



Productivity and economics of transparent polyethylene for soil solarization in groundnut (*Arachis hypogaea*)–bell pepper (*Capsicum annum*) sequence

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Received: February 2008

ABSTRACT

A field experiment was conducted during 2004 and 2005 at Bangalore to work out the economics of soil solarization on break-even basis with different thicknesses (0.05 and 0.10 mm) of transparent polyethylene (TPE) in groundnut (*Arachis hypogaea* L.) ñ bell pepper (*Capsicum annum* L.) sequence. Soil solarization with TPE 0.05 mm covered twice in the same season recorded significantly higher pod yield of groundnut (2.36 t/ha) and fruit yield of bell pepper (15.1 t/ha), followed by TPE 0.05 mm covered once in the same season (2.27 t/ha and 12.0 t/ha respectively) and TPE 0.10 mm covered twice (2.17 t/ha and 12.6 t/ha). Similarly, leaf area/plant and yield attributes, viz. number of pods/plant (23.0) and number of fruits/plant (6.4) were also superior in soil solarization with 0.05 mm twice, TPE 0.05 mm once (21.7 and 5.3 respectively) and TPE 0.10 mm twice (22.1 and 6.0). Significantly lower number of weeds and weed dry weight was recorded with TPE 0.05 mm twice in both groundnut and bell pepper crop sequence. Repetitive use of TPE 0.05 mm for two times in the same season recorded higher net income (Rs 139.95 x10³/ha) and B : C ratio (3.86) followed by TPE 0.05 mm for three times and TPE 0.10 mm for two times continuously in the same season. Soil solarization with TPE 0.05 mm thickness twice in the same season for groundnut ñ bell pepper sequence was found to be highly productive and most economical practice.

Key words: Bell pepper, Economics, Groundnut, Polyethylene sheet, Soil solarization, Weed control

Soil solarization is a non-hazardous and an efficient option for weed management, involving the use of transparent polyethylene (TPE) to cover the moist surface soil, which in turn increases the soil temperature (Katan, 1981). Though soil solarization is a very effective non-chemical weed-management tool, higher cost of polythene sheet is the limiting factor in its large-scale use and adoption (Habeeburrahman, 1992). Effectiveness of the repetitive use of TPE of different thicknesses on weed control and its productivity and the economics of crops need thorough investigation. Hence an experiment was carried out to know the cost effectiveness of repetitive use of transparent polyethylene of different thickness for soil solarization and also its effect on weeds and growth and yield of crops in groundnut–bell pepper sequence.

MATERIALS AND METHODS

A field experiment was carried out during summer 2004 and 2005 at University of Agricultural Sciences, Hebbal, Bangalore, situated in the Eastern Dry Zone of Karnataka at 12° 58' N latitude, 77°35' E longitude at an altitude of 930 m above mean sea level. Thorough land preparation was done to bring the soil to fine tilth, and

levelled. The sandy loam soil had pH 6.76, and available N, P and K 267, 24 and 157 kg/ha, respectively. Treatments were laid out as per the plan by making small bunds around each plot. Farmyard manure was applied at the rate of 10 t/ha and mixed thoroughly in the soil. The treatments consisting of two thicknesses of transparent polyethylene (0.05 and 0.10 mm) covered once, twice and thrice in the same season for 45 days duration, weedy check and weed-free throughout, were replicated thrice in randomized complete block design with plot size of 6.6 × 3.2 m. All the plots receiving solarization treatments with the fresh polyethylene sheets covered by stretching tightly and were sealed at all the sides to make it airtight, using moist soil. For the treatments involving solarization for the second and third time with the same polyethylene on different pieces of land, the polyethylene sheets of the respective plots were removed and the same polyethylene sheets were used to cover the plots for soil solarization.

Groundnut 'TMV 2' was sown at a spacing of 30 × 15 cm. After the groundnut harvest, the plots were divided into two subplots to superimpose the treatments with one hand-weeding and no weeding to study the residual effect of soil solarization on the sequence crop of bell pepper. Seedlings of bell pepper hybrid 'Indra' were transplanted

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at a spacing of 45 x 30 cm. Both the crops were raised with recommended package of practices. Polyethylene sheets were covered for the first time during January-March (15 January – 1 March), second time during March-April (1 March - 15 April), and the third time during April-May (15 April - 30 May).

Biometric observations on groundnut, viz. total dry weight at 60 days after sowing (DAS), number of pods/plant, pod yield, weed count and dry weight of weeds were recorded at harvest. In bell pepper, the leaf area/plant and total dry weight at 90 DAP and number of fruits, fruit yield, weed count and dry weight of weeds were recorded at harvest of the crop. Soil temperature was recorded with piercing type of digital thermometer at 5 cm and 10 cm depths in both solarized and non-solarized plots at 5 days interval between 1.30 PM and 2.30 PM. The data on weeds were subjected to square-root transformation before statistical analysis.

RESULTS AND DISCUSSION

Performance of groundnut

Among the solarization treatments, TPE 0.05 mm twice in the same season registered significantly higher pod yield of groundnut (2.36 t/ha) and was on par with TPE 0.05 mm once, TPE 0.10 mm once and TPE 0.10 mm twice in the same season. The increase in yield in these treatments was due to better performance of the crop in terms of growth and yield parameters, viz. total dry-matter accumulation and number of pods/plant (Table 1). The number of pods and total dry-matter accumulation/plant were significantly higher in all the solarized treatments compared with those in the weedy check. Among the solarization treatments, TPE 0.05 mm twice in the same season registered significantly higher number of pods/plant (23.0) and was on par with TPE 0.10 mm twice in the same season (22.1). Similarly, total dry-matter accumula-

tion/plant was significantly higher in TPE 0.05 mm once (19.6 g/plant) and was on par with TPE 0.05 mm twice in the same season (19.2 g/plant). This better performance of the crop in terms of growth and yield could be attributed to the reduced incidence of weeds and dry weight of weeds in these treatments. Yaduraju and Ahuja (1990), Mudalagiriappa (1999) and Soumya *et al.* (2004) also reported increase in yield of groundnut under weed-free situation.

Solarization with TPE 0.05 mm twice followed by TPE 0.10 mm twice and TPE 0.05 mm once showed significantly lower total number of weeds and dry weight of weeds at harvest. Among the solarized treatments TPE 0.10 mm thrice in the same season registered significantly higher number of weeds (67.6/m²) and dry weight of weeds (15.0 g/m²), followed by TPE 0.10 mm once and TPE 0.05 mm thrice in the same season. The significantly lower growth, yield attributes and pod yield (0.87 t/ha) were associated with higher number and dry weight of weeds in the weedy check compared with the rest of the treatments. This was owing to the inefficiency of transparent polyethylene film to absorb solar radiation and increase the soil temperature to lethal levels when covered for the third time, because the film could not withstand continuous exposure to solar radiation and remained broken and mutilated.

In general, the higher yield under soil solarization with TPE 0.05 mm or 0.10 mm was due to rise in soil temperature associated with better weed control compared with non-solarized weedy check. Temperature at 5 cm soil layer was higher than at 10 cm due to direct contact of short-wave solar radiation. The maximum yield response with 0.05 mm thick polyethylene used once can also be attributed to maximum soil temperature (50.8°C), leading to lethality of weed seeds. The extent of increase in soil temperature was reduced gradually with the repetitive use of

Table 1. Effect of repetitive use of transparent polyethylene (TPE) for soil solarization in groundnut (mean data of 2 years)

Treatment	Total dry weight at 60 DAS (g/plant)	No. of pods/plant	Pod yield (t/ha)	No. of weeds/m ² at harvest	Dry weight of weeds at harvest (g/m ²)
TPE 0.10 mm once	19.2	20.9	2.13	7.5 (56.0)	3.8 (13.9)
TPE 0.10 mm twice in the same season	18.9	22.1	2.17	6.1 (36.7)	3.1 (9.3)
TPE 0.10 mm thrice in the same season	15.0	16.1	1.40	8.2 (67.6)	3.9 (15.0)
TPE 0.05 mm once	19.6	21.7	2.27	6.9 (46.7)	3.5 (12.0)
TPE 0.05 mm twice in the same season	19.2	23.0	2.36	5.2 (26.7)	2.6 (6.2)
TPE 0.05 mm thrice in the same season	15.1	16.6	1.51	7.0 (48.4)	3.5 (11.6)
Weed-free check	21.5	25.7	2.59	0.7 (0.0)	0.7 (0.0)
Weedy check	11.9	10.8	0.87	9.3 (86.7)	4.7 (21.6)
SEm±	0.7	0.6	0.08	0.4	0.1
CD (P=0.05)	2.0	1.9	0.24	1.1	0.3

Figures in parentheses indicate original values

polyethylene considerably due to the broken and mutilated condition of TPE, which was not very effective in trapping long-wave radiation, and led to greater growth of weeds and ultimately poor response of groundnut.

Performance of bell pepper

The residual effect of soil solarization with TPE 0.05 mm twice in the same season was significantly superior in terms of fruit yield of bell pepper (15.1 t/ha), which could be due to superiority of the treatment in terms of leaf area/plant (424 cm²), total dry-matter accumulation (19.9 g/plant) and number of fruits/plant (6.4). This could be ascribed to significantly lower number of weeds (26.8/m²) and dry weight of weeds (11.4 g/m²) in solarization with

TPE 0.05 mm twice in the same season to the previous crop of groundnut (Table 2). Among the two superimposed treatments in bell pepper, weeding in sequence crop registered non-significant differences with no weeding. This was further attributed to better soil temperature achieved in soil solarization with TPE 0.05 mm twice, which was more lethal to weeds than the rest of the treatments. These results are in conformity with the findings of Nanjappa *et al.* (2005a).

Economics

Repetitive use of TPE 0.05 mm twice in the same season for soil solarization recorded higher gross income (Rs 188.83 x 10³/ha), net income (Rs 139.95 x 10³/ha) and B

Table 2. Residual effect of repetitive use of transparent polyethylene for soil solarization in bell pepper (mean data of 2 years)

Treatment	Leaf area/ plant at 90 DAP (cm ²)	Total dry weight at 90 DAP (g/plant)	No. of fruits/ plant	Fruit yield (t/ha)	No. of weeds/m ² at harvest	Dry weight of weeds at harvest (g/m ²)
<i>Soil solarization</i>						
TPE 0.10 mm once	407	18.81	5.1	11.5	7.0 (49.5)	4.3 (18.7)
TPE 0.10 mm twice in the same season	421	19.71	6.0	12.6	5.3 (28.3)	3.6 (12.9)
TPE 0.10 mm thrice in the same season	382	17.67	4.4	9.1	7.7 (60.5)	4.8 (23.1)
TPE 0.05 mm once	419	19.21	5.3	12.0	6.7 (44.5)	4.2 (17.1)
TPE 0.05 mm twice in the same season	424	19.90	6.4	15.1	5.2 (26.8)	3.4 (11.4)
TPE 0.05 mm thrice in the same season	379	18.07	4.6	10.6	7.2 (53.0)	4.6 (21.1)
Weed free check	418	19.07	5.8	14.3	6.6 (49.3)	4.9 (27.0)
Weedy check	332	16.51	4.0	9.2	9.3 (92.0)	6.3 (39.8)
SEm±	13	0.41	0.2	0.5	0.08	0.06
CD (P=0.05)	37	1.13	0.5	1.3	0.21	0.15
<i>Weed control</i>						
Weeding	449	20.70	5.9	13.3	5.5 (31.3)	3.8 (14.5)
No weeding	347	16.50	4.5	10.3	8.2 (69.7)	5.3 (28.3)
SEm±	7	0.20	0.1	0.2	0.04	0.03
CD (P=0.05)	18	0.57	0.2	0.6	0.11	0.08

Figures in parentheses indicate original values

Table 3. Economics of soil solarization with repetitive use of polyethylene (pooled data)

Treatment	Total cost of cultivation (× 10 ³ Rs/ha)	Gross income (×10 ³ Rs/ha)			Net income (× 10 ³ Rs/ha)	B : C ratio
		Groundnut	Bell pepper	Total		
<i>Soil solarization</i>						
TPE 0.10 mm once	72.07	34.32	114.83	149.14	77.07	2.07
TPE 0.10 mm twice in the same season	56.07	34.77	126.47	161.24	105.17	2.88
TPE 0.10 mm thrice in the same season	50.74	22.66	90.50	113.16	62.42	2.23
TPE 0.05 mm once	57.67	36.53	120.15	156.68	99.00	2.72
TPE 0.05 mm twice in the same season	48.87	37.85	150.98	188.83	139.95	3.86
TPE 0.05 mm thrice in the same season	45.94	24.41	105.68	130.09	84.15	2.83
Weed free check	41.87	41.72	143.48	185.20	143.32	4.42
Weedy check	40.07	14.24	92.20	106.44	66.37	2.66
<i>Weed control</i>						
Weeding	52.47	30.81	133.27	164.09	111.62	3.13
No weeding	51.67	30.81	102.79	133.61	81.94	2.59

: C ratio (3.86), followed by the use of TPE 0.05 mm thrice and TPE 0.10 mm twice continuously in the same season. Higher yield in these treatments and the lower investment in terms of break-even cost resulted in higher returns (Table 3). Among the two thicknesses of the polyethylene sheet used, TPE 0.05 mm resulted in higher net returns and B : C ratio than with TPE 0.10 mm due to lower cost of TPE 0.05 mm combined with the higher yields of groundnut and bell pepper. Nanjappa *et al.* (2005b) reported that TPE either 0.05 mm or 0.10 mm will not withstand continuous exposure to solar radiation and would get broken and mutilated.

It was concluded that soil solarization with TPE 0.05 mm twice in the same season or year continuously can minimize the cost on TPE with highest B : C ratio of 3.86 compared with 2.72 with solarization once.

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