USING OF BREEDING APPROACHES IN IMPROVING FRUIT QUALITY IN ANNA APPLE CULTIVAR

By

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B.Sc. Agric. (Genetics & Genetic Eng.), Fac. of Agric., Zagazig Univ., 2003

M.Sc. Env. Sc., Inst. of Env. Studies & Research, Ain Shams University, 2013

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ABSTRACT

Mai Ibrahim Anwar Mohamed: Using of Breeding Approaches in Improving Fruit quality in Anna Apple Cultivar. Unpublished Phd Thesis, Department of Horticulture, Faculty of Agriculture, Ain Shames University, 2020

Two field experiments were carried out during the two successive seasons of 2016 and 2017 in private sector farm at El–Sadate, Nubaria Governorate, Egypt at the first experiment on four apple cultivars *Malus domestica* (anna as famel and Ein Shemer, Dorset Golden, E25 as male). The purpose of this study was to determine the degree of self and cross-compatibility or incompatibility between these cultivars and anna cultivar via following pollen germination on stigma and pollen tube growth throughout style by fluorescence microscopy, fertilization, embryo sac development, fruit set and fruiting percentages. fruit properties were studied on anna fruit.

The results confirmed that anna cultivar is self-incompatible and cross incompatible of anna with Dorset Golden and Ein Shemer cultivars while, it is partial-compatible with E25cultivar although, these cultivars exhibited high pollen viability.

The highest significant initial fruit set, fruiting percentage for Dorset Golden. The second experiment studies the effect of chemical mutagenes (ethyl methane sulphonate (EMS), malic hydrazine (MH) and colchicines) with concentration at (0.05, 0.1and after grafting**,** vegetative growth, fruit quality and total percentage 0.2%) on survival yield of tree. The chemical mutagenes given the best results in vegetative growth, fruit quality and total yield of tree compared with control. However control gave highest after grafting. And also studies relationship and correlation percentage value on survival coefficient based on phenotypic dendogram found that colchicine 0.05% and colchicine 0.1%, this reflect a similar effect of colchicine at the two concentration on tested phenotype characteristics

Key Words: *Malus domestica*, Self and cross pollination, incompatibility, pollen viability, pollen tube growth, fruit set, (ethyl methane sulphonate (EMS), malic hydrazine (MH) and colchicines) survival percentage, vegetative growth, fruit quality and fruit properties.

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INTRODUCTION

The genus *Malus* belongs to the subfamily domestica of family *Rosaceae* which contains at least 22 widely recognized primary species. Apple is one of the deciduous fruit in Egypt the important species Anna, Ein Shamir, Dorset Golden, E25 and *Malus communis.* All examined species of apple were diploid (2n= 34, x=17) a few of them were polyploidy. Apple (*Mauls domestica)* is one of the most important fruit crops with **2006)**. The total area non-self-compatibility among known apple cultivars (**Hegedûs,** cultivated from apples in the Arab Republic of Egypt is about 71,544 feddans, the fruitful area is about 68,743 feddans, producing 716,271 tons, and the average production per feddan is about 10,420 tons / feddans (according to the statistics of the Ministry of Agriculture for the year **2017**). Mostly cultivated by Anna, Ein Shemer, Dorset Golden, E25 and *Malus communis*, cultivar. Most of this area is concentrated in Nubaria, Matrouh, New vally, North and South sinia Governorates. Apple pom fruits belongs from Southeast Asia, and it is one of the trees in the temperate zone whose cultivation extends from Japan and China in the east to North America in the west. The most important determinant of the spread and success of its cultivation is the availability cold of the necessary to break the dormancy phase in the winter need about (300-350) hour.

The cultivated apple is likely the result of inter specific hybridization (**Forsline *et al.*, 2003**). *Rosaceae* family has the gametophytic self incompatibility (GSI) system wherein pollen tube growth is controlled the S locus (**Schneider *et al.*, 2005 and Kubo *et al.*, 2010**). Self-incompatibility (SI) is an intraspecific reproductive barrier adopted by angiosperms that allows the pistil to distinguish between self (genetically related) and non-self (genetically unrelated) pollen **(Kubo *et al.*, 2010**). The pistil and pollen determinants of S-specificity in Rosaceae are a ribonuclease and an F-box protein, respectively (**Yamane and Tao,2009**). Apples have gametophytic self-incompatibility controlled by the multi-allelic S-locus **(De Nettancourt, 1977; Kobel *et al.*, 1939**), therefore pollinizers suitable for commercial cultivars should be selected according to their S-genotypes, flowering period synchronization, and so on (**Matsumoto *et al.*, 2003, 2007, 2009**).

Mutation with colchicine originally extracted from colchicum autumnale,may induce some morphological, cytological and histological changes, and even changes in the gene level and dobulication in chromosome **(Murali, *et al.*,2013).** Chemical mutagens such as ethyl methane sulphonate (EMS), a compound of the alkaline sulphonate series, is most frequently used for chemical mutagenesis in higher plants due to its potency and the ease with which it can be used it usually causas high frequency of gene mutations and lo frequency of chromosome aberrations **(Mohamed *et al.*, 2014).** Malic hydrazine induced a high frequency of somatic mutations and high yield of chromosome aberrations (**Tomas *et al.*, 2000).**

The present study aim to

1- Investigate self and cross pollination (compatibility and/or incompatibility) for Anna apple cultivar and Ein Shemer, Dorset Golden and E25 cultivars by following pollen germination and pollen tube growth

2- Produce hybrids between Anna as female cultivar and Ein Shemer, Dorset Golden and E25 cultivars under study as male plant of the fruit breeding department program.

3- Studying the effect of different pollen sources on fruit set, physical and chemical fruit properties.

4- To study the effect of some chemical substances i.e., (ethyl methane sulphonate (EMS), malic hydrazine (MH) and colchicine) at different concentrations on vegetative growth characteristics, fruit quality, chemical quality and survival percentage after grafting of apple cultivar.

REVIEW OF LITTERATURE

2.1. Cross and self pollination in apple cultivars:

Apple blossoms open very quickly if the weather is warm and dry. It is preferable, therefore, to collect and store pollen several weeks in advance of the bloom period to ensure that the pollen required is available when needed. It will retain its viability for 2 to 3 weeks at room temperature (**Janick and Moore, 1996**). The quality of pollen usually determined by comparing the performance of the different pollen types in the orchard (percentage fruit set in spring and fruit weight at harvest) and by comparing the percentage germination of pollen type *in vitro*. Lower viability of pollen related in correspondingly to lower fruit set.

2.1.1 Pollen viability

Pollination occurs when the pollen grain drop on the papillae of the stigmatic surface. Two principal ways in which pollen is transferred from anther to stigma; it is transferred by insects or by the wind. In a wind pollination system, stigmas of the flowers are relatively large compared to stigmas in other flowers, so that the chance of pollen grain to land on the stigma and germinate is greater than it would be otherwise. Pollen grains are very small and light. Also, the number of pollen grains formed is tremendous **(Westwood, 1978).**

Aulakh *et al.* (1981) reported that the difference in pollen viability in pear cultivars may be due to the difference in temperature and relative humidity (RH) during anthesis and its viability extended from 3rd week of February to 1st week of March. **Atawia (1997)** mentioned that viability of pollen grain for apple and pear sp. Ranged from 79.17-81.21% and 61.25-63.19% respectively. Mean while, germination of pollen grains of leconte cultivar.

Pollen could be frozen and stored for one year at (-18ºc) without significantly reducing fruit set provided that there was no warming of pollen during storage. **(La Franchie, 2002).**

In addition, **Singh *et al*. (2004)** found that pollen germination percentage on artificial medium ranged between (59.3-66.6 %) in LeConte pear cv. and stainable pollen grains percentage ranged between (75.6-81.7%). The different pollen viability in

cultivars may be due to the difference in temperature and relative humidity (RH) during anthesis.

of apple 2.1.2 Pollination

Apple pollen grains are elliptical, tricolpate and pollen germination is highly dependent on temperature. Most apple pollination occurs through cross-pollination; however, some cultivars have been reported to self-pollinate. Most apple cultivars have a gametophytic self-incompatibility (GSI) system; however, others are semi compatible, or fully self-compatible. The main insect pollinators of apple are honey bee and *Hymenopterans* especially, *Dipterans* and *Coleopterans*. Environmental conditions such as temperature, rain and high wind speed negatively affect pollination **(Fernando and Thomas, 2013).**

Jackson, (2003) reported that anthesisis the process of flowers opening coupled with anther dehiscence and pollen grainrelease.

Webster, (2002) and Singh *et al*. (2004) mentioned that the most commercial cultivars of pear are self incompatible, while others produce sterile pollen, moreover many conditions are also necessitate for cross pollination and most varieties fail to set crop with their own pollen and set better with cross pollination.

Tassinari *et al*. (2004) calculating the self pollination and the fertility index (ratio of seed no. /flower no.). Self pollination revealed a varying range of self fertility in pear cultivars.

A series of controlled crossings carried out to establish the relationship between *M. sylvestris* and its near relative, *M.* x *domestica*. By looking at fruit set, seed production, germination percentages, and development of seedlings following inter- and intraspecific crossings, no indication of neither pre- nor postzygotic barriers to hybridization between the two species was found. This can have important implications for management of the genetic resources of M. sylvestris **(Larsen *et al.* 2006)**.

Shogo *et al.* (2012) studied the inadequate partial pollination using one out of five pistils for pollination contributed to increasing generation of lopsided 'Fuji' apple fruits and to decreasing in the seed number in a fruit. Biased seed distribution also seemed related to the generation of lopsided 'Fuji' fruits. Two- or three-time repeated