Selection of Melon Genotypes with Resistance to Fusarium Wilt and Monosporascus Root Rot for Rootstocks

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ABSTRACT  A panel of 65 melon germplasm was used to screen for resistance to Fusarium oxysporum f. sp. melonis (Fom) and Monosporascus cannonballus. The screening test revealed 35 accessions that are highly resistant to Fom race 1 and 11 accessions with high resistance to M. cannonballus. A total of four accessions, ‘K134068’, ‘K133069’, ‘Wondae’ and ‘PI 414723’, showing resistance to both pathogens were selected as candidates for melon rootstock. Yield and quality of fruits harvested from ‘Earl’s elite’ (Muskmelon, Reticulatus Group) grafted onto the selected melon rootstocks were found comparable to or better than those of non-grafted melons. Nearly negligible incidence of fruit fermentation was observed when ‘Homerunstar’ (Honeydew type, Inodorus Group) was grafted with the selected melon rootstocks, unlike when it was grafted onto ‘Shintozwa’ (Cucurbita spp.) rootstock. The selected melon accessions with resistance to Fusarium wilt and Monosporascus root rot are considered to be potential and valuable genetic resources for breeding program of melon.

Keywords  Melon rootstock, Grafting, Soil-borne diseases, Monosporascus Root Rot, Fusarium wilt

INTRODUCTION

Soil-borne diseases aggravated by continuous cropping caused severe yield loss in melon production in Korea. Fusarium oxysporum f. sp. melonis (Fom) is believed to be the most destructive disease of melon (Lee 1994; Oda 1995). Fom attacks melon at any growth stage, even before sprouting, but mainly when the fruit is ripe (Mas et al. 1981). It causes either slow wilting accompanied by progressive yellowing, or a sudden wilting without prior yellowing and other related symptoms. Based on the host resistance genes associated with variants of this pathogen, Fom isolates were classified into four physiological races designated 0, 1, 2, and 1,2 (Risser et al. 1976).

Monosporascus cannonballus is another pathogen of melon which induces sudden wilting and has become a major production problem worldwide (Martyn and Miller 1996). Root infection and damage occur at all developmental stages but increase in water demand especially during fruit development and maturation can lead to vine collapse due to loss of water-uptake capacity (Martyn and Miller 1996).

Breeding new cultivars for disease resistance is time-consuming and does not guarantee durable resistance against new races of pathogens. However, grafting onto resistant rootstocks may enable the control of soil-borne diseases (Lee 1994; Oda 1995). Hence, combined breeding programs could be applied to prevent the occurrence of soil-borne diseases (McCreight et al. 1993).

Grafting is an important technique for sustainable production of fruit-bearing vegetables in Korea, Japan, and European countries where land is being used intensively (Lee 1994; Oda 1995). Grafting in melon cultivation makes possible increase in disease resistance and tolerance to environmental stresses such as soil salinity and low temperature. The use of rootstocks also increases adaptability of melon cultivars against different type of soil conditions.
including resistance to soil-borne diseases, which in turn contributes to total production yield and water use efficiency (Caruso et al. 1996; Yano et al. 2002). The available rootstock species for melon grafting are melon, pumpkin (Cucurbita spp.) and wax gourd (Benincasa hispida) (Traka-Mavrona et al. 2000). It was reported that the Cucurbita rootstock can influence performance of scion cultivars of melon in terms of plant growth (Ruiz and Romero 1999), fruit quality, yield, and wilt incidence (Ruiz et al. 1997; Traka-Mavrona et al. 2000; Nisini et al. 2002).

Effects of grafting to the performance of plants depend on the compatibility between rootstocks and scions, existing environmental condition, and cultivation. This is the reason why Lee (1994) suggested Cucumis melo is suitable rootstock for melon.

The objectives of this study were to select melon rootstocks for resistance against F. oxysporum f. sp. melonis (Fom) and M. cannonballus, and investigate the compatibility of the rootstock and scion being used.

**MATERIALS AND METHODS**

**Experiment location and plant materials**

The experiment was conducted at the National Institute of Horticultural & Herbal Science in Suwon, Korea (37°18′23″N, 126°58′40″E). A total of 65 melon accessions (Table 1) were screened for resistance against F. oxysporum f. sp. melonis race 1 and M. cannonballus. Screening against F. oxysporum f. sp. melonis race 1 and M. cannonballus was conducted under infested greenhouse. Melon plants were transplanted on July 9, 2011 in a randomized complete block design with three replications per genotype. Each bed was of 190 cm in size containing rows which were set at 45 cm apart.

**Rootstock and scion compatibility test**

Two melon cultivars, ‘Homerunstar’ and ‘Earl’s elite’, were grafted onto selected rootstocks: ‘K134068’, ‘K133069’, ‘Wondae’, and ‘PI 414723’, ‘Shintozwa’ (Cucurbita spp.). Both the rootstocks and scions were sown at the same time on March 31, 2011 for a synchronized grafting time. Grafting was done on April 8, 2011 when the melon seedlings (eight-day-old) are at cotyledon stage using the splice grafting technique described in Lee et al. (2010). The grafted seedlings were transferred into a mist room maintained at relative humidity of 95% for seven days. Humidity was gradually decreased later for acclimatization one week before transplanting.

Melon seedlings were transplanted in a greenhouse in rows with black polyethylene mulching films on May 7, 2011. The experimental design was consisted of randomized blocks with three replicates. A total of seven plants per replication was grown horizontally and spaced at 3 × 0.5 m (row-row x plant-plant) for each rootstock combination and cultivar. The cultivation was practiced as method described in Rural Developmental Administration (2005). Fruits from ‘Homerunstar’ and ‘Earl’s elite’ were harvested 45 and 55 days after fruit setting, respectively. The weight, length, width, soluble solid content, net formation, fermentation and appearance rate of fruits were investigated after harvest.

**Statistical analyses**

The statistical analysis was done using SAS software (SAS Institute 1995). The data from all the experiments were subjected to ANOVA and Duncan’s multiple range tests to determine the statistical significance of differences between treatments.
RESULTS AND DISCUSSION

Of the 65 melon accessions screened to develop disease resistant rootstocks, 35 were found highly resistant (HR) to *Fom* race 1 and 11 accessions showed high resistance to *M. cannonballus* (Table 1). Accessions with high resistance to both pathogens were selected as potential rootstocks for grafting, which include ‘K134068’, ‘K133069’, ‘Wondae’

Table 1. Disease severity of melon genotypes against *Fom* race 1 and *M. cannonballus.*

| Accession       | *Fom* race 1 | *M. cannonballus* | Accession       | *Fom* race 1 | *M. cannonballus* |
|-----------------|--------------|-------------------|-----------------|--------------|-------------------|
| K134068         | HR           | HR                | Seolnaehyang    | HR           | S                 |
| K134069         | HR           | HR                | V-3-6           | HR           | S                 |
| Wondae          | HR           | HR                | Earlsace        | MR           | MR                |
| PI 414723       | HR           | HR                | Acur            | S            | HR                |
| Irannetmelon    | HR           | MR                | Busan no.914    | S            | HR                |
| Dalaman         | HR           | MR                | Busan no.920    | S            | HR                |
| Hwangkeumchamoe | HR           | MR                | Unknown 3       | S            | HR                |
| Romans          | HR           | MR                | Unknown 4       | S            | HR                |
| Sageumok        | HR           | MR                | Unknown 5       | S            | HR                |
| Unknown 1       | HR           | MR                | Unknown 6       | S            | HR                |
| Unknown 2       | HR           | MR                | PMR Honeydew    | S            | SR                |
| B1              | HR           | SR                | Unknown 7       | S            | SR                |
| Baekdangkwan    | HR           | SR                | 05M40           | S            | S                 |
| Seonghwanchamoe | HR           | SR                | Charentais *Fom* 1 | S       | S                 |
| Cheongpisokwa   | HR           | SR                | Chunhyang       | S            | S                 |
| Chogambaekok    | HR           | SR                | Unknown 8       | S            | S                 |
| Daryang no.1    | HR           | SR                | 05M15           | S            | -                 |
| Julchamoe       | HR           | SR                | 05M28           | S            | -                 |
| Seonghwanchamoe | HR           | SR                | Acur Badem      | S            | -                 |
| 05M41           | HR           | S                 | Busan no.912    | S            | -                 |
| 05M42           | HR           | S                 | Busan no.928    | S            | -                 |
| Charentais *Fom* 2 | HR         | S                 | Busan no.951    | S            | -                 |
| Eunchoen        | HR           | S                 | Earlshappy      | S            | -                 |
| Gam             | HR           | S                 | Gamkwanilho     | S            | -                 |
| Gamro           | HR           | S                 | Giallo Canaria  | S            | -                 |
| Geummnodagieuncheon | HR    | S                 | Iranmelon       | S            | -                 |
| Hong            | HR           | S                 | Papais          | S            | -                 |
| Icheon          | HR           | S                 | Superstar       | S            | -                 |
| Joseonchamoe    | HR           | S                 | Unknown 9       | S            | -                 |
| Korea no.18     | HR           | S                 | Unknown 10      | S            | -                 |
| Korea no.2      | HR           | S                 | Veedrantais     | S            | -                 |
| New melon       | HR           | MR                | West            | S            | -                 |
| Oknaehyang      | HR           | S                 | Homrunstar      | S            | S                 |

*Disease severity: HR=highly resistant, MR=moderately resistant, SR=slightly resistant, S=susceptible*
Table 2. Fruit quality of ‘Earl’s elite’ (Muskmelon, Reticulatus Group) grafted onto different rootstocks.

| Rootstock   | Fruit weight (kg) | Fruit length (mm) | Fruit width (mm) | Soluble solid content (°Bx) | Net formation |
|-------------|-------------------|-------------------|------------------|----------------------------|---------------|
| K134068     | 1.4 ab             | 151.4 ab          | 136.4 ab         | 14.6 a                     | 3.1 a         |
| K134069     | 1.5 a              | 155.2 a           | 137.9 ab         | 13.8 a                     | 3.5 a         |
| Wondae      | 1.4 ab             | 151.4 ab          | 133.4 a          | 14.2 a                     | 3.3 a         |
| PI 414723   | 1.3 ab             | 147.3 ac          | 131.7 ab         | 14.2 a                     | 3.9 a         |
| Shintozwa   | 1.2 b              | 138.3 c           | 131.3 ab         | 14.8 a                     | 3.5 a         |
| non-grafted | 1.2 b              | 144.1 bc          | 129.3 b          | 13.7 a                     | 3.1 a         |

*Net formation: 1 good ~ 9 poor

Table 3. Fruit quality of ‘Homerunstar’ (honeydew type melon) grafted onto different rootstocks.

| Rootstock   | Fruit weight (kg) | Fruit length (mm) | Fruit width (mm) | Soluble solid content (°Bx) | Fermented fruit (%) | Appearance rate |
|-------------|-------------------|-------------------|------------------|----------------------------|---------------------|----------------|
| K134068     | 1.5 a              | 158.5 a           | 134.8 a          | 16.0 a                     | 6                   | 4.3 a          |
| K134069     | 1.4 ab             | 155.7 a           | 133.6 a          | 16.0 a                     | 6                   | 3.9 ac         |
| Wondae      | 1.4 ab             | 155.6 a           | 130.1 ab         | 15.7 a                     | 0                   | 3.8 ac         |
| PI 414723   | 1.5 a              | 160.3 a           | 135.1 a          | 15.8 a                     | 0                   | 4.2 ab         |
| Shintozwa   | 1.3 b              | 150.8 a           | 126.8 b          | 16.2 a                     | 81                  | 3.5 c          |
| non-grafted | 1.3 b              | 153.1 a           | 126.4 b          | 15.9 a                     | 6                   | 3.6 bc         |

*Appearance rate: 1 poor ~ 5 good
the present study did not cause deterioration in fruit quality while a conventional rootstock ‘Shintozwa’ did cause remarkable deterioration (Table 3). It was then suggested that the agents associated with fruit quality were translocated to the scion through the xylem which is likely not the case here considering the fruit quality of the rootstock-scion combination.

CONCLUSION

This study was conducted to select melon rootstocks with resistance against *Fusarium oxysporum* f. sp. *melonis* (*Fom*) and *Monosporascus cannonballus*, and to investigate the compatibility of the rootstock and the scion being used. The initial screening of 65 genotypes led to selection of four accessions (‘K134068’, ‘K133069’, ‘Wondae’ and ‘PI 414723’) with high resistance to both *Fom* race 1 and *M. cannonballus* for use as rootstocks. Subsequent compatibility assessment of grafted plants with the selected four rootstocks revealed comparable or even better performance of these plants compared to the checks ‘Shintozwa’ and non-grafted ones in terms of yield, fruit quality and fruit fermentation incidence. The findings further disproved the previous report that rootstock caused a remarkable deterioration in the fruit quality.

The selected melon genotypes with resistance to *Fusarium* wilt and *Monosporascus* root rot would serve as potential and valuable genetic resource for improvement of melon. These genotypes could also be utilized in the breeding programs that target to combine with other desirable characteristics such as cold and salt tolerance among others to address the needs of new hybrid varieties that can be produced successfully under greenhouse conditions.

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