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Response of maize to phosphorus fertilization in Posavina Canton

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Abstract

The field trial of phosphorus fertilization was conducted on calcareousalluvial alkaline soil of Posavina Canton (Bosnia and Herzegovina) in spring 2011: a) unfertilized; b) basic fertilization = 75 P_2O_5 kg ha^{-1}; c) a + 200 P_2O_5 kg ha^{-1}; d) a + 400 P_2O_5 kg ha^{-1}; e) a + 800 P_2O_5 kg ha^{-1}; f)a +1200 P_2O_5 kg ha^{-1}.The experiment was conducted in four replicates (basic plot 60 m^2). In this study maize (hybrid OsSK596) response (the 2011 growing season) was shown. Mean yield of maize grain of the fertilization treatments (b-e) in level of 11.03 t ha^{-1} was relative low due to less favorable weather conditions. Maize yield increases were 8% and 53% by f:b comparison and f:a comparison, respectively.

Key words: grain yield , maize, low-P calcareous soil, phosphorus fertilization

Introduction

Low levels of plant available phosphorus (P) is limiting factor of soil fertility in Bosnia and this nutritional disorder is mainly in connection with low pH (Okiljević et al., 1997; Resulović and Čustović, 2002; Marković and Supić, 2003; Marković et al., 2006; Komljenović et al., 2010). However, low P availabilities were found as considerable rare phenomenon on calcareous alluvial soils (Antunović et al., 2012). Applications of the higher P rates by fertilization are solution for improvement of soil fertility of P-deficient soils (Petosic et al., 2003, Komljenović et al., 2006, 2008). Aim of this study was testing maize response to ameliorative P fertilization on calcareous alluvial soil soil in PosavinaCanton of Federation of Bosnia and Herzegovina.

Material and methods

The field experiment

The field experiment of increasing rates of phosphorus fertilization was conducted in Posavina Canton (Odjak municipality, Vojskovaarea; Family Farm Jovic from Prud) of Federation entity (Bosnia and Herzegovina) in March 12, 2011.The fertilization treatments were as follows: a) unfertilized; b) basic fertilization = 75 P_2O_5 kg ha^{-1}; c) a + 200 P_2O_5 kg ha^{-1}; d) a + 400 P_2O_5 kg ha^{-1}; e) a + 800 P_2O_5 kg ha^{-1}; f)a +1200 P_2O_5 kg ha^{-1}.The experiment was conducted in four replicates (basic plot 60 m^2). Unfertilized plot (a) was conducted out of the experiment in continuation to the next about 100 m longitude of the experimental soil. Triplesuperphosfate (36 % P_2O_5 + 0.5 % water soluble Fe) originating from Adriatico Spa Loreo, Italy was used as source of phosphorus for basic fertilization. The source of P for increasing rates of P (the treatments b - e) was monoammonium phosphate or MAP (13% N + 53 % P_2O_5) of Petrokemija Fertilizer Factory Kutina, Croatia. Nitrogen added by MAP was equalized to level of 196 kg N ha^{-1} by using CAN (calcium ammonium nitrate: 27% N + 4.8 % MgO).

Maize hybrid OsSK596 originating from Agricultural Institute Osijek was sown in term April 18, 2011by pneumatic planting machine on planned plant density (PPD) 57143 plants ha^{-1}.Maize was harvested in September 28, 2011 and two internal rows of each replicates were harvested manually (basic plot of harvest: 10.5 m^2). Mass of cob was weighed by Kern electronic balance (d = 50 g). Ten maize cobs from of each basic plot

were taken for determination of grain moisture and shelling percentage. The cobs and grain of these samples were weighed by more precise Kern electronic balance (d = 5 g). Grain yield were calculated on 14% grain moisture and realized plant density basis. Plant density realization (PDR) was calculated by addition of plant numbers from total eight rows in level of the treatment and convert in plants per hectare and in percent of PPD. Sterile plants were calculated identically as PDR as difference between plants and cobs numbers.

Soil sampling and chemical analysis

Soil sampling was made by auger up to 30 cm of depth in term March 12, 2011 after conduction network of the experiment and before the planned fertilization according the scheme. Total 20 bores (one bore per basic plot) were made for the mean soil sample. The sample was prepared and analyzed in the Department of Agroecology, Faculty of Agriculture Osijek. Soil pH and humus were determined according ISO (1994, 1998). Plant available phosphorus nd potassium were determined according the AL-method (Egner et al., 1960).

Soil properties and weather characteristics

The experiment was conducted on Vojskova calcareous alluvial non-compacted soil situated close to watercourse of Staracariver. By soil test alkaline reaction (pH in 1n KCl: 7.95), moderate humus contents were found. Also, the soil was adequate supplied with potassium and low in phosphorus (Table 1).

Table 1. Soil characteristics

Soil properties (0-30 cm depth; sampling March 12, 2011 before starting of the of the trial)						
Soil designation	Soil pH H_2O	KCl	(mg/100 g) P_2O_5	K_2O	% Humus	% $CaCO_3$
Vojskova soil, plot Staraca	8.09	7.95	5.9	23.64	2.07	6.32

Table 2. Weather characteristics for Gradiste(close to Zupanja, Croatia) in 2011 growing season (Meteorological and Hydrological Service, 2011).

Period	GradisteWeather Bureau (LTM = long-term averages 1961-1990)							April - Sept.	
	Jan.-March	April	May	June	July	Aug.	Sept.	Total	Mean
	Precipitation (mm)							mm	^oC
2011	92	15	48	38	84	4	16	205	
LTM	119	53	66	81	72	66	56	394	
	Mean air-temperature (^oC)								
2011	3.0	13.9	20.3	21.1	22.4	23.5	20.7		20.3
LTM	3.2	11.5	16.7	19.6	21.2	20.7	16.6		17.7

The growing season 2011 was less favorable for maize because of water shortage and the higher air–temperatures, especially in August. For example, precipitation quantity in August (Gradiste: about 20 km distance from the experiment) was only 4 mm (long–term mean or LTM: 1971–1990 = 66 mm) and it was accompanied with mean air–temperature 23.4 ^oC (mean 1971–1990: 20.7 ^oC). Also, in the 6–month April–September period, precipitation quantities were 205 mm or about 50% lower and air–temperatures were 2.6^oC higher compared to LTM (Table 2).

Results and discussion

Mean yield of maize grain of the fertilization treatments (b-e) in level of 11.03 t ha^{-1} was relative low because used maize hybrid OsSK596) has considerable higher yield potential. However, this yield is result of less favorable weather conditions (Table 2). The higher yields of maize found in the growing seasons characterized the higher precipitation and the lower temperatures, especially in two summer months July and August (Shaw, 1988; Kovačević et al., 2009a, 2009b; Maklenović et al., 2009; Markulj et al., 2010). Under these conditions response of maize to P fertilization was low because yields were increased up to 8% only compared to basic fertilization. However, yield increase compared to unfertilized plot was 53% (Table 3). Also, the higher sterile plants contributions and the higher grain moisture were found in maize grown on the unfertilized treatment (12.7% and 7.3% and 22.3% and 21.1%, for *a* and*b-f* sterile plants and moisture status, respectively).

Table 3. Response of maize (the hybrid OsSK596) to phosphorus fertilization

The experiment Staraca (Vojskova calcareous alluvial soil): the growing season 2011						
Fertilization		Plant density (PD)*		Sterile	Grain	Grain
(12. 03. 2011.)		PDR	PPD	plants	moisture	yield
(P_2O_5 kg ha^{-1})		Plants ha^{-1}	(%)	(%)	(%)	(t ha^{-1})
a	unfertilized	53282	93.2	12.7	22.3	7.34
b	75 + 0	54633	95.6	6.0	21.0	10.76
c	75 + 200	55019	96.3	6.2	21.0	11.25
d	75 + 400	53861	94.2	9.3	21.2	10.94
e	75 + 800	55019	96.3	7.0	21.2	11.61
f	75 + 1200	55598	97.3	8.0	21.0	10.58
Average		54569	95.5	8.2	21.3	10.41
* PDR = PD realization, PPD = planned PD				LSD 5%	1.1	1.0
(100% PPD = 57143 plants ha^{-1})				LSD 1%	ns	1.4

Two additional field experiments were started in area of Odjak municipality at same time as Staraca experiment. Five rates of phosphorus up to 900 kg $P_2O_5ha^{-1}$ were used on Trnjaci calcareous soil low in available P and soybean was grown in the experiment for the 2011 growing season. By using 300 kg $P_2O_5ha^{-1}$ grain yield of soybean was increased for 20% compared to basic fertilization. Using of the higher P rates resulted by increases of grain protein contents for 2.56% and decrease of oil contents for 1.19% in comparison to the control (Antunovic et al., 2012). In the third experiment on Gornja Dubica acid soil, hydratized calcite in three rates up to 14.0 t ha^{-1} were applied. The mean grain yield of the maize hybrid OsSK596 in the 2011 growing season was only 6.13 t ha^{-1} or for 41% lower than in the phosphorus fertilization experiment. Using the highest rate of lime resulted by yield increase for 12% (5.82 and 6.53 t ha^{-1}, respectively) in comparison to the control (Jovic – the thesis, unpublished data).

Komljenović et al. (2006, 2008) applied ameliorative P fertilization in form of triple superphoshate up to 1500 kg P_2O_5 ha^{-1} on Knespolje soil in the northern Bosnia. The yield increases in 3-year testing were, depending on the year, from 17% to 32%. In the next study, Komljenović et al., (2010) applied triple superphosphate in rates up to 1750 P_2O_5 kg ha^{-1} on low-P acid Gradiska hydromorphic soil of northern Bosnia. P fertilization resulted mainly in considerable yield increase being 17% (4-year means: 4.30 and 5.02 t ha^{-1}, for control and ameliorative P-fertilized treatments, respectively). Yield increases were achieved mainly by application of the first step of P in level of 750 kgP_2O_5 ha^{-1}. However, by liming of Gradiska hydromorphic soil considerable higher response of maize were found because by application of dolomite up to 20 t ha^{-1} maize yield was increased (3-year average) for 48% (Markovic et al., 2008).

Conclusions

The growing season 2011 was less favorable for maize growing because of drought and the high air-temperatures, especially in August and September. Under these conditions, low response of maize on P rates added by fertilization was found. However, maize yield of unfertilized plot was 33% lower in comparison to average of P-treatments.

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Reakcija kukuruza na gnojidbu fosforom u Posavskom kantonu

Sažetak

Poljski pokus gnojidbe fosforom postavljen je na karbonatnom aluvijalnom tlu Posavskog kantona (Bosna i Hercegovina) u proljeće 2011.: a) negnojeno; b) osnovna gnojidba = 75 P_2O_5 kg ha^{-1}; c) a + 200 P_2O_5 kg ha^{-1}; d) a + 400 P_2O_5 kg ha^{-1}; e) a + 800 P_2O_5 kg ha^{-1}; f) a +1200 P_2O_5 kg ha^{-1}. Pokus je postavljen u četiri ponavljanja (osnovna parcela 60 m^2).U radu je prikazana reakcija kukuruza (hibrid OsSK596) u vegetaciji 2011. Prosječan prinos kukuruza na gnojenim tretmanima (b-e) iznosio je 11.03 t ha^{-1} bio je relativno nizak zbog nepovoljnih vremenskih prilika. Prinos kukuruza je povećan za 8%, odnosno za 53% usporedbom f:b, odnosnof:a.

Ključne riječi: prinos zrna, kukuruz, karbonatno tlo, gnojidba fosforom