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Effect of Stockosorb® on the Management of Bean and Cucumber Plants and Their Insect Pest, Silverleaf Whitefly, Using Three Levels of Irrigation

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Soil water is an important constraint in growing vegetable crops. The unappropriate use of water in modern agriculture is strongly discouraged. The effects of deficient and of excessive soil moisture on plant growth are well known. In the present study, effect of Stockosorb, a water retaining chemical, to maintain appropriate plant health, was studied in cucumber and beans. Stockosorb® was applied at the rate of 20 lbs/acre for each of three rates of water which were 50%, 80%, and 100% of recommended water practice. A control treatment was used without applying any stockosorb. Cucumber (*Cucumis sativus* L. 'Vlaspic') and bean (*Phaseolus vulgaris* L.) grown in the four levels of water management program, affected populations of various insect pests. Mean numbers of silverleaf whitefly adults were significantly fewer in plants grown under low level of irrigation (50% and 80%) than those grown under high level of irrigation (100%). Foliage quality did not differ among treatments. Mean numbers of flowers and fruits were the highest when plants were grown at the lowest level of irrigation (50%).

Soil moisture plays an important role on the growth of plants. Plant growth diminishes progressively as soil moisture falls below field capacity (Hagan, 1955). Plant growth responds as the available soil moisture is depleted within one irrigation cycle. On the other hand, plants respond favorably to relatively high soil moisture conditions. Plant growth is manifested in several ways, such as elongation of plant organs, increase in fresh and dry weight, and numbers of flowers and fruits.

Lack of proper percentage of water may cause compaction of soil. In compact soil, soil particles are pressed together, reducing pore space between them. Compaction may result in lack of sufficient pores for movement of water and fertilizer necessary for growth of plants. Moreover, in compact soil, exchange of gases slows down causing an increase in the likelihood of aeration related problems.

Frequent irrigation or high percentage of soil moisture may cause increased vegetative and decreased reproductive growth. Fast growing plants are attractive to insect pests and encourage rapid multiplication of pest population. Stockosorb® 300 is a K- based superabsorbent polymer. Stockosob® reduces frequent irrigation of crop fields by maintaining required moisture level for normal growth of plants (Evonik Industries, N. America; Germany). It has a quick rewetting ability even after complete drying out of soil and ensures normal growth of plants: this quality of Stockosob® increases efficiency of nitrates ensuring higher yield. Plants grown in polymer amended media contain higher concentrations of macro- and micronutrients (Dehgan et al. 1992). These plants have higher biomass and produced higher yield.

The present study has been undertaken to determine proper vegetative and reproductive growth of cucumber and bean growing under three management levels of water and Stockosorb®. We also determine population abundance of SLW [Silverleaf whitefly, *Bemisia argentifolii* (Bellows and Perring) (Homoptera: Aleyrodidae)], an important pest of cucumber and beans.

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Materials and Methods

'Vlaspic' cucumber was seeded on raised beds of Rockdale soil on 25 Mar. 2012. A randomized complete-block design was employed to provide four replicates each for four treatments comprising a plot size of one row, 50 ft. long. Plant spacing within the bed was 12 inches and between beds was 36 inches. Treatments evaluated in this study were: 1) Stockosorb® at 20 lb/treated acre or 7–8 lb/acre banded in the row—60% normal watering practice; 2) Stockosorb® at 20 lb/treated acre or 7–8 lb/ acre banded in the row—80% normal watering practice; 3) Stockosorb® at 20 lb/treated acre or 7–8 lb/acre banded in the row—100% normal watering practice; and 4) untreated check—No Stockosorb® and 100% normal watering practice.

Stockosorb® at the specified rate was applied in a 6 inch wide band on tops of preformed beds prior to mulching and mechanically incorporate into the top 6–8 inches of soil. Beds were covered with black-white normal plastic mulch and provided with drip tapes for irrigation. Plants were irrigated one hour every day to provide normal water which was considered 100% rate. For maintaining reduced rate of water, plants were irrigated 48 min and 30 min to achieve 80% and 50% of normal rate of water.

A similar study was conducted with 'Pod Squad' bean following similar planting and management practices as used in the cucumber trial. Stockosorb® rate, application and irrigation levels were also the same as discussed in the previous study.

The effectiveness of treatments in both crops was evaluated by recording SLW adults on five randomly selected leaves, one leaf/plant, in each treatment plot. In case of bean, SLW eggs and nymphs were also recorded. On three dates of sampling, vigor of each crop was recorded on a scale ranging from 0–6; where 0

indicates green and non damaged plants, and 6 indicates plants with SLW and worm damage on >70% leaves. Treatments were also evaluated by counting total number of flowers on randomly selected five plants/treatment/plot. Further efforts were made to determine effect of treatments on the marketable yield of cucumbers. For this purpose, cucumber fruits were harvested on two dates at weekly intervals.

Statistical Analysis. Data of all studies were subjected to square root ($x + 0.25$) transformation. Transformed data were analyzed using SAS statistical package (SAS Institute 1990). The Duncan Multiple *K* ratio *t* test was used to separate treatment means where significant ($P < 0.05$) differences occurred (Waller & Duncan 1969).

Results and Discussion

SLW Adults. On the first sampling date, mean number of SLW adults/cucumber leaf was significantly fewer on plants grown by applying reduced rates of water (60% and 80%) than the plants grown by using normal rate of water (100 %) (Table 1). Plants receiving normal irrigation (100%) and Stockosorb® did not differ from control plants receiving only 100% irrigation. On the subsequent sampling dates, similar pattern of SLW density was observed where reduced rate of water provided significant reduction of SLW adults.

The SLW adults were significantly fewer on the bean plants treated with 60% and 80% water (Table 2). Accordingly, mean numbers of eggs were significantly fewer on plants irrigated with lower levels of water (60 and 80%) (Table 3). Like SLW adults and eggs, mean numbers of SLW nymphs were significantly fewer on plants receiving 60% and 80% water than the plants receiving 100% water (Table 4).

Plant Vigor. Irrigation levels (60%, 80%, and 100%) did not affect foliage quality of cucumber plants in the present study (Table 5). Mean rating of bean foliage quality did not differ among various treatments on different sampling dates (Table 6). In an average, foliage quality was deteriorating with the spread of Bean Golden Mosaic Virus (BGMV) irrespective of any treatments.

Mean numbers of BGMV affected plants did not differ among plants receiving various levels of water (Table 7). This disease is transmitted by SLW. Water level did not restrict the movement of SLW.

Table 1. Mean numbers of Silverleaf whitefly adults on cucumber grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean numbers of adults			
Irrigation levels	First sample	Second sample	Third sample	Mean
60%	6.00 b	7.60 c	9.00 c	7.53 b
80%	4.40 b	8.80 bc	10.60 bc	7.93 b
100%	9.00 a	12.40 a	14.80 ab	12.07 a
100% (control)	11.20 a	11.00 ab	17.40 a	

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 2. Mean numbers of Silverleaf whitefly adults on bean grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean numbers of adults			
Irrigation levels	First sample	Second sample	Third sample	Mean
60%	4.70 b	6.30 b	7.80 c	6.26 c
80%	6.00 a	6.45 b	8.75 bc	7.06 b
100%	6.65 a	9.00 a	10.10 a	8.58 a
100% (control)	5.95 a	8.60 a	9.15 ab	7.90 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 3. Mean numbers of Silverleaf whitefly eggs on bean grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean numbers of eggs			
Irrigation levels	First sample	Second sample	Third sample	Mean
60%	8.65 b	10.20 b	8.75 b	9.20 b
80%	10.15 ab	10.80 b	11.55 a	10.83 a
100%	10.40 a	14.00 a	10.70 ab	11.70 a
100% (control)	10.30 a	14.00 a	10.10 ab	11.46 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 4. Mean numbers of Silverleaf whitefly nymphs on bean grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean numbers of nymphs			
Irrigation levels	First sample	Second sample	Third sample	Mean
60%	3.00 b	6.95 b	4.50 b	4.81 c
80%	3.55 b	8.15 ab	5.50 b	5.73 bc
100%	5.25 a	9.60 a	8.30 a	7.71 ab
100% (control)	6.35 a	6.50 b	8.90 a	7.25 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 5. Mean rating of cucumber foliage quality grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean rating of foliage quality			
Irrigation levels	First sample	Second sample	Third sample	Mean
60%	5.75 a	5.00 a	4.75 a	5.16 a
80%	5.50 a	5.25 a	4.75 a	5.16 a
100%	6.00 a	5.75 a	4.50 a	5.43 a
100% (control)	5.75 a	5.50 a	5.50 a	5.58 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 6. Mean rating of bean foliage quality grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean rating of bean foliage		
Irrigation levels	First sample	Second sample	Third sample
60%	6.00 a	5.75 a	4.50 a
80%	6.00 a	5.50 a	4.50 a
100%	6.00 a	5.25 a	3.75 a
100% (control)	6.00 a	5.50 a	3.50 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 7. Mean number of BGMV-infected plants grown on Stockosorb® treated beds using three levels of irrigation.

	Mean number of BGMV-infected plants		
Irrigation levels	First sample	Second sample	Third sample
60%	3.00 a	8.00 a	16.00 a
80%	2.50 a	10.00 a	19.25 a
100%	3.75 a	10.00 a	20.00 a
100% (control)	3.75 a	7.75 a	20.00 a

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 8. Mean number of cucumber flowers/plant grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean number of flowers/plant		
Irrigation levels	First sample	Second sample	Mean
60%	5.50 a	10.20 a	8.43 a
80%	4.95 ab	7.95 bc	6.45 b
100%	4.40 b	7.80 c	6.10 b
100% (control)	5.20 a	9.10 ab	7.15 ab

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Table 9. Mean marketable yield (lb) of cucumber fruits/plot grown on Stockosorb®-treated beds using three levels of irrigation.

	Mean yield (lb) on two dates		
Irrigation levels	First sample	Second sample	Mean
60%	23.75 a	20.00 a	21.87 a
80%	22.25 a	14.00 ab	18.12 ab
100%	17.50 a	11.75 b	14.62 b
100% (control)	14.25 b	12.75 b	13.50 b

Means within a column followed by a same letter do not differ significantly ($P > 0.05$; DMRT).

Flowers. The mean numbers of flowers/cucumber plant were significantly fewer when plants received 100% irrigation and Stockosorb® than the control plants with 100% irrigation and no Stockosorb® (Table 8). Plants receiving lowest level of irrigation (60%) produced highest numbers of flowers, and did not differ from the plants having 80% irrigation.

Marketable Yield. Highest marketable yield of cucumber was recorded when cucumber plants received lowest level of water (60%) (Table 9); and did not differ from 80% water level. One hundred percent water level had significantly lower yield than 60% and 80% levels.

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