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Determination of long-term effects of consecutive effective fresh chicken manure with solarization and verticillium wilt (*Verticillium dahlia* Klebb) on weed and its control in egg plant

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The aim of the study was to determine the weed density and the most economical way of weed control in eggplant (*Solanum melongena*) fields contaminated with *Verticillium dahliae* (Kleb) after the application of fresh chicken manure and solarization in the second year as the same crop was grown. The effect of solarization on weed and the labor need in weed control continued in a diminishing way in the consecutive observations. With fresh chicken manure (FCM), number of weeds (number m^{-2}) decreased but their green and dry biomass (weights g m^{-2}) increased. The labor need (d ha^{-1}) to control the weeds decreased. Similar results were also recorded for *V. dahliae* inoculation. As a result of the study, 50% of labor saving was achieved in the plots of solarization and either FCM rate combinations [sol x FCM (12 kg.m^{-2}); sol x FCM (6 kg.m^{-2})] compared to the control plots. Achieved savings in labor can afford to cover the costs of solarization and FCM.

Key words: Soil solarization, fresh chicken manure, *Verticillium dahliae*, eggplant, weed, weed control.

INTRODUCTION

Weeds can impact significantly on crop productivity. For long years in Turkey, weed control methods employed in fields against weeds were based on only mechanic methods and the herbicide applications. Thus, producers of some regions do not think of growing crops without herbicide application (Uygur, 2002). It is impossible to apply these methods in small plots. Although herbicides are accepted to be the most effective and fast solution in weed control, desired results cannot always be harvested. On the contrary, they can cause big environmental

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disorders.

Unconscious use of herbicides results in hardiness in weeds. As a result of increased public awareness in environment and the negative effects of the herbicides on human health alternative control methods have been researched (Önen, 2003).

Especially in eggplant (*Solanum melongena*) and intensive vegetable production, one of the most important problems is the yield losses due to weeds, manual control of which requires extra labor. However, this type of weed control cost high (Raffaelli et al., 2011). Instead, through fumigation of the soil just before weed seeds germinate weed problem along with the other soil rooted pathogens can be eliminated (Jarvis, 1993). Nevertheless, fumigants also cause some unwanted side effects. Thus, methyl bromide, a commonly used fumigant, was suggested to be completely abandoned from use in 2005 due to the harmful effect of it to ozonosphere (Katan, 1999).

Instead of these fumigants, solar energy use was considered first (Katan, 1987). By this method which is known as solarization, weed seed intensity was aimed to decrease through covering with plastic in high temperature days in a year for one or two months in order to be heated for pasteurization (Lalitha et al., 2003; Cimen et al., 2010a). The effect of solarization lasts more than one year (Katan et al., 1983; Satour et al., 1989; Candido et al., 2006; Cimen et al., 2010b).

Chicken manure contains significant amounts of nitrogen because of the presence of high levels of protein and amino acids. Owing to its high nutrient content, chicken manure has been considered to be one of the most valuable animal wastes as organic fertilizer (Chen and Jiang, 2014).

This study researched the most economic eggplant production by determining weed seed density in eggplant fields inoculated with *Verticillium dahliae* (Kleb) after the application of FCM and solarization together in the second year.

MATERIALS AND METHODS

Study was conducted in a loamy-clay soil in the research fields of the Department of Plant Protection, Faculty of Agriculture, Dicle University, Diyarbakir, Turkey (latitude 37°53 N, longitude 40°16 E, altitude 680 m above sea level) with dominant semi-arid characteristics during 2010 and 2012 years. The climate in Diyarbakir is dry and hot in summer and cold in winter. For solarization, soil was covered with 0.2 mm transparent polyethylene (PE) for 45 days. Trial was conducted in eggplant fields in 2012 after FCM and solarization application in 2010 and *Verticillium dahliae* (Kleb) inoculation in 2011. *V. dahliae* inoculation was repeated in the same plots in 2012 at the same rate.

Fresh and dry biomass weights of the weeds and the time required for manual weed control were observed. A one square meter quadrate, plant pressing tool and a scale were used in the study. Weed species and eggplant in the trial plots were the study material.

Weed observations were made in the trial plots, arranged in split-split plots trial design with three replications, where solarization, FCM and verticillium inoculation were employed in main, split and mini plots, respectively. A one-meter quadrate was used for weed count in a total of 36 plots, either of which had a size of 20 m^2. Weeds within the quadrate were counted by their genus and species and arithmetic means were calculated. Weed density and frequency was calculated according to Odum (1971).

The trial was established in 2010 to measure the effect of three factors, namely solarization, FCM and *V. dahliae* inoculation on the response variable, weed density and frequency. The field was divided into three blocks and each block was further splitted into two whole plots and solarization application cases (applied or not applied) were randomly assigned to the whole plots within each block. Moreover, each whole plot was divided into three split plots and three FCM rates (0, 6 and 12 $kg.m^{-1}$) were randomly devoted to the split plots within each whole plot. Furthermore, each split plot was bisected into split-split plots and *V. dahliae* inoculation cases (inoculated or not) was randomly assigned to each split-split plot. At each of the split-split plots (*V. dahliae* inoculation cases) 18 observations (3x2x3=18) were performed during the growing season. So a grand total of 36 measurements were available for the analysis.

Determination and counts of the weeds in trial plots

In order for the determination of the weeds, counts were performed in trial plots on 10.05.2012 after 20 months from solarization application (2010) and about 6 months from the first eggplant production season (2011), just before the planting of the eggplant seedlings. In total, 50 weed species of 16 different families were determined. Regarding the density in per square meter the first four weed species in rank were *Sorghum halepense*, *Convolvulus galaticus*, *Convolvulus arvensis* and *Amaranthus blitoides,* respect-tively. The results were summarized in Table 1 in counts per square meter (number m^{-2}).

Fresh and dry weed weights

In a total of four times, weeds were removed from the trial plots, one time before and three times after planting (10.05.2012). The weeds were dried for 12 weeks in greenhouse conditions after their fresh weights were measured. Later, their dry weights were measured using a precise electronic scale. Results were presented in Table 2.

Time required for manual weed removal

Weed clearings from the trial plots were performed manually by two labors on the above mentioned days and the time required for weed removal was determined at every turn. It was later converted into labor inputs per hectare (days ha^{-1}).

Statistical analysis

All the data were subjected to analysis of variance (ANOVA) and LSD through MSTATC computer programme as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The effect of solarization, FCM and *V. dahliae* inoculation on weeds in eggplant fields before growing season

The list of the weeds determined in the 36 trial plots on10.05.2012 was given in Table 1. Of the 50 weed species

Table 1. Observation of weed species and their natural distribution in the experimental area (count m^{-2}) (2012).

Number	Weed name	Count	Number	Weed name	Count
1	*Anagallis arvensis*	31	26	*Lactuca serriola*	44
2	*Amaranthus blitoides*	95	27	*Lallemantia iberica*	2
3	*Buglossoides arvensis*	2	28	*Lamium* sp.	24
4	*Bupleurum rotundifolium*	1	29	*Lathyrus aphaca*	2
5	*Cardaria draba*	41	30	*Lolium* sp.	3
6	*Carduus pycnocephalus*	5	31	*Malva neglecta*	3
7	*Carthamus* sp.	1	32	*Melilotus* sp.	4
8	*Centaurea balsamita*	8	33	*Molucella laevis*	6
9	*Centaurea iberica*	1	34	*Myagrum perfoliatum*	74
10	*Cichorium inthybus*	59	35	*Neslia apiculata*	3
11	*Convolvulus arvensis*	202	36	*Notobasis syriaca*	1
12	*Convolvulus betonicifolius*	9	37	*Phalaris* sp.	19
13	*Convolvulus galaticus*	247	38	*Poa* sp.	4
14	*Convolvulus stachydifolius*	4	39	*Polygonum aviculare*	84
15	*Conyza canadensis*	1	40	*Ranunculus arvensis*	14
16	*Coriandrum* sp.	4	41	*Sinapis arvensis*	39
17	*Crepis alpina*	44	42	*Sisymbrium officinale*	3
18	*Cynodon dactylon*	8	43	*Sonchus oleraceus*	12
19	*Euphorbia aleppica*	7	44	*Sorghum halepense*	260
20	*Euphorbia helioscopia*	3	45	*Tragopogon* sp.	4
21	*Foeniculum vulgare*	1	46	*Turgenia latifolia*	12
22	*Fumaria asepala*	17	47	*Vaccaria pyramidata*	26
23	*Galium tricornutum*	73	48	*Vicia narbonensis*	21
24	*Hordeum murinum*	2	49	*Vicia sativa*	12
25	*Lactuca saligna*	12	50	*Xanthium strumarium*	15

Table 2. Fresh and dry weed weights.

Applications	Total (count/m^2)	Weight (g/m^2)	
		Fresh	Dry
Solarization (Sol)			
Non solarized (-Sol)	27.05	2229	440
Solarized (+Sol)	16.44	1866	347
Fresh chicken manure (FCM)			
Control	24.79	1714	337
6 kg/m^2	19.33	2298	425
12 kg/m^2	21.12	2131	419
Sol × FCM		*	
- Sol × Control	32.50	1771	366
- Sol × FCM (6 kg/m^2)	22.41	2933	554
- Sol × FCM (12kg/m^2)	26.25	1983	400
+Sol × Control	17.08	1658	308
+Sol × FCM (6 kg/m^2)	16.25	1662	396
+Sol × FCM (12 kg/m^2)	16.00	2279	437
Inoculation (*V. dahliae*)	*		*
Non inoculated (- Ino)	24.91	1834	348
Inoculated (+ Ino)	17.58	2261	439

Table 2. Contd

Sol × Inoculation			
- Sol × (-) Ino.	29.50	2061	403
- Sol × (+) Ino	24.61	2397	478
+Sol × (-) Ino	20.33	1608	294
+Sol × (+) Ino	12.55	2125	400
FCM × Inoculation			
Cont × (-) Ino	32.25	1504	304
Cont × (+) Ino	17.33	1925	371
FCM (6 kg/m^2 × (-) Ino	22.00	1779	341
FCM (6 kg/m^2) × (+) Ino	16.66	2816	508
FCM (12 kg/m^2) × (-) Ino	20.50	2221	400
FCM (12 kg/m^2) × (+) Ino	21.75	2041	437
Sol × FCM × Inoculation			*
- Sol × Cont × (-) Ino	41.50	1725	358
- Sol × Cont × (+) Ino	23.50	1816	375
- Sol × FCM (6 kg/m^2 × (-) Ino	22.33	2091	400
- Sol × FCM (6 kg/m^2) × (+) Ino	22.50	3775	708
- Sol × FCM (12 kg/m^2) × (-) Ino	24.66	2366	450
- Sol × FCM (12 kg/m^2) × (+) Ino	27.83	1600	350
+Sol × Cont × (-) Ino	23.00	1283	250
+Sol × Cont × (+) Ino	11.16	2033	366
+Sol × FCM (6 kg/m^2)× (-) Ino	21.66	1466	283
+Sol × FCM (6 kg/m^2) × (+) Ino	10.83	1858	308
+Sol × FCM (12 kg/m^2) × (-) Ino	16.33	2075	350
+Sol × FCM (12 kg/m^2) × (+) Ino	15.66	2483	525

* , **Significant at 0.05 and 0.01 levels respectively.

given in Table 1 those exceeding the number of plots (36) are of 12 species. They have about 87% of share in grand total. The counts of these 12 species are presented in Table 3.

It is obvious from the table that the effect of solarization on the decrease in weeding before the second eggplant growing season does continue. The results were significant at 5% for *Galium tricornutum* and *Lactuca* species, and 1% level for the most common 12 weed species in the total. Solarization decreased the weeds about 36% per square meter. This result is in harmony with the findings reported by Katan et al. (1983); Satour et al. (1989); Candido et al. (2006), and Çimen et al. (2010b).

Again it is also evident in the same weed count that FCM application before solarization and *V. dahliae* inoculation during the first eggplant growing season decreased the number of weeds per square meter. However, the interactions among the three factors were found insignificant in dual and triple combinations (Table 4). In a previous study by Çimen and Basaran (2013), it was reported that FCM increased the soil temperature which might be the reason of the decrease of the weeds determined in this study. Thus, it was reported that broomrape (*Orabanche crenata*), an important problem in cabbage production in Lebanon, was controlled with FCM-Solarization application (Haidar and Sidahmed, 2000). *V. dahliae* is able to infect more than 400 plant species, including annual, herbaceous crops and weeds, as well as fruit, landscape, ornamental trees and shrubs (Pegg and Brady, 2002).

The effect of solarization and FCM on the 51 weed species and their fresh and dry weights (g m^{-2}) is presented in Table 5. It was obvious from the table that the effect of solarization, FCM and *V. Dahliae* on weed count is parallel to the common weed count results. Regarding the fresh and dry weed weights obtained from 50 weed species, it was decreased by solarization but increased by FCM and *V. dahliae* inoculation. The most outstanding case here is that *V. dahliae* inoculation decreased the number of weeds as it increased fresh and dry weed weights. This is related to diminishing competition of the weeds between and within the species (Özer et al., 2001) and can be best understood that at the end of the first eggplant production only the weeds tolerant to *V. dahlia* survived in the trial plots and they could

Table 3. Weeds (12 species) have about 87% of share in grand total.

Application	*Cardaria draba*	*Cichorium inthybus*	*Convolvulus arvensis*	*Convolvulus galaticus*	*Crepis alpina*	*Galium tricornutum*	*Lactuca serriola*	*Myagrum perfoliatum*	*Polygonum aviculare*	*Sinapis arvensis*	*Sorghum halepense*	*Amaranthus blitoides*	Total
Solarization (Sol)						*	*						**
Non solarized (-Sol)	0.02	1.38	3.69	2.52	0.91	1.66	0.66	1.69	1.25	0.91	5.22	1.25	**21.22**
Solarized (+Sol)	1.11	0.25	1.91	3.91	0.30	0.36	0.55	0.36	1.08	0.16	2.00	1.38	**13.41**
Fresh chicken manure (FCM)									*				
Control	0.04	0.25	4.62	4.79	1.37	0.91	0.58	1.50	0.50	0.41	4.33	0.29	**19.62**
6 kg/m^2	0.04	1.70	2.45	2.66	0.29	0.91	0.58	0.70	1.54	0.62	2.91	1.66	**16.12**
12 kg/m^2	1.62	0.50	1.33	2.20	0.16	1.20	0.66	0.87	1.45	0.58	3.68	2.00	**16.20**
Sol × FCM													
- Sol × Control	0.00	0.41	4.91	5.33	2.16	1.66	0.83	2.50	0.25	0.66	6.58	0.00	**25.33**
- Sol × FCM (6 kg/m^2)	0.08	3.08	3.50	0.83	0.33	1.83	0.58	1.41	1.75	1.16	3.75	0.16	**18.50**
- Sol × FCM (12kg/m^2)	0.00	0.66	2.66	1.41	0.25	1.50	0.58	1.16	1.75	0.91	5.33	3.58	**19.83**
+Sol × Control	0.08	0.08	4.33	4.25	0.58	0.16	0.33	0.50	0.75	0.16	2.08	0.58	**13.91**
+Sol × FCM (6 kg/m^2)	0.00	0.33	1.41	4.50	0.25	0.00	0.58	0.00	1.33	0.08	2.08	3.16	**13.75**
+Sol × FCM (12 kg/m^2)	3.25	0.33	0.00	3.00	0.08	0.91	0.75	0.58	1.16	0.25	1.83	0.41	**12.58**
Inoculation (*V. dahliae*)													
Non inoculated (- Ino)	0.86	1.41	2.72	4.75	0.72	0.91	0.69	0.97	1.47	0.36	3.38	2.33	**21.61**
Inoculated (+ Ino)	0.27	0.22	2.88	1.69	0.50	1.11	0.52	1.08	0.86	0.72	3.83	0.30	**14.02**
Sol × Inoculation													
- Sol × (-) Ino.	0.05	2.50	3.16	2.77	1.22	1.55	0.66	1.66	1.44	0.66	5.27	2.16	**23.16**
- Sol × (+) Ino	0.00	0.27	4.22	2.27	0.61	1.77	0.66	1.72	1.05	1.16	5.16	0.33	**19.27**
+Sol × (-) Ino	1.66	0.33	2.27	6.72	0.22	0.27	0.72	0.27	1.50	0.05	1.50	2.50	**18.05**
+Sol × (+) Ino	0.55	0.16	1.55	1.11	0.38	0.44	0.38	0.44	0.66	0.27	2.50	0.27	**8.77**
FCM × Inoculation													
Cont × (-) Ino	0.00	0.25	6.66	7.00	1.91	1.16	0.58	1.16	0.83	0.33	6.58	0.58	**27.08**
Cont × (+) Ino	0.08	0.25	2.58	2.58	0.83	0.66	0.58	1.83	0.16	0.50	2.08	0.00	**12.16**
FCM (6 kg/m^2 × (-) Ino	0.08	3.25	1.41	4.66	0.25	0.66	0.83	0.58	2.00	0.16	1.91	3.16	**19.00**
FCM (6 kg/m^2) × (+) Ino	0.00	0.16	3.50	0.66	0.33	1.16	0.33	0.83	1.08	1.08	3.91	0.16	**13.25**
FCM (12 kg/m^2) × (-) Ino	2.50	0.75	0.08	2.58	0.00	0.91	0.66	1.16	1.58	0.58	1.66	3.25	**15.75**
FCM (12 kg/m^2) × (+) Ino	0.75	0.25	2.58	1.83	0.33	1.50	0.66	0.58	1.33	0.58	5.50	0.75	**16.66**

Table 3. Contd.

Sol × FCM × Inoculation													
- Sol × Cont × (-) Ino	0.00	0.50	7.50	6.00	3.50	2.00	0.83	1.83	0.50	0.50	10.66	0.00	**33.83**
- Sol × Cont × (+) Ino	0.00	0.33	2.33	4.66	0.83	1.33	0.83	3.16	0.00	0.83	2.50	0.00	**16.83**
- Sol × FCM (6 kg/m^2 × (-) Ino	0.16	6.00	1.83	0.83	0.16	1.33	0.83	1.16	1.66	0.33	3.16	0.00	**17.50**
- Sol × FCM (6 kg/m^2) × (+) Ino	0.00	0.16	5.16	0.83	0.50	2.33	0.33	1.66	1.83	2.00	4.33	0.33	**19.50**
- Sol × FCM (12 kg/m^2) × (-) Ino	0.00	1.00	0.16	1.50	0.00	1.33	0.33	2.00	2.16	1.16	2.00	6.50	**18.16**
- Sol × FCM (12 kg/m^2) × (+) Ino	0.00	0.33	5.16	1.33	0.50	1.66	0.83	0.33	1.33	0.66	8.66	0.66	**21.50**
+Sol × Cont × (-) Ino	0.00	0.00	5.83	8.00	0.33	0.33	0.33	0.50	1.16	0.16	2.50	1.16	**20.33**
+Sol × Cont × (+) Ino	0.16	0.16	2.83	0.50	0.83	0.00	0.33	0.50	0.33	0.16	1.66	0.00	**7.50**
+Sol × FCM (6 kg/m^2)× (-) Ino	0.00	0.50	1.00	8.50	0.33	0.00	0.83	0.00	2.33	0.00	0.66	6.33	**20.50**
+Sol × FCM (6 kg/m^2) × (+) Ino	0.00	0.16	1.83	0.50	0.16	0.00	0.33	0.00	0.33	0.16	3.50	0.00	**7.00**
+Sol × FCM (12 kg/m^2) × (-) Ino	5.00	0.50	0.00	3.66	0.00	0.50	1.00	0.33	1.00	0.00	1.33	0.00	**13.33**
+Sol × FCM (12 kg/m^2) × (+) Ino	1.50	0.16	0.00	2.33	0.16	1.33	0.50	0.83	1.33	0.50	2.33	0.83	**11.83**

*, **Significant at 0.05 and 0.01 levels respectively.

grow fast and had vitality due to lack of competition of the other weed species, which resulted in an increase in both fresh and dry biomass weights of the weeds.

The effect of solarization, FCM and *V. Dahliae* inoculation on weeds in the fields during the second Eggplant growing season

Weeds were cleaned from the trial plots three times after the solarization during the second eggplant growing season. Fresh and dry weights (g m^{-2}) of the collected weeds and the time required for manual elimination (day ha^{-1}) are presented in Figure 1.

It is seen from Figure 1 that solarization decreased the fresh and dry weed weights (g m^{-2}) in all of the three weed removals as parallel to its effect on the decrease of weed species (Table 4). As in the case of total weed number total dry weed weight is statistically significant ($p<0.01$). Solarization decreased weed dry weight by 27%. Another remarkable result is that the first weed dry weight gradually decreased towards the last dry weight. Also, there was a harmony between the effect of solarization on weed dry weight and the labor input (day ha^{-1}) required for manual weed removal (Figure 1). Similar to the case in dry weed weight, the labor input needed in weed removal gradually decreased from the first to the last. Solarization provided 17% saving in labor input in weed control in the second year.

Even though FCM application before the solarization caused an increase in the fresh and dry weed weights (gm^{-2}) (Figure 1), it decreased the labor input required for weed removal (day ha^{-2}). The results of the second observation were significant ($p<0.01$) in both assessment criteria. However, the relationship between solarization and FCM were not significant in both assessment types.

V. dahliae inoculation, on the other hand, caused a decrease in fresh and dry weed weights in the first weed removal. But it increased fresh and dry weights in the second and third removals as in grand total (Figure 1). In all of three weed removals the results were significant ($p<0.05$). The same trend is also seen in labor input for weed removal (Figure 1).

In the plots of triplet combinations among the solarization, FCM and *V. dahliae* inoculation the highest fresh and dry weed weights were seen in applications of “(-)Sol x FCM (6 kg m-^{2} x (-) Ino” and “(-) Sol x FCM (6 kg m^{-2}) x (+) Ino” in values close to each other as the lowest dry weight was obtained from the solarization plots of FCM and *V. dahliae* applications “(+) Sol x FCM (6 kg m^{-2} x (-) Ino” and “(+) Sol x FCM (6 kg m^{-2}) x (+) Ino” (Table 4 and Figure 1).

As for the manual control of the weeds seen in triplet combination plots, the highest mean labour input in a growing season was 195.13 d.ha^{-1}, which was determined in the control plots where solarization, FCM and *V. dahliae* inoculation were not applied. The lowest labour input, on the other

Table 4. Effect of solarization with fresh chicken manure and verticillium wilt (*Verticillium dahliae* Klebb**)** inoculation on weed (weight/m^2) (2012).

Aplications	1. (1.07.12)		2. (07.08.12)		3. (01.11.12)		Total	
	Fresh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
Solarization (Sol)		*			**	**		**
Non solarized (-Sol)	495	156	327	89	358	87	1181	333
Solarized (+Sol)	474	123	193	59	223	60	892	243
Fresh chicken manure (FCM)			**					
Control	397	138	177	61	233	67	808	268
6 kg/m^2	514	130	313	82	318	76	1146	289
12 kg/m^2	543	151	290	79	321	77	1155	308
Sol × FCM								
- Sol × Control	388	148	195	63	230	63	813	276
- Sol × FCM (6 kg/m^2)	655	172	417	105	434	105	1506	383
- Sol × FCM (12kg/m^2)	441	147	370	100	411	94	1223	342
+Sol × Control	405	128	160	59	237	72	803	260
+Sol × FCM (6 kg/m^2)	373	87	209	59	202	48	785	195
+Sol × FCM (12 kg/m^2)	645	154	210	58	231	61	1087	275
Inoculation (*V. dahliae*)	*		*	*	*	*		
Non inoculated (- Ino)	597	151	227	65	233	58	1058	276
Inoculated (+ Ino)	372	128	293	83	348	89	1014	300
Sol × Inoculation								
- Sol × (-) Ino.	584	176	268	76	284	72	1136	324
- Sol × (+) Ino	406	136	387	103	432	103	1226	342
+Sol × (-) Ino	610	127	187	54	182	45	980	227
+Sol × (+) Ino	338	119	199	63	265	76	803	259
FCM × Inoculation								
Cont × (-) Ino	396	156	133	46	221	59	751	262
Cont × (+) Ino	398	120	222	76	246	76	866	273
FCM (6 kg/m^2 × (-) Ino	704	145	306	80	207	51	1218	278
FCM (6 kg/m^2) × (+) Ino	325	114	306	84	428	101	1073	300
FCM (12 kg/m^2) × (-) Ino	692	153	242	69	271	65	1206	283
FCM (12 kg/m^2) × (+) Ino	394	148	338	89	371	90	1104	328
Sol × FCM × Inoculation								
- Sol × Cont × (-) Ino	422	205	161	52	205	54	790	311
- Sol × Cont × (+) Ino	355	92	228	75	254	73	837	240
- Sol × FCM (6 kg/m^2 × (-) Ino	880	201	383	99	270	71	1534	372
- Sol × FCM (6 kg/m^2) × (+) Ino	430	143	450	111	598	139	1479	394
- Sol × FCM (12 kg/m^2) × (-) Ino	449	121	259	77	376	91	1085	290
- Sol × FCM (12 kg/m^2) × (+) Ino	433	174	482	122	445	96	1361	393
+Sol × Cont × (-) Ino	370	108	105	40	237	64	712	213
+Sol × Cont × (+) Ino	441	149	215	77	238	80	896	306
+Sol × FCM (6 kg/m^2)× (-) Ino	527	89	230	62	145	32	902	184
+Sol × FCM (6 kg/m^2) × (+) Ino	220	85	189	56	259	64	668	206
+Sol × FCM (12 kg/m^2) × (-) Ino	935	185	226	60	165	39	1327	285
+Sol × FCM (12 kg/m^2) × (+) Ino	355	123	194	56	297	84	846	264

*, ** Significant at 0.05 and 0.01 levels respectively.

Table 5. Effect of solarization with fresh chicken manure and verticillium wilt (*Verticillium dahliae* Klebb**)** inoculation on weed control manually (work day/ha) (2012).

Aplications	1. (1.07.12)	2. (07.08.12)	3. (01.11.12)	Total
Solarization (Sol)		**		
Non solarized (-Sol)	83.56	41.31	27.77	152.66
Solarized (+Sol)	74.88	29.51	21.41	125.81
Fresh chicken manure (FCM)				
Control	97.74	41.49	26.56	165.79
6 kg/m^2	66.66	33.68	23.78	124.13
12 kg/m^2	73.26	31.07	23.43	127.77
Sol × FCM				
- Sol × Control	100.34	46.87	29.51	176.73
- Sol × FCM (6 kg/m^2)	67.01	35.76	28.12	130.90
- Sol × FCM (12kg/m^2)	83.33	41.31	25.69	150.34
+Sol × Control	95.13	36.11	23.61	154.86
+Sol × FCM (6 kg/m^2)	66.31	31.59	19.44	117.36
+Sol × FCM (12 kg/m^2)	63.19	20.83	21.18	105.20
Inoculation (*V. dahliae*)	*			
Non inoculated (- Ino)	78.23	33.79	20.48	131.48
Inoculated (+ Ino)	80.20	37.03	28.70	145.95
Sol × Inoculation	*			
- Sol × (-) Ino.	83.56	43.98	24.30	151.85
- Sol × (+) Ino	83.56	38.65	31.25	153.47
+Sol × (-) Ino	72.91	23.61	16.66	113.19
+Sol × (+) Ino	76.85	35.41	26.15	138.42
FCM × Inoculation				
Cont × (-) Ino	103.12	41.31	26.73	171.18
Cont × (+) Ino	92.36	41.66	26.38	160.41
FCM (6 kg/m^2 × (-) Ino	63.54	28.81	14.93	107.29
FCM (6 kg/m^2) × (+) Ino	69.79	38.54	32.63	140.97
FCM (12 kg/m^2) × (-) Ino	68.05	31.25	19.79	119.09
FCM (12 kg/m^2) × (+) Ino	78.47	30.90	27.08	136.45
Sol × FCM × Inoculation	**			
- Sol × Cont × (-) Ino	105.55	57.63	32.63	195.13
- Sol × Cont × (+) Ino	95.13	36.11	27.08	158.33
- Sol × FCM (6 kg/m^2 × (-) Ino	64.58	33.33	19.44	117.36
- Sol × FCM (6 kg/m^2) × (+) Ino	69.44	38.19	36.80	144.44
- Sol × FCM (12 kg/m^2) × (-) Ino	80.55	40.97	21.52	143.05
- Sol × FCM (12 kg/m^2) × (+) Ino	86.11	41.66	29.86	157.63
+Sol × Cont × (-) Ino	100.69	25.00	21.52	147.22
+Sol × Cont × (+) Ino	89.58	47.22	25.69	162.50
+Sol × FCM (6 kg/m^2)× (-) Ino	62.50	24.30	10.41	97.22
+Sol × FCM (6 kg/m^2) × (+) Ino	70.13	38.88	28.47	137.50
+Sol × FCM (12 kg/m^2) × (-) Ino	55.55	21.52	18.05	95.13
+Sol × FCM (12 kg/m^2) × (+) Ino	70.83	20.13	24.30	115.27

*, ** Significant at 0.05 and 0.01 levels respectively.

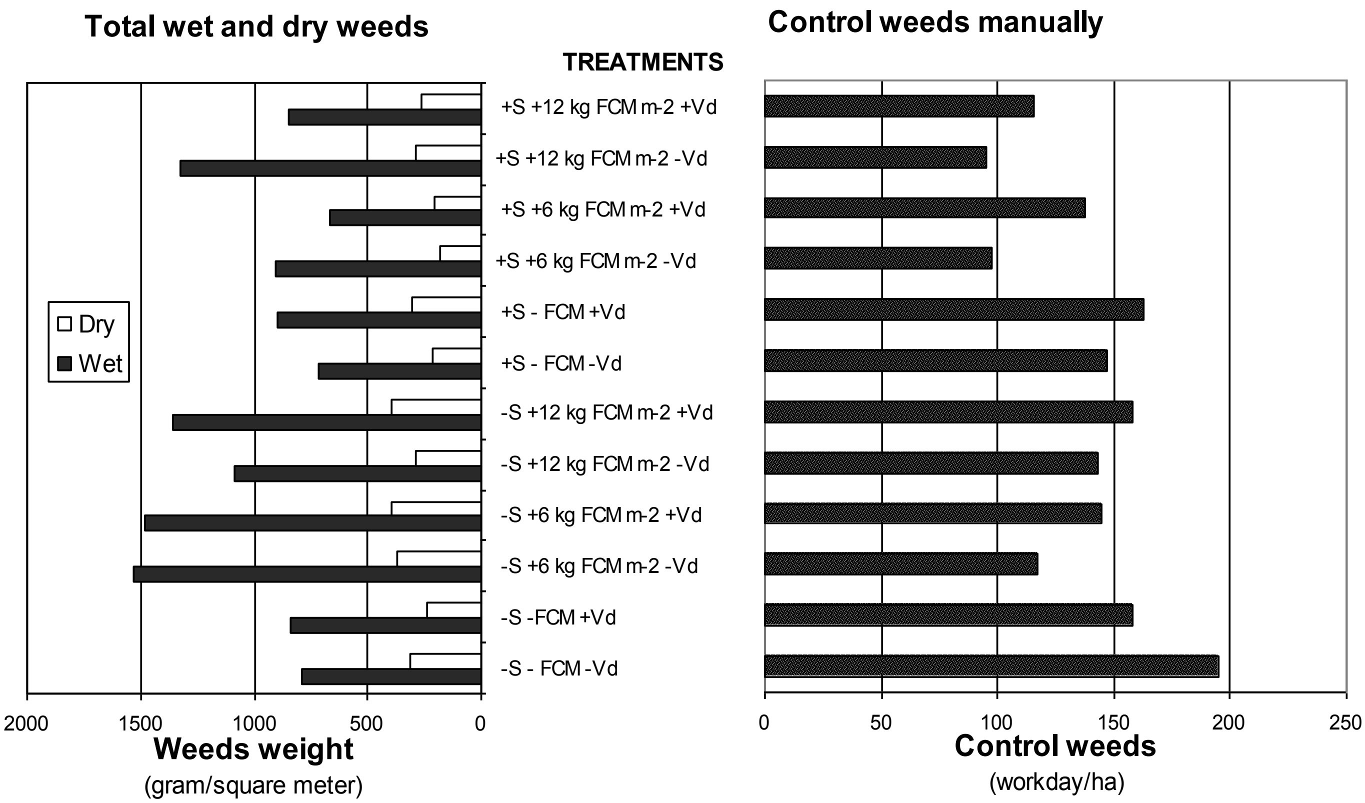

Figure 1. Effect of solarization with fresh chicken manure and verticillium wilt (*Verticillium dahliae* Klebb) inoculation on weed and its control manually (2012).

hand, was determined to be 95.13 and 97.22 d.ha^{-1} for the plots where two FCM rates (12 kgm^{-2} and 6 kgm^{-2}, respectively) and solarization applications were performed but seedlings were not infected with *V. dahliae,* the combinations were "+Sol x FCM (12 kgm^{-2}) x (-) Ino" and "+Sol x FCM (6 kgm^{-2}) x (-) Ino" (Figure 1). Both applications saved labour input about 50% compared to control plots.

Conclusion

In this study, the effect of together application of FCM and solarization on weed control gradually decreased in successively eggplant grown fields for two production season. In a previous study, in the high eggplant yielding applications of "+Sol x FCM (12 kgm^{-2}) x (-) Ino" and "+Sol x FCM (6 kgm^{-2}) x (-) Ino" 50% of labor savings was achieved in weed control, which may compensate the solarization and both FCM application costs. However, it was concluded that the achieved labor saving is not sufficient for adoption of these practices by the producers especially in places where hidden unemployment rate is quite high.

Conflict of interests

The author(s) did not declare any conflict of interest.

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