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CHARACTERISTICS IMPORTANT FOR ORGANIC BREEDING OF VEGETABLE CROPS

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The remarkable development and application of new genetic The Institute for Vegetable Crops possesses a rich germplasm collection of vegetables, utilized as gene resource for breeding specific traits. Onion and garlic breeding programs are based on chemical composition improvement. There are programs for identification and use of genotypes characterized by high tolerance to economically important diseases. Special attention is paid to breeding cucumber and tomato lines tolerant to late blight. As a result,

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late blight tolerant pickling cucumber line, as well as late blight tolerant tomato lines and hybrids are realized. Research on bean drought stress tolerance is initiated. Lettuce breeding program including research on spontaneous flora is started and interspecies hybrids were observed as possible genetic variability source. It is important to have access to a broad range of vegetable genotypes in order to meet the needs of organic agriculture production. Appreciating the concept of sustainable agriculture, it is important to introduce organic agriculture programs in breeding institutions.

Key words: disease tolerance, organic breeding, specific traits, vegetable germplasm

INTRODUCTION

The concept of sustainable agriculture implies the application of the acquired knowledge in order to produce healthy food (LAZIC, 2008). The regulation of the World Health Organization, ***Codex Alimentarius***, complies controlling the critical points of the production and the quality in the context of regulation, as well as using the natural resources. The ultimate aim to be achieved is the viable systems of production that are socially justified, economically payable and productive, and at the same time to protect health, improve community and animal welfare, and provide the safe environment.

Vegetable production based on sustainable agriculture is of interest to:

1. Small-scale, medium and large producers, through the value added and better conditions of sale at the market
2. Consumers, by better quality and healthy food that is produced in sustainable manners
3. Economy and industry, by greater profit from better products
4. Everybody, by higher quality of the environment

Tendencies of future plant selection will be on high production, better quality, optimization of production with low input of fertilizers and pesticides, tolerance to stresses and diseases (VAN WEAS, 2003).

Following the principles of the sustainable manners of agricultural production, the manners of work for each production system is defined, regarding the specific qualities of the agrosystem, including the conditions: soil, water, agricultural production, crops protection, breeding cattle, health of the cattle, cattle welfare, harvesting, processing and storing, welfare, health and safety of the population, animals and the landscape.

Therefore, the sphere of interest for the vegetable selection researchers is in the field of their contribution to the agricultural production within the scope of selecting the varieties, regarding the needs of the market, and in accordance with the environmental conditions, available resources; all these in order to preserve the fertility of the soil, prevent the development of the weeds, pests and diseases.

Crops grown in organic system must have familiar seed origin, so called certified seed (BOLETIN OFICIAL 1999). Markets for this kind of vegetables are in expansion.

However, there are no necessary quantities of seed for organic production (THOMPSON, 2000).

Agricultural Institutes in Serbia pay special attention to breeding of plant species and monitor the progress in this area. However, the finalization of these projects requires greater Government support. We are facing the lack of certified seed for organic production on the market today. Producers showed special interest for certain vegetable species such as peas, beans, green beans, onions, garlic, cucumbers, tomatoes and lettuce. Also, organic seed is crucial for scientific researches in selection, seed production and organic production of vegetables. Organic seed provides all necessary inputs for entire organic production (VALEMA, 2004).

The aim of this research was the characterization of organic vegetable breeding of certain species and seed production through quality, yield and resistance to plant pathogens in the agro-ecological conditions in Serbia.

SELECTION TECHNOLOGIES FOR CREATING VEGETABLE VARIETIES FOR SPECIFIC PURPOSES

Plant breeding is based on genetic variability, selection and recombination. It is multidisciplinary and creative work which is based on scientific disciplines such as genetics, physiology, molecular biology, growing technology and plant protection (VAN WEAS, 2003).

Compared to the methods available for conventional plant breeding, there are some limitations on the choice of the method for organic breeding. These methods can be classified as: permitted methods - intraspecific crossing, backcrossing, mass selection, individual selection, forbidden methods – interspecific crossing, protoplast fusion, genetic modification, induced mutations and conditionally permitted – use of hybrid varieties, somatic embryogenesis, meristem culture, and in vitro micropropagation anther culture.

1. The application of genetically modified organisms or their derivatives is banned in the organic production. Such a ban is included in our Organic Production and Organic Products Act ("Official Gazette of the RS", 62/06): "Genetically modified organisms and their derivatives cannot be used in organic production." (BERENJI, 2005).
2. Of the modern biotechnology methods, only the method of indirect selection via molecular markers is permitted because this method does not affect the change of the genetic plant construction.
3. The compromise for hybrid varieties that can be used in organic production is accepted, if they are fertile and if the sterility in the process of hybrid seed production is not chemically caused. Most probably, in organic production will be developed the three-line (TC) and four-line (DC), and not the two-line hybrids that dominate in the conventional production.

4. The application of the cytoplasmic male sterile products is banned, except if the fertility is permanently restored and it continues in further generations of propagation.
5. Neither direct nor indirect application of the genetic material that contains induced mutations is permitted.
6. The application of silver nitrate, silver thiosulfate, synthetic hormones, antibiotics and colchicines is banned in organic plant breeding (BERENJI, 2008).

RESULTS ACHIEVED IN THE DEVELOPMENT OF VEGETABLE VARIETIES FOR SPECIFIC PURPOSES

Cucumber selection

Cucumbers belong to leading species in the vegetable production in Yugoslavia. Continuous dissemination of its breeding range has been possible due to multiple usage and wide agro-ecological adaptability. Besides the fact that fruits are used in nutrition, both fresh and processed, it is also a raw material of the pharmaceutical industry.

However, breeding of this crop has been intensified only in recent 30 years in Serbia. Tendency of spreading production and increasing the use of cucumber in Serbian nutrition requires a wide range of varieties for pickling and for salad. Therefore, it is necessary to increase the number of cultivars for market and for consumers. Current trend of cucumber breeding in Serbia is heading towards the selection of genotypes with better quantitative characteristics. In the first place, these are varieties with non-bitter fruits, straight shape and with high yield. The exploiting of parthenocarpy of salad type of cucumber is also a current trend. New parthenocarp cucumber genotypes were intended for production in greenhouses.

Cucumber breeding to resistance to diseases is of great importance (PAVLOVIC *et al.,* 2002). Downy (Pseudoperonospora cubensis (Berk and Curt.) Rostow) and Cucumber Mosaic Virus cause the greatest problems in cucumber growing in Serbia as well as in other parts of the world (METWALLY and WEHNER, 1990).

Finding and identifying the selection material for these, economically most important diseases is of the greatest priority. The use of chemicals in cucumber protection of downy has reached emergency proportions. This too can be overcome only by breeding resistant genotypes in organic systems of production. Today, the Institute for Vegetable Crops has cucumber lines that are highly tolerant to downy mildew in conditions of spontaneous infection.

The Institute for Vegetable Crops in Smederevska Palanka possesses a collection of cucumber germplasm consisted of over 100 divergent genotypes that are included in our breeding programs. Pickling cucumber hybrid characterized with high tolerance to this plant pathogen was created using experimental crossings. Based on the results from the trial at the Institute for Vegetable Crops, the pickling

cucumber named Sirano F_1 is marked as the pickling cucumber hybrid that is the most resistant to blight (PAVLOVIC *et al.,* 2006).

Bulb vegetables selection

Garlic draws more and more attention as an industrial plant and its production is perspective. Garlic is characterized by high contents of dry matter, proteins, fats, carbohydrates, vitamin C, thiamine, and B_6. Furthermore, garlic is rich with minerals such as: Mg, Zn, Mn, Cu, Mo, and Se. It also possesses high energy values that can be paired with members of Fabaceae family. Through the new breeding programs, the chemical structure of garlic is emphasized. Based on detailed chemical analysis the best ecotypes are selected. The aim of the research was to create the ecotypes with the most favourable chemical composition, which would give valuable contribution to the process of utilization of this vegetable variety (PAVLOVIC *et al*., 2003a).

High biological value of onion is the result of its specific chemical composition dominated by sugars, vitamin C and characteristic ethereal oil. According to the average contents of vitamin C in bulbs (32.46 to 44.03 mg %), onion is a significant natural source of this vitamin. In our research higher genotypic variance and the phenotype variation coefficient is found, as compared to the ecological variance and the genotype variation coefficient. This suggests an important role of the genetic factors in the expression of this trait (PAVLOVIC *et al*., 2003b). It is confirmed with the broad-sense heritability values (0.75 and 0.76%). For dehydration in food industry only the onion genotypes with high percentage of dry matter contents are used. In many countries today, there are selection programs for the development of genotypes only for drying purposes. Variability of the chemical composition of onion in the field caused by climatic and soil conditions, as well as by the agricultural techniques is characteristic. Dry matter percentage in particular varieties suggests the part of the total bulb mass that can be used in the food production industry. In our research a high genotypic variability of the dry matter contents is found (PAVLOVIC *et al*., 2007).

Tomato selection

Tomato represents one of the most important sources of lycopene. It also contents a high level of other carotenoids (β-carotene), vitamins (vitamin C), minerals, flavonoids and phenolic acid. Antioxidant effects of the substances affect on the reduction of the possibility for human to contract diseases; the substances affect on the proliferation of cancerous cells; and act as preventive for cardiovascular diseases. Nutritional estimation of the optimal antioxidant quantity through daily consummation of tomato is 9-18 mg of carotenoids, 175-400 mg of vitamin C, 3-4 mg of vitamin E, 50 mg of flavonoids, 0.4 mg of folate and 25-30 mg of lycopene. Tomato is consider as a rich source (in 100 g) of: vitamin C (20-29 mg), carotene (0.2-2.3 mg) and phenolic acid (1-2000 mg), regarding to the total antioxidant contents. There are also small portions of vitamin E (0.49 mg), flavonoids (0.5-5 mg) and traces of selenium (0.5-10 mg), copper (90 mg) and zinc (240 μg). It is

recommended to consume 400 g per day of fresh tomato or other tomato products in five portions. Lycopene is one of the carotenoids that give naturally color to the tomato fruit and rank among the strongest antioxidants among all the other carotenoids. The intensive selection for tomato lycopene content has been performed. With adequate selection of the lines that will be used in hybrid development, it is expected that in process of the gene recombination we will get the most favorable nutritive contents ratio – especially antioxidants, with a particular emphasis on a lycopene (ZDRAVKOVIC *et al*., 2002a, 2003c, 2007).

Late blight, which is caused by the fungus Phytophtora infestans, emerges in tomato crops almost every year and causes considerable economic damages. Fungicide control of this parasite is not always effective and satisfactorily. The solution to this problem is in growing less sensitive or more resistant tomato varieties or hybrids. The research on tomato resistance to Phytophtora infestans is very complex due to high variability of the pathogen physiological races. Tomato genotypes that are the carriers of Ph-2 gene of resistance to this parasite were crossed with tomato genotypes with good production characteristics (yield and fruit quality) but more susceptible to this parasite. Successfully were selected tomato lines and hybrids that expressed a higher level of resistance than their parents (MIJATOVIC *et al.*, 2007; ZDRAVKOVIC *et al*., 2004).

Special projects were launched aimed to the effect of partial drying part of a root (PRD-treatment) on the growth of tomato plant, photosynthesis, transpiration, water potential, peroxidase activation of the cell wall, yield, sugar contents, lycopene contents, mineral contents and dry matter content. This treatment causes the increase of peroxidase activity and sugar contents in mature tomato fruits (STIKIC *et al*., 2003).

Tomato fruit firmness can be achieved by entering a gene for delayed maturation (rin, nor, alc) in the selection of tomatoes. Therefore, the process stops the ripening on a certain level of maturity. As a result of interrupted maturation process, satisfactory fruit firmness occurs, but with slightly less sugar, lycopene, beta carotene, etc. (CVIKIĆ *et al.,* 2000, ZDRAVKOVIC *et al.* 2008). Breeding for this trait in this manner are in opposite to the selection requirements for organic production. Fruits with greater firmness can be selected by accumulating firmness traits (ZDRAVKOVIC *et al*., 2007, 2008). Genotypes with "fruit firmness" gene cause long shelf life of mature tomato. (ZDRAVKOVIC *et al*., 2003, MARKOVIC *et al*., 2008).

Investigation of inheritance of yield and yield components in all plant species and in tomato is very important. Gene expression effects nutritional and quality characteristics and therefore the selection may lead to its increase and decrease (ZDRAVKOVIC *et al*., 2000, ATANASOVA and GEORGIEV, 2009).

The purpose of breeding crops with specific features designed for organic or other sustainable production requires researches in the field of seed production, so the results could be available to producers through new varieties. (VAN WEAS, 2003). Important features of research must be prices of seeds and final products. These aspects require a comparative analysis of conventional production and integrated crop management and organic methods (BRUMFIELD *et al*. 2000).

Dry beans selection

The project of breeding dry beans resistant to stressful conditions of drought has been set out at the Institute for Vegetable Crops, and aim of the project was controlling the negative effects of a high temperature and low rainfall. In our research 62 genotypes were used. Pure lines suitable for further selection have been chosen. The number of nodes in the pure lines is not dependent on the water quantity for irrigation, which includes them in the next breeding phase for stressful conditions (ZDRAVKOVIC M. *et al.,* 2004a; ZDRAVKOVIC M. *et al.,* 2004b). The effects of two microbiological fertilizers (SOJ 1 and SOJ 2) have been investigated on dry beans, in the variation with and without additional nutrition with mineral fertilizers (KAN). The first pod height was recorded. Microbiological fertilizers do not affect on this trait, whereas they exhibited a significant effect on the bean mass per plant (JARAK *et al.,* 2007).

Lettuce selection

Aimed at creating lettuce cultivars (*Lactuca sativa* L.) resistant to pathogens, the causal agents of plant diseases, and especially to virus diseases, research was carried out on the spontaneous flora in the locality of Pomoravlje and Sumadija where the genotypes of the species *Lactuca* sp. that are resistant to causal agents of virus diseases could be found. The interspecies hybrids *Lactuca virosa* L. x *Lactuca sativa* L., *L. saligna* L. x *L. sativa* L., were investigated as possible sources of genetic variability. *L. saligna* L. and *L. virosa* L. represent only a part of the population related to *L. sativa* L. Wild varieties of this species belong to the weed flora. After crossing, viable achenes were obtained only in the crossing *L. sativa* L. x *L. saligna* L. At initial crossings two populations of *L. saligna* L. were used, one with and the other without anthocyanin. The seedlings of *L. saligna* L. without anthocyanin were lost after brought out on the field. In the process of the selection of F_1 generation, 31 plants emerged. After transplantation on the field, only 19 plants survived. In 9 plants the fertility was provoked by colchicine, but the percentage of fertile achenes was low as compared to the number of achenes that were not viable. By collecting more genotypes of the species *Lactuca* sp. from spontaneous flora in the locality of Pomoravlje and Sumadija and investigating the possibilities of crossing with the cultivated lettuce (*Lactuca sativa* L.), the selection programs of this kind would be improved. Eventually, the final aim is to obtain the cultivar with the built-in genes of resistance to virus diseases and acceptable morphological characteristics (ZDRAVKOVIC *et al*., 2003b).

Our investigation was based on the problem of anthocyanin and vitamin C contents inheritance in F_1 progeny of lettuce. It was assumed that progenies with increased contents of these substances could be obtained. Diallel crossing of eight lettuce genotypes of different anthocyanin and vitamin C contents, classified into three varieties was performed. Parental and F_1 generations were investigated comparatively, and their mode of inheritance was determined. Concerning the inheritance of anthocyanin, dominant genes prevailed, and a higher content of this substance was succeeded in F_1 generation. Concerning the inheritance of vitamin C

content, dominance mode of inheritance was recorded, when it was compared to the parents with the lower vitamin C content. Apart from the dominance mode of inheritance, significant additive gene effects in inheriting vitamin C content was also recorded (ZDRAVKOVIC *et al*. 2002a; ZDRAVKOVIC *et al*. 2002b).

CONCLUSION

Irreplaceability of plants in human diet as well as negative urban and industrial development impact on ecosystems imposes the need for planning the breeding programs for specific purposes.

With the respect to the concept of viable agriculture and giving preference to biodiversity, intensifying and supporting such breeding programs at the Institutes becomes a necessity. The tendency of developing a new concept of agricultural production and greater consumption of healthy plants and their derivatives in human diet requires the existence of a broad range of vegetable varieties. It is of considerable importance to change the method of organizing the agricultural production, as well as passing new laws that would support and facilitate the introduction of the concept of viable development of the agro-system. The Institute for Vegetable Crops in Smederevska Palanka possesses a large collection of germplasm of vegetable varieties, which enables selecting the donors with favourable genes for some specific traits. This represents the basis for planning and modeling the ideotypes of vegetable varieties.

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SVOJSTVA OD ZNAČAJA ZA ORGANSKO OPLEMENJIVANJE POVRĆA

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I z v o d

Institut za povrtarstvo poseduje bogatu kolekciju germplazme povrtarskih biljaka, koja se koristi kao izvor gena za oplemenjivanje na pojedine specifične osobine. Program oplemenjivačkog rada na luku zasnovan je na poboljSanju njegovog hemijskog sastava. Postoje i programi za identifikaciju i koriSCenje genotipova koji se odlikuju visokim stepenom tolerantnosti na ekonomski značajnije bolesti. Posebna pažnja se posveCuje selekciji linija krastavca i paradajza tolerantnih prema plamenjači. Kao rezultat izdvojene su visoko tolerantne linije krastavca korniSona, kao i linije i hibridi paradajza sa viSim stepenom tolerancije. Pokrenut je projekat oplemenjivanja pasulja tolerantnog na stresne uslove suSe. Kod oplemenjivanja salate pristupilo se ispitivanju dela spontane flore, a kao moguC izvor genetičke varijabilnosti proučavani su i interspecies hibridi. Neophodno je raspolagati Sirokim spektrom sorti povrtarskih biljaka u cilju zadovoljenje potreba organske poljoprivredne proizvodnje. Uz poStovanje koncepta održive poljoprivrede, potrebno je uvođenje ovakvih programa u oplemenjivačke ustanove.

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