EFFECT OF POTASSIUM APPLIED ON DIFFERENT NP BACKGROUND ON YIELD OF WINTER WHEAT IN PRELUVOSOIL CONDITIONS FROM WESTERN PART OF ROMANIA IN 2008-2010 PERIOD

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Abstract

Wheat requires significant amount of potassium for optimum growth and development. Adequate potassium fertilization improves the quality of the active plant due to improved efficiency of photosynthesis, increased resistance to same diseases and greater water use efficiency. In Romania, potassium fertilizers have been used much less that nitrogen and phosphorus fertilizers and therefore much less research work has been done concerning their placement and their effect on yield and quality production. In this paper will discuss the role potassium plays for yield and hectolitre mass in preluvosoil conditions from western part of Romania. The long term field experiment was carried out at the Agricultural and Development Research Station Oradea – Romania, begining with 1974 to ascertain the effect of potassium application on wheat in a crop rotation. Four different level of potassium (K) were applied on four NP backgrounds. The best performance of the crop parameters was recorded when 80 kg/ha was applied a different NP backgrounds.

Key words: Winter wheat, potassium, background, yield, hectoliter mass.

INTRODUCTION

In Romania the efficacy of potassium fertilizers is weaker compared with that of nitrogen and phosphorus fertilizers (Ştefănescu and Tianu, 2001, Ciobanu, 2007b, Marinciu and Săulescu, 2008). Lots of researches have shown that the efficacy of potassium fertilizers depends on the nitrogen and phosphorus fertilizers (Brucher and Moroy, 1988, Cakmak, 2002). The efficacy is lower when potassium fertilizers are applied alone or only on phosphorus background but it increases when it is applied on nitrogen background (Pépo, 2002, Győri and Sipos, 2006, Burlacu, 2007). The soils need for potassium occurs primarily on soil that is lower in potassium supply, especially when high amounts of nitrogen and phosphorus fertilizers are applied on this soil (Albert, 2001, Noordwijk and Cadisch, 2002, Tanács et al, 2004, Szentpétery et al., 2004, Csathó, 2007). Variations in yield level of Romanian wheat crop have been claimed, due to the lack of suitability of the new Romanian varieties to new climatic conditions (Wagner and Tabără, 2007, Şandor et. al, 2010); however, some studies have shown that the main causes for this situation are inadequate technology requirements, especially

unbalanced fertilization (Hera et al., 1986, Cakmak, 2003, Ciobanu, 2007a, Tabără, 2008, Şemun, 2010).

In this paper, we analyses the influence of potassium fertilizers in a long time application on different NP backgrounds on yield wheat and its hectoliter mass – Crişana variety.

MATERIAL AND METHOD

Experimental site

The research data were obtained at the Agricultural Research and Development Station in Oradea in the long term field experiments with fertilizers, using a unique design in the entire research network of Research Institute of Fundulea.

The investigation has been carried out beginning with the autumn of 1974 in Oradea, in a flat plain area on the third terrace of the Crisul Repede River, whose geographical coordinates are: $21^0$56' Eastern longitude, $47^0$03' Northern latitude and 136 m altitude.

The solidification of rock consists of clay loam. The ground water is located at a depth of 6-8 m. The soil is a brown one with horizontal disposition and the main physical and chemical characteristics are shown in table 1. The presence of clay migration, B horizon is to be noticed in the thickness of the soil profile, with high and very high values of the bulk density and compaction level and low or very low total porosity and hydraulic conductivity.

Table 1

The main properties of the preluvosoil from Oradea – Romania

Soil depth cm	Sand	Silt	Clay	OC	Humus %	Ca CO_3 %	Al mobile mg/100g soil	PH 1:2 H_2O	N Total %	P mobile ppm	Kmobile ppm
0 - 5	43.5	28.3	28.2	1.25	2.32	0.00	3.68	6.3	0.12	21.8	83.0
5 - 15	41.8	28.4	29.8	1.12	2.28	0.00	2.32	6.4	0.11	22.7	102.1
15 - 30	40.0	28.5	31.5	1.02	1.91	0.00	0.52	6.3	0.09	5.7	112.1
30 - 60	32.0	28.0	40.0	0.99	1.93	0.00	0.77	6.6	0.09	6.1	117.9
60 - 90	24.1	36.7	39.2	0.29		0.00	0.32	6.6			
90 - 150	35.1	27.3	37.6	0.17		0.00	0.59	6.5			

The soil reaction is acid in the ploughing A horizon, then slightly acid. The lack of $CaCO_3$ in the soil profile is underlined. The mobile Al content in the A horizon may cause poor growth of some crops (clover). The soil is well provided with mobile potassium and phosphorus. The soil humus medium content may not cause distortions to the neutronic determination of the soil moisture (Table 2).

Table 2

The main agrochemical properties of preluvosoil in long term field experiment

K Rates	NP Rates	The soil content in nutritive elements			
		pH	Humus %	Mobile P ppm	Mobile K ppm
K_0	N_0P_0	6.1	1.59	48.2	95.8
	$N_{80}P_{40}$	5.92	1.66	35.6	127.2
	$N_{80}P_{80}$	5.65	1.83	36.3	173.1
	$N_{160}P_{80}$	5.05	1.71	45.1	208.3
Average		5,68	1.69	41.3	151.1
K_{40}	N_0P_0	5.75	1.75	81.3	87.3
	$N_{80}P_{40}$	5.78	2.04	72.4	124.9
	$N_{80}P_{80}$	5.52	2.28	71.8	150.3
	$N_{160}P_{80}$	4.91	1.87	68.1	161.3
Average		5.49	1.98	73.4	130.8
K_{80}	N_0P_0	5.62	1.98	128.3	88.9
	$N_{80}P_{40}$	5.55	2.5	120.1	117.1
	$N_{80}P_{80}$	5.45	2.37	101.5	140.6
	$N_{160}P_{80}$	4.68	1.87	95.2	127.3
Average		5.32	2.09	111.2	118.5
K_{120}	N_0P_0	5.48	1.75	82.5	69.7
	$N_{80}P_{40}$	5.45	2.04	73.4	107.1
	$N_{80}P_{80}$	5.21	2.28	70.2	126.1
	$N_{160}P_{80}$	4.55	1.87	65.2	147.6
Average		5.17	1.98	72.8	112.6

Long term NPK fertilizers application determines a differentiated evolution of preluvosoil chemical properties depending on the fertilizers rates applied, this having a strong influence on wheat yield and its quality.

The experiment was designed as a completely randomized block with four replications. All plots were seeded at a rate of approximately 550 seeds/m^2, using Crişana variety (created at Agricultural Research and Development Station Oradea), classified in A2 (B1) valuable group, being appreciated as an ameliorative one. It is recommended to be cultivated in the hill area of Crişana, Maramureş, Transylvania and Bucovina and in the plain area of western Romania. All samples were taken after seed sowing at the end of October and harvesting at the beginning of July. The total amount of N was applied in split: ½ at sowing and ½ in spring at the beginning of stem elongation of the crop. The phosphorus and potassium rates were given at sowing.

Field experiment with potassium fertilizers was set up in 1974 using a crop rotation: pea – winter wheat – maize – sunflower.

We have organized field experiments involving two experimental factors:

A factor – K fertilization

a_1 - K_0; a_2 - K_{40}; a_3- K80, a_4- K_{120}

B factor – NP fertilization

b: NP rates: b_1- N_0P_0; b_2- $N_{80}P_{40}$; b_3- $N_{80}P_{80}$; b_4- $N_{160}P_{80}$.

(N was applied as ammonium nitrate in spring, P was applied as superphosphate and K as KCl in autumn).

The crop rotation used in the field experiments was sunflower - wheat - corn - wheat.

The experiment maintenance imposed the following crop measures: chemical fertilization, using Nitrogen-based fertilizers in accordance with doses assessed for each experimental variant; weed control was performed using RIVAL and STAR control products; no treatments were done to control crop diseases. Harvesting was done at full plant maturity and was performed mechanically for each experimental field. In the field experiment the influence of fertilizers applied on wheat kernels yield was determined, and a statistical interpretation of the yield differences obtained between different treatments was made.

For each experimental variant, plant samples were taken in order to perform biometrical measurements as well as grain samples to test physical characteristics and to determine the main bread and milling characteristics.

Sampling and analytical method

Soil samples from top soil (0-20cm) were collected from each experimental plot in August 2010 after wheat harvesting.

All samples were taken to the laboratory and used for routine soil chemical analysis. PH was determined in water suspension.

The harvested grain was subjected to quality analysis in triplicate. Grain samples from three replications were evaluated for quality characteristics. The determination of test weight, grain moisture and hectoliter mass was done using standard methods.

RESULTS AND DISCUSSION

Effect of potassium on wheat yield level

Long term KxNP fertilizers application influenced the main agrochemical properties and this clearly reflected in grain yield obtained. The analysis of fertilized wheat variants has shown that potassium fertilizers applied in preluvosoil conditions had a differentiated influence on yield depending on the rate K level and of NP background utilized (Figure 1).

In the case of an N_0P_0 background the general level of yield wheat is low and the gains obtained as a result of potassium fertilizers application are very small. The values of yield level are ranging between 10 q/ha and 15 q/ha; the yield level obtained in variants fertilized with K_{120} is almost equal with the yield level obtained in variants fertilized with K_{80}.

In the case of $N_{80}P_{40}$ background the yield values ranged between 25 and 40 q/ha the maximum yield level being obtained in variant fertilized with K_{80}.

In variants fertilized with potassium applied on $N_{80}P_{80}$ the yield level has values between 36 and 45 q/ha, the maximum gain being 9 q/ha in the case of variants fertilized with K_{120} while in the case of background $N_{160}P_{80}$ the yield level values range between 50 and 55 q/ha, the maximum gain being obtained through K_{80} fertilization.

The best experimental results were obtained in the period 2008 – 2010, in the case of using $N_{160}P_{80}K_{80}$ rates, the maximum yield level was 55 q/ha.

The rate of 80 kg K_2O/ha applied on each NP background determined the higher yield spores.

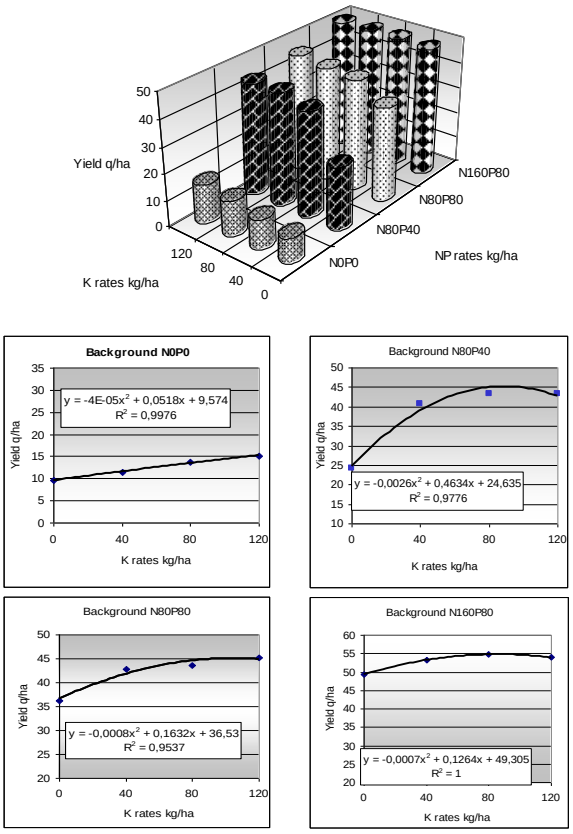

Fig. 1. The influence of KxNP fertilizers on winter wheat yield in preluvosoil conditions from Oradea 2008-2010

Hectoliter mass

Hectoliter mass (HM – kg/hl) is significantly influenced by the background created in long term field experiments and had a positive influence on grain yield.

According to the technical requirements, the hectoliter mass of wheat for bread manufacture has to be over 75 kg/hl and it is considered to be very good when HM is over 78 kg/hl.

The highest values for hectoliter mass were registered in the following variants $N_{80}P_{80}K_{80}$ and $N_{160}P_{80}K_{80}$.

The application of potassium fertilizers on each NP background leads to an increase in the values with 3 – 5 kg/hl.

The HM values from 80 kg/hl to 83 kg/hl show that potassium fertilization facilitates the grain filling (Figure 2).

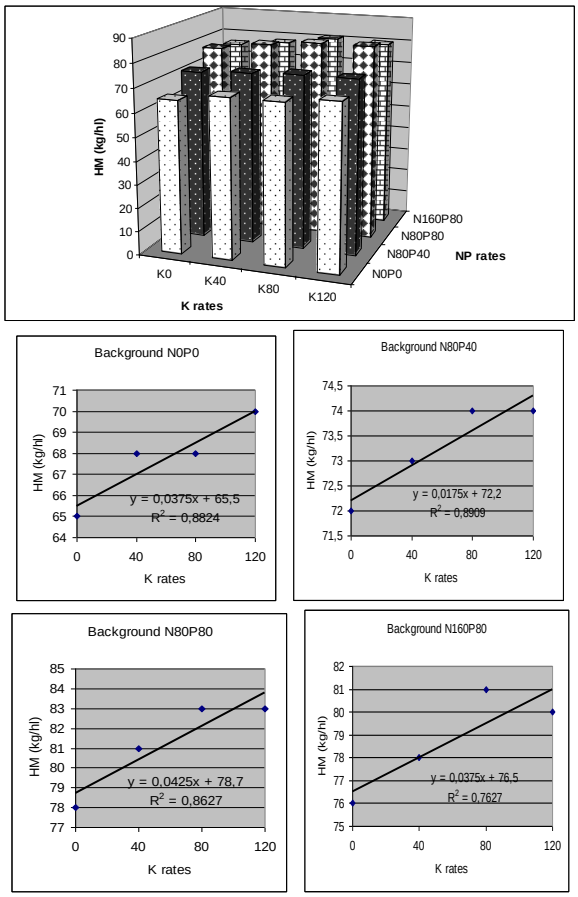

Fig. 2. The influence of KxNP fertilizers on hectoliter mass of winter wheat yield, Oradea 2008-2010

CONCLUSIONS

The potassium favors the synthesis of the carbon hydrates and contributes to resistance to drought and disease of the plants, which is positively correlated with yield level and hectoliter mass.

Long term balanced NPK fertilization maintains the potential preluvosoil fertility at a level that allows obtaining high wheat yields of good quality.

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