THE IMPACT OF N AND P SUPPLY ON THE PERFORMANCE OF YIELD COMPONENTS OF WINTER BARLEY (*HORDEUM VULGARE* L.)

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Abstract: Winter barley is one of the most important fodder plants due to its nutritional value, but the sown area size is rather small among the cereal crops. Barley production has a profound impact on the success of animal husbandry in Hungary. Relevant foreign and Hungarian publications on fertilisation and investigating contexts between yield components of winter barley can only be found in few recent periodicals. The aim of this investigation was to gain data about the effect of nitrogen and phosphorus supplies on the plant height, length of ear and grain yield per ear as well as the yield of winter barley. The long-term fertilisation experiment was set up in 1989 on a chernozem meadow soil, calcareous in the deeper layers, with four levels of N, P and K supplies respectively. The present paper discusses the N and P fertilisation results obtained in the 2011 year of the experiment. We measured the highest values - height (78.88 cm), length of ear (7.25 cm) and grain yield per ear (18.9 pieces per ear) - in the case of AL-P2O5 level of 194 mg kg-1and N 240 kg N ha -1supplies. Maximum grain yields were recorded at AL-P2O5 level of 194 mg kg -1 as well, but in the case of N, the 160 kg N ha -1 supply was proved to be adequate.

Keywords: nitrogen, phosphorus, winter barley, supply

Introduction

Barley is a member of the *Gramineae* family. It is a self pollinating diploid species with 14 chromosomes. The wild ancestor of domesticated barley, *Hordeum vulgare* ssp *spontaneum* is originated from the Fertile Crescent and believed to be one of the earliest domesticated grain crops. Outside this region, the wild barley is less common and is usually found in disturbed habitats (Zohary and Hopf 2000). However, in a study of genome-wide diversity markers Dai et al (2012) found Tibet to be an additional centre of domestication of cultivated barley.

Barley is the third most important cereal of ours from the point of view of both human consumption and of animal nutrition in Hungary. Barley is eaten by all domestic animals. The most ratio is used in the swine feeding - within it in swine fattening (Schmidt, 2004). Its protein content respectively and more essential amino acids ratio (f.i. lysine, threonine, tryptophan) are higher than in maize, but it does not reach the wheat characteristic value. Its fibre content is higher than that of both referred cereals thus it has excellent dietetic effect for swine. Content of NSP (no starch polysaccharide) is considerable, which is with unbeneficial effect digestion of poultry, thus poultry should be fed with it to a lesser extent (Schmidt, 2003; Mézes and Hausenblasz, 2009). Critical point of the barley production is the N- fertilization, which basically determines the yield and quality, furthermore some economic value measurement factors. Berhanu et al. (2013) found, that N supply was in close correlation with the productivity of winter barley. Kádár (2000) determined that abundant NP- supply can increase expressly speed of N- uptake of winter barley in the early phase of development respectively the plant is able to supply its N-need on the coming into ear. Dunai et al (2014) evaluated the impact of NPK fertilisation in single and combined applications with organic manure. It was stated, that crops can directly produce higher yields and while the more moist conditions increase the microbial activities, the efficiency of fertilizers can be better. These soil physical results enable crops to obtain more yields with using mineral and organic fertilizer in combined applications. Yielding ability of barley highly depends on the performance of yield components. Spikelets are arranged in triplets that alternate

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along the rachis as it is shown by Graph 1. In wild barley and other species of *Hordeum*, only the central spikelet is fertile, while the other two are reduced. This condition is retained in certain cultivars known as two-row barleys. A pair of mutations (one dominant, the other recessive) result in fertile lateral spikelets to produce six-row barleys (Zohary and Hopf 2000). Recent genetic studies have revealed that a mutation in one gene, *vrs1*, is responsible for the transition from two-row to six-row barley (Komatsuda et al 2006).

N and P impact on barley yield and yield components has been recently discussed in a short communication by the authors (Surányi and Izsáki 2016).

In this work we looked for an answer on how the N-, P- and K- supply of the soil affects the height, length of spike individual productivity of winter barley and what impact it has on the yield.

Materials and methods

Long-term mineral fertilisation experiments were set up at the experimental station of the Szent István University, Faculty of Economic, Agricultural and Health Sciences, Szarvas, in 1989. The soil of the experimental area had the following parameters: chernozem meadow soil, calcareous in the deeper layers, 85–100 cm humus layer, $pH_{(KCl)}$ 5.0–5.2, humus content 2.8–3.2%, upper limit of plasticity according to Arany (K_A) 50 and clay content 32%. The fertilisation was treatment of 4-4 nitrogen (N)-, phosphorus (P)- and potassium (K)- levels carried out in all possible combinations of four levels each of N, P and K, giving a total of 64 treatments, set up in a split–split plot design with three replications. The following fertiliser rates were applied: N: N_0 = 0, N_1 = 80, N_2 = 160 and N_3 = 240 kg N ha^{-1} year^{-1}; P (P_2O_5): P_0 = 0, P_1 = 100 kg ha^{-1} year^{-1}, P_2 = 500 kg ha^{-1} 1989, 1993 and 2001, and P_3 = 1000 kg ha^{-1} year^{-1} in 1989, 1993 and 2001; K (K_2O): K_0 = 0, K_1 = 300 kg ha^{-1} year^{-1} between 1989 and 1992 and 100 kg ha^{-1} year^{-1} from 1993, K_2 = 600 kg ha^{-1} in 1989 and 2001, 1000 kg ha^{-1} in 1993, and K_3 = 1200 kg ha^{-1} in 1989 and 2001 and 1500 kg ha^{-1} in 1993. The high rates of P and K replenishment fertilisation were used to create clearly distinct supply levels in the soil in order to investigate plant responses to nutrient status. The plot size of the sub-subplots was 4×5 = 20 m². For the plant investigations and the yield components analysis two times one meter row samples were taken from all treatments of the K_1 plots.

Results and discussion

Relationship between the N, P-supply and the height of winter barley

Increase of the N- doses (Figure 1.) – in mean P- treatments – rises stem length of winter barley (45.76; 63.47; 71.38; 75.76 cm), but we have to envisage in case of the excessive N-supply risk of lodging respectively its effect of environmental risk. The expanding P- supply does not show so pronounced effect as in case of N- supply (64.41; 63.77; 63.84; 64.36 cm). The adequate P- supply enhance growth and maturity of plant and at the same time increases resistance against lodging. Compared to P_0N_0 the P- supply increase resulted decrease in the length of straw. The lowest length of straw was observed at P_2N_0- supply level, while the highest values in case of maximum N- supply level (240 kg ha^{-1} N year^{-1}) on the same P-level (P_2, AL- 194 mg kg^{-1}). The increase of N-supply is in close relationship (r=0,95) with length of straw of winter barley (Figure 2.), but the P-supply did not affect significantly the investigated parameter.

Relationship between the N- and P-supply and length of spike

The increasing dose of N- supply (0; 80; 160; 240 kg ha^{-1} N year^{-1}) – on the average of P-supply – increased length of spike of winter barley (5.23; 6.22; 6.65; 7.04 cm) (Figure 3.), but different P- doses acted on reducing of investigated parameter (6.41; 6.21; 6.20; 6.31 cm). We measured the shortest length of spike in case of P_3N_0 – supply (4.73 cm), the longest

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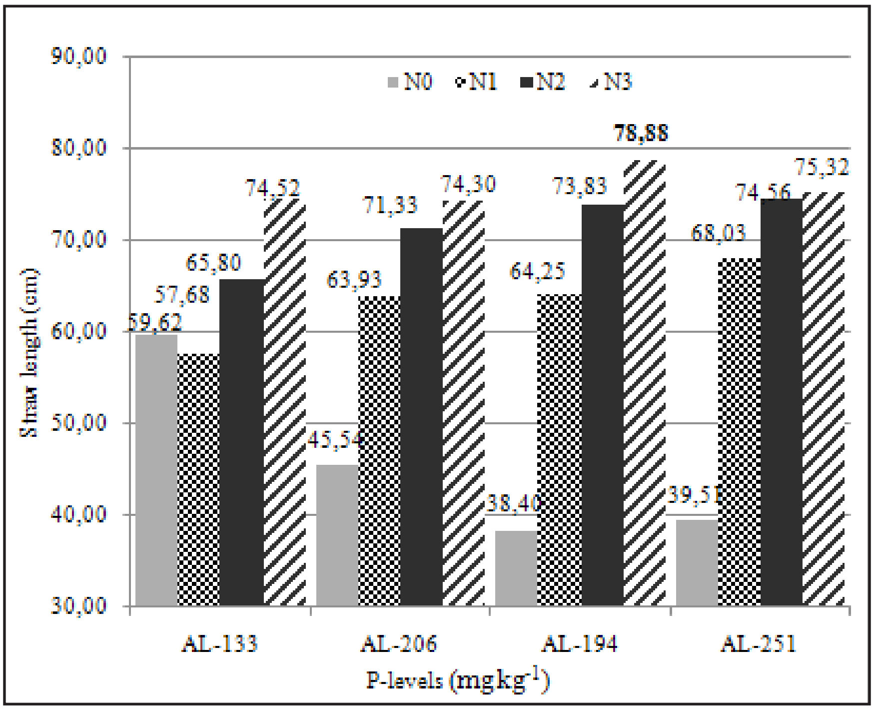

Figure 1. Effect of N- and P- supply on stem length of winter barley (cm)

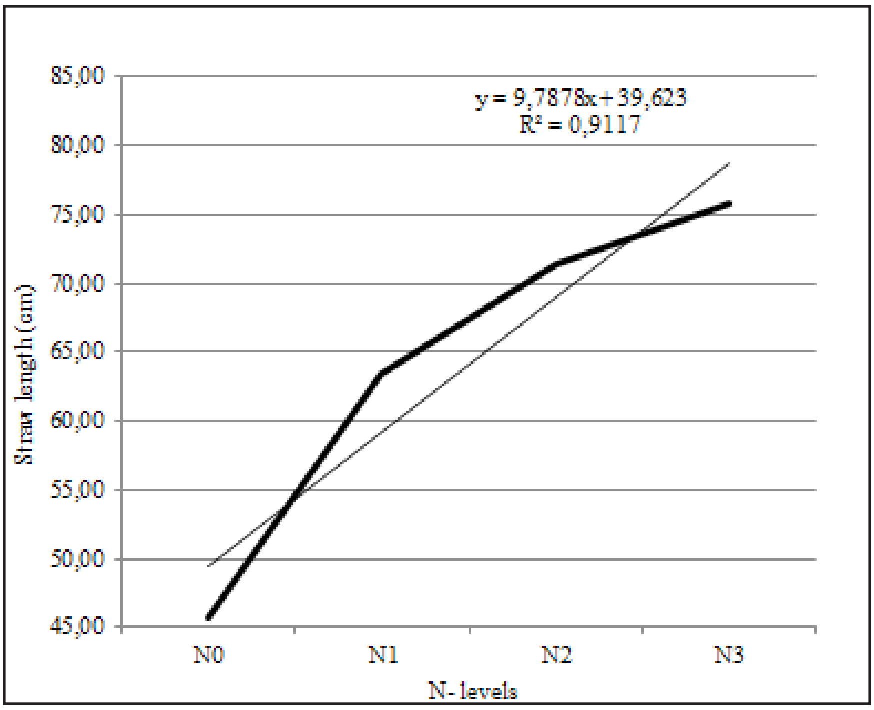

Figure 2. Correlation between N-supply and stem length of winter barley (cm)

in case of P_2N_3- supply (7.25 cm). Between N- supply and length of spike winter barley there is a very close correlation (r= 0.97) (Figure 4.), but P- supply did not result in significant changes.

Relationship between N-, P-supply and the grain number per spike

In case of this examined parameter, the increasing N-supply also rose the grain

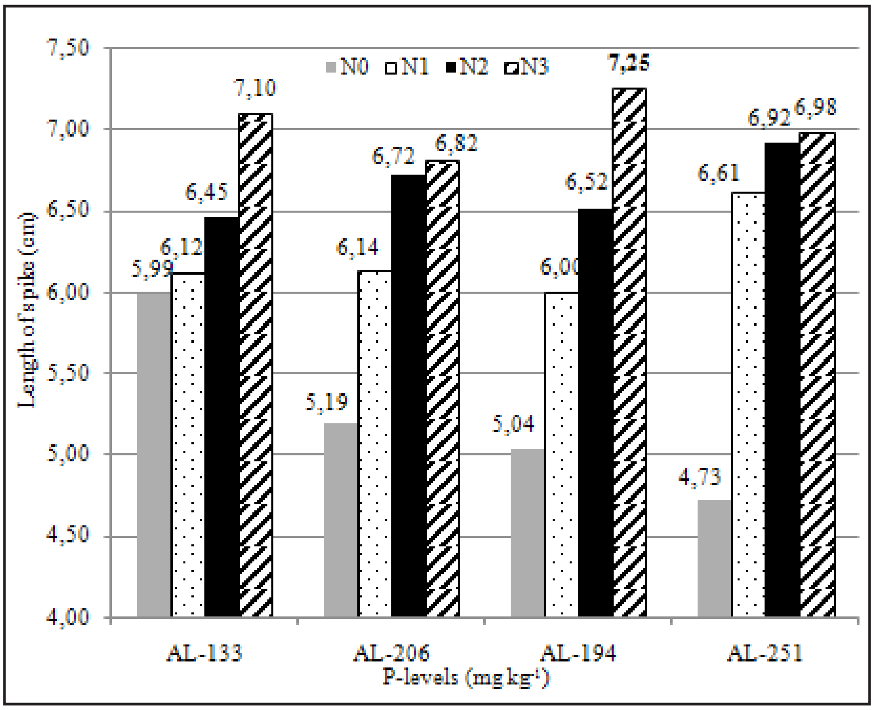

Figure 3. Effect of N- and P- supply on length of spike (cm)

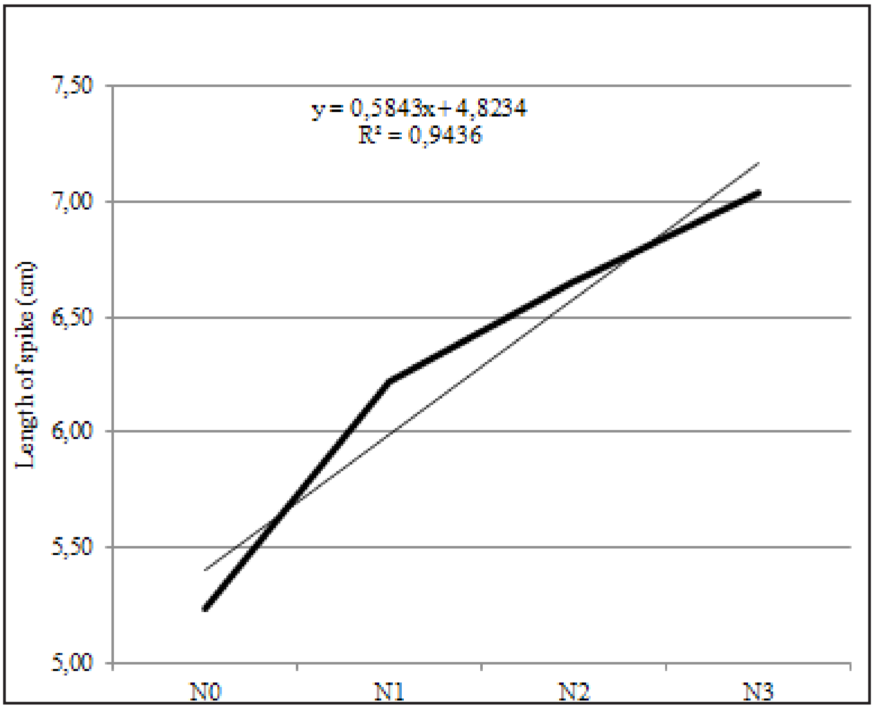

Figure 4. Correlation between the N-supply and length of spike (cm)

number per spike (Figure 5.) – on the average of P- supplies (13.64; 16.43; 17.46; 18.19 grain number per spike) and we found close correlation (r=0,95) between grain number per spike and N-supply, too (Figure 6.). The P-fertilization – without N- treatment – acted on the decrease of the grain number per spike. We got the smallest grain number in case of P_3N_0 – supply, the most in case of a N_{240} kg ha^{-1} year^{-1}, by P_2-level (18.9 grain number per spike).

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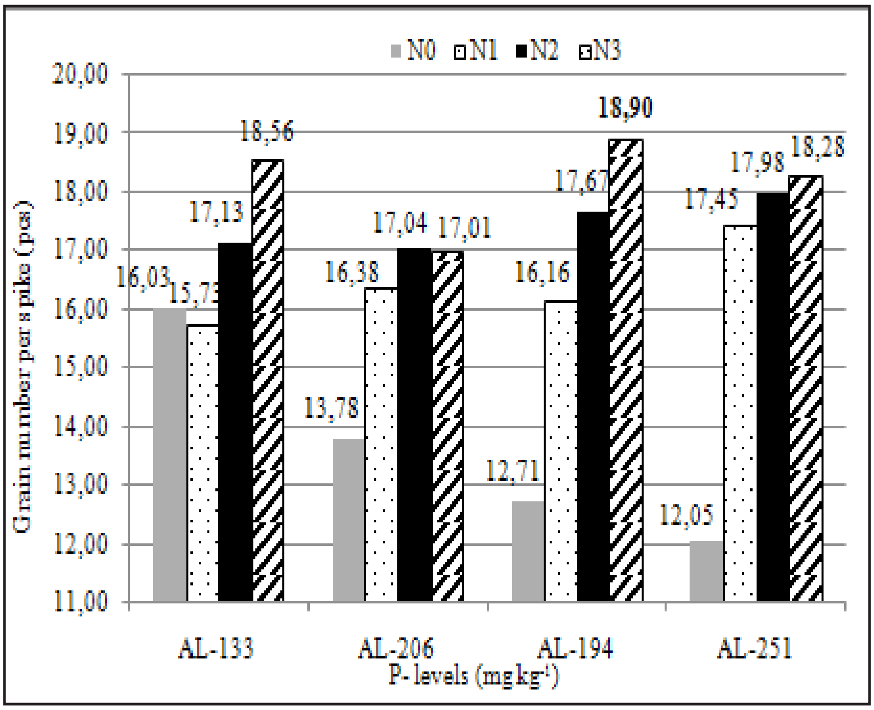

Figure 5. Effect of N- and P– supply on grain number per spike (pcs)

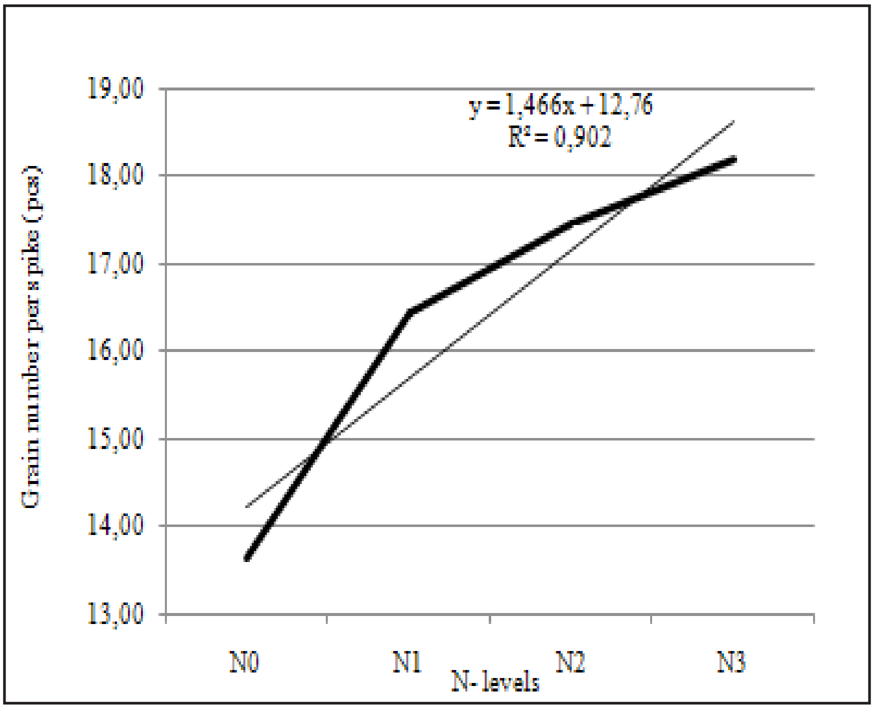

Figure 6. Correlation between the N- supply and grain number per spike (pcs)

Relationship between N-, P- supply and the yield of winter barley

In case of yield quantity, N- supply as well as P- supply affected on yield. Increasing the N- and P- supply (P_2N_2) after a level caused the decrease of yield (Figure 7.). The highest yield was obtained in case of P_2N_2. We found very close correlation in case of N- supply (Figure 8.) and P-supply, too.

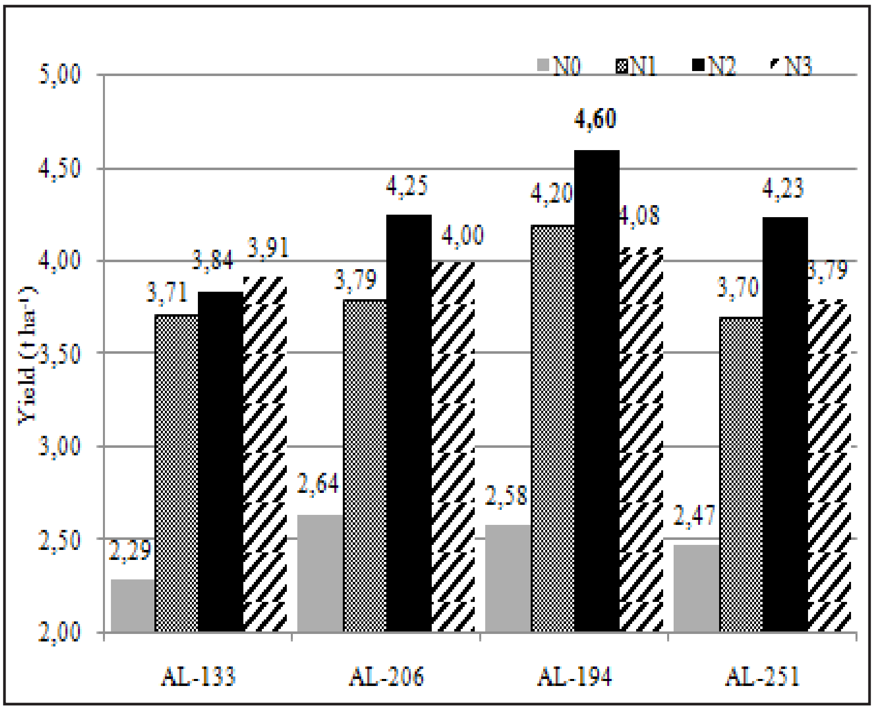

Figure 7. Effect of N- and P- supply on yield of winter barley (t ha^{-1})

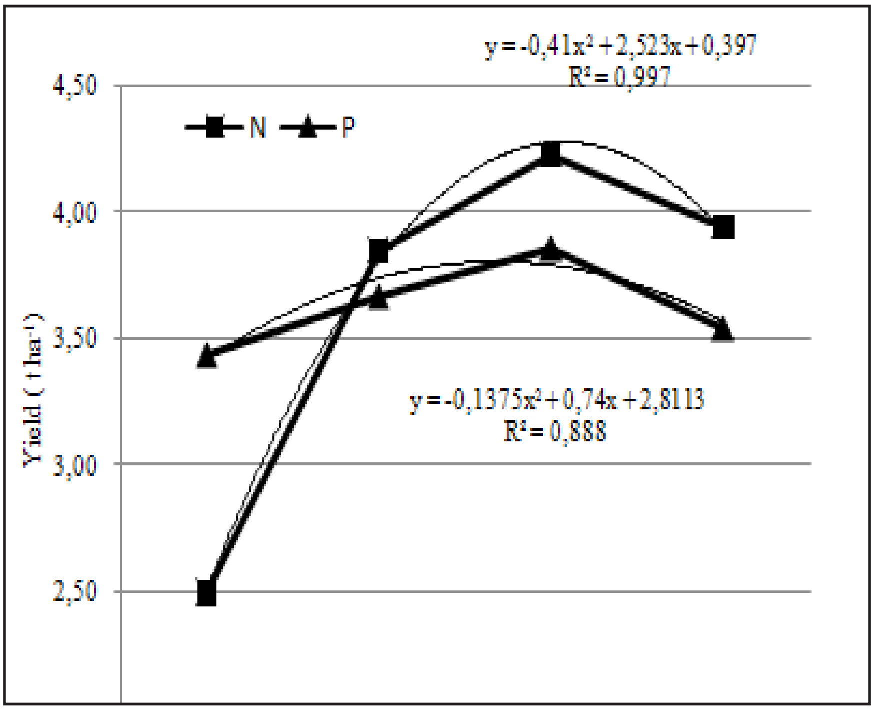

Figure 8. Correlation between the N- and P- supply and grain (t ha^{-1})

Conclusions

We measured the most extended height of plant, length of spike and the grain number per spike in case of the maximum N- supply (N_{240} kg ha^{-1} year^{-1}), but the maximum yield was resulted by N_2- supply ((N_{160} kg ha^{-1} year^{-1}). We received the longest of stem at P_2N_3- level, but the excessive N- supply raised predisposition on lodging, which may lead to yield decrease. The P- supply applied did not show so much

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effect on the height, length of spike and on the grain number per spike of winter barley as we found in case of N- supply. Yield of winter barley was increased at 160 kg N ha^{-1} $year^{-1}$. A bigger N- supply caused decrease of yield figures. The P- supply resulted in the maximum yield on 194 mg kg^{-1} AL- P_2O_5-level. The excessive P-level (251 mg kg^{-1}) caused decrease of yield.

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