Thinning of Apple Fruits with Foliar Fertilizers Goëmar BM 86 E and Goëmar Folical

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Summary

Thinning is a regular pomotechnical measure, which is performed by using different chemicals that cause fruit drop in intensive apple orchards. It is common that some apple cultivars overbear, giving small fruits of poor quality. Effects of chemical thinners of apple fruits are as follows: higher productiveness in the next vegetation period, higher percentage of first class apples and the lesser fruit drop before harvest and so on. Hormonal thinners that are currently being used in the surrounding countries are not allowed in our country because of their ecotoxicological characteristics. These products are not applicable in the concept of integral fruit production. The aim of this study was to investigate the impact of natural foliar fertilizer GOËMAR BM 86 E and GOËMAR FOLICAL on apple fruit thinning, and thus on the quantity and quality of harvested fruits. In this paper, four cultivars of apples are included: ‚Golden Delicious', ‚Granny Smith', ‚Braeburn' and ‚Idared'. In treated trees, these natural fertilizers caused increased fruit drop in relation to the control. Results showed higher sugar content in treated fruits in relation to untreated control fruits. Further research should be conducted to obtain more complete results about the influence of these foliar fertilizers on the apple fruit quality and quantity.

Key words

apple, cultivar, chemical thinning, foliar fertilizer

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Introduction

Consumers increasingly value the production of high quality, healthy fruits that ensure minimal impacts on the environment. In conventional apple orchards, chemical thinning is necessary to obtain a profitable fruit production.

The growth of every fruit depends on the space available for their growth. The fruit thinning process enables them to get optimum nutrition. Having too many fruits in the first year itself is not a very good trait and this is most common mistake fruit growers tend to make. It is important to point out that apple cultivars showing a biennial bearing habit should be thinned as early as possible, to reduce the competition among the fruits for the rather limited resource and thus to increase the allocation of the resource into the reproductive growth (floral initiation) (Kim, 2010). Weight of extra fruit can cause tree limbs to break. Excessive fruit set often will result in small fruit with poor quality and flavor. In addition, thinning helps to prevent biennial production and maintain a balance between vegetative growth and fruiting (Dennis, 2000).

Achieving the optimal ratio between fruit yield and quality as well as establishing regular cropping in orchards are the reasons for practicing chemical thinning of apples. Fruit thinning of in intensive orchards with different chemical matters is routine pomotechnical measure. Mode of action for the most of the chemical thinners is to disturb the endogenous hormonal system of plants and to reduce the transport of auxin to the lateral fruits (selective thinning) (Bangerth, 2000). Apples can be thinned chemically, by hand, or by a combination of both. Although hand thinning has a primary advantage of removing poor quality or damaged fruit, the thinning job in the major apple producing countries largely depends on the chemical method (Dennis, 2000; Wertheim, 2000).

Fruit thinning can be done manually, but labor costs make this approach prohibitively expensive and requires a lot of time, but it can be used as a supplement to chemical thinning. This method has provided a reliable way to improve fruit size and yields over a two year period (Bergh, 1992; Knight, 1980; Palmer at al., 1991; Schumacher at al., 1980; Schumacher at al., 1980; Schumacher at al., 1984).

Fruit thinning can also reduce the spread of some diseases. For example, if the fruit are touching each other, brown rot can quickly spread from one fruit to another just before harvest. Air movement around tightly clustered fruit is minimal, so the surface of unthinned fruit does not dry quickly, allowing disease organisms to multiply and spread (Ingels et al., 2001).

Hormonal thinners that are currently being used in the surrounding countries are not allowed in our country because of their ecotoxicological characteristics. These products are not applicable in the concept of integral fruit production. With the aim of finding adequate solutions to prevent the occurrence of alternative bearing, and that would be safe for human health, we studied the effect of seaweed organic fertilizers that are ordinary used to supplement the nutrient needs of plants on fruit thinning.

Seaweeds are a known source of plant growth regulators (Jameson, 1993), organic osmolites (e.g., betaines), amino acids, mineral nutrients, vitamins, and vitamin precursors (Berlyn and Russo, 1990; Blunden et al., 1985). Florial fertilizers as bio-regulator can be used to reduce negativ effects of alternate bearing.

The predominant species of seaweed in the North Atlantic Ocean is *Ascophyllum nodosum* that belongs to the brown algae (*Phaeochyceae*) (Verkleij, 1992). *Laminaria*, *Fucus*, *Ecklonia* and *Durvillea* are other seaweeds that have been used to prepare seaweed extracts. Seaweed extract has been used in agriculture for centuries (Crouch, 1990). The use of seaweed extract has been reported to have beneficial effects on plants (Metting et al., 1990). On the other hand, a review of literature about the use of seaweed products in agriculture shows inconsistent results. This is due in part to the variability of seaweed products available on the market.

The aim of this study was to evaluate the effect of organic foliar fertilizer on fruit thinning, and thus on the quantity and quality of harvested apple fruit. Bearing in mind that the alternative bearing in intensive orchards is common occurrence, which results in large fluctuations in yield and quality of harvested fruits, we believe that this research has great significance for solving these problems. With proper using of these products, which are ecotoxicologically acceptable our fruit producers would provide continuity in yields and quality of harvested fruit, and hence greater market competitiveness.

Material and methods

Open field thinning experiment was carried in an eight year old apple orchard. In this study, four cultivars of apples were included: 'Granny Smith', 'Golden Delicious', 'Braeburn' and 'Idared'. All cultivars were treated in different stages of fruit development, and the terms of the treatments were determined on the basis of the manufacturers' recommendations. Fruit thinning was performed by organic fertilizers Geomar BM 86 and Geomar Folical.

Geomar BM 86 E is a liquid foliar fertilizer used in orchards. It is a natural product that contains the seaweed cream GA14 with macro (N 4.1%) and micro elements (B – 2.7%, MgO – 4.8% and molybdenum 0.02%). Algae from which the cream GA 14 is produced is *Ascophyllom nodosum*. Research performed by the Research Center Goëmar and Freanch CNRS (French National Centre for Scientific Research) found elicit in GA 14. Elicits are active molecules that directly affect the physiological process in fruits by stimulating ensimes that enhance plant nutrition and improve plant defense system. BM 86 E stimulates the synthesis of polyamines in flowering period that are crucial for the process of cell division during fruit set.

GOËMAR BM 86 E: provides good and regular fruit set; assists in early differentiation of the dominant fruits, and stimulates early growth stages. Three applications were performed during beginning of flowering, full flowering and over flowering at the rate of three liters per ha.

GOËMAR BM 86 E helps to achieve an optimal number of fruits per tree in order to: provide regular fruit set (to achieve optimal yields each year; to ensure adequate profit, and to reduce labor cost for hand thinning) and produce fruit dimensions acceptable for the market (to achieve first class fruits, and to maximize the return of producers investment).

Table 1. Results of generative organ development observed between thinned and unthinned (control) trees (average from 10 trees)

Cultivar	Thinned trees				Unthinned (control) trees			
	Number of corymbs	Number of flowers per corymb	Number of fruits before June fruit drop	Number of fruits before harvest	Number of corymbs	Number of flowers per corymb	Number of fruits before June fruit drop	Number of fruits before harvest
Idared	57	5	49	45	58	5	55	41
Golden Delicious	152	5	119	88	139	5	188	145
Granny Smith	124	5	55	51	125	5	83	66
Braeburn	76	5	94	60	89	5	87	55

The primary mode of action of BM 86 is through the increased production of polyamines in plant growth via the active ingredient GA 142. These are naturally occurring substances found in plants and they act essentially as promoters of growth (Stephen and Hensley, 2007). GA 14 stimulates plant's metabolism to take up more available elements from the soil. It affects better nutrient absorption at root level and ensures the preferential diffusion of nutrients to the areas experiencing strong growth. BM 86 enhances chemical thinning process through improved translocation of nutrients to the king fruit. This leads to better, more even fruit development.

GOËMAR FOLICAL is a natural calcium fertilizer with natural herbal composition. It is a liquid formulation containing seaweed cream GA 14, calcium oxide 14.2% and boron 1.3%. Used in three to five applications every ten to fifteen days, at the rate of seven liters per ha.

GOËMAR BM 86 E performance is achieved through three applications: the beginning of flowering, full flowering and over flowering at the rate of three liters per ha. GOËMAR FOLICAL is used at the rate of three to five treatments every ten to fifteen days at the rate of seven liters per ha. Treatments were performed with motor backpack sprayer "VILLAGER DM 25".

Trial was set up with variants that included ten trees plus control. Treatments were taken when the temperature (ranging from 20 to 25°C) and relative humidity were appropriate (≥70%). Temperature and relative humidity were recommended by Vittone (2003) and Elfving (2007). Treatments were carried out when there was no wind.

Counting of corymbs on selected branches was done: before treatments; before June fruit drop, and just before harvest. After the harvest, yields and quality of harvested fruits were determined. Measuring of fruit weight was done by digital scale, fruits length and width with hand caliper, fruit firmness with hand penetrometer and sugar content with hand refractometer. All these measurements were taken on sample consisting of 100 fruits per treatment. Data were analyzed with two way ANOVA and LSD test using StatPlus®2007.

Results

The results of our research indicate that fruit weight (Table 2) was highly significantly different in thinned and unthinned trees, in all tested cultivars with the exception of cultivar Braeburn that showed no significant difference in fruit weight.

As for fruit index (Table 3) there was highly significant difference in thinned and unthinned trees in cultivars 'Golden Delicious' and 'Idared', and there was significant difference in cultivars 'Granny Smith' and 'Braeburn'.

Table 2. Results of measuring fruit weight (g) in thinned and unthinned (control) trees

Cultivar	Thinned trees	Unthinned (control) trees
Idared	211.6**	195.4
Golden Delicious	158.6**	106.6
Granny Smith	153.4**	139.2
Braeburn	145.4 n.s.	141.2

LSD	Factor A (Thinning)	Factor B (Cultivar)	Interaction (A/B)
LSD 0.05	7.0	9.9	14.0
LSD 0.01	9.4	13.2	18.7

Note: n.s., *, ** the difference between thinned and unthinned trees is nonsignificant, or significant at P≤0.05 or 0.01 according to the LSD test, respectively

Table 3. Results of measuring fruit index in thinned and unthinned (control) trees

Cultivar	Thinned trees	Unthinned (control) trees
Idared	0.79	0.81*
Golden Delicious	0.90	0.92**
Granny Smith	0.86*	0.85
Braeburn	0.84	0.85*

LSD	Factor A (Thinning)	Factor B (Cultivar)	Interaction (A/B)
LSD 0.05	0.005	0.014	0.010
LSD 0.01	0.013	0.019	0.026

Note: *, ** the difference between thinned and unthinned trees is significant at P≤0.05 or 0.01 according to the LSD test, respectively

Fruit firmness (Table 4) showed significant difference in treated and untreated (control) trees in cultivar Braeburn, and highly significant difference in cultivars 'Idared' and 'Golden Delicious'. Cultivar Granny Smith did not show statistically significant difference between thinned and unthinned (control) trees.

Natural foliar fertilizers, which are used in this research, enhanced fruit thinning and affected better fruit quality. Our results show that sugar content (Table 5) was only significantly higher in fruits from thinned 'Idared' and 'Braeburn' trees, while cultivars 'Granny Smith' and 'Golden Delicious' showed no statistically significant difference in sugar content.

Table 4. Results of measuring fruit firmness (kg/cm^2) in thinned and unthinned (control) trees

Cultivar	Thinned trees		Unthinned (control) trees
Idared	6.7**		7.1**
Golden Delicious	7.0**		8.8**
Granny Smith	7.3		7.4 n.s.
Braeburn	8.2*		8.0*
LSD	Factor A (Thinning)	Factor B (Cultivar)	Interaction (A/B)
LSD 0.05	0.18	0.24	0.35
LSD 0.01	0.24	0.33	0.46

Note: n.s., *, ** the difference between thinned and unthinned trees is nonsignificant, or significant at P≤0.05 or 0.01 according to the LSD test, respectively

Table 5. Results of measuring sugar content of fruits (%) in thinned and unthinned (control) trees

Cultivar	Thinned trees		Unthinned (control) trees
Idared	11*		10,7
Golden Delicious	10.9 n.s.		10.9
Granny Smith	9.9 n.s.		9.8
Braeburn	10.4*		10.1
Average	10.6 n.s.		10.4
LSD	Factor A (Thinning)	Factor B (Cultivar)	Interaction (A/B)
LSD 0.05	0.26	0.36	0.53
LSD 0.01	0.35	0.49	0.70

Note: n.s., *, the difference between thinned and unthinned trees is nonsignificant, or significant at P≤0.05 according to the LSD test, respectively

Discussion

Thinning is the removal of a portion of the crop before it matures on the tree to increase the marketability of the remaining fruit and to reduce the biennial bearing tendency of the tree. Since fruit thinning is a crucial intervention to avoid alternate bearing, to ensure constant and profitable apple yields, and high fruit quality, alternative strategies to the expensive and time consuming practice of hand-thinning are required (Spinelli et al., 2009).

Our study, where we tested the influence of the foliar fertilizers GOËMAR FOLICAL and GOËMAR BM 86 E on apple fruit thinning, showed that application of these foliar fertilizers influenced the increase of fruit weight in all tested apple cultivars. Also foliar fertilizers in our study influenced the decrease in fruit index. Results with hormonal chemical thinners (Nokad, Dirager) showed the increase of average fruit weight in cultivar Golden Delicious, the elongation of apple fruits and higher dry matter content (Keserović et al., 2009). It was well documented that the role of chemical thinning materials in increasing fruit size is mainly via reducing competing fruits due to reduced crop load (Kook, 2009).

Johnson (1994) reported of increased fruit firmness as a direct result of the reduction in fruit number and yield. This is not in agreement with our data since our study showed that fruit firmness was higher in unthinned apple fruits in relation to thinned trees.

Foliar fertilizers used in this study to determine the fruit thinning effect showed no excessive thinning and phytotoxicity in all tested apple cultivars. Recent study of some chemical fruit thinners (Ammonium Thiosulfate – ATS) showed that higher rate of application coused a phytotoxic damage to spur leaves and sometimes even to spur buds. It seems that the appropriate rate of ATS should be variable according to the cultivar (Kook, 2009).

When the quantity of fruit on the tree in relation to the amount of foliage is excessive, fruit bud formation is reduced or prevented. Thus, in the season following the reduction in bloom results in a short crop; then under the conditions in the reduced crop load, too many fruit buds form. Once begun, such a fruiting pattern tends to become established (Williams and Edgerton, 1981).

The goal of thinning is that in flower corymbs remain only one or two fruits, and that other less developed fruits drop. Effects of chemical thinning of apple fruits are: elimination of the alternative bearing, higher average fruit weight, higher number of larger fruits, better fruit color, higher sugar, vitamin and acid content, as well as easier chemical protection, lower occurrence of fruit maggots; easier harvest of larger fruits, lesser sorting costs, lesser fruit drop before harvest and reduced limb breakage and winter injury (Keserović et al., 2009). Foliar fertilizers used in this study showed tendency of increased fruit thinning before June drop in thinned trees (Table 1). Due to that reason, the thinning effect of foliar fertilizers used in this study is much stronger than their possible fertilizing effect on fruit quality. Keserović et al. (2009) states that hormonal fruit thinners influenced lower fruit drop before harvest in apple cultivar Idared.

Because of many benefits, thinning practices became more common but still remained expensive. Therefore, one of the aims of this research was to determine the effect of these foliar fertilizers on the reduction of alternative bearing, so that additional benefit and potential cost reduction would be determined, hence these organic fertilizers are multi effective and inexpensive.

To achieve optimum results in certain apple growing regions different programs of thinning treatments were performed several times during the growing season and thus achieved targeted yields and fruit quality (Vittone, 2003; Elfving, 2007). Our results showed that application of organic foliar fertilizer GOËMAR FOLICAL and GOËMAR BM 86 E affected quality and quantity of harvested fruits (Tables 2, 4 and 5).

There are many factors that may effect the performance of thinning treatments, such as dose, weather conditions during and after routine treatment, training systems and applied agricultural practices in the orchard, as well as the time of application. Environmental factors such as humidity, affect both thickness and composition of plant leaf cuticle (Lee and Priestly, 1924). Therefore, during the application tretmants in this trial, it was taken into account that the temperature and relative humidity were according to the recommendations of Vittone (2003) and Elfving (2007).

Stopar (2002) suggests that in cultivar Golden Delicious trees that were not thinned had 83% smaller fruits than 70 mm. Our

results of fruit index showed that unthinned trees had elongated fruits in relation to thinned trees (Table 3). Idared cultivar is characterized with a tendency to alternative bearing and over fruiting in certain years when there is larger number of small fruits (Keserović et al., 2005; Gvozdenović, 2007).

Conclusion

Our study show that the thinning methods with these foliar fertilizers significantly affect apple fruit weight and quality. Chemical thinners significantly affect apple fruit quality (Jemrić *et al*., 2005). Therefore, this research should receive much more attention to find optimal thinning strategies that will have booth good thinning effect and positive effect on fruit quality.

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