)	46.77 (1.69)	465.35 (2.67)	508.90 (2.71)
T_2	5.36 (0.87)	5.99 (0.90)	6.08 (0.91)	17.83 (1.30)	3.02 (1.70)	3.51 (0.74)	48.33 1.77)	72.45 (1.87)
T_3	8.00 (1.00)	6.13 (0.91)	9.65 (1.07)	12.05 (1.15)	3.09 (0.71)	5.55 (0.88)	60.54 (1.80)	62.41 (1.81)
T_4	5.75 (0.89)	8.14 (1.01)	7.05 (0.96)	5.60 (0.88)	13.62 (1.19)	18.66 (1.32)	96.51 (1.99)	108.54 (2.04)
T_5	5.02 (0.85)	3.39 (0.73)	2.88 (0.69)	3.13 (0.71)	7.14 (0.96)	9.77 (1.07)	38.46 (1.61)	43.82 (1.66)
T_6	6.63 (0.94)	8.02 (1.00)	4.21 (0.79)	4.29 (0.80)	17.61 (1.29)	19.39 (1.33)	90.77 (1.97)	96.82 (2.00)
T_7	2.24 (0.63)	2.75 (0.68)	1.39 (0.53)	1.77 (0.58)	5.64 (0.93)	8.11 (1.01)	35.71 (1.58)	38.14 (1.60)
T_8	10.58 (1.10)	11.04 (1.12)	11.86 (1.14)	12.18 (1.15)	30.50 (1.51)	36.64 (1.59)	195.29 (2.30)	208.81 (2.32)
T_9	9.90 (1.07)	7.27 (0.97)	6.15 (0.91)	2.92 (0.69)	29.96 (1.50)	32.66 (1.54)	170.24 (2.24)	158.55 (2.21)
T_{10}	10.09 (1.08)	7.05 (0.96)	7.33 (0.97)	8.09 (1.00)	26.08 (1.45)	34.71 (1.57)	173.88 (2.25)	168.85 (2.23)
T_{11}	6.06 (0.91)	6.83 (0.95)	8.84 (1.01)	2.26 (0.63)	22.46 (1.39)	27.19 (1.47)	128.65 (2.12)	137.12 (2.14)
T_{12}	5.92 (0.90)	6.71 (0.94)	5.89 (0.90)	5.47 (0.87)	20.81 (1.36)	22.24 (1.38)	98.51 (2.00)	103.95 (2.03)
T_{13}	6.83 (0.95)	7.50 (0.98)	7.01 (0.96)	6.35 (0.92)	24.93 (1.43)	29.42 (1.50)	145.57 (2.17)	155.77 (2.20)
T_{14}	5.45 (0.87)	6.08 (0.91)	6.05 (0.91)	4.27 (0.80)	17.27 (1.29)	23.37 (1.40)	95.75 (1.99)	102.85 (2.02)
CD (P = 0.05)	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03

Details of treatments are given in text; figures in parentheses indicate log (x + 2) value; BLW, broad-leaved weeds

smother crop. In second crop also, the same trend was followed. Growing of cotton with smother crops such as greengram and cowpea up to 40 DAS significantly suppressed the growth of grasses as well as broad-leaved weeds due to initial rapid growth and development of good canopy cover by greengram and cowpea. Balasubramanian (1985) also reported that cowpea and lablab in cotton as smother intercrops effectively suppressed the weeds during the critical period of crop–weed competition. Regarding the allelopathic treatments, *Parthenium* whole plant extract (10%) spray and *Parthenium* incorporation at 2 tonnes/ha followed by hand-weeding at 40 DAS considerably decreased the total weed population irrespective of stages. The release of some allelochemicals such as sequiterpene, lactones, alkaloids, Parthenin, kaemferol, P-coumaric acid and caffeic acid by *Parthenium* might be the reason for control of weed population at earlier stages. Arunachalam (1997) found that *Parthenium* whole plant extract suppressed *Cyperus* population at 40 DAS under field conditions. Umapathy *et al.* (1998) reported that *Parthenium* incorporation at 5 tonnes/ha effectively controlled *Trianthema portulacastrum* and *Cyperus rotundus* in blackgram.

Crop growth

Weed-management practices exerted significant positive effect on crop growth characters in cotton irrespective of stages in both the crops. Cinmethylin at 0.5 kg/ha, followed by hand-weeding at 40 DAS registered higher plant height, leaf-area index (LAI) and dry matter of cotton. This treatment was followed by Pendimethalin at 1.0 kg/ha, followed by hand-weeding at 40 DAS. Cinmethylin at 0.6 kg/ha + HW at 40 DAS recorded lesser growth. Cinmethylin at higher rate (0.6 kg/ha) caused some phytotoxicity in cotton plants. Cinmethylin at 0.5 kg/ha + HW recorded higher values of growth characters owing to better weed control and efficient utilization of light, space, water and nutrients for their growth. This might be owing to increased weed-control efficiency and reduced weed density by the treatment. Application of Cinmethylin at 0.6 kg/ha + HW reduced the plant height, LAI and crop dry matter. This might be due to the initial phytotoxicity exhibited in the form of chlorosis, reduced plant vigour, and number of leaves. Pendimethalin at 1.0 kg/ha + HW at 40 DAS recorded higher plant growth characters due to better control of broad-leaved weeds such as *Digera arvensis* and *Trianthema portulacastrum* as well as grasses like *Daclyloctenium aegyptium* from the initial phases of growth. Growing of smother crops such as greengram and cowpea up to 40 DAS suppressed the weed growth and thereby improved the plant height, The LAI and dry matter through effective reduction in dry-matter production and nutrient uptake by weeds, thereby facilitating more availability and uptake of nutrients by the crop. This promoted better crop growth with increased canopy development and production of more number of bolls. In unweeded control, lowest crop dry matter was recorded due to the severe competition exerted by weeds at all the stages of crop growth. Reduced dry matter of cotton by increased weed population under

Table 3. Effect of weed-management practices on growth and seed-cotton yield of irrigated cotton ('MCU 5')

Treatment	Plant height (cm) at 120 DAS		Leaf-area index at 120 DAS		Dry matter (kg/ha) at 120 DAS		Number of bolls/plant		Seed-cotton yield (kg/ha)	
	1998–99	1999–2000	1998–99	1999–2000	1998–99	1999–2000	1998–99	1999–2000	1998–99	1999–2000
T_1	74.23	67.92	2.62	2.49	2,398	2,178	9.96	8.89	754	678
T_2	98.61	94.17	3.55	3.48	4,638	4,436	16.93	16.23	1,651	1,556
T_3	105.40	100.40	3.76	3.69	4,951	4,721	18.26	17.31	1,764	1,669
T_4	93.98	90.06	3.43	3.38	4,401	4,181	15.00	14.28	1,569	1,490
T_5	109.10	104.19	3.88	3.81	5,245	4,995	22.15	21.13	1,878	1,781
T_6	96.03	91.23	3.45	3.41	4,513	4,291	16.92	15.98	1,595	1,505
T_7	100.75	95.71	3.60	3.54	4,741	4,513	17.87	17.02	1,688	1,604
T_8	80.13	75.93	2.94	2.88	2,628	2,453	12.62	11.93	850	775
T_9	82.53	81.37	3.23	3.20	2,893	2,693	12.80	12.08	948	873
T_{10}	85.29	81.45	3.32	3.28	3,405	3,209	14.27	13.58	1,137	1,059
T_{11}	89.06	84.70	3.36	3.31	3,592	3,391	14.33	13.67	1,266	1,195
T_{12}	96.53	92.07	3.50	3.45	4,535	4,325	17.20	16.35	1,615	1,530
T_{13}	78.40	72.91	2.88	2.78	2,598	2,423	11.14	10.23	832	763
T_{14}	97.99	94.32	3.52	3.47	4,612	4,420	17.78	16.53	1,640	1,548
CD (P = 0.05)	3.48	5.42	0.12	0.21	251.40	238.00	0.98	0.93	85.00	78.00

Details of treatments are given in text
DAS, Days after sowing

ineffective weed-control situation was reported by Singh (1983).

Seed-cotton yield

All the weed-management practices significantly improved the seed-cotton yield over unweeded control. In both the crops, application of Cinmethylin at 0.5 kg/ha + HW registered higher seed-cotton yield of 1,878 and 1,781 kg/ha due to effective control of predominant weeds like *Dactyloctenium aegyptium, Echinochloa colonum* and *Chloris barbata* among grasses; *Cyperus rotundus* among sedges; and few broad-leaved weeds resulting in lesser competition of weeds for crop growth. This facilitated the cotton crop to utilize more moisture, nutrients and solar radiation by which the plant height, LAI, dry matter and nutrient uptake were promoted in cotton crop. All the factors collectively contributed for higher seed-cotton yield. These results are in accordance with the findings of Forney *et al.*, (1985) in soybean. Growing of greengram and cowpea as smother crops recorded lower weed population and thereby increased seed-cotton yield. This might be due to reduced weed competition and increased yield-contributing characters. This result is in accordance with reports of Balasubramanian (1985).

Thus pre-emergence application of Cinmethylin at 0.5 kg/ha, followed by hand-weeding at 40 DAS gave the effective control of weeds, resulting in the higher seed-cotton yield and it can be recommended as most efficient and economical method of weed management in cotton. Growing of greengram and cowpea as weed smother crops along with cotton up to 40 DAS also gave good suppression of weeds and recorded higher seed-cotton yield and it may be recommended as an efficient and economic method of non-chemical weed-management practices for irrigated cotton.

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