CULTIVATION OF RASPBERRY

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I N T R O D U C T I O N

Raspberry (Rubus idaeus) in global agricultural practice is a type of fruit with great economic importance. This plant is well adapted for cultivation in our agro-climatic conditions. Although its production in our country is in small quantities, there are very favourable conditions for expansion, for our internal needs as well as for export to the foreign markets, whether it is for consumption as fresh, frozen fruits or processed products (juice, jam, marmalade, etc.).

Development of fruit market for consumption, in combination with the processing industry is a very important segment to achieve a maximum production of this fruit, insuring a stable profit for farmers. Long-term development of the market for consumption of fruits and processing capacities for raspberry requires continuous improvement of production especially the improvement of technological measures. Introduction of new cultivars in production, and use of contemporary protection methods can have an impact in extending the productive period of the crop. Production of two tons of raspberry fruits per 0.1 ha for consumption as fresh, can be achieved with utilization of regular technology for its cultivation.

It should be emphasized that production of raspberries, despite costs related to the price of propagation material, irrigation system, expenditures for plant protection preparations against causes of diseases and pests, structure including holders, posts in the single fence cultivation system, labour for planting, pruning, protection against diseases and pests, harvesting, still this production can be profitable. At the same time it should be taken into consideration that there is a possibility of expansion of demands for larger quantities of this product in the domestic and external market. This applies to all farmers that produce large amounts of high quality raspberry fruits.
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It is important to emphasize that our producers should become familiar and continue following the standards relating to quality prevailing in the EU market when it comes to producing raspberry fruits, what is a guarantee of actual competition.

The purpose of this publication is to provide technical information on all aspects of raspberry production, so, the producers are competitive in the current tough market of raspberry fruits. The brochure, first of all is dedicated for producers who start for the first time to deal with this activity, to complement previous experience and current work, as well as for farmers that for a long time are dealing with cultivation of raspberry.

1. IMPORTANCE OF CULTIVATING RASPBERRIES

Pomological classification ranks the raspberry in the group of berries, and it is ranked as second, immediately after strawberry. In view of biological and ecological features and other technical and technological requirements, diversity of fruits usage, market opportunity, etc. in our conditions, raspberry has very good prospects among the berries.

In comparison with other fruits, raspberry has some advantages as follows:

- Can be cultivated in poorer lands,
- Does not have specific climatic requirements,
- Starting fast with fruit production and providing regular production,
- Enables fast turnover of the capital,
- Risk of production is small,
- Production technology is simple,
- It is an intensive crop providing employment to a significant number of people, especially those that are weaker (women, children, elderly and disabled people),
• Gives fruits with high nutritional value. Its fruits contain dietary and prophylactic value. Fruits contain: sugar, acids, minerals, pectin substances, cellulose, albumins, fat substance and vitamins,

• They have healing properties - raspberry fruits have anti-cancer effects,

• It is distinguished by continuous ripening of fruits, so the ripening and harvesting is done for a longer period of time, enabling greater engagement of labour,

• They are products demanded in the market as fresh table fruits or as raw material for processing.

Figure 1: Fresh Raspberry Fruits
2. ECOLOGICAL CONDITIONS

2.1. Ecological conditions for cultivation of raspberry

**Soil** – Raspberry doesn’t have specific requirements on the type of soil for successful cultivation. Nevertheless more suitable are soils with deep working layer of over one meter, loose, permeable, with moisture (75%), low acidity, moderately heavy (50% clay) and fertile (5% humus). Forest and deep alluvial lands are the most favourable types for the cultivation of raspberries.

**Climatic conditions** – The raspberry plants often can be found in mountainous regions, in places with light, but also in the shade, in high air moisture and with slightly lower summer temperatures. Although raspberries can be found at an altitude up to 2000 m, it is recommended that the most favourable regions for the cultivation of raspberries should be selected those at an altitude up to 1000 m.

For the successful cultivation of raspberries most suitable are the regions with a medium climate, with an average monthly temperature of 10°C, with annual rainfall from 800 to 1000 mm, with their regular distribution, with fresh summers and harsh winters. In order to have a good design of the raspberry orchard it is recommended the northeast or northwest position and the terrain inclination of up to 10%.

Raspberries are blooming later, so they are less damaged by late spring frosts. Negative effect of frost in this period affects the side shoots in biennial branches. Mature canes of raspberry stand well the low temperatures. However, in some susceptible cultivars in some years may be caused minor or severe damages by frosts. Factors affecting sensitivity to low winter temperatures should be taken into consideration:
• A cultivar insufficiently resistant to frost as a biological feature,
• Poor protection and preparation of canes for winter, which can be:
  • Fertilization with excessive doses of nitrogen at the end of vegetation,
  • Damaging of the vegetative parts by disease causes and pests,
  • A sharp decline in temperatures in the autumn or at the early vegetation in spring

In regions with lot of snowing should be applied cultivation with armature and cultivars with greater strength of growing to ensure a more solid growth of vegetative parts. During the winter season usually are not placed holders, instead canes are left free so they will be protected from low temperatures by the layer of snow. In spring healthy parts stronger and undamaged by frosts are raised vertically and tight with a wire to the holder.

2.2. Damages caused to raspberry canes by frost

Raspberry cultivars in the winter are affected by the action of frost, primarily in cold weather, and in the absence of a layer of snow. Symptoms of wounds caused by frost in this period appear in sporadic damage in generative buds of canes, which appear in the spring of the second year of cultivation. Damages caused by frosts appear in the form of sporadic fruit buds awakening, intermittent stains of dry tissue, signs in the form of dots in the canes, etc.

*Fig.2. Raspberry cane well maturated and lignified is resistant to low temperatures during the winter.*
Damages by frost to the biennial raspberry cultivar can be avoided if canes are left to lie on the surface of the soil in the late autumn, so that in the winter they are covered by the layer of snow, which acts as a good protection from frost for them. It is not recommended leaving the canes of raspberry cultivar Willamette or Meeker in the winter period staying in vertical position or to stay connected to the holder.

Fig. 3 and 4. Frozen raspberry canes of Willamette cultivar, with offshoots standing in vertical position in the winter (left); sporadic frosts cause reduction of awakening of generative fruit buds at the raspberry Willamette cultivar (right).

3. BIOLOGICAL PROPERTIES

3.1. Biological properties of raspberry

Raspberry is a bushy deciduous perennial plant, with two types of underground and aboveground organs: vegetative and generative. The vegetative organs, whose function is to keep it alive are: root, stem and leaf, while the generative organs whose function is continuity of the kind are: flower, fruit and seed.
Fig. 5. Vegetative and generative organs of raspberry

The underground system or root is a vegetative organ of raspberry, which is usually well developed, with a radial symmetry. The underground system of raspberry in intensive production is defined as a shallow root system that at the extent of the underground system conditions setting of holders and good preparation of land for raspberry plantations and later proper maintenance.

Fig. 6. The root system of raspberry

As pointed out earlier, in the practical sense, it can be concluded: the aboveground system of raspberry fully depends on the root; therefore even smaller injuries can have serious impact on production. Therefore the medium where the root is developed should possess features that enable undisturbed awakening of buds and appearance of new growths, while it is very important that these organs are not immersed in water, because in the absence of oxygen they suffocate and appear diseases that cause root rotting and eventually damages the root system. Raspberry roots should never be covered with organic matter as mulch, because it hinders appearance of new offshoots.

The aboveground system of raspberry isn’t resistant as the root system is. Based on production features, respectively on the time of fruit-bearing two types of raspberry exist: annual and biennial. The biennial type gives yield in biennial canes for a period of one month (four weeks) of ripened fruits, from June to July. In such type belong all types of
raspberry including the cultivar Willamette, which constitutes 95% of total production.

Meeker is the second cultivar of this group, which is cultivated in smaller percentage. In the first year this cultivar does not yield. On the other hand in raspberry kinds of annual type fruits are formed on top of annual canes for a longer period of time, in months August to October, then such seedlings dry up and get destroyed. Typical representative of this type of raspberry are Heritage, Autumn Bliss, etc.

The aboveground raspberry system comprises of biennial canes, which are carriers of production elements, which after giving fruits dry out. From the morphological point of view in raspberries are two distinguished forms of growth that constitute the structural parts of growth of the aboveground system:

- Canes – growing that derive from the vegetative growing points – living two years.
- Canes – one year growing shoots (productive shoots) from growing points (generative buds) in the aboveground system – in canes.

*Fig.7. Aboveground system of raspberry:*

a) Vegetative growth - SHOOTS,

b) Productive shoots – CANES
At raspberries exist two types of buds: vegetative found in the underground system – at the root, and generative (mixed) in the leaf axil of annual canes.

Fig. 8. Buds in canes

Morphogenesis of biennial shrubs of raspberry cultivars, through the vegetative cycle, develops as follows:

- In the first year growth and development of canes starts from vegetative buds of the root (growth and development of canes). Beginning of buds’ differentiation in canes (all buds in canes will be generative).

- Second year – growth and development of canes with productive elements (fruiting canes) from generative buds of last year canes growth. After fruiting and harvesting of fruits, canes with fruiting elements dry out, respectively those biennial are removed.
3.1.1. Multiplication of raspberries

Raspberries multiply in many ways, but in practice two are used more frequently: multiplication with root seedlings, multiplication with mature canes and green canes.

Multiplication with root canes is achieved with fast multiplication of raspberry. Parts of canes are cut in such a way to have at least one underground developed bud, but their optimal number is 2-3 buds. Parts should have well developed roots with a diameter of 3-4 mm.

Red raspberries with a developed root mass multiply by mature canes or green canes. Qualitative canes obtained from the parent raspberry plants, which are from the clean, healthy cultivars from special closed chambers.

Fig. 9. Morphogenesis of biennial raspberry shrubs: first year - a) appearance of new shoots; b) vegetative growth of shoots; c) falling of leaves and entrance into the phase of peace; second year - d) generative buds awakening and development of canes; e) after harvesting natural drying from the top to the base, removal of growths up to base.

Fig. 10. Root parts of raspberry
After production of canes from the parent plants, can be further multiplied in the open field, in the nursery, in a place isolated from other nurseries in a distance of at least 400 m (standard propagating material).

**Fig. 11. Multiplication of raspberry with canes from vegetative buds of the parent plant root, young seedlings developed after a certain time separated from the parent plant root and represent new seedlings for planting.**

Raspberry propagate with shoots – from vegetative buds of parent plant root, new shoots are developed, which after a period of time separate from parent plant root, and represent new raspberry seedlings.

4. PREPARATORY WORK TO ESTABLISH A RASPBERRY PLANTATION

Work undertaken to establish new orchards with raspberry includes:

- Selection of location,
- Preparing the soil for planting,
- Selection of the propagating material,
- Planting techniques, form of cultivation,
- Orchard management measures,
- Pruning of trees, irrigation, soil maintenance and protection against causes of diseases and pests.
4.1. Selection of location to set up a raspberry orchard

There are key factors that should be considered when selecting the place to set up a raspberry orchard. This should include: assessment of the plot, analysing the preceding crop, type of soil and value of fertility, ensuring drainage, ensuring defence belts against wind, solar radiation tests, and proximity of water for irrigation and access to traffic.

By evaluating the plot it is understood that the location to establish the orchard should be well lighted by the sun. In this regard should be avoided places that are in the shade. The best sites are those well drained, naturally fertile, and rich in organic matter (2-4%), with a pH of 6-7. In case of raspberry best soils are those with sandy clay or clay only, and drained clay soils. Soils that contain phosphorus 5-10 kg per 0.1 ha, 25 to 30 kg potassium per 0.1 ha, 15 to 20 kg of magnesium per 0.1 ha and cation exchange capacity (CEC) from 8-16 are optimal soils.

Soil drainage from groundwater is very important factor in determining the place to set up an orchard, because the root system of raspberries reaches depths of up to 1 meter. Plots with water impermeable layer should be eliminated. The level of the ground water should not be above 1 m, because raspberry roots are very sensitive to the lack of oxygen in the soil.

Also many raspberry cultivars are susceptible to fungi that infect the root system, which dominate the land with poor ventilation. When the root system dries out, the plant is deformed, what is more present at high temperatures in summer and in the absence of water in the soil. There is a very practical test by which it is determined sufficient ventilation in an orchard. A pit 75 cm deep and 15 cm wide may be opened in the place where the establishment of the orchard is planned. The pit is opened in early spring and late autumn, when the soil is saturated with moisture, but yet not frozen. In the pit are poured 20 litres of water and the water level is checked after an hour.
If the water is still in the bottom of the pit, the conclusion is that such land is too wet for cultivation of raspberries. Raspberries should be planted in places - slopes, with gentle decline, where excess water does not stand for a long time.

*Fig.12. Plots in hilly terrains are ideal places for the cultivation of raspberries.*

Also relevant ventilation or drainage between plants is an important factor for this crop. Air circulation decreases humidity around the plant and prevents creation of conditions for the appearance of diseases on the leaves. Air circulation reduces the risk from the influence of spring frost. If orchard is established in a steep terrain and at a greater altitude, keep in mind that cold air moves toward the lower part of the terrain, toward its lowest point, the air is lighter, and with such circulation finally is avoided the negative impact of spring frost. On the other hand, in some cases, raspberry orchards should be protected from the influence of strong wind. Strong winds can cause mechanical damages to this noble crop. Selecting exposure, although not a critical factor, nevertheless, is important and therefore it should be taken into consideration when the raspberry orchard is established. For this type of plants, in regard to this factor, better suit the north inclined terrains. Southern exposure can be used to establish orchards, but in that case it should be taken into account that the temperature for the plants can be high in winter. In example, some warm days in the month of January-February can stimulate the awakening of buds, while subsequent days with low temperatures can cause serious damages to the plant.

New orchards should be planted far away from wild raspberries. Wild orchards with this kind of fruit in a diameter of 300 m should be avoided, because these represent a source of disease spreading in new orchards. Raspberry orchards should not be placed in plots with the following pre-
crops: strawberry, tomato, potato, eggplant, pepper or old orchards of raspberry.

Fig. 13. An example of the preceding crop impact on cultivation of raspberry: place where the orchard is established (a) was a pasture (left) and (b) with strawberry (right).

Vegetables and fruits mentioned are sensitive to fungi *Verticillium veneti*, causing vascular fading, which can be transferred to the new raspberry orchards.

As a suitable pre-crop for raspberry are plants of *Fabaceae* family.

4.2. Preparing the soil for planting raspberries

Good preparation of the land to set up a raspberry orchard largely depends on the quantity and quality of production expected to be obtained. For this reason, success also depends on the cultivar selected for the designed orchard.

When selecting the plot for raspberry orchard, i.e. before preparing the soil, of primary importance to know the preceding crops that have been in the plot. As good pre-crop for raspberry may be all crucifers, vetch (*Vicia sativa*), and as inappropriate are: strawberries, raspberries, blackberries, vine, potato, tomato. In order to clean the plot from weeds and terrestrial insects, like caterpillars, wire worms, a year before establishing the raspberry orchard, cereals are sown, or plants of *Fabaceae* family (examples of suitable pre-crops).

Preparing the soil to set up a raspberry orchard implies taking the following measures: soil analysis, regulation of land and improving its fertility with ameliorative measures, fertilization, deep ploughing and harrowing, and preparation of the land surface for planting.
4.2.1. Soil analysis

Soil analyses must be done several months prior to planting by taking samples; soil samples are taken in several locations of the plot, at 30 cm and 60 cm depth. It is recommended to take two samples for a surface of 0.1 ha.

![Soil sampler](Fig. 14. Soil sampler)

In larger plots, if only one sample is taken for analysis is insufficient and may show incorrect results, and in addition also inappropriate measures may be taken to improve the soil properties. It is easier to make improvements in selected soils before planting the trees. Soil analysis determine: soil pH, organic matter content, salts content, content of micro and macro elements and the presence of nematodes. Such analyses are done in commercial labs, or scientific institutions, or professional institutions. Also you may obtain your own equipment to determine soil pH, content of salts and some minerals directly in the field.

4.2.1.1. Soil pH value

The soil pH can be determined by using the tester strips with the help of a portable pH meter. The procedure is simple and it implies taking a small quantity of soil with a teaspoon, then wet it with water forming a muddy mass. But before mixing the soil with water, the water pH value should be checked since it should have a neutral value pH = 7.0. The tip of the strip is inserted in the mud so that the water begins to rise to the strip, while the soil particles remain on the surface. The colour of the strip changes within minutes. The average value of pH can be determined by comparing the colour of the strip with the colours’ list in the test strip. The procedure of pH
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Meter use consists on inserting the electrode into the soil prepared with water and simultaneously reading in the value shown in the indicator. If the soil pH value is below 6.0, to the soil should be added calcium carbonate, in order to improve the pH value. The quantity of lime (CaCO3) used to increase the pH value to 6.5 depends on the soil type and it differs.

*Table 1. Quantities of Calcium Carbonate used to improve the pH value, raising it from the initial value to 6.5*

<table>
<thead>
<tr>
<th>Initial value of PH</th>
<th>Kg/m²</th>
</tr>
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<tbody>
<tr>
<td>6.0</td>
<td>0.23</td>
</tr>
<tr>
<td>5.5</td>
<td>0.50</td>
</tr>
<tr>
<td>5.0</td>
<td>0.90</td>
</tr>
<tr>
<td>4.5</td>
<td>1.25</td>
</tr>
</tbody>
</table>

If the content of magnesium is low, to increase it is used dolomite (calcium magnesium carbonate), aiming to improve the soil’s pH value and content of magnesium (Mg). Calcium carbonate or slaked lime dust should be used few months before planting trees, in order to ensure adequate time for chemical changes in the soil.

*Fig. 15. Distribution of lime by hand before planting the raspberry*
Lime should be entered into the soil with the help of roto-tiller at the depth of at least 30 cm. For the successful cultivation of raspberries it is recommended treatment of the selected plots with lime. With the aim of saving, treatment of plots with lime can be done in rows, or in places where trees will be planted. The ability of lime to improve the soil pH value is determined based on the size of the particles and their purity. Small particles of lime are more active in improving the soil pH value.

4.2.1.2. Salinity

Raspberries are sensitive to the increased salinity, high content of salts in the soil. If the total amount of such salts in the soil is 800 ppm then planting of raspberries is not recommended. The high concentration of salt in the root system area consequently prevents the absorption of water and nutrients by the tree. Large concentration of melting/dissolving salts in the soil inhibits growth of roots; therefore the canes are weak and with deformed growing. Stagnation of plants growing and decreased productivity may occur before the appearance of symptoms in the leaves of trees. These are certain signs of the large amount of salts in the soil. Raspberries planted in soil with a high content of salts display chlorosis/necrosis and atrophy in the lateral parts of leaves and visible sores in older leaves.

*Fig. 16. Necrosis of old leaves edges are symptoms of toxic impact of salts*

The toxicity of salts in the soil may be due to their level in the water used for irrigation or in soils with poor drainage, but also the excessive use of fertilizers during fertilization or their use through the leaves. Raspberry is very sensitive to the presence of chloride and sodium salts, and plants damaging is visible in the hot summer months. Plants that
grow in salty soils have the appearance of those growing with shortage of water.

It is important in advance to test the water and the soil and to use regular irrigation and fertilization procedures, in order to prevent the accumulation of salts in the soil. Analysis of the leaves is of primary importance in checking the presence of salts. Like this the harmful effects of the sodium chloride salt may be detected even before the symptoms appear on the leaves of trees. Analysis of lateral burned parts of leaves is an indicator of poisonous toxic impact of chloride or sodium. If in the damaged leaves is determined amount greater than 0.2% of sodium or 0.5% of chloride, in this case this is a sign that the wounds on the leaves are caused by their toxic impact. The concentration of soluble salts represents the total amount of fertilizers and other ions that are in the area of the plants root system. Salts in the soil are present as mineral ions with positive or negative electricity. These electrified particles magnify the conductive capacity of the soil. Their concentration in the soil can be determined through measurement of this parameter (EC). Soluble salts are measured with an EC meter and are expressed as part of a million in one centimetre (mmhos/cm) or decisiemens per meter (dS/m), which are numerically equal. Value of 1 mmho/cm is approximately equal to 670 parts in a million (ppm) of the total quantity of salt. Production of table fruits decreases when conductivity of saturated extracts in the root system area is greater than 1.2 dS/m. Production of table fruits approximately decreases for 10% in salty soil with 1.3 dS/m, 25% to 1.8 dS/m and 50% when the ground conductivity is 2.3 dS/m, mmhos/cm (these values are approximate 1300-1500 ppm in a saturated extract). If the soil analysis shows EC to be greater than 1.2 dS/m, it is recommended the basic improvement of the land.
4.2.1.3. Content of mineral elements

Tests of micro and macro elements’ content in the soil must be made before planting raspberries, in order to determine the nutritional values of the soil where the crop will be cultivated. Such tests are done as a regular measure during the utilization of the orchard; results of such testing can be combined with results of the leaves tests, respectively tests of specific organs of raspberry, with the aim to optimize fertilization in all orchard maintenance phases. Optimal content of mineral elements with proper concentration are explained under the chapter “Fertilization of raspberry” of the present booklet.

4.2.1.4. Nematodes

During tests of primary importance is to determine the degree of soil infection with nematodes. These are microscopic sized organisms, with cylindrical body found in soil. There are different types of nematodes; some are very harmful for raspberries.

Nematodes cause damage by feeding on the root system; infected plants have a weak growth, and after a period of time get deformed. In addition to direct damage to plants, they are carriers of many diseases. These organisms move into the pores of the soil and thus spread in few centimetres distance. Simultaneously these organisms spread to new plots during the regular land cultivation. Some species of nematodes cause the poor growth of raspberries. Most important are the root nematodes of the genus Pratylenchus, with a significant number of their
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presence in the soil from 500 to 1000 individuals in a kilogram of soil. In lands with greater number of these pests is not recommended planting of raspberries. It should be emphasized that there are no appropriate protection means for their control in orchards. But, soil disinfection with nematocides can be done during the soil preparation before planting the crops.

4.2.2. Regulation of the land and improvement of fertility

The volume and number of measures needed to regulate the land before all depends on the existing situation of the plot in which raspberries will be cultivated. As first levelling of the surface should be done as a necessary measure to prepare the plot, with the aim of removing physical barriers and other obstacles, such as depression of the land, which in the future will be collectors of surface waters.

Removal of weeds is also a measure that is regularly used at this stage of soil preparation. Herbicides should be also used to control weeds. These chemicals control most of perennial and annual weeds. If the soil in the plot where the raspberries will be cultivated is of a poor quality, it is necessary to improve the fertility respectively its physical and chemical properties. Improving the soil fertility is achieved with ameliorative measures; fertilization with organic and mineral fertilizers, and if necessary also calcification is done, improving the pH value, drainage and to provide the irrigation system for the plot.

Soils that are rich in organic matter are very suitable for growing raspberries. Such lands, with suitable texture, are more resistant to the wash out of basic mineral elements.
Organic substances improve the properties of water regime; respectively increase the capacity for holding moisture. Enriching the soil with organic matter should not be overlooked. Quantities of organic matter that can be added to the soil are not limited. Enriching the soil with organic matter can be done with straw mixed with farmyard manure, green fertilizers (Sudanese grass, rye, cereals) or compost. In most cases the amount of manure ranges from 3 to 5 tons per 0.1 ha, while larger quantities, in order to increase the water capacity of the soil, should be used in sandy soils, thereby improving the structure, drainage, ventilation as are soils with greater amounts of clay. Immediately after the distribution farmyard manure must be mixed with the soil in order not to lose nutrients, so the loses reduce to a minimum. Decomposition of organic matter in the soil is done by microorganisms needing additional amounts of nitrogen, except in cases with organic matter from nitrogen fixing plants. Because of this, to the mixed fertilizer are added 6 kg of nitrogen per ton of manure, while for manure from non-nitrogen fixing plants the amount of nitrogen to be added to the manure mixed with farmyard manure or green manure is 12 kg/ton. Poultry manure, applied in the autumn, is used in quantities 0.5 - 1.0 ton per 0.1 ha. Organic matter must be entered into the soil before planting in depth from 10 to 15 cm. These substances raise the nutrients, cations, the capacity of the soil, micro-elements, etc. Depending on the condition of soil fertility, the quantity of fertilizer NPK for ameliorative fertilization (5:20:30, 5:22:35, 6:26:26, 7:14:21, 10:20:30) ranges from 1.5-2.5 t/ha. If fertilization is done in rows (not the entire
surface is fertilized) the amount of manure can be reduced to three times. The most appropriate time for ameliorative fertilization is in two periods: before the deep land ploughing 50% and after the deep land ploughing 50%. Immediately after the distribution of the farmyard manure, and if necessary of fertilizers and lime, the ploughing is done at 30-40 cm depth. Deep ploughing of the soil is done in lands with average moisture, within a month before planting seedlings. If there is an impermeable layer, with deep ploughing this condition of the land will be removed. Deep ploughing of the land results with breaking up of the impermeable layer of soil with vibrant machines - chisel, that creates narrow channels in the soil at 75-100 cm depth. Machine chisels are placed at depth below the soil impermeable layer and operate there.

Fig. 19. Braking up the soil’s impermeable layer

Braking up of the soil’s impermeable layer is done twice in the same plot, so that in the second time the tractor moves at 90⁰ angle compared to the first time. It should be emphasized that the land at the time of undertaking this operation must have average moisture because otherwise if there is excess of moisture the desired effect of this measure isn’t achieved. After ploughing the land plot is cleaned of large stones and the remaining roots of weeds and trees, and then the soil surface is prepared for planting, which implies adding the rest of manure and mineral fertilizers, disc harrowing and harrowing, until the surface of soil is loosened. In preparing the soil surface for planting are undertaken measures to deal with disinfection and disinfestation of the soil with chemicals
4.3. Selection of the planting material to establish a raspberry orchard

When establishing a raspberry orchard the planting material used should not originate from an old producing orchard, because such a material can be infected, and has the potential to reduce production. Material from old production orchards can be derived from seeds that have fallen to the ground and from them are developed plants which have lost the pure features of the type. Like this are obtained individuals with unknown genetic properties and unstable.

![Fig. 20. Raspberry seedlings: a) good seedling (first class), b) weak seedling.](image)

Planting material that should be planted in the raspberry orchard should be of a very good quality, possessing attestation guarantying purity of cultivar and appropriate health condition, which from the morphological point of view should meet all standards of the underground root system and other aboveground parts development. A standard raspberry seedling must be over 50 cm tall, in average 8 to 12 mm thick, with a root system with at least 8-10 main roots, with a length of 12-20 cm and a thickness of 2 mm, and with lateral radicles and hairs. Each seedling or set (usually with 50 pieces of seedlings), must have the statement note where is written: type, cultivar, type of seedling, the manufacturer's name, address, and for which planting year seedlings may be used.

4.4. Raspberry planting techniques
CULTIVATION OF RASPBERRY

After preparing the soil and the use of all necessary supplements to improve the properties of soil, other measure means setting the rows for planting. Raspberries can be planted in flat plots without elevations and or pits, provided that they are well drained. However, these crops in flat plots with poor drainage should be planted in raised beddings with dimensions: height 25 cm and width 60 cm.

Fig. 21. Formation of beddings in lands with poor drainage.

Distance between rows should be 2.2-2.5 m, for the raspberry. This distance provides the needed living space as well as makes possible performance without hindrance of agro-technical measures, fertilization, treatment for protection against diseases and pests, harvesting and for obtaining quantitative and qualitative production. The distance between the rows also depends on the size of machines used for maintenance of the orchard. In the first place it should be suitable for the use of cultivators and tillers. Raspberry orchard should be established in drained plots, so that the placement of rows is on the opposite side of the falling of the terrain to prevent the soil erosion. Although raspberry planting can be done from October to early April, with mature seedlings, but more frequent period for this operation is the late autumn and early spring. Planting in the autumn has several advantages and provides better results in the success of seedlings. Before planting refreshing of the root system of seedlings is needed, cutting the roots for a quarter of their total length, and then immersing them in a solution prepared from dung and clay with water, adding chemical preparations with fungicide effect (Previcur) for disinfection of roots.
Raspberry seedlings according to the rule are planted at the depth they have been in the nursery before extraction, but in practice due to soil compression they are planted 3-4 cm deeper. Planting is usually done in cloudy weather, while planting technique depends on the quality of soil preparation. If the soil is well prepared, planting is done in the furrow, which in practice is more common case.

Fig.22. Furrows for planting of raspberry

If the plot is not well prepared, you must open separate holes per raspberry 20 x 20 cm. In these holes is possible to place appropriately roots of seedlings. Cloudy weather is more suitable for planting of seedlings, technique that does not differ from the techniques of planting other trees. With the fertile soil layer is covered the root system, then is put the farmyard manure compost in quantity 1-2 kg per hole, 0.1 kg NPK, 8:16:22, then the planting place is covered with soil softly pressed. After planting if rainfall is missing, each seedling is watered with 3 litres of water. Shortening the planted seedlings is a measure that depends on planting techniques. This measure is taken in 3-4 buds, respectively, in 20 cm length. This is done in order to thrive better and to stimulate greater vegetative growth strength.
4.5. Selecting the cultivation system.

4.5.1. Raspberry cultivation system

There are two systems of raspberry cultivation:

- With shrub – square and rectangular distance
- Single fence system (green fence) – vertical single fence and V single fence.

Vertical single fence system for raspberry production orchards today represents the best standard system for cultivation of this fruit.

Cultivating shrub shaped raspberry currently is rarely used and it is an amateur system of arboriculture. Single fence system of raspberry cultivation among others provides enough work space in orchards, and also provides good and quality production of fruit. Raspberry canes grow in the vertical direction, but can lean toward the ground when fruits are ripened. For this reason single fence system requires installation of holders that provide support for the canes to stay in vertical position even when they have fruits in bulk. At the vertical single fence system holders or posts are from wood or concrete with a length of 2 - 2.5 m, width of 8-12 cm between them is placed

Fig. 23. Raspberry planting techniques
the galvanized wire with a diameter of 3 mm. Wooden posts, before placed as holders, in order to protect them from rotting, up to the half of their length are burned in flames, then soaked in burned engine oil, copper sulphate or painted with oil colours.

Fig. 24. Cultivation of raspberry with the vertical single fence system

Holding posts are inserted in the soil at 50-70 cm depth, at the distance of 6-10 m. The distance between them depends on the type of holders as well as on the cultivar’s vegetation, those of wood are placed every 6 meters, while the concrete ones every 10 m.

At the vertical single fence system, depending on the position of the wire, there are two types of holders that currently are being used in the arboriculture practice when cultivating raspberries:
Posts on which is connected a wire thread in two/three levels, the so called system I;

Posts with double wire thread in two/three levels in horizontal position, the so called system T.

The single fence system-I usually is used at biennial cultivars, while the system T is very suitable for annual cultivars and for a small number of cultivars Meeker. At the single fence system I canes are tied to the wire individually and thus do not lie on the ground under the weight of fruits. Usually in this system are present two wire threads, the first at the height of 0.9 m, the second thread at the height of 1.8 m, while the height of the post reaches 2.0 m. The distance between rows is approximately 2.5 m, and in a row number of productive biennial canes up to a meter should be 6-7. This is the standard way of cultivating Willamette cultivar.

At the single fence system T are placed two horizontal boards of 60 cm length, with dimensions of 2.0 x 2.5 x 60 cm, which are fastened at each post at 0.8 m height and 1.7 m height from the ground. In each corner of the traverse, which extends at the length of the row a galvanized or plasticised wire is reinforced. Width between the two wire threads or two rows is 60 cm. Canes are directed to grow between two threads or rows of wire.
At the Meeker biennial cultivar of raspberry number of canes in a meter of length is 5, while the distance between rows should be 2.5 - 3.0 m.

4.6. Managing measures in raspberry orchards

4.6.1. Care for the new orchards and pruning of raspberry

Care for the orchard of raspberry in the first year after planting implies the regular tillage, weed control, fertilization, pomotechnics, irrigation 3-4 times, protection against infectious disease and pests. Regarding pomotechnics in the first year after planting the part of seedling that has remained 20 cm above the soil surface should be removed in the moment when new canes are formed and have reached the height of 25 cm.

Fig. 27,28 Scheme of raspberry seedlings thrive in the first year, in the spring after planting, period when the old part of seedling is removed.

If the old part of the seedling is not eliminated, then during the vegetation it will be developed and will form fruits, it is biennial, but such a development would be detrimental to young canes to be formed in that year, which will produce fruits next year, and in this case they will be deformed, not sufficiently developed. At the end of the
vegetation occurs drying out of the old part of seedling. In cases when young canes that bring fruits next year are not developed, production of raspberries in this case could be compromised.

Fig. 29. *Old parts of raspberry, not removed, after planting have as a consequence poor development of canes*

During vegetation young canes develop covering the whole area in rows. Since young canes are malleable and lei in the ground, to keep them in the vertical direction these are inserted between the wire threads and tied with a string.

Fig. 30. *Tying the string in parallel with the wire enables vertical position of canes*

At the end of the first year of the raspberry cultivation, each planting site provides 2-3 young canes at a proper distance. At the end of vegetation the string is removed, and shoots are let free to lie on the ground, so that in winter will be under the snow layer and like this protected from the adverse effects of frost.
Fig. 31. Untied canes of raspberry in the autumn lying freely on the land surface

In spring in the beginning of vegetation (production year) thinning of sprouts is done so frozen, weak, broken and immature canes up to the base are removed, and only the best are left. Number of canes left in a meter length is 6-7, while at the cultivar Meeker this number ranges to 5 canes. After thinning sprouts left are tied to the wire for the purpose of fixing with classic tying with plastic strings or fasteners.

Fig. 32. Tying to wire of biennial canes with plastic fasteners

Each cane left is shortened with a steep cut above the bud at 1.8 – 2.0 m height from the soil or practically at the height above the last wire where four buds are found, respectively the complete height of the cane to have 24 buds. This is done in spring. After pruning shallow digging is done in rows with raspberry plants.
At the beginning of vegetation, in the years of utilization, permanently grow new canes from the point of growth from the root, of which the first series are always removed to the level of the soil surface, in order to stimulate new growth and to control the habitus of the aboveground system. But the question arises to what time these growth should be removed? Such time is determined by the fruit growers in their orchards according to the conditions, but a rule exists according to which the best canes to be saved for next year are those that in the current year grow at height of up to 1 meter (time when they have passed the first level of the wire) at the time of fruit harvesting on biennial canes.

Fig. 34. A the time of harvest in old canes, new canes should be tall up to the first level of wire
In practice, this time should be 15 May. But the best is to undertake the following actions: all canes that emerge until 15 May are removed, after this time the others are left to remain. If the young canes at the harvest time haven’t reached the first level of the wire, in such case removal of young canes is done two days earlier, on 13 May. After harvest the cut biennial shoots begin to dry up from the tip to the base, so they are completely removed. Such canes after cutting stay in orchards few dozen days, serving as protection for young canes that if exposed to the direct sunbeam their leaves can obtain burning spots. After this period again are removed young canes along with old canes and are burned in order not to be a source of infection.

To ensure successfully the working space the young canes, as stated earlier, with a string are tied in parallel with the wire to stay in the vertical direction, until the late autumn, and then released to lie free in direction of the land.

Fig. 35. Realising the canes of raspberry in late autumn

4.6.3. FERTILIZATION OF RASPBERRIES

Appropriate nutrition of plant is one of the fundamental factors for good growth, profitable production with standard quality of raspberry fruits. Fertilization of the crop depends on: soil texture, soil pH reaction, presence of organic matter in the orchard. Before planting soil analyses should be done through which is determined the presence of each macro
and micro element in the soil, and soil pH reaction. Also during the vegetation period tests of leaves should be done to determine level of nutrients in plants, as well as to find out the level of nitrogen and potassium wash out in the soil. Like this, is determined the necessary quantity of nutrients to be used for raspberry. The growth strength and the plant habitus, thickness of canes, leaf size and colour, are indicators of the health status of the plant, but also of the need for fertilization.

Raspberries usually are fertilized with fertilizers combining four methods: the use of farmyard manure, distribution of mineral fertilizers in the form of grains, with fertilizers soluble in water, the crystalline in the irrigation system and with the use of micro elements through treatment of leaves.

In general fertilization by all methods depends on the content of nutrients in the soil, natural soil fertility and existing potential of the irrigation system. If there is no irrigation system, fertilization can be made with distribution of farmyard manure and distribution of artificial fertilizer grains.

Fig. 36. Strong and healthy canes of Willamette raspberry cultivar, as result of the appropriate fertilizing program
4.6.3.1. Fertilization with farmyard manure

Since farmyard manure is very valuable and easy to find, however with a lower content of nutrients, it is recommended to use one ton per 0.10 ha, and it represents a very important fertilization program. The content of nutrients in farmyard manure has an irregular ratio between nitrogen, phosphorus and potassium (NPK). In addition the farmyard manure acts slowly. Based on research, such manure acts in a period of up to three years. In the first year is used 50%, in the second year 30% and 20% in the third year. Thus, following common practice in orchards with raspberry, the cattle manure compost should be used every third year in the amount of 1-2 tons per 0.1 ha, depending on the fertility of the soil.

Poultry manure with high content of nitrogen is recommended to be used in quantities of 0.5 - 1.0 ton per 0.1 ha. If the farmyard manure is prepared according to all criteria, it can be used at any time during the season. It is recommended only the use of farmyard manure well composted. When using organic fertilizers, especially un-composted farmyard manure which is not inactivated, it contains non-structural materials, and it is difficult to be distributed in the rows space. Additionally un-composted farmyard manure contains various weed seeds and many pests and pathogens causing diseases. Composted farmyard manure, with organic matter decomposed at an appropriate scale, very easily can be distributed with a shovel or fork and it has multiple impacts, improves and maintains the soil structure, increases fertility, stimulates the development of beneficial microorganisms, etc. Research has shown that one ton of composted farmyard manure used in orchards with raspberry contains 2 kg of effective nitrogen. Compost and straw mixed with farmyard manure represent a valuable supplement of organic matter in the soil, but have less nutritional value compared to the pure farmyard manure. In the raspberry orchards
organic matter in the form of farmyard manure is distributed in the autumn after the removal of back fruited canes. Such manure affects the increase of nutrients in soil and plant warming during the winter. Manure can be used in a way that on both sides of the raw are opened shallow furrows in a 45 cm distance from the canes.

**Fig. 37. Preparing furrows to apply the farmyard manure**

During the preparation of land to set up a raspberry orchard, compost or manure should be thrown in rows or elevated beddings, before planting, at 10 cm depth. Farmyard manure can also be used after planting when the plants reach the height of 8 cm. Fertilization with farmyard manure should be used once a year in orchards of raspberry, but should not be the sole source of nutrients. Besides manure it is recommended the use of mineral fertilizers and water-soluble ones.

4.6.3.2. Fertilization with mineral fertilizers in the form of grains

Most important for raspberry are three elements: nitrogen (N), potassium (K) and phosphorus (P). For the growth of these crops, regardless of the type of growth, in the first year should be used approximately 3.5 kg of nitrogen per 0.10 ha. However, the use of fertilizers in the first year should be avoided until the emergence of the canes, because new raspberry plants are very sensitive and can be damaged by increased concentration of salts in the soil. In the coming years for the biennial raspberry type, nitrogen (N) should be used in the amount of 7.5 kg/0.1 ha, while for the annual type of this crop are used 11 kg of nitrogen /0.1 ha. Phosphorus should be used every year in the amount of 2.5 - 3 kg/0.1 ha. Also potassium should be used
every year but in quantity 5-6 kg/0.1 ha. Fertilization of biennial raspberry types should be done two or three times per year.

*Fig.38. Fertilization of raspberry is done between rows*

It is better to make the first fertilization in the spring when new growth starts, and the second after May or in the beginning of June, and the third in mid-July. In this case should be taken into consideration the use of farmyard manure in order to reduce the amount of mineral fertilizers. If the composted farmyard manure is used, in this case the appropriate amount of nitrogen is 50%, but if the fresh farmyard manure is used then the appropriate amount of nitrogen can be 90%. When using mineral fertilizers this should be taken into consideration. Fertilization with mineral fertilizers made in rows at a distance of 25-30 cm away from the plant and placed at 5-10 cm depth. Fertilization of raspberry is done in combination: NPK 10:20:30, 10:12:26; KAN and Urea. Each year is used farmyard manure with 400-600 kg/ha of NPK, and in years when manure is not used quantity of fertilizers increase to 600-700 kg/ha. Spring fertilization presents supplementary fertilization and is done with mineral nitrogen fertilizers, with KAN or Urea, in quantities from 200 to 300 kg/ha. If necessary a second supplementary fertilization can be applied, in order to avoid appearance of the lack of nitrogen symptoms, with KAN or Urea in quantities from 150 to 200 kg/ha.
4.6.3.3. Fertigation – fertilization through irrigation

Before planting raspberries, for fertilization can be used approximately 25% of the total quantity of nitrogen, phosphorus, potassium fertilizers and fertilizers with microelements. Remaining quantities of fertilizer with N, P, K may be used during the vegetation period through the irrigation system. With this system can be made corrections and can be used the remaining quantity of N, P, K, if they are not used in the form of grains (granules) or mixed with farmyard manure.

*Fig. 39. Drop irrigation system serves also for fertigation*

In larger plots can be used pure nitrogen in quantity 3-5 kg/0.10 ha, pure phosphorus 1.5 - 2.0 kg/0.1 ha and pure potassium in quantity 3-4 kg/0.1ha. These fertilizers should be used between the canes growing phase in spring and harvesting stage.

Nitrogen should be used after mid August. In soils rich in organic matter, the entire amount of N, P, K can be used by the irrigation system, which ensures successful growth and good production. At least 50% of the nitrogen should be in the form of nitrate. Better results in quantity and quality of raspberry fruits are achieved if N and K are used through the irrigation system or in the form of grains. During the use of fertilizers in this way the frequency of their use has little significance compared with the amount of fertilizer used.

Use of smaller amounts of fertilizer several times through the irrigation system, in most cases can result in reducing the burning of leaves from the large amount of high concentration of salts in the soil. Water-soluble
fertilizers are used in duration 1-2 hours a day or every other day during the flourishing and fruit formation phase. Commercial fertilizers soluble in water often consist of nitrogen (N) and potassium (K). Concentrated fertilizers are used more easily; in a very short time to the soil are added quantities of nutrients. During the use of fertilizers with irrigation should avoid cases of blockage of the system, while fertilizers used in this way must be soluble in water. If during irrigation are used several materials, mineral fertilizers in combination should not react to each other. Other chemical compounds that are used in this way must be compatible with other elements used through the irrigation system. Such fertilizers with high or low pH are corrosive to copper, zinc, bronze alloys and other metal parts of the irrigation system. Therefore the irrigation system components that come into contact with corrosive mixtures of fertilizers should be produced from stainless steel or plastics or other materials.

Fertilizers used through the irrigation system are: urea, potassium nitrate, ammonium phosphate. Phosphorus in the soil has important drift if used through the irrigation system in small quantities. In general raspberries very early need phosphorus, so it is important that this element is used while planting or immediately after planting. Phosphorus-based fertilizers used through the irrigation system can react with the potassium in water and create insoluble forms, and as a consequence pipe holes are blocked. But, if done according to the rules of use of such fertilizers through irrigation system this problem can be successfully avoided. Solution for this problem can be acidification of phosphoric acid in stock, mix with sulphuric acid or sulphuric acid injection immediately after injection of phosphoric acid. Injection of acidic solutions into water prevents precipitation of phosphorus, but without harmful effects in the soil.
4.6.3.4. Use through the leaves of fertilizers with microelements

Time of use of foliar fertilizers containing microelements is very limiting. Therefore more injuries can be caused in the raspberry crop if they are used in large quantities. If the tests determine absence of any of microelements, the appropriate use of the certain microelement through leaf treatment may be sufficient to eliminate the disorders observed. Such treatments with microelements can be made every 10 days until the complete elimination of symptoms caused by their absence. To fertilizers formulated with microelements are added moistening means, if these do not already contain such substances. Fertilizers for treatment of leaves are not used during the flourishing of raspberry, because it may have phytotoxic action in flowers. Fertilizers with microelements in the form of grains used to treat the soil do not have sufficient effect as fertilizers with microelements used to treat the leaves.

4.6.3.5. Leaf tests

For the best adjustment of the fertilizing program, fruit growers every year should check the content of nutrients in raspberry plants. In accordance with the tissue tests it is necessary to take the appropriate fertilization measures. For correct setting of these parameters should be tested leaves of this crop. To this end from each plant are taken 5 mature leaves together with petioles in order to create a representative sample for tests. Undoubtedly selected plants from all parts of the orchard should be tested in order to ascertain that abnormal occurrences are related to nutrients. Optimum quantity, quantity below the optimum and maximum are shown in Table 2. Decline of production can occur if the quantity of nutrients is below or above the optimal level.
Tab. 2. Classification of nutrients’ concentration in the leaves of raspberry

<table>
<thead>
<tr>
<th>Elements</th>
<th>Below optimum</th>
<th>Optimum</th>
<th>Above optimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microelements %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>&lt; 2.2</td>
<td>2.8</td>
<td>&gt; 4.0</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>&lt; 0.2</td>
<td>0.3</td>
<td>&gt; 0.6</td>
</tr>
<tr>
<td>Potassium</td>
<td>&lt; 1.0</td>
<td>1.5</td>
<td>&gt; 3.0</td>
</tr>
<tr>
<td>Calcium</td>
<td>&lt; 0.5</td>
<td>0.6 – 2.5</td>
<td>&gt; 2.5</td>
</tr>
<tr>
<td>Magnesium</td>
<td>&lt; 0.3</td>
<td>0.4</td>
<td>&gt; 1.0</td>
</tr>
<tr>
<td>Sulphur</td>
<td>&lt; 0.3</td>
<td>0.4</td>
<td>&gt; 0.5</td>
</tr>
<tr>
<td>Microelements (ppm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>&lt; 20</td>
<td>80</td>
<td>&gt; 300</td>
</tr>
<tr>
<td>Iron</td>
<td>&lt; 30</td>
<td>50</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>Zinc</td>
<td>&lt; 15</td>
<td>35</td>
<td>&gt; 80</td>
</tr>
<tr>
<td>Copper</td>
<td>&lt; 2</td>
<td>10</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>Bohrium</td>
<td>&lt; 25</td>
<td>50</td>
<td>&gt; 80</td>
</tr>
</tbody>
</table>

4.6.3.6. Symptoms of lack of nutrients

Raspberry nutritional status in most cases can be determined by external appearance of the leaves of plants. Symptoms of inadequate fertility can often be determined by special signs for certain elements. Each of the macro and micro elements show characteristic symptoms of their deficit in plants. Diagnosing visual signs of deficit of nutrients in raspberry plants is the second way that with their help growers can determine fertilization regime.
and overcoming the revealed problems. Though, damage is caused to orchard before obvious symptoms occur. If deficit of nutrients is compensated earlier, then plants can more easily overcome such a situation. Typical symptoms of lack of nutrients in the raspberry plant’s leaves are described in the following table (Tab. 3) and are illustrated with pictures.

Tab.3. Symptoms of the lack of certain nutrients in the leaves of raspberry

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>The leaves are green to yellow, on the edge reddish or these may include the entire surface.</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>The leaves are weakened, and withered and get a dark colour. Change of colour to violet especially at the bottom or basal part of the leaf. Weak growing. Leaves are small, with small surface.</td>
</tr>
<tr>
<td>Potassium</td>
<td>In the leaves are visible wounds, burns, drying and yellowing in the length of edges. The appearance of dark and brown colour in the lamina of the leaf. Such symptoms appear on older leaves. The leaves have a curly appearance, curled from behind, although their burnt ends are turned toward the front side of the lamina.</td>
</tr>
</tbody>
</table>
Fig. 40. Burnings in the leaf edges, appearance of brown colour in the raspberry leaves are signs of a lack of potassium. Such leaves bend towards the backside of lamina, while the parts burned on the surface of the leaf look curled.

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium</td>
<td>Chlorosis in old leaves, especially expressed at veins and at the length of edges. Leaf necrosis is in case of bigger deficit of this element.</td>
</tr>
</tbody>
</table>

Fig. 41. Lack of magnesium is revealed with yellowing of older leaves, starting from edges but expanding to the internal parts of the leaf surface.
<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Leaf tips are dry and shrunken at the edge/ margin of the youngest leaves.</td>
</tr>
<tr>
<td>Sulphur</td>
<td>The leaves colour is green to yellow. It's similar to the lack of nitrogen, but without appearance of red colour. In the later stage of development, in the absence of this element, necrotic areas appear in the leaf lamina.</td>
</tr>
<tr>
<td>Iron</td>
<td>Yellowing and appearance of chlorosis on the length of leaf veins, which is more evident in young leaves, loss of green colour in the rib. In the absence of this element appears larger whitening of lamina and brown areas.</td>
</tr>
</tbody>
</table>

*Fig. 42. Iron deficiency occurs with strong yellowing of leaves and young canes*

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td>Yellowing and chlorosis in the length of leaf veins. Yellowing of the leaf begins near edges and progressively extends to the middle, with a clear delineation. Old leaves remain green in colour or are slightly chlorotic. In the absence of this element appear burns and leaf bending toward the edges.</td>
</tr>
<tr>
<td>Element</td>
<td>Symptoms</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Zinc</td>
<td>Appear short inter-nodes, narrow leaves, withering of the canes and productive parts. In advanced stages appear small leaves, narrowed starting from the tip, shrunken in the curves. But more specific symptoms are &quot;typical rosettes&quot; and smaller leaves.</td>
</tr>
<tr>
<td>Copper</td>
<td>Appearance of the light green colour. Parts near veins get a green light colour. Occurs bleaching of the leaf surface, with a clear delineation with the green colour.</td>
</tr>
<tr>
<td>Bohrium</td>
<td>Shrinking and burning of leaves tips, associated with yellowing and shrinking of edges. Reduction in growth due to the awakening of vegetative growing points. Roots are short, compressed and with dark colour.</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Uniform yellowing of young mature leaves and necrosis in older leaves. The leaf lamina is twisted toward the surface starting from the edges.</td>
</tr>
</tbody>
</table>
4.6.4. Irrigation of raspberries

Cultivation of raspberries requires a considerable amount of water for irrigation, in order to have a rapid growth of this crop and to give a good yield. Lack of water in the fruit development stage as consequence has formation of small sized fruits. The best is to provide the water uniformly throughout the vegetation period. The amount of water necessary for the growth and development of raspberry depends on weather conditions, state of the plant as well as from the growth energy. It was found that the amount of water that should be provided to the crop per day ranges from 0.5-0.8 cm. Raspberries can use the entire amount of water found in the surface layer of soil up to 60 cm depth. The different types of soils are distinguished by water content in the vegetation. Well drained sandy soils can hold water 5 cm, whereas clay soils hold water level up to 10 cm. In general it is assumed that irrigation should begin as soon as 50% of appropriate water is used. With careful assessment of this situation, depending on rainfall and soil type, can appear after 5-10 days.

When it comes to selection of the raspberry irrigation system, the recommended one is the drop irrigation system. This system has several advantages: a small amount of water is needed and its power enables uniform spreading of moisture, does not create conditions for the development of fruit rotting. Disadvantages of this system are: requires a clean water source (in order to avoid blocking of holes), periodic replacement, and the possibility to damage the system during soil cultivation and damages that can be caused by rodents or by people. There are two types of the drop irrigation system:
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- Classic drop irrigation system with pipes having holes drilled in its entire length leaking water without pressure, used in flat plots (type - T)

- Drain system from which water is released in the vicinity of the plant under pressure. This system is used in steep places and aims to a better distribution of water.

In most cases the more widespread is the first type of irrigation system or type T. Various system types are placed in a way that only lie on the surface of the soil, or are covered with earth, or are placed at the height of the first level wire. If the irrigation system is entered in the ground, drains are put at 10 to 20 cm depth, not to damage during tillage.

The need for irrigation can be determined in a very simple way: take up a small amount of earth and try to make it as a grain. Such earth is taken from the depth, where the largest root system of crops is developed that is 15-20 cm.

If when tightening the hand palm the earth sample becomes compact and dense and from it is formed a ball, the moisture content in the soil is sufficient. But if the soil sample at hand after tightening is loose, the amount of moisture in the soil is decreasing, so it is necessary to begin with irrigation.

Time and amount of water to be provided for irrigation can be determined by a tensiometer. Insert into the ground two small samplers, top of the one at 15 cm depth and the top of the other at 30 cm depth. If soil moisture at 15 cm depth falls below 40-45% of field water capacity, it is the time to start with irrigation. For a better orientation, raspberries from flowering stage until the end of harvest require 2.5 - 3.8 cm of water per week, which can be provided by rain or irrigation. Larger quantities of water than 3.8 cm per week are needed in June for the development of fruits. In closed conditions bigger quantities of water are required than in the open field.
Watering of the biennial raspberry cultivars (Willamette, Meeker, etc.) later in the summer and autumn is not recommended, because it hinders full maturation of canes so they are not completely prepared for winter. How much water is needed for irrigation, in general, it can be said that the amount of water needed is the one that will make possible to have the level of humidity of 100% at the soil depth of 60 cm. It should be stressed that the irrigation system is efficient only 75%, so from the irrigation system should be released 3.3 cm, in order to ensure an appropriate amount of moisture in the ground 2.5 cm. Also is not recommended irrigation with fast waters, rather irrigation is done with slow waters so that the soil will absorb the entire amount of water. Irrigation with excessive amounts of water can be harmful, so care should be taken in this regard. This may cause new growths that are very sensitive, soft fruits, which are very sensitive to touching, what hampers their handling. Irrigation with excessive amounts of water as consequence has wash out of nutrients, especially of soluble nitrogen from the area of the plant root system, prevents adequate ventilation, normal growth of roots and enables the appearance of pathogens causing root rotting.

Fig. 43. Irrigation of raspberry with the drop system, type–T.
5. CURRENT RASPBERRY CULTIVARS

**Willamette** - is the leading raspberry cultivar in the US and Canada. It is also well suited for our production conditions. It originates from America, created at the University of Oregon, with the crossing of Newburg and Lloyd George. It belongs to the group of medium early cultivars, with the beginning of fruit ripening in the second half of June.

This cultivar is distinguished by fruits of medium to large size, with average mass 5g, cup-shaped, dark red colour, with sufficient hardness, with pleasant taste and smell.

![Raspberry fruit](image)

*Fig.44. Raspberry fruit*

Fruits are easily harvested. They are suitable for consumption as fresh but also for various processing. The plant has strong growth, but during cultivation can be very lush, forms a large number of canes that should be thinned. Flourishing is average early, it is a self pollinated plant and mainly single productive, but in some years it may productive twice. In the phase of full productivity, with good maintenance, gives a yield of over 10-15 tons per hectare. Cultivar Willamette is ranked among the leading cultivars and is one of the most important cultivars economically.
Cultivar Meeker - is created in the US, while in production was introduced in 1967. It belongs to the group of cultivars with the average late ripening that begins one week later than in case of the cultivar Willamette.

It has big and strong fruits, with a mass of 5.5 g, having a pleasant taste and smell. Fruits can be used as fresh table fruits, but also as raw material for processing and freezing. The plant has strong growth, and compared with Willamette forms a smaller number of canes, but they are lusher. It is recommended for cultivation in flat regions, with a distance between rows 2.5 - 3.0 m. Flourishing is average late, it is self-pollinating and single productive. Gives a high yield of 12-15 t/ha, sometimes the yield is even greater. It is a cultivar resistant to anthracnose (*Didymella applanata*), but is vulnerable to viruses and low temperatures due to the shorter vegetation. The raspberry cultivar Meeker, currently, along with the cultivar Willamette is recommended for cultivation in intensive orchards.

Polka

Polka is regarded as one of the best cultivars of raspberries in recent years. It is created in the same research centre as the cultivar 'Polana'. Its author is one of the most famous breeders of today Dr. Jan Danek from Poland. Fruits have an average weight above 6g! Polka has big fruits with an excellent taste. **Polka provides high and qualitative yield.** Fruits ripen in July and continue until late autumn when the first autumn frosts occur. Higher productivity comes in August.
Harvesting, sorting and packing of the raspberry fruits

Given that ripening isn’t in the same time, harvesting is done continuously and in most cases lasts up to one month.

Ensuring placement, in order to achieve the economic effects depends not only on the fact of extending the period of harvesting of the fruit, but also by the fact that fruits of these crops do not stay for a long time, and require that the fruits are put on the market in the shortest time.

Raspberry fruit harvest starts when the fruit gets the colour of skin that is characteristic for certain cultivars and when they detach easily from the stem of the flower.

![Correct harvesting of raspberry](image)

During the harvest it is necessary to be careful not to press fruits of these trees, while they are collected without the floral crown and without the stem. Harvesting of this tree, depending on climatic conditions, is done every second day while harvesting technique implies removal of fruits, without hurting them, using thumb, index finger and middle finger. To harvest one hectare of raspberry and blackberry 15 pickers are needed who are engaged every day in duration of one month. From this data is possible to understand that out of the total cost for cultivation of this crop, 70-80% goes to harvesting. The most favourable time for harvesting of raspberry fruits are early morning hours and late afternoon hours.
Fruits harvested at high air temperature or during the raining weather, due to undesired chemical processes, quickly rotten and lose the value. Distribution of fruits harvested in the early hours of the morning should be done within the same day, while the fruits harvested in late afternoon the next day. Raspberry fruits placed on the market must belong to these categories:

- **Extra** (fruits of this category necessarily should have the shape, development and colour of the cultivar. Also they should have a uniform size, same shape, good ripening, and characteristic colour of the skin and without the floral cups).

- **Category I** (fruits of this category should be well developed, with a uniform size and degree of ripeness, with deviation 2%, with expressed colour skin that is characteristic of the cultivar. Also among the fruits of this category only 5% can have their floral cup).

- **Category II** (fruits of this category should not necessarily have a uniform ripening, while 10% of them can possess the floral cup).

Raspberry fruit during harvest are packaged in packaging that isn’t heavy, or expensive, but that is suitable for handling. Types of packaging depend on the final use of the fruits harvested. If fruits of these trees are harvested for fresh use they are packaged in boxes 0.5 - 1.0 kg, produced from peeled wood, cardboard with paraffin or plastic box.

Boxes for packing 10 to 15 of them, with appropriate dimensions, can be placed in Dutch crates that are open, shallow, with dimensions 45 x 24 x 7.5 cm, which are more suitable for urban transportation of fruits.
Raspberry fruits used for freezing are packed in wooden or Dutch plastic crates placed in two layers in order to freeze them much easier. Fruits for processing also are packed in Dutch crates or in any packaging suitable for this purpose, while fruits for processing into pulp are packed in plastic barrels, with the use of sulphydryl acid as a tool for conservation.
CULTIVATION OF RASPBERRY

INITIATIVE FOR AGRICULTURAL DEVELOPMENT OF KOSOVO

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