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RESEARCH REGARDING INTEGRATED PEST MANAGEMENT STRATEGIES IN SWEET CHERRY ORCHARDS IN SOUTH-EAST ROMANIA

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Abstract

Integrated Pest Management refers to a control system of harmful organisms designed to help farmers fight pests effectively by choosing the most appropriate technological, physical, chemical and biological practices to ensure a high yield, in terms of quantity and quality, and to be friendly to the environment and human health. Consequently, the European Union requires the application of several principles of Integrated Pest Management that fit within sustainable farm management. In sweet cherry orchards the combination of non-chemical methods that may be individually less efficient than pesticides can generate valuable synergies. In Dobroudja region, Constanta county, in sweet cherry orchards, it was successfully managed to integrate appropriate practices that discouraged the development of pests and limited the number of phytosanitary treatments to the minimum necessary level. A high level of yield was obtained to varieties Kordia, Van and Skeena, assessed in 2022.

Key words*: sweet cherry, integrated pest management, harmful organisms, control*

INTRODUCTION

Due to public awareness of the health advantages of cherries, which are abundant in polyphenolics (namely anthocyanins and hydroxycinnamic acids), production and consumption of cherries have surged in recent years. Turkey, the USA, and Iran were the top producers of sweet cherries in the world, increasing production from 1.9 to 2.32 million tons over the past 16 years.

Thanks to their luxurious tasting fruits and the fact that they are among the first fruits to be found on the market, cherries are highly appreciated by consumers. They have high content in vitamins, mineral salts, sugars, too.

The priorities for sweet cherry farmers are increased fruit quality, such as size, appearance, firmness, flavor, and shelf life, ripening time and extending seasonality, self-fertility, abiotic and biotic stress resistance (Budan & Petre, 2006; Sansavini & Lugli, 2008). Also, a big challenge for farmers is to obtain fruit free of pesticide residues since year after year diseases and pests damage crops and large imports from neighbouring countries reach the domestic market. So that, in fruit growing, it is inconceivable to obtain high yields in terms of quantity and quality without the use of fertilisers and fungicides, as fruit trees occupied land is generally poorly fertile, terraced or unsuitable for other crops for a long time (Jalobă et al., 2019). In cherry, monilliosis in wet springs causes 60-100% loss of the fruit crop and makes the trees sick until they die. (Tomșa & Tomșa, 2003). Other deleterious diseases are bacterial spot (*Pseudomonas syringae* van Hall), shot-hole (*Stigmina carpophila* Léveillé, M.B. Ellis), anthracnose (*Coccomyces hiemalis* Higgins), leaf red spot (*Mycosphaerella cerasella* Aderhold), witches' broom (*Taphrina cerasi* Fuckel, Sadebeck), leaf scorch (*Gnomonia erythrostoma* Auerswald) and others.

As regards for pests the most damaging to cherry trees in Romania are the European cherry fly (*Rhagoletis cerasi* L.), San José scale (*Comstockaspis perniciosa* syn. *Quadraspidiotus perniciosus* C.), plum fruit moth (*Grapholita funebrana*, T.), apple and thorn fruit weevil (*Rhynchites aequatus* L., Coleoptera: Attelabidae), black cherry aphid (*Myzus cerasi*

F., Hemiptera: Aphididae), spotted wing drosophila (*Drosophila suzukii* M., Diptera: Drosophilidae).

Nowadays, buyers of sweet cherries and other stone fruits are rightfully worried about the contamination of the fruit with pesticides. Consequently, the requirement for naturally `clean and safe' agriculture products is still increasing (Pekar, 1999).

Pesticides with a focus on contact or systemic effects have historically been used to treat cherry diseases and pests from early spring until just before harvest. However, it is also desirable to minimize the use of plant protection products and their risk by 50% to fulfill the objectives of the "farm-to-fork" strategy (https://ec.europa.eu/food/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf). The EU Farm to Fork Strategy was introduced by the European Commission in May 2020 with the goal of ensuring a sustainable food value chain. The idea of Integrated Pest and Disease Management (IPM) has undergone more than 50 years of development and has been described and reduced numerous times. The IOBC (International Organization for Biological and Integrated Control of noxious animals and plants) is one company that has received special distinction for developing IPM tactics. The Sustainable Use Directive (directive 2009/128/EC), has made IPM the norm for crop protection in Europe. This study tested practical cultural control strategies for integration into traditional commercial sweet cherry growing, aimed at controlling specific pests and diseases and lessening the impact of pesticide use on cherry ecosystems and the environment.

MATERIALS AND METHODS

The research was conducted in a commercial sweet cherry orchard belonging to Ostrovit S.A., Constanța county in 2022, where the experimental plants material consisted of sweet cherry trees of the cultivar Kordia (row spacing: 4.5 m; plant spacing within the row: 2.5 m, vase-shaped crown) grafted on Gisela 5 rootstock, Van (6 m x 4 m, vase-shaped crown) grafted on Mahaleb rootstock and Skeena (6 m x 2 m, fan-trained tree) grafted on Colt. Eight randomized points of assessment were chosen over the whole surface of each variety. During growing season one hundred shoots, one hundred flowers and one hundred leaves were analysed visualy and in the laboratory under the microscope. One hundred fruits were examined before and during harvesting to assess pests and diseases incidence. It was used the following formula: Incidence % $=\frac{(n*100)}{N}$, where n represents number of plant organs affected and N is number of organs assessed (Vlad, 2020).

For pests there were assessements, seasonal abundance was obtained by using pheromone traps and yellow double-sticky traps (10 traps/orchard), hung in the middle exterior tree canopy, 1.5-2 m above the ground, one trap per tree, at a distance of 10-13 m from each other and replaced every 5 days from April to June. Other attractants after 3-4 weeks. The ecological parameters of abundance (A), dominance (D%), constancy (C%) and ecological significance (W%) have been calculated using specific formulas (Simionescu, 1983; Stan, 1994; Baban, 2006): $D\% = \frac{A\times 100}{n}$, where: A - number of individuals in a species (abundance); n - total number of individuals of all species in a sample.

For the dominance values, species were classified as subreceding species (D1 < 1%), receding species (D2 = 1-2%), subdominant species (D3 = 2-5%), dominant species (D4 = 5-10%) and eudominant species (D5 > 10%).

$C\% = \frac{ns \times 100}{n}$, where: ns - number of samples with one species; n - total number of samples.

Regarding constancy values, species were classified as accidental species (C1 = 1-25%), accessory species (C2 = 25-50%), constant species (C3 = 50-75%), and euconstant species (C4 = 75-100%).

$W\% = \frac{D \times C}{100}$ For the ecological significance, species were classified as accidental species (W1 < 1%), accessory species (W2 = 1-5%) and characteristic species (W3 > 5%).

IPM measures

Organizational measures. When orchard was set up, the planting material held a phytosanitary passport and was free of viroids. The varieties settled are resistant or diseases - tolerant and yield efficient since the rootstocks are very suitable to Dobroudja soil conditions (especially Colt).

The exposure of the orchard is east and south – east and is terraced on a hill bounded by a protective hedge formed of acacia and carob trees. It is located near a branch of the Danube in the Pacuiul lui Soare area.

Trees were designed by yearly pruning as vase-shaped form or fan-shaped. This improve the structure, increase flowering wood and assist with disease resistance by having good air flow and low humidity. Planting density is wide enough to reduce diseases (humidity), correct spacing (no damage - entrance for bacteria). Orchard soil has good drainage that increases benefitial insects and decrease bacterial infections.

Hygenic measures for machinery, equipments and tools are taken so that at the end of every working day they are cleaned or disinfected.

Spraying atomizers calibration is executed by an authorized professional team that inspects and adjust every year. The spraying machines uses a drift-reducing technology.

Storage of pesticides and PPP remnants are managed in accordance with EU laws and the disposal of empty packages follows the national programme SCAPA (The Pesticide Packaging Collection System).

All the fruits are harvested in the whole orchard so as not to keep a source of infection for the next season.

Cultivation techiniques. Mechanical control of the specific weeds orchards is practiced by mowing between rows and by hoeing between trees in order to remove them because they may be vector viruses and serve as alternate hosts for harmful insects. Also, the water in the soil is thus preserved by the vegetal cover.

The branches and plant material resulting from pruning are ground by a prunings harvesting chopper (Figure 1). This enhaces the fertility of the soil.

Figure 1. Chopped prunings

Removal of infected plant parts and prepruning are carried out by qualified workers.

If frosts occurs between buds burst stage and fruit set stage (especially at flowering), during the night, orchard is protected by biofumigation in order to save the yield.

Tree trunks are painted with lime in the spring to prevent certain pests to reach their damage place.

Organic fertilization (18 t/ha) is provided by livestock manure from the company's Angus cow farm located in the orchard located nearby.

Irrigation and treatments water is assured by water pumped from the neighbouring Danube.

During flowering, over-pollination with Tripol bumblebees (*Bumbus terestris*) hives is used (Figure 2).

Figure 2. Pollination hives

Monitoring. In this case study two types of traps were used for pest monitoring, pheromone traps and yellow double sticky traps with the dimensions of 20 x 40 cm (Figure 3).

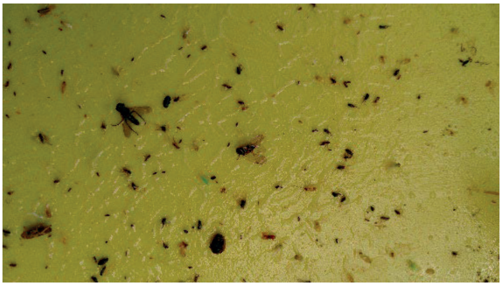

Figure 3. Yellow sticky trap

These traps were checked out daily by specialized personnel and the results were recorded on notebooks and reported to the central data organizer.

Treatments. Spraying schedule (Table 1)

Table 1. Treatments applied in cherry orchard

Phenophase	Plant protection Product	Target
Winter dormancy	Bouillie Bordelaise WDG 5 kg/ha Polisulf Tip MIF 20l/ha	Bacterial and fungal diseases, common red spider mite, San José scale
Before bloom	Merpan 80 WP 2 kg/ha Vitra 50 WP 1.5 kg/ha Teppeki 0.140 l/ha Evobor	Monilinia, leaf spot, shoot blight leaf scorch, leaf spot, crown gall, aphids, flowering, stress resistance
During bloom	Score 250 EC 0.2l/ha Navu Forte 4 kg/ha Algamin 2.5 l/ha Kelom EDTA Calcium 1 kg/ha	Monilinia, leaf spot, shoot blight, foliar fertilization, resistance, colour, growth
After bloom	Signum 0.5 kg/ha Exirel 0.75 l/ha Fertigofol Ultra 4l/ha Borocal 2l/ha	Monilinia, anthracnose, cherry fruit fly, fertilization, fruit fall, firmness
Fruit about half final size	Dodifun SC 1.25 l/ha Chorus 50 0.6 kg/ha Karate Zeon 0.15l/ha Cropmax 2kg/ha Xilato ZnMn 1l/ha Rizammina 2.0 kg/ha	Leaf spot, monilinia, cherry fruit fly, fertilization, foliar fertilizer
Fruit about 70% of final size	Switch 1 kg/ha Merpan 80 WP 2 kg/ha Movento 100 SC 1.8 l/ha Algamin 2.5 l/ha	Monilinia, shoot blight fruit fly, aphids resistance, colour

RESULTS AND DISCUSSIONS

During the spring at flowering stage, weather conditions made it necessary to carry out two fumigation interventions during the night due to the drop in temperature down to -3 degrees. However, the percentage of affected flowers was insignificant (3%). The flowers continued to develop and additional pollination resulted in a higher number of tied fruits. Treatments scheme applied in the orchard together with IPM measures proved very good efficacy in diseases management. Their incidence % is shown in Table 2.

Table 2. Diseases incidence % in cherry varieties

Pathogen	Kordia	Van	Skeena
Viroids	0	0	0
Pseudomonas syringae	0	0	0
Taphrina cerasi	0	0	0
Stigmina carpophila	8	5	6
Gnomonia erythrostoma	1	2	1
Monilinia laxa (shoots)	2	1	1
Monilinia laxa (flowers)	3	5	2
Monilinia fructigena (fruits)	7	3	5
Coccomyces hiemalis (leaves)	10	5	5
Nectria species	0	0	0

Moniliosis of cherry was very well controlled so as it had a very low incidence: 1-2% on shoots, 2-5% on flowers and 3-7% on fruits. Most common disease was anthracnose which reached a maximum incidence of 10% in Kordia variety. Symptoms of other diseases didn`t occur or they were very weak.

Three mechanised interventions have provided good weed control, but the biggest problem is *Sorghum halepense*, an invasive perennial weed that can regenerate very quickly after mowing, especially after high amount of rainfall. Out of a total of 117 traps the total number of individuals was 455 of which the dominant species were *Rhagoletis cerasi*, *Grapholita funebrana*, *Anarsia lineatella*, *Rhynchites aequatus* (Table 3). A relatively low abundance had also the species *Q. perniciosus* and *M. cerasi*, which do not appear in the table, but because pest control is difficult, the situation needs to be regularly monitored.

Table 3. Cherry pests captures on yellow double-sticky traps in the whole orchard

Taxa	Sweet cherry						
	A	D		C		W	
	(no)	Class	%	Class	%	Class	%
Tephritidae							
Rhagoletis cerasi, Linnaeus, 1758	45	9.89	D4	51.28	C3	5.07	W3
Tortricidae							
Grapholita funebrana, Treitschke, 1835	30	6.59	D4	34.18	C2	2.25	W2
Gelechiidae							
Anarsia lineatella, Zeller, 1839	10	2.19	D3	17.09	C1	0.37	W1
Attelabidae							
Rhynchites aequatus, Schneider, 1791	15	3.29	D3	8.54	C1	0.28	W1

Maintaining a clean orchard by picking up dropped fruit from the orchard floor and removing wild and abandoned host trees are two crucial cultural controls that growers can adopt to prevent or reduce European cherry fruit fly (*R. cerasi*) outbreaks. Adding ground cover, weed barrier cloth, or mulch to the soil beneath the tree canopy will also aid in preventing larvae from burrowing into the soil

or emerging adults from appearing from the soil.
After the end of the cherries harvesting in the whole orchard, yields were calculated and reported. The following productions resulted: Kordia 13.8 t/ha; Skeena 11.5 t/ha; Van 12.4 t/ha. Fruits were very good - looking with excellent marketability (Figure 4). Cracking index was at a low level for each variety, ranging from 2 to 5%.

Figure 4. Van harvested fruits

CONCLUSIONS

In the Ostrov fruit-growing area, sweet cherry has been grown for a long time, so there is a high load of pathogenic inoculum. The most dangerous pathogen, monilliosis, was successfully controlled, creating the conditions for a high yield, commercial appearance and increased marketability. Other cherry diseases have not caused any problems, but they should be monitored in the future. Leaf blight of cherry (anthracnose) had the highest level of incidence (10% at Kordia variety), but this fact didn`t endangered the quantity and quality of the yield.
Besides targeted pest control and optimisation of the way in which chemical treatments are applied, one can start to think about diversification in and around the cherry fields to reduce pest pressure or increase biological control. Also, this can be adjusted to improve the crop's capacity to withstand pests, be less visible or attractive or be more competitive.
Climatic factors such as temperature, wind, rain, and relative humidity, as well as natural enemies, play important roles in the population dynamics. Any of the regional pest species may experience an outbreak in good years and environmental circumstances. With a focus on cost-effectiveness and environmental safety, sanitation and harvest management become important for every orchard. In order to mitigate the effects of disease and pests, our work highlights the necessity to investigate the potential impacts of local management in cherry orchards. However, a strong experimental design is still lacking to demonstrate the significance of the identified cultural practices. Given the unpredictability of insecticide use (E.U. wanting to reduce by 50% the use of chemical pesticides by 2030), local crop management cannot entirely rely on insecticide control.

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