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Efficacy of Different Treatments on Some Weed Species in Strawberry

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Abstract: In this study the efficacy of solarization (S), dazomet (D) and metam-sodium (MS) treatments on some weed species and their potential as alternative to methyl bromide (MB) was investigated in strawberry growing areas in Aydin province of Turkey. Efficacies of treatments were variable for weed species. Total five weed species, namely common purslane, annual bluegrass, common chamomille, horseweed and shepherd's purse were considered in this study. Highest efficacy on weeds was provided by MB application, but S is a safe alternative to MB under suitable climatic conditions, because its application is economic and safer to environment and user. In case of horseweed none of the treatments reduced the coverage of this species significantly.

Key words: Weed control, dazomet, methyl bromide, metam-sodium, solarization, strawberry

INTRODUCTION

Strawberry production is carried out on 9,700 ha with total production of 117,000 tons. About 40% of total strawberry production of Turkey was realized in Aydin Province in 2001 (Anonymous, 2001). Weeds are one of the most important yield limiting factors in growing areas. Survey studies carried out in Aydin province of Turkey showed weed species such as common purslane (*Portulaca oleracea* L.), pigweed species (*Amaranthus* spp.), purple nutsedge (*Cyperus rotundus* L.), heliotrope species (*Heliotropium* spp.), bermudagrass (*Cynodon dactylon* L. Pers.), large crabgrass (*Digitaria sanguinalis* L. Scop.), wild radish (*Raphanus raphanistrum* L.), lambs quarters (*Chenopodium album* L.), foxtail (*Setaria* spp.), barnyardgrass (*Echinochloa cruss-galli* L.), black nightshade (*Solanum nigrum* L.), johnsongrass (*Sorghum halepense* L. Pers.), sowthistle (*Sonchus* sp.) and puncture vine (*Tribulus terrestris* L) were the most common species from planting stage to mulching on raised beds (late summer to autumn). And horseweed (*Conyza canadensis* L.), common purslane, purple nutsedge, redroot pigweed (*Amaranthus retroflexus* L.), common chamomille (*Matricaria chamomilla* L.), annual bluegrass (*Poa annua* L.), shepherd's purse (*Capsella bursa-pastoris* L.) Medik., prostrate knotweed (*Polygonum aviculare* L.), common chickweed (*Stelleria media* L. Vill.) and lamb squarters were found as the most common weed species in strawberry growing areas before and during harvest time (Boz *et al*., 2002).

In addition to the yield decrease in strawberry fields due to weed competition, weeds also cause secondary negative effects to crop by serving as host plants to some diseases and insects, especially to mites or cause difficulties during harvest. Although weeds cause such great problems in strawberry production, there are a few control methods practiced by farmers. Weed control in strawberry is usually carried out by hand weeding, hoeing or mulching with black polyethylene sheets. These practices provide generally sufficient control of weeds, but a more effective and safer method is needed in order to protect the strawberry seedlings from damage caused by mechanical cultivation.

Soil fumigation with methyl bromide controls wide spectrum of weeds and it is used commonly in strawberry fields. However this fumigant will be banned in Turkey by 2008 due to its ozone depleting characteristics and therefore alternative methods for controlling weeds are need to be investigated. Other fumigants such as dazomet and metam-sodium are harmless to ozone layer and used to control weeds in strawberry growing areas. As another alternative to methyl bromide, there is an increasing interest to control pests by physical control methods. Especially in the regions with high summer temperature such as in Israel, solarization is applied in order to control weeds, soil-borne diseases and nematodes (Katan and De Vay, 1991).

In this study the efficacy of solarization (S), dazomet (D) and metam-sodium (MS) and methyl bromide (MB) applications on weed species of common purslane, annual bluegrass, common chamomille, horseweed and shepherd's purse was investigated in strawberry growing areas in Aydin province of Turkey.

MATERIALS AND METHODS

Trial was conducted as randomized block design. Plots were sixty square meter in size with 6 m in width and

Table 1: Maximum temperatures of solarized (S.A.) and non-solarized (N-Sol) areas (°C)

	16.06.1999		21.06.1999		28.06.1999		2.07.1999		14.07.1999	
Depth	N-Sol	S.A.	N-Sol	S.A.	N-Sol	S.A.	N-Sol	S.A.	N-Sol	S.A.
0 cm	36.4	49.3	51.0	63.3	46.6	58.9	59.0	68.0	59.1	69.0
10 cm	32.2	38.2	37.9	43.8	35.2	45.2	34.7	43.6	35.9	44.7
20 cm	30.0	33.8	34.8	37.7	29.3	38.6	30.0	37.0	33.5	41.0

10 m in length. Treatments were solarization (S), methyl bromide (MB), metam-sodium (MS) and dazomet (D) each had 3 replicates. An untreated plot served as control at each block.

For S, moistened soil was covered manually with a polyethylene sheet (thickness: 110 μm) from June 10 to July 14th. Soil temperature was weekly recorded from 0, 10 and 20 cm depths of the soil (Table 1). For the MS application, drip irrigation pipes were laid on the soil and the soil was covered with polyethylene sheet and then MS was applied one time (100 ml per square meter) in liquid form in July 2nd and the soil was covered until July 14th. The D was applied in granular form as 50 g per square meter in moistened soil and it was mixed to the soil by rotary tillers to 10-15 cm soil depth. Soil was also covered after D application from July 2nd to 14th. For MB application soil was tilled in 40 cm depth and covered with polyethylene sheet before the application. The MB was applied 50 g per square meter and the cover stayed for three days after the application. After removal of transparent sheets, raised beds were prepared for all plots and strawberry seedlings cv. Camarosa were planted on raised beds in July 17th, 1999. Farmer's practices were applied to grow plants such as growing plants on raised beds, seedlings were planted 25 cm in width and 30 cm in length rows and drip irrigation was used to water plants. The weeds were sampled in six different, 0.15 square meter-area (0.5x0.3 m) on each plot by visual determination. The weeds were removed by hoeing after each observation. Observations were taken nine times during 1999-2000 and twice in 2001-2002 growing seasons between raised beds. In addition, the weeds were sampled nine times from the hole around the strawberry seedlings during 1999-2000 growing season.

Statistical Analyses: Data from trials were subjected to the variance analysis and standard errors for each analyze were given in tables.

RESULTS AND DISCUSSION

Efficacy of treatments on the coverage of weeds between rows: The temperature values recorded during solarization on solarized and non solarised plots were shown in Table 1. It was observed that solarization increased the soil temperature up to 13°C.

During observations it was determined that common purslane, annual bluegrass, common chamomille, horseweed, shepherd's purse were the most common species on experimental plots.

In terms of the efficacy of different weed control measurements on all weeds; no effect of treatments were observed at four observations, carried out between 6.9.1999 and 1.11.1999. At the observation date on 29.11.1999 MB, S and MS treatments reduced the weed coverage significantly, whereas D showed no effect on weeds. On 21.1.2000 it was observed that all treatments reduced the weed density as compared to non treated plots significantly. Similarly all applications affected the weed coverage on 8.4.2000 significantly, but the highest effect was observed with MS. Results from 20.5.2000 was similar to 21.1.2000. Observation from 15.5.2001 showed that only MB controlled weeds effectively, all other treatments showed no effect on weeds (Fig. 1, Table 2).

From these common purslane was affected only by MB application on 20.05.2000 significantly (Fig. 1, Table 2). On all other observation times the coverage of this weed was not significantly different from untreated plots. However, Defilippi *et al.* (1998) stated that S provided effective control of weed species such as common purslane, *Convolvulus arvensis*, *Veronica persica* and barnyardgrass. In contrast Tekin *et al.* (1997) pointed out that common purslane could not be controlled effectively by S and MB, but S+MB controlled this weed effectively. In terms of MS, MacDonald *et al.* (2001) showed that MS application reduced the germination of common purslane by over 95%. Hartz *et al.* (2001) investigated the efficacy of 1,3-dichloropropene, MS and chloropicrin on *Malva parviflora*, prostrate knotweed and common purslane and found that common purslane was the most sensitive weed species to all compounds.

Coverage of annual bluegrass was reduced significantly by MS application on 21.01.2000. Although all other treatments reduced the coverage of this weed, this reduction was not statistically significant (Fig. 1, Table 2). In terms of S, this application reduced this weed 89-100% in the upper 5 cm of soil and MS (930 L.ha^{-1}) the most effective treatment for reducing the viable annual bluegrass (Peachey *et al.*, 2001).

The coverage of common chamomille was reduced by all applications on 1.11.1999, but this reduction is not reliable, because of very low density of this weed on

Table 2: Weed coverage at different observation times after different treatments

Date	C	MB	S	MS	D
Total weed coverage between raised beds					
06.09.1999	24.83±21.2a*	11.83±5.95a	21.11±8.69a	35.50±7.06a	12.56±7.14a
20.09.1999	0.44±0.19b	0.17±0.10b	1.36±0.91b	5.83±3.10a	0.14±0.14b
04.10.1999	14.05±11.28a	8.60±5.20a	13.78±0.98a	15.08±7.84a	2.08±1.47a
01.11.1999	5.16±0.65a	3.97±3.36a	0.94±0.07a	1.64±0.86a	2.88±1.15a
29.11.1999	13.45±2.43a	4.31±2.23b	4.78±1.79b	3.61±0.94b	11.64±1.83a
21.01.2000	69.49±5.20a	23.60±2.20b	31.24±12.46b	19.94±3.40b	41.95±8.30b
08.04.2000	38.75±5.76a	14.91±2.14bc	20.83±6.30bc	10.72±4.21c	23.21±1.59b
04.05.2000	38.48±10.6a	24.76±6.89a	35.27±12.94a	19.61±4.70a	27.27±8.67a
20.05.2000	81.50±7.82a	31.44±8.47b	50.02±14.32b	33.49±9.50b	38.56±9.92b
23.04.2001	23.19±8.71a	20.38±4.27a	21.66±4.61a	24.14±7.39a	17.61±7.62a
15.05.2001	74.44±6.07a	46.38±8.96b	70.55±7.47a	63.80±10.10a	67.06±6.40a
Commonpurslane(*Portulacaoleracea*)					
06.09.1999	24.44±21.1a	11.78±6.0a	21.11±8.69a	32.78±8.02a	12.22±7.29a
20.09.1999	0.36±0.18a	0.06±0.06a	1.31±0.95a	4.36±3.45a	0.14±0.14a
04.10.1999	7.78±5.37a	3.89±3.25a	11.67±1.45a	12.78±7.56a	1.94±1.55a
01.11.1999	1.14±0.32a	0.11±0.11a	0.14±0.10a	0.17±0.10a	0.92±0.87a
08.04.2000	0.64±0.20b	1.41±0.22ab	2.55±1.29ab	1.39±0.68ab	3.47±1.14a
04.05.2000	7.04±1.92a	2.78±1.22a	11.72±3.12a	6.39±2.33a	8.95±3.66a
20.05.2000	28.61±8.06a	7.45±2.35b	20.95±7.90ab	14.17±2.94ab	11.72±3.70ab
23.04.2001	0.67±0.20a	0.39±0.39a	1.94±0.92a	1.50±0.98a	1.34±0.60a
15.05.2001	4.17±1.11ab	3.10±0.96b	8.39±1.20a	4.97±1.03ab	4.83±1.62ab
Annual bluegrass (*Poa annua*)					
01.11.1999	0.47±0.18a	0.30±0.22a	0.16±0.08a	0.06±0.05a	0.02±0.02a
29.11.1999	5.00±2.57a	2.14±1.70a	1.22±0.39a	0.78±0.31a	2.42±0.46a
21.01.2000	21.11±6.92a	9.55±2.87ab	9.81±4.16ab	4.55±0.86b	10.28±1.46ab
08.04.2000	0.28±0.28a	0.00±0.00a	0.28±0.28a	0.00±0.00a	0.28±0.28a
04.05.2000	0.11±0.11a	0.00±0.00a	0.06±0.05a	0.11±0.11a	0.00±0.00a
20.05.2000	0.55±0.40a	0.00±0.00a	0.55±0.28a	0.00±0.00a	1.39±1.39a
23.04.2001	0.06±0.06b	0.33±0.00a	0.00±0.00b	0.00±0.00b	0.00±0.00b
15.05.2001	0.22±0.22a	1.56±0.78a	0.56±0.56a	1.50±1.50a	0.00±0.00a
Common chamomille (*Matricaria chamomille*)					
01.11.1999	0.44±0.11a	0.00±0.00b	0.00±0.00b	0.02±0.02b	0.06±0.06b
29.11.1999	2.78±0.45a	0.25±0.05b	1.14±0.85ab	0.50±0.17b	2.53±0.53a
21.01.2000	20.83±4.64a	2.11±0.22b	9.11±6.70ab	5.11±2.65b	11.05±2.23ab
08.04.2000	12.50±2.92a	1.17±0.38bc	3.83±1.42bc	0.78±0.23c	7.72±2.41ab
04.05.2000	4.83±2.03a	0.00±0.00b	2.50±1.27ab	2.39±1.73ab	5.78±2.12a
20.05.2000	6.56±1.54a	0.28±0.28a	3.78±3.12a	0.83±0.48a	4.89±1.92a
23.04.2001	1.47±0.70a	1.28±0.58a	0.56±0.31a	0.06±0.06a	1.22±0.53a
15.05.2001	6.83±2.37a	1.28±0.65b	2.05±1.03b	1.05±0.14a	2.56±0.80a
Horseweed(*Conyzacanadensis*)					
01.11.1999	0.00±0.00a	0.06±0.06a	0.06±0.06a	0.11±0.11a	0.39±0.24a
29.11.1999	1.00±0.35ab	1.47±0.39a	0.11±0.11b	0.14±0.14b	0.50±0.29ab
21.01.2000	0.17±0.17a	0.39±0.24a	0.28±0.28a	1.94±1.94a	0.78±0.49a
08.04.2000	3.06±0.39a	2.08±0.91a	3.14±1.10a	2.28±1.18a	3.80±1.14a
04.05.2000	5.33±2.33a	3.55±0.68a	3.61±0.80a	3.39±1.21a	4.66±1.59a
20.05.2000	8.28±3.22a	6.11±1.47a	4.75±0.17a	7.28±3.57a	11.39±3.10a
23.04.2001	10.33±4.48a	6.28±1.90a	10.22±1.97a	10.33±3.34a	9.11±3.28a
15.05.2001	20.17±6.58a	13.11±5.09a	21.39±4.32a	24.44±5.80a	19.17±3.82a
Shepherd'spurse(*Capsella bursa-pastoris*)					
04.10.1999	0.11±0.11a	0.00±0.00a	0.00±0.00a	0.00±0.00a	0.00±0.00a
01.11.1999	1.22±0.45a	0.17±0.09b	0.06±0.06b	0.03±0.02b	0.28±0.28b
29.11.1999	0.89±0.80a	0.28±0.28a	0.58±0.43a	0.47±0.47a	1.83±0.09a
21.01.2000	9.95±3.91a	2.05±1.66a	3.06±1.83a	2.83±1.60a	5.28±3.20a
08.04.2000	16.0±7.90a	9.05±3.25a	8.78±8.13a	3.72±2.58a	4.61±2.44a
04.05.2000	14.61±9.84a	16.39±6.68a	12.61±11.38a	5.00±3.47a	5.56±4.37a
20.05.2000	21.11±10.47a	15.00±8.71ab	13.33±12.12ab	6.39±5.98b	5.00±4.20b
23.04.2001	0.00±0.00a	0.95±0.64a	0.00±0.00a	0.11±0.11a	0.94±0.94a
15.05.2001	0.44±0.44b	3.83±1.32a	0.50±0.29b	0.17±0.17b	0.83±0.83b
Coverageof weeds from hole around strawberry seedlings					
06.09.1999	1.17±0.79a	0.83±0.75a	0.94±0.69a	0.34±0.10a	0.44±0.29a
20.09.1999	3.02±1.62ab	1.86±1.32ab	6.10±2.72a	2.02±0.99ab	0.47±0.35b
04.10.1999	14.86±6.39a	8.67±2.59a	9.16±3.37a	11.75±1.11a	7.42±1.77a
01.11.1999	3.61±2.24a	2.00±0.39a	1.97±0.97a	1.11±0.46a	0.75±0.50a
29.11.1999	8.58±0.65a	1.83±0.60b	4.50±2.56ab	2.22±0.87b	2.92±1.28b
21.01.2000	36.50±10.43a	5.38±2.24b	7.11±4.78b	2.77±0.29b	6.28±4.49b
08.04.2000	16.33±2.69a	7.39±0.71b	11.58±3.08ab	6.81±1.24b	6.64±0.45b
04.05.2000	4.28±0.77a	1.83±0.42b	2.11±0.83b	1.83±0.20b	2.00±0.58b
20.05.2000	12.66±4.44a	3.22±1.20b	3.75±0.76b	2.00±0.29b	2.39±1.25b

*Comparison of means was carried out only within each observation date. Means with similar letters are not significant.

C: Control, MB: Methyl-bromide, S: Solarization, MS: Metam-Sodium, D: Dazomet

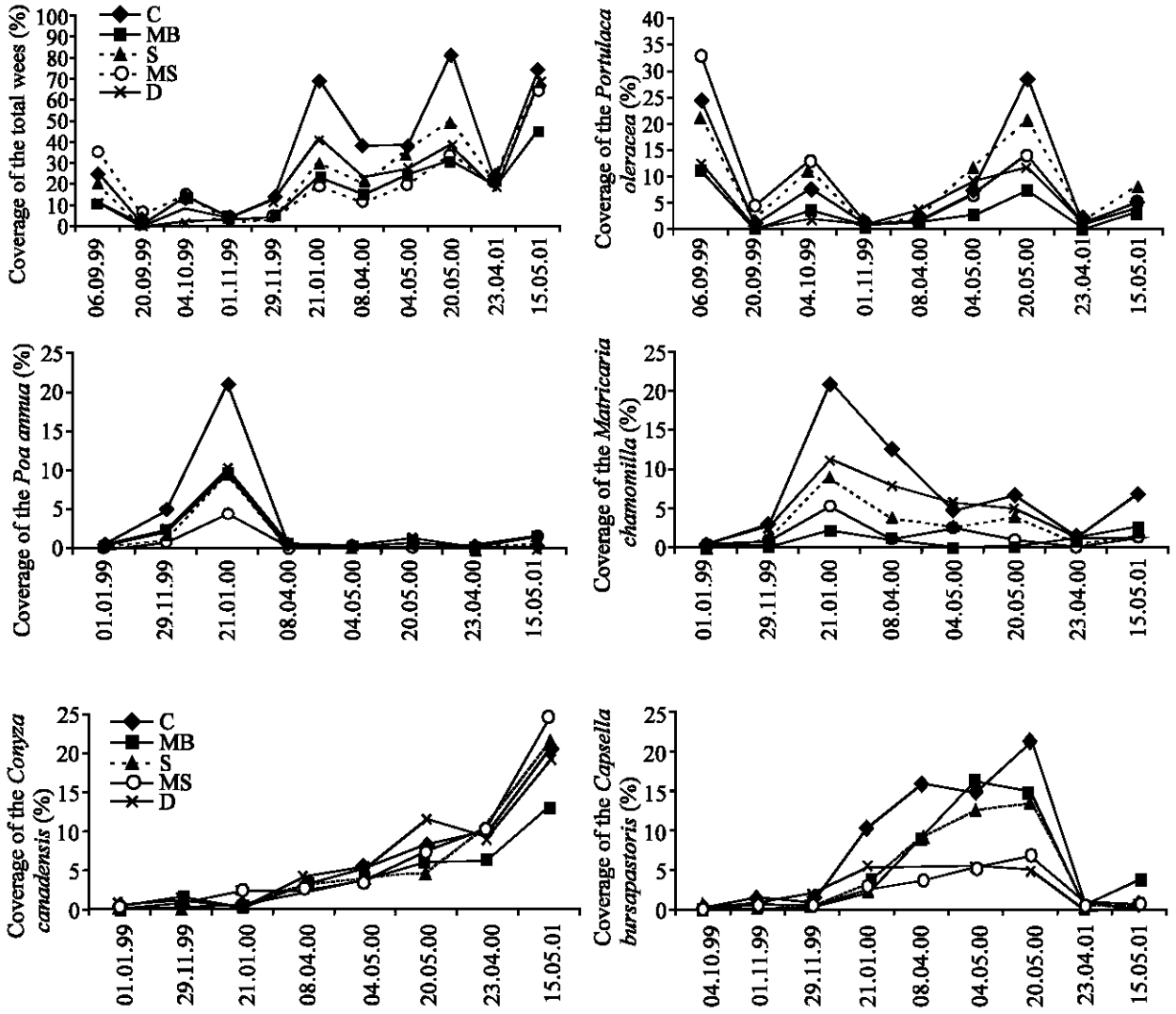

Fig. 1: Coverage of the weed species in inter-rows after some treatments.
Dominant weed species are; Common purslane (*Portulaca oleracea*)
Annual bluegrass (*Poa annua*)
Common chamomille (*Matricaria chamomille*)
Horseweed (*Conyza canadensis*)
Shepherd's purse (*Capsella bursa-pastoris*)

untreated plots at this date. In general MB and MS applications reduced the coverage of this weed significantly, except for 2 observation times (Fig. 1, Table 2).

In case of horseweed none of the treatments reduced the coverage of this species significantly (Fig. 1, Table 2).

The coverage of shepherd's purse was reduced by all applications on 1.11.1999. On 20.5.2000 MS and D treatments reduced the coverage of this weed significantly (Fig. 1, Table 2). In study by Tekin *et al.* (1997) it was found that S, S+MB (30 g m^{-2}) and MB (60 g m^{-2}) applications were found to be effective against this weed. Also Fennimore *et al.* (2000) reported that the biomass of this weed was decreased by 59-79% with MS application.

Efficacy of treatments on the coverage of weeds on the rows around seedlings: Observations on 21.1.2000, 4.5.2000 and 20.5.2000 showed that all treatments reduced the coverage of weeds significantly. Despite a decrease in

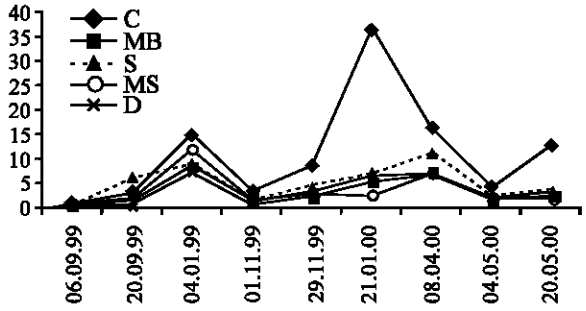

Fig. 2: Coverage of the weeds from the hole around the strawberry seedlings after some treatments
Dominant weed species are; Common purslane (*Portulaca oleracea*)
Annual bluegrass (*Poa annua*)
Common chamomille (*Matricaria chamomille*)
Horseweed (*Conyza canadensis*)
Shepherd's purse (*Capsella bursa-pastoris*)

the weed coverage by all treatments on 29.11.1999 and 8.4.2000, the coverage of weeds on S plots was not significantly different from those on untreated plots (Fig. 2, Table 2).

As results of this study are summarized, efficacies of treatments are variable according to weed species and/or observation dates. In general none of the treatments reduced the coverage of horseweed. Also no treatment showed higher efficacy on weeds than methyl bromide, but solarization applicable under suitable climatic conditions, because its application is economic and safer to environment and user.

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