

### SENESCENCE OF *RIN*, *rin/rin*, *rin/+* AND *+/+* TOMATO FRUITS

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Ripening inhibitor (*rin*) gene is a spontaneous recessive mutant which changes fruit ripening aspects (most important synthesis of carotene, especially lycopene). It also delays fruit senescence. Tomato is a vegetable crop with specific maturing climax (pik). Tomato genotypes homozygote for *rin* gene does not have this maturing climax, so the ethylene production and red, lycopene colour does not appear. In order to research the maturing process material from the final tomato selection cycle we used: pure line S-49 (genetic constitution *u/u*, with uniform ripening), line hom 4 (*rin/rin*, homozygote with *ripening inhibitor*) and hybrid combination 449 F1 (*u/rin*, heterozygote for *ripening inhibitor*). Fruits with uniform ripening and hybrids ripened simultaneously, while homozygote with *rin* gene did not ripe at all. Ethylene stimulates the appearance of yellow colour in *rin* fruits and the lycopene production. After treatment with ETEPHONE (0.1%) (Ethylene) fruits with uniform ripening, senescence more quickly, while hybrids senescence slowly. *Rin* homozygotes did not change colour, but the fruits senescence more quickly comparing to control. Ethylene treatment speeded the maturing and senescence process in tomato fruits. Extended maturing process as a result influence of *rin* gene, makes the new created hybrids a late maturing ones. On the other

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hand, the firmness of fruits is improved as well as the »shelf life«, which enables longer transportation and storing, coordinated maturing according to market demands. The aim was to research the maturing process of *rin* heterozygote, and the reaction of some genotypes to treatment with ET-REL (Ethylene) in order to decrease extremely late maturing.

*Key words:* tomato, fruit maturing and senescence, uniform maturing, effects of ETEPHONE

## INTRODUCTION

Gene *rin* (ripening inhibitor) stops or elongates the usual fruit maturing processes excluding the seed maturing. All these mutants do not increase ethylene production, while for *rin* gene, there is no ethylene whatsoever (TIMOTY and TIGCHELAAR, 1977; TIGCHELAAR *et al.* 1988). The first change of fruit colour for F<sub>1</sub> hybrids gained from crossing *rin* genotypes with normal ripening varieties is very late. Late appearance of fruit colour points to slow lycopene synthesis. These fruits have late maturing and senescence and longer *shelf life* (fruits are fresh long after picking) (LUKASHENKO, 1990; AGAR *et al.*, 1994; GRANGES *et al.*, 1995; FARKASH, 1995).

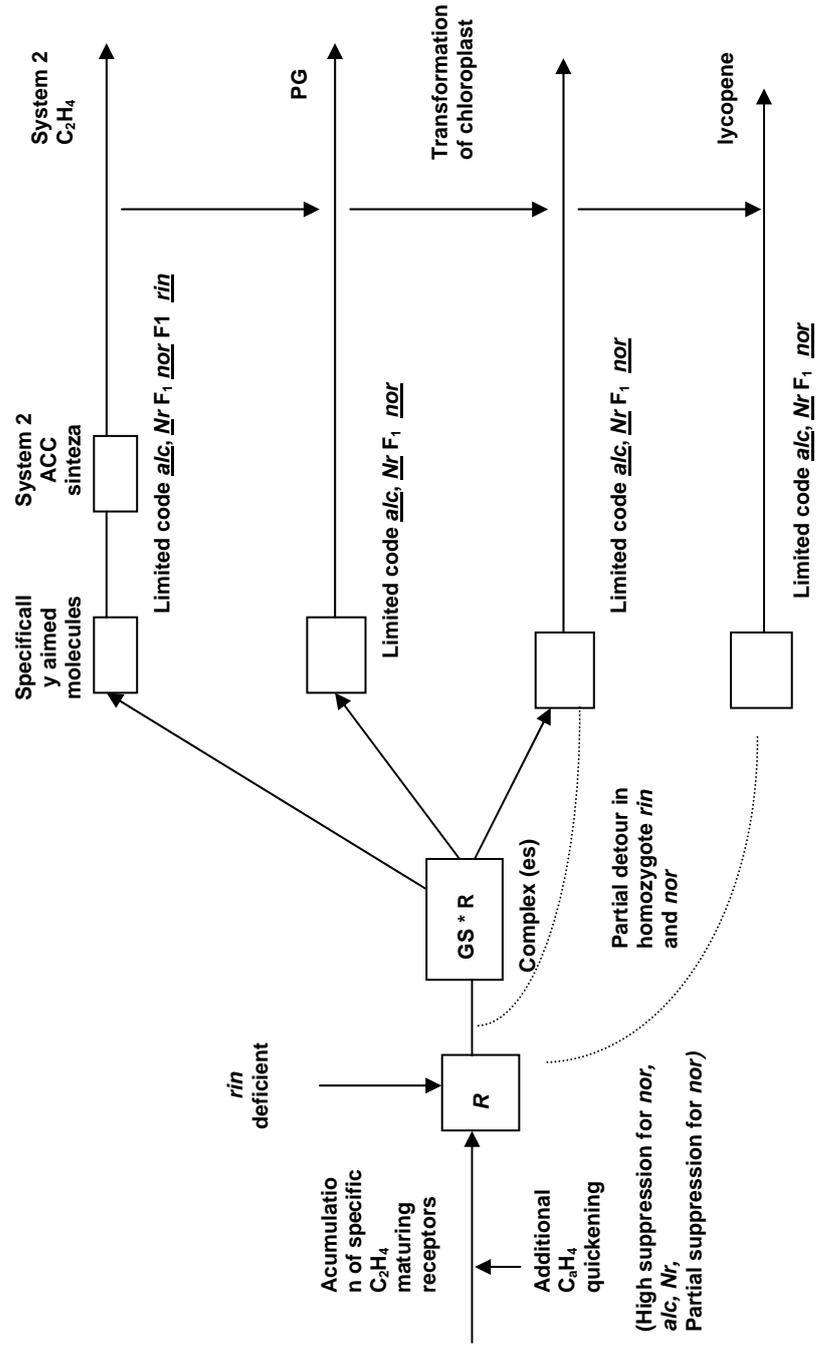
Table 1. Maturing of hetero zygote +/-*rin* fruits

Maturing characteristics	+/ <i>rin</i>
Time from pollination to respirator climax	delays 2-3 days
Respirator climax	delays significantly from normal
Decrease of ethylene production	delays 35-50% from normal
Shelf life	Normal
PG activity	25-60% from normal
Carotene accumulation	delays and stops maturing
Fruit quality	
a) pH	normal
b) titrate acids	normal
c) soluble matters	normal

(TIGCHELAAR *et al.*, 1988)

For heterozygote normal x mutated genotypes, most changes are: decrease number of fruit and late ripening (Table 1). From the physiological point of view, period from pollination till maturing is not the same for hybrid genotypes, normal and homozygote mutants. This diversity could be explained by un-harmonized gene reaction, which is being activated in various fruit development stadiums and during the maturing process (Scheme 1).

The most critical moment is the begging of ethylene production, which is low for genotypes with *rin* gene comparing to genotypes with uniform ripening. In that way the begging of maturing process is postponed and it takes more time for complete ripening i.e. till the full colour and therefore they delay the maturing.



Scheme 1. - Genetic control of tomato maturing

Fruits do not have a good taste (MC GLASSON *et al.*, 1987; GAVRISH and KOROL, 1988; GRANGES *et al.*, 1995; AGAR *et al.*, 1994).

There are lots of commercial tomato hybrids bearers of *rin* gene, which delay fruit maturing and practically these are middle late hybrids with good fruit firmness (GAVRISH and KOROL, 1988; TIGCHELAAR and SILVAS RIOS, 1988). The aim was to research the ripening of *rin* heterozygote, as a reaction of genotypes to ETREL (ETEPHONE) treatment in order to reduce the extreme values of late ripening.

#### MATERIAL AND METHODS

For researching the effect of ethylene in maturing processes, the researching material was selected from the finishing cycle of selection pure line S-49 (genetic constitution  $+/+$ , with uniform ripening), line hom 4 (*rin/rin*, homozygote for ripening inhibitor) and hybrid combination 449 F1 ( $+/rin$ , heterozygote for ripening inhibitor). Plants were grown in green house conditions in the Centre for Vegetable Crops. Fruits were picked on July 31<sup>st</sup> 2003 in condition when the seed is mature and the colour of fruits is still green. The picked fruits were stored in dark room on 23<sup>o</sup>C. Data regarding the maturing and senescence were taken every two days, starting from 9.09.2003.

Half of the fruits were treated with 0.1% etephonee solution for 1 minute. Non treated fruits were the control both for genotypes and treatments.

Results of research were presented regarding the trend of maturing and senescence of fruits during the shelf life (NEGIĆ *et al.*, 1991)

#### RESULTS AND DISCUSSION

Based on visual comparisons of the fruit colour, we found significant decrease of  $+/rin$  comparing to control. *Rin* fruits were red, while the inner colour was similar to the wild type. Heterozygote  $+/rin$  showed significant similarity to homozygote control ( $+/+$ ) except for the colour.

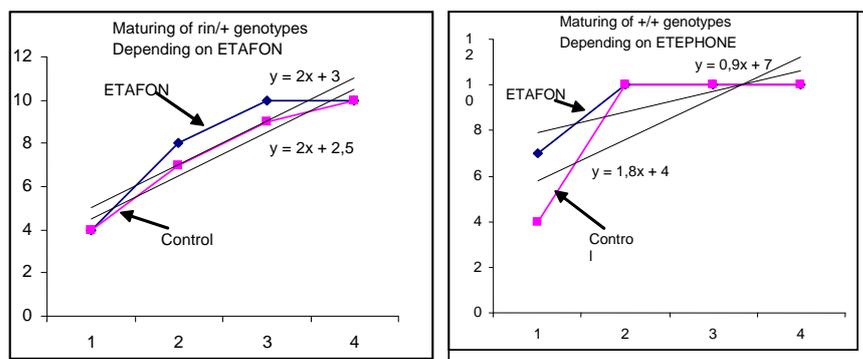


Fig. 1 and 2 - Fruit maturing influenced by (ETEPHONE)

Results of fruit maturing influenced by ethylene for genotypes bearers of different genes for tomato fruit ripening, showed that fruits treated with *rin/+* (449 F<sub>1</sub>) genotype have similar ripening period comparing to control. Comparing to +/+ (S-49), fruits with uniform ripening matured more quickly comparing to genotype *rin/+*, but the control was mature in 5 days. Treated variant started to ripe earlier during the first days after picking and was completely mature after 5 days (Fig. 1. and 2.). Concentration of 100 ppm of ETAFONE did not cause change of colour for *rin/rin* genotypes till the end of experiment.

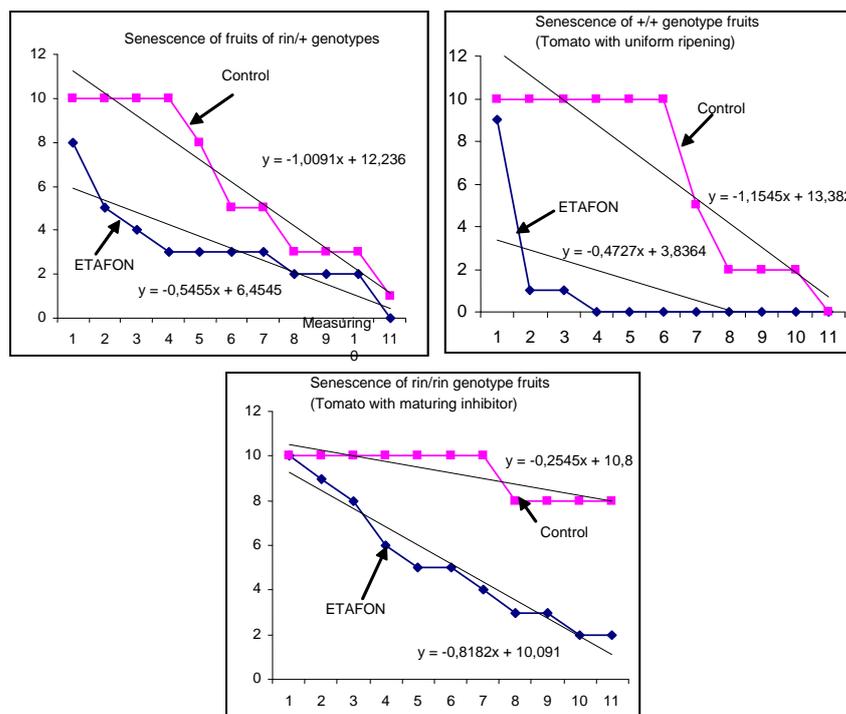


Fig. 3-5. - Senescence (falling of fruits) comparing to control

Eleven observations showed that fruits were falling and that the differences were greater than in maturing process. Fruits of *rin/+* genotypes were falling rapidly, and treated fruits were falling more rapidly than control. Treated fruits of +/+ gene constitution were falling rapidly, while non treated fruits had longer shelf life. Fruits had good quality for 18 days, and than they started to fall rapidly. For control variant *rin/rin* (hom4) we found that fruits did not fall due to over-maturing, except for few specimens that were contaminated with saprophyte pathogens. Treated variant was falling rapidly while fruits even did not reach the red colour (Fig. 3-5.).

Tomato is a vegetable crop with specific maturing climax. Genotypes  $+/+$  (S-49) and  $rin/+$  (449 F1), have a climax maturing, while we did not found one for genotype  $rin/rin$  (hom4) (Fig. 6-8.).

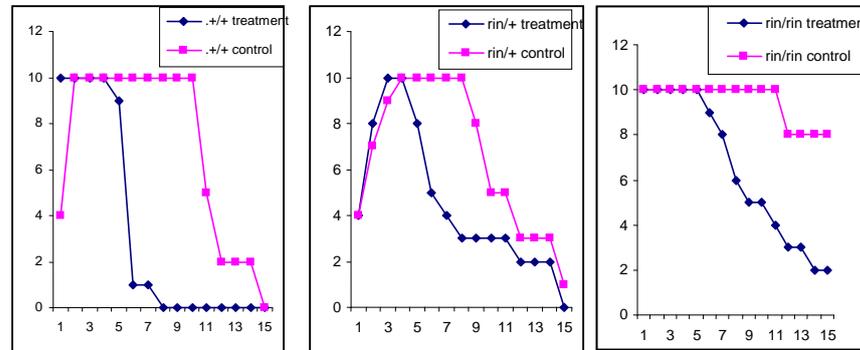


Fig. 6-8. - Maturing and climaxes of researched genotypes comparing to control

Fifteen days of shelf life could be useful information for planning storing, transportation or longer disposal of tomato fruits on the market. Two weeks period from picking till fresh consumption is a usual period for long distance transportation. This sort of usage of tomato demands picking of fruits in their late green phase when they can be transported for 90 days and stay fresh (LIN, 1979; SISLER, 1982).

In our research, ethylene concentration of 1000 ppm did not cause the change of colour for  $rin/rin$  tomato fruit genotypes. According to BUESCHER (1977) the maximal colour was reached with 10000 ppm of ethylene solution (when researching various ethylene quantities). When researching various genotypes, BUESCHER *et al.* (1975) found that carotene synthesis is increased due to ETEPHONE. Our results showed various reactions of certain genotypes comparing to variant treated with ETEPHONE. The most noticeable effect is rapid appearance of colour for genotypes with uniform ripening, than heterozygotes during ripening, as well as rapid senescence of fruits in treated variants. The  $rin$  homozygote fruits failed rapidly, although they did not change colour, previously. MC GLASSON (1985) found that  $rin$  homozygote fruits behave typically non-climacteric. Heterozygote  $rin$  gene (449 F1) fruits were the same as fruits with uniform ripening (S-49), but with longer shelf life. Comparing to  $rin$  homozygote fruits (hom 4), heterozygote (449F1) fruits were not so long-lasting, but that again, usable regardless to ethrel applying in their ripening process, since they were falling slower than homozygote (S-49) with uniform ripening.

Longer shelf life means a greater firmness of fruits. Delayed maturing and greater firmness of fruits have a favourable influence on longer shelf life and give more time for transportation to long distance. Preservation can be shortened by using ethylene (SHERMAN, 1985) which proves that control of maturing an important process for commercial vegetable growing.

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**SAZREVANJE I STARENJE-PROPADANJE PLODOVA PARADAJZA *Rin rin/rin, rin/+* I *+/+* GENETSKE KONSTITUCIJE**

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**Izvod**

Inhibitor sazrevanja (*rin*) gen predstavlja spontani recesivni mutant koji menja aspekte sazrevanja ploda, a najznačajniji sintezu karotenoida posebno likopina. Takođe usporava starenje plodova. Paradajz spada u biljke koje imaju katakteristični vrhunac (pik) prilikom sazrevanja plodova. Genotipovi paradajza homozigoti za *rin* gen nemaju ovaj vrhunac u sazrevanju, tako da izostaje produkcija etilena i crvena likopinska boja. Za potrebe ispitivanja procesa sazrevanja, korišćeni su materijali iz završnih ciklusa selekcije paradajza: čista linija S-49 (genetske konstitucije *+/+*, uniformnog sazrevanja), linija hom 4 (*rin/rin*, homozigot za *ripening inhibitor*) i hibridna kombinacija 449 F1 (*+/rin*, heterozigot za *ripening inhibitor*). Plodovi sa uniformnim sazrevanjem i hibridi sazrevali su isto vreme dok homozigoti za *rin* gene nisu sazrevali. Etilen stimuliše razvoj žute boje u *rin* plodovima stimuliše pojavu likopina. Posle tretmana etephoneom (0.1%) (etilen) od plodova sa uniformnim sazrevanjem utvrđeno je brže propadanje, kod hibrida je utvrđen duži period izdržljivosti, odnosno sporije propadanje. Kod *rin* homozigota nije dobijena promena boje, ali su plodovi propadali ubrzanije u odnosu na netretiranu varijantu. Tretman etilenom ubrzavao je procese sazrevanja, ali i starenja plodova paradajza. Prolongacija sazrevanja kao posledica delovanja *rin* gena svrstava dobijene hibride u kasniju grupu sazrevanja, čime se gubi na ranostasnosti. S druge, strane dobija se na čvrstini plodova i na »shef life«, koji omogućava duži transport i skladištenje, a ukoliko se ubiraju zeleni plodovi i na koordiniranom sazrevanju prema potrebama tržišta. Cilj ispitivanja je bio da se utvrdi ponašanje u sazrevanje *rin* heterozigota, kao i reakcija genotipova na tretman etrelom u cilju ublažavanja ekstremnih vrednosti kasnog sazrevanja.

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