

CROP PERFORMANCE OF SIX TOMATO AND THEIR TOP CROSSES TO CV. 'SUPERMARMANDE'

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ABSTRACT

Six F_1 hybrids obtained from crossing cvs. Strain-B, Early Pak, Floradade, UC97-3, Sel-6 and Cal Ace to cv. Supermarmande were evaluated for fruit yield and some of its main components. All F_1 crosses produced higher fruit yield than their respective parental lines except when using Sel-6. Only one cross ('Supermarmande' X 'Cal Ace') exceeded the best parent for early yield. Four crosses produced larger number of fruits/plant than the best parents while two crosses were similar to their respective lower parent. The fruit weight of crosses was similar to the smaller fruit parent except for crosses of 'Floradade' and 'Cal Ace'. However, number of locules, except for crosses of 'Strain-B' and 'Floradade', was similar to the parent of larger locules number. All crosses except one (Supermarmande' X 'Sel-6') were similar to thicker flesh parent. The six top crosses did not show deviation for total soluble solids from the best parent. While two crosses were lower than their respective parents in ascorbic acid content, other two crosses showed increased contents or were similar to their respective parents. The differential expression of heterosis in the present study reflects a variety of diversity for gene arrays for various component traits among the used six lines and the tester 'Supermarmande'. Out of the present study, cross 'Supermarmande' X 'Cal Ace' exhibited outstanding total and early yields combined with large fruit size of thick flesh and high TSS. On average, 212% and 167% increases in total yield over cvs Supermarmande' and 'Cal Ace', respectively, were produced by the cross 'Supermarmande' X 'Cal Ace'. This cross may be exploited as hybrid cultivar.

Key Words: Crop improvement, F_1 hybrids, Heterosis, *Lycopersicon esculentum*, Tomato production, Fruit yield.

INTRODUCTION

Utilizing F_1 hybrid cultivars in crop production is one of the green revolution core technologies arose in the past century (Mohamed *et al* 2002a and b). F_1 hybrids, in contrast to open pollinated cultivars, commonly exhibit enhanced growth and both crop uniformity and stability (Khalf-Allah 1970, Frankel 1983, Mohamed *et al* 2002a and b). Manifestation of hybrid vigor in crop productivity has been found useful to intensify land use and increase crop return per unit area. Dominant genes of desirable traits from both parents can be incorporated in their F_1 cross and this is regarded as reason of hybrid vigor. However, non-allelic gene interactions would also occur and in general, therefore, genomic heterogeneity is postulated to induce hybrid vigor phenomenon. In spite of the interest in heterosis, its application remained confined for long years to some few major field crops (Frankel 1983). Nowadays, F_1 hybrid seed production became widely spread in various crops including many vegetables. One reason behind this is that seed producing companies found the F_1 hybrid a good way to preserve their

intellectual property rights for new cultivar production (Hassan 1991a and 1994).

Tomato is one of the vegetable crops that have received a great interest with regard to production of F_1 hybrid cultivars (Dev *et al* 1994, Hegazi *et al* 1995, Khalf-Allah 1970, Kumar *et al* 1995 and Mohamed 1987). Due to high prices, however, currently hybrid cultivars are mostly utilized in protected cultivation where intensive nursing is applied. Establishment of national investment in hybrid seed production industry can provide tomato growers with F_1 seeds of reasonable prices to substantially extend production application into the open field. On the other side, this would create job opportunities and income for seed producers while saving hard currency transfer to export hybrid seeds and assure national control on future agricultural production.

As a first step in hybrid seed production, availability of highly homozygous but diverse parental lines is essential (Maluf *et al* 1983). Subsequently, production and test of different hybrid combinations is performed using suitable mating system such as diallel (Griffing 1956) and top crossings (Singh and Chaudhary 1985). Top crossing would be the mating system of choice if having one or few lines that are commercially desirable and possessing high adaptability. When merely hybrid cultivar is decided it would be no more than utilizing first statistics (arithmetic means) to select among different hybrid combinations in field trials (Anbu *et al* 1980). Going further to use sophisticated parameters based on second degree statistics may not be practically needed. In this study, F_1 hybrid combinations resulting from top crossing of six different tomato cultivars to parent 'Supermarmande' was studied. 'Supermarmande' was chosen as common parent because it is a highly desirable cultivar for production in Upper Egypt and it is especially adapted to cold during winter season.

MATERIALS AND METHODS

The present study was conducted during two successive years (1998/1999 and 1999/2000) in the Agricultural Research Station, Assiut University using 7 tomato (*Lycopersicon esculentum* Mill.) cultivars (Table 1). Top crosses were produced using 6 cvs as pollen lines and the cv. 'Supermarmande' as tester. All cvs were selfed for two generation (S_1) before crossing. Selfing and crossing were conducted following hand emasculation and pollination procedure (Hassan 1991a). Seeds of the seven cvs and the produced six F_1 hybrids were sown in nursery during August 1998 and seedlings were transplanted 45 days later in the open field. Plants were spaced at 30 cm in 3 m long and 1 m wide ridges. The experiment for evaluation of the parental cvs and F_1 hybrids was randomized complete-blocks with three replicates. Cultural practices were applied as recommended for production of tomato crop (Hassan 1991b). Measurements

were recorded for fruit yield harvested during the first 2 weeks (early yield), total fruit yield, average fruit weight, number of locules/fruit, fruit flesh thickness, total soluble solids (TSS, using Carl Zeiss hand refract meter) and ascorbic acid content of fruits juice (Shirokov 1974). All data were subjected to analysis of variance (Gomez and Gomez, 1984). Based on lack of interaction between the variables tomato entries and year, means were pooled over the two years. Means were separated using the "Least Significant Differences" ($LSD_{0.05}$) test.

Table 1. List of cultivars used in the present study and their seed source.

Cultivar	Source
Strain-B	Slius & Groot, Netherlands
Early Pak	Niagara Seed Co., USA
FloradDade	Castle Seed Co., USA
UC97-3	Castle Seed Co., USA
Sel-6	Assiut University Breed
Cal Ace	Peto Seed Do., USA
Supermarmande	Slius & Groot, Netherlands

RESULTS AND DISCUSSION

All F_1 top crosses to 'Supermarmande' produced higher fruit yield than their respective parental lines (Fig. 1A), except when using Sel-6. However, only one cross ('Supermarmande' X 'Cal Ace') exceeded its parents for early yield (Fig. 1B). Early yield of other crosses was similar to lower parent ('Supermarmande' X 'Strain-B') or higher parent ('Supermarmande' X 'Sel-6') or lower than the two parents ('Supermarmande' X 'Early Pack'). Four crosses produced larger number of fruits per plant than their respective parents (Fig. 1C) while two crosses were similar to their respective lower parent. The fruit weight of the crosses was similar to their respective smaller fruit parent except for crosses of 'Floradade' and 'Cal Ace' (Fig. 1D). On the other hand, number of locules for the crosses, except those of 'Strain-B' and 'Floradade', was similar to the respective parent of larger locules number (Fig. 2A). All crosses except one (Supermarmande' X 'Sel-6') exhibited flesh thickness similar to thicker flesh parent (Fig. 2B). The six top crosses did not show deviation for total soluble solids (TSS) from their respective higher parent (Fig. 2C). While two crosses were lower than their respective parents in ascorbic acid content, other two crosses showed increased contents or were similar to their respective parents (Fig. 2D).

Literature showed that manifestation of positive heterosis over the best parent for total yield is a common phenomenon in tomato (Ahmed and Petrescu, 1983. Dod *et al* 1992, Kumar *et al* 1995, Govindarasu *et al* 1982, Mohamed 1987 and 1997). Total yield is complex trait and noticeably, its heterosis usually results from increased fruit number per plant due to hybrid vigor expression in plant growth (Dev *et al* 1994, Kumar *et al* 1995,

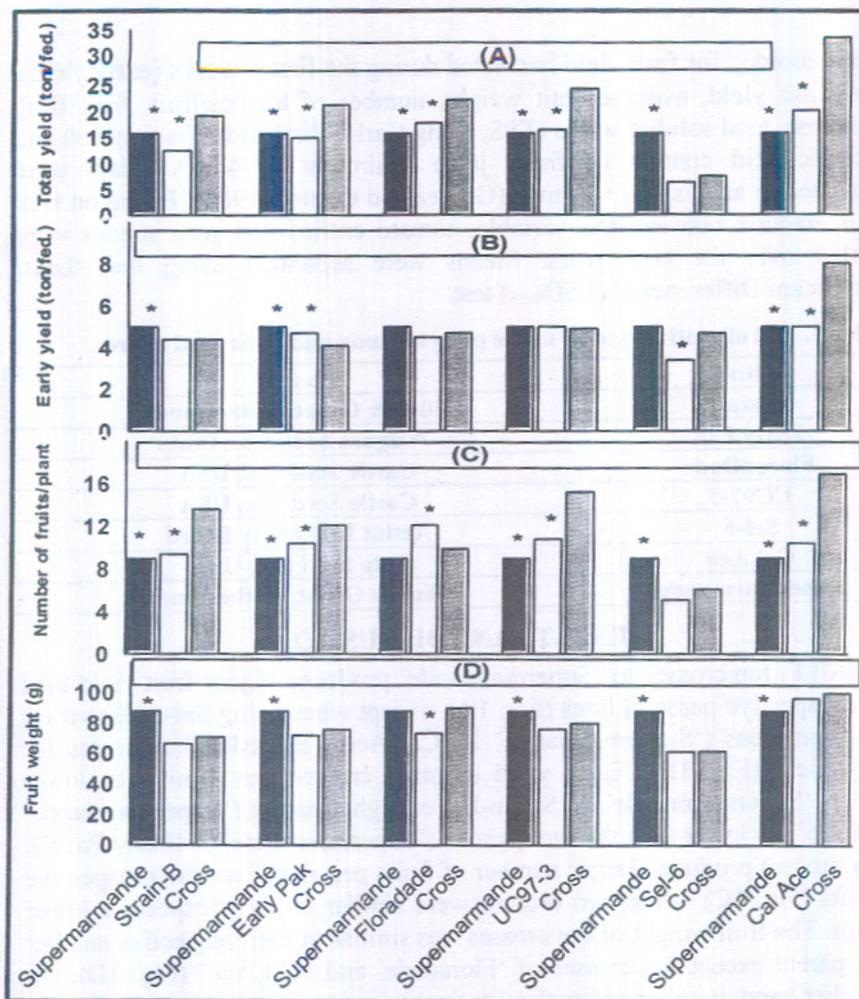


Fig. 1. Performance of six F₁ top crosses to cv 'supermarmande' for total and early fruit yield, number of fruits per plant and fruit weight. Star on the bar within each bar group (cross and their two parents) indicates significant deviation from the cross mean at 0.05 level of probability.

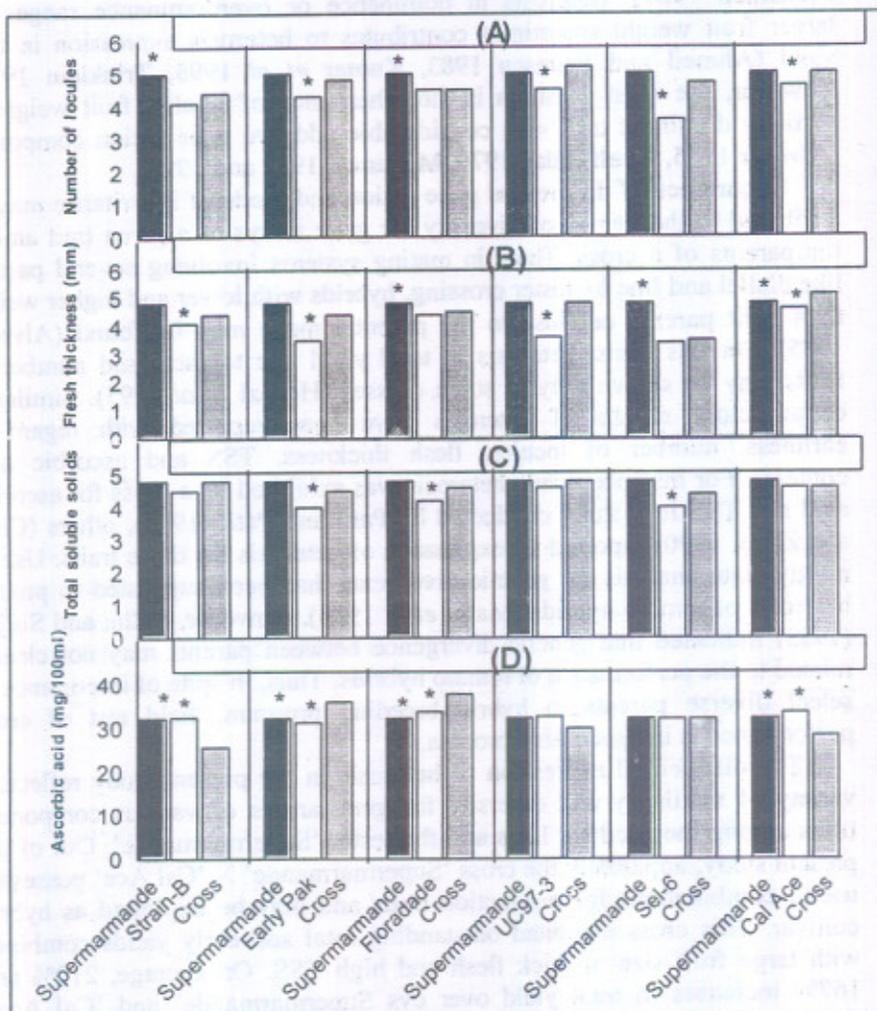


Fig. 2. Performance of six F_1 top crosses to cv 'supermarmande' number of locules per fruit, flesh thickness, total soluble solids and ascorbic acid content in the fruit juice. Star on the bar within each bar group (cross and their two parents) indicates significant deviation from the cross mean at 0.05 level of probability.

Mohamed 1987). Heterosis in dominance or overdominance ranges for larger fruit weight sometimes contributes to heterosis expression in total yield (Ahmed and Petrescu 1983, Kumar *et al* 1995, Trinklein 1975). However, the most common is the inheritance of smaller fruit weight as partially dominant trait with considerable additive gene action component (Alvarez 1985, Khalf-Allah 1970, Mohamed 1987 and 1997).

Occurrence of differential gene action and mode of inheritance may be attributed to the degree of diversity for gene arrays of a given trait among the parents of a cross. Thus, in mating systems involving several parents like diallel and line by tester crossing, hybrids with lower and higher weight than their parents or close to the parental mean may be found (Alvarez 1985). On this basis, heterosis in total yield due to increased number of fruits may be shown only in some crosses (Hegazi *et al* 1995). Similarly, contradictory results of heterosis have been reported with regard to earliness, number of locules, flesh thickness, TSS and ascorbic acid contents. For instance, while heterosis was exhibited by a cross for ascorbic acid and TSS in a study conducted by Patil and Patil (1988), others (Chen and Zhao, 1990) reported no expression of heterosis for these traits. Use of multivariate analysis for genetic divergence has been suggested to predict heterosis of tomato hybrids (Maluf *et al* 1983). However, Sidhu and Surjan (1993) indicated that genetic divergence between parents may not clearly related to the performance of tomato hybrids. Thus, in spite of importance to select diverse parents in hybrid breeding program, field test of cross performance is indispensable process.

The differential expression of heterosis in the present study reflects a variety of similarity and diversity for gene arrays of various component traits among the used six lines and the tester 'Supermarmande'. Out of the present study, apparently the cross 'Supermarmande' X 'Cal Ace' possesses useful combinations for production traits and may be exploited as hybrid cultivar. This cross exhibited outstanding total and early yields combined with large fruit size of thick flesh and high TSS. On average, 212% and 167% increases in total yield over cvs 'Supermarmande' and 'Cal Ace', respectively, were produced by the cross 'Supermarmande' X 'Cal Ace'.

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الإداء المحصولي لست هجن قميه لصنف الطماطم "سوبر مارند"

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استخدم في هذه الدراسة والتي اجريت بمحطه البحوث الزراعيه بكلية الزراعة - جامعه اسيوط ست هجن قميه للاصناف ستين بي و ابرلى باك و فلورايد و يوسى 97-3 و سيل 6 و كال ايس كمعطى لحيوب اللقاح مع الصنف السوبر مارند كام. وقد وجد من تجارب التقييم ان كل الهجن قد انتجت محصولا اعلى من الاباء عدا هجين (سيل 6 x سوبر مارند) اما بالنسبه للمحصول الميكر فقد وجد هجين واحد فقط هو (سوبر مرند x كال ايس) متعليا افضل ابويه ، وقد انتج اربع هجن عدد ثمار اكثر/نبات عن افضل ابويها ، وقد وجد ان وزن الثمره للهجن كان يماثل الاب ذو الثمار الصغيره عدا في الهجين (سوبر مارند x فلورايد) و (سوبر مرند x كال ايس) . وكان عدد الحجات/الثمره مشابهه للاب الاكثر عددا في الحجات عدا الهجن (سوبر مارند x ستين بي) و (سوبر مارند x فلورايد) وكان كل الهجن عدا (سوبر مارند x سيل 6) مشابهه لثمار الاب الاكثر سمكا للحم ولم يظهر اى من الهجن اتحراف معنوى للمواد الصلبه الذاتيه فى عصيرها عن افضل ابويها. وكان هناك تباين فى اداء الهجين بالنسبه لمكونات حمض الاسكوربيك فى عصير الثمار. وهذه الدراسه تقدم الهجين (سوبر مارند x كال ايس) لامكان تقيمه كصنف هجين جديد فى الطماطم نظرا لافطاره تفوق معنوى واضح فى محصول الثمار والتكبير ويصاحب ذلك انتاج ثمار كبيره الحجم ذات لحم سميك مع ارتفاع نسبه المواد الصلبه الذاتيه فى عصيرها. وقد كانت الزيادة فى محصول هذا الهجين 212% مقارنة بالسوبر مارند و 167% مقارنة بالكال ايس

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