PRODUCTIVITY OF TRITICALE (*TRITICOSECALE*) IN ASPECT OF INTERCROPPING WITH NARROW-LEAF LUPINE (*LUPINUS ANGUSTIFOLIUS*)

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ABSTRACT – Productivity of triticale (*Triticosecale*) in aspect of intercropping with narrow-leaf lupine (*Lupinus angustifolius*)
The experiment was conducted in the years 2009-2010 in an experimental facility of Wrocław Agricultural University located in Pawłowice (17º02´E, 51º31´N, on a height of 122 meters above sea level.). The goal of the research was to determine the influence of the way the cropping is performed (pure and mixed sowing of narrow-leaf lupine) on the productivity of the Dublet triticale variety. The mixed cropping had four different proportions of triticale and narrow-leaf lupine sowing. The most important morphological attributes of triticale and the elements of cropping structure were determined.
As an outcome of the performed research the fact was stated, that the sowing proportions affect both whole plants and seeds attributes changes. Influence of narrow-leaf lupine type on the quantity of grain yield in the mixtures was observed. Majority of biometric attributes was showing a statistically significant dependency on the amount of the sowing mixture components.

Keywords: narrow-leaf lupine, triticale, intercropping, yield

INTRODUCTION

According to FAOSTAT data Poland is the world's head producer of triticale. The amount of the triticale production makes half of the wheat production which is a dominant cereal in sowing structure in Poland (FAOSTAT, 2008). In year 2009, according to GUS data, cereals cultivated for seed purposes made 80% of sowing areas. Aside from pure sowing, cereals are also sown in cereal and cereal-legume mixtures. The growing domination of cereals in crops acreage which is observed in few last years in Poland causes some decrease of the share of other species (GUS, 2009). This is not a very beneficial phenomenon from ecological and phytosanitary point of view (FRANCIS, 1989). Cereal monoculture leads to excessive extraction of natural resources of the soil and pest accumulation resulting in a decrease of the yield (JOŃCZYK ET AL. 2007). That is why the growth of other plant species (especially the legumes) in the sowing structure is so significant.
The acreage of legumes crops for seeds intended for fodder usage in 2009 was only 92 thousands hectares of which cereal - legume mixture were half of the sowing acreage (GUS, 2009).

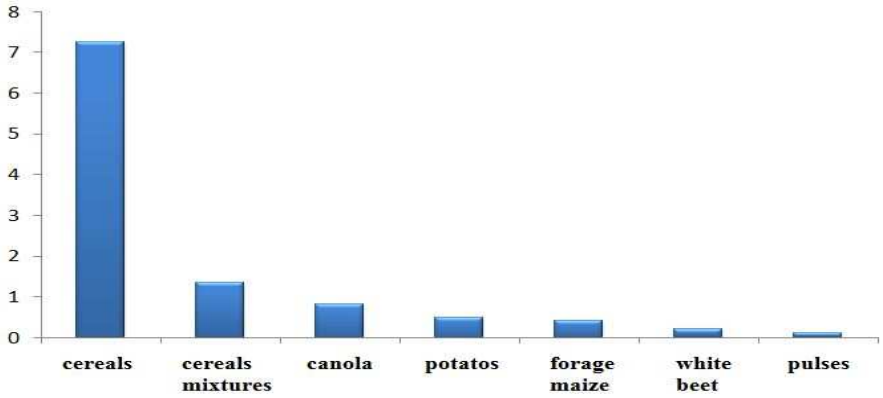

Figure 1. Sowing structure in Poland in millions of hectares, 2009 (GUS)

Plants belonging to *Fabaceae* family, because of the symbiosis with *Bradyrhizobium* bacteria, are limiting the necessity of the usage of high doses of nitrogenous fertilizers and as a result of this also washout of alimentary elements into groundwater is decreased (KSIĘŻAK, 2000; GRZEGORCZYK, OLSZEWSKA, 1997). Cereal-legume mixtures are increasing the biodiversity (KOSTUCH, JANOWSKI, 1999) leading to the yield stability increase (FRANCIS, 1989; NOWOROLNIK, 2000). Cropping of leguminous plants for grains mixed with cereal results with hard feed that is balanced in terms of amino acids content of proteins (KSIĘŻAK ET AL., 2009).
The main aim of research was to determine the influence of diversified intercropping density with narrow-leaf lupine on productivity of triticale. The influence of narrow-leaf lupine type on forming morphological attributes of triticale was also studied.

MATERIAL AND METHOD

The experiment was set up in "split-plot" arrangement in four repetitions in the experimental station of Wroclaw University of Environmental and Life Sciences. In years 2009-2010 field researches on the influence of diversified density of sowing mixture with narrow-leaf lupine on the productivity of spring triticale was conducted. The Dublet variety of spring triticale was cultivated with two types of narrow-leaf lupine: Graf and Zeus. The mixtures were intercropped in four sowing proportions. The control objects were plots with pure sow of spring triticale.

Table 1. Quantity of triticale and narrow-leaf lupine seed per 1 m^2 in intercropping mixtures

Quantity of sown triticale (seeds per m^2)	Quantity of sown narrow-leaf lupine (seeds per m^2)
400	-
320	20
240	40
160	60
80	80

Surface of each plot was 15 square meters, the row width was 15 cm, the depth of sowing was 2-4 cm. The experiment was put on light soil, qualified as V bonitation class. Before the sowing fertilization in doses of 30 kg N, 60 kg P_2O_5, 120 kg K_2O per hectare was applied.
Within the scope of the research on 10 randomly selected plants of triticale from every plot the following attributes were measured: plants height, spike length, flag leaf length, amount of kernels in one spike, weight of kernels in one spike, mass of the productive stalk, mass of the above-ground part and thousand kernels weight. The grain humidity was brought to 13%.

RESULTS

Because of weak branching, the Graf type of narrow-leaf lupine is useful for sowing in a mix with triticale. The Zeus type has a faster growing rate, and gives greater yield of green mass (HR Smolice). The different growing rate of both types of lupine might modify the morphological traits of the spring triticale. Ignaczak and Andrzejewska (1997) observed that cereal plants sown in mixes gave better yield than those sown purely.

Table 2. Morphologicaly traits of spring triticale plants (mean values per year, 2009-2010, G – with Graf, Z – with Zeus)

Quantity of sown seeds [seeds per m^2]		Height of the plant [cm]		Length of the spike [cm]		Length of the flag leaf [cm]		Weight of the above ground part [g]		Weight of the productive stalk [g]	
Lupine	Triticale	G	Z	G	Z	G	Z	G	Z	G	Z
80	80	100,5	101,1	7,5	7,8	11,3	12,8	1,86	1,81	3,72	4,22
60	160	96,0	99,8	6,9	7,0	10,3	10,5	1,51	1,57	3,50	3,59
40	240	92,5	95,5	6,3	6,0	9,3	9,4	1,30	1,32	2,82	3,09
20	320	92,3	96,3	6,3	6,5	9,0	9,8	1,23	1,39	2,58	3,12
-	400	89,5		5,2		8,5		0,99		2,24	
NIR (α =0,05)		4,5		0,6		1,4		0,25		0,60	

Source: own calculation

According to the averages from the years 2009-2010 it was observed that the proportion of triticale in a mix with lupine had an influence on the traits shown in *table 2*. All the analysed morphological traits of spring triticale decreased with the increase of the amount of grain and with the decrease of the amount of narrow-leaf lupine.

Table 3. Traits of spring triticale grain (mean per year, 2009-2010, G – with Graf, Z – with Zeus)

Quantity of sown seeds (seeds per m^2)		Amount of kernels from one spike (szt.)		Weight of kernels from one spike (g)		Thousand Grain Weight (g)	
Lupine	Triticale	G	Z	G	Z	G	Z
80	80	40,6	50,7	1,43	1,91	3,78	3,86
60	160	44,6	45,1	1,59	1,62	3,90	3,81
40	240	36,7	48,4	1,23	1,48	3,55	3,88
20	320	32,5	39,7	1,11	1,44	3,59	3,83
-	400	29,35		1,05		3,76	
NIR (α =0,05)		7,2		0,33		r.n.	

Source: own calculation

The amount and weight of kernels from one spike are related. When the Graf type lupine was used in the mix, the best results were achieved when sowing 160 seeds of triticale and 60 seeds of lupine on a square meter. When the Zeus type lupine was used the amount and weight of kernels from one spike were the greatest when 80 seeds of triticale and 80 seeds of lupine were used in the mix. Also Kotecki et al (2003) observed the decrease of the amount and weight of kernels from one spike with the increase of the number triticale seeds added to the mix. Thousand Grain Weight (TGW) is a trait that is not dependent on the density of the sow and the type of lupine in the mix.

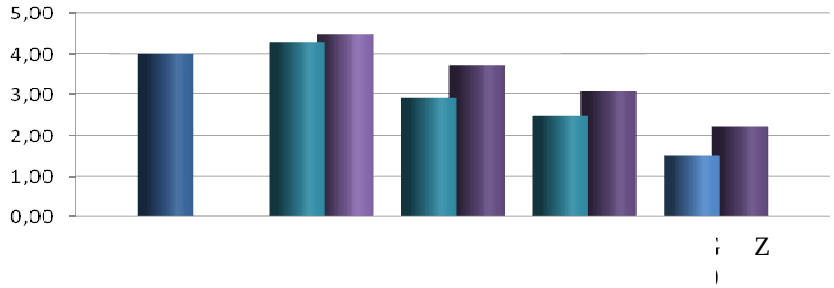

Figure 2. Quantity of triticale grain yield (t·ha^{-1}) (G – with Graf, Z – with Zeus) depending on sow density (triticale/lupine)

Figure 2 shows the comparison of triticale crops acquired from mixes with Graf (G) and Zeus (Z) narrow-leaf lupine types in five sowing proportions. The mix with the Zeus type lupine gave better results in every instance. The best results were achieved with a mixed sowing of 320 seeds of triticale and 20 seeds of any type of narrow-leaf lupine. Kotecki et al. (2003) during the cultivation of triticale and lupine gained best results from pure sowing triticale.

CONCLUSIONS

The averages from the years 2009-2010 for all the analysed traits, excluding the weight of a thousand seeds, have shown a crucial statistical dependence in the amount of spring triticale and narrow-leaf lupine sown on a square meter.
The height of the plant, length of the flag leaf, length of the spike, weight of the above ground part, and the productive stalk were bigger when less triticale was added to the mix, despite the type of the lupine.
The amount and weight of the kernels from one spike are mutually dependent traits. The largest values where achieved while sowing 80 seeds of triticale and 80 seeds of lupine with the Zeus type and 160 seeds of triticale and 60 seeds of lupine with the Graf type.
The yield of crops from both mixes was largest when sown with 320 seeds of triticale and 20 seeds of lupine and decreased when less triticale was added. The size of the crop was dependent on the type of lupine and was larger with the Zeus type.

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