THE EFFECT OF CROP ROTATION AND MINERAL FERTILIZATION ON THE YIELD OF WINTER WHEAT IN A LONG-TERM FILED EXPERIMENT

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Abstract

The effects of crop rotation and nutrien supply, as well as were studied on the crop yields of winter wheat variety GK Csillag during the 2010/2011 crop year. The experiments were conducted in triculture (pea – wheat – corn) and biculture (wheat – corn), at five nutrition levels, with the use of one crop protection technologie (conventional) at the Látókép Research Site of the University of Debrecen, Centre of Agricultural Sciences.
The crop rotation system influenced the optimal level of fertilization. Following corn pre-crop, the maximum of wheat yields was achieved at N_{200}+PK level, in all three crop protection technologies (8423 kg·ha^{-1}). In triculture after pea pre-crop the maximum rates were achieved at N_{100}+PK level (10050 kg·ha^{-1}). In biculture crop yields significantly increased up to N_{200}+PK nutrition level. In tricultue at N_{100}+PK nutrition level no significant increase was found.

Key words: winter wheat, forecrop, fertilization, yield

INTRODUCTION

Winter wheat is one of the crops with the highest reaction to fertilization. In the recent decades a significant increase in yields has been achieved by the use of higher-yielding varieties and the application of fertilisation (Pepó-Ruzsányi 1990). Due to applied higher fertilizer amounts and better quality the yield safety of the crops increased as well (Koltay-Balla 1982). Nelson (1982) calls the attention to the importance of the timing of N-fertilisation, for the early applied N can be utilized better by the crops.

Pepó (2009) has stated the optimal fertilizer dosages for winter wheat: depending on the crop-year and irrigation $N_{150-200}$+PK is optimal for bi-culture, while in case of tri-culture this value varies in the range of N_{50-150}+PK. Montemurro (2007) has not detected any further change in yield amount or protein-content of winter wheat at a fertilizer dosage between N_{120}+PK and N_{180}+PK. Márton (2002) has revealed that N-, NP- and NPK-fertilisation has resulted in a yield-increment of 1 t ha^{-1} in contrast to the

control plots. The yield of winter wheat could be increased economically only in the full-treatments with NPK-(3,4 t ha^{-1}) and NPKMg-(3,7 t ha^{-1}).
In a certain crop-year it is the nutrient-supply among all external agro-technical production factors that has the most significant effect on the quality parameters of winter wheat, because this crop is one of the crops with the highest demand and reaction to nutrient-supply (Győri and Győriné Mile, 1998). According to Pepó (2002), one of the most important production factors in winter wheat production technology is the nutrient-supply, for this factor affects indirectly or directly all other technological elements.

The modifying effect of the pre-crop to the nutrient-amount is quite complex. Győrffy (1975) has revealed in his long-term experiment in Martonvásár in the average of the crop-years between 1960 and 1972 that the yield of monoculture-wheat was 14-35% lower than that of any other crop-rotation. Tóth-Kismányoky (2001) has stated that the direct pre-crop affected the grain-yield of winter wheat in a significant extent, but the composition of the crop-rotation system did not have any significant effect. In this experiment oat-vetch mixture proved to be the best pre-crop for winter wheat, while Sudan grass was the worse.

MATERIAL AND METHOD

The experiments were conducted as part of the long-term trial adjusted by Prof. Dr. László Ruzsányi in 1983, in triculture (pea – wheat – corn) and biculture (wheat – corn), at five nutrition levels, with the use of one crop protection technologie (conventional) at the Látókép Research Site of the Centre of Agricultural Scienses, University of Debrecen. The research area is located on the Hajdúság loess ridge, 15 km from Debrecen, along Route 33. The wheat variety used in the long-term trial was GK Csillag, which was sown at 5,8 million germs/ha (October 24th, 2010.).

The soil of the research site is plain and homogen, its genetic soil type is calciferous chernozem. Starting state data show that the soil-physical category of the soil is loam, its pH value is almost neutral, phosphorus supply is medium, and potassium supply is medium – good. Humus content is medium, the thickness of humus layer is about 80 cm. Estimated depth to groundwater is 3-5 m.

The agrotechnical interventions applied in the trial met the requirements of modern wheat cultivation. In the conventional plant protection technologie the crops were protected against weeds with the combination of Solar 0,2 l/ha + Duplosan DP 1,5 l/ha + Mezzo 10 g/ha (April 20th, 2011). In the stock where conventional plant protection technology was applied, Tango Star was used in a 0,8 l/ha dose (May 20th, 2011.), while pest control measures were not applied.

In the vegetation period of 2010/2011 there was a significant difference between the weather conditions of the autumn-winter and spring-early summer months. This significantly determined the vegetative and generative development, ear-development, fertility and grain development processes of winter cereals. There was a contrast between the weather conditions of the vegetation period of 2010/2011. While the autumn-winter months were wet, the weather of the spring-early summer months was rather dry.

The slow sprouting in October could be compensated by the favourable effect of the November weather to the development of the crop and tillering. The different temperature periods in December have hardened the winter wheat cultures sufficiently. This and the properly thick and lasting snow layer have ensured a good protection against the hard January and particularly February weather. Due to the warm weather in the spring the development of winter wheat cultures was faster than the average. June could be characterized with low precipitation and warm temperatures. The cool and wet weather in the beginning of July had a delaying effect to the harvest and decreased the yield of winter wheat cultures.
Table 1. summarizes the tendency of the meteorological factors during the crop year of 2010/2011.

Table 1.

Meteorological parameters in the vegetation period of winter wheat (precipitation, mean monthly temperature, Debrecen, 2010/2011.)

Month	Precipitation (mm)			Month	Temperature (^{0}C)		
	2010/2011	30-year average	Difference 2011		2010/2011	30-year average	Difference 2011
October	22,8	30,8	-8	October	6,9	10,3	-3,4
November	52,9	45,2	7,7	November	7,7	4,5	3,2
December	104,2	43,5	60,7	December	-1,7	-0,2	-1,5
January	19,2	37	-17,8	January	-1,2	-2,6	1,4
February	16,8	30,2	-13,4	February	-2,5	0,2	-2,7
March	35,1	33,5	1,6	March	5	5	0
April	15,6	42,4	-26,8	April	12,2	10,7	1,5
May	52,3	58,8	-6,5	May	16,4	15,8	0,6
June	22	79,5	-57,5	June	20,5	18,8	1,7
Total annual precipitation (mm)	340,9	400,9	-60	Mean annual temperature(^{0}C)	7,0	6,9	0,1

RESULTS AND DISSCUSIONS

The effect of the different crop rotation and fertilization on winter wheat yield are summarised in *Table 2.* Following corn pre-crop, the maximum of wheat yields was achieved at N_{200}+PK level (8423 kg·ha^{-1}). In triculture after pea pre-crop the maximum rates were achieved at N_{100}+PK level (10050 kg·ha^{-1}). The crop rotation system influenced the optimal level of fertilization. Having compared the maximum crop yield of the stands after corn and pea precrops, we found that the wheat yield in triculture was 1627 kg ha^{-1} higher than in biculture. The reason for that is the fact that pea increases the nitrogen supply of the soil, spares its hydrological regime, has favourable effects on the physical and chemical properties, hereby increases yield amount. In biculture crop yields significantly increased up to N_{200}+PK nutrition level. In tricultue at N_{100}+PK nutrition level no significant increase was found.

Table 2.

Effect of fertilisation on the yield of the winter wheat in biculture and triculture (Debrecen, 2011.)

Biculture 2011.			Triculture 2011.		
Fertiliser rate (kg ha^{-1})	Repetition	Yield (kg ha^{-1})	Fertiliser rate (kg ha^{-1})	Repetiton	Yield (kg ha^{-1})
Ø	I.	1976	Ø	I.	6796
	II.	2180		II.	6208
	III.	1951		III.	6805
	IV.	2077		IV.	6471
	average	**2046**		average	**6570**
N50+PK	I.	4327	N50+PK	I.	8603
	II.	4005		II.	8492
	III.	4103		III.	9105
	IV.	4353		IV.	9048
	average	**4197**		average	**8812**
N100+PK	I.	6270	N100+PK	I.	9972
	II.	6719		II.	10278
	III.	6403		III.	9905
	IV.	6688		IV.	10045
	average	**6520**		average	**10050**
N150+PK	I.	7458	N150+PK	I.	10170
	II.	8016		II.	9572
	III.	7612		III.	10070
	IV.	7882		IV.	9508
	average	**7742**		average	**9830**
N200+PK	I.	7976	N200+PK	I.	10072
	II.	8703		II.	9240
	III.	8509		III.	9403
	IV.	8504		IV.	9853
	average	**8423**		average	**9642**
SZD 5%		337			461

CONCLUSIONS

The effects of crop rotation and nutrien supply, as well as were studied on the crop yields of winter wheat variety GK Csillag during the 2010/2011 crop year. The crop rotation system influenced the optimal level of fertilization. Following corn pre-crop, the maximum of wheat yields was achieved at N_{200}+PK level, in all three crop protection technologies (8423 kg·ha^{-1}). In triculture after pea pre-crop the maximum rates were achieved at N_{100}+PK level (10050 kg·ha^{-1}). In biculture crop yields significantly increased up to N_{200}+PK nutrition level. In tricultue at N_{100}+PK nutrition level no significant increase was found.

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