GRAFTING IN WATERMELON

By

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B.Sc. Agric. Sci. (Vegetable Crops), Fac. Agric., Cairo Univ.,2008

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ABSTRACT

This study was conducted in the experimental farm of Sakata Seed Company, located in Ismalia Governorate, Egypt in 2012 and 2013. Watermelon [*Citrullus lanatus* (Thunb.) Matsum and Nakai] cultivar Aswan F_1 was grafted onto 5 different rootstocks, namely, 6001, Squash 3, Kazako, Emphasis and Argentario. The ungrafted Aswan watermelon cultivar was used as the control. Plants were grown in sandy soil under open field conditions. The results showed that while survival rate was low (64%) in control, it ranged from 82.0% to 100% in grafted plants. Grafted plants showed more vigorous vegetative growth than the control plants. When the soil was heavily infected with soil borne diseases, in the first season, the control plants had 7.987 ton/fed yield, while all types of rootstocks produced 30–127 % higher yield than the control. When the soil was free from soil borne diseases, in the second season, the control plants had 16.178 ton/fed yield, while grafted plants produced 9–13 % higher yield than the control. In contrast, Kazako rootstock had 12% less yield than the control. This could be attributed to incomplete compatibility of Kazako rootstock. Length and diameter of fruit and rend of fruit were positively influenced by grafting in the first year, while TSS% was significantly reduced by grafting in the second season. The study showed the importance of using grafting in heavily infected with soil borne diseases and importance of choosing the rootstocks that positively influence plant growth as well as yield and quality of scion fruit for the commercial use of grafting in watermelon fields.

Keywords: rootstock, grafting, survival rate, plant growth, yield, soil borne diseases, watermelon.

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INTRODUCTION

Watermelon *(Citrullus lanatus* Thunb.) is one of the most important vegetable crops in Egypt. It is now considered as one of the cash crop besides being a lovely summer fruit. Recently, watermelon fruits have become recognized more for their nutritional qualities it is a source of liquid containing over 90% water and 10 to 12% total solids including vitamin A, C, B6 and potassium (USDA, 2001). It has been reported that the red pigment of watermelon, lycopene, has inhibiting qualities to some forms of cancer (USDA, 2007).

In 2011, the area planted with watermelon was 171447 feddans with an average yield of 10.04 Ton/fed. According to statistical data of Ministry of agriculture (2012**).** The most famous variety which is grown in Egypt is "Aswan F_I" (supplied by Sakata Company, Japan). Spreading soil-borne diseases, which are resulted from the frequent cultivation of watermelon in the same area, is one of the most important producing regions for such crop, but is one of limiting factors facing watermelon growers in Egypt. Most watermelon varieties deteriorated as a result of the infection by disease pathogens. The problems of soil-borne diseases that have been introduced to watermelon cultivations are fusarium wilt *(Fusarium oxysporum* F. *niveum),* sudden wilt *(Monosporascus cannonballus),* and root-Knot nematode *(Meloidogyne* spp.). These diseases cause a decrease in yield and quality. There are different ways to prevent soil-borne diseases such as crop rotation, breeding programs, soil fumigant (methyl

bromide) (Rivero *et al*., 2003; Yetisir and Sari, 2003).

However, because of the great hazards of such chemicals, Methyl bromide has been banded; other chemicals are not efficient and have negative impact on health and environment.

Another control strategy is using of resistant varieties. It is effective on reducing yield loss, minimizing pesticide use and eliminating ruin problem, even some fruit characteristics may not meet the grower demand. To overcome such problems, the use of seedlings grafted on *Cucurbita* and *Lagenaria* rootstocks, which have an acquired resistance to soil borne diseases, was suggested by several researchers as an environmentally safe alternative to methyl bromide (Henderson *et al.,* 1970; Lee, 1994; Cohen *et al.,* 2000; Lee ,2003; Miguel *et al.,* 2004; Oda, 2007; King *et al.,* 2008; Boughalleb *et al.,* 2008). It was reported that the resistance of grafted plants to *Fusarium* wilt is related to rootstock's resistance (Heo, 1991).

The production of grafted plants first began in Japan and Korea in the late 1920s with watermelon (*Citrullus lanatus*)Thunb.) Matsum. & Nakai var. lanatus) grafted onto gourd rootstock (Davis *et al.,* 2008). In the beginning, grafting was adopted to reduce the effect of soilborne disease like Fusarium wilt (Scheffer 1957; Lee 1994; Ioannou 2001; Davis *et al.,* 2008). However, at present, grafting is being used for improving yield (Bersi 2002 ; Kacjan- Marsic and Osvald, 2004 ; Davis *et al.,* 2008), enhancing nutrient uptake (Ruiz *et al.,* 1997 ; Colla *et al*., 2010b), increasing the synthesis of endogenous hormones (Proebsting *et al.* 1992; Dong *et al.,* 2008), improving water use efficiency (Cohen and Naor 2002; Rouphael *et al.,* 2008a) and reducing

uptake of pollutants from agricultural soils (Otani and Seike 2006, 2007). In many cases, grafting was also used to alter hormonal production which in turn influences sex expression and flowering order of grafted plants (Satoh, 1996).

The use of grafted seedlings in Cucurbits has increased greatly in recent years in many of the major vegetable producing regions of the world. More than 700 million grafted seedlings were estimated to have been produced in 2008 in Korea and Japan alone (Lee *et al.,* 2010). The use of grafted seedlings is expected to increase rapidly throughout the world during the next few decades (Davis *et al.*, 2008; Lee *et al.*, 2010). Cucurbit plants are grafted onto various rootstock species and varieties using a range of grafting methods. Cucurbit crops that are commonly grafted include watermelon, melon and cucumber. Recently, Sakata *et al.* (2007) reviewed an article regarding on vegetable grafting and spread of its methods for this in Japan began around 1920 with a study on watermelon. Initially, *Cucurbita moschata* was used as a rootstock with watermelon to prevent fusarium wilt. In the 1930s, watermelon cultivation was achieved rootstocks from bottle gourd *(Lagenaria siceraria)* or wax gourd *(Benincasa hispida)*, nevertheless, and especially bottle gourd, was rapidly adopted after suitable rootstock species and accessions had been selected and a stable grafting method using cotyledonary-stage seedlings had been developed. Since the 1950s through the 1970s, sudden wilt of bottle gourd-grafted watermelon caused by the pathogens *Fusarium oxysporum* f.sp. *lagenariae* and/or *Pythium* spp. or by physiological disorders spread, and rootstocks to replace that of bottle gourd were

sought. Based on the results of various trials, mainly on *Cucurbita* spp., the fusarium wilt-resistant *(F. oxysporum* f.sp. *lagenariae)* bottle gourd cultivar 'Renshi' was, eventually, released in the 1980s. Since then, fusarium wilt-resistant bottle gourd rootstocks have been the main rootstocks used in Japan. The best choice for a rootstock cultivar is dependent on the production area, and many different rootstock species and cultivars are used for various conditions. The state of grafting of cucurbitaceous vegetables in Japan is briefly surveyed. The most common rootstocks for watermelon in the present time are bottle gourd, interspecific hybrids between *Cucurbita maxima* and *Cucurbita moschata* and wild watermelon (*C. lanatus* var. *citroides*) (Davis *et al.*, 2008). The compatibility of watermelon with any of these rootstocks is generally high, although there is variability within the species (Yamamuro and Marukawa, 1974). The most commonly used *Cucurbita spp*. rootstock is an interspecific *C. maxima* × *C. moschata* hybrid (Colla *et al.,* 2011).

In cucurbits such as watermelon, grafting over bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) results in early formation of female flowers (Satoh, 1996). However, in some cases like pumpkin (*Cucurbita maxima* Duchesne), bottle gourd, wax gourd [*Benincasa hispida* (Thunb.) Cogn.] and watermelon-grafted watermelon, especially in plants with ‘Shintoza’-type rootstocks (*C. maxima* Duchesne × *C. moschata* Duchesne), flowering was delayed (Yamasaki *et al.* 1994) . It was found that grafting also can limit the toxic effect caused by boron, copper, cadmium and manganese in many crops

(Edelstein *et al*., 2005; Arao *et al.,* 2008; Rouphael *et al.,* 2008b; Savvas *et al.*, 2009).

In addition to above-mentioned examples, workers have used grafting to improve quality of fruits (Fernández-García *et al.,* 2004; Colla *et al.,* 2006), though there are contradicting views on this particular beneficial effect of grafting in vegetable crops. However, changes in grafted cucurbit fruit quality appear to be both rootstock, and scion-dependent, causing contradictory reports in the literature. Grafting reportedly caused a small reduction in the sugar content of both watermelon and melon **(**Lopez-Galarza *et al*., 2004; Xu *et al*., 2005c). The total sugar content of watermelons grafted onto bottle gourd rootstock was reported to be lower than in self-rooted watermelons (Yao *et al*., 2003; Lopez-Galarza, *et al.*, 2004; Liu *et al*., 2006; Alexopoulos, *et al.,* 2007). They reported that *Cucurbita* sp. rootstock decreased the quality of watermelon fruit, but that fruit from scion grafted onto bottle gourd differed only slightly from control fruit. In contrast, other scientists found no difference in soluble solids between grafted and non-grafted (Miguel *et al*., 2004; Colla *et al*., 2006). On the other hand, Salam *et al*. (2002) showed a marked increase in watermelon TSS content when grafted onto bottle gourd. The increase of sucrose in grafted plants was accompanied by an increase of sucrose phosphate synthase and sucrose synthase activities (Xu *et al*., 2006a). In addition, it appears that sugar accumulation in mature fruit varies with rootstocks (Gao and Liao 2006; Xu *et al*., 2006b).

Quality (Brix, lycopene, flesh firmness, rind thickness, and fruit shape) of watermelon was greatly affected by grafting (Yetisir and Sari, 2003; Yetisir *et al*., 2003; Davis and Perkins- Veazie, 2005). Flesh firmness was increased slightly, lycopene was typically higher, and Brix typically lower in watermelon fruit from grafted plants using gourd rootstocks (Davis and Perkins-Veazie, 2005). Other reports demonstrated that grafting watermelon could increase lycopene (Proietti *et al*., 2008) and total carotenoids (Liu *et al.,* 2003) by 40% (Proietti *et al*., 2008) and increase amino acids, especially citrulline [a nonessential amino acid with vasodilation properties by up to 35% (Lee *et al*., 1996**)**. Taken together, reports to date indicate that depending on the rootstock-scion selection, fruit yield and quality attributes may be either positively or negatively affected by grafting (Oda, 1999; Pulgar *et al.,* 2000; Huh *et al.*, 2003; Yetisir and Sari, 2003).

In Egypt, Mounir (1965) produced grafted watermelon plants on many rootstocks for protection from fusarium wilt. Kapiel *et al.* (2005) observed that the fruit size of watermelons grafted to rootstocks having vigorous root systems is often significantly increased compared to fruits from intact plants. El-Eslamboly (2010) demonstrated that, grafting method can be used for new goal such as multiplication in difficult propagation vegetable crops such as multiplication seedless watermelon. El-Eslamboly (2010) found also that, grafting watermelon positively affected on plant vigor and plant height. Grafting Aswan hybrid on different rootstocks gave significant increases in fruit rind thickness and firmness compared with ungrafted plants. Abd El-Wanis *et al.* (2013) found that grafting of watermelon (Aswan F1 hybrid) on

bottle gourd rootstock (*Lagenaria siceraria*) local variety showed significant increment in most studied characteristics such as vegetative growth (plant height, stem diameter, leaf area, number of leaves, number of branches, plant fresh and dry weight and dry matter percentage), early and total yield in addition to fruit characters, as compared with non-grafted watermelon (control).

The objective of the present work was study the effect of grafting using different rootstocks on the yield and quality of watermelon**.**