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# INTEGRATED PEST MANAGEMENT (IPM), AN ATTEMPT AGAINST SUDDEN WILT DISEASE IN MELON

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## ABSTRACT

Sudden wilt of melon, caused by the fungus *Monosporascus cannonballus*, is a worldwide problem. Soil disinfestations by fumigation with methyl bromide before planting is a common treatment for disease management but, because methyl bromide will be banned from use in developed countries in the near future, alternative measures of disease suppression are needed. Two field experiments were conducted during the early autumn of 2004 and 2005 seasons in Nubaria area, Alex-Desert Road to find out the effect of soil fumigation by some fumigants against melon sudden wilt with management aspects, like solarization, grafting, and removing or adding a layer of soil in diseased fields. Results revealed that generally, methyl bromide was the superior treatment in controlling *Monosporascus* followed by Dazomet, Metham-sodium and Formalin, respectively. Grafting treatment was better than solarization against wilt disease. Removing 20 cm of the top surface of infected field before planting or adding a layer of soil (20cm) taken from virgin sandy soil to the infected field resulted in significant reduction in wilt, but removing treatment was better than adding treatment against disease. Total yield as well as marketable yield had been affected strongly by wilt incidence percent, the lowest values of wilt incidence and consequently the highest values of melon yield were achieved under methyl bromide combined with grafting treatment. Grafted plants produced fruits with low sugars content.

Finally, the lesson to be learned from the present study that methyl bromide as a single method of control should be avoided because there appear to be promising alternative methods for the management of *Monosporascus* wilt of melon, especially when used in combination.

## INTRODUCTION

Melon sudden wilt or vine decline, also known as melon collapse or melon dieback, is a root rot disease with damaging consequences for the melon crop (*Cucumis melo* L.) around the world (Mertely *et al.* 1991 in Southern United States; Martyn *et al.*, 1994 in Tunisia, Garcia-Jimenez *et al.*, 1994 in Spain; Karlatti *et al.* 1997 in Saudi Arabia; Cohen *et al.* 1999 in Israel and Merghany, 2006 in Egypt.)

Plants affected by this disease suffer root damage (discoloration, brownish lesions, and necrosis) in the taproot and secondary roots from the early growth stages, which results in loss of their water uptake capacity. This deterioration of the root system leads to a gradual vine yellowing and decay, two weeks before harvest often resulting in total collapse as the plant approaches fruit maturity, the period of maximum demand for water. As a consequence a high percentage of fruits do not reach commercial size, have low sugar content and suffer from sun scald, resulting in most cases in a total loss of the crop (Mertely *et al.*, 1993; Garcia – Jimene *et al.*, 1994; Ray and Marvin *et al.*, 1996).

In commercial fields in Egypt, the melon crop can be totally destroyed by this disease especially in the autumn cropping season, whereas disease incidence and severity in a crop raised in the same plot during the following winter-spring season can be much lower. In recent time, Merghany in Egypt (2006) reported that the major causal agent for this disease is *Monosporascus connonballus*. Similar results in other countries were reported by other investgators (Martyn *et al.*, 1994; Martyn and Miller 1996, Karlatti *et al.*, 1997 and Cohen *et al.*, 1999 and 2000). They reported that the main causal of melon sudden wilt is *Monosporascus cannonballus*.

To date, disease management in melon fields has been mainly based on methyl bromide fumigation of the soil prior to planting. Since methyl bromide use will be prohibited in the near future (Ristaino and Thomas, 1997), there is an urgent need to develop alternative strategies for disease management.

Growing melon grafted onto *Cucurbita* rootstocks to manage soil borne pathogens is common in the Mediterranean Basin and South east Asia and have good rootstock-scion compatibility (Lee, 1994). Also, Uematsu *et al.* (1992) and Mertely *et al.* (1993) reported that *Monosporascus* wilt incidence on grafted melon plants was significantly lower than on non-grafted plants and the slow disease development and the large root system of the rootstock enable the grafted plants to complete the growing season. Cohen *et al.* (2000) reported that grafting is an effective method of managing melon *Monosporascus* wilt.

Solarization alone have slightly effect against *Monosporascus* wilt, but combining solarization with various fumigants resulted in effective control of *Monosporascus* and an increase in yield (Reuveni *et al.*, 1983).

The use of fumigants alone at lower dosages is not effective method against melon wilt but combined with solarization or grafting lead to minimization melon wilt incidence (Cohen *et al.*, 2000). Methyl bromide at 50 $g/m^2$ effectively controls *M. cannonballus* and produces a commercially acceptable melon yield (Reuveni *et al.*, 1983 Gamliel *et al.*, 1996, and Martyn and Miller, 1996).

The present study discuss approaches for the control of *Monosporascus* wilt, with an emphasis on the potential for integrated management, in view of the coming phase-out of methyl bromide. These approaches include soil fumigation by some fumigants, grafting melon plants onto *Cucurbita*, soil solarization, removing a layer (20 cm) of the top surface of soil in a field with a history of melon wilt or adding a layer of 20 cm obtained from virgin land sandy soil to diseased plots. All these treatments each alone or combined together, as an attempt to improve disease control, this is the purpose of this study.

## MATERIALS AND METHODS

Two field experiments were carried out during early autumn season of 2004 and 2005 in Nubaria area, Alex-Desert Road. Seeds of melon cv. Ideal (Galia type, Syngenta Co.) and *Cucurbita* "pumpkin" rootstock (Camelforce cv., Nunhems Co.) were sown in seedlings trays containing 84 cells of inverse pyramid shape, filled with a 1:1 (v/v) mixture of peat and vermiculite on $10^{th}$ and $13^{rd}$ of June in 2004, and 2005, respectively. Transplanting was carried out 4 weeks later in non-grafted plants and five weeks in grafted plants (four true leaves stage). All experiments were conducted in a field with a history of sudden wilt caused by *Monosporascus cannonballus* (ATUT, 2001). This field has been planted with melon 3 years (in 2001, 2002 and 2003) before carrying out the present study, and it was used again in the same plots in this study in 2004 and 2005. Soil analysis of the experimental site according to the method described by Chapman and Pratt, (1961) and are shown in Table (1), it was sandy in texture, having a pH of 8.2 and drip irrigation was the used system depends on ground water.

Each experiment included twenty-five treatments which were:

a- Four fumigants application plus the control (No fumigants).

b- Four soil treatments plus the control treatment (Untreated), the four treatment were:

1- Grafting
2- Solarization
3- Removing a layer of soil (20 cm) from the top surface of the infected field under this study.
4- Adding a layer of soil (20 cm) taken from virgin sandy soil to the top surface of the infected field under the present study.

**1- Fumigants application:**

Four fumigants, i.e., Methyl bromide, Dazomet, Metham-sodium and Formalin each at rate of 30 $gm/m^2$ were used for soil fumigation. Methyl bromide was applied using the hot gas method, Dazomet was spread on the soil and rototilled, Metham- sodium and Formalin were applied via drip-irrigation system.

**2- Grafting procedure:**

The *Cucurbita* "pumpkin" rootstock (Camelforce cv.) was used in this study. Seeds of the melon cultivar (Ideal) and of the rootstock were sown in seedling trays in early autumn as mentioned above in the same planting date. Grafting operation was made at the two-leaf stage, according to the method described by Cohen *et al.* (2004). The true leaves, one cotyledon and the growing point of the rootstock were removed with a razor blade. The roots and the lower part of the hypocotyl of the scion were also removed. Each scion was placed on the side of a rootstock (side grafted) and secured with polyethylene thread. Grafted plants were transferred to a mist chamber (relative humidity 90-95%) for a week.

**3- Soil treatments:**

**a- Solarization:**

Black plastic mulch with thickness of 55μ was used in covering the planting beds a month before planting with field water capacity of 60% until end of the growing season. Soil temperature was recorded through the growing season under this treatment (Table, 2 ).

**b- Removing a layer of soil**

A layer of 20 cm of the top surface of last season beds was removed and after that, field preparation and building beds for new season of this study have been done.

**c- Adding a layer of soil**

In another treatment, after field preparation and planting beds building, a layer of 20 cm of virgin sandy soil was added on the top surface of beds.

A split plot design with three replicates was used. The main plots were occupied with fumigants applications, whereas grafting and soil treatments were allocated at random to the sub-plot

In all above treatments, the plot area was consisting of 4 beds with 15 m long, and the bed centers were 175 cm apart, so, the plot area was $105m^2$. Black plastic mulch was used in covering the beds in both seasons. Grafted and non-grafted plants were transplanted with spacing of 50 cm.

The obtained data were subjected to the statistical analysis according to Gomez and Gomez (1984). The mean values were compared to each other using Fisher's protected least significant difference (P=0. 05).

**Data recorded:**

**A- Wilt incidence (%):**

Data on disease incidence was recorded during the two growing seasons. A plant was considered dead when the whole plant exhibited irreversible wilt symptoms. The number of wilted plants and the total number of plants per plot were used to calculate the incidence of wilt (%). Data for disease incidence were transformed prior to analysis. When the F values were significant at >0. 05, differences among the treatments were determined by Fisher's protected least significant difference (LSD) test.

**B- Yield**

In each plot in both diseased and healthy plants, fruits were collected, weighted, graded to marketable yield as well as total yield per feddan were calculated. Total yield included defected and non-defected fruits, whereas marketable yield included only non-defected fruits. The following defects have been recorded in galia melon in this study:

- Lack of color.
- Malformation.
- Net malformation.
- Sun scald.
- Decay.
- Scarring.
- Ground spot.
- Under weight (<300 gm).

Marketable yield was calculated in fruits free from the above defects, round and symmetrical fruits with complete netting

**C. TSS content %:**

Five fruits of each plot from each harvest were randomly taken and the total soluble solids percentage (TSS%) were determined using a hand refractometer.

**Table (1): Physical and chemical characteristics of the site experimental soil.**

***Physical characteristics:**

| Season | Coarse sand | Find sand % | Silt % | Clay % | Texture class |
|---|---|---|---|---|---|
| 2004 | 75.48 | 12.36 | 4.11 | 8.05 | sandy |
| 2005 | 77.00 | 11.06 | 4.18 | 8.12 | sandy |

***Chemical characteristics:**

| Season | pH | EC dS/m | $HCO_3$ | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $CL^{-}$ | $So_4^{-}$ |
|---|---|---|---|---|---|---|---|---|
| 2004 | 8.2 | 1.12 | 2.17 | 0.013 | 27.1 | 48.7 | 45.6 | 3.62 |
| 2005 | 8.2 | 1.10 | 2.23 | 0.019 | 29.5 | 49.5 | 47.4 | 3.71 |

**Table (2): Monthly average of soil temperature (°C) under black plastic mulch***

| Season | May | June | July | August | September |
|---|---|---|---|---|---|
| 2004 | 39.5 | 38.8 | 43.7 | 46.8 | 41.8 |
| 2005 | 40.1 | 39.9 | 44.1 | 47.3 | 42.2 |

*** Soil temperature:**

In solarization treatment two beds per each plot have been chosen randomly and data logger thermometer was placed 25cm depth under plastic mulch in three sites per bed separated by 2m for each thermometer. Soil temperature was recorded daily in mid-day. Average of soil temperature per day were transformed to weekly average and consequently to monthly average.

## RESULTS AND DISCUSSION

**1-Effect of fumigants application:**

**A- Wilt incidence %:**

Data in Tables (3 and 4 ) prove that since the phase-out process was initiated for methyl bromide in 1992 (Cohen *et al.*, 2000), approaches for reducing dosage and emission were developed, as well as alternative approaches, including the use of other fumigants. As shown in Tables (3 and 4), wilt incidence was significantly affected by soil fumigation with fumigants applications. Methyl bromide was the superior one to temptation and controlling *Monosporascus* followed by Dazomet, Metham-sodium and Formalin, respectively. Although methyl bromide usage will be prohibited in developed countries, the use of other fumigants like Metham-sodium, Dazomet and Formalin at reduced dosage will be allowed for the next 15 years in the developed countries (Ristaino and Thomas, 1997). The same data in Tables (3 and 4 ) reveal that 45% of unfumigated plants (control) have been lost. Similar results were obtained recently by Merghany (2006), who found that sever wilt was developed in untreated plants and 80% of the plants have been lost in these plots compared with methyl bromide treatment.

**Table (3): Effect of some fumigants application on melon sudden wilt, melon yield and TSS content, 2004 season.**

| Fumigants application | Wilt incidence (%) | Total yield (Ton /fed.) | Marketable yield (Ton / fed.) | TSS content (%) |
|---|---|---|---|---|
| **Methyl bromide** | 20.6 | 10.160 | 5.528 | 11.2 |
| **Dazomet** | 27.6 | 9.068 | 4.454 | 11.1 |
| **Metham - sodium** | 33.6 | 8.107 | 3.657 | 10.8 |
| **Formalin** | 38.9 | 7.601 | 2.863 | 10.9 |
| **No fumigants(control)** | 45.5 | 6.820 | 2.324 | 11.1 |
| **L.S.D at 0. 05** | **4.3** | **0.427** | **0.319** | **N.S.** |

**Table (4): Effect of some fumigants application on melon sudden wilt, melon yield and TSS content, 2005 season**

| Fumigants application | Wilt incidence % | Total yield (Ton/fed.) | Marketab le yield (Ton/fed.) | TSS content (%) |
|---|---|---|---|---|
| **Methyl bromide** | 22.3 | 9.607 | 4.26 | 11.2 |
| **Dazomet** | 29.5 | 8.633 | 4.028 | 11.2 |
| **Metham - sodium** | 36.2 | 7.748 | 3.273 | 10.9 |
| **Formalin** | 40.8 | 7.276 | 2.392 | 11.0 |
| **No fumigants(control)** | 48.3 | 6.295 | 1.938 | 11.1 |
| **L.S.D. at 0. 05** | **4.5** | **0.409** | **0.302** | **NS** |

**B-yield**

Although, the lowest values of wilt incidence in this study resulted in the highest values of total yield, but marketable yield parameter still affected by wilt incidence percentage. This phenomenon is the main problem with this disease as mentioned above, a high percentage of fruit do not reach commercial size, have low sugar content and suffer from sun scald, resulting in most cases in loss of the crop, two weeks before harvesting (Mertely *et al.*, 1993 and Garcia-Jimenez *et al.*, 1994). Methyl bromide application resulted in increasing marketable yield to be 5. 528 ton/fed followed by Dazomet, Metham-sodium and Formalin which was 4. 454, 3. 657 and 2. 863 ton/fed, respectively compared with unfumigated plants which produced 2. 324 ton/fed as a marketable yield in this study (Table, 3 ).

**C- TSS content:**

As shown in Tables (3 and 4 ), total soluble solids content didn't affect by fumigants applications. The highest values were recorded in plots treated by Methyl bromide followed by Dazomet, Metham-sodium and Formalin, respectively.

**2- Effect of Grafting:**

**A-Wilt incidence:**

Data presented in Tables, (5 and 6) reveal that sever wilt incidence was recorded in untreated plants (no grafting), while grafting treatment resulted in wilt incidence reduction, it was the superior one. This approach can serve as a short-term solution and can be effective method of managing melon wilt until high-quality resistant melon cultivars are released. These results are similar with those reported by Uematsu *et al.* (1992) and Mertely *et al.* (1993) who reported that *Monosporascus* wilt incidence on grafted melon plants was significantly lower than on non- grafted plants, and the slow disease development and the large root system enable the grafted plants to complete the growing season. Cohen *et al.* (2002 and 2004) reported that the rootstock's vigorous root system on a grafted plant is capable of absorbing water and nutrients more efficiently than the non grafted plant and may serve as a supplier of endogenous plant hormones, thus led to yield increases beyond that due to disease control.

**B- Yield:**

In the present study, data in Tables (5 and 6 ) prove that highly significant differences were recorded in melon yield due to grafting treatment. The grafted plants produced high record of both total and marketable yield compared to non-grafted plants. Cohen *et al.* (2002 and 2004) reported that the rootstock's vigorous root system on a grafted plant is capable of absorbing water and nutrients more efficiently than the non grafted plant and may serve as a supplier of endogenous plant hormones, thus led to yield increases beyond that due to disease control.

**C-TSS content:**

On the other hand, the grafted plants produced fruits with low content of sugars, while high sugar content was recorded in non-grafted plants (Tables, 5 and 6 ). This may be due to bitter substances in most *Cucurbita* rootstock's which its concentration is less in $F_1$ seeds than $F_2$ segregations (Cohen *et al.*, 2004).

**3- Effect of Solarization:**

**A- Wilt incidence:**

Although solarization treatment is not used in Egypt on a large scale, but data in Tables (5 and 6 ) promote this situation to be changed rapidly. The results prove that solarization treatment significantly affected in wilt incidence reduction. More than 50 % of the untreated plants have been died, whereas, these ratio changed to be not exceed more than 25 and 27% in solarized plots in 2004 and 2005 seasons, respectively. Ray and Marvin (1996) reported that *Monosporascus* appears to be adapted to hot, semiarid climates and the optimum temperature for

*Monosporascus* growth ranged from 30-35°C, no more. Also, Cohen *et al.* (1999) reported that in commercial fields, the melon crop can be totally destroyed by *Monosporacus* wilt in the autumn cropping season, whereas disease incidence and severity in a crop raised in the same plot during the following winter-spring season can be much lower. Similar results were obtained by Kim *et al.* (1996) and Pivonia *et al.* (1999) who reported that differences in soil temperature between crop seasons have been suggested as a possible cause for such a phenomenon, and this idea has been supported by enhanced wilting obtained following artificial heating of the soil during the winter-spring crop season. Melon wilt reduction in this treatment may be due to high temperature, it was more than 40. 0°C in 2005 and 2006, respectively (Table,2 ) and these temperature acted as a treatment to be enough to inhibit *Monosporascus* wilt in melon plants. These results are in agreement with those reported by Uematsu *et al.* (1992). They reported that vegetative mycelia growth of *Monosporascus* is optimal over the range of 25-35°C, perithecia formation in vitro is optimal at 25 to 30°C, whereas isolates from Japan had a growth optimum of 28 to 32°C and were inhibited above 40°C. Similar results were observed with isolates from the United States and Israel (Reuveni *et al.*, 1983), while an isolate from Libya had an optimum of 45°C (Hawksworth and Ciccaron 1978). Also Pivonia *et al.* (1999) found that the controlled laboratory tests revealed that exposure of *Monosporascus* ascospores to 55°C for 5hr. was sufficient for total inhibition of ascospore germination.

**B-Yield:**

Data presented in Tables, (5 and 6) reveal that highly significant differences were recorded in total yield as well as marketable yield due to solarization treatment. As a consequence a low percentage of wilt incidence under solarization treatment, the total yield as well as marketable yield were improved compared to untreated plants. The marketable yield in solarized plots was 4. 749 ton/feddan compared to untreated plots, it was 2. 165 ton/feddan (Table, 5), this is because a high percentage of fruits do not reach commercial size, have low sugars content and suffer from sunscald, resulting in most cases in a marketable loss of the crop, two weeks before harvest (Mertely *et al.* 1993; Garcia – Jimenez *et al.* 1999; Ray and Mervin 1996 and Merghany, 2006).

**C-TSS content:**

TSS content was better in fruits collected from solarized plants compared to untreated plants which had low TSS content (Tables, 5 and 6 ).

**3- Removing or adding a layer of soil:**

**A- Wilt incidence:**

Data in Tables (5 and 6 ) reveal that highly significant difference between treated and untreated plots were observed in wilt incidence percent due to adding or removing a layer of soil. In spite of removing or adding a layer of soil in controlling *Monosporascus* are not known traits, the results in Tables (5 and 6) prove that these methods can play an important role in controlling melon wilt in fields with a history of *Monosporascus* symptoms. Removing 20cm of the top surface of infected soil resulted in wilt reduction, it was 32. 4 and 34. 5% in 2004 and 2005 seasons, respectively, whereas adding 20cm of virgin sandy land to the top surface of planting beds in a field with a history of melon wilt resulted in melon wilt reduction by 39. 0 and 41 9 in 2004 and 2005 seasons, respectively. On the other hand, more than 50% of the untreated plots have been wilted.

**B- Yield:**

As a consequence of high percentage of *Monosporascus* wilt in untreated plots, reduction in total yield as well as marketable yield was observed (Tables, 5 and 6). The treatments of removing or adding a layer of soil resulted in improving both total and marketable yield compared to untreated plots. Marketable yield was 3.556 and 2.894 ton/fed in the treatments of removing and adding a layer of soil. respectively. whereas it was 2.165 ton/fed. in untreated plots ( Table. 5 ).

**C-TSS content:**

Although significant differences in total soluble solids content were observed between treatments of removing or adding a layer of soil and the other treatments, i.e. grafting and solarization, but no significant differences were recorded between removing or adding treatments and untreated treatment (Tables. 5 and 6).

**Table (5): Effect of soil treatments on melon sudden wilt, melon yield and TSS content, 2004 season**

| Soil treatments | Wilt incidence (%) | Total yield (Ton /fed.) | Marketable yield (Ton / fed.) | TSS content (%) |
|---|---|---|---|---|
| **Grafting** | 18.4 | 10.182 | 5.462 | 10.3 |
| **Solarization** | 24.9 | 9.395 | 4.749 | 11.7 |
| **Removing a layer of soil (20 cm)** | 32.4 | 8.518 | 3.556 | 11.2 |
| **Adding a layer of soil (20 cm)** | 39.0 | 7.494 | 2.894 | 11.2 |
| **Untreated (control)** | 51.4 | 6.177 | 2.165 | 11.2 |
| **L.S.D. at 0. 05** | **4.4** | **0.417** | **0.311** | **0.5** |

**Table (6): Effect of soil treatments on melon sudden wilt, melon yield and TSS content, 2005 season**

| Soil treatments | Wilt incidence (%) | Total yield (Ton /fed.) | Marketable yield (Ton / fed.) | TSS content (%) |
|---|---|---|---|---|
| **Grafting** | 19.2 | 9.934 | 4.959 | 10.2 |
| **Solarization** | 26.7 | 8.942 | 4.149 | 11.8 |
| **Removing a layer of soil (20 cm)** | 34.5 | 7.981 | 3.072 | 11.1 |
| **Adding a layer of soil (20 cm)** | 41.9 | 7.121 | 2.531 | 11.2 |
| **Untreated (control)** | 54.8 | 5.581 | 1.801 | 11.0 |
| **L.S.D at 0. 05** | **4.5** | **0.415** | **0.307** | **0.5** |

**4- Interaction effect:**

**A- Fumigants application with grafting**

Data presented in Tables, (7 and 8) reveal that sever wilt incidence was recorded in untreated plants (no fumigants, no grafting), while fumigants treatments and grafting each alone or their combination led to wilt incidence reduction. Methyl bromide treatment was the superior one followed by Dazomet, Metham-sodium and Formalin, respectively each with grafting in reducing wilt incidence and consequently improve both total and marketable yield. *Monosporascus* wilt was observed in 69.4% of non-fumigated plants, but grafting in these plants decreased wilt incidence to be 28.9 % ( Table, 7 ). The same trend was observed with methyl bromide, Dazomet, Metham-sodium and Formalin, wilt incidence in untreated plots was 34.9, 42.3 51.5 and 59.3 respectively, but grafting these plots resulted in wilt reduction to be 5.3, 13.8, 19.7 and 24.5, respectively (Table, 7). This approach can serve as a short-term solution and can be effective method of managing melon wilt until high-quality resistant melon cultivars are released. These results are similar with those reported by Uematsu *et al.* (1992) and Mertely *et al.* (1993) who reported that *Monosporascus* wilt incidence on grafted melon plants was significantly lower than non grafted plants, and the slow disease development and the large root system enable the grafted plants to complete the growing season. Cohen *et al.* (2002 and 2004) reported that the rootstock's vigorous root system on a grafted plant is capable of absorbing water and nutrients more efficiently than the non grafted plant and may serve as a supplier of endogenous plant hormones, thus led to yield increases beyond that due to disease control.

In the present study, fumigated and grafted plants produced high record of both total and marketable yield compared to non-fumigated and non-grafted plants which led to increased died plants, 2 to 3 weeks before harvest. The highest values of both total and marketable yield were obtained under grafting and methyl bromide treatment combination (Tables, 7 and 8 ).

On the other hand, the grafted plants under all fumigants application produced fruits with low content of sugars, while high sugar content was recorded in non-grafted plants under all fumigants in this study (Tables, 7 and 8).

**B- Fumigants with solarization:**

As shown in Tables, (7 and 8), wilt incidence was significantly affected by soil fumigation with fumigants combined with soil solarization. Methyl bromide was the superior one to temptation and controlling *Monosporascus* followed by Dazomet, Metham-sodium and Formalin, respectively. Although methyl bromide usage will be prohibited in developed countries, the use of other fumigants like Metham-sodium, Dazomet and Formalin at reduced dosage will be allowed for the next 15 years in the developed countries (Ristaino and Thomas, 1997). Solarization alone reduced wilt incidence, however, combining solarization with various fumigants resulted in effective control of *Monosporascus* and an increase in yield and improve TSS content. The obtained data coincide with those of Reuveni *et al.* (1983) Martyn and Miller (1996), Gamliel *et al.* (1996), Edelstein *et al.* (1999). Also, Cohen *et al.* (2000) reported that methyl bromide at 50 $gm/m^2$ effectively controls *M. cannonballus* and it can also be effective at lower dosages (25 $gm/m^2$) when applied with solarization, whereas each treatment alone was moderately effective.

**Table (7): Effect of interaction between fumigants application and soil treatments on melon sudden wilt, melon yield and TSS content, 2004 season.**

| Fumigants application | Soil Treatments | Wilt incidence % | Total yield (ton/fed) | Marketable yield (ton/fed) | TSS content (%) |
|---|---|---|---|---|---|
| Methyl bromide | Grafting | 5.3 | 11.875 | 8.007 | 10.5 |
| | solariztion | 13.6 | 11.072 | 7.146 | 11.9 |
| | Removing a layer of soil | 21.7 | 10.191 | 5.045 | 11.3 |
| | Adding a layer of soil | 27.8 | 9.280 | 4.131 | 11.5 |
| | Untreated | 34.9 | 8.384 | 3.312 | 11.0 |
| Dazomet | Grafting | 13.8 | 11.158 | 6.651 | 10.4 |
| | solariztion | 20.5 | 10.011 | 5.495 | 11.9 |
| | Removing a layer of soil | 26.9 | 9.398 | 4.415 | 11.1 |
| | Adding a layer of soil | 34.5 | 7.656 | 3.113 | 11.5 |
| | Untreated | 42.3 | 7.120 | 2.597 | 11.0 |
| Metham-sodium | Grafting | 19.7 | 9.740 | 5.109 | 10.2 |
| | Solariztion | 25.2 | 9.153 | 4.865 | 11.5 |
| | Removing a layer of soil | 33.2 | 8.241 | 3.426 | 10.8 |
| | Adding a layer of soil | 38.8 | 7.192 | 2.929 | 10.9 |
| | Untreated | 51.5 | 6.210 | 1.960 | 10.8 |
| Formalin | Grafting | 24.5 | 9.272 | 4.038 | 10.2 |
| | Solariztion | 29.0 | 8.804 | 3.489 | 11.5 |
| | Removing a layer of soil | 37.8 | 7.686 | 2.796 | 11.0 |
| | Adding a layer of soil | 43.9 | 7.125 | 2.468 | 11.0 |
| | Untreated | 59.3 | 5.166 | 1.527 | 11.0 |
| No fumigants | Grafting | 28. 9 | 8. 865 | 3. 509 | 10.3 |
| | Solariztion | 36. 5 | 7. 936 | 2. 750 | 11.8 |
| | Removing a layer of soil | 42. 8 | 7. 076 | 2. 099 | 11.2 |
| | Adding a layer of soil | 50. 1 | 6. 218 | 1. 832 | 11.4 |
| | Untreated | 69. 4 | 4. 005 | 1. 430 | 11.0 |
| L.S.D at 0.05 | | 4. 4 | 0. 388 | 0. 350 | 0.5 |

Generally, fumigants combined with solarization treatment resulted in increasing both total and marketable yield to be 11.072 ton/fed under methyl bromide, instead of 8. 384 ton/fed as a total yield in non solarized plants (Table, 7). The same trend was recorded under the other fumigants in the present study. Melon wilt reduction and consequently yield increasing in this treatment may be due to high temperature, it was more than 40.0°C in 2005 and 2006 (Table, 2) and these temperature acted as a treatment to be enough to inhibit *Monosporascus* wilt in melon plants. These results are in agreement with those reported by Uematsu *et al.* (1992). They reported that vegetative mycelia growth of *Monosporascus* is optimal over the range of 25-35°C, perithecia formation in vitro is optimal at 25 to 30°C, whereas isolates from Japan had a growth optimum of 28 to 32°C and were inhibited above 40°C. Similar results were observed with isolates from the United States and Israel (Reuveni *et al.*, 1983), while an isolate from Libya had an optimum of 45°C (Hawksworth and Ciccaron 1978). Also, Pivonia *et al.* (1999) found that the controlled laboratory tests revealed that exposure of *Monosporascus* ascospores to 55°C for 5hr. was sufficient for total inhibition of ascospores germination.

**Table (8): Effect of interaction between fumigants application and soil treatments on melon sudden wilt, melon yield and TSS content, 2005 season.**

| Fumigants application | Soil Treatments | Wilt incidence % | Total yield (ton/fed) | Marke-table yield (ton/fed) | TSS content (%) |
|---|---|---|---|---|---|
| Methyl bromide | Grafting | 7.8 | 11.340 | 7.103 | 10.1 |
| | solariztion | 12.9 | 10.882 | 6.534 | 12.1 |
| | Removing a layer of soil | 24.6 | 9.274 | 4.452 | 11.2 |
| | Adding a layer of soil | 28.5 | 8.750 | 3.682 | 11.5 |
| | Untreated | 37.9 | 7.793 | 2.861 | 11.1 |
| Dazomet | Grafting | 14.9 | 10.569 | 5.818 | 10.4 |
| | solariztion | 21.8 | 9.462 | 4.892 | 11.8 |
| | Removing a layer of soil | 30.2 | 8.535 | 3.890 | 11.2 |
| | Adding a layer of soil | 36.3 | 7.847 | 3.093 | 11.5 |
| | Untreated | 44.4 | 6.755 | 2.450 | 11.1 |
| Metham-sodium | Grafting | 18.9 | 9.813 | 5.019 | 10.3 |
| | Solariztion | 28.4 | 8.677 | 4.437 | 11.8 |
| | Removing a layer of soil | 35.9 | 7.820 | 2.992 | 10.7 |
| | Adding a layer of soil | 42.3 | 7.039 | 2.401 | 10.7 |
| | Untreated | 55.8 | 5.392 | 1.519 | 11.0 |
| Formalin | Grafting | 25.3 | 9.337 | 3.758 | 10.2 |
| | Solariztion | 32.7 | 8.210 | 2.860 | 11.7 |
| | Removing a layer of soil | 36.2 | 7.719 | 2.316 | 11.1 |
| | Adding a layer of soil | 46.7 | 6.566 | 1.860 | 11.2 |
| | Untreated | 63.3 | 4.551 | 1.170 | 11.0 |
| No fumigant s | Grafting | 29.4 | 8.613 | 3.098 | 10.4 |
| | Solariztion | 37.9 | 7.483 | 2.251 | 11.7 |
| | Removing a layer of soil | 45.8 | 6.560 | 1.714 | 11.3 |
| | Adding a layer of soil | 55.7 | 5.404 | 1.620 | 11.2 |
| | Untreated | 72.7 | 3.415 | 1.007 | 11.0 |
| L.S.D at 0.05 | | 4.5 | 0.422 | 0.377 | 0.5 |

TSS content was improved due to the interaction between fumigants application and solarization compared to fumigants application alone and significant differences were observed (Tables, 7 and 8).

**C- Fumigants with removing or adding a layer of soil:**

Regarding to effect of adding or removing a layer of soil (20cm) on wilt incidence and melon yield, there is no enough information in this issue, but data in Tables, (7 and 8) prove that such these agriculture practices can play an important role in wilt incidence reduction. Highly significant differences between treated and untreated plots in wilt incidence percent as well as yield and TSS content were observed due to adding or removing a layer of soil combined with fumigants application.

Wilt incidence in control plots (no adding or removing) observed in 69.4% of the plants in 2004 season (Table, 7) and 72.7 % in 2005 season (Table,8), whereas removing 20cm of the top surface of the soil in a field with a history of *Monospoarascus* reduced melon wilt to be 21.7, 26.9, 33.2 and 37.8 under combination with Methyl bromide,Dazomet, Metham-sodium and Formalin, respectively (Table 7). Similarly, adding a layer of 20 cm of soil taken from virgin sandy soil to the top surface of the planting beds in a field with a history of *Monosporascus* wilt resulted in melon wilt reduction, but it was lower than removing treatment (Tables, 7 and 8).

As a consequence of *Monosporascus* wilt reduction due to interaction effect between fumigants application and removing or adding a layer of soil treatments, both total and marketable yield have been improved compared to each treatment alone or untreated plants (Tables, 7 and 8).

TSS content was improved under removing or adding a layer of soil treatments combined with fumigants application (Tables, 7 and 8).

**Concluding Remarks**

The lesson to be learned from the present study that methyl bromide crisis is that dependence on a single method of control should be avoided, since pesticides can be banned. There appear to be promising alternative methods for the management of *Monosporascus* wilt of melon, especially when used in combination. For example, solarization, which is moderately effective alone in controlling melon wilt, still has the potential to be a component in a disease management program, either by modifying the technology or by combining it with a suitable pesticide at reduced dosage. Similarly, grafting also can contribute to management programs. Grafted plants used alone or with another soil disinfestations method may satisfactorily suppress melon wilt. Any agricultural practice that improves the plant's ability to overcome the disease like adding 20cm as a layer of virgin sandy soil to the top surface of planting beds in a field with a history of melon wilt or removing a layer of 20cm from the top surface of this field can be an important component in the integrated approach. To date, research on biological control of disease has been studied; there fore, these alternatives should also be considered in future research.

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## المكافحة المتكاملة للآفات ـ محاولة ضد مرض الذبول الفجائى فى القاوون

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أجريت هذه الدراسة بمنطقة النوبارية في سنتين متتاليتين في عروة خريفية مبكرة لعامي ٢٠٠٤، ٢٠٠٥ وذلك لدراسة تأثير كل من التعقيم الشمسي للتربة، والتطعيم على أصول مقاومة، بالإضافة إلى تعقيم التربة ببعض المطهرات الفطرية ، وإزالة أو إضافة طبقة من التربة من وإلي الحقل المصاب وعلاقة ذلك بمكافحة مرض الذبول الفجائى فى القاوون والذى يسببه الفطر مونوسبوراسكس كانونبلس. وأظهرت الدراسة النتائج التالية:-

١) أدى استخدام بعض المطهرات الفطرية إلى انخفاض نسبة الإصابة بالمرض، وكان أفضل هذه المعاملات هي معاملة بروميد الميثايل.

٢) كان تأثير معاملة التطعيم أكثر فعالية فى مقاومة المرض بالمقارنة بمعاملة التعقيم الشمسي.

٣) كانت معاملة إزالة طبقة سمكها ٢٠ سم من السطح العلوى لحقل مصاب بالمرض أكثر فعالية فى مقاومة المرض إذا ما قورنت بمعاملة إضافة طبقة سمكها ٢٠ سم مأخوذة من تربة بكر لم تزرع من قبل بأى محصول، وتم إضافتها إلى مصاطب الزراعة لهذا الحقل.

٤) أدت التداخلات بين المعاملات تحت الدراسة إلى أكثر فعالية فى مقاومة المرض بمقارنتها إذا ما استخدمت بحالة فردية.

٥) تأثر المحصول بمعدل حدوث الإصابة، وخاصة المحصول القابل للتسويق وكذلك محتوى الثمار من السكريات.

٦) أدى استخدام التطعيم الى انخفاض محتوي الثمار من السكريات الكلية.

وتوصى الدراسة إلى أنه بالرغم من استخدام بروميد الميثايل فـى مقاومـة المرض مازال هو الأكثر فعالية، إلا أن هناك بعـض البـدائل الآمنـة التـى يمكـن استخدامها للتقليل من فرصة حدوث المرض، وهو ما أثبتته نتائج هذه الدراسة.