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RESPONSE OF RASPBERRY (*RUBUS IDAEUS* L.) ON SOIL MULCHING AND FOLIAR NUTRITION WITH MANGANESE

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Abstract. Raspberry is one of the most important species of fruit plants in Poland. The consumer usefulness and processing of fruits determined the taste and chemical composition. The raspberry fruits contain many valuable and important for human health ingredients. Furthermore the raspberries have a very high value of beekeeping. The main determinants of achieving a high yield and high biological value are a good supply of plant in the macro- and micronutrients and properly prepared soil.

The aim of the study was to determine the response of raspberry on the soil mulching and foliar nutrition with manganese. In the study were included the following factors: I) type of bedding: black foil, black agri-woven, pine bark, wheat straw, soil without bedding – control; II) foliar nutrition with manganese and without foliar nutrition. Yield of fruits, weight of 100 fruits, length of shoots, fruiting terms and the number of harvests were specified. It was found that the soil bedding in the raspberries rows had no significant effect on the plant yielding, weight of fruits, length of shoots and the number of harvests. Foliar nutrition with manganese had a significant negative impact on the yield of raspberry fruits and their mass. While the foliar nutrition of plants had a significantly positive impact on the growth of raspberry shoots.

Key words: *Rubus idaeus*, raspberry, soil bedding, manganese, biometric features

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Introduction

Raspberry is one of the most important species of fruit plants in temperate climate zone. The area of raspberry cultivation still increases and develops also the processing industry. In 2008, the harvest of raspberries in Poland amounted to 81 600 tons, which accounted for 16% of world production, and Poland became the second producer in the world (GUS 2009a, b). For several years the largest raspberry crop region is Lublin (Wieniarska 1992). From here comes more than 80% of the domestic production of raspberries.

The consumer usefulness and processing of fruits determined the taste and chemical composition. Flavor and aroma depend on sugars, organic acids and volatile substances. While the biological value depends on the level of antioxidants, which include inter alia: ascorbic acid and anthocyanins (Wieniarska *et al.* 2005). Deserve a special attention should be paid to such components as: phenolic acids, tannins and flavonoids. A major role plays the ellagic acid, which has the hemostatic properties and lowering blood pressure. This component is considered as the prototype of a new class of substance, which prevents the formation of cancer.

Raspberries have a very high value of beekeeping. Honey yield of several years plantation amounted to 120-240 kg per one hectare. While the pollen productivity of one hectare plantation, depending on the cultivar amounted to 3-13 kg (Szklanowska & Wieniarska 1985).

One of the most important conditions for obtaining a high yield and high biological value is a good supply of plant in the macro- and micronutrients (Czuba 1996).

Manganese is an essential micronutrient which has a major impact on carbohydrates metabolism, protein synthesis, nucleic acids and lipids (Cakmak 2000; Henriques 2003). Manganese characterized by the fact that in the soil solution can be in various forms: Mn^{2+}, Mn^{4+}, Mn^{3+} and other (Fotyma & Mercik 1995). Mobilization of manganese in the form

of Mn^{2+} plays a crucial role in the nutrition of plants. An important factor influencing availability of manganese, next to the pH, is the activity of microorganisms in the rhizosphere, root secretions and the presence of organic acids (Grzebisz 2008). For the proper functioning, the plants need 20-40 mg Mn · kg^{-1} d.m. A normal content of manganese is in a wide range from 20-1000 mg Mn · kg^{-1} d.m. (Gediga 2000 b).

Significant impact on the activity of microorganisms in rhizosphere has a mulching of soil (Sas-Paszt & Głuszek 2007). Mulch has a positive influence on the physical and chemical properties of soil. Protect against erosion (Gordon *et al.* 1993) and preventing soil degradation (Słowińska-Jurkiewicz *et al.* 2001).

The aim of the study was to determine the response of raspberry on the soil mulching and foliar nutrition of liquid fertilizer "Mikrovit Mn 6".

Material and methods

The experiment was conducted in 2009, on the raspberry plantation '*Polana*' cultivar, grown for autumn harvest. Plantation is located in a village Skorczyce, near Kraśnik town, in Lublin region. Raspberry bushes were planted in autumn 2003, in spacing 4.0 × 0.5 m, on a good wheat complex soil. The plot area was 15 m^2.

In the study were included the following factors: I) type of bedding: black foil, black agri-woven, pine bark, wheat straw, soil without bedding – control; II) foliar nutrition with manganese and without foliar nutrition.

The beddings were placed on the soil in the first decade of April, in the rows of plants, a width of 100 cm. The organic materials were placed to form a layer thickness of 5 cm. The foliar nutrition with manganese was applied three times – 2 June, 16 June and 30 June. A liquid fertilizer "Mikrovit Mn 6" was applied at a dose 1.5 $dm^3 \cdot ha^{-1}$, using up 750 dm^3 of solution.

Harvesting began on July 22. Yield of fruits, weight of 100 fruits, length of shoots, fruiting terms and the number of harvests were specified.

The results were statistically processed by means of variance analysis. The difference significance was estimated using Tukey's test for significance level α=0.05.

Results and discussion

Yield of fruits

The raspberry fruit yield, irrespective of the studied factors amounted to an average 13.47 t · ha^{-1} (Tab. 1). The type of bedding had no significant effect on the yield of raspberries. Under the influence of mulching with pine bark and wheat straw, the yield of fruits was lower than in the cultivation without bedding. Similar results were obtained by Szewczuk (1995) Szewczuk & Sosna (2001), Markuszewski & Kopytowski (2008) and Czynczyk *et al.* (2009) with bedding the rows of apple trees. However Mika & Krzewińska (1996) showed a positive effect of bark mulch and polyethylene foil on the apple trees yielding. Kulesza (1995) noted a significant increase in the yield of apples under the influence of mulching with pine bark.

In raspberry cultivation, the highest yield of fruits, irrespective of foliar nutrition, was harvested in the objects with black foil, an average 13.74 t · ha^{-1}, and the smallest in the objects with pine bark, an average – 13.09 t · ha^{-1}.

A triple feeding of plants had a negative influence on the yield of raspberries. Irrespective of the soil mulching, foliar nutrition of plants resulted in a significant reduction in the yield (by 13.2%). Reduction of the tomato yield under the influence of feeding plants with manganese noted Chohura *et al.* (2004). Also Gediga (2000a) received significantly lower yields of faba bean and millet as a result of soil fertilization with manganese.

There are studies which showing a positive effect of feeding with manganese on the plants yielding. Wróbel & Domaradzki (2006) showed a beneficial effect of this treatment on the yield of sugar beet. Similar Szewczuk (2009), under influence of foliar nutrition with "Mikrovit Mn" reported an increase in tuber yield of potato.

Length of raspberry shoots

Length of raspberry shoots amounted an

Table 1. Yield of raspberry fruits ($t \cdot ha^{-1}$).

Type of bedding	Foliar nutrition		
	Mn	without Mn	mean
Black foil	12,47	14.59	13.53
Black agri-woven	12.71	14.77	13.74
Pine bark	11.94	14.24	13.09
Wheat straw	12.18	14.47	13.32
Control	13.24	14.06	13.65
Mean	12.51	14.42	13.47
$LSD_{(0.05)}$ for:	type of bedding		n.s.
	foliar nutrition		0.77

Table 2. Length of raspberry shoots (cm).

Type of bedding	Foliar nutrition		
	Mn	without Mn	mean
Black foil	114.9	110.3	112.6
Black agri-woven	123.2	112.8	118.0
Pine bark	113.8	111.7	112.8
Wheat straw	110.9	104.2	107.6
Control	120.1	107.3	113.7
Mean	116.6	109.3	112.1
$LSD_{(0.05)}$ for:	type of bedding		n.s.
	foliar nutrition		5.4

Table 3. Weight of 100 fruits (g).

Type of bedding	Foliar nutrition		
	Mn	without Mn	mean
Black foil	326	367	347
Black agri-woven	314	361	338
Pine bark	316	357	337
Wheat straw	337	353	345
Control	338	347	343
Mean	326	357	342
$LSD_{(0.05)}$ for:	type of bedding		n.s.
	foliar nutrition		7.7

average 112.1 cm (Tab. 2). Applied the soil bedding had no a significant influence on the growth of shoots. However, it was found that the plants grown in mulched sites with agri-woven characterized by the longest shoots (an average 118.0 cm). The shortest shoots had the plants in mulched sites with wheat straw (107,6 cm). Similar results received Pliszka & Scibisz (1989) in cultivation of *Vaccinium vitis-idea* L. Whereas Markuszewski & Kopytowski (2008) showed that the apple trees grow stronger in mulching sites with woven. Also

Krzewińska & Mika (1997) observed a positive effect of organic and synthetic beddings on the growth of apple trees. Szwedo & Lipecki (1997) reported a beneficial influence of soil mulching with straw on the growth of cherry and apple trees.

A foliar nutrition with manganese had a positive impact on growth of raspberry shoots. Manganese fed plants exhibited the greatest length of shoots, an average 116.6 cm, while not feeding plants had a shorter shoots (by 6.3%).

Weight of fruits

Weight of 100 fruits of raspberry amounted an average 342 g (Tab. 3). Soil mulching had no significant influence on the weight of raspberry fruits. Fruit weight was significantly dependent on harvest date and foliar nutrition with manganese. The largest mass characterized the fruits at the beginning of the harvest, and the smallest collected at the end of harvest.

Foliar nutrition with manganese had a significantly negative impact on the mass of raspberry fruits. Weight of 100 fruits collected from the feeding plants was less, an average by 8.7%, compared with fruits from not fertilized plants. Differently to foliar nutrition with manganese responded the oats. Tobiasz-Salach & Bobrecka-Jamro (2009) showed a beneficial effect of manganese on the weight increase of 1000 grains of oats.

Fruiting term and the number of harvests

Type of bedding and foliar nutrition with manganese had no apparent effect on the fruiting term and the number of harvests. Fruit harvest started at the beginning of the third decade of July (Tab. 4). The earliest ripe the fruits on the bushes in the objects with synthetic beddings and pine bark (22 July), two days later in the objects with wheat straw, and at the latest (25 July) ripe the fruits on the plants in the sites without bedding.

Foliar nutrition with manganese resulted in shortening the period of fruiting plants. Fed raspberries ended fruiting period in the first decade of September, but the plants not fertilized with manganese finished fruiting period in the second decade of September.

Foliar nutrition with manganese had also a large impact on the number of harvests (Tab. 5). In the objects with not feeding plants carried out three harvests more than in the objects with feeding plants.

Conclusions

- Soil bedding in the raspberries rows had no significant effect on the plant yielding, weight of fruits, length of shoots and the number of harvests.
- Foliar nutrition with manganese had significantly negative impact on the yield of raspberry fruits and their mass.
- Foliar nutrition of plants had significantly positive influence on the growth of raspberry shoots.

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Table 4. Terms of raspberry fruiting.

Type of bedding	Foliar nutrition			
	Mn		without Mn	
	first harvest	last harvest	first harvest	last harvest
Black foil	22.07	05.09	22.07	15.09
Black agri-woven	22.07	05.09	22.07	15.09
Pine bark	22.07	05.09	22.07	14.09
Wheat straw	24.07	08.09	22.07	14.09
Control	25.07	08.09	22.07	12.09

Table 5. Number of fruits harvests.

Type of bedding	Foliar nutrition		
	Mn	without Mn	mean
Black foil	11	16	14
Black agri-woven	11	16	14
Pine bark	12	15	14
Wheat straw	13	15	14
Control	13	14	14
Mean	12	15	14

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