

Influence of Biodiversity Measures on the Improvement of Integrated Vegetable Production

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Summary

Integrated vegetable production is based on a balanced application of agrotechnical measures taking into account economic, environmental and toxicological measures, while at the same time the economic effect, ecological and toxicological acceptable measures such as biodiversity conservation are preferred. Safety and sustainability of an ecosystem is maintained by increasing agro-biodiversity, which includes preserving local cultivated varieties of vegetables, maintaining agro-biodiversity in the soil, green manure, intensification of crop rotation, low allopathic relations in polyculture, planting useful plants for biodiversity conservation and providing habitat for beneficial organisms. Under Professional supervision by Advisory Service in Croatia integrated vegetable production in continental Croatia is mostly represented in Osijek-Baranja, Virovitica-Podravina and Međimurje County and in the Mediterranean area in Istria. The implementation of agro-biodiversity friendly measures was monitored over three-year period on farms engaged in the integrated vegetable production.

Results have shown that biodiversity measures were mainly maintained in: Međimurje, Krapina-Zagorje and Bjelovar-Bilogora counties. Production of cucumbers, carrots, tomatoes, pumpkins and lettuce was predominant in the above mentioned counties. The total of 76.5% of farms under professional supervision of the integrated vegetable production fully implemented the measure, which is a proof of producers being educated and informed about the importance of maintaining biodiversity.

Key words

agro-biodiversity, integrated production, vegetables

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Introduction

The intensification of agricultural production in the second half of the 20th century resulted in increased human population and consequently in increased food demand. Thus, negative effects on the environment and human health are inevitable. Improper plant protection usage has had a leading role in this issue. Modern agricultural production requires production of crops in a way that will not harm the environment. In order to produce safe food, agricultural production is legally regulated within the EU member states. Within Regulation (EU) 1305/2013, a mandatory measure (agriculture, environment and climate change) is prescribed and it must be part of a Rural Development Programme of each member state (The European Parliament and the Council of the European Union, 2013). Strategy and Action plan for the protection of biological and landscape diversity of the Republic of Croatia is the fundamental document on the environmental protection. This document provides long-term objectives and guidelines for the conservation of biological and landscape diversity and protected sights of nature, including ways of its enforcement. The document is in a compliance with the overall economic, social and cultural development of the Republic of Croatia. The main objective of the Strategy and Action plan for protection of biological and landscape diversity of the Republic of Croatia is to maintain or enhance agro-biodiversity on agricultural areas via sustainable management. Stimulation of agricultural production that contributes to the biodiversity maintenance is set up as a strategic guideline (Croatian Parliament, 2008). Biodiversity is kept vibrant by respecting and implementing the following principles of good agricultural practices (GAP): soil and water conservation, proper use of machinery, prescribed agrotechnical and mechanical measures, balanced fertilization, proper application of plant protection products, and biological plant protection. Integrated pest management (IPM) implies a balanced application of agrotechnical measures respecting the economic, environmental and toxicological factors. Priority is given to ecologically and toxicologically more acceptable measures at the same economic effect (Ministry of Agriculture, 2012, 2014). Integrated agricultural production in Croatia was established in 2010 by the Agriculture Act, the first corresponding Ordinance and prescribed Technical Guidelines. Producers are obliged to produce in accordance with the legislation. Professional supervision is carried out by Advisory Service. Integrated professional supervision includes various areas of agricultural production. Thus, integrated vegetables production is followed by production of grapes. On the other side, crop production dominates is followed by the production of fruits (Pohajda et al., 2015 a, 2016). Once the professional supervision affirms the compliance with the legislation, producers are allowed to mark their products with the label of the integrated production (Pohajda, 2013). Professional supervision, among other requirements, also affirms the success of implementation of requirements regarding biodiversity maintenance. Maintenance of ecological infrastructure in an environmentally friendly way can be maintained by constructing dry walls, hedges and inter-row grassing of permanent crops (Saunders et al., 2013). Hedges serve as wind protectors, reducing evapotranspiration due to reduced mixing of air masses. Furthermore, hedges are effective in maintaining

predator-parasite relations (Pohajda, 2008). Intensification of crop rotation and polyculture with emphasis on selecting crops with beneficial allelopathic effect will also provide favorable conditions for the biodiversity maintenance (Balzan and Moonen, 2014; Jankowska et al., 2009). One must take into account conservation of natural enemies and their habitats (Sarwar, 2014). The reduction of environmental pollution primarily by low pesticide usage goes in favor with this measure (Pohajda et al., 2015 b). The intensive use of mineral fertilizers and pesticides has resulted in higher yields but has also harmful effect on the soil and water quality.

It is important to emphasize runoff of mineral fertilizers nutrients (nitrate, phosphorus) in the groundwater. It was estimated that in the European Union about 20% of drinking water contains levels of agrochemical residues above permitted by regulations. Maintaining soil fertility by acceptable measures such as green manure enriches soil with organic matter (Mancinelli et al., 2013), and soil biological activity is enhanced having beneficial effect on the useful microorganism growth. Natural process of symbiotic nitrogen fixation has a special role in soil protection endeavors. Root nodule symbiosis enables plants to make use of nitrogen-fixing bacteria to convert needed atmospheric nitrogen into a form that is directly available for plant growth. Thus, the above processes meet the environmental, economic and energy aspects. In the context of cross-compliance, inoculation is performed by using vaccines. The use of vaccines for pre-seeding inoculation of legumes is in accordance with the cross-compliance principles. Accordingly, the soil and water protection against harmful excess of nitrate as a result of excessive fertilization with mineral fertilizers is ensured (Pohajda, 2012). The experience of Advisory Service is that the lack of information or funds of producers is the most common cause of the negative influence on the environment. That is why producers engaged in the integrated production are obliged to continuous education attendance. Among these are the producers engaged in the integrated vegetable production. The Republic of Croatia has extremely favorable natural conditions for the production of vegetables, although vegetable production takes the last place (659.22 ha) in the overall integrated production (Ministry of Agriculture, 2016 a). In spite of the reduction of the overall vegetable production during the last decade, Ministry of Agriculture has provided data on the increase in the number of integrated producers and the areas under integrated production according to the Register of producers in integrated production in 2010. In 2015 there was a 104.955,76 ha under integrated agricultural production, of which only 0.63% of the areas were under vegetable production. According to data obtained from the Ministry of Agriculture in 2015, in the continental part of Croatia vegetables were most commonly produced in Osijek-Baranja (73.05 ha) and in Koprivnica-Križevci County (8.22 ha). Vegetables in the Mediterranean area were most commonly produced in Istria County (22.75 ha) (Ministry of Agriculture, 2016 b).

With the strategy and action plan for the protection of biological and landscape diversity of the Republic of Croatia, long-term objectives and guidelines for the conservation of biological and landscape diversity are defined. Methods for the conservation of biological diversity are described according to overall economic, social and cultural development of the Republic of Croatia.

Materials and methods

The Advisory Service carries out professional supervision which is defined with Supervisory form. The scope of materials and methods of this work is defined by the Regulation and Technical Guidelines for integrated production and accompanying Supervisory form, as follows.

Conservation of biological diversity is one of the prescribed requirements in Supervisory form of integrated production. Compliance with the requirements of agricultural production prescribed by the Regulation and Technical Guidelines for integrated production is established in the mentioned document.

Requirements concerning biological diversity prescribed in the Supervisory form are:

1. Minimum 5% of land should be left and maintained as ecological infrastructure (dry walls, hedges and inter-row grassing of permanent crops).
2. At least two measures of conservation of natural enemies and their habitats should be implemented (birdhouses, useful insects etc.).
3. Safe distance between field and sensitive habitat (water protection areas, wellsprings, ponds, protected species etc.).
4. Maintaining soil fertility by adequate measures (calcification, green manure, etc.).
5. Implementation of plant protection measures such as agro-technical, mechanical, physical, biological, biotechnical and crop rotation.

The implementation of measures was researched on family farms in the Republic of Croatia (Advisory Service, 2016).

Research was conducted in the Croatia during three vegetation seasons (year 2013, 2014 and 2015) on family farms that applied for professional supervision in integrated vegetable production during all three seasons. Thirteen counties were included in the research: 11 counties in the continental part of Croatia and two counties in the Mediterranean area.



Figure 1. Research areas of biodiversity in the integrated production of vegetables (green color)

Professional supervision of the integrated vegetables production in 2013 included the continental counties of: Bjelovar-Bilogora, Brod-Posavina, Koprivnica-Križevci, Krapina-Zagorje, Međimurje, Osijek-Baranja, Požega-Slavonija, Virovitica-Podravina and Vukovar-Srijem. Research has been conducted in the Mediterranean area during the first season in Istria County.

Professional supervision on the integrated vegetable production in 2014 included the following continental counties: Bjelovar-Bilogora, Koprivnica-Križevci, Krapina-Zagorje, Međimurje, Osijek-Baranja, Požega-Slavonija, Sisak-Moslavina, Virovitica-Podravina and Vukovar-Srijem. Research has been conducted in the Mediterranean area during the second season in Istria County.

Professional supervision of the integrated vegetable production in 2015 included the following continental counties: Bjelovar-Bilogora, Brod-Posavina, Zagreb, Koprivnica-Križevci, Međimurje, Osijek-Baranja, Požega-Slavonija, Virovitica-Podravina and Vukovar-Srijem. Research has been conducted in the Mediterranean area during the third season in Istria and Zadar County.

Based on the principles of integrated production, majority of vegetable producers in 2013 was located in following counties: Virovitica-Podravina, Osijek-Baranja and Bjelovar-Bilogora County. During 2014 most of the producers were located in Virovitica-Podravina, Požega-Slavonija and Osijek-Baranja. During the third season of research (2015), most of the vegetable producers, as in previous season, were located in: Virovitica-Podravina, Požega-Slavonija and Osijek-Baranja County.

Results and discussion

Research determined that the number of producers in the integrated vegetable production has increased from season to season. According to what was stated above, increasing agricultural areas under integrated production were proportional to the number of producers. Thus, professional supervision of the integrated vegetable production in 2013 was conducted on 109.56 ha. In 2014 professional supervision on integrated vegetables production was conducted on 204.09 ha. In the third season (2015) research was conducted on 380.08 ha. Professional supervision of the integrated vegetable production affirmed 5.16% of the integrated vegetables producers in 2013, 4.68% in 2014 and 5.9% integrated vegetable producers in 2015. Presence of the integrated vegetable producers by counties through all three seasons is presented in Figure 2.

Professional supervision of the integrated vegetable production affirmed that the highest integrated vegetable production in 2013 was in Virovitica-Podravina (41.78 ha), Istria (26.86 ha) and Koprivnica-Križevci County (13.88 ha). In 2014 the highest integrated vegetable production was in Osijek-Baranja (87.9 ha), Međimurje (24.02 ha) and Koprivnica-Križevci County (23.14 ha). In 2015 the highest integrated vegetable production was in Osijek-Baranja (218.6 ha), Požega-Slavonija (75.74 ha) and Virovitica-Podravina County (24.36 ha). Results obtained in this research are linked to larger agricultural areas, as a result of traditional vegetables production in those counties.

In 2013 about 78% of family farms implemented requirements for maintaining and increasing biodiversity, and the

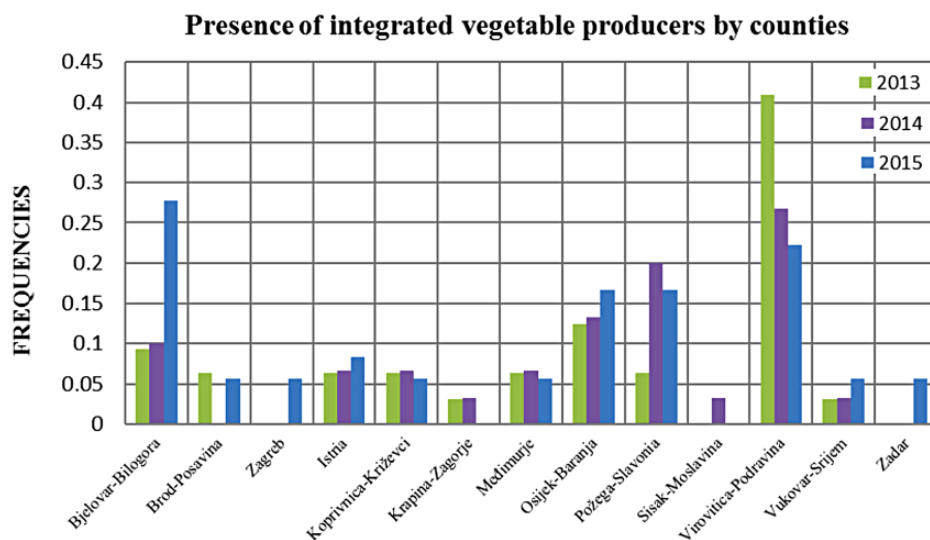


Figure 2. Presence of the integrated vegetable producers in frequencies

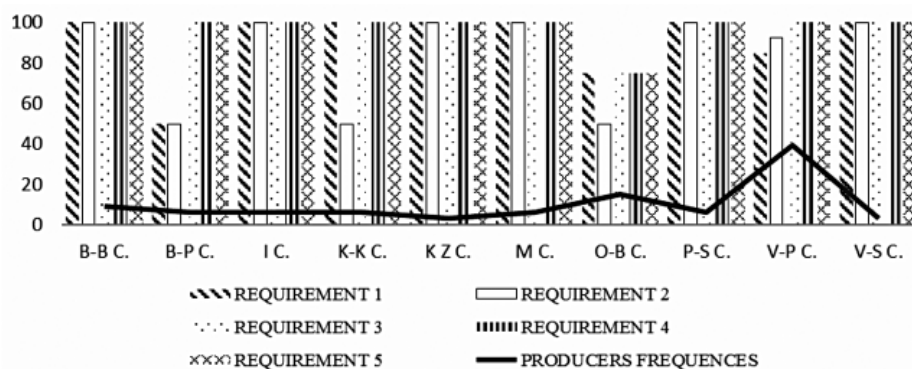


Figure 3. Biodiversity maintenance in the integrated production in 2013 (taken from supervisory forms for all producers) Legend: B-B C: Bjelovar-Bilogora, B-P C: Brod-Posavina, I C: Istria, K-K C: Koprivnica-Križevci, K-Z C: Krapina-Zagorje, M C: Međimurje, O-B C: Osijek-Baranja, P-S C: Požega Slavonija, V-P C: Virovitica-Podravina, V-S C: Vukovar-Srijem.

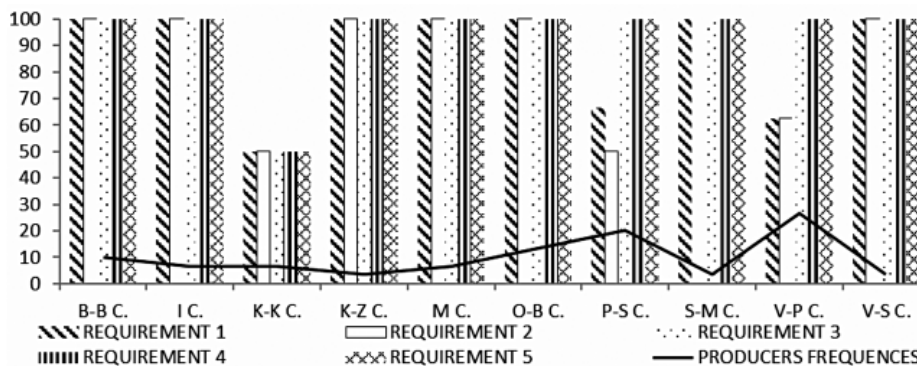


Figure 4. Biodiversity maintenance in the integrated production in 2014 (taken from supervisory forms for all producers) Legend: B-B C: Bjelovar-Bilogora, I C: Istria, K-K C: Koprivnica-Križevci, K-Z C: Krapina-Zagorje, M C: Međimurje, O-B C: Osijek-Baranja, P-S C: Požega Slavonija, S-M C: Sisak Moslavina, V-P C: Virovitica-Podravina, V-S C: Vukovar-Srijem.

highest share was in Bjelovar-Bilogora, Istria, Krapina-Zagorje and Međimurje County. Results of biodiversity maintenance in the integrated production are given in Figure 3.

Linear graph represents the amount of producers in each county compared to total amount of integrated vegetable producers in 2013.

Total 73.33% of family farms in 2014 have completely fulfilled requirements for maintaining biodiversity, especially in Osijek-Baranja, Bjelovar-Bilogora and Međimurje County. Results of

maintaining biodiversity in the integrated production are given in Figure 3. Linear graph represents amount of producers in each county compared to total amount of integrated vegetable producers in 2014.

In 2015, about 77% of the family farms completely fulfilled the requirements for maintaining biodiversity, especially in Osijek-Baranja, Požega-Slavonija and Virovitica-Podravina County. Results of maintaining biodiversity in integrated production are shown in Figure 4.

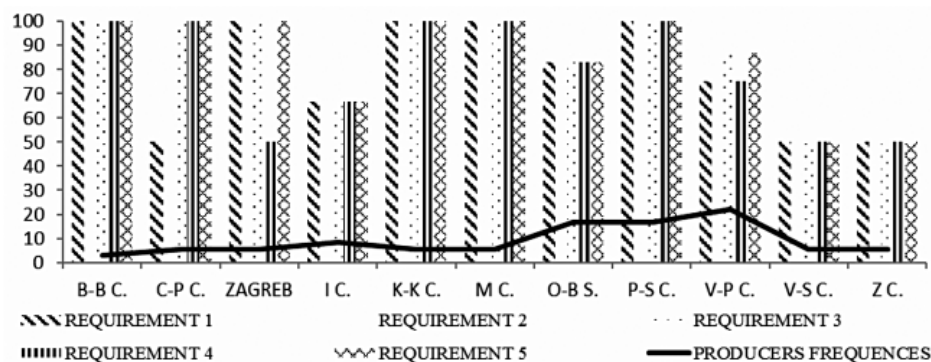


Figure 5. Biodiversity maintenance in the integrated production in 2015 (taken from supervisory forms for all producers)
 Legend: B-B C: Bjelovar-Bilogora, B-P C: Brod-Posavina, ZAGREB: Zagreb, I C: Istria, K-K C: Koprivnica-Križevci, M C: Međimurje, O-B C: Osijek-Baranja, P-S C: Požega Slavonija, V-P C: Virovitica-Podravina; V-S C: Vukovar-Srijem.

Principles of biodiversity during 2013, 2014 and 2015 have been implemented by 76.5 % producers from: Bjelovar-Bilogora, Krapina-Zagorje and Međimurje counties especially in carrot, cucumber, cabbage and chicory production.

In each year of the research at least one of the family farms failed to fulfill all the proposed requirements: in 2013 Osijek-Baranja, 2014 in Koprivnica-Križevci and 2015 in Virovitica-Podravina, Istria, Zadar, Osijek-Baranja and Vukovar-Srijem County.

Nevertheless, requirements for the conservation of biodiversity in Croatia have been successfully implemented as a result of increasing producers awareness of biodiversity conservation.

The positive influence of consistent and continuous education and professional supervision in the integrated production has been confirmed and should be stimulated and conducted in the future.

Conclusions

Although in 2014 agricultural area of integrated vegetable production has increased, integrated vegetable production in Croatia is a still minor field of agriculture production.

The integrated vegetable production share was the highest in Virovitica-Podravina, Istria and Koprivnica-Križevci County in 2013, and Osijek-Baranja, Međimurje and Koprivnica-Križevci County in 2014. In 2015, the highest share of the integrated vegetable production was in Osijek-Baranja, Požega-Slavonija and Virovitica-Podravina County.

The requirements for maintaining and increasing biodiversity were fully implemented during 2013, 2014 and 2015 by 76.5% of producers from: Bjelovar-Bilogora, Krapina-Zagorje and Međimurje County.

In 2013 it has been affirmed that 3.1 % of producers did not fulfill at least one biodiversity conservation requirement and in 2014 about 3.33% of producers. In 2015, about 13.9% of producers did not fulfill at least one biodiversity requirement.

Research has shown successful implementation of biodiversity conservation requirements and positive influence of continuous education and professional supervision in the integrated production that should be stimulated and conducted in the future.

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