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MANAGEMENT PRACTICES FOR CONVENTIONAL APPLE PRODUCTION IN THE PLOVDIV REGION

(in relation to the implementation of Task 1 of Component 1, Working Package 1.2 of the National Science Program "Healthy foods for a strong bioeconomy and quality of life" of the Ministry of Education and Science)

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Abstract

The current study summarises information regarding previously applied agricultural practices in the field of apple cultivation. The presented practices have been conducted for a period of five years in an orchard with Florina variety apples – grafted on MM106 rootstock – as a part of conventional fruit production in the experimental field of the Department of Fruit Growing at the Agricultural University - Plovdiv.

This information, combined with future studies of soil composition, as well as vegetative and reproductive manifestations of plants, can be used to develop a database enhancing the access to knowledge and experience in the future and facilitating the comparison and selection of the most appropriate agricultural practices for apple cultivation.

Keywords: apple, agricultural practices, conventional production.

REVIEW

The extensive development of fundamental science in the last several decades has also influenced agricultural practice and fruit growing, in particular. The creation of superintensive plants can be considered as a breakthrough in the field of fruit growing (Dobrevska, 2010, 2013).

Significant attention is paid to variety composition and health status of fruit planting material, as well as the chemical protection of fruit production process in the context of constantly increasing global population and higher food demand which lead to requirements for intensive production (Kovachevski et al., 1987; Stancheva, 2001; Andreev and Ignatiadis, 1997; Angelova et al., 2006).

Some other agrotechnical activities are very important, as they contribute to the production of high quality and quantity of fruit output. The applied effective measures in intensive plantations and their proper future maintenance in the context of the productive trees at a later stage enhance the achievement of quality output (Pepelyankov et al., 2003; Csigai and Hrotko, 2007).

Although indirectly, the applied system of soil surface in orchards contributes to quality fruit production. One of the most effective systems refers to turf-mulching one where the space between lines is grassed. The grass is periodically mowed and the inter-row strips are processed or treated with herbicide (Taseva, 1995).

The skillful use of various grass combinations contributes to maintaining good water and air balance in soil, as well as enhancing micobiological activity. This in turn leads to soil fertility and fruit quality (Glenn and Welker, 1989; Hogue and Nielsen, 1987; Olivera and Merwin, 2000).

Fertilization and irrigation are other agrotechnical activities in orchards which influence the access to quality output. Perennial cultivation of

fruit crops in the same place leads to the extraction of large quantities of mineral nutrients from soil. Hence, fertilization is viewed as an important agrotechnical measure for maintaining regular fruit output. Nowadays, various new chemical combinations are developed and applied. They are easily absorbed by plants as a part of the nutrition process. Reasonable fertilization may simultaneously enhance fruit production and extend the lifespan of plants (Bergmann, 1992).

In the context of fruit growing, watering requirements depend on plants' biological characteristics, age and phenophases, types of rootstocks and varieties, methods of cultivation (maintenance of soil surface, density of planting and pruning), as well as environmental conditions. Given the ecological conditions of our country, which is characterized by hot summer and insufficient rainfall during this period, irrigation is one of the most important agrotechnical measures supporting growth and fruit output. The cultivation of moisture-preferring apple variety in industrial orchards is impossible without adequate irrigation (MAF, Ordinance No. 18, 2009).

The current study summarises information regarding previously applied agricultural practices in the field of apple cultivation. The presented practices have been conducted for a period of five years in a plantation of Florina variety – grafted on MM106 rootstock – as a part of conventional fruit production in the experimental field of the Department of Fruit Growing at the Agricultural University - Plovdiv.

This information, combined with future studies of soil composition, as well as vegetative and reproductive manifestations of plants, can be used to develop a database enhancing the access to knowledge and experience in the future and facilitating the comparison and selection of the most appropriate agriculatural practices for apple cultivation in the above-mentioned area.

In general, the good condition of apple trees depends on the conduct of relevant agricultural technology in orchards. Plant protection is one of the key agrotechnical measures. Under conventional production conditions, plant protection is of quite importance not only during the vegetation period, but also during winter months. It is usually recommended to conduct three prophylactic winter treatments against the hibernating forms of economically important diseases and pests (Borovinova and Dzhuvinov, 2013).

The information from the presented tables shows that 1-2 winter prophylactic chemical treatments are conducted in February and March when trees are in winter dormancy. Treatments aim at combating the winter forms of Venturia inaequalis, Podosphaera leucotricha and Erwinial amylovora. The copper-containing pesticides Funguran ON 50 VP – 0,3% (contact broad-spectrum, 77% Cu-hydrooxid) and Shampion VP – 0,3% (contact) are applied. The mineral oil Akarzin – 3% is used during the buds swelling phase in order to combat against the winter forms of mites and other economically important pests.

Chemical treatments are usually applied at 8-10 day interval during the vegetation period, depending on weather conditions and the residual effects of the previously used fungicide. Typically, fungicidal treatment regimens include two pre-blossoming, 1-2 during-blossoming and 8-10 post-blossoming activities (Dzhuvinov et al., 2016).

The initial pre-blossoming treatment is conducted during "mouse ears" phase, whereas the second one takes place during "colour button" phase. The information from the presented tables shows that the sulfur-containing Tiram 80 VG – 0,3% (contact broad-spectrum) is applied against the above-mentioned economically important plant diseases. During the second pre-blossoming treatment, Tiram 80 VG – 0,3% (contact broad-spectrum) and the systemic Horus 50 EK and Punch 40 EK – 0,0075% are applied. Insecticides are added to the applied fungicides during the second pre-blossoming treatment. The combined organophosphorus and pyrethroid Nurele D – 0,04% and Mospilan 20 VG – 25g/dka, which belongs to the group of neonicotinoids, are applied against the initial active forms of some pests.

The systemic Punch 40 EK – 0,0075% and Skor 250 EK – 0,02% (broad-scpectrum systemic) are the selected fungicides for phophilcatic and combating purposes of economically important plant diseases during the initial during-blossoming treatment. In combination with them, Avant 150 EK – 0,035% (broad-spectrum contact), Mospilan 20 VG – 25g/dka and Ortus 5 SK – 0,05% (contact acricide) are applied for prophylactic and combating

leaf-eating caterpillars, aphids and mites. During the second during-blossoming treatment, the fungicide Skor 250 EK – 0,02% and the only broad-spectrum and contact product with protective and locally penetrating effect Delan 700 VDG – 0,05% are used in combination with the insecticides Mospilan 20 VG – 25 g/dka and the broad-spectrum contact product Koragen 20 SK 16 ml/dka against chewing and sucking enemies.

In the first reporting year, the post-blooming sprays were eleven, in the second - also eleven, in the third - seven, in the fourth - ten and in the fifth - eight. The different numbers are explained with changing weather conditions and the effects of the previously applied pesticides.

The fungicides Tiram 80 VG – 0,3%, Folikur 250 EV – 0,04% (broad-spectrum systemic) Delan 700 VDG – 0,05%, Skor 250 EK – 0,02%, Horus 50 EK – 0,03%, Shavit F 72 VDG – 0,2% (systemic and contact) and Bayfidan 250 EK (systemic) – 0,015% are applied in the month of May during the five-year period for prophylactic purposes and to combat Venturia inaequalis and Podosphaera leucotricha. Plants have experienced a different number of treatments over the years with Nurele D – 0,04%, Fyuri 10 EK – 0,125% (new generation of contact synthetic pyrethroid) and Koragen 20 SK – 16 ml/dka in order to combat apple fruit worm, round-mine moth, aphids and spider mites.

Due to the above-mentioned reason, the number of treatments tends to vary in the month of June. Delan 700 VDG – 0,05%, Skor 250 EK – 0,02%, Punch 40 EK – 0,0075% and Horus 50 EK – 0,03% are applied against the economically important plant diseases. In combination with them, the following insecticides are also applied to combat chewing and sucking enemies: Avant 150 EK – 0,035% (broad-spectrum contact), Dikline 2,5 EK – 0,05% (pyrethorid contact), Koragen 20 SK – 16 ml/dka, Nurele D – 0,04% and Mospilan 20 VG – 25g/dka.

Plant protection measures in July are significantly reduced due to the high average air temperatures and low atmospheric humidity which prevent the development of pathogens. The fungicides Skor 250 EK – 0,02% and Horus 50 EK – 0.03% are applied in combination with the insecticides Nurele D – 0,04%, Avant 150 EK – 0,035%, Fyuri 10 EK – 0,125%, Koragen 20 SK – 16 ml/dka and Detsis 100 EK – 0,012%.

The chemical treatments of plants are minimised in the month of August. Insecticides against apple fruit worm are mainly applied - Fyuri 10 EK – 0,125% and Detsis 100EK - 0,012%.

Winter pruning is another important and compulsory agrotechnical activity for every fruit tree. It covers a set of operations, which are designed to regulate the growth and fruit production processes, so that the most optimal economic results are achieved. Unlike other agrotechnical activities, such as plant protection, fertilizing, irrigating and mowing of grass between lines, pruning not only contributes to achieving a balance between growth and reproduction of trees, but also locally influences the development of specific parts of tree crowns (Mitov et al., 1996; Dobrevska, 2013).

In the context of the studied orchard, which operated at full production capacity, winter pruning was carried out in February – March during the entire five-year period.

The soil surface maintenance system in fruit plantations also contributes, albeit indirectly, to achieving maximum yields of quality fruits. Each system includes a set of activities which lead to positive economic results due to the maintainance of sustainable soil fertility (Stamatov et al., 1982; Mitov et al., 1996).

Turf-mulching system is applied in the context of the studied plants. The former is a system for planned soil grassing by planting appropriate grass varieties which are repetitively mowed during vegetation and the mowed leaf mass is left on the grassed area (Todorov et al., 1974). The information from the above-mentioned tables shows that periodic mowing was performed during May, June, July, August and September during the five-year period.

The inter-row strips are kept clear of weeds either by treatment or by the use of herbicides. During the five-year period, the total, leafy, systemic Nasa 360 SL - 600 ml / dka and Klinik 36 SL - 600 ml / dka were applied against annual and perennial deciduous and wheat crops weeds.

Multi-year development and the ability of fruit plants to accumulate a significant amount of mineral nutrients to use before starting and after the

apparent cessation of their growth are important features of mineral nutrition and determine the approach to fertilization. Fertilization largely influences the growth and fruit production of trees (Stoilov, 1976; Mitov et al., 1996). There are easily digestable forms in the context of contemporary cultivation conditions. The concentrated combination of N, P and K is a good example, as it is quickly absorbed by plants and activates their immune system, enhancing their resistance against a number of pests.

The combined fertilizer NPK, which contains the three most important nutritional elements for fruit-growing trees, is used in a doze of 30 kg/dka in the months of March and October during the five-year study period. The combination with minimum content of N (NPK – 6:15:15) is used during autumn fertilization.

From the review of the above-mentioned plant protection measures and the applied fertilization activities, it is seen that perticides with synthetic compounds have been used with the purpose of eliminating economically important pests and enriching the soil in the orchard. Their long-term extensive use already proves its harmful effects on humans (Staneva and Gospodinova, 2018).

The hot and dry summer in Bulgaria and the insufficient rainfall during this period determine irrigation as one of the most important agrotechnical activities in apple orchard.

Irrigation in the studied apple orchard is local, drip irrigation. The irrigation process is fully automized; thereby saving water and considerably increasing labour productivity (Mitov et al., 1996). Water is supplied into the inter-row strip, approximately 2 m wide, keeping soil moisture close to the limit of absorbing water by soil. The aim is to perform irrigation during the most suitable phenophases of apple tree development, as well as achieving a little higher irrigation levels because of the grassed rows.

The information from the presented tables shows that irrigation volumes in the orchard are very insufficient. There is one irrigation activity in May and two activities per month during June, July and August.

There are forthcoming studies in the monitored test area with Florina variety apple, which is conventionally produced in the experimental field of the Department of Fruit Growing, located near the village of Brestnik, Plovdiv region. These will be fulfilled according to the assigned tasks of Component 1, Working Package 1.2 of the National Science Program “Healthy foods for a strong bioeconomy and quality of life” of the Ministry of Education and Science.

CONCLUSIONS

The results of future studies on soil composition (nutrients, humidity, microflora), vegetative and reproductive manifestations of plants, etc., together with collected and presented information for certain previously applied agrotechnical activities can be a source of knowledge, experience and selection of the most appropriate agricultural practices for apple cultivation.

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Table 1. VILLAGE OF BRESTNIK, PLOVDIV REGION, FLORINA APPLE VARIETY

APPLIED AGRICULTURAL PRACTICES (2014)

№	Agricultural practices		Months											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Winter and vegetative, phytosanitary measures	Pests			Venturia inaequalis; Podosphaera leucotriha	1. Venturia inaequalis; Podosphaera leucotriha 2. Venturia inaequalis; Podosphaera leucotriha; Aphis spp 3. Venturia inaequalis; Podosphaera leucotriha; Leaf gnawing insect	1. Venturia inaequalis;Cydia (Carpocapsa) pomonella + Cemiostoma scitella 2. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1. Venturia inaequalis; Cydia (Carpocapsa) pomonella; Panonichus ulmi 2. Cydia (Carpocapsa) pomonella 3. Venturia inaequalis; Cydia (Carpocapsa) pomonella 4. Venturia inaequalis; Podosphaera leucotriha; Aphis spp; Cydia (Carpocapsa) pomonella 5. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella 2. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella 3. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1. Cydia (Carpocapsa) pomonella 2. Cydia (Carpocapsa) pomonella 3. Cydia (Carpocapsa) pomonella				
		Pesticides			Shampion VP - 0,3 %	1.Panch 40EK- 0,0075% 2.Horus 50EK-0,03% 3. Panch 40EK- 0,0075% Avant 150EK- 0,035%	1.Tiram 80VG- 0,3% Nurele D-0,04% 2.Folikur-0,04% Fyuri 10 EK- 0,0125%	1. Delan 700VDG- 0,05% Avant 150EK-0,035% Ortos-0,05% 2.Diklain 0,05% 3.Skor 250 EK-0,02% Avant 150EK- 0,035% 4.Skor 250EK-0,02% Mospilan 20SP- 0,0125% Avant 150EK-0,035% 5.Panch 40EK- 0,0075% Avant 150EK- 0,035%	1.Skor 250EK- 0,02% Nurele D-0,04% 2.Skor 250EK- 0,02% Nurele D-0,04% 3.Skor 250EK- 0,02% Nurele D-0,04%	1. Fyuri 10 EK-0,0125% 2.Detsis 100EK- 0,0125% 3. Detsis 100EK- 0,0125%				
2.	Pruning				*	*								
3.	Spraying with herbicides						* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka				
4.	Fertilizing				* NPK 30 kg/dka							* NPK 30 kg/dka		
5.	Irrigation						*	**	**	**				
6.	Mowing						*	*	*	*	*			

Table 2. VILLAGE OF BRESTNIK, PLOVDIV REGION, FLORINA APPLE VARIETY
APPLIED AGRICULTURAL PRACTICES (2015)

№	Agricultural practices		Months											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Winter and vegetative, phytosanitary measures	Pests			Venturia inaequalis; Podosphaera leucotriha	1. Venturia inaequalis; Podosphaera leucotriha 2. Venturia inaequalis; Podosphaera leucotriha; Aphis spp 3. Venturia inaequalis; Podosphaera leucotriha; Leaf gnawing insect	1÷4. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1÷2. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella 2. Cydia (Carpocapsa) pomonella 3. Cydia (Carpocapsa) pomonella	1. Cydia (Carpocapsa) pomonella 2. Cydia (Carpocapsa) pomonella				
		Pesticides			Shampion VP - 0,3 %	1. Tiram 80VG-0,3% 2. Horus 50VG-0,03% Nurele D-0,04% 3. Skor 250 EK-0,02% Mospilan 20VG-25g/dka	1. Skor 250 EK-0,02% Koragen 20SK-16ml/dka 2. Horus 50VG-0,03% Delan 700VG-0,035% Nurele D-0,04% 3.Shavit 72VDG-0,2% Nurele D-0,04% 4.Skor 250 EK-0,02% Nurele D-0,04%	1.Horus 50VG-0,03% Koragen 20SK-16ml/dka 2. Shavit 72VDG-0,2% Nurele D-0,04%	1. Horus 50VG-0,03% Avant -0,030 % 2. Nurele D-0,04% 3. Fyuri 10 EK-0,0125%	1. Detsis 100EK-0,0125% 2. Detsis 100EK-0,0125%				
2.	Pruning			*	*									
3.	Spraying with herbicides						* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka				
4.	Fertilizing				* NPK 30 kg/dka							* NPK 30 kg/dka		
5.	Irrigation						*	**	**	**				
6.	Mowing						*	*	*	*	*			

APPLIED AGRICULTURAL PRACTICES (2016)

№	Agricultural practices		Months											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Winter and vegetative, phytosanitary measures	Pests		1. Erwinia amylovora + Venturia inaequalis.	1. Venturia inaequalis	1. Venturia inaequalis; Aphis spp 2. Venturia inaequalis; Panonichus ulmi; Podosphaera leucotriha 3. Venturia inaequalis; Podosphaera leucotriha. 4. Venturia inaequalis; Podosphaera leucotriha; Aphis spp; Cydia (Carpocapsa) pomonella	1 Venturia inaequalis; Podosphaera leucotriha 2. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella 3. Venturia inaequalis; Podosphaera leucotriha							
		Pesticides		1.Fungura n ON 50VP-0,3%	1. Tiram 80 VG-0,3%	1. Horus 50VG-0,3% Mospilan 20VG-25g/dka 2. Skor 250 EK-0,02% Ortus 5 SK – 0,05% 3. Skor 250 EK-0,02% Delan 700VDG-0,05% 4. Delan 700VG-0,05% Skor 250 EK-0,02% Koragen 20SK-16ml/dka Mospilan 20VG-25g/dka	1.Skor 250 EK-0,02% Delan 700VG-0,05% 2.Skor 250 EK-0,02% Delan 700VG-0,05% Koragen 20SK-16ml/dka 3.Bayfidan 250EK-0,015% Delan 700VG-0,015%							
2.	Pruning			*	*									
3.	Spraying with herbicides						* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka				
4.	Fertilizing				* NPK 30 kg/dka							* NPK 30 kg/dka		
5.	Irrigation						*	**	**	**				
6.	Mowing						*	*	*	*	*			

Table 4. VILLAGE OF BRESTNIK, PLOVDIV REGION, FLORINA APPLE VARIETY
APPLIED AGRICULTURAL PRACTICES (2017)

№	Agricultural practices		Months											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Winter and vegetative, phytosanitary measures	Pests			1. Venturia inaequalis; Podosphaera leucotriha	1. Venturia inaequalis; Podosphaera leucotriha; Leaf gnawing insect 2. Venturia inaequalis; Podosphaera leucotriha; Aphis spp 3. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1÷4 Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1÷3. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella 4. Cydia (Carpocapsa) pomonella	1. Cydia (Carpocapsa) pomonella 2. Cydia (Carpocapsa) pomonella	1. Cydia (Carpocapsa) pomonella				
		Pesticides			1. Funguran ON 50VP-0,3%	1. Tiram 80 VG-0,3% Nurele D-0,04% 2. Skor 250 EK-0,02% Mospilan 20VG-25g/dka 3. Skor 250 EK-0,02% Koragen 20SK-16ml/dka	1. Horus 50VG-0,03% Delan 700VG-0,035% Nurele D-0,04% 2. Shavit 72VDG-0,2% Nurele D-0,04% 3. Skor 250 EK-0,02% Nurele D-0,04% 4. Skor 250 EK-0,02% Nurele D-0,04%	1.Delan 700VG-0,05% Skor 250 EK-0,02% Koragen 20SK-16ml/dka 2. Horus 50VG-0,03% Avant -0,080 % 3. Skor 250 EK-0,02% Nurele D-0,04% 4. Nurele D-0,04%	1. Fyuri 10 EK-0,0125% 2. Detsis 10EK-0,0125%	Detsis 100EK-0,0125%				
2.	Pruning			*	*									
3.	Spraying with herbicides						* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka				
4.	Fertilizing				* NPK 30 kg/dka									
5.	Irrigation						*	**	**	**				
6.	Mowing						*	*	*	*	*			

Table 5. VILLAGE OF BRESTNIK, PLOVDIV REGION, FLORINA APPLE VARIETY
APPLIED AGRICULTURAL PRACTICES (2018)

№	Agricultural practices		Months											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	Winter and vegetative, phytosanitary measures	Pests			1. Venturia inaequalis; Panonichus ulmi; Podosphaera leucotriha	1. Venturia inaequalis; Podosphaera leucotriha 2. Venturia inaequalis; Podosphaera leucotriha; Aphis spp 3. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1÷3. Venturia inaequalis; Podosphaera leucotriha; Cydia (Carpocapsa) pomonella	1÷2. Cydia (Carpocapsa) pomonella	1. Cydia (Carpocapsa) pomonella 2. Venturia inaequalis; Podosphaera leucotriha 3. Cydia (Carpocapsa) pomonella					
		Pesticides			1. Funguran ON 50VP-0,3%	1. Tiram 80 VG-0,3% 2. Delan-30 g/dka Skor 250 EK-0,02% Mospilan 20VG-25g/dka 3.Skor 250 EK-0,02% Koragen 20SK-16ml/dka	1. Horus 50VG-0,05% Delan 700VG-0,035% Nurele D-0,04% 2. Shavit 72VDG-0,2% Nurele D-0,04% 3.Skor 250 EK-0,02% Nurele D-0,04%	1. Nurele D-0,04% 2. Nurele D-0,04%	1. Koragen 20SK-16ml/dka 2. Skor 250 EK-0,02% 3. Detsis 100EK-0,012%					
2.	Pruning			*	*									
3.	Spraying with herbicides						* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka	* Nasa, Klinik 600ml/dka				
4.	Fertilizing				* NPK 30 kg/dka							* NPK 30 kg/dka		
5.	Irrigation						*	**	**	**				
6.	Mowing						*	*	*	*	*			