Agricultural Sciences, 3 (1998) 41 - 45

Efficacy of Crop Cover in Controlling Viral Disease of Squash

A. Zouba[1] and M.V. Lopez

Department of Agronomy, Horticulture, Entomology and Plant Pathology
College of Agriculture, Sultan Qaboos University
P.O. Box 34, Al Khod 123, Sultanate of Oman

فاعلية تغطية النباتات في الحد من أمراض الكوسة الفيروسية

ع. زوبا و إم. في. لوبز

خلاصة: تمت دراسة فاعلية تغطية النباتات في الحد من أمراض الكوسة الفيروسية تحت ظروف الحقل. أوضحت نتائج الدراسة أن تغطية النباتات لمدة تتراوح بين ١٥ و ٣٠ يوماً تسببت في تأخير الإصابة وحدة انتشار الأمراض الفيروسية مما أدى إلى تحسين النمو الخضري وبالتالي كمية ونوعية الإنتاج. ولوحظ إن الفترة المثلى للتغطية كانت ٢١ يوماً حيث أن التغطية لمدة ٣٠ يوماً لم تنتج عنها فروق معنوية في نوعية وكمية الإنتاج.

ABSTRACT: The efficacy of using crop cover in controlling viral diseases of squash was studied under field conditions. Results of the study revealed that crop cover of 15 to 30 d delayed the onset of disease incidence, spread and severity of viral diseases, leading to improvement in vegetative growth and consequently, to increase and subsequent improvement in fruit yield and quality. It was observed that 21 d was the optimal coverage period for higher fruit yield. Vegetative growth and fruit yield and quality did not differ significantly for plants under cover for 15 d and 30 d.

Squash (*Cucurbita pepo* L.) is among the most important and predominant cucurbit crops in the Sultanate of Oman. It is widely grown during the fall, winter and spring seasons. This crop is repeatedly subjected to high levels of viral disease epidemics caused by viruses such as watermelon mosaic virus 2 (WMV-2), zucchini yellow mosaic virus (ZYMV), papaya ring spot virus (PRSV), cucumber mosaic virus (CMV) and unidentified whitefly-transmitted viruses (Zouba *et al,*1997). Due to the large number of viruses associated with squash and the lack of resistant cultivars, measures were limited to the use of insecticides to control viriluferous vectors. However, such methods were not fully effective due to the limited success of pesticides in controlling non-persistent virus (Broadbent, 1969; Jayasena and Randles, 1985) and the upsurging pesticide resistance of the whitefly *Bemisia tabaci* (Dittrich *et al,* 1990). Insect-proof crop cover, used to prevent infectious vectors from attacking crops, have helped in reducing disease losses in squash and tomato (Natwick and Darazo, 1985; Al Musa *et al,* 1987). A recent survey of cucurbit viruses held during the 1994-1996 period in the Batinah region of the Sultanate of Oman showed that 37% of the surveyed cucurbit fields were covered with spunbounded polyester(Agryl) for a period ranging from 25 to 45 d (Zouba *et al, 1997).* Most growers were satisfied with the level of control achieved. However, problems such as etiolation of plants resulting from prolonged shading, controlling weeds under cover, and exclusion of beneficial insects were common. The main objective of the present study was to evaluate the efficacy of crop cover in controlling virus diseases of squash and to determine the optimum coverage period.

Materials and Methods

A field crop cover experiment for squash (cv. Eskenderany hybrid) was conducted from mid September to the end of December using a randomized complete block (RCB) design with four treatments, namely: control - uncovered; covered for 15 d; covered for 21 d, and; covered for 30 d following 100% seedling emergence and three replications.

The field was prepared and mixed with 2 liters of vermiculite and 2.5 g of complete fertilizer (15-15-15 + trace elements) per hill. Seeds were sown on a 3 row, 8 m long plot/treatment/replication at a distance of 1.50 m between rows and 0.50 m between hills. The insect-proof polypropylene crop cover (Agryl - SODACA, France) supported by frames of poly-ethylene pipes was put in place just after seeding at an

[1]Corresponding Author.

approximate height of 50 cm above the soil surface. The edges were covered with soil for additional support.

DISEASE INCIDENCE AND SEVERITY: The number of plants showing typical viral symptoms relative to total plants per treatment were recorded weekly up to a period of 12 wk when all plants became infected. Counting commenced immediately for the uncovered treatment, while for the covered treatments counting was done after the removal of the cover.

Disease Severity was estimated at 28 and 49 d after seedling emergence using a four interval scale: 0 - no symptoms; 1 - slight symptoms on young leaves; 2 - most leaves showing symptoms and plant slightly stunted; 3 - leaves showing severe symptoms and plant severely stunted. Individual score on plants for each treatment were averaged.

FRUIT YIELD AND QUALITY PARAMETERS: The total weight and number of fruits, their mean values per plant and the percentage of fruit deformity were determined.

GROWTH PARAMETERS: The stem length and leaf count were obtained by randomly selecting 30 plants per treatment per replication. The stem length was measured from the soil surface up to the tip of the youngest shoot. Leaf number was counted from the first true leaf up to the youngest fully expanded leaf. Average internode length was obtained by dividing the stem length by the total number of leaves per plant. The petiole length was determined by randomly selecting 15 plants per treatment per replication. The length of 8 full-grown petioles from the base up to the middle part of the stem was measured. The values were summed up and divided by the number of samples to get the mean. Root and shoot dry weights were estimated by randomly selecting 5 plants per treatment per replication. These were partitioned into root and shoot. Root and shoot fresh weights were obtained and the samples where then placed in an oven at 70°C for at least 3 d after which dry weights were obtained. Vegetative growth and fruit yield and quality parameters were statistically analyzed using the analysis of variance procedure. Comparison of treatment means was done using the least significant difference (LSD) method at 5% level of significance.

Results

DISEASE INCIDENCE AND SEVERITY: Virus symptoms in uncovered squash plants became noticeable 2 wk after seedling emergence with 10% infection (Figure 1). This increased to 50, 75, 95 and 100% in 3,4,5 and 6 wk, respectively. In plants covered with Agryl for 15 d, virus symptoms were initially observed 4 weeks after emergence with 4% infection and going up to 25, 64, 87, 94 and 100% in 5,6,7,8 and 9 wk, respectively. A further delay in virus spread was noticed in plants

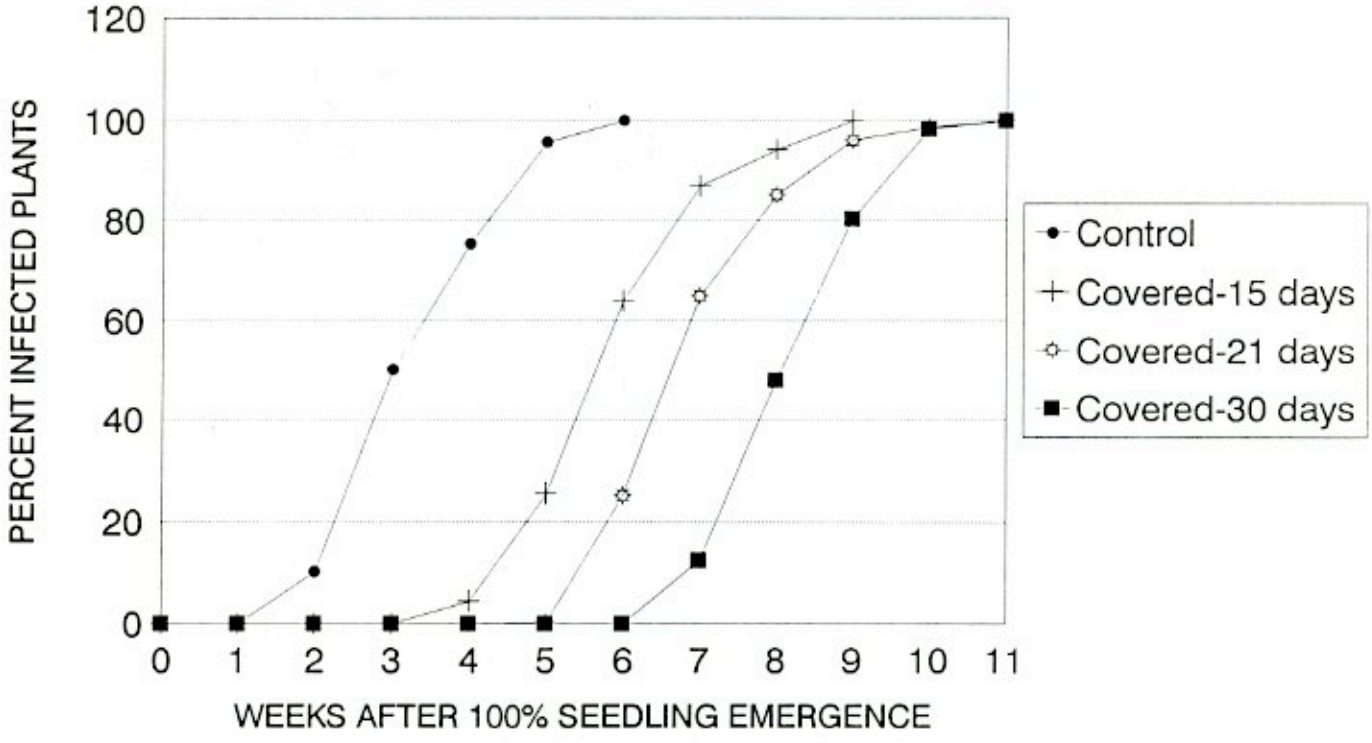

Figure 1. Temporal infection of squash plants following emergence in control and after 15, 21 and 30 d with cover.

covered for 21 and 30 d. It took 11 wk for virus symptoms to appear in 100% of the plants. Besides the delay in disease incidence and spread of virus, severity of symptoms in infected plants was noticed to be highest in the controls followed in descending order by plants covered for 15, 21 and 30 d (Table 1).

NUMBER OF FRUITS AND TOTAL FRUIT YIELD AND QUALITY: The number of marketable fruits per plant was higher in covered plants than in the control (Table 2). However, there were no significant differences among plants covered for 15, 21 and 30 d. On the other hand, there was a significant increase in the number of aborted fruits in covered compared to uncovered plants. This was more noticeable in 21 and 30 d coverage periods. The total fruit yield in terms of weight per plant was found to be significantly higher in covered than in uncovered plants (Table 3). The highest yield was obtained with 30 d coverage followed in descending order by plants covered for 21 and 15 d and lastly, by the uncovered controls.

The yield expressed as number of fruits per plant was also observed to be higher in covered than in uncovered plants while no significant differences among covered treatments were detected. Fruit quality in terms of mean weight per fruit was higher in covered than in uncovered plants. Fruit weight was highest in plants covered for 30 and 21 d followed in descending order by those covered for 15 d and the uncovered control.

Fruit quality in terms of percent deformity was not significant among the treatments.

VEGETATIVE GROWTH: The length of stem and petiole was greatest in plants covered for 30 d followed in decreasing order by those covered for 21 and 15 d and control (Table 4). However, there was no difference between plants covered for 21 and 30 d and between plants covered for 15 and 21 d. Leaf number and internode length were significantly higher in covered than in uncovered plants while no differences were detected among the covered plants. Root and shoot dry weights showed increases in covered compared to uncovered plants. Root dry weight was highest in plants covered for 30 and 21 d followed by15 d. Meanwhile, no difference was observed in the shoot dry weight of plants among the covered treatments.

Discussion

The length of time following seedling emergence after which all plants showed virus symptoms was prolonged by crop cover. The treatment also reduced disease severity.

The efficacy of crop cover was reflected in the increase in the number of marketable fruits harvested compared to the uncovered treatment. However, covering the crop also increased the number of aborted fruits, with plants attaining a higher abortion rate starting in the third week of harvest, 9 wk after 100% seedling emergence reaching its peak in the 5th and 6th wk (i.e. 11 and 12 weeks after seedling emergence, respectively). The peak period coincided with 100% disease infection for the 21 and 30 d coverage periods. Covering squash for 15 d signi-ficantly increased fruit weight and fruit number per plant compared to the control. However, prolonging the crop cover to 21 and 30 d resulted in a further increase in fruit weight but not in their number. The length of the coverage period seemed to have its maximum effect on fruit growth at 21 d since no further increase was registered at 30 d. The increase in fruit yield due to crop cover was reinforced by an improvement in quality in terms of increased weight of individual fruit. Covering squash for 15-30 d almost doubled individual fruit weight. Those with those covered for 21 and 30 d showed significantly higher weight than those covered for 15 d.

TABLE 1

Virus disease severity in covered and uncovered squash plants. Evaluation was made 4 and 7 weeks following 100% seedling emergence using a disease scale from 0-3

Cover Period (d)	Mean Disease Severity	
	Four Weeks	Seven Weeks
Control	1.11[a]	2.17[a]
15	0.08[b]	1.29[b]
21	0.00[b]	0.86[c]
30	0.00[b]	0.13[d]
LSD values (0.05)	0.37	0.36

[abcd] Means within a column having the same letter are not significantly different from each other at 5% level (LSD)

TABLE 2

Number of marketable and aborted fruits produced by uncovered and covered squash plants

Cover Period (d)	Number of Fruits per Plant	
	Marketable	Aborted
Control	5.08[c]	3.04[b]
15	9.07[ab]	3.97[ab]
21	9.78[a]	5.13[a]
30	9.19[a]	5.08[a]
LSD values (0.05)	1.61	1.90

[abcd] Means within a column having the same letter are not significantly different from each other at 5% level (LSD)

TABLE 3

Total yield and quality of fruits produced by uncovered and covered squash plants

Cover Period (d)	Total Yield per Plant*		Mean Weight Per Plant** (g)	Fruit Deformity (%)
	Weight (g)	Number of Fruits		
Control	311.11[c]	8.12[b]	56.75[c]	8.09[a]
15	885.05[b]	13.04[a]	94.46[b]	8.15[a]
21	1,083.57[a]	14.91[a]	107.42[a]	4.96[a]
30	1,085.59[a]	14.26[a]	113.93[a]	4.90[a]
LSD Values (0.05)	150.78	2.94	6.70	3.42

[abc] Means within a column having the same letter are not significantly different from each other at 5% level (LSD)
*Includes marketable and aborted fruits (i.e. total weight/plant = total weight/plot ÷total number of plants/plot)
**Excluding aborted fruits (i.e. mean weight per plant = total marketable weight/plant ÷total number of marketable fruits/plant)

TABLE 4

Vegetative growth of uncovered and covered squash plants

Cover Period (d)	Stem Length (cm)	Leaf Count	Internode Length (cm)	Petiole Length (cm)	Root Dry Weight (g)	Shoot Dry Weight (g)
Control	34.13[c]	37.02[b]	0.91[b]	23.19[c]	0.92[c]	60.86[b]
15	52.40[b]	40.11[a]	1.31[a]	30.01[b]	1.72[b]	122.29[a]
21	56.46[ab]	40.28[a]	1.40[a]	33.39[ab]	2.18[a]	123.82[a]
30	60.76[a]	41.13[a]	1.47[a]	36.12[a]	2.35[a]	139.68[a]
LSD Values (0.05)	8.33	1.86	0.16	5.64	0.42	17.45

[abc] Means within a column having the same letter are not significantly different from each other at 5% level (LSD).

higher weight than those covered for 15 d. Meanwhile, fruit deformity as a component of quality was found not to be affected by crop cover.

The increase in yield and improvement in the quality of squash fruits brought about by crop cover was the result of reduced viral disease severity which in turn resulted in improvement of vegetative growth, (i.e. stem length, leaf number, internode length and petiole) as well as root and shoot dry weights. In contrast, the growth of severely infected uncovered plants was poor as shown by the shorter length of stem, internodes and petioles, lower number of leaves and low root and shoot dry weights. It can therefore be argued that the delay in infection of covered plants enabled them to grow to their full potential. On the other hand, the reverse was true for uncovered plants which had low fruit yield and consequently small fruit size. These results are in line with the previous finding that virus infected plants suffer from early occurrence of high respiration and low Photosynthesis rates (Lele and Mukerji, 1979). With covered plants the increase in all vegetative parameters was probably due to the creation of a favorable microclimatic environment and a delay in the transmission of viruses and development of symptoms. However, with the covered treatments, it was only the length of stem and petiole and root dry weight that increased significantly when the period of crop cover was prolonged from 15 to 21 and 30 d. Other parameters such as leaf number, length of internode and shoot dry weight did not increase. Meanwhile, crop cover for a period of 21 d did not show a difference in all vegetative parameters other than the 30 d coverage. This finding followed the same trend exhibited by fruit yield parameters thereby providing additional proof of the efficacy of crop cover for 21 d. It was also observed that prolonging crop cover from 21 to 30 d resulted in etiolation of plants and a higher weed population.

Conclusions

Crop cover was found to be effective in delaying the onset of viral disease incidence, spread and severity in squash. This resulted in an increase in total fruit yield in terms of weight and number and improvement in quality in terms of fruit weight and hence, on the size of marketable fruits per plant. The large increase in yield of covered plants can be traced to low viral

disease severity which in turn induced improvement in vegetative growth such as longer stem, internode and petiole, greater number of leaves and higher root and shoot dry weights. However, 21 d of crop cover was found to be optimum since it resulted in a higher fruit yield than 15 d coverage, which did not differ from that of the 30 d coverage.

References

Al-Musa,A.M., N.I.K. Nazer and N.S. Sharaf. 1987. Effect of certain combined agricultural treatments on whitefly population and incidence of yellow leaf curl virus. *Dirasat(Jordan)* 14:127-134.

Broadbent, L. 1969. Disease control through vector control. In: *Viruses, Vectors and Vegetation*. K. Maramorosch (Ed.) 593-630. Interscience Publishers. New York, U.S.A.

Dittrich, V., S. Uk and G.H. Ernst. 1990. Chemical control and insecticide resistance of whiteflies. In: *Whiteflies: Their Bionomics, Present Status and Management*, Andover, hants, UK, Intercept Ltd. I.D. Gerling, (Ed). 263-285.

Jayasena, K.W. and J.W. Randles. 1985. The effect of insecticide and a plant barrier row on aphid populations and the spread of bean yellow mosaic potyvirus and subterranean clover red leaf uteovirus in *Vicia faba* in South Australia. *Ann. Appl. Biol.* 107:355-361.

Lele, A. and K.G. Mukerji. 1979. Metabolic changes caused by virus infection in cucumber and french bean. *Ind. Phytopath.*32:236-241.

Natwick, E.T. and M. Darazo. 1985. Polyester covers protect vegetables from whiteflies and virus diseases. *Calif. Agri.* 39:21-22.

Zouba, A.A., A.J. Khan, M. Lopez and Y.M. Al-Maqbaly. 1997. Survey of virus diseases of cucurbits in the Batinah region of the Sultanate of Oman. *Arab J. Pl. Prot.* 15:43-46.

Published with the approval of the College of Agriculture, S.Q.U., as paper number 221197.