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THE IMPORTANCE OF FIELD PEA IN THE PRODUCTION OF QUALITY ANIMAL FEED RICH IN PROTEINS

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IMPORTANCE OF PEA

Field pea (*Pisum sativum* L. var. *arvense* Poir.) originates from the Middle East and the Mediterranean centre of diversity, from where it quickly spread in all directions, especially in Europe, North Africa and Central Asia. At the same time, field pea is one of the first domesticated plant species with about ten thousand years old archaeological findings in Syria. Along with lentils, broad beans and several species of small grains, pea was one of the earliest crops in Europe, after the last ice age.

Depending on the plant part that is used, there are two types of field pea: forage and protein. Forage pea is characterized by luxuriant canopy; it is cut at the stage of full flowering and first pods formation; and the whole canopy is used. Forage pea can be grown as single crop, or more often intercropped with supporting crop (small grains). On the other side, protein pea, also known as pea used for dry seed, is grown as a single crop and only for mature seed rich in protein.

Winter forage pea is one of the cheapest, high quality and the most profitable aspects of forage production on arable land in different agro-ecological conditions.

Maize silage and alfalfa hay are the basic bulk feed for cattle in Serbia. However, winter forage pea can be more suitable for the specific requests of some production regions in Serbia (acidic soils of central and western Serbia), or requests of smaller producers with intensified crop rotation.

Field pea is a high valued component in nutrition of all species and categories of farm animals, because it has a quality chemical composition of forage dry matter, i.e. it has high content of crude proteins, calcium and stimulating substances, such as vitamin C, while the content of crude cellulose is similar to that of alfalfa.

Winter field pea can be used as green forage, hay, silage, dehydrated food, in form of grain, as concentrated feed, as well as for green manure. Lately, pea has increasingly been used for haylage due to relatively short season, high yields and excellent forage quality.

Differences in physical and chemical quality of alfalfa haylage and forage pea are minimal, which is highly important for uniformity of meals and avoiding changes in micro flora in the animals' rumen. Therefore, our recommendation

is to organise haylage production from winter forage pea mixture on about 20% of areas intended for production of fodder, beside usual production of perennial legumes haylage. NS cultivars of winter forage pea created at the Institute of Field and Vegetable Crops in Novi Sad currently dominate the national market. In such production conditions NS cultivars achieve high yields of green forage (40-60 t/ha) or 8-11 t/ha of hay, balanced and of excellent quality with 18-22% of crude proteins in dry matter. The most frequent cultivars are Kosmaj and NS Pionir because they are high yielding and very resistant to low temperatures and frost.

Pea grain is more often being used as one of the protein components for preparation of protein feed for nutrition of non-ruminants and ruminants as alternative and additional source of plant proteins produced on family farms. Protein pea has lower protein content than soybean, but it compensates it with significantly higher and safer grain yields. Unlike soybean, pea grain is not subjected to heating processing, but it is immediately milled and used as one of the components in concentrate production. In addition to the large number of developed and released cultivars, three cultivars of spring protein pea are currently the most prevalent on the Serbian market: NS-Junior (for mixed usage – forage or grain), Dukat and Partner, which are common peas for grain with high potential of grain yield. The Institute of Field and Vegetable Crops has recently developed one cultivar of winter pea for grain, NS-Mraz, which is very early maturing, uniformly ripening and high yielding.

In addition to the direct benefits for livestock feed production, growing winter field pea as intercrop positively affects large number of agricultural production factors, with special emphasis on the development of sustainable production systems and organic agriculture. Higher ratio of winter field pea types in the production reduces or completely eliminates use of mineral fertilizers and pesticides, which enables production of healthy and safe livestock feed.

Growing field pea is useful for the improvement of physical, chemical and biological characteristics of soil in different ways. Growing field pea as intercrop indirectly increases soil fertility, biogenesis, while compaction of the individual layers of the land is reduced. Field pea as green manure positively affects soil structure, increases infiltration and field water capacity. Timely ploughing in of pea as intercrop in spring improves structure and fertility of soil, and positively affects water and air soil regime.

Field pea leaves significant quantities of nitrogen and organic matter in the soil after the harvest due to symbiosis with N-fixing bacteria (nodule bacteria). Those residues are necessary for the growth and development of succeeding crops, which makes field pea an excellent preceding crop.

Winter field pea shoot in the stage of flowering can be ploughed in between grapevines or fruit trees, which enriches the soil with about 170 kg/ha of pure nitrogen.

BIOLOGICAL TRAITS / GROWING CONDITIONS

Soil requirements - Pea does not have large requirements and can be grown on different types of soil. The most adequate soils are deep, fertile and loose, and well supplied with moisture. Pea root system develops slowly at the initial stages, which makes it more sensitive to the lack of moisture in the soil. The optimum pH of the soil ranges between 6.8 and 7.4. Pea can be grown on acidic soils only after soil liming. Heavy, acidic and salinated soils are not suitable for pea production.

Heat requirements - Pea is a crop of moderate, humid and cool regions, with modest requirements for heat. It germinates and emerges at the temperature of 4-5°C. When the soil temperature is 10°C, emergence occurs in seven days, while lower soil temperatures slower the germination, which in that case can last for 12-20 days. Pea is very resistant toward low temperatures during the whole winter period. It tolerates black frost up to -17°C in short periods without any damages. In addition, it tolerates even significantly lower temperatures under snow cover. Optimum temperatures for intensive plant growth and formation of quality green forage range between 12 and 16°C. Optimum temperatures for flowering range from 16 to 20°C, while the optimum temperature for the grain filling is 16-22°C. High daily temperatures in time of flowering have adverse effects on pea, especially during low relative air humidity. Temperatures above 26°C slow the growth and negatively affect the yields and seed quality, while the crop completely stops growing above 35°C.

Light requirements - Pea is a long-day crop and has high requirements for light. Lack of light prolongs the growing period and slows down plant growth, while shading of the dense canopy of winter pea in spring causes crop lodging. In northern short-day regions peas grow and develop faster. Therefore, early maturing cultivars are less responsive to longer light periods than the late maturing cultivars. Due to long growing period, pea for grain should not be grown in shade in conditions of low light.

Water requirements - Pea has high water requirements. It does not handle drought, but its cultivation is possible in arid agro-ecological conditions due to the well-developed root system. Peas germinate when moisture reaches 110-120% of seed mass. Pea requires plentiful amounts of moisture in all phenological phases of development, especially during bud formation, flowering and fertilisation. The most critical stage for moisture supply begins with bud formation and ends at full flowering. However, excessive moisture causes plant lodging, especially in cultivars of forage pea with luxurious vegetative mass. Optimum soil moisture for achieving high yields is 70-80% of field water capacity. Grain yield can be significantly increased if the crop is watered during flowering and pod formation stages. Winter crops and early spring crops rarely experience water shortage. Growing in the system can be “useful” for the succeeding crop.

Mineral nutrition requirements - Field pea has a relatively short growing season, which is the reason it should have sufficient quantities of available mineral nutrients in the soil. The highest requirements towards nutrients are during the flowering stage and at the beginning of pod formation.

Peas receive a significant portion of nitrogen by fixing molecular nitrogen from the atmosphere by nodule bacteria (up to 70%), while the remaining 30% of mineral nitrogen comes from the soil. Besides nodule bacteria presence, soil reaction between pH 5.6 and 6.0 is required for successful nitrogen fixation. Good supply of moisture and nutrients is also required. Presence of nitrogen in large amounts, especially nitrate, in the area of root system has negative effect on microbiological activity. On the other side, when there is nitrogen deficit in the soil, it is necessary to compensate the lack of this element by fertilization, in order to secure pea plants in initial stages of growth. Growing pea in mixture with small grains requires topdressing with nitrogen fertilizers because of its positive effects on yield and small grains quality.

Phosphorus directly affects yield and quality of pea grain. Phosphorus uptake begins after the appearance of the sixth leaf, reaches its maximum at the stages of flowering and pod formation, and afterwards it significantly decreases until the full ripeness. Phosphorus has a favourable effect on the root growth and development of nodule bacteria; it decreases the harmful effect of the large amounts of nitrogen, which therefore affects yield increase and seed quality. Photosynthetic activity of leaves reduces during phosphorus deficiency in the plant.
After nitrogen, pea crops mostly absorb potassium, which has multiple effects. This element affects particular physiological processes (breathing, photosynthesis,

protein synthesis, etc.), increases plant resistance toward low temperatures and drought. Potassium uptake begins with the appearance of 2-3 leaves, and reaches its maximum at the stage of pod formation. At the beginning of grain filling, the content of potassium rapidly reduces in vegetative organs due to its transfer to the seed.

The amount of nutrients removed from the soil by yield depends on the method of pea utilisation. Forage pea absorbs 30% less nutrients than pea for grain production. Pea removes 5.7 kg of N, 1.0-1.1 kg of P_2O_5 and 1.3 kg of K_2O during formation of 100 kg of seed and 150 kg of straw.

Besides nitrogen, phosphorus and potassium, significant role in the growth and development of pea crops belongs to calcium, magnesium, molybdenum and boron.

MANAGEMENT PRACTICE

Field selection

Field selection is particularly important in growing pea for seed. Specifically, field has to be almost ideally flat due to crop lodging and mechanized harvest. Winter pea is a good preceding crop for all field crops, except for other annual and perennial leguminous crops. Due to symbiosis with root nodule bacteria that are

able to absorb atmospheric nitrogen directly, winter pea leaves behind significant quantities of nitrogen and organic matter in the soil for succeeding crop (average 70 kg/ha N, and maximum up to 17 kg/ha N), which makes it an excellent preceding crop. Yield of wheat which is sown after the peas is higher by 15-20% compared to other preceding crops. After cutting winter peas for haylage, soil remains in favourable structural condition and with sufficient time for doing basic tillage and pre-sowing preparation for succeeding crop, such as forage sorghum, Sudan grass or maize hybrids of early maturity groups under irrigation.

The most favourable preceding crops to the winter forage pea are the crops with growing season that ends in summer or early fall, such as wheat, barley and other small grains or maize and sunflower hybrids with short growing season. In that way there is enough time for quality tillage and sowing by optimum date.

Tillage

Soil preparation for sowing peas must be timely and quality in order to provide moisture accumulation and preservation in the soil, pest and weed control, favourable air regime necessary for life and activity of soil microorganisms. Basic tillage for winter forage pea is performed in the same way as for the winter small grains at the depth of 20 to 25 cm. Soil is additionally crumbled by pre-sowing preparation in the top layer (8-10 cm), and soil must be levelled. Thus, good conditions for quality sowing are created, that will provide timely and uniform emergence. Besides, soils that are well levelled create favourable climate for easy and quality cutting and small losses.

Fertilization

Timely use of mineral fertilizers in appropriate quantities has a great effect on realisation of genetic potential of winter field pea. On chernozem, that is about 45 kg/ha of nitrogen and respectively 60-80 kg/ha of phosphorus and potassium. The best solution is to fertilize with 2/3 of phosphorus and potassium during basic tillage, and the remaining part together with the total amount of nitrogen before sowing.

Sowing

Sowing period - Optimum period for sowing winter field pea is in early October, which enables plants to enter the winter period well prepared with about 10 cm height. Winter cultivars of field pea germinate and form vegetative organs when temperature is 4 to 5°C, which makes them resistant during winter period.

Crop density - JOne of the main preconditions for achieving high yields is optimum crop density, where attention should be payed to possible losses after the sowing, and during germination and emergence. Winter cultivars of forage pea can be grown as single crop or in a mixture with small grains. Quantity of seed for sowing depends on seed size (cultivar trait), crop purpose (forage or seed) and seed use value. In the first case, the required quantity of seed for sowing one hectare is about 150 kg of pea for the cultivar Kosmaj or NS Pionir. This sowing rate achieves appropriate crop density of about 1-1.2 million of well-developed plants per hectare, or a stand of circa 100-120 plants per m2. In the second case, winter field pea is sown together with small grains, mostly with winter cultivars of oats, triticale, wheat, barley or rye. In percentage, it is around 75 to 85% of pea compared to the sowing rate of single crops and 15 to 25% of small grains. Biological requirements and morphological traits of species or cultivars are very important when choosing supporting crops in mixtures. Cultivar that has been chosen as a supporting crop has to be resistant to lodging. In addition, other elements have to be harmonized: duration of growing season, crop height, degree of suppression and tillering. Based on this the optimum sowing rate can be determined. Previous studies on this topic showed that the best supporting crops for peas are oats and wheat, followed by triticale, barley and rye.
Growing field pea in a mixture with small grains is highly beneficial. Mixture provides a balanced livestock feed in terms of quality, contains proteins and carbohydrate components, reduces pea lodging and significantly increases forage yield.

Sowing method - Winter forage pea is sown with wheat seeders, with interrow distance of 12.5 cm and at the depth from 4 to 5 cm. Sowing depth must be uniform so that emergence could be uniformed also, as well as crop ripening. After the sowing, it is recommended to roll the soil, which has favourable effect on rate and uniformity of crop emergence. Rolling should not be performed in conditions of waterlogged sowing layer and rainy fall.

PEA PESTS

Pea weevil – causal agent *Bruchus pisorum* L.

Pea weevil regularly appears in pea crop. Strong infestation can decrease grain yield by 50%, and seed germination up to 75%.

Imago hibernates through the winter in the stored pea grains or in pea grains in the field under the crop residues or tree bark. It forms one generation per year. Females oviposit eggs on young green pods, mostly single or in couples. Larva drills and penetrates the pod, where it spends the whole cycle feeding with grain, and it usually damages the germ, which causes seed to lose germination ability. Weevilled grains are not suitable for human and livestock nutrition.

Pest management: Harvest residues should be ploughed in to destroy infested grains. Avoid sowing near the forests, orchards and storages. It is necessary to perform fumigation when infestation with weevil in pea seeds is suspected.
Chemical treatments are performed when presence of 2-3 imagines is determined after 25 sweeps with net, which is usually during the period when 10% of flowers are open. It is necessary to treat only the edge parts when infestation is not strong,

which therefore stops infestation to spread to the rest of field, and reduces the quantity of insecticide that should be applied.

Aphids – causal agents *Aphididae*

As summer crop, pea is a very favourable host and provides ideal conditions to several aphids: black bean aphid, pea aphid, etc. During the year, aphids form a large number of generations, often more than ten.
They can cause direct and indirect damage by their nutrition. Crops should be regularly controlled, mostly on the edges of the field where aphids are usually initially spotted, in order to detect this pest timely.

When infestation is strong, aphids can stop pod formation by sucking out juices, which decreases the yield. If aphids appear before flowering and pod formation, pea yield can be decreased by more than 60%. In addition, aphids cause indirect damage as virus vectors. During nutrition they transfer the virus from infested to healthy plants.

Pest management: One of the most important cultivation practices that can be performed in order to control abundance of these pests is weed control, because it is the ideal place for mass reproduction of aphids. Pea should be sown on early or late sowing dates, in order to avoid mass infestation. Pea should not be sown near alfalfa and clover fields.

Natural enemies that affect abundance of aphids come from different insect groups. They can be classified into parasitoids and predators. The most common parasitoids of aphids are specialized species from *Braconidae family* – Hymenoptera, which use only this insect group *(Aphididae)* for their growth and development. The most common species of parasitoid wasps that use aphid *A. pisum* as their host are: *Aphidius ervi Hal., A. eadyi Starý, A. picipes* Nees and *Praon barbatum* Mack., where the most abundant species is *A. ervi.*

During the inspection of the crop it is necessary to pay attention to the structure and frequency of natural enemies, because depending on their composition and size, there is a possibility of avoiding the use of chemical control methods. The possibility of spreading the infestation to the rest of the crop is reduced by treating the edge portions of the field, as well as the use of insecticides. Insecticides based on malathion, thiamethoxam, dichlorvos, cypermethrin, dimethoate and others can be used for the control of aphids.

Plant Village-Aphididae

Feeding larvae pea weevil

Ascochyta-Symptoms in the pod

Ascochyta-a symptom of the tree and leaves

Pea powdery mildew-*Erysiphie pisi*

Pea downy mildew -*Peronospora viciae*

Photography autors:
Dalibor Živanov i Filip Franeta

Pea thrips – causal agent *Kakothrips robustus* Uzel.

During May and June, larval stages of the pea thrips damage top parts of the crop, buds, flowers and pods, and cause deformities of generative organs. Warm weather during June is very favourable for the reproduction and development, while heavy rains and cool weather in the same period can reduce pea thrips abundance.

Clover weevils – causal agent *Sitona spp.*

Clover weevils are oligophagous insects from the order of beetles that use leguminous crops for their nutrition. They are harmful as larvae, when living underground and feeding with root and root nodules, as well as imagines feeding with pea leaves. When the infestation is strong, during warm and dry weather - which is the time of clover weevil occurrence, all the leaves get bitten. At that period, crop emergence and fields with young plants are especially threatened. Control is performed by application of different pyrethroids.

Leaf mining flies – causal agents *Liriomyza spp.* and *Chromatomyia spp.*

Leaf mining flies in larval stages cause damage by feeding with leaf mesophyll, while not damaging the cuticle. Products of such diet are so-called “mines” on crop leaves.

Pea midge – causal agent *Contarinia pisi* (Winnertz)

Pea midge attacks and damages leguminous crops. It is harmful while in larval stage, because it feeds with flower buds that later fall out or produce stunted pods. This species rarely occurs abundantly in Serbia.

PEA DISEASES

Ascochyta disease – causal agent *Ascochyta spp.*

Ascochyta blights are a complex disease caused by three fungi: *Ascochyta pisi* Lib., *Ascochyta pinodes* (Berk. and Blox.) Jones, (sexual stage: *Mycosphaerella pinodes* (Berk. and Blox) and *Ascochyta pinodella* (synonym: *Phoma medicaginis var. pinodella* (L.K. Jones) Boerema). Of the three fungi, *A. pinodes* is of the most importance, because it can reduce the yield by 50-75%.

In Serbia, Ascochyta blights are included in economically important pathogens both in field and confectionery pea. The disease infects leaves, stalk, pods and seed. Characteristic symptoms can be detected on pods in the form of dark spots, up to 1 cm in diameter, with mycelia inside that destroy the tissue. Mycelia penetrate deep, thus infecting the seed, so that such seeds lose their germination and become unusable. Diseased seedlings are formed from such seeds, and soon they die.

Control: Basic cultivation practices in controlling this disease include: sowing certified seed, use of tolerant cultivars, three-year crop rotation, ploughing in harvest residues, disinfection of seed by fungicides, and manipulation with sowing dates. Registered fungicides in Serbia are based on ziram. Application of these fungicides is recommended after the occurrence of the very first symptoms.

Species *Chaetomium globosum* Kunze is the most destructive antagonist to this fungi. Application of these fungi reduces the abundance of Ascochyta pisi germinating pycnospores by 70%. In addition, one of the management practices in organic production of field pea is growing peas intercropped with small grains. Intercropping field pea with oats in ratio 50:50 can reduce the intensity of the disease by 19-45%.

Pea powdery mildew – causal agent *Erysiphe pisi* DC.

This is an important parasite in moderate climate conditions and regions where pea matures in summer. Favourable conditions for pathogen development are cool and wet nights, with optimum day temperatures of 20°C. In favourable agro-ecological conditions, powdery mildew decreases yield by 25-50%.

White fluffy mycelium develops on the surface of the infected tissue. At the beginning, mycelia infect particular parts of the plant, and later spread to all parts of the shoot. Tissue beneath the mycelia changes colour from purple to completely dark, causing its complete deterioration. At the end of the growing season, spherical cleistothecia form on the infected parts of crop. E. pisi is kept alive by cleistothecia on harvest residues or by mycelia on the infected crops.

Control: Sow certified seeds, grow resistant cultivars, rotate crops, sow pea early, and control the weeds. There are no officially registered fungicides against this disease in Serbia, but preparations based on tebuconazole, propiconazole, and others can be used for this purpose. Fungicides should be applied when infection degree per single crop is less than 5%.

Pea downy mildew – causal agent Peronospora viciae (Berk.) Casp. f. sp. pisi Sydow

Downy mildew symptoms on pea can be both systemic and local. Systemic infection occurs by sowing infected seed. Infected seedlings are stunted, deformed, while leaves are chlorotic and covered with mycelial cover. The sources of primary inoculum are oospores that can keep their vitality in the soil for 10-15 years. Secondary infections during growing period occur by conidia that spread locally by drops of rain or over long distances by air flow. Local infection is manifested as chlorotic spot that is bordered by leaf nervature. Strong infection can affect leaf petiole, stem and tendrils, while the final outcome may be drying out of the whole plants. Strong dews increase sporulation, while heavy rains rinse spores from plants. Additionally, infection deteriorates growth. Losses in yield and quality occur as the result of infection severity, when the whole plant is covered with grey mycelia. Oospores usually form on pea pods when favourable conditions for pathogen development have passed.

Control: Use certified seed, grow resistant cultivars, sow in wide rows to provide better aeration of the crop, do not sow in late fall, and rotate crops. One of the recommended cultivation practices is seed fungicide treatment. Phytosanitary measures, such as destruction of infected crop residues and their ploughing in are beneficial for inoculum reduction for the following year. Fungicides should be applied on leaves only when it is inevitable, because not only it is very expensive, but there is also a risk of resistance development within pathogen population. There are no officially registered fungicides against this disease in Serbia, but preparations based on metalaxyl, mancozeb and propineb can be applied for this purpose.

Pea rust – causal agent U. pisi (Pers.) Wint. and U. viciae – fabae (Pers.) J. Schröt (sin. Uromyces fabae Pers. de Bary)

Pea rust became important pathogen on peas in the mid-eighties, especially in regions with warm and wet climate. Causal agents of pea rust are *Uromyces viciae-fabae* (syn. *U. fabae*) (Pers.) J. Schröt and *U. pisi* (Pers.) Wint.

Rust occurs frequently in Serbia. In favourable years, it can cause yield reduction by 30%. The greatest damages occur on seed pea, because it is harvested in late spring. Symptoms are manifested on the whole shoot. The very first uredospore is detected on lower leaves when the plant is 10-20 cm high. Later, characteristic symptoms such as rusty powder mass of uredospore occur on leaves. Infected leaves wither and fall off, while pods have delayed growth, and grains do not form.

It survives through the winter in crop residues in form of teliospores and on rhizomes of milkweed in form of mycelium.

Control: Grow resistant cultivars, plough in crop residues, control the weed (as secondary host), remove transitional host, and rotate crops. Apply fungicides right after the occurrence of the first symptoms. There are no officially registered fungicides against this disease in Serbia, but in case of infection preparations based on difenoconazole can be applied.

Weed control

First herbicide treatment based on pendimethalin should be performed after the sowing, and before crop and weed emergence. Later, if there is a need for correctional treatments against grass and broadleaf weeds, herbicides based on clethodim or fluazifop-p-butyl can be used for grass weeds, and imazamox and bentazon based herbicides for broadleaf weed. It is necessary to seek expert advice before any use of herbicides in order to prevent unwanted mistakes.

CUTTING FORAGE PEA

Time of cutting pea depends on its use and purpose. If winter forage pea is used for green forage, it should be cut at the stage of full flowering and first pods formation. If winter field pea is used for dairy cows haylage, single or in mixture with small grains, it should be cut at the stage of full bud formation and the beginning of pea flowering, when it has the highest content of proteins. For nutrition of beef cattle, winter field pea is cut somewhat later, at the stage of flowering (from the middle to the end of full flowering), but before ear formation of small grains, thus achieving high yields and satisfactory quality.

Winter cultivars of forage pea achieve stable yields ranging from 45 t/ha to 55 t/ha of green forage, that is between 9 t/ha and 11 t/ha of hay, and with about 20% of crude proteins in the dry matter of forage.

If winter pea is cut in optimum date, in average agro-ecological conditions of Serbia, it is possible to produce another 60 t/ha of green forage from Sudan grass or sorghum at the same field. In that way, total annual yield of about 120 t/ha of green forage can be achieved. This method of production reduces costs of nutrition in livestock breeding, and in extremely dry conditions it can affect stability of livestock feed production through two crops.

HARVEST OF PROTEIN PEA

Harvest of protein pea is the most complex cultivation practice in the production technology of this species. In order to reduce the losses to a minimum, the following should be considered: crop condition, weather conditions at the time of harvest, adjusting the harvester, and the harvest itself.

Losses and damages are minimal if the harvest is performed timely, with optimum seed moisture. Winter protein pea matures relatively fast and when the grain moisture content is about 40%, plants still have green leaves. From that moment, moisture content suddenly drops to 15-17% in short time, which is considered optimum for the beginning of harvest. The highest moisture content in the grain is about 18%, when quality mechanized harvest of pea is possible. If the harvest is performed later, with very low moisture content (lower than 13%), grain losses are higher due to mechanical damages caused by rotary working organs of the harvester.

Pea is harvested using wheat harvesters, with specific adjustments that are similar to those made for soybean harvest. Adjusting the header requires special care, considering that the height of cut should be set to around 5 cm from the soil surface. If the height of cut is higher than 5 cm, the pods of lower nodes stay on the plant, and the plants that are at the bottom of wheel tracks remain unharvested. On the other side, when height of cut is lower than 5 cm, particular quantity of soil enters the harvester together with the plants. Lifters should be put on header when there are lodged crops in order to collect all the plants that are lodged. Revolution rate of winch should be regulated, or reduced, so it does not damage the pods and disperse the seeds or grains. Rotation speed of the winch should be only slightly greater than the speed of a combine, and it usually ranges between 3.0 and 3.6 km/h, or 5-6 km/h in optimum conditions (less lodged plants and lower weed infestation). Worm conveyor should have fewer rotations in order to avoid grain breakage with increase of backlash between the threshing drum and threshing concave. Rotation speed of the threshing drum is from 12 to 15 m/s (approximately 500-550 rotations per minute). Backlash between the threshing drum and threshing concave should be 15-20 mm at the input, and 8-10 mm at the output. Sieve is adjusted based on 1,000 grain weight. Strength of wind-flaw is very important, and it is set not to eject shrivelled grains with small straw and chaff, and depends on the weight of the shrivelled grains.

Problems during harvest usually occur when crops are lodged, which is the reason header raise more impurities while lifting the crops. In addition, uneven maturing and occurrence of late weed can also cause problems during harvest. Unfavourable weather conditions (a large amount of precipitation, wind, high temperatures) at the time of harvest lead to significant mechanical damages of the grain, as well as to the increased percentage of grains infected with fungi. In addition, pods crack and grain is dispersed, and altogether cause decrease in yield and quality of grain. Postponing harvest for just three days can decrease pea yield by as much as 30%.

It is very important to note that winter protein pea is harvested 7-10 days before the harvest of winter barley, which gives producers the opportunity for gradual harvest of pea, barley, and wheat at the end.

Winter pea grain yields in agro-ecological conditions of Serbia range from 4 to 6 t/ha, depending on cultivar and growing conditions.

Grain should be cleaned of impurities and additionally dried, so that grains contain 13% of moisture. If pea is about to be stored for a long period, it is necessary to fumigate against pea weevil.

USE OF FIELD PEA

Field pea is a high protein crop suitable for growing for livestock feed in different manners: green forage, hay, haylage, silage, for dehydration, and as dry grain.

Green forage - This is the most economical field pea utilisation with the smallest losses. At the same time, this manner of field pea utilisation, especially if it is a large mass, is not suitable for long preservation, which significantly decreases its time of exploitation. Yield and nutritional value of green forage significantly depend on cutting periods. The most intense period of dry matter and protein accumulation is at the stage of pod formation and grain filling. Pea reaches its maximum yield of green forage and protein at the stage of grain filling in grains of medium pods, wherein pods of bottom floors turn yellow, while top pods start the grain filling.

Hay - Field pea is suitable for making hay, if it is cut before the beginning of grain filling. In order to prevent pea lodging and provide balanced nutrients, pea should be grown in a mixture with small grains that have higher content of dry matter. In that way, better conditions for drying are provided. In that case, cutting is performed from the middle to the full flowering, but before ear emergence of the small grains. Making hay from field pea is rarely used, compared to the other forms of conserved bulk fodder, considering the fact that pea is a nutrient with the most variable chemical composition and nutritive value. Due to their significant effect, weather conditions can lead to great losses in yield and quality of forage. A high content of moisture is the largest problem in drying field pea, so 6-8 days are needed to make the hay. Besides, significant barrier for making hay in agro-ecological conditions of Serbia is frequent rain during May, at the time of field pea cutting.

Need for dehydration of green forage occurs in some cases. Therefore, pea flour is made with quality same as the quality of alfalfa flour.

Haylage - Haylage of forage pea is one of the recent methods of forage conservation. Making haylage from peas is a suitable way of preparing livestock feed, compared to making hay and silage due to fewer mechanical damages, preserved leaf and unchanged chemical composition. Cut green mass must wither until the moisture content is about 50%. After that, withered mass should be chopped and compressed with an aim of air extrusion and creation of anaerobic conditions. In that way, it is harder for bacteria and fungi to infect the organic matter. Forage prepared by this method keeps freshness, and the leaf, as main protein source, is preserved in the whole. Significantly fewer organic acids are formed

(especially milk and acetic acid) in the process of haylage preparation. Related to that, pH value of haylage remains at a very high level. Less acidity, that is higher pH value of haylage compared to silage, enables its use in the quantities as basic nutrient for all categories of ruminants. Due to all of the above-mentioned, cattle eagerly eat pea haylage, better than many other forage feed. About 30% more of dry matter is achieved with haylage production of winter forage pea per area unit (22-25 t/ha of haylage), than in hay preparation. The process of making haylage is less dependent on weather conditions, because 3-4 times less time is needed for withering cut mass, than for hay drying. Process of haylage production is suitable for complete mechanisation.

Silage - Field pea forage from single cropping is not suitable for making silage due to low sugar content and high buffer potential, which can be compensated by growing peas in a mixture with small grains. Pea is used for silage when 2/3 of pods are formed, and small grains complete their ear formation, in order to achieve the highest possible content of dry matter. Silage production of field pea forage is performed with an addition of different chemical preservatives and nutrients rich in carbohydrates. Silage of green pea grain with an addition of sodium metabisulfite (Na2S2O5), fresh whey and maize wholemeal is characterized by the content of crude proteins of about 10%, and environment reaction of about 4.5-5.0, which is a favourable solution for the preservation of nutrients of field pea until the moment of use.

Dry grain - One of the greatest benefits of growing field pea compared to other annual forage crops is very low content of toxic matters in the grain, which enables its grain to be used in a diet of farm animals immediately after the harvest, which makes a family farm independent from the processing industry.

Pea for dry grain is an excellent source of plant proteins (23-27%) and can significantly compensate protein deficit of plant origin for the needs of livestock production. Digestibility of the grain is extremely high, which includes pea among grainy fodder with the highest digestibility. Pea grain is rich in methionine, one of the most important amino acids in the nutrition of farm animals, while the content of lysine is high as well, which gives additional nutritive value to the pea. Milled pea grain in concentrate meals can be in different ratios, which depends on the species and categories of farm animals – 15% for hens, more than 15% for pigs, up to 30% for fattening pigs, 2.0-2.5 kg daily for beef cattle and 3.5-4.0 kg daily for dairy cows.

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