

Hydroponic Cultivation and Biological Protection of Pepper (*Capsicum annum L.*)

Nada Paradjickovic, T. Vinkovic, D. Iljkic

University of J. J. Strossmayer in Osijek, Croatia

Faculty of Agriculture in Osijek, Croatia

Abstract: The advantage of production technology provides an opportunity of applying different methods of plant protection such as biological control of pests and diseases. This especially refers to hydroponics, because this production technology is mainly indoor production where the use of biological control is possible. The hydroponic technology advantages are known in relation to pepper cultivation in the soil in protected areas, and these are: high yields, good fruit quality and continuous harvesting throughout the year. In our investigation we used several bio-control systems for pests and diseases. At the end of the experiment, it was concluded that bio-control can substitute traditional protection with pesticides for several reasons: highly effective, consumers' and producers' health preserving, easy to apply and environment friendly.

Key words: biological control, diseases, hydroponics, pepper, pests.

Introduction

Hydroponic cultivation is a significant factor of vegetable crop, but most producers do not have the basic knowledge on this production.

Advantages of hydroponic technology are known in relation to pepper cultivation in the soil in protected areas, and these are: high yields, good fruit quality and continuous harvesting throughout the year. Bumblebees were used for flower pollination.

In these conditions biological pepper control provides production without the use of chemical pesticides.

Monitoring of the occurrence of the whitefly (*Trialeurodes vaporariorum*), western trips (*Frankliniella occidentalis*), red spider (*Tetranychus urticae*) and Sciaridine grub, was carried out in greenhouses of Vukovar in 2003 and in

greenhouses Vegic in Klobuk (BiH) in 2004, with the cocurrent control of fungal diseases in both places.

Trialeurodes vaporariorum is an economically very important pest, and in intensive greenhouse pepper production, producers are often incapable of controlling it.

High insecticide resistance, fast pest propagation and frequent harvest require the use of biological control. *Trialeurodes vaporariorum* pest digests sap which is necessary for growth, and the superfluity of sap beams in molasses covering the flower, leaf and fruit reducing assimilation, and also decreasing the product quality.

For flying control and mechanical protection yellow and blue sticky traps of medium size were used. *Frankliniella occidentalis* develops in a very short period of time (5 – 7 days) in late spring and summer periods. It makes big damages by destroying pollen of the flower, it damages young and new fruits, and also in the shape of brown lines underrates the commercial produce value. *Tetranychus urticae* is a maggot regularly occurring in pepper plantations in intensive production during summer when there is a low relative air humidity and high temperature. Sciaride – larvae feed on live and dead tissues of the plant especially in the root neck zone. It often causes secondary plant diseases *Pythium*, *Botrytis*, *Phytophthora* etc.

Material and Methods

The investigation was carried out in hydroponic pepper production greenhouses. The greenhouses were located in Vukovar (20,000 m²) and Klobuk - BiH (3,000 m²).

Time of planting and harvesting: 15th – 20th February to 18th October – 1st November in 2004 (Klobuk) and the same for Vukovar.

Method of cultivation: coconut fibre (volume 7.5 l and 11.5 l) – in beds (origin India) and rockwool cubes 10 x 10 cm (Grodan NL).

Cultivars used: hybrid F1 Istra – block pepper (CPM) hybrid F1 Danubia – Type HRF.

Planting density: 3 plants/ m²

Temperature and relative humidity were: sunny day, 24-25°C, night 17-18 °C cloudy day 17-19 °C, night 15-16 °C, relative air humidity 68-80%, water capacity WC% in the root zone 72-75%.

Climate regulation: computer microprocessor with sensors for measuring pH, EC (mS/cm) nutritious suspension, solar radiation W/m² etc. Bumblebees were used for flower pollination.

The analysis of nutritious solution incoming and outcoming (filtrate), and the analysis of plant tissue (leaves and fruits) were carried out at the Soil Institution in Osijek and in Aalsmeer NL during production for providing corrections, and biological control recommendations were given by Biobest NV from Belgium.

The pepper plants cultivated in coconut fibres were watered 6-8 times, and at the rockwool cultivation they were watered 3-12 times a day which especially depended on the daylight capacity, and the rate to be used was determined by the

microprocessor. During pepper growing the following biological agents were used: for control of *Trialeurodes vaporariorum* Agri Sea Green (Agri 50 E) – sea weed agent was used. Predators for the control of *Frankliniella occidentalis* Amblyseius – System were used. For *Sciaride* larvae control Steinernema – System was used.

For fungal diseases control, a biological damping-off agent TRI 003 (*Trichoderma harzianum* - T-22 isolate) was used. The application of TRI 003 was done two times in a 10 days' period with 35 g TRI 003/1000 plants by watering.

All pest control agents are products of Biobest NV, Westerlo – Belgium, and the application was carried out based on their recommendations.

Excessive root zone humidity causes root neck rot and at the same time the occurrence of *Sciaride*, whose larvae destroy the tissue.

Relative air humidity over 88% and root zone humidity exceeding 90% in warmer days (air temperature >35°C) cause Ca absorption problems and the fruit BER (blossom end rot) occurrence.

Results and Discussion

The yield of the Istra hybrid was higher on cocohusk substrate, and that of the Danubia hybrid was higher on the rockwool (Table 1. and Table 2.).

Total yields were 8.37 kg/m² (Danubia) and 12.36 kg/ m² (Istra).

Air temperatures higher than 35 °C and high air humidity exceeding 90% caused BER occurrence (Papadopoulos, 1997) due to low calcium ion mobility. An increase in market products was induced by foliar Ca application every five days from 20th May – 28th June for both localities. An increase in market products share by foliar appliance of Ca was determined by Parađiković et al. (2000), Bar-Tal et al. (2001), Poljak et al. (2003).

Table 1. Influence of harvest date, rockwool (a) and coco husk (b) on the yield and concentration of elements in pepper Danubia F1 (average 30 fruits)

Harvest month	Weight (g)		Dry matter%		N %		P ₂ O ₅ %		K ₂ O %		Ca %		Mg %	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b
June	81	77	7,2	6,7	2,38	2,18	0,5	0,3	3,6	3,4	0,54	0,30	2,09	1,86
July	99	86	7,9	7,1	2,44	2,38	0,4	0,3	4,1	4,0	0,51	0,47	2,27	1,94
August	111	99	7,7	7,4	2,63	2,59	0,4	0,3	5,1	4,3	0,63	0,32	2,08	2,00
September	103	82	7,9	6,8	2,66	2,60	0,6	0,4	7,1	5,3	0,71	0,41	2,02	1,87
Oktober	109	101	6,8	6,7	3,29	3,19	0,5	0,4	6,5	6,4	1,66	1,06	3,00	2,40

The whitefly control was carried out in 8 replications using the Agri 50 E biological agent which has insecticidal and fungicidal effects at plant-height-dependent rates: 1m – 3 l / 1500 l of water, 2m – 4 l / 2000 l of water

The interval between the applications was 5 days. The agent was not toxic to useful predators. Results were satisfactory throughout the growing period.

Table 2. Influence of harvest date, rockwool (a) and cocohusk (b) on the yield and concentration of elements in pepper Istra F1 (average 30 fruits)

Harvest month	Weight (g)		Dry matter%		N %		P ₂ O ₅ %		K ₂ O %		Ca %		Mg %	
	a	b	a	b	a	b	a	b	a	b	a	b	a	b
June	153	162	8,4	8,9	2,3	3,17	0,3	0,7	3,3	6,3	0,61	1,06	1,76	2,66
July	158	168	7,9	8,4	2,7	3,23	0,4	0,8	4,4	6,7	0,92	1,02	1,65	2,14
August	165	174	8,1	8,7	3,1	3,40	0,4	0,8	4,0	6,5	0,72	1,30	1,78	2,27
September	172	179	8,0	9,1	2,9	3,26	0,5	0,6	3,2	7,1	0,58	0,97	1,48	1,78
Oktober	162	174	7,6	7,9	2,17	2,54	0,5	0,6	4,3	6,8	0,46	1,44	1,60	2,04

Biological control of *Frankliniella occidentalis* was done by combined introduction of predators *Amblyseius cucumeris* (A.c.) and *Amblyseius degenerans* (A.d.) resistant to lower relative humidity and higher air temperature ($\pm 55\%$, $\pm 35^\circ\text{C}$) and especially recommended in pepper growing. They were applied in June (50 A.c. per square meter and 0.2 A.d. per square meter) and July (100 A.c. per square meter and 0.3 A.d. per square meter). The application of these two predators resulted in complete control of pest.

Biological control of red spider (*Tetranychus urticae*) was done by introduction of predator *Phytoseilus persimilis* (Phytoseilus - System) in the beginning (4 predators/m²) and at the end of May (16 predators/m² - (3:1 ratio; adults: nymphs)).

Sciaride - larvae were controlled by the application of nematode *Steinernema feltiae* watering the plants with the rate of 100000 nematodes/1 L water/2 m² used.

The main pepper growing problem is the fungus disease caused by *Phytophthora debarianum* inducing damping-off of young seedlings. Based on literature most authors conclude that the plant becomes resistant towards the parasite. However, it is a well known fact that the plant can become sensitive in later growth stages, but also that the parasite can be controlled using the biological preparation TRI 003 (*Trichoderma harzianum* - isolate T-22; Bio-Works USA) (Hayes, 1998; Ulmer 1998; Paradiković et al., 2007; Čosić et al., 2000; Paradiković et al., 2004). After application of TRI 003 the plants have fully recovered and continued to grow healthy.

Conclusions

Hydroponic pepper cultivation advantages are as follows:

- There is no contact with soil
- Optimal water and nutrient supply based on computer microclimate monitoring, which ensures faster growth and development, higher stress resistance and higher yields
- Prolonged vegetation and less men labour
- Harvest are daily and prolonged, so that biological control is a major part of such production

The research results on hydroponically grown pepper showed the possibility of practical application of complete biological control without the use of chemical

pesticides and this kind of technology (hydroponics + biological control) can be considered to be main vegetable and flower production technology when indoor production is the case.

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HIDROPONSKO GAJENJE I BIOLOŠKA ZAŠTITA PAPRIKE (*Capsicum annum L.*)

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Nada Paradjković, T. Vinković, D. Iljkić
Sveučilište J. J. Štrosmajer u Osijeku, Hrvatska
Poljoprivredni fakultet u Osijeku, Hrvatska

Rezime

Prednost tehnologije proizvodnje je takva da omogućava primenu različitih metoda zaštite biljaka poput biološkog suzbijanja štetočina i bolesti. Ovo se naročito odnosi na hidroponsko gajenje biljaka zbog toga što se ova tehnologija proizvodnje uglavnom odvija u zatvorenom prostoru i zbog toga što je moguće primeniti biološko suzbijanje. Poznate su prednosti hidroponske tehnologije u pogledu gajenja paprike na zemljištima zaštićenih područja: visoki prinosi, dobar kvalitet ploda i stalna berba tokom cele godine. U našim istraživanjima primenili smo nekoliko sistema biološkog suzbijanja štetočina i bolesti. Na kraju eksperimenta, zaključeno je da bio-suzbijanje može da zameni tradicionalni način zaštite pesticidima iz nekoliko razloga: visoka efikasnost, očuvanje zdravlja potrošača i proizvođača, laka primena i ekološka podobnost.