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INTEGRATED PRODUCTION OF PEPPER IN REPUBLIC OF MACEDONIA

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ABSTRACT

In the last few years in Republic of Macedonia it is favor producing vegetable with higher standards related to the safe food and the need of protection of the environment.

80 % of the vegetable production in Republic of Macedonia is for export. Because of already known reasons, part of traditional markets for Macedonian vegetable is opened for entrance on countries that have bigger and more concurrent production than ours. For more competitiveness of our products on these markets, also for getting new markets in EU it is necessary implementing standards for production of safety food. That kind of production, with higher standards, also asks the food industry in Republic of Macedonia which their final products place on the markets in EU.

One of the measures for protection of the pepper that put into the standards for safety food production, and that also gives protection of the environment, is the integral protection.

Integral pest management of crops is plant protection systems that use all suitable techniques and methods of compatible mode, so the population of pests stays under the economic threshold level.

"...favoring all the other measures respectively the chemical measures..."

Key words: integral protection, safety food, pepper, market, food industry.

1 INTRODUCTION

The pepper (*Capsicum annuum* L.) is one of the basic garden-stuff in the world. It originates from the tropical parts of South America, and today it is grown in Italy, Hungary, Bulgaria, Greece, Serbia, Monte Negro, Spain, Turkey, USA, South America and Australia.

More visible ascent of expansion in our country, the pepper production shows from the seventies of XX century, most of all as a result of building of the hydro melioration systems and development of the can industry.

Pepper fruits are distinguished with high nutrition and delicious values, which is due to the relative high content and harmonic proportion of sugars, acids, vitamins and minerals.

The content of vitamin C in the fresh pepper fruit is 3 – 4 times higher than in the lemon (to 400 mg). The proteins are represented with 1,4 %, no nitrogen are 5,44 %, cellulose 1,8 % and minerals 0,69 % (Jankulovski, 1983).

Pepper fruit is used as fresh fruit, canned, and for different ways of other production.

In Republic of Macedonia, almost, there is no region where pepper is not grown. The most represented is in the region Strumica – Radovis, with 2200 ha, than in the region of Gradsko – Rosoman, with 1352 ha, and in the other regions is represented on smaller regions. In the region of Strumica, there are very favorable climatic and soil conditions for successfully growing of pepper. Besides on open field it is also grown in greenhouses. Some varieties of industrial pepper and feferony could be produced with direct seeding.

The representation of the pepper is very variable, and in the last ten years is moving around 2500 – 3000 ha, with average yield of about 18000 – 25000 kg/ha. Improving the technology of production with reaching good quality and better yield. But, that increasing of the quality and quantity of pepper production asks solving the problems of protection of the pepper from pests.

The pest insects are one of the main reasons for decreasing the yield and the quality of the fruits of the pepper in our country. Control of the number of the population of the pest insects is great ecological problem, for which it is necessary determination of the quality content of the pests. After doing such analyze, the real important importance of the pest insects could be seen.

Pepper as a crop is suitable as food for many pests. The seed and the germ could be totally destroyed from the insects that spend all or part of their life in the soil (mole cricket, the wireworms and others), so the plant cannot germinate. Some insects damage the root system biting it or getting inside the root (nematodes, wireworms etc.), due to the plant wilts. At young plants the insects bite the stem (mole cricket and some moths) so the plants are very tender so they are easy breakable. The pepper leaves are very good food to more insects (the owlet moths, leaf aphids, thrips, whiteflies, cicadas, the two spotted spider mite). The damages that they do cause deformation of the leaves, curling, yellowing and appearance of other symptoms. Some insects damage the plant flowers (the western flower thrips). Also some insects feed with the young pepper fruits and also deform or they totally destroy them (leaf aphids, thrips, and owlet moths).

Beside the direct damages that cause, some insects, like leaf aphids, thrips, some cicadas and others, transmit virus diseases, that cause economically important damages, decreasing the yield and the quality of the fruits.

Part of the pepper entomofauna are insect species that feed on insects (ladybeetles, green lacewings) so they take part in population regulation of the pest insects. Also, practical meaning have the species which hosts are phytophagous insects (parasitic wasps).

The negative influence of the pesticides on useful entomofauna is big. In order to keep the useful entomofauna, and on other hand to solve the problems with the pest insects the most effectively, the modern day plant protection system suggest integral protection. The integrated pest management allows using of all methods for controlling of pest insects that will decrease their number under the economic threshold. This system of measures underlines the meaning of the cropping techniques, but does not exclude the using the chemical measures. They are their compound, but their use is rational and strictly specific to previously determined economical and ecological threshold levels.

2 INTEGRATED PRODUCTION OF PEPPER

Integrated production is a high quality production method prioritizing ecologically safer cropping techniques and minimizing the use of synthetic chemicals in order to increase safety for human health and the environment. The implementation of this protocol requires the involvement of specialists who may recommend the adoption of the best cropping techniques.

The method of integrated production of pepper results from the critical evaluation of the literature on the crop and from an in-depth comparison with the experiences gained by the technicians working in the area. Integrated production method is dynamic and must be updated on the basis of the field experience, the cultivar innovations, the control of the physiological disorders (both in terms of products and production strategies) and market needs.

2.1 VOCATION

Before starting the cultivation of pepper, the following aspects shall be taken into account:

- Cropping environment;
- Farm organization;
- Technical and logistical factors (fruit and vegetable market, cooling plants, transport facilities, etc.);
- Technical support and assistance.

All these parameters make up the vocation of an area for the cultivation of a given species.

2.1.1 Pedoclimatic requirements

The ideal environment for the crop shall respond to the following parameters (Table 1).

Table 1. Optimal values of the soil parameters

Soil parameters	Optimal values
Texture	Loam or sandy loam
Drainage	Well drained
Groundwater	>80 – 100
Effective depth	30 cm
pH	6 – 8, ideally 6,7 – 7,3
Total and active limestone	<10
Salinity	bellow 3 mS/cm

The optimal values for the climatic parameters are given in Table 2.

Table 2. Ooptimal values for the climatic parameters

Climatic parameters	Optimal values
Germination temperature	15 °C
Minimum temperature	10 °C
Growing temperature	25 – 30 °C, 14 – 16 °C (night)
Fruit setting temperature	24 – 26 °C, 16 – 18 °C (night)
Maximum temperature	35 °C

It is advisable to consult meteorological data or bulletins of the area.
Pepper growing areas shall be located at a distance of at least 500 m from landfields.

2.1.2. Maintaining the natural agroecosystem

Ecological areas must be maintained on the farm that is to say areas where neither fertilizers nor pesticides are administrated (at least 3 % of the total surface area). In order to strengthen the biodiversity, farms shall envisage at least one natural or ecological option among the following:

- Hedges;
- Sound management of unproductive areas;
- Maintaining pebble walls;
- Releasing beneficial insects.

2.2 CHOICE OF THE NURSERY MATERIAL

The best practice is the use of healthy material that allows preventing diseases induced by viruses, bacteria, fungi, phytoplasmas and insects.

But, it is mandatory to use nursery seeds and material provided with phytosanitary and trueness-to-type certification according to national legislation. Certification shall testify that the propagating material is not obtained with molecular engineering techniques (Genetically Modified Organisms).

The use of grafted plants is allowed.

2.2.1. Choice of cultivars

The choice of cultivars is crucial for achieving a good quality standard of production. Pepper cultivars available on the market differ among them for their agricultural characteristics (Yield, earliness, resistance to diseases, etc) and for the fruit morphological traits (shape, size and epicarp color and maturity).

The characteristic of hardiness and tolerance/resistance to pests and pathogens are a priority in the choice of cultivars. It shall be specified that any pepper cultivar with the above traits can be used.

It is advisable to use cultivars with fruits square or oblong 3-lobed or 4-lobed.

2.3 CROPPING TECHNIQUES

2.3.1 Rotations and crop successions

The adoption of a proper rotation needs considering that the pepper is a root crop cultivation. It must be included in a rotation designed to maintain the soil fertility, to reduce growth of weeds and pest attacks.

As for crop successions, close attention shall be paid to the cultural operations on the previous crop mainly in terms of weeding and pest control.

The farm must respect a two-year rotation during which no solanaceae (potato, eggplant, tomato) shall be grown.

2.3.2 Soil tillage

The pepper requests the typical preparatory tillage for renewal crops. Deep plugging allows creating the best conditions for the root system. Soil management is designed to favor the management of water resources overcoming root asphyxia and/or runoff.

Preparatory tillage consists in a deep plugging at a 40 – 50 cm depth followed by an accurate clod breaking.

Later, if the soil has a good structure, a rotary tillage is enough with, eventually, a harrowing. Transplant is done on a leveled soil free from weeds. Prevent soil from getting compact and from developing hard pan.

2.3.3 Planting distance and density

Transplanting allows improving simultaneous ripening and is fit for all types of growing: open field, semi-forced and in greenhouse. For transplanting, the plants used are 35 – 40 days old, have their soil ball, are grown in containers, a developed root system and 3 – 4 true leaves.

The planting distance and density vary according to the training system, soil type and cultivar vigor.

After their establishment, plantlets must be irrigated.

For greenhouses growing, pollinating insects are needed for pollination.

It is obligated that the crops shall be established by transplanting certified plantlets. The density is usually 65000 plants/ha in open field and 25000 plants/ha in greenhouse, which is usually obtained placing plants at a distance of 20 – 40 cm on the row and 70 – 90 cm between the rows.

2.3.4 Fertilization

The supply of nutrients is designed to achieve a quality production.

The fertilization scheme shall be drawn up on the basis of the soil analysis and with the support of a specialized technician.

For the supply of a nitrogen based fertilizers opt for the fractionated form: 30 % administered at pre transplant, the remaining amount at the beginning of flowering and at early fruit ripening.

Organic – mineral fertilizers are advisable since they enrich the soil with nutrients, improve the structure and slow down tiredness phenomena.

Should recent soil analyses be lacking, a complete survey is to be carried out on the following soil characteristics:

1. soil texture;
2. soil reaction (pH);
3. active limestone (%);
4. organic matter (5) and total nitrogen (%);
5. assimilable phosphorus (P_2O_5 ppm);
6. assimilable potassium (K_2O ppm);
7. calcium (ppm), magnesium (ppm);
8. cation exchange capacity (C.E.C., in meq/100g);
9. Mg/K ratio;
10. Parameters for the evaluation of soil and irrigation water salinity).

Analyses must be repeated every 5 years so as to define the right amount of nutrients. Max doses, for a production of about 35 – 40 t/ha and for a medium textured, loamy soil, are:

- 260 – 300 kg/ha of Nitrogen;
- 80 – 100 kg/ha of Phosphorus (P_2O_5);
- 320 – 350 kg/ha of Potassium (K_2O).

In case of fertigation, the above mentioned amounts may be reduced by 30 %.

2.3.5 Irrigation

Pepper water requirements are high and vary according to the phases of the growing cycle; if they are not satisfied, fruit production and quality may undergo negative repercussions.

Avoid water scarcity at the beginning of fruit setting when the plant grows actively and has to support berry swelling.

In general, in order to meet the crop water requirements, increasing watering volumes may be applied according to the phonological stage of the crop with a frequency related to the soil type and meteorological pattern.

Drip irrigation is the suggested method. By way of example, we may consider a watering volume of 200 - 300 m^3/ha per interval, for 15 – 20 irrigations, with an irrigation frequency of 4 – 5 days.

In the management of irrigation, remember to avoid excess water which makes the plant more susceptible to pathogens (mainly fungi) and fruits less resistant to handling and transport.

2.4 HARVEST

The quality and the color of fruits strictly depend on the harvest time which is identified on the basis of the fruit development (within the typical shape of the cultivar) and the ripening degree of the fruit. When the fruit is harvested unripe, it is green in color for all cultivars and turns red or yellow afterwards.

Harvest shall be made with scissors, removing a small portion of stalk. It is advisable to pick up the fruits in the early cool hours of the day; do not leave the harvested produce in the sun light. Avoid mechanical damages.

3 GENERAL PRINCIPLES OF INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools in a way that minimizes economic, health and environmental risks.

In choice of control means, the following should be prioritized:

- Cultivar resistant or tolerant to pest attacks;
- Use of healthy and certified propagating material;
- Application of agricultural practices which create conditions unfavorable to pests (long crop rotations, balanced fertilizations, trickle irrigations, etc.);
- Use of physical and mechanical means;
- Use of biological means (beneficial insects and mites and antimicrobials);
- Use of substances of natural origin (sulphur, copper, etc.).

Phytosanitary products shall be used only when the plant pest infestation reaches the "economic threshold" or when the environmental conditions are favorable to fungal or bacterial infections.

Criteria for choice of phytosanitary products:

- Never use products whose labels report risk factors with specific reference to carcinogenic, teratogenic, mutagenic actions, etc. (R40, R43, R63, etc.);
- Never use toxic and very toxic products;
- Limit the use of noxious products.

3.1 INTEGRAL PEST MANAGEMENT OF PEPPER FROM PESTS

Pests	Treatment criteria	Active ingredients	Notes and use restrictions
Pyralis (*Ostrinia nubilalis*)	**Threshold** - presence **Agricultural treatments** - Cover greenhouses with a net and leave it throughout the growing cycle; - Hang pheromone traps to check the introduction of adults; compare them with other traps placed outside; - Remove fruits with flowers. **Chemical treatments:** - When the net is absent or in the open field, hang pheromone traps. - On the first generation when the number of caught individuals increases. - On the second generation apply precautionary treatments soon after the first catches.	*Bacillus thuringiensis* (var. *kurstaki*) Teflubenzuron Lifenuron Deltamethrine (1) Zeta-cipermetrin (1) Lambda-cialotrin (1) Spinosad (2) Acetaprimid (3)	(1) Max 2 treatments with pyretroids (2) Max 2 treatments independently of the pest (3) Max 1 treatment independently of the pest
Aphids (*Myzus persicae, Macrosiphum euphorbiae, Aphis gossypii, Aphis fabae, Aulacorthum solani*)	**Treshold for greenhouse releases** Presence **Biological treatments:** - *Chrysopa carnea* (10 – 30 larvae / m); - *Aphidius colemani* (4 – 8 individuals per m^2 in 4 – 6 releases at weekly intervals); - *Harmonia axyridis* (20 – 30 larvae per infestation focus). **Chemical treatments:** Presence with growing colonies.	*Chrysopa carnea* *Aphidius colemani* *Harmonia axyridis* Pirimicarb Imidacloprid (1) Pimetrozin (2) Thiamethoxan (3) Acetaprimid (3)	(1) Max 1 treatment independently of the pest (2) Max 2 treatments independently of the pest (3) Max 1 treatment independently of the pest
White flies (*Trialeurodes vaporiariorum*)	**Treshold for greenhouse releases** Presence	*Encarsia formosa* *Eritmocerus*	Max 1 treatment independently of the pest

	Biological treatments: *Eretmocerus mundus* (8 – 16 puparium/m^2 broken down in at least 4 releases at weekly intervals.	*eremicus* *Macrolophus caliginosus* Imidacloprid (1) Thiamethoxan (1) Bifentrin Buprofezin	
Thrips (*Thrips tabaci, Frankliniella occidentalis*)	**Treshold for greenhouse releases** Presence Use chromotropic traps (blue or yellow) for monitoring (one every 50 m^2) **Biological treatments:** *Orius laevigatus*: 1 – 2 predators per m2 distributed in several releases	*Orius laevigatus* *Beauveria bassiana* Lifenuron (1) Spinosad (2)	(1) Max 2 treatments (2) Max 2 treatments independently of the pest In the greenhouse and max 1 treatment
Noctuid lepidoptera (*Autographa gamma, Mamestra brassicae, Helicoverpa armigera, Spodoptera littoralis, Udea ferruginalis, ecc.*)	**Chemical treatments**: Occasional treatments against young larvae	*Bacillus thuringiensis* Lifenuron (1) Spinosad (2)	(1) Max 1 treatments: alternative products (2) Max 2 treatments independently of the pest

4 CONCLUSION

From all above mentioned we can conclude that the main aim of the integrated pepper production is getting ecologically safe products in aspect of keeping people's health and the environment.

As a result of that kind of production the concurrency of our products on the markets in EU shall increase, which markets ask implementation of standards for production of safe food?

That kind favor of production of agricultural products with higher standards than the last conventional production ask also the food industry in Republic of Macedonia, that their products place on the EU markets.