

# The ecophysiological needs of plums and their impact on ecological production of plum in Bosnia and Herzegovina

## Abstract

Organic farming takes up more and more areas in agricultural production. It is based on the principles of preserving human and animal health and maintaining the balance in agrobiocenosis and therefore prohibits the use of a majority of water-soluble mineral fertilizers and phytopharmaceuticals of chemical origin (except those from the list of allowed products). In ecological farming of plums, optimization of fertilization is very important, which must comply with ecological principles and regulations which included fertilization with a relatively narrow range of allowed organic fertilizers (manure, compost, manure, slurry, peat, guano, sawdust) and mineral additives (calcium carbonate, crude phosphates, basic slag, raw potassium salt, potassium sulphate, gypsum, wood ash, calcium chloride, sodium chloride, etc.).

Nutrition methods in organic plum production is different from nutrition in conventional production, primarily due to limited selection of available fertilizers, and the most important difference is the inability to use water soluble individual and complex fertilizers. It is precisely for this reason that in organic agriculture, the emphasis on maintaining humidity, optimum pH and soil moisture is considerably more important than necessary prerequisites for sufficient availability of nutrients in the soil.

Keywords: Ecological plum production, fertilization optimization, keeping humidity, organic fertilizers.

## 1. INTRODUCTION

Plum in Bosnia and Herzegovina is a national fruit. In the last century, ex-Yugoslavia was one of the largest plum producers with 18% of world production, but over time, plum lost the economic importance it once had. Nevertheless, it is today the most widespread fruit culture on the territory of Bosnia and Herzegovina. According to the National Directorate of Statistics (2006), in Bosnia and Herzegovina there are 10.9 million plum trees with an average yield of 9.3-9.5 kg per tree. The fruit of plum is rich in vitamins and abundance of minerals, pectin and organic acids, and occupies a very important place in human nutrition. It is a good antioxidant, and its anthocyanins can provide human protection against oxidative stress. Fruit plums contain 75 to 87% water and 13 to 25% dry matter. The taste of the fruit depends on ratio of sugar and organic acids. In the fruit of the plum predominates glucose, while it is less fructose. Among the acids most are malic and citric. The total amount of organic acids expressed as malic acid ranges from 0.39 to 2.28%. The percentage of acids and sugars varies with the same variety, depending on climatic and soil conditions. In the mature fruit of plums the pH value ranges from 3.3 to 3.6.

The fleshy part of the plum of the plum contains up to 0.69% of pectic substances, which are important in the technology of jellies, marmalades and similar products. Nitrogenous substances participate in the chemical composition of the fruit with 0.6 to 0.8% (amino acids, amides, ammonia compounds and nitrogen bases), and minerals with only 0.5%. Of the mineral substances, the highest is potassium (54.59%) and phosphorus (17.7%). Plum fruit contain large amounts of fat (Mitrović Olga et al., 2009).

Bosnia and Herzegovina fulfills the basic geographical and climatic precondition for plum cultivation, and the remaining attention is paid to the technology of breeding, and most of the nutrition and protection of plums. The plum lives and yields on the same land for 30-50 years, and in some cases even longer. Through this relatively long period, plum with its root system from the soil, take out large amounts of nutrients are available in the form that are necessary for the growth and development of vegetative and generative organs. Particular accent is given to the high yielding as a necessary factor for the production process. A very important factor of cost-effective production is the maintenance of soil fertility, but sometimes the soil does not have the optimal amount of nutrients for the plant, so it is necessary to provide agricultural land with the help of agro-technical measures by fertilizing the nutrients in the soil or plant nutrients by foliar application.

The repair of chemical, physical and biological characteristics of the land should be done by the analysis of the soil, in compliance with the rules of the agronomic profession in accordance with modern plum cultivation technologies. Applying modern knowledge about plum cultivation technology, while adhering to already known principles of sustainable agricultural production and processing technology, plums can result in growing plum production and revitalizing the status of an economically significant culture. A study of agroecological and technological characteristics of production with the

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61 soil conditioning plan and fertilization plan prior to planting and the fertilization plan for the future plum  
62 planting, significantly contributes to the sustainable ecological production of plums in Bosnia and  
63 Herzegovina, which could quantitatively and qualitatively realize the great potential of placing on the  
64 market of organic products.

65 Organic production is a complete food production management system that combines the best  
66 ecological practices, a high degree of biodiversity, the conservation of natural resources, the  
67 application of high animal welfare standards and the way of production in line with consumer  
68 expectations, using natural substances and processes. Organic production has a dual social role. On  
69 the one hand, it provides public goods that contribute to the protection of the environment and animal  
70 welfare, and on the other, contributes to the development of rural areas (EC Regulation 834/2007).  
71 Organic agriculture is a specific agricultural production system that represents a systematic and  
72 comprehensive approach to sustainable survival, taking into account factors that influence sustainable  
73 development and vulnerability at the physical, economic and socio-cultural level (Eyhorn, 2007).  
74 Therefore, organic production can significantly contribute to the development of rural communities  
75 (Lobley et al., 2005; El-Hage Scialabba and Hattam, 2002; Eyhorn, 2007).

76 At the same time, organic food can respond to increasingly lucrative consumer demands for healthy,  
77 quality and safe food, whose production will not impair water and soil quality, biodiversity and animal  
78 welfare. Therefore, it is classified as a higher quality food. According to Little and Frost (2008), the  
79 main elements of organic production systems are:

- 80 • Good soil management leading to good fertility, maintaining high content of organic matter, high  
81 microbiological activity and good land structure,
- 82 • Well-designed crop rotation that are important for balanced crop nutrition, weed control and  
83 minimize disease and pest problems,
- 84 • Preventive, not chemical, approach to controlling weeds, diseases and pests,
- 85 • Profitable contribution of organic cover crops and livestock.

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## 89 2. MATERIAL AND METHODS

91 For this work the data of the Federal Hydrometeorological Institute of BiH were used for: temperature,  
92 precipitation and insolation for 2017. Data were processed for the whole of BiH, but the accent was  
93 placed on the territory of the Tuzla Canton. For temperature it is described average air temperatures,  
94 average annual temperatures, temperature deviations and based on this is given a conclusion on  
95 whether and how much it affects plum cultivation. According to the distribution of percentile, rainfall  
96 conditions in 2017 were classified into categories (10-25 percentiles), normal (26-74 percentiles), rain  
97 (75-90 percentiles) and very rainy (> 98 percentile). Months with the highest precipitation are shown,  
98 as are the months with the least amount of precipitation and extreme values. Measured both the  
99 number of hours of sunshine and the number of sunny days. On the basis of the obtained data from  
100 the Federal Hydrometeorological Institute as well as the soil conditions in BiH and the Tuzla Canton  
101 area, the state and possibilities of ecological production of plums in BiH as well as the orientational  
102 standards of fertilization of plums in organic farming are taken into consideration in the principles of  
103 ecological agriculture. A study for nutrient requirements in the production of plums was made on the  
104 basis of literature and source data.

## 105 3. RESULTS AND DISCUSSION

### 106 3.1. Temperature

108 During deep winter hibernation plum tolerate absolute minimum temperatures even below -30 ° C. In  
109 the opening phase of the flower buds, the flowers can be damaged at -1 ° C to -5 ° C, and in the full  
110 flowering phase, frost is expected at temperatures from -0.5 ° C to -2.2 ° C. As with other fruiting  
111 species, small fruits are still sensitive, and they suffer at temperatures of -0.5 ° C to -2 ° C. The quality  
112 of the fruit most depends on the average temperature during June, July and August. If the average  
113 temperatures are 18 - 20 ° C these months then these areas are excellent for the production of plums  
114 (Ivo Krpina et al., 2004). Average annual air temperatures in 2017 were considerably above the  
115 standard normal value (1961-1990) throughout the observed territory of Bosnia and Herzegovina. The  
116 average air temperatures ranged between 10.4 ° C in Bugojno and 16.0 ° C in Mostar, on the  
117 mountains between 1.8 ° C on Bjelašnica and 8.2 ° C on Ivan Sedlo. Temperature deviations ranged  
118 from 0.6 ° C to Bjelašnica to 2.1 ° C in Gradačac (Table 1.). The spatial distribution of average annual  
119 temperatures in Bosnia and Herzegovina is shown in Figure 1. As for temperature conditions in  
120 Bosnia and Herzegovina, we can conclude that the average temperatures do not indicate bigger

121 problems for plums or deviations of 0.6 ° C on Bjelašnica to 2, 5 ° C in Gradacac are not a major  
 122 problem in the plum production.  
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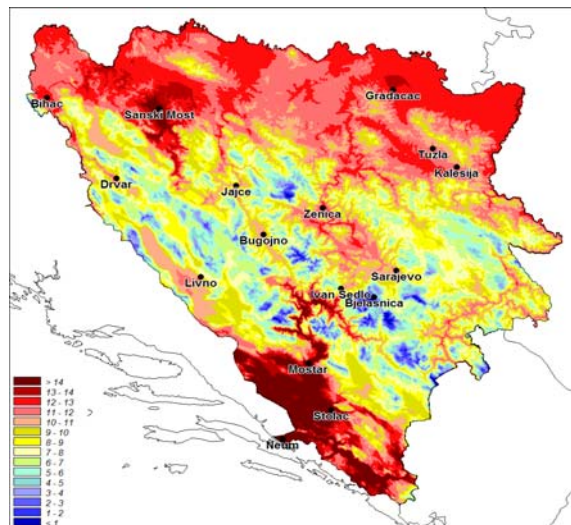


Figure 1. Spatial distribution of average air temperature

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**Table 1. The deviation of the average annual air temperature related to the climatic standard normal and the associated percentiles**

STATION	ANOMALY	PERCENTILES	STATION	ANOMALY	PERCENTILES
BIHAĆ	1.8	100	Livno	1.3	100
BJELAŠNICA	0.6	91	Mostar	1.5	100
BUGOJNO	1.6	100	Neum	///	///
DRVAR	1.4	100	Sanski Most	1.6	100
GRADAČAC	2.1	100	Sarajevo	1.4	100
IVAN SEDLO	1.0	99	Stolac	1.2	100
JAJCE	1.1	100	Tuzla	1.5	100
KALESIJA	1.5	100	Zenica	1.7	100

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### 3.2. Precipitation

For the cultivation of plums, the annual amount of precipitation, as well as their distribution during the year, are a very important factor. For normal growth, development and fruiting of the plum it is necessary that the soil be sufficiently humid during the entire vegetation period. Most plum varieties are best managed in regions with an annual rainfall of 700 to 1000 mm (with a fall of 350-600 mm in the vegetation period) and relative humidity of 75-85% (Mišić, 2006). The critical boundary for plum cultivation is 600 mm precipitation per year. However, the amount of this quantity depends on several factors, primarily on the layout of precipitation, soil properties, temperatures in the course of vegetation, etc. (Ivo Krpina et al., Voćarstvo, Zagreb, 2004). In BiH, in the so-called plum area (areas where there is a tradition of plum cultivation in which favorable agronomic conditions for plum cultivation such as Gradačac, Čelić, Srebrenik, etc.) fall more than 800 mm of precipitation. The analysis of annual rainfall amounts expressed in % of the average values shows that in 2017, deviations in relation to the perennial average (1961-1990) ranged between 83.7% in Mostar and 116.2% in Bihac. Total rainfall in 2017 was in the range of 825.4 mm at the meteorological station Gradačac to 1522.6 mm at the meteorological station Bihac (Table 2).

**Table 2. The deviation of the average precipitation sum related to the climatic standard normal and the associated percentiles**

STATION	ANOMALY	PERCENTILES	STATION	ANOMALY	PERCENTILES
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BIHAĆ	116.2	89	Livno	92.2	33
BJELAŠNICA	108.7	58	Mostar	83.7	17
BUGOJNO	110.1	74	Neum	///	///
DRVAR	94.2	38	Sanski Most	107.5	70
GRADAČAC	94.3	32	Sarajevo	100.6	47
IVAN SEDLO	94.8	38	Stolac	80.0	12
JAJCE	107.8	60	Tuzla	113.1	94
KALESIJA	139.5	90	Zenica	113.0	87

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152 December and September were the months with the highest rainfall in 2017, while August was the  
153 month with the smallest amount. At the meteorological station Mostar in August, 4.8 mm of  
154 precipitation was measured, while in Bihać in September it was measured 335.0 mm, which is the  
155 largest monthly sum in 2017 at one station. In the inhabited areas, the highest height of the snow  
156 cover was measured in Bihać 54 cm (18.01.), While in the mountainous areas (Bjelašnica) 113 cm  
157 (11.03.) Was recorded.

158 The number of precipitation days  $\geq 1.0$  mm in 2017 ranged from 76 in Mostar to 131 days at the Ivan  
159 Sedlo meteorological station. Most days with rainfall  $\geq 1.0$  mm was registered in December and April  
160 and at least in August. Most days with precipitation  $\geq 10.0$  mm were recorded at the weather station  
161 Ivan Sedlo (48), and at least at the meteorological station Gradačac (26). In September, most days  
162 were recorded with precipitation  $\geq 10.0$  mm, and in August on most station there were no precipitation  
163 days  $\geq 10.0$  mm. As for Tuzla, there were 96 days with precipitation  $\geq 1.0$  mm, with precipitation  $\geq 10$   
164 mm 35 days and precipitation  $\geq 20$  mm for 16 days. (Federal Hydrometeorological Institute of BiH)  
165 (Table 3).  
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170 **Table 3. Number of days with characteristic rainfall, snow cover and maximum snow cover**  
171 **height**  
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PADAVINE	$\geq 1.0$ MM	$\geq 10.0$ MM	$\geq 20.0$ MM	NUMBER OF DAYS > 1 CM	MAX HEIGHT
STATION	2017. number of days	2017. number of days	2017. number of days	2017. number of days	cm
SARAJEVO	113	30	15	70	39
MOSTAR	76	40	22	0	0
BIHAĆ	110	45	26	45	54
TUZLA	96	35	16	49	26
BJELAŠNICA	128	37	17	211	113

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### 176 3.3. Insolation

177 The number of hours of sunshine (insolation) in 2017 was higher in all analyzed stations compared to  
178 the thirty year average (1961-1990). Less hours of sunshine (1986) were recorded at the  
179 meteorological station Bjelašnica, which is 342 hours more sunshine than the perennial average.  
180 Most hours (2694) were recorded at the meteorological station Mostar, or 340 hours more sunshine  
181 from the perennial averages (Figure 2). The largest deviation was recorded at the meteorological  
182 station Bihać, where during 2017 there were 590 hours of sunshine more than average. The lowest  
183 deviation of the sunshine relative to the perennial average was recorded in Mostar (Table 4).

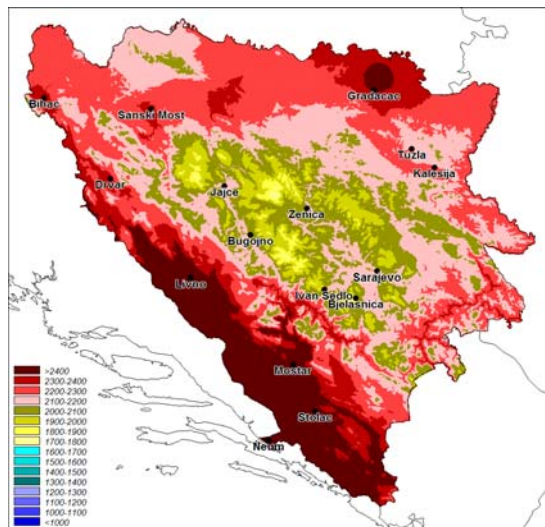


Figure 2. Spatial distribution of insolation (h) in 2017

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186 The most pronounced monthly positive deviation of the sunshine expressed in% of the average  
 187 values relative to the reference series (1961-1990) was registered in January at the meteorological  
 188 station Sarajevo. The number of hours of sunshine at the meteorological stations in Sarajevo was  
 189 198% higher than the average, and 113 hours of sunshine were recorded. The most pronounced  
 190 monthly negative deviation of the sunshine was recorded in December at the meteorological station  
 191 Bjelašnica. Bjelašnica recorded 60 hours of sunshine, which amounts to about 72% of the average  
 192 value.

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Table 4. Number of hours of sunshine in 2017

STATION	NUMBER OF HOURS OF SUNSHINE COMPARED TO PERENNIAL AVERAGES
MOSTAR	340 hours more compared to perennial averages
BIHAĆ	590 hours more compared to perennial averages
BJELAŠNICA	342 hours more compared to perennial averages

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195 Regarding the meteorological data for Bosnia and Herzegovina, they are not a major problem for the  
 196 cultivation of plums. From the data we see that the temperature, precipitation and sunshine  
 197 correspond to the ephophysiological needs of the plum. Problems occur in droughty years or in years  
 198 when precipitation is increased.

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### 3.4. Necessary amounts and concentrations of nutrients in plum production

200 For normal life of the plums, as well as other green plants, 17 biogenic elements are necessary  
 201 (Nešković et al., 2003). Biogenic macroelements plants are adopt and accumulate in large quantities,  
 202 and other biogenic elements (Fe, B, Zn, Mn, Mo, Cu, Cl, Ni), i.e. microelements are used in smaller  
 203 quantities. Biogenic macroelements primarily are used as building materials, and biogenic  
 204 microelements as biocatalysts in the plant. Plum tree is supplied with carbon, hydrogen and partly  
 205 oxygen from the air, while other biogenic elements come from the soil. However, the above-ground  
 206 organs of the plant, especially the leaf, can absorb biogenic elements with the so-called leaf nutrition.  
 207 In this way, plant can adopt the necessary nutrients. Plum leaves are the richest mineral plants  
 208 organs, followed by buds and fruits (Table 5 and 6).

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Table 5. Quantities of macroelements expressed in% of dry matter in various plum organs (Sarić, 1975. I Childers, 1969.)

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NUTRITION	FRUIT	LEAF	SPROUT	BUDWOOD	TREE AND BRANCHES	ROOT
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N %	0,71-1,20	1,80-2,10	0,43	0,97	0,37	0,34
P <sub>2</sub> O <sub>5</sub> %	0,22-0,30	0,33-0,60	0,10	0,27	0,09	0,10
K <sub>2</sub> O %	1,41-2,27	1,80-3,00	0,23	0,43	0,21	0,21
CAO %	0,11	2,80-5,60	0,84	2,31	0,63	0,59

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**Table 6. Optimal quantities of biogenic elements in normal plum leaves (in mg per kg of dry substance) in August (Childers, 1966.; Westwood, 1978.; Faust, 1989.)**

ELEMENT	CHILDERS (1966.)	WESTWOOD (1978.)	FAUST (1989.)
N	25.300-30.000	22.000	25.000
K	8.400-46.600	14.000	25.000
CA	27.800-51.600	10.000	25.000
P	550-770	1.200	2.000
MG	26.900-29.400	2.400	4.000
S	2.200-4.700	-	-
FE	-	50	120
MN	53-93	25	50
ZN	-	18	30
B	33	35	35
CU	7-10	4	10

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220 The amount of biogenic elements in the normal plum leaves (Table 6) ranges from 4 mg for copper to  
221 51,600 mg per kilogram of dry calcium. For normal growth and fruiting, the same amount of copper is  
222 as important as 12,900 times more calcium. The plum root receives mineral matter dissolved in water  
223 in the form of ions (anions and cations) by diffusion, osmosis and contact ion exchange. The  
224 absorption and content of mineral substances are influenced by: the selective permeability of  
225 protoplasm in the absorption root zone, temperature, pH, antagonism and synergism between anion  
226 and cation, aeration, stage of individual plant development, phenofase in the annual plum cycle, and  
227 the organ of the plant receiving mineral substances. When the concentration of nutrients is above the  
228 level of good supply, there is no need for fertilization to increase availability, as economically justified  
229 results will not be obtained. In that sense it is very important to interpret the results of soil analysis  
230 well.

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### 232 3.5. Organic fertilization and soil

233 Some studies (Blanco-Canqui et al., 2017, Hondebrink et al., 2017, Shah et al., 2017) show that eco-  
234 systems of plant production function normally or in some aspects even better than conventional  
235 systems involving the use herbicides and other agrochemicals. The necessary soil stability in  
236 ecological agroecosystems is improved by the addition of organic matter through organic manure,  
237 compost, green manure, organic by-products on organic farms and well-designed crop rotation, that  
238 largely involve the sowing of cover crops and shamrock. The above mentioned agro-technical  
239 measures in practice mitigate the negative effects of soil treatment on the structure and quantity of  
240 organic matter, i.e. humus. Yagodin (1984) states that the continuous application of solid organic  
241 fertilizers improves the chemical properties of soil, increases the humus content, microbiological  
242 activity, and there is also a positive influence on water-air relations in the soil. Furthermore, the  
243 capacity to replace the bases and the saturation level of the adsorption complex with bases (Ca, Mg,  
244 K) increases, while the acidity slowly decreases, as is the amount of mobile Al, Fe and Mn. Butorac  
245 and Sar (1988) point out that the application of organic fertilizers is one of the ways of removing  
246 the harmful effect of excessive acidity of the soil, primarily thanks to the mechanism of antitoxic  
247 activity. This mechanism is activated to a greater degree only during the many years of intensive  
248 application of organic fertilizers, when organic acids contained in organic manure block Al, Cu and  
249 other elements in the form of heavily soluble organic compounds, and organic acids form chelates  
250 with metals. Along with the mentioned effect of organic acids on reducing the toxicity of aluminum,  
251 manganese and other elements, and other substances from organic fertilizers, such as antagonistic  
252 elements (P, Ca, Mg, S, Si), they also have an impact on the suppression of toxicity. Continuous  
253 application of organic fertilizers allowed in organic agricultural production increases the amount of soil  
254 organic matter, reduces erosion, improves soil infiltration and aeration; improves the soil biological  
255 activity during the decomposition; and promotes long-term yield of cultures acting residually to release  
256 nutrients in the soil Hati and Bandyopadhyay, 2011).

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**Comment [H6]:** Standardize: put in acronyms or in full. Exemple: aluminum or Al. In all the text.

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### 3.6. Plan for fertilizing a young plantation to full fertility

Young orchards are plantation at the stage of intense growth and fruit development. This is the stage from planting till it develops the basic skeletal branches, with the characteristics of the intended breeding form. This phase is shorter in intensive than extensive plantations. Young fruit trees should be regularly fertilized in order to foster faster growth and development. The correct fertilization depends largely on the rate of growth and the development of fruit trees. In the first and second year fruit is fertilized individually, and the fertilization zone around the fruit trees should be slightly wider than the crochets (Kantoci, 2012). The result plums fertilization depends predominantly on the biogenic element or other factor that is at a minimum (Mišić, 2006). The selection of fertilizers depends on the soil, climate and weather conditions, variety and plum substrate, crown shape and breeding system, growth and yield, nutrient consumption of plums, quality, composition and physiological activity of fertilizers (Mišić, 2006). When in the agromelioration all biogenic elements are brought to the proper level, the fertilization of plum K and P may be absent during the first few years of the care of a young plantation (Mišić, 2006). Otherwise, fertilization with N, P and K is carried out from the first year. The orientation norms of certain nutrients during the first three years of young sponge care are shown in Table 5 (Mišić, 2006).

**Table 7. Orientation norms of individual nutritions (in g per tree) for fertilization of young plums**

YEAR PLANTATION	AFTER N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
FIRST	30	10	40
SECOND	60	20	80
THIRD	90	30	120

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Depending on the soil properties, a greater or lesser part of nutrients from the fertilizer binds (immobilized) in forms that are hard to reach by fruit trees. For example, easily available phosphate (monoclonation phosphate) is often bind to Fe or Al in the soil in a heavily accessible or inaccessible form (tetra and penta phosphate Fe or Al). While, N in the soil is easily subjected to rinsing processes, resulting in large losses if fertilization is not done gradually on several occasions (Kantoci, 2012).

Fertilization for medium high yield:

Average nutrient requirements for medium high yield are nitrogen (N) 90 kg / ha, phosphorus (P<sub>2</sub>O<sub>5</sub>) 50 kg /-ha and potassium (K<sub>2</sub>O) 140 kg /-ha. In the autumn after harvest, it is necessary to give from 390 kg /-ha of NPK 6-18-36 (or 1 kg /-tree), in March 100 kg /-ha urea (or 0.4 kg /-tree), and in May 60 kg /-ha of KAN (or 0.3 kg /-tree), (Pavlović, 2016.) (Table 8).

**Table 8. Average nutrient requirements for medium high yield**

PERIOD OF YEAR	KIND AND QUANTITY OF FERTILIZER
AUTUMN	NPK 6-18-36 390 kg/ha
MARCH	UREA 100 kg/ha
MAY	KAN 60 kg/ha

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Foliar nutrition should be carried out on two occasions (or more in case of a more expressed deficit of microelements):

- before blooming: 0.5% solution foliar preparation on Boric (B) base
- after blooming: 1 to 2% solution of foliar preparation with macro and micro elements (Pavlović, 2016).

Fertilization for high yield:

Average nutrient requirements for high yield are nitrogen (N) 160 kg /-ha, phosphorus (P<sub>2</sub>O<sub>5</sub>) 90 kg /-ha and potassium (K<sub>2</sub>O) 250 kg /-ha. In the autumn after the harvest, it is necessary to give 680 kg /-

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308 | ha NPK 6-18-36 (or 1.7 kg-/tree), in March 180 kg-/ha urea (or 0.5 kg-/tree) and in May with 100 kg  
309 | /-ha KAN (0,4 kg-/tree). (Pavlović, G. 2016.) (Table 9-)

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311 **Table 9. Average nutrient requirements for high yield**

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PERIOD OF YEAR	KIND AND QUANTITY OF FERTILIZER
AUTUMN	NPK 6-18-36 680 kg/ha
MARCH	UREA 180 kg/ha
MAY	KAN 100 kg/ha

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314 | On lime soil it is recommended that in the autumn after harvest you give 830 kg-/ha NPK 5-20-30S  
315 | (or 2.1 kg-/tree), in March 175 kg-/ha urea (0.5 kg-/tree), and in May 100 kg-/ha of AN (0.3 kg-/  
316 | tree) (Pavlović G. 2016.).

317 | For organic fertilizers can be used compost, vermicompost, slurry, manure, rigid cow manure, solid  
318 | chicken manure, rigid horse manure, rigid pig manure and chicken dry manure . Each of them has  
319 | different ranges of nutrient concentration. Range of nutrient concentrations are different due to the  
320 | different proportions of the litter of these solid and liquid excretions. The litter has a lower N content,  
321 | but absorbs a large amount of liquid secretions and increases the concentration of N and K, which are  
322 | mainly excreted in the urine. The extracellular extracts, however, contain mostly P, which is why the  
323 | low concentration of P in the slurries (Lončarić, 2015). Since the plum requires a large amount of  
324 | nutrients, and the use of mineral fertilizers is not allowed in organic production, alternative solutions  
325 | are used. Dry chicken manure is imposed as one of favorable solutions for soil with a lower level of  
326 | available P because in 1 ton of dry chicken manure there is 30-38 kg N, 20-30 kg P<sub>2</sub>O<sub>5</sub> and 20-22 kg  
327 | K<sub>2</sub>O (Lončarić Z., 2015). In solid chicken manure (in fresh state) the concentrations are slightly lower:  
328 | 12-20 kg-/t N, 12-14 kg-/t P<sub>2</sub>O<sub>5</sub> and 5-7 kg-/t K<sub>2</sub>O (Loncaric, 2015). On the other hand, for soil with  
329 | lower K level is more suitable for organic fertilizer mixtures containing liquid manure (liquid manure)  
330 | and plant waste (green mass, straw, corn) that are richer in K (eg composted mixtures of plant waste  
331 | and manure).

#### 332 333 **4. CONCLUSION**

334 | The content of organic matter is an important factor in fertilizing plums. On the one hand, it provides  
335 | the necessary nutrients, and now on the other hand it affects the physical and chemical properties of  
336 | the soil. Organic matter of soil (humus) is the most important factor of soil elasticity. The amount of  
337 | organic matter directly affects the fertilization needs. In the first year of breeding, in the basic  
338 | fertilization of fruit with a thick assembly, it is fertilized by one fruit with 0.15 to 0.2 kg with some of the  
339 | complex fertilizers (depending on the availability of P and K in soil) as NPK 7-20-30, NPK 6-18-36,  
340 | NPK (SO<sub>3</sub>) 7-14-21 (24) or 0.1 kg NPK 8-26-26, NPK 10-30-20, NPK (MgO, SO<sub>3</sub>) 7-14-21 (2-, 18). In  
341 | the second year of cultivation fertilization is done at the same time and with the same types of  
342 | fertilizers, with the amount increasing by 30 to 50%. In terms of nutrition in the fullfruiting phase, plum  
343 | is significantly different from other types of fruit trees, because in addition to N, it requires large  
344 | amounts of K in the soil. Fertilization is best done on the basis of chemical soil analyzes, nutritional  
345 | status of plums determined by the analysis of leaves and the expected yield. The specificity of  
346 | fertilization in organic agriculture is necessarily omitted from water-soluble mineral fertilizers, and the  
347 | necessary nutrients are introduced into the soil by organic fertilizers and allowed additives (organic  
348 | and /-or mineral origin) from the list of permitted fertilizers in organic production. Plum annually yields  
349 | 40 to 60 kg / ha N. Orientation of this amount of available N in the soil is done by organic fertilizers  
350 | with different N concentration ranges. It is used cow, chicken, pig, horse manure and dry chicken  
351 | manure with the highest N content (30 to 38 kg-/t N). Phosphorus and potassium are provided partly  
352 | from the already mentioned organic fertilizers, and partly by the use of natural minerals or by-products  
353 | such as phosphorites, Tomas phosphate, potassium sulphate, potassium chloride. Microelements are  
354 | provided by fertilizing organic fertilizers, as well as micro-fertilizers and preparations that are used by  
355 | foliar or soil application in organic farming.

#### 356 357 **5. LITERATURE**

358 | Alföldi et al., (2002.). In: El-Hage Scialabba, N.; Hattam, C.(Eds) Organic agriculture, environment  
359 | and food security. Environment and Natural Resources Management Series, N°4. FAO, Rome  
360 | Anastasijevic, V., Sisakovic, N.: Composting of urban green spaces' organic waste as a must of  
361 | sustainable urban greenspace management. Proceeding of the 8th Symposium of flora of  
362 | Southeastern Serbia and Neighbouring Regions, Nis, 2005.  
363

Comment [H7]: ???

Comment [H8]: ????

Comment [H9]: ????

364 Benaković D. (2016.). Principi utvrđivanje optimalne gnojidbe i mjera kondicioniranja tla  
365 Blanco-Canqui, H., Francis, C. A., Galusha, T. D. (2017.). Does organic farming accumulate carbon in  
366 deeper soil profiles in the long term?. *Geoderma*, 288, 213-221.  
367 Butorac, A. (1999.). *Opća agronomija*, Zagreb  
368 Čosić, T., Mesić M. (2008). *Fertilizers and fertilizers*, Faculty of Agriculture, University of Zagreb  
369 Pavlović, G., (2016). *Fertilization by fruit varieties*  
370 Kantoci, D. (2012). Fertilizing fruit trees. *Bulletin of the Protection of Bilja*, 35 (5), 40-45.  
371 Kastori, R. (1983). *The Role of Elements in Plant Nutrition*. Matica srpska, Novi Sad  
372 Kordic A. (2014). Application of visual diagnostics and analysis of plant material in horticulture.  
373 Krpina, I. (2004). *Fruit production*.  
374 Kurtović, M. et al. (2008). *Integral production of bone fruits*, Faculty of Agriculture in Sarajevo,  
375 Sarajevo  
376 Little T, Frost D. (2008). *Organic fruit and vegetable production*  
377 Lončarić, Z. (2010). Internal materials for the module "Fertilization in organic agriculture" and  
378 presentations from lectures. Osijek.  
379 Lončarić, Z., Parađiković, N., Popović, B., Lončarić, R., Kanisek, J. (2015). Fertilization of fertilizers,  
380 organic fertilizers and composting. Faculty of Agriculture, University of Osijek.  
381 Lončarić, Z., Popović, B., Ivezic, V., Karalić, K., Manojlović, M., Čabovski, R., Lončarić, R. (2014).  
382 Mineral and organic fertilization on family farms in the border region of Croatia and Serbia.  
383 Proceedings of the 49th Croatian and 9th International Symposium of Agronomists. Marić, S.,  
384 Lončarić, Z., editor (s). Faculty of Agriculture, University of Osijek, Osijek. 77-81.  
385 Marschner, H. (1995). *Mineral nutrition of higher plants*. Academic Press Ltd.  
386 Mišić, P. (2006). *Plum*.  
387 Mitrović Olga, Zlatković Branislav, Kandić Miodrag, Gavrilović-Damnjanović Jelica, Popović Branko,  
388 Milinković Vladan: Fruit growing, Technological characteristics of fruits of some new varieties of plums  
389 for drying, vol. 43, no. 167-168 (2009) 101-106  
390 Mratinić, E. (2004). *Plum*. Partenon, Belgrade  
391 Shah, A., Askaard, M., Rasmussen, I. A., Jimenez, E. M. C., Olesen, J. E. (2017). Productivity of  
392 organic and conventional arable cropping systems in long-term experiments in Denmark. *European*  
393 *Journal of Agronomy*, 90, 12-22.  
394 Vukadinović V., Bertić B. (2013). *Fertilization philosophy: everything you need to know about*  
395 *fertilization*.  
396 Vukadinović, V. and Bertić, B. (1989). *Practicum from agrochemistry and nutrition of plants*, Faculty of  
397 Agriculture in Osijek, Osijek.  
398 Vukadinović, V. and Lončarić, Z. (1998). *Plant nutrition*, Faculty of Agriculture in Osijek, Osijek  
399 Vukadinović, V. and Lončarić, Z. (1998). *Plant nutrition*. Faculty of Agriculture in Osijek.  
400 Yagodin, B.A. (1984). *Agricultural chemistry*, Mir Publishers, Moscow.  
401 Znaor, D. (1996). *Organic farming*. Nakladni zavod Globus. Zagreb.  
402