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Effect of soil solarization and farmyard manure application on weed control and productivity of sunflower (*Helianthus annuus*) - bell pepper (*Capsicum annuum*) sequence

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ABSTRACT

A field experiment was conducted for 2 consecutive years (2003 and 2004) at Bangalore to study the effect of soil solarization with moisture regimes, time of farmyard manure (FYM) application and duration of solarization on weed dynamics and yield of sunflower – bell pepper crop sequence. Soil solarization for 60 days with irrigation up to field capacity (FC) and FYM application before solarization proved superior for weed control and yield of this sequence. It was followed by 45 days solarization, FYM application after solarization with irrigation up to FC and irrigation up to 50% FC. Non-solarized weedy check recorded significantly lower yield and higher weed dominance compared with all other treatments.

Key words: Bell pepper, FYM, Soil moisture regime, Solarization, Sunflower, Weed dynamics

Sunflower (*Helianthus annuus* L.), an important oilseed crop with short duration and photo-insensitivity, suits well to rainy (*kharif*) season. Bell pepper (*Capsicum annuum* L.), a high value vegetable crop rich in vitamins C and A, is cultivated mainly during winter (*rabi*) season both for domestic and export market. These crops are highly responsive to nutrients and weed management. A number of methods, viz. cultural, manual or mechanical, biological and chemical, are being adopted to manage the weeds. Cultural and mechanical methods are aimed to improve the competitive ability of crop against weeds and are a viable option only within a certain range of soil condition. Further, they have some limitations as they are laborious, time consuming and expensive. Besides, these methods are used only after attainment of a certain stage of crop growth, but by this time the weeds already cause damage to the crop plants by depriving them of nutrients, moisture and space. Chemical weed control is caught up with growing apprehension among ecologists about their use. Hence innovative approaches to control weeds are in great demand around the world, particularly those that are cost effective and less harmful to the environment. The search for such methods of soil disinfection through soil solarization offers greater potentialities. This method is non-hazardous to the user, and the environment can be kept cleaner as it is dependent on renewable source of energy. Further, this can be adopted as durable method of nutrient and weed management. The effectiveness of this viable method depends on many factors, such as heat conduction and accumulation, which are governed by moisture and manuring. In light of these, the present investigation was undertaken to see the effectiveness of soil solarization for weed control in sunflower – bell pepper crop sequence.

MATERIALS AND METHODS

A field experiment was conducted during 2003 and 2004 to study the effect of soil solarization with moisture regimes and time of farmyard manure (FYM) application and duration on weed dynamics on yield of sunflower - bell pepper crop sequence at Bangalore. The soils were red, sandy clay loam with pH 6.53. The available N, P and K were 181.8, 12.7 and 183.5 kg/ha, respectively. The experiment consisted of 14 treatments, viz. 3 moisture regimes irrigation up to field capacity (FC) and 50% field capacity along with unirrigated control, 2 timings of FYM application (before and after solarization), and 2 durations of solarization (45 and 60 days), with a non-solarized weedy check and two hand weedings. It was carried out in randomized complete block design with 3 replications. The solarization treatment with 0.05 mm TPE was imposed during March–May followed by sunflower and bell pepper crop sequence. FYM was applied before solarization, manure was incorporated during final land preparation. A calculated quantity of irrigation water measured

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with parshall flume was applied before solarization, and the duration of solarization was planned by removing polyethylene on a fixed date. Weed seeds were counted after solarization through Malone physical extraction method and the available nutrients were estimated using the standard procedure. Sunflower (Cargill hybrid 'SH 3322') was sown at a spacing of 60 x 30 cm. After sunflower, the land was prepared by shallow digging and the plots were transplanted with bell pepper seedlings cv. 'Indra' raised on nursery beds. Recommended packages of practices were adopted for crop production. Observations on weed count, and the dry weight, growth and yield parameters of crop were recorded at harvest. The pooled data (mean of 2003 and 2004) were analysed statistically. The observations on weed count and dry weight of weeds were subjected to square-root transformation ($\sqrt{x + 0.5}$).

RESULTS AND DISCUSSION

Yield of sunflower

Soil solarization for 60 days with irrigation up to FC and FYM application before solarization recorded significantly higher sunflower seed yield (3.26 t/ha) followed by 45 days solarization (3.25 t/ha) than non-solarized weedy check (1.47 t/ha) and 2 hand-weedings (2.47 t/ha) treatments. Soil solarization with irrigation up to FC gave 111.7-122.0 and 25.8-31.9% more yield, while that of 50% FC gave 95.9-103.0 and 16.4-20.6% more yield than non-solarized weedy check and 2 hand weedings, respectively (Table 1). The increase in seed yield was a reflection of improved yield parameters, as evident from capitulum diameter, seeds/capitulum and seed weight/capitulum recorded with 60 days solarization with FYM application before solarization and irrigation up to FC (19.2 cm), It was on a par with other treatments of solarization with irrigation up to FC. These results are in conformity with the findings of Chandrakumar (2002). This can be attributed to satisfactory weed control with these treatments (Table 3), which might have greatly reduced the competition for growth factors, thus stimulating the crops to put forth more number of leaves, exposing more green leaf area to sunlight and thus accumulating more dry matter in the plant. Further, increased growth and yield in solarization with irrigation up to FC can be attributed to higher nutrient availability (Table 4) due to rapid mineralization. Sunflower, being a nutrient responsive crop, showed improvement in growth parameters upon soil solarization, as significant increase in the availability of most of the nutrients was noticed in the present study. These results are in consonance with the findings of Biradar and Hosmani (1997).

Table 1. Yield and yield attributes of sunflower as influenced by soil-moisture regimes and FYM with soil solarization (mean data of 2 seasons)

Treatment*	Capitulum diameter (cm)	Seeds/ capitulum	Seed yield (g/capitulum)	100-seed weight (g)	Thalamus weight (g)	Seed yield (t/ha)	Stover yield (t/ha)
T_1	19.2	989.7	56.81	8.01	49.61	3.26	6.73
T_2	19.1	981.9	56.04	8.00	50.19	3.25	6.63
T_3	18.9	976.0	56.01	7.95	48.67	3.16	6.41
T_4	18.8	971.1	55.78	7.94	48.50	3.11	6.33
T_5	18.3	960.7	53.67	7.71	47.70	2.98	5.58
T_6	18.1	956.4	53.34	7.64	47.76	2.94	5.49
T_7	17.8	945.9	52.03	7.58	48.39	2.88	5.39
T_8	17.4	947.4	52.00	7.60	48.16	2.88	5.26
T_9	15.6	896.9	48.70	7.52	41.06	2.27	4.77
T_{10}	15.2	897.5	48.74	7.36	40.28	2.25	4.72
T_{11}	15.1	882.8	48.37	7.35	39.64	2.10	4.66
T_{12}	15.1	874.3	48.00	7.33	39.82	2.10	4.55
T_{13}	10.1	623.6	39.40	7.09	42.58	1.47	3.65
T_{14}	18.4	967.2	53.78	7.83	49.44	2.47	6.18
SEm±	0.3	14.3	0.82	0.14	1.58	0.09	0.26
CD (P=0.05)	0.9	41.8	2.39	0.41	4.62	0.25	0.76

*T_1, irrigation up to FC+10 t FYM/ha before solarization with TPE 0.05 mm for 60 days; T_2, irrigation up to FC + 10 t FYM/ha before solarization with TPE 0.05 mm for 45 days; T_3, irrigation up to FC + 10 t FYM/ha after solarization with TPE 0.05 mm for 60 days; T_4, irrigation up to FC + 10 t FYM/ha after solarization with TPE 0.05 mm for 45 days; T_5, Irrigation up to 50% FC + 10 t FYM/ha before solarization with TPE 0.05 mm for 60 days; T_6, irrigation up to 50% FC + 10 t FYM/ha before solarization with TPE 0.05 mm for 45 days; T_7, irrigation up to 50% FC + 10 t FYM/ha after solarization with TPE 0.05 mm for 60 days; T_8, irrigation up to 50% FC + 10 t FYM/ha after solarization with TPE 0.05 mm for 45 days; T_9, control (dry) + 10 t FYM/ha before solarization with TPE 0.05 mm for 60 days; T_{10}, control (dry) + 10 t FYM/ha before solarization with TPE 0.05 mm for 45 days; T_{11}, control (dry) + 10 t FYM/ha after solarization with TPE 0.05 mm for 60 days; T_{12}, control (dry) + 10 t FYM/ha after solarization with TPE 0.05 mm for 45 days; T_{13}, non-solarized control + 10 t FYM/ha (weedy check); T_{14}, 2 hand weedings + 10 t FYM/ha

Yield of bell pepper

Soil solarization greatly influenced the fruit yield of bell pepper. The residual effect of solarization for 60 days with irrigation up to FC and application of FYM after solarization recorded significantly higher fruit yield (23.67 t/ha). It was on a par with all the solarized treatments with irrigation up to FC. Significantly lowest fruit yield (Table 2) was recorded with non-solarized weedy check (9.69 t/ha). The higher yield was attributed to better control of weeds when solarization was done with sufficient amount of irrigation, which reduced the source of weed infestation for the succeeding crop and in turn minimized the competition for resources. This can be substantiated with the lower count of weed seeds in these treatments after solarization than all other treatments (Table 3).

Table 2. Yield and yield attributes of bell pepper as influenced by residual effects of soil solarization and FYM application (mean data of 2 seasons)

Treatment	Fruits/ plant	Fruit yield (g/plant)	Average fruit weight (g)	Fruit yield (t/ha)
T_1	7.9	408.52	51.87	23.10
T_2	8.2	424.48	52.21	23.30
T_3	7.8	401.66	51.28	23.67
T_4	7.8	391.64	50.64	21.50
T_5	6.7	345.32	51.32	19.20
T_6	6.5	336.14	51.48	18.70
T_7	6.4	335.80	52.34	18.70
T_8	6.2	318.70	51.58	17.70
T_9	4.7	250.42	53.08	13.90
T_{10}	4.8	246.36	51.84	13.70
T_{11}	4.9	254.17	52.02	14.10
T_{12}	4.7	247.46	52.48	13.70
T_{13}	3.6	191.12	52.61	9.69
T_{14}	7.6	394.87	51.69	21.90
SEm±	0.2	8.90	0.82	0.58
CD (P=0.05)	0.5	24.92	NS	1.63

Details of treatments are given with Table 1

Weed dynamics

Weed count and dry weight at harvest in sunflower were significantly lower with two hand weedings (39.2 g/m^2 and 4.75 g/0.25 m^2), followed by soil solarization with irrigation up to FC. Significantly more number and weight of weeds were noticed in non-solarized weedy check (283.3 g/m^2 and 32.80 g/0.25m^2). In bell pepper the non-solarized weedy check recorded significantly higher total number and weight of weeds (161.5 g/m^2 and 47.28 g/0.25m^2) than other treatments. Higher weed count in non-solarized control treatments can be traced to the weed-seed bank, which was significantly higher with non-solarized control treatments (Table 3). Solarization treatments effectively reduced the weed-seed bank due to build up of higher soil temperature, killing the weed seeds present in the soil or by thermal killing of emerged weeds by solar scorching. These findings are in consonance with those of Nanjappa *et al.* (1999).

Available nutrients after solarization

Soil solarization for 60 days with irrigation up to FC and application of manure before solarization recorded

Table 3. Weed count and weed dry weight in sunflower and bell pepper at harvest as influenced by soil solarization and FYM application (mean data of 2 seasons)

Treatment	Weed seed count (per 200 g)	Sunflower		Bell pepper	
		Weed count (No./m^2)	Weed dry weight (g/0.25 m^2)	Weed count (No./m^2)	Weed dry weight (g/0.25 m^2)
T_1	86.50	7.1 (50.7)	2.48 (5.65)	7.6 (58.0)	4.17 (16.99)
T_2	89.50	7.4 (55.0)	2.51 (5.82)	7.7 (59.3)	4.20 (17.32)
T_3	94.00	8.1 (65.0)	2.81 (7.43)	7.9 (61.8)	4.30 (18.13)
T_4	96.00	8.4 (70.2)	2.83 (7.54)	8.0 (63.7)	4.34 (18.40)
T_5	98.50	9.3 (86.3)	3.19 (9.70)	8.6 (72.9)	4.73 (21.92)
T_6	102.00	9.6 (91.3)	3.23 (9.98)	8.7 (75.5)	4.75 (22.16)
T_7	108.83	10.5 (110.0)	3.59 (12.48)	8.8 (77.3)	4.86 (23.19)
T_8	111.00	10.8 (116.3)	3.65 (12.89)	8.9 (79.7)	4.92 (23.75)
T_9	125.17	12.7 (160.2)	4.24 (17.53)	9.9 (98.5)	5.48 (29.66)
T_{10}	126.83	13.0 (167.5)	4.32 (18.25)	10.0 (100.3)	5.53 (30.18)
T_{11}	128.83	13.8 (190.2)	4.59 (20.67)	10.3 (106.5)	5.67 (31.78)
T_{12}	128.50	13.9 (193.5)	4.64 (21.08)	10.6 (111.9)	5.77 (33.05)
T_{13}	189.67	16.8 (283.3)	5.75 (32.80)	12.7 (161.5)	6.88 (47.28)
T_{14}	185.33	6.2 (39.2)	2.27 (4.75)	8.7 (75.3)	4.76 (22.38)
SEm±	4.78	0.2	0.08	0.2	0.09
CD (P=0.05)	13.97	0.6	0.21	0.4	0.26

Details of treatments are given with Table 1

Table 4. Available soil nutrients after solarization as influenced by soil-moisture regimes and FYM (mean data of 2 seasons)

Treatment	Available soil nutrients after solarization					
	N (kg/ha)	P (kg/ha)	K (kg/ha)	Ca (cmol(p+)/kg)	Mg (cmol(p⁺)/kg)	S (kg/ha)
T_1	243.07	21.08	222.32	0.366	0.173	28.39
T_2	234.40	20.33	220.13	0.348	0.169	27.16
T_3	240.58	21.09	218.79	0.362	0.173	27.13
T_4	232.09	20.27	215.55	0.335	0.169	26.45
T_5	227.07	19.49	208.06	0.322	0.164	25.36
T_6	220.53	19.12	204.30	0.318	0.162	24.81
T_7	223.72	19.48	205.48	0.325	0.159	24.43
T_8	220.33	18.55	201.69	0.314	0.157	23.50
T_9	207.76	14.53	190.84	0.305	0.147	19.16
T_{10}	201.51	14.13	189.43	0.285	0.145	18.13
T_{11}	206.90	14.35	192.06	0.285	0.143	18.26
T_{12}	200.80	14.40	186.72	0.278	0.141	18.39
T_{13}	183.81	11.43	168.18	0.228	0.113	13.64
T_{14}	187.91	11.51	173.44	0.240	0.120	13.96
SEm±	4.34	0.54	3.30	0.008	0.003	0.85
CD (P=0.05)	12.66	1.56	9.62	0.025	0.009	2.49

Details of treatments are given with Table 1

significantly higher available N (32.2%), P (91.0%), K (32.3%), S (108.1%), exchangeable Ca (60.5%) and Mg (44.2%), followed by solarization for 45 days with moisture up to FC and FYM application before solarization and other solarization treatments . The significant increase in available N upon soil solarization with irrigation up to FC and FYM application before solarization can be attributed to higher rate of mineralization of organic N in the soil due to prevailing higher soil temperature in combination with relatively higher moisture content. The mineralization of N is known to be stimulated due to release of labile organic matter. Further, it was found that the rate of N mineralization was more responsive to temperature than to moisture. The increased available P was owing to increased phosphatase activity (Chandrkumar, 2002). Higher rate of release of non-exchangeable K to exchangeable form and quick dissolution of hydroxyl-apatite was due to build-up of higher temperature. The exchangeable Ca and Mg increased due to dissolution of soil carbonates and increased N concentration (Salero *et al.*, 2000). Further, the increased nutrient availability might also be due to immediate release of nutrients by the death of micro-organisms present in soil.

It was concluded that the application of 10 t/ha farm yard manure before solarization for 45-60 days with irrigation up to field capacity was effective in reducing weed menace, release of nutrients and improving the productivity of sunflower – bell pepper sequence.

REFERENCES

Biradar, I.B. and Hosmani, M.M. 1997. Effect of soil solarization on weed control and its after effects on growth and yield of groundnut (*Arachis hypogaea* L.). *Karnataka Journal of Agricultural Sciences* **10**(4): 966–970.

Chandrakumar, S.S. 2002. Studies on weed control and chemical properties of soil as influenced by soil solarization in sunflower - bell pepper crop sequence. Ph.D *thesis*, University of Agricultural Sciences, Bangalore.

Kumar, B., Yaduraju, N.T., Ahuja, K.N. and Prasad, D. 1993. Effect of soil solarization on weeds and nematodes under tropical Indian condition. *Weed Research* **33:** 423–429.

Nanjappa, H.V., Jayadeva, H.M. and Ramachandrappa, B.K. 1999. Effect of soil solarization for a period of one month during March to June on annual and perennial weeds in tomato crop. *In*: *Biennial Conference, Indian Society of Weed Science, Banaras Hindu University, Varanasi, UP*.

Salero, M.I., Lori, G.A., Gimenez, O.O., Gimenez, J.E. and Beltrano, J. 2000. Use of soil solarization to improve growth of Eucalyptus forest nursery seedlings in Argentina. *New Forests* **20**(3): 235–248.