The Consequences of Excessive Chemicalization on Fruits Quality

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Chemistry in agriculture has been considered for several decades a formula synonymous with progress and development, as chemical engineering, mechanization, irrigation, modern agro-technical processes have contributed to a substantial increase in production. At present, the use of pesticides to increase agricultural productivity is considered to be a global hazard to the environment. This study examines changes in tree tolerance for major diseases and pests, disease and pest behavior, and the changes that occur in the recommended pesticide treatment. The researches were carried out on different species of fruit trees (apple, plum, and almond), cultivated in an intensive system, in five orchards located in Bihor county. The behavior of each species, as well as the behavior of different varieties with respect to tolerance to major diseases and pests, have been observed over the last 5 years (2013-2017). In addition, pesticide residues were monitored from all crops of apple, plum and almond. During 2015-2017, from March to May, the diseases were more virulent, requiring intensive intervention with systemic and contact fungicide combinations to achieve optimal efficiency; this fact has been correlated with the increase in the number of samples containing pesticide residues. This perspective allows an ecological remodeling of current progress in orchard development, including all aspects of environmental protection and the impact on population2 s health.

Keywords: excessive chemicalization, tree, pesticide, population2 s health

Agriculture chemicalization has been a formula synonymous with progress and development, since chemicalization, mechanization, irrigation, modern agro technical processes have contributed to the substantial increase of agricultural production. But there are more and more evidences that the inappropriate or exaggerated use of these technologies threatens the gains obtained by increasing productivity and creates serious problems with the resources and environmental pollution. At the same time, a strong impact on the composition and quality of agricultural soil is due to inappropriate discharges and management of household waste [1,2], public institution waste [3,4], animal waste [5], industrial waste (especially medical and pharmaceutical [2,6,7], chemical [8,9], petroleum [10], etc.

It is well known the important role of microorganisms and of the enzymes developed by them in the process of soil matter recycling, in the formation of specific nutrients needed for the growth of superior plants [11,12]. Starting from the concept that the soil is an enzymatic system where the enzymes accumulated together with the proliferating microorganisms enzymes have a special biological significance, contributing to the fertility of the soil, to the creation of favorable conditions for the nutrition of the superior plants, it has been demonstrated that the enzymatic potential is an indicator of soil biology and biochemistry [13,14].

All soils contain enzymes that determine the metabolic processes of the soil. Enzyme levels in the soil system vary in different quantities due to the fact that each soil type has different amounts of organic matter, composition and activity of living organisms, and intensity of biological processes [12]. Therefore, soil enzymes (as an index of soil quality) may reflect changes in soil quality caused by time or other conditions [13,14]. Obviously, along with other soil components, enzymes are also influenced by the physical, chemical, microbiological, and biochemical properties of the environment in which they are found (environmental conditions), so that all the qualities and properties of the soil, implicitly the quality of the entire environment, are reflected in the production of plants, vegetables or fruits and their nutritional content [15-20].

Also, the widespread use of fertilizers and growth promoters had as collateral consequences the proliferation of some plant species among the weeds. These in turn have driven to an increased use of herbicides. Pollution due to herbicides is manifested as a result of their long-term use. In some cases, soil structure destruction, a progressive decrease in organic carbon levels in soil superficial horizons, a worsening of cationic exchange capacity, and water retention capacity are observed. The toxic appearance of microflora and micro fauna in the soil should not be neglected either [21].

The priority use of chemical methods of combating the pests and diseases that cause significant losses, to the detriment of biological and physical methods, has led to the chemical pollution of soil and other environmental factors. Extensive and excessive, often inappropriate use of synthetic pesticides is a major source of pollution, with serious human health hazards, and has led to a new shortcoming that compromises the very reason for their use, namely the emergence and development of pests resistant to pesticides. The immediate tendency was to increase the applied doses to compensate for the decrease in pesticide efficacy [22].

Pesticides represent the most dangerous source of environmental pollution, by the vastness of the areas they are used on and their toxicity. Here, a very important role in the way in which environment is managed is played by the proper education of the people for protection of the environment, saving energy, and the way in which the entrepreneurs manage their agricultural business or their business that generate waste [23-32].

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As pesticide use leads to contamination and the exposure of some population categories, agriculture is considered to be one of the most dangerous sectors of activity due to the accumulation of these pesticides in soil and then in groundwater, being a permanent risk for the population. Thus, the use of pesticides to increase agricultural productivity is currently estimated to be a global ecological hazard, placed on the third place by WHO's report [33].

Experimental part

Working procedures

Our researches were carried out on different species of fruit trees (apple, plum, and almond), cultivated in an intensive system, in five orchards located in Bihor county. The behavior of each species, as well as the behavior of different varieties with respect to tolerance to major diseases and pests have been observed over the last 5 years (2013-2017).

Phytosanitary treatments are carried out at optimum moments depending on the phenophases of growth of fruit tree species and the phases of the occurrence of the diseases and pests, as well as after the forecast and warning bulletins issued by the County Phytosanitary Authority.

Pesticide residue monitoring was carried out on samples taken after fruit harvesting and storage by producers, from warehouses or wholesale warehouses. During the years 2013-2017, 25 apple samples, 20 plum samples, and 40 almond samples (from varieties presented in table 1) were taken every year. Analysis were performed by using the multiresidual method described by Stajnbaher et al [34].

Table 1
APPLE, PLUM, AND ALMOND INVESTIGATED VARIETIES

Plum	Apple	Almond
Minerva	Florina	Sandi
Centenar	Liberty	April
Stanley	Golden delicious	Vio
Anna Spath	Golden of Bistrita	Adria
	Prima	Alexandru
		Nicoleta
		Adeluta
		Cristi

Table 2
OPTIMUM MOMENTS AND PHYTOSANITARY TREATMENTS PERFORMED FOR APPLE TREE

Phenophase	The disease and pest	Recommended pesticide products biologically compatible	Dose %
1. Fruit bud swelling	San Jose louse, larvae, eggs of aphids, mites	Imidacloprid 4%+ mineral oil	1.5
2. The budding out of floral buds	Apple blossom weevil, mildew	Triadimezol 2%+ folpet 70%+ Deltametrin 50 g/L	0.2 0.015
3. The burst into leaves	Fire blight, scab, hibernating mites eggs (P. ulmi)	Copper 50%+ Zeta-cipermetrin 100 g/L	0.2 0.01
4. The beginning of the bloom (the first open flowers)	Scab, mildew, defoliators, mining insects	Methyl thiophanate 70%+ Lambda-cihalotrin 50 g/L	0.1 0.02
5. The beginning of shaking petals (10-15%) on warning	Scab, mildew, defoliators, fruit wasp, mining insects	Difenoconazole 250 g/L+ Mancozeb 80%+ Esfenvalerat 5%	0.02 0.2 0.02
6. Fruit as big as pea seed (14 days after the treatment 5) on warning	Scab, mildew, fruitworm (G1T2), defoliators, mining insects	Tebuconazole 250 g/L+ Captan 80%+ Tiacloprid 480 g/L	0.08 0.2 0.02
7. Fruit as big as the peanut (14 days after the treatment 6) on warning	Scab, mildew, fruitworm (G1T2), mining insects	Fenhexamid 500 g/L+ Lambda-cihalotrin 50 g/L	0.08 0.02
8. Fruit as big as a nut (at 14 days after the treatment 7) on warning	Scab, mildew, fruitworm (G1T3), mining insects, defoliators.	Difenoconazole 250 g/L+ Mancozeb 80%+ Deltametrin 50 g/L	0.02 0.2 0.015

Results and discussions

Apple species

In the apple species, the scab (*Venturia inaequalis*) occurs in spring through the appearance of small, olive-green spots on both sides of the leaf. In the development phase, the spots get a velvety brown appearance, more elongated lesions, often located along the ribs. After about 3-4 weeks, the leaves turn yellow and fall. In the years with severe infection, trees can be defoliated by the end of June. *Venturia inaequalis* fungus attacks flowers, fruits, and young shoots. In the case of apple studied varieties, there were performed treatments recommended by the County Phytosanitary Authority, presented in table 2.

In the period between March and May, when the climate is humid and with low temperatures, treatments should be introduced to combat the scab (*Venturia inaequalis*) in apple, treatments which over the last three years (2015-2017) had to be repeated very often. Due to the virulence with which these diseases have occurred, treatments have been performed weekly with systemic and contact fungicide combinations to achieve optimal effectiveness.

For the apple tree, after the treatment number 5, it was required an intervention after 7 days with a systemic and contact fungicide combination to effectively combat the scab in the Golden delicious variety even though the recommendations were to perform the treatment after 14 days. The situation was repeated after the treatments 6, 7, and 8, with the alternation of the mixture of substances. Consequently, in the years 2015-2017, in addition to those recommended by the County Phytosanitary Authority, 4 treatments with combinations of systemic and contact fungicides were performed in all five orchards.

Plum and almond species

In the plum and almond species was observed the occurrence and evolution of moniliasis *(Monilinia laxa),* a disease that is manifested on flowers, leaves, shoots, fruits. The organs parasitized by the fungus wither, turn brown and finally dry out. In the case of the shoots, their tip dries and bends (in appearance they can be confused with those who suffer late spring frosts). Wet climate conditions and low temperatures in the spring are very propitious for the disease progression.

Also in the plum and almond species were observed the occurrence and evolution of the leaves scaring (*Coryneum beijerinckí*), which is manifested on leaves, young shoots and fruits. On the leaves, after de-bud, spots of different sizes and colors appear, depending on the species; in time, the tissue next to the spots becomes

9-10. At 10-14 days after treatment 8 (on warning); Treatment 10 after approximatively 10-12 days after treatment 9	Scab, mildew, San Jose louse (G1T1-T2), woolly aphid, mining insects, defoliators, mites	*Antiventuric contact fungicide* Folpet 80%+ *Antioidic fungicide* Sulfur 80%+ *Insecticide* Clopirifos 250 g/L+Deltametrin 6 g/L+ *Acaricide* Hexithiazox 10%	0.2 0.3 0.1 0.03
11. At 10 days after treatment 10	Scab, mildew, San Jose louse(G1T1), defoliators, mites etc.	*Antiventuric contact fungicide* Captan 80%+ *Antioidic fungicide* Propiconazole 250 g/L+ *Insecticide* Zeta-cipermetrin 100 g/L	0.2 0.03 0.02
12. At 10-14 days after treatment 11 – on warning	Scab, mildew, apple worm (G2T1), mining insects, defoliators, mites	*Antiventuric contact fungicide*+ *antioidic fungicide*+ *Insecticide* (see treatments 9 and 10)	-
13 At 10-12 days after treatment 12 – on warning	Scab, mildew, San Jose louse (G2T1), woolly aphid, apple worm (G2T2), mining insects, defoliators, mites	The same as treatment 11. It is recommended to alternate the mixture used in previous treatments	-
14. At 10-12 days after treatment 13	Scab, mildew, San Jose louse (G2T2), woolly aphid, mining insects, defoliators	The same as treatments 9 and 10 It is recommended to alternate the mixture used in previous treatments	-
15 After the fall of the leaves	Scab, mildew, fire blight	Copper 50%	0.4

Table 2
Continuated

necrotic and falls, so the leaves seem pierced. The stains may be isolated or intertwined, case in which the perforations become larger, irregular. Under the conditions of an intense attack there occurs an early defoliation of the trees. During periods with high atmospheric humidity, the disease extends on green shoots and on fruit.

In the almond, blistering leaves (*Taphrina deformans*) occurs in spring, with symptoms like reddish areas on the developing leaves. These areas become thicker and wrinkled, severely deforming the leaves that will corrugate. The affected areas first thicken, becoming yellowish-white and then gray with a velvety surface. Later, the affected leaves will be yellow, red or brown, and may remain in the tree or may fall. They are replaced by a second set of leaves that usually develops normally unless the weather conditions favor further development of the fungus.

In the case of plum and almond studied varieties, there were performed treatments recommended by the County Phytosanitary Authority, presented in tables 3 and 4.

Phenophase	Disease and pest	Recommended pesticide products biologically compatible	Dose %
1. Vegetative rest	Shelled lice (San Jose louse, Eulecanium corni, eggs of aphids, etc.	Imidacloprid 4%+ mineral oil	1.5
2. Blooming of the corolla (10-15% of inflorescences)	Bacterial scarring and monilium mycotics, red staining of the leaves, eggs of mites	Copper 50%	0.2
3. 10-15% of flowers have shaken	Bacterial scarring and monilium mycotics, red staining of the leaves, plum wasp	Methyl thiophanate 70%+ Mancozeb 80%+ Esfenvalerat 5%	0.1 0.2 0.02
4. At 10-12 days after treatment 3	Red staining of the leaves, moniliasis, mycotic scaring, kernel wasp	Mancozeb 80%+ Tiacloprid 480 g/L	0.2 0.02
5. At 6-8 days after treatment 4	The same treatment as 4 and partly for the plum worm (G1T1)	Captan 80%+ Lambda-cihalotrin 50 g/L	0.2 0.02
6. At 6-8 days after treatment 5 (on warning)	Red staining of leaves, moniliasis, mycotic scaring, plum wasp (G1T2)	Difenoconazole 250 g/L+ Mancozeb 80%+ Deltametrin 50 g/L	0.02 0.2 0.015
7. At 6-8 days after treatment 6 (on warning) (J)	The same as treatment 6. Plum wasp (G1T3) and San Jose louse (G1T1)	Folpet 80%+ Zeta-cipermetrin 100 g/L	0.2 0,01
8-9. At 10-12 days after treatment 7 (on warning)	San Jose louse G1T2, defoliators, mining insects, mites (when PED=3-5 mobile shapes/leaf)	Captan 80%+ Tebuconazole 250 g/L+ Clopirifos 250 g/L+Deltametrin 6 g/L+ Hexithiazox 10% It is recommended to use other products than the previous ones	0.2 0.08 0.1 0.03
10-11. At 10-14 days after treatment 9 (on warning)	Moniliasis, plum worm (G2T1-2), defoliators, mining insects, mites	Mancozeb 80%+ Propiconazole 250 g/L+ Clopirifos 250 g/L+Deltametrin 6 g/L+ Hexithiazox 10% It is recommended to use other products than the previous ones	0.2 0.03 0.1 0.03
12-13. At 14 days after treatment 11	Moniliasis, San Jose louse, defoliators	The same as treaments 10 - 12. It is recommended to use other mixture	-
14. After the fall of the leaves.	Bacterial and mycotic scaring of the leaves, moniliasis	Copper 50%	0.4

Table 3
OPTIMUM MOMENTS AND PHYTOSANITARY TREATMENTS MADE/ PERFORMED FOR PLUM TREE

Phenophase	Disease and pest	Pesticide products biologically compatible	Dose %
1. Vegetative rest	Shelled lice (San Jose louse), eggs of aphids, mites etc.	Imidacloprid 4%+ mineral oil	1.5
2-3. Bud swelling and the first flower blooming	Bacterial and mycotic scarring, moniliasis, leaf deformation	Methyl thiophanate 70%+ Zeta-cipermetrin 100 g/L	0.1 0.01
4. At petal shaking (on warning) - approximatively 15-20 April.	Bacterial and mycotic scarring, moniliasis, leaf deformation and mildew and fruit worm (G1T1), mining insects, defoliators etc.	Difenoconazole 250 g/L+ Mancozeb 80%+ Propiconazole 250 g/L+ Tiacloprid 480 g/L	0.02 0.2 0.03 0.02
5-6-7. At 10 days distance, approximatively 25 April - 25 May (on warning).	Bacterial and mycotic scarring, moniliasis, leaf deformation and mildew, moths and fruit worm (G1T1-3), defoliators, mining insects etc.	Fenhexamid 500 g/L+ Captan 80%+ Tebuconazole 250 g/L+ Deltametrin 50 g/L It is recommended to use other products than the previous ones	0.08 0.2 0.08 0.015
8-9. At approximatively 14 days after treatment 7 (on warning)	The same as treatment 7 + San Jose louse (G1T1-2), mites (PED + 3-5 mobile forms)	Methyl thiophanate 70%+ Mancozeb 80%+ Sulfur 80%+ Lambda-cihalotrin 50 g/L+ *Acaricide* Hexithiazox 10% It is recommended to use other products than the previous ones	0.1 0.2 0.3 0.02 0.03
10. Before harvesting (fruit ripening)	Moniliasis (fruits)	Difenoconazole 250 g/L+ Mancozeb 80%	0.02 0.2
11. After the fall of the leaves.	The same treatment as 2	Copper 50%	0.4

Table 4
OPTIMUM MOMENTS AND PHYTOSANITARY TREATMENTS PERFORMED FOR ALMOND TREE

In the plum species, although recommended to be performed only on alert, treatments 6, 7, 8 were put into practice due to the moniliasis (*Monilinia laxa*), a disease that was manifested strongly in the period April-May 2015-2017.

In the almond species there were no major problems with the diseases, except that the recommended treatments, especially those from the period 25 April - 25 May, were performed 10 days apart, even if only recommended at the alert.

Recommended treatments in tables 1-3 are given in all specialized books of fruit tree growing, phytopathology and entomology, being standard recommendations for each species. Their presentation was considered to be appropriate to show why the treatments were made at the beginning of the year, every year of the life of the tree. The opportunity of performing the treatments at 7 days is given by the observations made in the fruit tree plantation: seeing that the effectiveness of the treatment is not the one expected, and the effects of the diseases are obvious and knowing what effects these diseases have and that they can lead to total compromise of production, it is recommended to apply another treatment, with other substances, in order not to create disease resistance to certain substances in the coming years. One can't speak of an order of product efficacy because it was sprinkled with the substances that are given as having the best efficacy on the disease (the respective pest). However, when the disease occurs again, another sprinkle must be given.

Possible risks to health caused by pesticide residues from fruits are debated in the scientific literature [35-37] and especially in the media.Therefore they represent a subject of great interest to both the scientific world as well as for consumers and authorities. Taking into account the potential risk of pesticides for population2 s health and the excessive use of pesticides in agricultural crops, maximum limits have been set for their residues in food. In the same time, fruit and vegetable production is subjected to a constant monitoring [37-39].

Analysis of Pesticide Residue Monitoring Reports issued by the Ministry of Agriculture and Rural Development of the Government of Romania [39] from 2011-2016 on samples from products on the local market shows that the share of fruit containing pesticide residues fluctuates from one year to another. A clear growth tendency can be observed in the last 3 years. These data are in concordance with the observations made in this study during 2013-2017 (fig. 1).

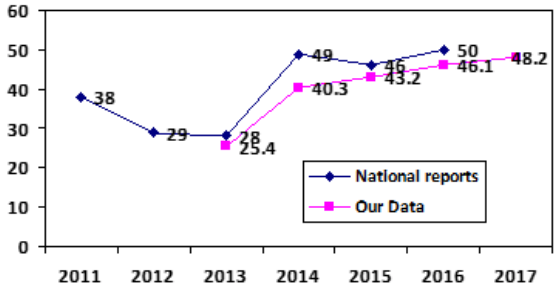

Fig.1. Fruit containing pesticide residues fluctuation (in %) - comparison between national reported data [38] (National Reports are not presenting yet data for 2017) and our data

In the case of apples, although there was a downward trend in pesticide-containing samples in 2016 compared to 2015 (fig. 2), but the number of non-conforming samples increased significantly. In the case of plums, there was observed an increase in the number of samples containing pesticide residues (fig. 2), without non-conforming evidence being found. Reports do not indicate almond fruit verification. The main pesticides found in the form of fruit residues in 2016 were fungicides.

According to data provided by the World Health Organization [33], about 30% of the foods included in the human diet are represented by fruits and vegetables. Being usually consumed raw or semi-processed, they contain pesticide residues in larger quantities, compared to other food groups. Contaminated foods thus become the primary route of exposure of the population to pesticides and are associated with severe effects on human health [38,39]. Severe effects are reported, the most common being nausea and headache, but also chronic effects such as endocrine disorders, cancer and reproductive dysfunction [37-43]. Thus, the need to develop and approach strategies to allow safe use of pesticides and to find non-toxic alternatives is foreseen.

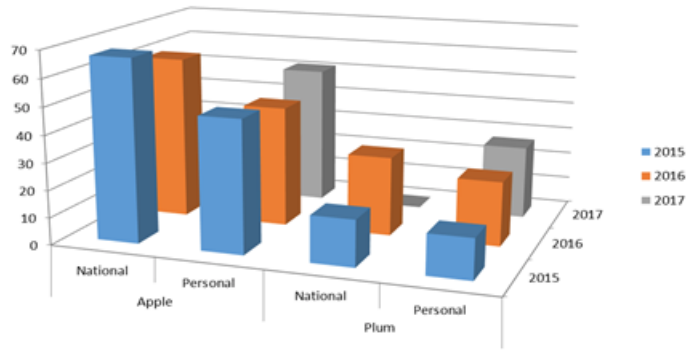

Fig.2. Apples and plums trend in pesticide-containing samples (in %) during the last 3 years (National Reports are not presenting yet data for 2017)

There is a need for ecological remodeling of the current progress in fruit tree growing to ensure the protection of the environment. This should not mean traditional culture systems, but rather the use of modern technologies based mostly on the yields of biological processes, on the virtues of photosynthesis and the use with high efficiency of the solar energy, on the quality of the decomposition and humification phenomenon, on the predominantly organic fertilization and crop cultivation associated with soil improvers in orchards, on integrated prevention and control systems, predominantly biological, on other methods of mechanization and irrigation, and finally on the integration of fruit tree growing into sustainable and competitive agroecosystems.

For this purpose it is necessary to extend the cultivation of varieties with resistance to the attack of pathogens, to stress conditions, varieties cultivated in different ecological areas to allow maximum expression of the genetic potential with which the variety is endowed, especially from productive point of view. Fertilization in fruit tree growing should be based on organic fertilizers, with the use of mineral fertilizers limited for balancing mineral nutrition according to species requirements and the balance of mineral elements in the soil. Reducing to a minimum the number of mechanical interventions on the soil in fruit tree plantations involves the separation of some traffic lanes designed only for the passage of aggregates.

It is also necessary to develop specific strategies to increase the safe application of pesticides, promoting alternative techniques, which will certainly reduce the risks and their effects on human health and the environment. The application of integrated pest control through the rational combination of chemical and biological means, the use of physico-mechanical and agro-technical methods are measures that can facilitate the reduction of environmental pollution and the decrease of the negative impact on the health of the population.

Conclusions

In the last three years (2015-2017), in the period between March and May, the diseases were more virulent, requiring very intensive intervention with systemic and contact fungicide combinations to achieve optimal efficacy. It was also necessary to intervene with a large number of spills as well as to associate substances with different effects for each studied species.

This perspective allows an ecological remodeling of current progress in orchard development, including all aspects of environmental protection and impacts on population health.

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