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Effect of soil solarization in summer on weed growth and yield of succeeding rainy-season sorghum (*Sorghum bicolor*)

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ABSTRACT

A field investigation was carried out at Dharwad during April 1990 to October 1991 to study the influence of soil solarization on weed growth in succeeding rainy (*kharif*)-season sorghum [*Sorghum bicolor* (L.) Moench] and the resultant influence on the yield of the crop. The increase in soil temperature due to transparent polyethylene 0.05 mm, transparent polythene 0.1 mm and black polyethylene was 8.7–11.0°C, 5.1–5.8°C and 2.5–3.2°C respectively over the control. There was a significant reduction in count and dry weight of weeds even up to the harvest of sorghum due to solarization with transparent polyethylene. The transparent polyethylene of 0.05 mm thickness was superior to that of 0.1 mm thickness. Solarization for 30 and 40 days caused maximum reduction in weeds. The performance of black plythene and solarization for 10 and 20 days with transparent polyethylene was on a par with non-solarized control. The maximum weed reduction was obtained by 0.05 for 40 days which was better than the normal practice of weed control. Maximum grain yield of 42.3 q/ha was recorded by transparent polythene 0.05 for 40 days, which was better than the normal practice of weed control.

Soil solarization, a method of heating the surface soil by using plastic sheets placed on moist soil to trap the freely available solar radiation, is identified as a method of disinfestation of the soil against pests including weeds. Typical maximum temperature in solarized plots at 5 cm soil depth was as high as 50 °C on days of maximum air temperatures of 35–38 °C (Katân, 1980). Investigators from Israel, Jordan, the USA and elsewhere have indicated weed control by the rise in soil temperature due to solarization. In many instances, weed control was evident even up to the end of the growing season of crops (Grinstein *et al.*, 1979).

There are many locations in India facing extreme summer. While studying the effect of soil solarization on disease control, many authors have reported significant increase in soil temperature (Chauhan *et al.*, 1988). However, no serious efforts have been taken so far in India to conduct experiment on the efficiency of soil solarization for weed control in crops. Hence this investigation was carried out to determine the effectiveness of soil solarization in controlling the weeds of the succeeding rainy-season sorghum [*Sorghum bicolor* (L.) Moench] and its resultant influence on the crop yield.

MATERIALS AND METHODS

The field experiment was carried out at the Agricultural College Farm, Dharwad, of the University of Agricultural Sciences, for 2 years (from April 1990 to October 1991). The experiment consisted of 12 treatments replicated thrice in the randomized block design. The treatments included solarization with transparent polyethylene (TP) of 0.05 mm thickness for 10, 20, 30 and 40 days (T_1 to T_4), with TP of 0.1 mm thickness for 10, 20, 30 and 40 days (T_5 to T_8), non-solarized unweeded control (T_9), weed-free check (T_{10}), normal practice (T_{11}) and black polyethylene (BP) for 40 days (T_{12}). Normal practice consisted of 2 inter-cultivations + hand-weedings at 25 days after sowing (DAS) and at 45 DAS.

The polyethylene sheets in the solarized plots were spread on 30 April in 1990 and 19 April in 1991. They were removed after the respective periods of solarization. Sowing of sorghum ('CSH 5') was done on 18 June in 1990 and 12 June in 1991, at a spacing of 37.5 cm x 10 cm. After sowing, no weeding was done in plots T_1 to T_8 and T_{12} (solarized plots) and also unweeded control (T_9). Weeds were removed as and when they emerged in the weed-free check treatment (T_{10}). During the solarization period, soil temperature was recorded on alternate days at 2.30 to 3.30 PM. using ordinary mercury-inglass thermometer inserted into the soil after making holes up to 5 cm depth with the help of marked rods. The weed count and weed dry weight were recorded at 30, 60 and 90 DAS and at harvest, along with the biometric observations. The data on weed count and dry weight were subjected to $\sqrt{X + 1}$ and log (X + 2) transformation respectively before statistical analysis.

RESULTS AND DISCUSSION

Effect on soil temperature

Generally, the values of soil temperatures recorded were in the order TP 0.05 mm > TP 0.1 mm > BP > control (Table 1). During 1990, the maximum soil temperature re-

Table 1. Influence of solarization treatments on soil-temperature maxima

Treatment	Mean maximum soil temperature (°C)		Frequency (%) with temperature exceeding			
	1990 (39.5[a])	1991 (40.0[a])	1990		1991	
			40 °C	45 °C	40 °C	45 °C
TP (0.05 mm) 10 days	49.7	52.7	30	20	40	25
TP (0.05 mm) 20 days	48.7	51.7	50	35	50	45
TP (0.05 mm) 30 days	48.5	52.3	70	40	70	55
TP (0.05 mm) 40 days	49.2	52.2	80	40	80	55
TP (0.10 mm) 10 days	46.5	46.7	30	10	40	20
TP (0.10 mm) 20 days	46.8	46.3	50	15	45	35
TP (0.10 mm) 30 days	45.8	46.3	65	20	50	40
TP (0.10 mm) 40 days	46.2	46.8	75	20	65	40
Unweeded control	41.0	41.7	15		25	
Weed-free check	40.8	41.2	20		25	
Normal practice	41.7	41.2	20		25	
BP 40 days	44.2	44.2	50		50	
CD (P = 0.05)	1.7	1.8				

a, Maximum air temperature; b, expressed as a precentage of the total number of 20 observations
TP, Transparent polyethylene; BP, black polyethylene

corded by TP 0.05 mm, TP 0.1 mm and BP reached 49.7, 46.8 and 44.2 °C resectively on a day of maximum air temperature of 39.5 °C, the values being higher over the control by 8.7, 5.8 and 3.2°C. The corresponding figures for 1991 were 52.7, 46.8 and 44.2 °C on a day of maximum air temperature of 40.0 °C which were higher over non-solarized control by 11.0, 5.1 and 2.5°C. The results indicated that BP recorded lesser temperature as compared to TP. These results are in agreement with those of Horowitz *et al.* (1983). The supremacy of transparent polyethylene in raising soil temperature to higher magnitudes can be because it allows maximum transmittance of the incoming short-wave radiation. It is also seen that thinner TP is comparatively more effective than thicker TP owing to its higher radiation transmittance. This finding agrees with that of Lodha (1989). The actual influence that the duration of solarization had on soil temperature is that with increase in duration there was increase in the frequency of the daily soil temperature maxima crossing lethal limits of 40 and

Table 2. Influence of solarization treatments on number and dry weight (g) of weeds/m^2 at different growth stages and on yield of sorghum (mean data of 2 years)

Treatment	60 DAS		At harvest		Grain yield (q/ha)	Straw yield (q/ha)
	Count	Dry weight	Count	Dry weight		
TP (0.05 mm) 10 days	10.10 (101.0)	1.326 (19.17)	11.63 (134.3)	1.489 (28.88)	23.7	37.8
TP (0.05 mm) 20 days	9.20 (83.7)	1.206 (14.07)	11.13 (122.9)	1.471 (27.61)	28.2	42.3
TP (0.05 mm) 30 days	6.22 (37.7)	0.928 (6.48)	9.05 (80.7)	1.163 (12.59)	37.2	59.7
TP (0.05 mm) 40 days	5.00 (24.0)	0.655 (2.52)	7.22 (51.2)	0.097 (6.09)	42.3	60.3
TP (0.10 mm) 10 days	10.50 (110.2)	1.348 (20.27)	12.15 (46.5)	1.537 (32.50)	23.2	35.7
TP (0.10 mm) 20 days	10.30 (105.0)	1.308 (18.31)	11.95 (141.8)	1.477 (28.02)	25.2	38.5
TP (0.10 mm) 30 days	8.01 (63.2)	1.119 (11.16)	10.59 (111.2)	1.313 (18.58)	32.2	51.3
TP (0.10 mm) 40 days	6.74 (44.5)	0.978 (7.51)	8.80 (76.4)	1.158 (12.42)	36.8	59.1
Unweeded control	11.39 (28.7)	1.422 (25.66)	12.21 (168.0)	1.566 (34.86)	22.0	37.5
Weed-free check	1.00 (0.0)	0.301 (0.0)	1.00 (0.0)	0.301 0.0	42.3	67.4
Normal practice	7.44 (54.3)	0.916 (6.24)	9.43 (88.0)	1.177 (13.07)	35.1	51.8
BP 40 days	10.14 (101.8)	1.167 (12.68)	11.76 (137.2)	1.415 (24.01)	25.6	42.8
CD ($P = 0.05$)	0.98	0.240	1.43	0.141	1.4	6.9

Figures in parentheses indicate original values

TP, Transparent polyethylene; BP, black polyethylene

45°C. When duration of solarization increased from 10 to 40 days with TP of 0.05 mm, the frequency for temperature exceeding 40 °C increased from 30 to 80 in 1990 and 40 to 80 in 1991. These observations are in conformity with those of Horowitz *et al.* (1983). The year 1991 recorded slightly higher frequencies for temperature exceeding 40 and 45 °C.

Effect on weeds

Solarization treatments with TP of 0.05 mm and 0.1 mm for 30 and 40 days significantly reduced weed count and dry weight at all stages of crop (Table 2). This can be attributed to the effect of high soil temperature. It is seen that in the above treatments soil temperature crossed the lethal limit with a higher frequency. Similar reduction in weed count and dry weight due to solarization has been reported earlier (Grinstein *et al.*, 1979). The reduction in weed count and dry weight was more due to 0.05 mm TP than 0.1 mm TP. Rise in soil temperature recorded in this study was also in the same order. Rise in temperature to higher levels by 0.05 mm TP might have caused the death or damage of the weed seed present in the soil to a greater extent, thus reducing their emergence and dry weights to the minimum. Standifer *et al.* (1984) also observed the superiority of thin TP and that of TP in general over BP with respect to weed control.

Effect on sorghum yield

Maximum grain yield (42.3 q/ha) was recorded by 0.05 mm TP for 40 days, which was on par with weed-free check (Table 2). The increase in grain yield over non-solarized control was 92.4, 92.0 and 46.3% due to 0.05 mm TP for 40 days, weed-free check and normal practice respectively. The stover yield recorded by 0.05 mm TP for 40 days (66.3 q/ha) was also on par with weed-free check. The drastic reduction in weed count and dry weight achieved by the TP of 0.05 for 40 days might have resulted in better availability of resources and thereby the grain and stover yields of sorghum might have increased. The increase in yield of sorghum as a result of weed control through soil solarization is in line with that obtained in groundnut (Grinstein *et al.*, 1979).

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