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MULCHING AND NITROGEN FERTILIZATION IN A PRUNE ORCHARD

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ABSTRACT

The experiment started in the spring of 1996 aimed to check whether the use of cereal straw mulch may cause nitrogen deficiency in prune trees of 'Empress' budded on 'Wangenheimer' seedlings, and whether the application of nitrogen fertilizers is necessary to prevent such deficiency. The following rates of nitrogen (as ammonium nitrate) were used every spring up to 2003: (1) control without nitrogen; (2) 25 kg N ha^{-1} in April; (3) 25 kg N ha^{-1} in April and again in June; (4) 50 kg N ha^{-1} in April. No visible symptoms of nitrogen deficiency were observed in trees growing on plots mulched during seven consecutive years with cereal straw, even on those without N supply. Fertilization had no significant influence on growth, yield and fruit quality, although some effects of nitrogen application on the examined characteristics were observed. The lack of reaction to fertilization described above may be due to a high fertility of soil on which the experiment was set up.

Key words: mulching, nitrogen fertilization, prune orchard

INTRODUCTION

The aim of the experiment started in the spring of 1996 was to check whether the use of cereal straw as mulch in a prune orchard could cause the nitrogen deficiency in trees and whether nitrogen fertilization is necessary to prevent such a reaction. Prunes are known for having high nitrogen requirements (Grzyb and Rozpara, 2000) and the use of organic mulches in orchards can be a reason for a temporary lack of nitrogen available to trees. Positive effect of black foil on the growth and yielding of prunes is reported by Olszewski et al. (1998) and Stankievitch (2000). Grzyb and Rozpara (2000) recommended the use of farmyard manure for mulching in prune orchards, but in the case when other organic materials are used they advise

some additional nitrogen rates to be supplied. In the preliminary report presented in Canada (Lipecki et al., 2000) we pointed out that the trees showed no symptoms of nitrogen deficiency and there was no yield reaction to this nutrient supply as compared to the control (mulched, but without N fertilization). In this paper the final results of the experiment carried out in 1996-2003 are presented.

MATERIAL AND METHODS

'Empress' trees budded on 'Wangenheimer' seedlings were planted at a distance of 5 x 2 m in a rich soil containing in the 0-25 cm layer 55 mg P_20_5, 36 mg K_20 and 8.3 mg Mg 100 g^{-1}; pH_{KCl} was 6.60. The soil in orchard rows was mulched with cereal straw just after planting the trees and again every spring up to 2003. The mulched strips were 1.5 m wide and the mulch was 15 cm deep. Mowed sod was maintained between tree rows. The following rates of nitrogen (as ammonium nitrate) were used every spring: (1) control without nitrogen; (2) 25 kg ha^{-1} in April; (3) 25 kg ha^{-1} in April and again in June and (4) 50 kg ha^{-1} in April. No other fertilizers were used. There were four blocks containing five trees each; thus the total number of trees was 80.

The following measurements were conducted:

- TCSA value (cm^2) at the height of 30 cm in the spring of 1996 and again in the autumn of 2003, then the increase of TCSA was calculated;
- yield of fruits in kg per tree;
- mean weight of one fruit (g), using 100 fruits from each replication;
- soluble solids content in fruit with Abbe refractometer in 10 replications (%);
- dry weight content in fruit in 5 replications (%);
- fresh weight (g) of one leaf (100 leaves from one-year-old shoots from each treatment);
- fruit firmness measured in 20 replications with Facchini penetrometer (kG);
- content of N, P, K, Ca and Mg in the leaves (% dry weight) using the following procedures: N with Kjeldahl`s method, P – colorimetrically, K, Ca and Mg – using AAS;
- soil was analysed in the summer of 1996 and again in 2003; samples were taken from the following layers: 0-20 and 20-40 cm (1996) and 0-20, 20-40 and 40-60 cm, from the mulched areas of the orchard in treatments 1 and 4 and from grassed alleyways (2003). Organic matter content was analysed using Tiurin`s method, P – by colorimeter, K and Mg – AAS and total N – by Kjeldahl`s method.

RESULTS AND DISCUSSION

There were neither significant differences in the TCSA between treatments at the beginning and end of the experiment, nor in the increase of this value in

1996-2003 (Tab. 1). However, the strongest tree growth was observed in the control (1) and the weakest – in treatment 4.

Table 1. Growth parameters of 'Empress' trees depending on nitrogen fertilization

Treatment	TCSA [cm^2]			Mean weight of one leaf [g]
	1997	2003	increase in 1997-2003	
(1) Control	1.94 a*	71.65 a	69.71 a	0.95 a
(2) N 25	1.91 a	62.68 a	60.77 a	0.97 a
(3) N 25+25	2.19 a	67.09 a	64.09 a	0.99 a
(4) N 50	2.14 a	62.57 a	60.43 a	0.99 a

*Means followed by the same letter do not differ significantly at P = 0.05

Fruit yields were not significantly different (Tab. 2). Fertilization increased the mean weight of one fruit as compared to controls, but differences were also negligible. Similarly, there were no significant differences in the content of soluble solids and dry matter in fruit, although there was some tendency towards an increase of these parameters in fertilized treatments. Similar tends were observed in the case of fruit firmness, fresh weight of one leaf and the value of productivity index.

Table 2. Yield and some fruit characteristics of `Empress` and the value of productivity index

Treatment	Yield 1997-2003 [kg $tree^{-1}$]	Mean weight of fruit [g]	Soluble solid [%]	Dry weight [%]	Fruit firmness [kG]	Productivity index ** [yield: TCSA] 2003
(1) Control	68.5 a*	70.4 a	15.39 a	17.39 a	0.90 a	0.96
(2) N 25	62.8 a	72.7 a	15.40 a	16.99 a	1.08 a	1.00
(3) N 25+25	69.4 a	73.2 a	16.01 a	17.45 a	1.21 a	1.03
(4) N 50	66.4 a	73.1 a	15.93 a	17.83 a	0.93 a	1.06

*For explanation, see Table 1; ** Without statistical analysis

The content of N, K and Ca in the leaves showed a tendency to increase in fertilized treatments, whereas P slightly decreased whereas Mg level did not show any regularity (Tab. 3).

Table 3. Content of mineral elements in leaves [% d.w.]; mean for 1997-2002

Treatment	Nitrogen	Potassium	Phosphorus	Calcium	Magnesium
(1) Control	2.63 a*	2.71 a	0.26 a	1.93 a	0.34 a
(2) N 25	2.69 a	2.63 a	0.24 a	1.96 a	0.33 a
(3) N 25+25	2.75 a	2.61 a	0.25 a	2.05 a	0.34 a
(4) N 50	2.72 a	2.67 a	0.23 a	2.12 a	0.37 a

*For explanation, see Table 1

T a b l e 4. Soil chemical properties in 1996 and 2003*

Treatment	Soil layer [cm]	pH	P_2O_5 [mg 100 g^{-1}]	K_2O [mg 100 g^{-1}]	Mg [mg 100 g^{-1}]	Organic matter [%]	Total N [%]
1996							
Before the start of experiment	0 -20 20-40	6.60 6.40	55.4 36.0	36.0 18.0	8.3 8.8	1.90 1.10	- -
2003							
Control (1)	0-20 20-40 40-60	6.66 6.70 6.55	49.0 47.5 34.5	25.0 22.0 16.8	10.1 10.7 9.8	1.78 1.32 0.92	0.120 0.110 0.085
N 50 (4)	0-20 20-40 40-60	6.15 6.20 6.12	40.0 42.5 35.7	27.5 22.3 18.6	13.5 13.1 12.8	2.31 1.90 1.22	0.145 0.130 0.065
Sod between rows	0-20 20-40 40-60	7.03 7.07 6.91	39.8 37.3 30.2	43.3 32.0 20.0	9.6 10.3 11.9	2.16 1.77 1.04	0.130 0.110 0.065

*Without statistical analysis

In comparison to 1996, seven years later soil acidity increased in treatment 4, fertilized with 50 kg N (Tab. 4). Also, the comparison between this treatment and the control (1) showed that the fertilization enhanced soil acidity in all the layers studied. The soil under the mowed sod between tree rows was rather neutral (pH 6.91-7.07). In 2003 there was on increase of organic matter content in treatment 4 and under sod, whereas it declined in the top layer of the control. It is possible, that without sufficient supply of nitrogen (as in treatment 4), straw was mineralized slowly, so the content of organic matter was smaller than in plots receiving 50 kg N annually. The amount of total nitrogen was the lowest in the top layer of the control plots, even in comparison to the soil under sod. During seven years the level of P decreased in all treatments, especially under sod and in plots supplied with 50 kg of N. The greatest reduction in K content in the soil was observed in the control, whereas under sod its level enhanced over this period. Magnesium showed an increase in all treatments, the highest in plots fertilized with 50 kg N. It should be noticed that only under sod Mg content increased with depth, whereas the soil in tree rows showed opposite.

Results of the 7-year experiment showed no significant influence of nitrogen fertilization on all the parameters studied. According to Kłossowski et al. (1977/78) and Southwick et al. (1999) medium rather than high rates of this element should be recommended for prunes. Szwedo et al. (2003) found no effect of different levels of N supply on the quality of 'Top' and 'Bluefre' fruit; however, an increase of N in fruit was significant, as was a decrease in P

content. The lack of prune reaction found in this study could be due to a very rich soil, which created excellent conditions for trees. The use of straw mulch did not cause visible symptoms of nitrogen deficiency even in the control treatment, in which the soil contained the smallest amount of nitrogen. This also could be connected with the richness of soil. Thus, in the conditions of this experiment nitrogen, fertilization was not necessary to prevent this element deficiency, presumably caused by the use of cereal straw mulch. It should be stressed, however, that we had no real control trees (without mulch) because of limited material, so the conclusion in this respect should be somewhat restricted

CONCLUSIONS

1. Nitrogen fertilization had no significant effect on the growth of trees, yield and fruit quality of 'Empress' prune, although some tendencies in the influence of this element were noticed.
2. No visible symptoms of nitrogen deficiency were observed in trees growing on plots mulched during 7 years with cereal straw, even without N supply.
3. A lack of such reaction could be due to a rich soil on which the experiment was conducted.
4. During the 7-yers experiment some changes in soil chemical properties were observed as an effect of N fertilization and in soil between the tree rows.

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ŚCIÓŁKOWANIE I NAWOŻENIE AZOTOWE W SADZIE ŚLIWOWYM

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STRESZCZENIE

Doświadczenie rozpoczęto na wiosnę roku 1996 w celu ustalenia, czy użycie słomy zbożowej jako ściółki może spowodować niedobór azotu u drzew śliwy odmiany `Empress` okulizowanych na siewkach `Węgierki Wangenheima` oraz czy stosowanie nawożenia azotowego jest niezbędne dla zapobiegania ewentualnym niedoborom. Następujące dawki azotu w postaci saletry amonowej stosowano corocznie na wiosnę do roku 2003: (1) – kontrola bez nawożenia azotowego; (2) – 25 kg N^{-1} w kwietniu; (3) – 25 kg N^{-1} w kwietniu i ponownie w czerwcu; (4) – 50 kg N^{-1} w kwietniu. Nie stwierdzono widocznych objawów niedoboru azotu u drzew na poletkach ściółkowanych słomą, nawet bez nawożenia azotowego. Nawożenie nie miało istotnego wpływu na wzrost drzew, plonowanie i jakość owoców, aczkolwiek stwierdzono pewien wpływ tego zabiegu na badane cechy. Brak reakcji na nawożenie mógł być spowodowany wysoką żyznością gleby, na której założono doświadczenie.

Słowa kluczowe: ściółkowanie, nawożenie azotowe, sad śliwowy