Study upon the impact of chemical thinning with ethephon on the quality of two peach varieties cultivated in the Western part of Romania

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Abstract

Fruit thinning of peach trees research was placed in a private orchard in the western part of Romania, in an area favourable for peach culture. The objective was to observe the impact of chemical thinning with different doses of ethephon 39.5% (Ethrel) upon peaches' physical and chemical features.The biological material consisted in two peach tree varieties: *Spring Lady* and *Maja*. Fruits samples were collected from plots where there were used four concentrations of ethephon 39.5%: 125 ppm, 250 ppm, 350 ppm and 500 ppm. The thinned variants were compared with a control – not thinned variant.The treatment was done after 25 days after fruit binding, when the kernel had 10-12 mm. Out of the two varieties, *Maja* remarked by the high quantities of sugars and small amounts of acidity in fruits. Fruits' size was improved when the distance between the fruits on a mixed branch increased. Thinning with 125 ppm ethephon was not sufficient to obtain fruits with a good quality, while 250 ppm ethephon provided medium quality fruits, but not for Extra and Ist quality class. Thinning with 350 ppm and 500 ppm ethephon had results as large and colorful fruits of Extra and Ist quality.

Keywords: Peach, thinning, ethephon, weight, chemical composition.

INTRODUCTION

Peach tree is a species that annually needs to be thinned. The advantages of thinning are well-known, so that by reducing the number of flower or fruits, the remained fruits will be larger as size, better as quality and the balance between growth and fructification will be visibly improved. At the same time, this operation determines a good flower buds' differentiation in the following years, without affecting the tree, which otherwise depletes, degarnishes and finally perishes (Costa, Vizzotto, 2000).

According to Stănică and Branişte, 2011, this operation is done after 15-30 days from fruits binding with the substance Ethrel (ethephon) 120-180 mg/l or 250-500 ppm completed by manual thinning before kernel's strengthening, the effect being satisfying after 2-3 weeks. Thinning's intensity depends on the fruit load, the planting system, the variety and fruits' size.

Ethrel® is a plant growth regulator, which may be used for bloom thinning for many fruit tree species. It is recommended that the thinning would be done at the end of blooming or two weeks after it, in order to avoid the risk of spring frost at bloom (Byers et al., 2003).

For peach tree, which has a natural tendency of overloading with fruits, we have to consider the fact that over 90% of the flowers set fruits. On one tree, in optimum fecundation conditions, there are binded 2,000-3,000 fruits, of which there can be properly fed almost 400-600 fruits. (Drăgănescu et al., 2005).

Standardization of production technology is a major operation and is achieved by: fructification pruning, chemical standardization of flowers and fruits; manual or mechanized fruit thinning. Fructification pruning is the main rate-setting operation of a load of fruit, but for peach tree this operation does not fully solve the problem because the species is auto-fertile and, as mentioned above, the percentage of binding being up to 90% of all flowers (Iordănescu and Micu, 2011).

The main chemical substances in peaches are sugars,

organic acids, pectin substances, tannins, vitamins and minerals. Sugars and acidity are two important features because they are the ones which interest the consumers. Nowadays, there are requested on markets sweet-sour fruits, juicy and flavoured, all these parameters being influenced by the culture technology of peaches. The distance between the trees per row, the distance between the fruits per branch, the balance between the vegetative part and the fructification part of the trees, all these allow a good lightening of the tree crown. Light determines large coloured fruits, with a higher content of sugars than acidity and at the same time a larger amount of good substances in the composition of peaches. That is why thinning is so important in determining superior quality fruits (Iordănescu, 2008).

Iron and copper have a beneficial role for the human body, in participating in the synthesis of normal blood cells roandi. Iron is an essential nutrient for living organisms, needed to make hemoglobin, the myoglobin, and enzymes. Copper, cobalt, manganese and vitamin C are necessary for iron to be assimilated in plant products (fruits, vegetables, grains), because this metal is essential for the metabolism of vitamin B. Copper is the basic component of the exterior of epithelial nerve fibers, collagen, the most important element of protein structure greatly influences the body and skin pigment production (Mayer, 1997).

Zinc helps in stimulation of nerve and muscle, but and the immune system. Has the particularity to participate in the formation of over 200 different types of enzymes. Zinc vegetable protein can be used properly by the body compared to that of animal protein (Mayer, 1997).

Manganese participates in many functions in the body. In the first phase and acts as a coenzyme, this facilitates many metabolic processes in the body. Benefits of manganese in the body are numerous. It is involved in bone formation, participates in thyroid functions in connective tissue formation, and is involved in the functions of sex hormones in calcium absorption, in normalizing blood sugar levels in immune function and the metabolism of fat and carbohydrates (Mayer, 1997).

Standardization of production is required for the following biological features: peach develops every year a number of fruit buds (probably 10 times more than are needed for a good crop of fruit); flowering buds are in groups of two very close, so there is not enough space for fruits' growth; in the absence of rate-setting, fruits remain small, of poor quality, trees degenerate, vegetative growths will be weak and will freeze in winter (Drăgănescu, 2002; Ivaşcu et al., 2002).

The objective of this research was to observe the impact of chemical thinning with ethephon 39.5% (Ethrel), used as a treatment in different concentrations, upon peaches' physical and chemical features of *Spring Lady* and *Maja* varieties. At the same time, it was aimed to determine which of the used concentrations of ethephon 39.5% (Ethrel) could be recommended for use for peach rate-setting, mainly because in the culture area it is the most used product for fruit thinning.

Spring Lady is an American variety obtained at Red Bluff Research Ranch, California, being approved as a new variety in 1980, but its origins are not known. Fruits ripen 20 days earlier than Redhaven, which, in conditions of the research culture area, is at the end of June–the beginning of July, differing from one year to another according to the climate conditions.The fruit is middle sized, sometimes larger, having 150-175g and it is spherical, slightly elongated. The background colour is green-yellowish, at full ripening being completely covered with red. The pulp is yellow, very juicy, firm, the taste is sweet-sour, of good quality. The pulp is adherent to the kernel, which is of medium size, round-oblong shaped. This variety is quite resistant to diseases and frost, it has a long harvesting period and is holding up relatively well in transport (Ivaşcu and Hoza, 2003).

Maja is a peach variety obtained in Belgrad at PKB Agroekonomik Institute, being approved as a new variety in 1985. It was obtained by self-fecundation of Glohaven variety, which ripens, in conditions of Periam culture area, at 5-7 days after Redhaven variety. The fruit is large (180-220 g), spherical, slightly elongated, the background colour is yellow, and the covering colour is deep red, covering 60-70% of the fruit. The pulp is yellow with infiltration of red around the kernel, firm, juicy, sweet-sour, with a good flavour. The kernel is medium to large size, round-oblong shaped.This variety is very suitable for fresh consumption and industrial processing due to the pulp, which is rather firm and of intense yellow color (Ivascu and Hoza, 2003).

MATERIAL AND METHODS

The experimental site and the material

The research concerning fruit thinning of peach trees was placed in a private orchard in the western part of Romania, in Periam locality, at 62 km far from Timisoara, Timis County, area known as being favourable for peach culture and with a long tradition for this culture in Romania.

The trees were planted at the distance of 4.0 x 2.5 m, determining a density of 1,000 trees/ha. They had a tree crown system simple palmet. The soil was maintained as work field, by ploughing at 18-22 cm depth, and in the vegetation period there were done 3-4 mechanical hoeings. On the tree row the soil was maintained clean of weeds by the use of herbicide Roundup 360 SL (4 l/ha). Fertilization was done with chemical fertilizers (nitrogen, phosphorus and potassium), using the approximate doses of 90-100 kg/ha N, 60-80 kg/ha P_2O_5 and 100-120 kg/ha K_2O. The water needs were assured by 2-4 local

irrigation, according to the amount of rainfall during the year, and the treatments against diseases and pests was done 8-12 times per year, as necessary.

The biological material consisted in two peach tree varieties cultivated in the area: *Spring Lady* and *Maja*. These two varieties were chosen for the research because they are being cultivated on large surfaces in the Western part of Romania and they have a high request on the area market due to their good flavour, aspect and juiciness.

Experimental design

In this experiment we used Ethrel® (ethephon 39.5%) as thinning method for all the varieties, in four concentrations: 125 ppm, 250 ppm, 350 ppm and 500 ppm. The treatment with this substance was done after 25 days from fruit set, when the kernel had 10-12 mm, being observed 5 trees for each variant. The experimental variants were established according with the amount of ethephon used: V1 – 125 ppm, V2 – 250 ppm, V3 – 350 ppm, V4 – 500 ppm and V5 – control variant – not thinned.

Laboratory analysis

Fruits' quality was determined under two aspects: the physical features (D, big diameter; d, small diameter; H, height; Is, size index; weight of peaches) and the chemical features (dry soluble substance, sugars content, acidity and sugar-acidity index).

For both varieties there were taken 30 samples of peaches which were analysed in the laboratory, being calculated the average value for each element presented in this article.

The biometrical elements of fruits were determined by measuring the samples and calculating the average value for each parameter.

The size index was calculated with the formula (Drăgănescu, 2002):

$Is = (D + d + H) / 3$

The average weight of fruits was determined by weighting 30 fruits for each variety and for each variant. After that the pulp was taken off of the kernel, the kernels were well cleaned and then weighted in order to establish pulp's and kernel's weight and percentages of the total weight of fruits. Analyses of variance (ANOVA) on this parameter were performed using SPSS Inc® (Statistical Package for Social Sciences), Win TM, version 18, LSD (Least significant difference) test (P=0.05) was applied when significant treatment differences were detected. The control variant was considered the not thinned one.

For the chemical composition of fruits, first there was determined the soluble dry substance with the digital refractometer, in percentages, by squeezing the juice from fruits and after that there was calculated the total sugars percentage, with the formula:

Total sugars % = [(soluble dry substance x 4.25) / 4] – 2.5

Minerals were determined by calcinations of 3 g of pulp at 600ºC, the ash being cooled afterwards at room temperature, and then treated with HCl 10% (Alexa, 2003). Different metals were determined by atomic absorption spectrophotometry, such as: cobalt, manganese, copper, zinc, magnesium and iron. These metals were determined by direct aspiration of the sample (10 ml of digest solution – „Wet Digest" method), suitably diluted with distilled deionized water, after removal of suspended matter by centrifugation, using atomic absorption apectroscopic standard solutions for Co, Mn, Cu, Zn, Mg and Fe.

Fruits' acidity was determined by the method of suspension in water (tritimetric method): 5 g of juice were combined with 50 ml of water and mixed for 5 minutes. After homogenization there were added 3 drops of phenolphthalein and this mix was titrated with NaOH 0.1 N, until pink colour appeared and persisted for one minute. Two determinations were done in parallel for the same sample (Alexa, 2004). After that the acidity is calculated with the formula:

$Ac = (V \times 0.1/ m) \times 100$

Where:

Ac, fruits' acidity;

V, volume of NaOH 0.1 N used for titration (ml);

m, weight of sample (g);

0.1, normality of NaOH solution

Sugar-acidity index was established by dividing sugars content by the acidity content.

RESULTS

In table 1 were pointed out the big (D) and small (d) diameter results (mm) for both peach tree varieties: Spring Lady and Maja. Considering the bid diameter (D), for both varieties the fruits from variants 1, 2 and 5 were considered of medium size, having between 45mm and 65 mm (Drăgănescu, 2002). For Spring Lady variety, the fruits were big in variants 3 and 4, while for Maja variety only in variant 4, where the big diameter (D) was over 65 mm. The size index showed big fruits in variants 3 and 4 (over 60 mm) for both peach varieties.

The average weight of *Spring Lady* peaches had values of 79.1 g in V5 – not thinned and up to 172.4 g in V4, so that the pulp proportion was of 95.1% in V5 and 96.8% in V4. By this it is notable the great impact of chemical thinning upon fruits' size compared with the fruits from the not thinned peach trees (figure 1).

The statistic analyse of the average weight of peaches obtained in the five variants, shows that in all thinning variants there were obtained larger fruits compared with the control variant (V5). The differences (represented by

Table 1. Fruits' biometrical elements for Spring Lady, 2008

Variety	*Variant*	*Big diameter (mm)*		*Small diameter (mm)*		*Height (mm)*		*Is*
		$X \pm s_x$	s%	$X \pm s_x$	s%	$X \pm s_x$	s%	$X \pm s_x$
Spring Lady	V1-125ppm	47.4±1.7	15.8	46.5±1.9	18.0	46.6±1.5	14.2	46.8±1.7
	V2-250ppm	55.9±1.8	14.2	53.2±1.8	14.9	51.3±1.4	12.0	53.5±1.6
	V3-350ppm	66.1±1.6	10.7	62.2±1.6	11.3	62.1±1.4	9.9	63.5±1.5
	V4-500ppm	67.3±1.6	10.5	63.1±1.6	11.2	62.1±1.6	11.4	64.2±1.6
	V5-not thinned	57.3±1.5	11.5	51.6±1.5	12.8	52.9±1.7	14.2	53.9±1.6
Maja	V1-125ppm	54.4±1.9	15.4	52.3±2.1	17.7	52.0±1.3	11.0	52.9±1.8
	V2-250ppm	56.7±1.7	13.2	54.7±1.9	15.3	53.8±1.7	13.9	55.1±1.7
	V3-350ppm	63.2±1.8	12.6	62.8±1.7	11.9	62.2±1.9	13.5	62.7±1.8
	V4-500ppm	65.2±1.8	12.2	64.8±1.8	12.3	64.2±1.8	12.4	64.7±1.8
	V5-not thinned	57.9±1.7	12.9	52.6±1.6	13.4	50.8±2.0	17.4	53.8±2.3

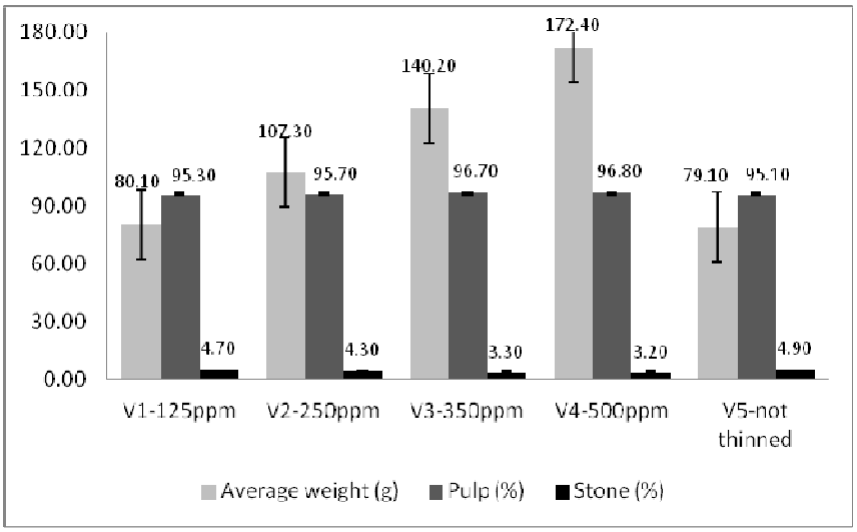

Figure 1. Fruits' physical-mechanical features for Spring Lady variety, 2008

the black line in the figure) were not statistically assured for fruits in variant 1 (125 ppm) and very significant positive in all the other three thinning variants (figure 2).

The average weight of *Maja* peaches had values of 73.5 g in V5 – not thinned and 170.2 g in V4. The pulp proportion ranged from 93.6% in V5 and 96.9% in V4, and the kernel represented 6.4% of the total weight in V5 – not thinned and 3.1% in V4 (figure 3).

The statistic analyse of peaches' average weight shows that the differences (represented by the black line in the chart) were distinct significant positive in the variant were there were applied 125 ppm and very significant positive in variants 2, 3 and 4 compared to non thinned variant (figure 4).

For *Spring Lady* variety, the refractometric dry substance had very small values, which is a characteristic of the variety. The total sugars and total acidity contents increased from V5 – not thinned to V4, while sugars-acidity index presented similar results as total sugars and total acidity contents (figure 5).

Maja variety had a content of refractometric dry substance higher in V3 and V4 than in other variants. The total sugars had values between 9.16% and 10.14% and total acidity varied from 0.36% to 0.39% the results were not presenting statistical differences.

Sugars-acidity index presented a higher concentration in V3 where there were applied 350 ppm of ethephon (figure 6).

Spring Lady peaches had a normal content of minerals (characteristic for peaches), which did not over pass the maximum admissible limits in fruits. As a remark, it can be said that the values were very close, so

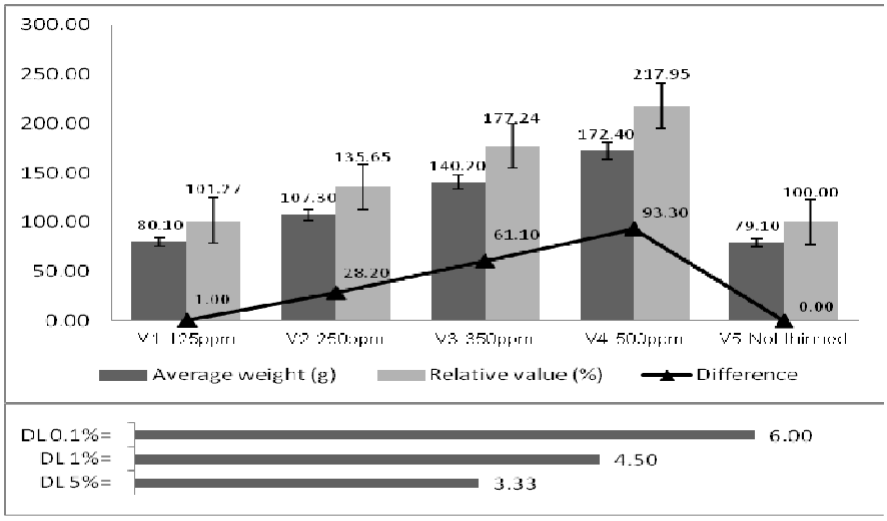

Figure 2. Synthesis of results concerning Spring Lady variety's fruits' weight, 2008

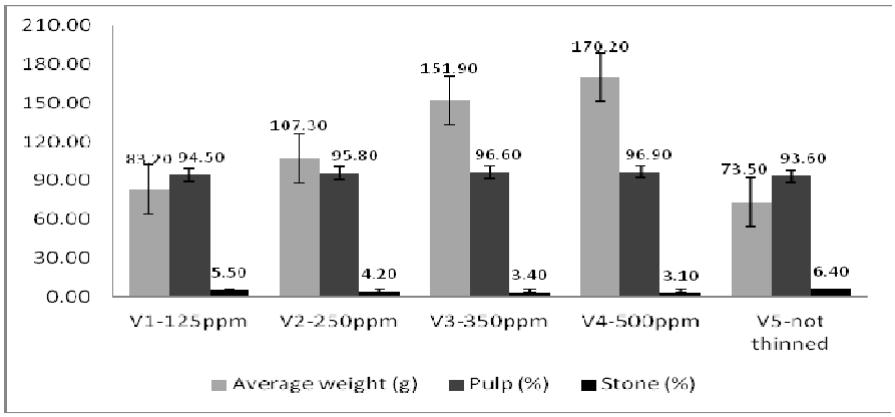

Figure 3. Fruits' physical-mechanical features for Maja variety, 2008

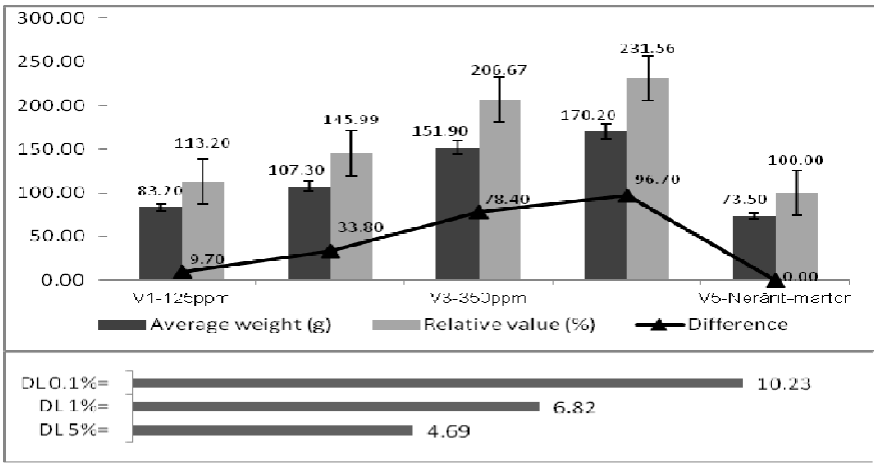

Figure 4. Synthesis of results concerning Maja variety's fruits' weight, 2008

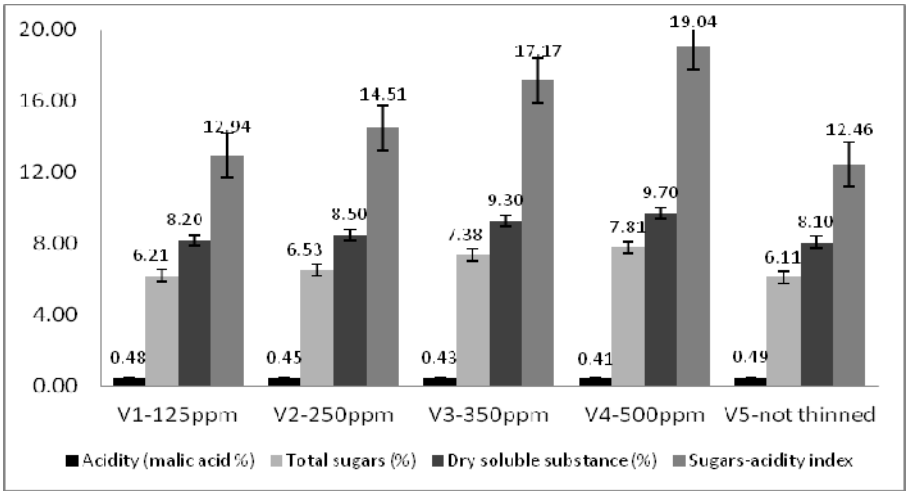

Figure 5. Fruits' chemical composition for Spring Lady variety, 2008

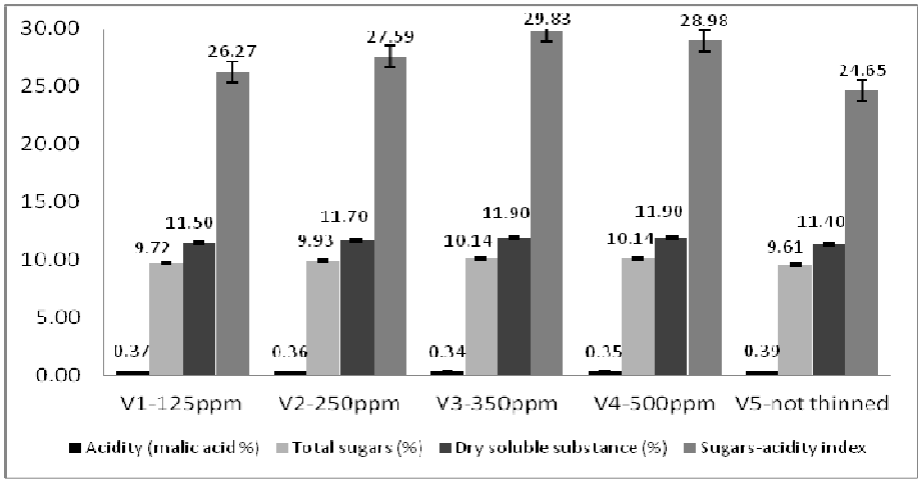

Figure 6. Fruits' chemical composition for Maja variety, 2008

that they were not statistically assured, for some elements higher in the thinned variants, but for some not.

For all microelements, there were higher quantities in V4 and V3. This can be explained by the smaller number of fruits remained on the trees after thinning, which determines a higher accumulation of different chemical components, Variant 5 – not thinned had the smallest concentrations of microelements, excepting copper (Cu), which was lower in V1 (table 2).

For *Maja* variety microelements' content varied for each variant, but in V5 and V1 there were determined the smallest amounts of metals. Variants 2, 3 and 4 had higher metals' contents, but because the values were so close to each other, none of them were statistically assured (table 3). The values of al microelements did not overpass the maximum admissible limits in fruits.

By observing the two varieties it was notable that both are valuable for peaches cultivation, but in conditions of the culture area *Maja* variety remarked by the high quantities of sugars and small amounts of acidity in fruits.

However, the differences between the two varieties are due to their genetical nature and maybe due to some phenological differences insufficiently approximated, while applying the thinning treatments.

In case of biometrical indexes it was noticed a considerable increase in fruit size correlated with the degree of thinning. The fact that in all cases the variation coefficients (s%) decreased slightly from V1 to V4 lead to the idea that as the fruits are severely thinned (from V1 to V4) it is increased the degree of fruits uniformity. In other words, in variants 2, 3 and mainly 4, the fruits are larger and more uniform.

Table 2. Fruits' metals content (ppm) for Spring Lady variety, 2008

Variant	*Co ppm*	*Mn ppm*	*Cu ppm*	*Zn ppm*	*Mg %*	*Fe ppm*
V1-125ppm	0.12	0.25	0.18	0.12	0.007	4.20
V2-250ppm	0.14	0.27	0.19	0.12	0.008	4.41
V3-350ppm	0.13	0.29	0.20	0.13	0.009	4.44
V4-500ppm	0.14	0.29	0.21	0.14	0.009	4.51
V5-Nerărit-martor	0.11	0.22	0.19	0.11	0.006	4.17

Table 3. Fruits' metals content (ppm) for Maja variety, 2008

Variant	*Co ppm*	*Mn ppm*	*Cu ppm*	*Zn ppm*	*Mg %*	*Fe ppm*
V1-125ppm	0.11	0.26	0.18	0.11	0.005	4.20
V2-250ppm	0.13	0.27	0.19	0.14	0.007	4.30
V3-350ppm	0.15	0.26	0.23	0.13	0.008	4.30
V4-500ppm	0.14	0.28	0.22	0.12	0.008	4.40
V5-Not thinned	0.11	0.25	0.18	0.12	0.006	4.10

DISCUSSIONS

The severe thinning determines excessive reduction in production, which is undesirable if the increased fruits size does not determine increased crop value (Reighard et al., 2006).

In our study, it appears that for each variety fruit size improves on increasing the distance between the fruits on a mixed branch.

It was observed that thinning with 150 ppm ethephon is not sufficient to obtain good quality fruits, while thinning with 250 ppm ethephon provides medium quality fruits, but is insufficient for Extra class and even for the Ist quality class.

Thinning with 350 ppm and 500 ppm ethephon leads to Extra high quality and Ist quality, large and colorful fruits.

Stover et al. (2004) noted that thinning, beyond that required for fruit rate-setting, can be excessive and counter-productive, even though fruit size may be substantially increased, which is why he recommends to quantify the economic benefit of thinning, so that there would be an economical balance between the production and fruits' quality.

Thinning lead to changes in fruit size and by this of course it changed fruits' size and the proportion of main components, namely pulp and kernel. For small fruits we noticed underdeveloped pulp and the peel thin and over-pubescent.

The average weight of fruits calculated with analyses of variance method showed that all thinned variants gave superior size peaches than the ones obtained din the control – not thinned variant. The biggest fruits were obtained in those variants where thinning was more severe (350-500 ppm ethephon).

Osborne (2008) noticed that partial crop thinning done with blossom-thinning agents can improve fruit size and also the crop value of *Babygold 5* peach variety.

Concerning the sugars-acidity index, which expresses the taste quality of fruits, at large values of this index fruits had a weak acidity, being bland, tasting normal and not quenching the thirst, while at low values of this index, the fruits are too sour, quench thirst, but the taste is too harsh, especially when accompanied by a large amount of tannins (Draganescu, 2002).

In this experiment, total sugars content was higher in the thinned variants, than in the not thinned one, while acidity was reverse. Total sugars increased in the severe thinning variants, which was normal because the trees fed a smaller number of fruits, which got larger and with higher amounts of sugars.

In the category of minerals, or metals, there take part several elements, which by over passing the maximum admissible limits can be very toxic to organisms. Under this limit, minor minerals like copper, cobalt, iron, zincous, manganese or magnesium, which can be found in aliments, fruits and vegetables are essential components of some proteins involved in metabolism, having a favourable impact upon human organism. Otherwise, one can suffer of nutritional deficiencies (Lee, 1993).

Minerals content in peaches belonging to *Spring Lady* and *Maja* varieties did not over pass the maximum admissible limits, so that they are good and recommendable for organism.

Developing a research upon chemical thinning with ethephon in different concentrations, determined us to recommend for commercial orchards the use of this substance in concentrations of 250 ppm (variant 2 in our experiment) or 350 ppm (variant 3 in our experiment).

This recommendation is done basing on the fact that

using a lower concentration for chemical thinning the values obtained are almost similar to the ones from the not thinned fruits, even if the fruit load is smaller than in the not thinned trees – there is maintained a good balance in the tree so that it doesn't deplete and it is able to produce and carry fruit loads in the coming years. The sever thinning with 500 ppm ethephon is not recommended in commercial orchards because, even though the fruits are of superior quality, the productions are very damaged, being smaller with 2-3 times than the ones obtained in the not thinned variant.

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