

**STUDIES ON BREEDING AND IMPROVEMENT
OF POTATO (*Solanum tuberosum* L.) THROUGH
MUTAGENESIS AND SELECTION**

By

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**B.Sc. Agric. Sci. (Horticulture), Fac. Agric., Aleppo Univ., Syria, 2000
M.Sc. Agric. Sci. (Vegetable Crops), Fac. Agric., Cairo Univ., Egypt, 2006**

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APPROVAL SHEET

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ABSTRACT

This work was carried out at the Experimental Farm, Faculty of Agriculture, Cairo University, during the period from 2006 to 2009. The main objective of this work was to study the efficiency of the mutagen ethyl methane sulphonate (EMS) in the process of mutation in three cultivars of potato, namely, Atlas, Nicola and Simon, as well as, to induce genetic variability for selecting mutants with improved yield and quality of potato tubers, and to produce potato genotypes more resistant to early blight disease (caused by *A. solani* fungi). Sprouted tubers of potato cultivars were soaked in 0, 20, 30 and 40 mM/l water solution of EMS for 3 hours. Significant differences were detected among all tested EMS concentrations in survival percentage, Stem number per plant, plant height, stem diameter, growth vigor and yield and its component characteristics: the number of tubers/plant, tuber weight (g), and total tubers weight (g)/plant for the three cultivars. The gradual increase in EMS concentrations resulted in significant gradual decreases in vegetative, yield and its component characteristics. The highest concentration of EMS (40) mM/L exhibited the most inhibition effect on plant vegetative traits characteristics. Selection for yield and quality improvement began in the M_1V_2 . Thirty one clones -with improved characteristics- were selected from the three potato cvs. Atlas, Nicola and Simon as follow: Twelve plant from Atlas cv., Eleven plant from Nicola cv., Eight plant from Simon cv.. Concerning evaluation and selection for resistant to early blight disease, nine clones were selected at M_1V_2 from all obtained and evaluated cultivars; four from Atlas, two from Nicola and three from Simon according to its resistant to *A. solani* L. fungi. The nine selected clones of M_1V_2 generation and evaluated in the M_1V_3 generation were significantly more tolerance to *A. solani* with lower disease progress curves and significantly decreased mean infection ratings. There were significant differences in early blight scoring between the selected clones and the control at all evaluation times in the three cultivars. The genetic variability among some of the selected clones of potato which showed high levels of tolerance to early blight inoculation (A1, A2, S1, S2, N1) and their original cultivar (Aco, Sco, Nco) for cvs. Atlas, Simon and Nicola, respectively; Based on randomly amplified polymorphic DNA (RAPD) relationships analyses were studied, using seven random 10-mer primers. The bands were polymorphic at the used primers amplification. It could be concluded that each selected clone was geneticaly different from other clones and original cultivar. Further studies in the future will include detailed investigations on those clones, studies will detect the stability of early blight tolerance, morphological characters and as well will estimate its yield quantitatively and qualitatively under field conditions.

Key words: Potato, mutations, selection, early blight, ethyl methane sulphonate, fingerprint, RAPD-PCR

DEDICATION

This thesis is dedicated to the Most High God (Allah) my creator and savior, without whose grace, power and wisdom I would not have reached this height in my academic pursuit; and to my wife Rasha and my kids Naya and Issa for their patience and help, and to my late father (may Allah have mercy on his sole) and mother, whose upbringing, love and support constantly sustained my early childhood, secondary and university education as well as to my sisters and brothers (Yosra, Samar, sameer, Samer and Waseem) for their love, kindness, constant encouragement and all the support they lovely offered along the period of my post graduation.

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the important crops all over the world after wheat (*Triticum aestivum*), maize (*Zea mays*) and rice (*Oryza sativa*). The importance of potato in industrialized countries is well known. However, its importance in developing countries is less widely recognized. Potato is one of the most important vegetable crops grown in Egypt as its average production is 2,760,460 Mt (Metric ton), while in Syria the production is 570,128 Mt in 2007 year (FAO). Potatoes are cultivated under different environmental conditions.

There are 162 tuber-bearing *Solanum* species in *Solanaceae*, out of which 8 are cultivated. Among this *S. tuberosum* is the only tetraploid world-wide distributed species. A considerable effort has been made to improve potato qualities by classical breeding techniques. However, due to the tetrasomic inheritance the extreme heterozygosity of parental breeding lines, the chances of finding superior potato cultivars with a virtually complete set of desired agronomic traits is remote.

Potato is a tetraploid, vegetatively propagated crop, and as such poses several problems for plant breeders. These include a high level of heterozygosity, common occurrence of pollen sterility, selection difficulties in the seedling and first clonal years, difficulties in germplasm storage and transport, and the build-up of viruses.

Even today, major potato cultivars generally lack at least some agronomically important characteristics like disease and pest resistance

and environmental stress tolerance. Therefore induced mutations in potato have received much attention (Van-Enckevort *et al.*, 1998).

Mutation breeding combines several advantages in plant improvement by upgrading a specific character without disrupting the original genetic make-up of the cultivar; it provides a rapid method to improve local crop varieties, without going through extensive hybridization and back crossing used in conventional breeding. It is more effective than hybridization even when desired genes are present but tightly linked to undesirable genes.

Induce mutations is a preferred technique for breeding vegetatively propagated crops because even single desirable mutant can be multiplied to take long term advantage of its superiority. Mutation breeding is applicable to all the crop plants but it has special application in vegetatively propagated plants.

Plants of vegetatively propagated crop species are usually very heterozygous; vegetative propagation ensures that this heterozygosity is maintained by perpetuating the same genotype. This means that once the breeder has achieved the desired level of resistance to a parasite in vegetatively propagated crop, this level of resistance can be maintained without further selection while it is being multiplied. In this respect vegetatively propagated crops resemble self-pollinated crops (Russell, 1978).

One of the most promising techniques for producing disease resistant forms of plants is the use of mutagenic agents. It has been demonstrated by several workers that genetic variability for several

desired characters can be induced successfully through mutations and its practical value in plant improvement programmes has been well established. The main advantage of mutation breeding is the possibility of improving one or two characters without changing the rest of the genotype.

Sources of resistance to disease can be induced, or, more accurately, made to occur more frequently, by mutagenic chemicals or radiation treatments of the host plant. Induced mutations for disease resistance usually occur naturally, albeit at low frequencies. Nevertheless, induced mutations can be an effective way of increasing the frequency of genes for resistance which occur only rarely in natural population (Russell, 1978).

Early blight, caused by *Alternaria solani* L. fungus, is one of the main diseases of potatoes that occurs in most potato-growing regions world-wide, Especially at tropical climates, where potatoes are grown under irrigation, causing yield-losses through defoliation of the plants. The fungicides used to control the disease are expensive and frequently inefficient (Rodreguez *et al.*, 2007). Developing new potato cultivars with resistance to early blight may reduce losses in the field and in storage, and lessen the need for fungicide applications.

The main objective of this work was to study the efficiency of the mutagene Ethyl Methane Sulphonate (EMS) in the process of mutation in three cultivars of potato, namely, Atlas, Nicola and Simon, as well as, to induce genetic variability for selecting mutants with improved yield and quality of potato tubers, and to produce potato