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EFFECT OF FERTILIZATION METHODS ON GROWTH OF PEAR TREES, YIELDING AND FRUIT QUALITY

Tomasz Lipa * & Iwona Szot **

Abstract. The experiment was carried out in the commercial orchard near Lublin on five-year old pear trees of two cultivars: *'Conference'* and *'Lukasowka'*, planted on Quince MA. The objective of the study was evaluated the reaction of pear on the method of application of fertilizers. In the early spring the surface broadcasting of fertilizers was used (N – 71,5 kg, P_2O_5 – 33,0 kg, K_2O – 114,0 kg) and from the May to the middle of August the fertigation was applied (N – 76,4 kg, P_2O_5 – 49,5 kg, K_2O – 84,2 kg). Method of fertilizer's applications had no significant effect on the growth of evaluated trees. There were no differences in quantity of yield in dependence on the method of fertilization. In the case of cv. *'Lukasowka'* the beneficial influence of the way of fertilization on morphology of fruits (their diameter, height and mass) was stated. Such an effect was not observed in the case of the *'Conference'*.

Key words: *Pyrus*, surface broadcasting of fertilizers, pear size, macro- and micronutrients in soil

*University of Life Sciences, Department of Pomology, 58 Leszczyńskiego str., 20-068 Lublin, Poland; * tomasz.lipa@up.lublin.pl, ** szoti@autograf.pl*

Introduction

Proper water management is the basis for optimal growth and yield of fruit plants. The other, no less important, yielding factor is the fertilization. From correct fertilization depends not only quantity, but also the quality of the crop.

Pear is a species sensitive to drought (Neri *et al.* 2003; Giacobbo *et al.* 2008). Climate warming and water shortage in Polish conditions is becoming one of the reasons for failures in the cultivation of this species (Lipa *et al.* 2012). Therefore more and more growers install irrigation systems in the newly estsablished orchard with dwarf trees.

In order to obtain the highest quality pears, the balanced fertilization should be kept. However, the choice of the appropriate fertilization plan involves a number of elements affecting the proper nutrition tree. These factors include: the type of rootstock, variety, soil type, weather conditions (Gomand *et al.* 2010).

In the literature (Arkel *et al.* 2007; Wojcik 2007; Zygmuntowska & Jadczuk-Tobjasz 2008) are numerous reports indicating the diverse response to surface broadcasting of fertilizers on pear trees. Much less information is available for fertilization by fertigation. According to many authors the effectiveness of fertigation, also depends on cultivar (Treder 1998; Ochmian *et al.* 2006). Aim of this study was to compare two methods of fertilization on the tree growth, yield and quality of pears cv. *'Conferencja'* and *'Lukasowka'*.

Material and methods

The experiment was carried out in the commercial orchard near Lublin (51°03'11.87'' N, 22°50'49.29'' E). Five-year old pear trees of two cultivars: *'Conference'* and *'Lukasowka'* on Quince MA were grown in space 3.2×0.8 m. Doses of macronutrients served with fertilizers are given in Tab. 1. All fertilizers for fertigation were applied at a concentration from 0.1 to 0.2% (1-2 kg/1000 l of water). Fertigation was carried out regularly: every 2-3 days, taking into account the indications of tensiometer.

Soil sampling analysis

Content of nutrients in the soil; soil samples were taken from two horizons: I – 0-25 cm, II – 26-50 cm in autumn (in the end of vegetative

Table 1. Comparison of doses of fertilizer in the pure component.

Nutrient composition	Treatment	
	Fertigation ($kg \cdot ha^{-1}$)	Surface broadcasting of fertilizers ($kg \cdot ha^{-1}$)
N	76.4	71.5
P_2O_5	49.5	33.0
K_2O	84.2	114.0

season). Content of available potassium and phosphorus was processed with the Egner-Riehm method, and content of available magnesium – with the Schachtschabel method. The determining micronutrients: Mn, Cu, Zn and Fe in soil were made in 1M HCl extract by AAS method and B – by colorimetric method.

Three growth and fruit quality

The following measurements were taken on individual plot basis at harvest: The trunk diameter was measured at 30 cm aboveground for each plot. Fruit yield was determined by harvesting all fruits from each tree separately ($kg \cdot tree^{-1}$) and the yield was recalculated for $kg \cdot ha^{-1}$. For size determination, tree measurements (mm) at right angles were taken per fruit, with a digital caliper: two equatorial diameters (at 90°) from which the mean diameter was created and length from stem to blossom end of the fruit – height of fruit; the dry matter content (%) in five replications with the oven-drying method; the soluble solids content (%) in ten replications was determined with an Abbé refractometer; the total sugar content (%) in three replications was determined according to the Loof-Schoorl method (KREŁKOWSKA-KUŁAS 1993), the acidity (%) was determined potentiometrically by titration with 0.1 N NaOH solution and was converted to malic acid (YERMAKOV *et al.* 1987). Flesh firmness of fruit was measured on the three positions around the equator approximately 120° apart, perpendicular to the stem – bottom axis, using Magness-Taylor penetrometer (mod. FT 327) with 8.0 mm probe in 30 replications.

The obtained results on yield, plant material, and growing medium were statistically analyzed by analysis of variance based on Tukey's test at a significance level of $\alpha = 0.05$.

Results and discussion

Chemical analysis of the soil after the season (in autumn) showed higher levels of potassium and phosphorus at fertigation treatment, and magnesium at treatment with

Table 2. The influence of fertilization methods on macronutrient content in two soil horizon.

Treatment	Soil horizon	The content of available forms in $mg \cdot 100g^{-1}$ of soil		
		Phosphorus	Potassium	Magnesium
Surface broadcasting of fertilizers	Plow layer 0-25 cm	10.4	56.9	11.7
	Under-plow layer 26-50 cm	9.2	38.6	11.7
	Mean	9.8	47.8	11.7
Fertigation	Plow layer 0-25 cm	11.6	46.9	11.0
	Under-plow layer 26-50 cm	11.2	38.6	10.4
	Mean	11.4	42.8	10.7

Table 3. The influence of fertilization methods on micronutriens content in soil.

Treatment	Content of micronutriens in $mg \cdot kg^{-1}$ of soil				
	Boron	Manganese	Copper	Zink	Iron
Surface broadcasting of fertilizers	2.40	134.6	9.56	14.5	773
Fertigation	2.34	155.9	9.18	14.8	772

Table 4. The influence of fertilization methods on the trunk diameter (mm) and the mean length of one-year old shoots (cm).

Cultivar	Treatment	Trunk diameter (mm)	Mean length of one-year old shoots (cm)
'Conference'	Surface broadcasting of fertilizers	54.6 b*	51.5 a
	Fertigation	54.9 b	51.3 a
'Lukasowka'	Surface broadcasting of fertilizers	45.2 a	66.6 b
	Fertigation	46.9 a	69.4 b
Mean	Surface broadcasting of fertilizers	49.9 A	59.1 A
	Fertigation	50.9 A	60.4 A

Table 5. The influence of fertilization methods on the diameter and height of fruit, as well as mean fruit mass.

Cultivar	Treatment	Diameter of fruit (mm)	Height of fruit (mm)	Mean fruit mass (g)
'Conference'	Surface broadcasting of fertilizers	66.0 a	100.0 c	202.1 ab
	Fertigation	64.7 a	109.8 c	190.9 a
'Lukasowkaa'	Surface broadcasting of fertilizers	70.1 b	83.4 a	210.9 b
	Fertigation	76.0 c	94.0 b	262.5 c
Mean	Surface broadcasting of fertilizers	68.1 A	91.7 A	206.5 A
	Fertigation	70.4 A	101.9 B	226.7 B

Table 6. The influence of fertilization methods on some quality features of fruits.

Cultivar	Treatment	Flesh firmness (kG/cm^2)	Soluble solids (%)	Total sugar (%)	Acidity (%)	Dry matter (%)
'Conference'	Surface broadcasting of fertilizers	5.7 a	14.2 a	8.4 b	0.15 a	17.2 c
	Fertigation	5.3 a	17.1 b	8.0 b	0.16 a	16.8 bc
'Lukasowka'	Surface broadcasting of fertilizers	5.5 a	17.5 b	7.5 a	0.24 b	16.5 b
	Fertigation	5.6 a	17.0 b	8.1 b	0.29 c	15.8 a
Mean	Surface broadcasting of fertilizers	5.7 A	15.9 A	8.0 A	0.20 A	16.9 A
	Fertigation	5.5 A	17.1 B	8.1 A	0.23 A	16.3 A

*Means within the column followed by the same letter are not significantly differ by Tukey's Multiple Range Test at P≤0.05.

surface broadcasting of fertilizers. Soil richness of micronutrients was similar for the evaluated methods of fertilization (Tabs. 2-3).

Method of fertilizer applications had no significant effect on the diameter of the tree trunk and the average increasment in length of one-year shoots (Tab. 4). Zygmuntowska & Jadczuk-Tobjasz (2008) showed the influence of fertilizing on growth of five pear cultivars.

In the case of cv. *'Lukasowka'* the significant influence of the way of fertilization on morphology of fruits (their diameter, height and mass) was stated (Tab. 5). Significant bigger fruits after fertigation were obtained. In the study of Zygmuntowska & Jadczuk-Tobjasz (2008) fertilizing with potassium, independently on rate and method of application, increased the fruit mass.

In the present study, the firmness of flesh of evaluated cultivars remained at a level of 5.3 kG/cm^2 to 5.7 kG/cm^2. There was no significant effect of fertilization method on this feature

Table 7. The influence of fertilization methods on fruit yield (kg/tree, t/ha).

Cultivar	Tretment	Fruit yield ($kg \cdot tree^{-1}$)	Fruit yield ($t \cdot ha^{-1}$)
'Conference'	Surface broadcasting of fertilizers	11.2	36.9
	Fertigation	11.7	38.5
'Lukasowka'	Surface broadcasting of fertilizers	8.8	29.2
	Fertigation	9.0	29,7
Mean	Surface broadcasting of fertilizers	10.0	33.1
	Fertigation	10.4	34.1

(Tab. 6). Similar results were obtained by Klein & Spieler (1987), who in his experiment, carried out on apples stated that fertigation had no effect on the chemical composition and other fruit properties. Also Zydlik & Pacholak (1997) did not observe a significant impact of fertigation on the fruit quality, especially on flesh firmness. The influence of fertilizing with potassium on flesh firmness was detected by Zygmuntowska & Jadczuk-Tobjasz (2008). The fruits with the biggest firmness were in treatment with the highest rate of potassium.

There were no significant differences in quantity of yield in dependence on the method of fertilization (Tab. 7). Also in the study of Ochmian (2006) and Olszewski *et al.* (1999) fertigation had no significant effect on fruit yield of apple trees. However Zygmuntowska & Jadczuk-Tobjasz (2008) stated the significant influence of potassium fertilizing on yielding of pear.

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