Bulgarian Journal of Agricultural Science, 20 (No 2) 2014, 391-404
Agricultural Academy

RASPBERRY BREEDING AND PROTECTION AGAINST DISEASE AND PESTS

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Abstract

TOTIC, I., 2014. Raspberry breeding and protection against disease and pests. *Bulg. J. Agric. Sci.*, 20: 391-404

The raspberry *(Rubus idaeus)* is a very important type of small perennial berry. Based on the extent of its production, it comes second only to the strawberry and currant, and based on its economic importance, it is second only to the strawberry. Considering that the first raspberry cultivars in the true sense of the word originated from the beginning of the 17th century, polmology has managed to this day to register and systematize over one thousand raspberry cultivars. The raspberry belongs to the group of products, which have the greatest degree of marketability, and in some countries (the Republic of Serbia) over 99 % of the overall production is meant to be sold on the market. In suitable agro-ecological and technical conditions (a professional staff, processing and freezing capacities, organized purchase locations, high quality roads and means of transportation, a sufficient workforce needed to harvest the crop), it is possible to achieve a yield of up to 35 tons per acre. Raspberry canes meant for planting need to be formed in suitable soil and must be healthy. Raspberries are traditionally cultivated in open areas, and lately also in high tunnels. The canes are susceptible to disease caused by different types of pests and weeds. In order to protect them, it is necessary to regularly resort to pomotechnic and agrotechnic measures in order to prevent cane decay and a poor harvest. The protection of the raspberry has to be professional and must continue over planting, blooming time, and up to the harvest, which lasts on average for 30 days, and even after it is over.

Key words: raspberries, cultivars, raspberry cane formation, disease and pests, protection

Introduction

The raspberry is a member of the *Rosaceae* or rose family, the genus *Rubus,* and *Idaeobatus subgenus*. It is a shrub, which has many canes which develop from the root and which can further be used to multiply the plant. Its canes are thick, thorny and can reach heights of over three meters (Laun et al., 1994). Depending on the cultivar, it can be bred in almost any conditions, in the open and in closed environments, but for a good yield and high quality crop, ideal climatic factors, among other factors, are necessary. The ideal climatic conditions for the breeding of raspberries are cooler summers with moderate amounts of rainfall during harvest time (the end of May and beginning of June), a wet late summer, conducive for the development of new canes, and relatively mild winters with temperatures which do not exceed -18°C (Haffner et al., 2000). Practice has shown that the raspberry can, without much difficulty, thrive at lower temperatures, even those as low as -26°C. In the absence of ideal climatic conditions, certain raspberry cultivars can yield a high quality harvest if they can withstand frost or if they mature in the fall months. For breeding, a fact that must be taken into consideration prior to planting, plots of land with a north by northwest orientation are considered most suitable. Until recently, the best raspberry cultivars were bred at an altitude between 400 and 800 meters. Today, due to climatic change, this level has been moved to elevations over 2000 meters. The Heritage raspberry cultivar gives the best yield at elevations of 1000 meters, while the red and yellow raspberry cultivars (*Rubus idaeus)* in Colorado (the United States) are very successfully bred at elevations of up to 8 500 feet (Keep, 1988) or over 2,600 meters.

Even though its natural habitat are forests, and even though it thrives better in hilly and mountainous areas, more so than in valleys which are more susceptible to the consequences of drought, the raspberry gives its best yield in full but not strong sunlight. When selecting the soil for raspberry breeding, we should take into consideration the fact that it

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should be planted in partial shade and that no other crops had been planted on that plot for at least the three previous years (including potatoes, tomatoes, eggplant, pepper, bell peppers, strawberries, blackberries), which is how long it takes for the habitats of various insects and pests, which cause the fungal and viral diseases, to be destroyed. The raspberry is a deciduous shrub or semi-shrub with a life span of between 12 and 15 years. Professional producers (Petrovic and Miloshevic, 1998) claim that it can even live up to 20 years, if the canes are healthy, if they are planted in soil which is a suitable micro relief and if it is treated in accordance with professional instructions. The practical experience of countries, which are more intensely involved in raspberry production (the Russian Federation, Serbia, Poland, the Ukraine, and the United States of America), is that due to the uniform quality of the soil, the raspberry should preferably be bred on smaller than larger plots, since on larger plots it is difficult to find a unified micro relief.

The presence of various insects (pests) during the period of intense and vegetative growth creates a microclimate suitable for the development of a large number of cryptogamic diseases, which are harmful for the canes. The most frequent causes of raspberry disease include pathogenic fungi, bacteria, viruses and similar organisms. The current means of protection of the raspberry from diseases, pests and weeds are implemented using agrotechnic and pomotechnic measures, which contribute to the vitality of the root, cane and leaf. Many diseases can successfully be prevented using herbicides and pesticides in prescribed amounts. In such situations, the canes and leaves are sprayed: before the start of the vegetation period, before bloom time and after the harvest. In order to prevent annual weeds, in addition to pesticides and herbicides, plastic foil can also be used. The use of plastic foil increases the yield from between 10 and 20% and increases the ripening of the fruit by 2 to 3 days. Even though it is exposed to various diseases, the raspberry and its related products are very beneficial for the preservation of human health (Bowen-Forbes et al., 2010). It is rich in antioxidants and anti-inflammatory phytonutrients, and as many studies have shown (Goto et al., 2012), the raspberry is very successful in destroying cancer cells, it helps patients with diabetes and is very beneficial to individuals who have weight problems. It is a 'cultured' and commercial plant, and is a very valued commodity.

The Historic Dimension of Raspberry Breeding

According to the botanic systematization of plants, the raspberry belongs to the taxonomic categories of Focke (1910, 1914) and Haskell (1945, 1961) (Petrovic and Miloshevic, 1998). It is an aggregate fruit (Angiospermae) from the order of roses (Rosales Lindley) and the rose family (Rosaceae Jussieu), subfamily (Rosoidae), genus (Rubus Tourn) and subgenus (Idaeobatus Focke). The botanic systematization is important because it outlines that only the subgenus (Idaeobatus Focke) encompasses 195 types and subtypes of wild raspberry which can be found on all the continents (Kempler et al., 2006). Thus, it is important to mention that the first domestic raspberry cultivars were formed through somatic mutations, selection, natural, and mountain crossbreeding of a great many types of raspberries, which has determined their historical dimension. The first precise data on the origin of the raspberry was published by Hedrick in his work "The small fruits of New York" (Hedrick, 1925), which does not mean that there were no data or professional opinions published before that. However, previous opinions were supported by myths and legends. Thus, the father of modern botany, Carl Linne in his work "Historia naturale", relying on the clues given by the Greek naturalist Pliny the Elder (1 AD) proffered the data that the raspberry is a kind of wild berry which originates from the Greek mountain Ida, located on the island of Crete. According to legend, when Zeus was a child, his mother hid him from his infuriated father Chronos, who intended to kill him, behind some raspberry bushes located on that mountain. This data was used in 1753 to give the raspberry its Latin name of Rubus idaeus (Sarvikivi, et al., 2012). Zeus later became the head Greek divinity and the raspberry was awarded the status of a divine plant. The Romans continued raspberry breeding on the European continent. Written data confirms that the Roman naturalist Palladius (4 AD) described the raspberry as a garden-variety plant with medicinal properties whose fruits and leaves could be used as a universal cure.

On the territory of what is today known as the United States of America, prior to the arrival of European immigrants, the raspberry was cultivated and used as food and medicine by the North-American Native Americans. However, this data is not founded on any firm facts, since based on the recorded data on the raspberry, it can be determined that it was first brought to the American content from the Caucasus, from Asia Minor, and that it spread via new trade routes and frequent journeys across the Bering strait. Thus, the first settlers began their own way of cultivating and breeding the raspberry, and the first commercial plantations were founded in 1771, on which the English Red and Common Red raspberry cultivars were bred. There are authors who claim that the red raspberry (*Rubus idaeus*) was not brought from Asia Minor, and instead, that it was an indigenous species characteristic to some of the regions of the United States of America (Crandal and Daubeny, 1990), such as Alaska, Hawaii and Western America. Today, these areas are widely populated by cultivars and hybrids, which originate from the modern-

day American red raspberry (*Rubus strigosus*) and the American black raspberry (*Rubus occidentaalis* L.). One of these cultivars is the purple American raspberry (*Rubus neglectus*), which was the result of cross-breeding between the red and black American raspberry, as was noted as far back as 1832 by William Robert Prince in his work "A Pomological Manual" (Petrovic and Miloshevic, 1998).

On the territory of Great Britain, up until the second half of the 16th century, there were no significant facts that would indicate that there was any raspberry breeding in that region. Many years later, more precisely in 1618, William Dawson published a series of data on the significant increase in the breeding of the raspberry, only to have Parkinson, in his work "The Raspis Berrie" in 1629, give a detailed account of the activities needed for its cultivation. The explanations contributed to the production of raspberries continuing at a quicker pace, and the result was that, at the very end of the 18th century in England (as in the United States of America), more than 20 cultivars of the red raspberry were being bred. During this period, many English raspberry cultivars were exported into the United States where they were cross-bred with the indigenous cultivars, thus enabling the creation of new high quality types. Whether justified or not, during World War II very little attention was paid to the maintenance of the health of the raspberry in Great Britain (Pritts, 2006). The English industry battled this problem up until the 1970's, when raspberry production was finally reorganized and the certification programs and heat-therapeutic treatments for the elimination of viruses, which attack the raspberry, were put into practice. The greatest producer of the raspberry today is the Russian Federation (Mishic, 1986), a fact which is widely disputed, considering that the statistical data do not include the overall number of cultivated and uncultivated (wild) raspberries, which do not thrive in large amounts on the territory of the Russian Federation. Data on the Russian raspberry growing on Russian territory can be found in the notes of the naturalist and founder of Moscow Yuri Dolgoruki from the 12th century, who stated that they grew near the town in the form of dense and impassable shrubbery and that they provided good shelter for animals.

The Formation of Canes and the Raspberry Breeding System

When making the final decision to form canes for planting from a particular raspberry cultivar, it is important to take several significant steps, which can largely determine the outcome. The first step is to select the system according to which the raspberry will be bred, and to take into consideration the possibility of its use in continuity, under the condition that the choice itself proves to be a good solution. The second step is to select the area of the plot and the location for what will be the future raspberry patch. Then, the soil is prepared for cultivation and canes suitable for planting are purchased. In addition, it is also important to make the decision of whether to opt for traditional raspberry breeding "out in the open" or to choose the high-tunnel system. At first glance, it would seem that there are no special differences between them; however, pronounced differences exist.

Raspberry production in the United States is gaining in importance daily. One of the problems, but also one of the challenges, is the tendency to supply all the inhabitants with fresh raspberries under equal conditions. The primary reason is that almost every scientific study has indicated, first and foremost, that the inhabitants of the United States of America have great problems with obesity (Ali et al., 2011), diabetes and various types of carcinoma (of the esophagus, the colon, breast cancer, uterine cancer), and secondly, that the raspberry, with its own nutritional components (Stober et al., 2007), is a type of fruit which is very successful in fighting these types of problems. Almost all the universities in the United Sates, and especially Cornell University in the state of Michigan, and Pennsylvania State University, have carried out extensive research on the breeding of a wide variety of raspberry cultivars (including other berries as well), which today is done in high tunnels. Agronomy experts, researchers and agricultural experts from the green house system of production have borrowed the idea for this system of raspberry breeding. However, in accordance with its technical nature, the glass tunnel is not the best choice for raspberry breeding: it would not be cost-effective, as its installment and maintenance are complicated and expensive and the temperatures would exceed the most suitable ones (Carey et al., 2009). For that reason, advantage was given to green house tunnels for production. The conclusion of the experts is that this system will also not be cost effective for every producer, due to the high expenses in terms of investment and the rapidly increasing energy expenditure (Giacomelli, 2009), especially during the winter period, when due to low temperatures, additional heating of the tunnel was unavoidable.

The rapidly increasing energy expenditure, irrespective of its great part in the overall production costs, cannot be a hindrance but a motivation for more intense production, which should decrease the dependence on imported raspberries. The expenses can be covered, but only if they occur because of the increase in local and regional production with the goal of creating a steady supply for the market, which is currently dependent on the import of raspberries. The system of raspberry production in high tunnels offers the opportunity to easily overcome any decreases (Spaw and Williams, 2004) in the raspberry supply chain in the period between late fall

and early spring. It offers cheaper possibilities when the temperatures are not especially low and in the lack of great frost, since energy expenditure is not as extensive then. In addition, plastic tunnels could help weaker raspberry canes to survive the winter even in those regions in which frost and low temperatures might destroy or damage them. It is also a new technological innovation, which is in accord with the modern general goals of the development of new raspberry cultivars. It is suitable to the field of modern technology in the production of berries, makes the conditions for production uniform and enables the inhabitants in the north and northeast areas of the United States of America to enjoy fruit they have produced themselves (Demchak, 2009).

The high tunnel is similar to a great oval hall, which is covered with long plastic sheets whose walls (sides), entrance and exit can easily be uncovered. Uncovering the plastic sheets along the sides and the entrance/exit sides of the tunnel enables a natural regulation of temperature. This establishes the balance between tunnel production and the conditions, which can be determined in the human environment. What is characteristic of the tunnels is that they are not heated; however, should the need occur, additional heat can be introduced by installing heaters which provide the necessary temperature in the tunnel during cold periods. In order to provide additional heat protection during heavy frost and periodical low temperatures, the tunnel has to be covered. High plastic tunnels need to have their own systems for water supply since, based on their functioning, they do not allow access to rainfall. When planting raspberries, the canes can be placed into the soil directly, but can also be introduced into the soil along with artificial containers, on condition that the canes are placed relatively close to one another, prior to the installment of plastic sheets, that is, during the installment of a high tunnel. Installing the tunnel over rows of newly planted canes is for the time being a very difficult mission (Pritts, 2009), since care has to be taken to preserve the canes and not to alter the spacing between them. Considering that, instead of plastic sheet for covering the tunnel, it is possible to use glass and similar products; examples from Scotland (Heidenreich et al., 2012) have indicated that plastic foil is at an advantage over other materials. Namely, high tunnels are covered with double layers of polyethylene, which is elastic, easy to handle and does not require special elements to keep it bound firmly to the base, which is usually the metal construction of the tunnel, and can be, which is preferable, removed seasonally. These tunnels, unlike green houses, do not contain electric installations, automated heating or ventilation systems. Their advantage is that they are constructed to be opened manually for purposes of ventilation and the seasonal removal of the plastic roof when necessary.

As far as the raspberry breeding system is concerned, selection depends on the type of cane selected for planting, the biological characteristics of the selected raspberry cultivar, the configuration and incline of the terrain, the existing infrastructure on the very plot or at least in its vicinity, the possibility of the use of mechanization and the availability of a sufficient work force. Considering that, the selection of the system for the formation of canes for planting is the most serious issue and requires extensive elaboration, in practice three systems are used most frequently, including: the *support system*, the *system of suckering shrubs* and the *system of bands*.

1. The first system is the *support system*, which includes
- the vertical support system,
- the cross-arm system,
- the two-wire system,
- the fan-shaped system and
- the V-shaped system.

The basic characteristics of the support system is that it is simple, cheap, and in this system the raspberry fruiting canes are tied to tight wires strung between wooden posts which have been inserted into the ground at a depth of at least half a meter. The vertical position of the cane enables unobstructed use of mechanization and natural airflow and provides enough sunlight for all the raspberry rows. The poles which are usually made of acacia trees must not be shorter than 2.2 meters, have a diameter less than 10 cm, and have to be dug into the ground to at least 50 cm, positioned at a distance of 5 and 7 meters, depending on the configuration of the location. The positioning of the posts and the tightening of the wire (the construction of the support system), represent the most difficult tasks, a costly operation and the most complicated phase in the formation of the canes. The length of the wire per acre is from 4 to 4.500 meters, which means that for one acre of land, we need between 900 and 1000 posts and approximately 10 000 meters of steel alloy or zinc alloy wire, with a diameter of 2 or 2.2 mm, positioned in two, or sometimes even three levels (Nenadic, 1996). The distance between the poles at the same time represents the width of the support system, which is between 2 and 3 meters, and which offers enough room for the maneuvering of agricultural machinery used in the cultivation of the canes. The advantages of this system are the prevention of the breakage of the canes and their bending towards the ground, easy pruning of old (last year's) canes from the young, greater exposure to sunlight which guarantees that the raspberry patch will have high quality content, high quality fruit and various benefits during harvest time.

2. The second system is known as the *suckering shrubs system* and includes the following variants:
- suckering shrubs without bound canes – free shrubs,

- suckering shrubs with bound canes – with a support pole or without one and
- suckering shrubs with a square or rectangular distribution of canes.

When forming new raspberry canes, the suckering shrub system is not used as frequently as the support system. If the breeder actually decides to form a raspberry patch using the suckering shrub system, then he needs to follow special principles of organization. With unbound canes, due to the need to form shrubs, at least 3 to 4 canes are planted in the same place at a distance of 10-15 cm. In the case of the system with or without a support pole, 8 to 10 canes are planted in the same place, and in the case of square or rectangular shrubs, between 5 and 8 canes. If the canes are distributed on a square surface, then the distance between the shrubs is from 1 to 3 meters and 3 to 4 canes are planted in the same place. However, when planting on a rectangular basis, the distance between the shrubs is between from 1 to 1.5 meters and between the rows from 2.5 to 3 meters, with at least 3 canes planted in the same location. The square or rectangular system of planting in the first year enables the cross maneuvering of the mechanical devices, but during the second year, the rule does not apply for the rectangular system. The movement of machines can only be along a straight line, just like in the support system. The aforementioned systems have been adjusted to the breeding of raspberries whose cultivars have thick and short canes (Heritage, Marlboro, Jelichka), who after harvest are pruned all the way to the ground and do not require any binding, that is the creation of a vertical post.

3. The third system is the *band system*, which is the least frequently used and comes in two forms:
- the wide band system and
- the narrow band system.

The band system, in any of its forms, requires the obligatory formation of posts consisting of two tight wires or two and/or three levels. It is a complicated system (Bair and Lantin, 1988) since the posts represent the position onto which wires are attached. The dimensions of the wires for wide bands are from 70 to 90 x 5 x 5 cm, and for the narrow bands from 40 to 50 x 5 x 5 cm, while the edges of the posts are necessarily drilled so that wires could be inserted more easily into the openings and tightened. The distance between two wires can be different, smaller or somewhat greater, which is a characteristic of this system. The space between the bands is filled with canes, while the interspace is ploughed with the use of mechanical devices (Petrovic and Miloshevic, 1998). In the wide band system, the width of the band ranges from 60 and 80 cm, while the distance between the rows is from 3 to 3.5 meters. The formed posts most often have one pair of wires, which are tightened between the posts at a height of 1 to 1.2 meters above the ground. This system has one large advantage – a great yield (Dounelly et al., 1900). However, this advantage is annulled by the shortcoming that it is not conducive for the breeding of raspberries for commercial purposes. The main shortcomings include the development of a large number of canes, which under their own weight touch the ground, thus leaving the fruit to become soiled and rot quickly. Insufficient airflow causes quick rotting and the occurrence of fungal disease, and largely makes harvesting difficult. A special problem is the formation of shading which reduces the quality of the fruit.

In the case of the narrow band system, the width of the band ranges from between 30 to 40 cm. The distance between the rows is from 2.5 to 3 meters, and within the rows between 25 and 50 cm, depending on the size and type of mechanization, which is used during the soil treatment. The post is usually built on two levels, that is, with two levels of double tightened wires. The wires of the first level are tightened at a height of 60 to 70 cm above the ground, and of the other at a height of 1.2 to 1.4 meters. In moderate conditions of raspberry breeding (appropriate climatic conditions, the timely treatment of the canes prior to and following the harvest), this system provides a great multitude of young canes, high yields and good quality of the fruit.

Determining the optimal surface soil of the plot of land used to form the canes for planting is one of the primary tasks of the producers and production organizers. The experiences of producers from the countries, which intensively and successfully take part in the production of raspberries, are that raspberries can be cultivated on large surfaces of land and on certain farms. (Gwozdecki, 2004). The surface of the plot determines the quality of the selected soil and the extent of production (Paunovic et al., 1974), with the addition that the extent of production depends on the workforce available for harvesting the raspberries. If raspberries could be harvested like grain or other cultures whose harvest does not require a great workforce, the plots covered in its cultivars would be immeasurable. The raspberry is a plant whose fruit is handpicked up to 90% and is slowly set aside in certain quantities into specially made containers. However, the limiting factors are the pickers and difficult access of the mechanization to certain plots and operations, for which reason the slope of the terrain should not exceed 8 degrees. When selecting a plot for the formation of raspberry canes for planting, we should take into consideration that, due to the possibility of damaging the root, the soil should not be plowed to great depths. The best way to select soil prior to planting is to give soil samples for analyses, which are carried out at institutions, involved in pomology. For chemical analyses, soil samples are extracted from depths of no less than 40 cm, while for physical analyses they are extracted from depths between 80 and 100 cm. If the analy-

ses show that the selected soil is suitable for the formation of canes, what follows is the planting and the introduction of organic and mineral fertilizers. The best organic fertilizer, which improves the physical, chemical and microbiological features of the selected soil, is manure (sheep, bovine and equine). In order to increase the humus content by 1%, it is necessary to go to a depth of at least 40 cm, and to introduce 50 tons of manure for each acre of land (Knight et al., 1989). In addition to manure, vermicast, humus produced through the production of worms (lumbriculture) is also used. Considering that, it is not possible to produce it in great amounts, mineral fertilizer that contains nitrogen, phosphorus, and potassium in the following proportions: N 8: P 12: K 26, enriched by 3% MgO is being used more and more (Stanisavljevic, 1991). However, on plots which have a higher potassium content, the best results are achieved through the introduction of the popular "three fifteens", that is, N 15: P 15 : K 15 (Brocic, 1997).

In the case of planting, experience has shown that fall is more suitable than spring. Planting in late spring is not recommended due to the size of the buds on the root from which the canes stem, and which can later be destroyed. In addition, in the spring, the soil contains smaller amounts of moisture, which along with the warm spring winds make it difficult for the canes to take. Raspberries should not be planted in soil that is excessively damp due to the formation of a firm earthen cover, which does not enable the canes to push through from the underground buds. For the same reason it is not appropriate to stomp around the planted canes. On the other hand, it is highly recommended that the selected canes be obtained exclusively from authentic cultivars, and that they are healthy (Lehotay and Valverde, 1997), with a well-developed root system and the guarantee that they are not diseased. The canes are planted in cloudy weather at the same depth from which they had previously been extracted. After planting, at depths neither too shallow nor too deep, the canes are pruned to a height of 20 to 30 cm from the ground, that is, are pruned down to 3 or 4 healthy buds. Every cane should be watered extensively and manure (mineral fertilizer) should not be applied directly onto the root hair of the canes (Velichkovic et al., 2000), so that the root would not dry out completely.

Raspberry Cultivars and Influential Producers

In theory and practice, three types of raspberry canes can be found: experimental, amateur and commercial. Experimental canes are used for scientific research and the collection of information in vestigio regarding the characteristics of existing cultivars and of the possibilities of their further improvement, as well as for research into the creation of new ones. In addition, an analysis of imported cultivars is also carried out, so that their characteristics could be taken into consideration, as well as their intrinsic values (resilience, the quality of the yield) and decisions made regarding their breeding on new locations. Experimental canes are formed by scientific institutions, which deal in the breeding, protection and the improvement of the raspberry cultivars professionally. For example, in the United States of America, almost every university is involved in scientific research into the extent of raspberry production (Pennsylvania State University, Colorado State University, Ohio State University and others). Amateur canes are specific to small producers who breed raspberries with enthusiasm, on small plots, in their own yards or on their own land. The produced raspberries are mainly processed for household use, and the amounts that possibly exceed the family's needs can be sold on the market. Commercial canes are usually formed from one raspberry cultivar, on larger plots than those for amateur canes, and almost the entire yield is sold on the market. These canes depend on the soil surface and raspberry cultivar, they cannot be processed without the use of mechanization, cannot be maintained without adequate chemical protection and without hiring an additional workforce (in all stages of the production process), especially during harvest time.

When it comes to raspberry cultivars, more than one thousand have been classified, which means that science has invested a lot of effort into the process, investing the same effort and the same amount of professional attention to each species. Considering the large number of cultivars, it is sufficient to mention only those which are mass-produced and which have shown good results: those, which possess the necessary quality, are cost effective and allow continuity in production. It seems that the best classification of raspberries is made based on the country of origin, since it is known that by transferring the canes from one country to another or from one continent to another, some sorts have practically been appropriated (Richey and Myers, 2001) and so have lost their original integrity. Globally speaking, there are high quality raspberry producers, both in terms of cultivars, which have been used to form canes and the quality of the yield, and in terms of the amount offered primarily on the foreign market. One exception is the United States of America, which is a great producer, but also a great importer of raspberries from Mexico, Chile, Australia and New Zealand.

Based on the data from the Food and Agriculture Organization (FAO), five of the greatest raspberry producers for the period from 2001 to 2008 are the Russian Federation, the Republic of Serbia, Poland, the United States of America and the Ukraine (Table 1). The Russian Federation was the world's biggest raspberry producer in the specified period thanks primarily to the large areas of land on which raspberries are cultivated. Its' participation in the overall world production is a fantastic

33%. It is also a great consumer and its population consumes almost all of the produced fresh raspberries available on the local market. The best-known raspberry cultivars, which are bred in the Russian Federation, are Balzam, Sputnica, Brigantina and Skromnica. Right after the Russian Federation, with an average annual production of over 80 000 tons and with a 17.5% participation in the world market, comes the Republic of Serbia, which in the last few years has experienced a significant decrease in production. It has no indigenous raspberry cultivar but has successfully bred north-American cultivars, most often Willamette, Marlboro and Meeker. It is the largest exporter of frozen raspberries in the world. The United States of America comes third in terms of production and has the widest range of cultivars, which are successfully bred in Washington, California and Oregon. The best known raspberry cultivars originate from the United States of America, including Willamette, Heritage, Meeker, Titan, Clyde, Merion, Sodus, Golden Harvest. The entire raspberry cultivars bred in the United States of America is red, black, purple and yellow in color. The leader in the production of red raspberries is the state of Washington, which in 2009 produced almost 30 000 tons, which is half of the overall production of raspberries in the United States of America.

Poland, with a production rate of 55 000 tons of raspberries is the third producer in the world, and the first in the European Union. Its production is flourishing considering that the rate of increase for the given period is dominant in comparison to the best producers in the world, and covers 7.39% of the market at the annual level. Poland has more than 10 000 acres covered in raspberry cultivars, while individual raspberry patches do not exceed an area of one acre. Considering that production is more intense, it includes foreign summer bearing raspberries such as Norne, Vetena, Malling Seedling, Malling Jewel and Canby. However, Poland has its indigenous summer bearing Beskid and Nawojka and fall bearing cultivars Polka, Polana, Pokusa and Poranna Rosa, most of which can withstand very strong frost (Gwozdecki, 2004). The Ukraine, with an annual production of a little over 22 000 tons holds a high fifth position with a tendency for increase in production. Even though raspberries are produced in over 40 countries worldwide, the aforementioned five countries take part in the world production with over 80%. It is interesting that Canada has a great number of indigenous raspberry cultivars not found in the aforementioned group of countries. Raspberry cultivars which originate from Canada are bred the world over, and the best known are Skina, Chilkotin, Chilivak, Hajda, Komoks, Nova, Njutka and Loudon. Great Britain does not top the scale of producers even though it possesses several very high quality cultivars, for example, Malling Exploit, Glen Clova, Glen Moi and Glen Prosen, which were cross-bred with north-American ones, and have produced very high quality and resilient cultivars which are now being bred in the United States of America and Canada (Knight et al., 1989).

According to the reports of the Food and Agriculture Organization (FAO) from 2005, in 2003 and in 2004 Great Britain produced 8000 tons of raspberries which made up 2% of the overall world production, while in 2003 Canada produced 14 200 tons, which made 4% of the overall world production. The following year, 2004, Canadian production significantly decreased and was only 13,700 tons, but its share of the world market remained an unchanged 4 %. Plots, yields, and the production of raspberries in the world have noted a dynamic growth (especially in terms of production) which is why the realistic expectations are that this trend will continue (Veljkovic and Shevarlic, 2010). Raspberries are a very high demand goods as a table fruit, due to their specific and refreshing taste and their content of antioxidants (Aiyer et al., 2011), but they are also very interesting as a raw material used to manufacture a number of products.

The Protection of Raspberries from Diseases and Their Causes

From the aspect of the health and safety of raspberry canes and the quality of the raspberry yield which has to be maintained, we should take into consideration the importance of the education of a large percentage of the rural population

Table 1
The biggest raspberry producers in the world in the period from 2001 to 2008

Country	Average	Variation interval		CV, %	Global structure 100%	Extent of change 100%
		Min.	Max			
The Russian Federation	157.5	110.0	175.0	14.7	33.0	-1.07
The Republic of Serbia	83.6	77.0	94.4	7.74	17.5	-0.63
USA	64.3	51.7	82.8	17.93	13.5	2.55
Poland	55.0	43.0	81.6	22.72	11.5	7.39
The Ukraine	22.6	18.1	27.2	15.90	4.7	5.47

Source: The data were calculated on the basis of FAO reports, www.fao.org Retrieved November 14. 2012, 11: 15.

which is intensely involved in raspberry production. Education primarily refers to being acquainted with the purpose, effects and use for agrotechnic and chemical means of protection of the canes during the overall production process. Proper training has become an important part of the agricultural activity of the 21st century, founded on the principles of the green revolution. Raspberry producers, who act in accordance with the recommendations and the advice of professional services and use pesticides only in the prescribed amounts, can preserve their canes. They possess elementary knowledge of the field of ecology, agronomy, sociology and economy, which helps them find solutions for the occurring problems. It is a case of knowing the basic components of protection, which during specific production cycles enable permanent treatments along with the agrotechnic measures they are used with. Certain authors (Sheremeshic, 2012) have found room for recommendations in addition to the aforementioned balance and scientific achievements, to implement organic production instead of the conventional one. Their opinion is that the advantage of organic production is that it allows every operation to be viewed and analyzed individually, which is not the case with conventional production.

In the fight against pests, which cause disease, professionals do not have any choice, considering that individuals (farms) which have been involved in the production of raspberries are of the opinion that they have completely mastered the breeding technology. This has created a dogma, which is the basic obstacle for accepting professional guidance, and advice, which is why more and more canes for planting are being damaged and are deteriorating, while the producer is left without any possibility for covering his extensive investments. Rejecting the dogma would enable producers to identify pests and master skills for the application of measures for the fight against pests and the diseases they cause.

1. The raspberry, like other fruit, is prone to many diseases (Table 2), which are caused by various culprits (insects,

Table 2
Fungal diseaess *(mycoses),* viral diseases *(viroses)* and bacterial disease *(bacterioses)*

No.	Type of disease	Botanical order
I	**Fungal disease (*mycoses*)**	
1	Raspberry spur blights	*Didymella applanata*
2	Cane blight	*Leptosphaeria coniohiryum*
3	Anthracnose	*Elsinoe veneta*
4	Leaf spot	*Sphaerulina rubi,*
5	Gray mold disease	*Botryotinia fuckeliana* de Bary
6	Verticillum wilt	*Verticillium albo-atrum* Reinke et Beerth
7	Powdery mildew	*Sphaerotheca macularis*
8	Yellow rust	*Phragmidium rubi idaei*
II	**Viral diseases (*viroses*)**	
1	The yellow net virus	*Rubus idaeus yellow net virus-RYNV*
2	The necrotic virus	*Niger rubus idaeus necrosis virus-NRNV*
3	Mottle leaf virus	*Rubus idaeus folium maculo virus-RFMV*
4	Leaf spot virus	*Rubus idaeus folium macula virus-RFMV*
5	Chlorosis of the leaf vein virus	*Rubus idaeus chlorosis virus-RCV*
6	Curled leaf virus	*Rubus idaeus folium crispum virus-RLCV*
III	**Viral diseases (*viroses*) - viral transfer via nematodes**	
1	Ash ring and line pattern virus	*Arabis musivo virus-AMV*
2	The ringspot virus	*Raspberry rigspot virus-RRV*
IV	**Viral diseases (*viroses*) - viral transfer via pollen**	
1	The fruit dwarfing virus	*Rubus idaeus fruticosum pumilio virus-RFPV*
2	The dwarf virus	*Rubus stunt-RS*
V	**Bacterial diseases (*bacterioses*)**	
1	Crown gall disease	*Agrobacterium tumafaciens* Smith and Town
2	Cane gall	*Agrobacterium rubi* Star and Weiss

Source: Adapted from - The agricultural society of Valjevo d.o.o. - Valjevo. The Republic of Serbia.

vermin, viruses, fungi, mites, bacteria) and many other microorganisms. Because raspberry canes are not relocated on average for two decades once they have been planted, it is natural that in the case of poor protection the causes of disease become very effective and lead to serious diseases (Green, 1971). If a certain disease attacks a raspberry cane, it can be exposed to various types of danger: decreased yield, loss of a high-quality harvest, and sometimes overall and early rot. Thus, protection represents a responsible activity, a complex phase incorporated within the production process, for now is the key precondition for survival, the maintenance of the quality of the fruit and continued successful production.

In all the countries, which are intensely involved in the breeding of raspberry, the cultivars (quality or non-quality) represent the basic feature of the future canes. Which raspberry cultivars are bred worldwide and on which soil is not of great importance, but it is important that they are equally susceptible to diseases, weeds and pests that destroy the root, underground tree, leaf and fruit (Leposavic et al., 2004). Most of these problems can be avoided primarily through the purchase of high quality canes bred from verified cultivars whose status meets high business standards and that during the transfer from the producer-retailer they remain healthy and free from damage. The canes are used with a bare root, which has numerous small root hairs, and a shoot in which various insect larvae could be found and prove to be a potential cause of disease. If during the planting process or even later, it makes no difference when, insects develop from the larvae, along with various viruses and mycoplasmatic diseases they will, over time, become the limiting factor in the production of raspberries, since the producers will suffer extensive damage. It is customary for the disease affecting the raspberry cultivar to be blamed primarily on insects, then pests and finally poor climatic conditions, while very little attention is paid to the main cause, which is man.

The human factor contributes the most to the spreading of viral diseases to which the raspberry is susceptible, as man uses canes that were produced through standard vegetative breeding (Laun et al., 1994), both for replacing destroyed canes and for the formation of new ones. In this case, no one, not even the producer himself, using his own canes, can with certainty claim that they were absolutely healthy. But the producer who is at the same time a distributor of the canes, offers them on the market and thus contributes, first, to the spreading of diseases which had previously attacked his canes, and second, also causes and increases damage. Thus, except for his canes, which have previously been affected by disease, each following cane that is formed is already doomed to suffer from the same or similar type of disease. Bearing in mind the fact that each conventional raspberry cane represents a "production plant under the open sky", their infestation with harmful insects and the diseases, which they cause, should not lead to any dilemmas among the producers of any protective measures. Because they were formed in an open terrain, they are available to living organisms, so that many pests make their nests in them or in their vicinity.

Similarly, there are many ways in which disease and weeds can find themselves in the canes planted in high tunnels. Pests can be introduced into high tunnels through parts of the canes prior to installation and during the installation of the tunnel, using material meant to treat the canes under the plastic roof. Thus, the insects, which contribute to the development of disease, seek out suitable conditions, and producers should find a way to successfully prevent them from doing so. In man's struggle with pests, the tunnel has contributed significantly to the successful reduction in the onset of disease to a minimum in comparison to raspberry breeding in the open. The structure of the tunnel helps reduce the ecological conditions (Pottorff and Panter, 2009) which are conducive to the development of disease, primarily through the suspension of rainfall, and then the necessary ventilation of the tunnels with the aim of achieving relative air moisture levels. In this case, the leaves of the canes remain dry, which prevents the development of harmful insects. One should not reconcile them to the fact that high protective and cautionary measures used in the breeding of conventional raspberry canes and canes planted in tunnels are sufficient, as it is not possible to win the battle against disease even in high tunnels. It can be possible, but such a struggle is exhausting since it demands numerous activities and large investments. For example, powdery mildew and rust are very frequent diseases, which favor air moisture levels above the natural moisture level of the raspberry leaf. They lead producer to despair along with the insects which attack the entire raspberry (the root, plant, leaf, fruit) and are not always visible to the naked eye, such as, for example, mites, whose presence can be determined based on the small yellow specks on the leaves, which eventually turn a bronze or brown color (Montri and Biernbaum, 2009). The problem of mites is that they are most successfully dealt with through the moderate addition of fertilizer, adequate watering and the protection offered by chemicals administered under the watchful eye of professionals. Considering that drought and the dense rows of canes create the optimal conditions for the development of various kinds of pests, and thus disease, raspberry canes need to be pruned, sunned and aired. The pruning and shading is achieved by removing thin, weak and damaged canes (Pantelic, 1982) which enables light and air to reach the center of the rows.

2. *Insects-pests* which most often attack the raspberry are the raspberry bug (*Byturus tomentosus*), the raspberry

moth (*Lampronia rubiella*), the spider mite (*Tetranychus urticae*), the big raspberry mite and the small raspberry mite (*Amphorophora idaei-Aphis idaei*), with the added fact that this list is not exhaustive. Pest control is aimed at the larvae and the adult insects. Carbamide or pyrethrin spray combined with some other means are most frequently used to destroy them, prior to bloom time but also immediately after the buds on the canes open. In addition, the use of oil-based chemicals is also frequent in the treatment of canes during the dormant period of vegetation. However, adult insects are destroyed using malathion or other organophosphate insecticides (Wittwer, and Castilla, 1995). To eliminate the eggs and young spider mites we usually use miticides during the early phase of the development of the disease. The Spanish Tree Cricket (*Oecanthus pellucens*) is a very persistent type of pest, which is effectively destroyed, with the help of carbaryl. However, before any type of treatment involving these insecticides, it should be borne in mind that insecticides, which are used with the goal of successfully destroying pests, often do not solve the problem, quite the contrary. As long as they destroy pests, they also upset the natural balance since they also destroy those arthropods, which kill the pests and do not to harm the raspberry canes. However, one thing is for sure, all of the aforementioned insects, in addition to many others, cause great material damage (up to 80% of the crop) and great problems for raspberry producers and the producers of protective chemicals.

In the available research, pests are mostly divided into three groups:

- Specific harmful insects,
- Polyphagous harmful insects and
- The remaining pests - mites (Table 3).

In order for the raspberry canes to be protected from insects - causes of the disease - it is necessary to organize professional protection during the entire production process, one that would include the identification of the pests, the selection of agrotechnical measures, chemicals and the suitable procedures for the proper treatment. The identification of the vermin on the canes is the first phase and the consequence of their systematic location, which usually commences at the beginning of March that is, the beginning of April, and ends at the beginning of September. The recommendation is to carry out from eight to ten identifications per year, which is sufficient (Wells and Loy, 1999) to gather valuable information for making timely decisions and the selection of preventive measures. The identification of pests during the harvest is difficult to perform due to the time limitations, caution and the ability of the insects to make use of their special features (mimicry), and that is successfully avoid being detected by the producers. The canes should necessarily be checked twice a week after harvest since different types of pests appear at that time.

As far as specific chemical treatments of the canes are concerned, the matter is actually much more complex. For example, many producers use dithiocarbamate and fungicides which are, according to their chemical composition, are derivates of the dithiocarbamate acid to protect raspberries from mould, without taking into account the fact that their use is limited to the beginning of bloom time. This means that the legal prohibition on their presence in the raspberry fruit is ignored, even though it can easily be ascertained through a routine and regular control of the raspberry samples. For this reason entire loads of already frozen raspberries were shipped back to the Republic of Serbia from the member states of the European Union (Kovačević et al., 2004), since during the quality control protocol, the presence of dangerous components was determined. The media in the Republic of Serbia on October 9, 2010 reported that the export of Serbian raspberries was severely compromised (Press online, author Nedeljkovic), irrespective of the fact that Serbia is one of the most significant producers and exporters of frozen raspberries in the world. In 2009 alone, the Republic of Serbia had to revoke 120 tons of raspberries, which were delivered to foreign buyers, since they contained more pesticides than allowed by the standards of the European Union. Foreign buyers determined that the producers used more than 20 active substances, which were not allowed in the European Union. Local production of raspberries allows up to 2 mg/kg of carbamate in the raspberry fruit, while the accepted norms in the world allow the presence of only 0.02 mg/kg. Thus, most of the samples of the studied raspberries contained dithiocarbamate in amounts, which exceeded the allowed values several times over: from 0.07 mg/kg to 0.23 mg/kg.

The strategy of managing raspberry diseases is very similar in the systems of organic and conventional production. The only difference is that organic producers do not make sufficient use of synthetic “conventional” means to fight fungal infections (fungicides). Both systems require the development of integrated programs for disease management and regular and rigorous control. The main components of the disease management of the raspberry are the use of specific breeding experience (Start, 2001), the development of knowledge in the field of biology and pathology, the use of resilient cultivars and the timely use of approved chemicals for destroying pests, fungal, bacteriological and viral diseases. When treating canes with the aim of protecting them from pests, we should pay special attention to the limitations imposed upon the use of pesticide and the periods of time in which they are used. Excessive doses of pesticides lead to a weakening of the canes and poor quality of the fruit, since

Table 3
The clasification of pests *(insects)*

No.	Type of pest	Botanical order
I	**Specific pests**	
1	The raspberry beetle	*Byturus tomentosus* Fabr
2	The raspberry weevil	*Anthonomus rubi* Herbst
3	The raspberry moth	*Incurvaria rubiella* Bjerk
4	The raspberry cane borer	*Agrilus rubicola* Abeille
5	The raspberry clearwing	*Bembecia hyilaeiformus* Lasp
6	The cane boring beetle	*Coroebus rubi* Linne
7	The raspberry cane midge	*Thomasniana theobaldi* Barnes
8	Aphids	*Aphididae*
9	The raspberry gall midge	*Lasioptera rubi* Heeg
10	The raspberry cane maggot	*Pegomia rubivora* Coqu
11	The raspberry cane moth	*Notocelia udmanniana* Linne
II	**Polyphagous insects**	
1	The chafer beetle	*Melolontha melolontha* L
2	The squalid beetle	*Tropinota hirta* Poda
3	The Spanish Tree Cricket	*Oecantus pellunces* Scop
4	A soft scale insect	*Coccidae*
5	Treehoppers	*Centrotus cornutus* L
6	The new forest cicada	*Cicadeta montana* Scop
7	The powdered quaker moth	*Orthosia gracilis*
8	The small emperor moth	*Saturnia pavonia* L
9	The leopard moth	*Zeuzera pyrina* L
10	The june beetle	*Amphymallon solstitialis* L
11	The gypsy moth	*Lymantria dispar* L
III	**Mites (Acarina)**	
1	The raspberry mite	*Neotetranichus rubicola* Trag
2	The raspberry leaf mite	*Phyllcoptes (Eriophyes) gracilis*
3	The raspberry bud mite	*Acalitus (Eriophyes) esyggi*
4	The two-spotted spider mite	*Tetranychus urticae*
5	The European red mite	*Panonicus ulmi* Koch

Source: Adapted from the data of the Institute of Immunology and virology "Torlak", Belgrade, the Republic of Serbia

they impede its nutritional structure. For this reason, we need to determine a basic program for the protection of raspberry canes from disease and pests based on the use of chemicals during the entire year, prior to vegetation, during vegetation and following the harvest (Table 4). However, no plan should be rigid and should instead be adjusted to the conditions of the terrain, which could lead to certain changes. Changes could occur as a result of the change in the position of the canes, the extent to which the producers are supplied with suitable chemicals, how the protective procedures are carried out, the ecological and biological features of the pesticides, and adhering to instructions and advice with the aim of professional and appropriate use of mechanization.

Conclusion

The results of this research have led to the corroboration of certain data related to the breeding of raspberries, and to the refutation of others. The opinion that the values, which the raspberry offers, are nutritional, relaxation and economic can be verified, and as a result raspberries are intensely bred on large areas all over the world. Today the world's production has been reduced to five continents and is estimated at more than 400 000 tons per year. The four main regions in which raspberries are intensely grown include the Russian Federation, Europe (Poland, the Ukraine, Serbia, Germany, Great Britain), the United States of America and the sates of the Pa-

Table 4
The raspberry protection program

No.	Phase of development	Diseases and pests	Protective measures
1	Winter spraying	Cane blight Raspberry spur blights Anthracnose The raspberry moth	Cuprablau Z (0,35 %) Galmin (1,0-2,0%)
2	Spraying prior to budding	Cane blight Raspberry spur blights	Funguran-OH (0,3%)
3	Pruning buds	Cane blight Raspberry spur blights Mites The raspberry weevil	Captan WP-50 (0,25%) Sanmite (0,06%) Afinex 20SP (0,02%)
4	Prior to bloom time	Raspberry spur blights Cane blight The raspberry weevil The raspberry bud mite	Queen / Quadris (0,075%) Pyrus (0,2%), Nurelle-D (0,15%)
5	7 days following the harvest	Powdery mildew	Switch 62,5 WG (0,08%)
6	10 days following the harvest	Raspberry spur blights Cane blight The raspberry gall midge The raspberry moth Mites	Dithane M 45 (0,25%) Actara 25 WG (0,02%) Demitan (0,06%) ili Afinex (0,025%)
7	In September	Mottle leaf virus Harmful insects Cane blight	Cuprablau Z Ultra (0,3 %) Nurelle-D (0,10%) Sanmite 20 WP (0,06%)
8	Weed control	Annual and perennial weeds "Chemical mowing"	Focus ultra (1,0-3,0 l/ha) Kletox (0,8-2,0 l/ha) Agram (3,0 - 5,0 l/ha)

Source: http://www.agromarket.rs/index.php?/ser/Zastita-bilja/Programi-zastite/Malina. Retrieved: 03.11.2012. 13:40

cific coast (British Columbia, Washington and Oregon) and Chile, New Zealand, and Australia. The latter not only have a significant role in production, but are also the main suppliers of the market of the northern hemisphere with fresh and high quality raspberries during the winter period. The reason why raspberries are bred so widely and consumed in such amounts is that they are an exclusive type of berry, which possesses an extraordinary nutritive profile. Raspberries are a very rich resource of phytonutrients, anthocyanins, flavonoids, stilbenoids, phenolic acids, tannins, lignans and the like. Raspberries are a rich source of material used to regulate the function of the digestive tract, vitamin C, vitamin E and vitamin K and magnesium, pholate, omega-3 acids, copper and potassium (Beekwilder et al., 2005). In addition to the aforementioned components, the nutritional profile of the raspberry contains a wide spectrum of nutrient matter, such as carbohydrates, sugar, soluble fibers, sodium, minerals, and amino acids. With the aforementioned components, it is an actual reservoir of health and generator of good mood among the consumers who use it, who are convinced of its medicinal effects and the role it plays in the protection against many illnesses that afflict humans. The relaxation value of the raspberry lies in the very nature of its breeding, that is, the high requirements in the engagement of the workforce, more than the involvement of mechanical devices, and due to the constant physical activities to which producers are constantly exposed.

Once the first conditions are met and work on the canes can commence, that is, the disappearance of snow, the producers have every reason and commitment to constantly spend their time among them. The advantage of the raspberry cane lies in the fact that producers spend time in the open air every day, that the production processes are not difficult, and that there is a certain economic interest involved in the process, that is, a third value category – a guaranteed yield and commer-

cial value. However, we need to accept the fact that previous conditions for breeding raspberries no longer exist, that there is less quality soil to be found and that the possibility of increasing raspberry patches has decreased. In addition to that, the production conditions have been significantly altered, so that no crop, not only the raspberry, can thrive without the use of mineral fertilizers, herbicides and pesticides. In addition, commercial value cannot always be calculated beforehand for the simple reason that the quality of the raspberry, which does not satisfy the set standards, can alter the plans of the producers. The Republic of Serbia with nearly 100 000 tons of frozen raspberries per year, but of doubtful quality, has on several occasions been threatened with a ban from exporting into the European Union. It is time to reject the breeding of raspberries below the standards and rules, which were determined by the relevant bodies and institutions. The European Union is the greatest important or raspberries in the world with nearly 500 million consumers. It is a very attractive market since its member countries are characterized by permanent economic growth and its significance can be reflected in the high standard of the consumers, in the lack of this type of product and the vicinity of the producer. In addition to that, the export of raspberries to the aforementioned market is not simple and requires much adjustment to suit the statutes of the European Council - EC, No 2200/96, which sets the standards for 35 products consumed fresh.

The problematic detail in raspberry production is the improper use of chemicals for the protection of raspberries. It leads to traces of very dangerous and largely carcinogenic substances in the fruit, which are either acceptable in very low levels or are not allowed by law. Naturally, it is primarily the result of pesticide use. Pesticides represent a heterogeneous group of chemicals with different biological, chemical and physical features, due to which there is no universal technology or method for the precise determination of doses. The pesticide residue found in the raspberry fruits, which are used by consumers in their diet, can, even in very small amounts, cause serious health problems, and largely is the cause of carcinogenic illnesses. This especially refers to fungicides since they are cytotoxic based on their internal structure. It is well-known that any appeal to the producers, that they can only expect full commercial success in the production of raspberries if they clearly identify the pests and take proactive measures against any possible disease, has fallen on deaf ears. Only rare producers use chemical protection in accordance with the recommendations of experts for plant protection and the legal norms. However, their knowledge is being directed towards the goal that effective protection can only be made possible through the proper use of various acaricides and insecticides, fungicides and herbicides, which are used to destroy insects such as mites, plant lice, bacteria and microorganisms, as well as weeds. The interest that producers have for the increase in the yield is the only reason for the extensive and unlawful use of pesticides in uncontrolled doses. This dimension places the consumer into an inferior position in relation to the producer, since the consumer in his intent to consume the raspberry fruit, fresh or in the form of frozen goods, has no insight into the actual content of the fruit and the expected level of quality.

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Received February, 14, 2013; accepted for printing December, 2, 2013.