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Influence of N fertilization and predecessors on Triticale yield structure characteristics

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Abstract

The soil and climatic conditions of Stara Zagora are favorable for triticale cultivation. Its productivity is similar to that of wheat. Advantage of triticale compared to wheat, is that it can be grown with success and in mountainous areas, wherever wheat, rye, barley and oats productivity is lower. Nitrogen fertilization and predecessor are factors affecting triticale yield structure parameters determining in a big degree productivity of triticale. The study was carried out with Triticale variety Rogen. Cultivation was performed according to the conventional technology of cropping. Triticale was grown after 5 predecessors and 4 levels of N fertilization were applied according to the predecessors as follows: Winter pea (*Pisum arvense* L.) and Spring pea (*Pisum sativum* L.) – N 0; 40; 80; 120 kg/ha; Sunflower (*Helianthus annuus* L.); Wheat (*Triticum aestivum* L.); Triticale (× *Triticosecale* Wittm.) – N 0; 60; 120; 180 kg/ha. Morphological characteristics (structure element of the yield) were measured: Specific weight of the stem, g; Height of the stem, cm; Length of the spike, cm; Weight of the spike, g; Number of the spikelets in 1 spike; Number of the grains in 1 spike; Weight of the grain in 1 spike, g; Hectoliter mass of the grain, kg; Specific weight of 1000 grains, g. The effect of Nitrogen fertilization on the triticale yield structure characteristics is different depending on the separate parameters. The highest positive effect of N fertilization – about 22 % increasing compared to non fertilization is obtained for weight of the stem, weight of spike and weight of grains in spike. Fertilization has a lower effect on the height of stem, length of spike, number of spikelets and number of grains. Fertilization does not change hectoliter mass and the weight of 1000 grains. Weight of stem correlates with height of stem. Weight of spike correlates with length of spike, number of grains in spike, weight of grain in spike and number of spikelets. Weight of grain correlates with number of grains in the spike, weight of spike and weight of stem. Specific weight of 1000 grains and hectoliter mass of grain do not correlate positively with other parameters. Climate circumstances and combination of rains and temperature during the years are factors influencing of a higher degree on the parameters – weight and height of stem, length of spike, hectoliter mass and specific weight of 1000 grains with power impact 50 – 88 %. Nitrogen fertilization as a factor has a bigger effect on the weight of spike, number of spikelets, number of grains and weight of grain in 1 spike. Weight of spike is the most important parameter with highest contribution to yield structure and is positive in F1 and F2. Weight of stem and length of spike are the next parameters positive in F1 and negative in F2. Number of grains, hectoliter mass, and weight of 1000 grain are negative for F1 and positive for F2. Number of spikelets, weight of grain, stem height are negative for the two F1 and F2.

Key words: Triticale, yield, structure components, N fertilization, predecessors, P C Analyses.

Introduction

Triticale can be used with success as a substitute of wheat and maize for the production of grain for fodder purposes. As wintering crop its cultivation is guaranteed in respect of water supply compared with maize. The soil and climatic conditions of Bulgaria are favorable for triticale cultivation. Its productivity is similar to that of wheat. Advantage of triticale compared to wheat, is that it can be grown with success and in mountainous areas, wherever wheat, rye, barley and oats productivity is lower. Triticale has a good protein and energy value and is

considered for very good source for feeding of animals. Triticale is culture, which exceeds the yield of grain and fresh biomass other cereals by the temperate climate areas. Comparative study of 29 triticale varieties in the area of Elena (mountain) demonstrated that with the highest productive opportunities had been variety AD-7291. It exceeds the winter wheat variety Sadovo 1, average with 1449 kg/ha, and barley variety Mirage-with 1695 kg/ha grain (Popov et al., 1981). And in other areas of the country triticale - AD 7291 shows higher yield of grain and a high content of protein and lysine than wheat. This is due to the larger number of spikelet and grains in the spike (Popov and Macov, 1980; Furdgev and Kosturski, 1984). In the experiments performed during 1983-1985, triticale Vihren variety exceeds the wheat Sadowo 1 variety with 9.9 to 18.5%, rye-30,9% and winter barley with 37.4%. With the good economic qualities are varieties of triticale Murgash and Persenk (Tsankova et al., 1986). The higher yield of grain obtained from triticale AD-7291, due to the high genetic potential of this variety was highly productive sprouting, crop density and a large number of spikelet in a spike. (Dimova, 1983; Kabanova and Chaika 2001). The percentage participation of the **spike** in the formation of the total assimilating area of the plant in triticale is significantly higher than that of wheat, barley and rye (Popov et al., 1982). Baychev (1996) has established a high positive correlation between the number and the mass of the grains from one spike.

The influence of predecessors on the productivity and quality of triticale is difficult to determine, since in each case and the influence of other factors – type and variety, soil type, level of fertilization, especially of nitrogen etc. (Shtereva and Tsvetkov, 1985). In the experiment conducted in General Toshevo, they examine the impact of legumes, sunflower, maize and Triticale. The predecessors influence the phases of development and the sensitivity of triticale to diseases. The best conditions of development and the lowest degree of infection with basal decay and *Fusarium* are identified after legume predecessor. After this predecessor are obtained the highest yield, followed by sunflower, maize and triticale. According to Dimitrova-Doneva (2007) under the terms of the Strandzha mountain area the highest grain yield of triticale is obtained after predecessor winter oilseed rape compared with stubble and sorghum. Tanchev (2007) reaches similar results and receives a higher grain yield from triticale after stubble average for the period of the study compared with predecessor sorghum. After forage peas or after a mixture of feed peas and wheat, grain yield and the content of total nitrogen in Triticale grain, are higher in comparison with predecessor wheat. The number of spikes of m2, the number of grain in a spike and the mass of 1000 seeds is increased after these predecessors (Buraczyńska and Ceglarek, 2011).

Yield and morphological structure elements depends on the amount of nitrogen fertilization. According to Kirchev et al. (2006) in the soil-climatic conditions of Plovdiv area is an acceptable implementation of maximum test norm N 180 kg/ha, since there is a satisfactory energy return. Under the terms of General Toshevo should not apply higher than N 120 kg/ha nitrogen fertilization doses due to the higher fertility and nitrogen supply of the chernozem soils.

The aim of present study was to establish the effect of nitrogen fertilization on the yield structure characteristics of triticale cultivated after different predecessors.

Material and methods

The survey was conducted in the area of the town Stara Zagora, located in the region of South Central Bulgaria. The study was carried out with Triticale Rogen variety. Cultivation was performed according to the conventional technology of cropping. The soils are Gleic Chromic Luvisols, neutral, and well reserved with K_2O, moderate with P_2O_5 and low with Nitrogen. Triticale was grown after 5 predecessors and 4 levels of N fertilization were applied according to the predecessors as follows: Winter pea (*Pisum arvense* L.) – N 0; 40; 80; 120 kg.ha^{-1}; Spring pea (*Pisum sativum* L.) – N 0; 40; 80; 120 kg/ha; Sunflower (*Helianthus annuus* L.) – N 0; 60; 120; 180 kg/ha; Wheat (*Tristicum aestivum* L.) – N 0; 60; 120; 180 kg/ha; Triticale (× *Triticosecale* Wittm.) – N 0; 60; 120; 180 kg/ha. Morphological characteristics (structure element of the yield) were measured: Specific weight of the stem, g; Height of the stem, cm; Length of the spike, cm; Weight of the spike, g; Number of spikelets; Number of grains in 1 spike; Weight of the grain in 1 spike, g; Hectolitre mass of grain, kg; Specific weight of the grain (weight of 1000 grains), g.

For the period 2010-2012 have fallen on average rainfall 572.3 mm. The amount of rainfall from sowing to harvesting of triticale for time from October to July for the three-year

period averaged 430.7 mm. In 2010 water supply has been higher – 535.6 mm. Compared with previous 55 years period – 411.6 mm – it was greater. During the vegetation period of 2011 the rainfall was lowest – 273.6 mm.

A middle position occupies 2012 with the uneven distribution of rainfall.

The average annual air temperature for the period 2010-2012 was 13.1 °C, with variation from 12.4 to 13.6 °C. The temperature during the growing season is 9.4 °C almost as over the past 55 year previous period.

The average humidity is 71%, with variation from 66 to 75%. During vegetation of 2010-2012 humidity is somewhat low compared with the average for the 55-year previous period.

Results and Discussion

Morphological structure of plants includes important indicators related to the productive potential of the crops. It defines structural elements on the yield of main and additional production. Through them, explaining the changes in productive indicators under the influence of various factors is possible.

The weight of the stem is an important indicator, which characterizes the productive potential and sustainability of the plants.

Specific weight of triticale in full ripening stage and harvesting was 4.29 g with variation of 2.77 to 5.6 g (Table 1). The lower weight of the stem is for unfertilized conditions. Nitrogen fertilization has a positive effect and leads to increasing the stem weight adequate with increasing of the N fertilizer amount. Nitrogen fertilization increases with 22.06 % stem weight compared to non fertilization. Average for all variants included for each predecessor the weight is little higher when triticale is cultivated after triticale and after sunflower. Average the stem weight was a little lower when triticale is cultivated after legume predecessors (winter pea and spring pea) and higher after other type of predecessors (sunflower, wheat, triticale). The height of stem average is 103.31 cm with variation from 78.1 to 125.8 cm. Nitrogen fertilization increases with 7.07 % the height compared to non fertilization control. The effect of N fertilization on the stem height is significantly lower compared to those of specific stem weight. The difference among the predecessors is very small. The height of stem is little higher when triticale is cultivated after wheat as predecessor.

Length of spike is average 10.58 cm with variation from 8.42 to 13.20 cm. Nitrogen fertilization increases the length of spike with 12.19 % compared to non fertilization. Predecessors have not significant influence on the spike length and the values for the legume and other types of predecessors are equal.

Weight of spike average for all level of fertilization and after all predecessors was 2.38 g with variation from 1.72 to 3.3 g. For this parameter the effect of N fertilization is well expressed and increasing of specific spike weight is with 22.07 % compared to non fertilization. This tendency is the same as the effect of the fertilization to the stem weight. The difference among the spike weight from the predecessors is insufficient.

Number of normal formed spikelets in the spike is average 22.99 with variation from 18.6 to 27.5. N fertilization increases with 6.28 % the number of spikelets in spike. The type of predecessors has not significant effect on the number of spikelets in the spike and this is normally because the number of spikelets is a genetically determined sign and could be difficult changed.

The number of normal grains in the spike is average 43.92 with variation from 30.2 to 61.5. Fertilization increases with 15.07 % the number of grain in the spike. The lower number of spike was obtained when triticale is cultivated after spring pea and higher after winter pea and sunflower.

Weight of grain in spike is average 1.8 g with variation from 1.26 to 2.55 g. The effect of fertilization for this parameter – increasing with 22.08 % also confirms that fertilization has a higher effect on the weight than other parameters. The effect of predecessor on the weight of grain from the spike is insufficient.

Specific weight of 1000 grains is average 41.8 g with variation from 32.4 to 50.0 g. This parameter was not influenced from the fertilization and the specific weight of 1000 grains is the same for fertilized and unfertilized variants.

Hectoliter mass as a parameter determining volume weight of the grain is 68.59 kg, with variation from 61.1 to 73.9 kg. Fertilization and predecessors have not positive effect on the hectoliter mass of grain. This tendency is the same as the specific weight of 1000 grain.

Table 1. Morphological structure parameters of triticale average for 2010–2012, n=240

Predecessor	Nitrogen fertilization, kg/ha	Weight of stem, g	Height of stem, cm	Length of spike, cm	Weight of spike,g	Number of spikelets in spike	Number of grains in spike	Weight of grain in spike, g	Weight of 1000 grain, g	Hectoliter mass, kg
1. Winter pea	0	3.69a	97.9a	9.7a	2.05a	22.6a	41.1a	1.6a	42.17a	69.69a
	40	4.10b	101.6b	10.4b	2.30b	23.1b	44.2b	1.8b	42.10a	69.78a
	80	4.43c	104.0c	10.9c	2.48c	23.3c	45.8c	1.8bc	42.19a	69.91a
	120	4.77d	106.4d	11.4d	2.61d	24.0d	48.1d	2.1d	42.20a	69.68a
	Average (40-120)	4.44	104.0	10.9	2.47	23.4	46.1	1.9	42.16	69.79
2. Spring pea	0	3.75a	99.1a	9.6a	2.06a	22.5a	39.9a	1.6a	42.92a	69.68a
	40	4.12b	101.8b	10.3b	2.29b	22.9b	42.7b	1.8b	41.76b	69.65a
	80	4.60c	105.1c	10.9c	2.54c	23.4c	44.0c	1.9c	41.92b	69.59a
	120	4.76d	107.3d	11.3d	2.65d	23.8d	45.9d	2.0d	41.00b	69.11a
	Average (40-120)	4.50	104.8	10.8	2.50	23.4	44.2	1.9	41.56	69.45
3. Sun flower	0	3.64a	97.2a	9.7a	2.04a	21.6a	39.8a	1.5a	42.43a	68.77b
	60	4.05b	99.4b	10.3b	2.24b	22.1b	42.3b	1.7b	42.1ab	68.50b
	120	4.58c	105.8c	10.7c	2.59c	23.3c	45.4c	1.8c	41.58b	68.01b
	180	4.90d	108.0d	11.4d	2.74d	23.8d	50.7d	2.0d	40.76b	67.72c
	Average (60-180)	4.52	104.4	10.8	2.53	23.1	46.1	1.8	41.48	68.07
4. Wheat	0	3.53a	99.1a	9.8a	1.98a	22.0a	38.0a	1.5a	41.94a	68.54b
	60	4.09b	102.9b	10.4b	2.26b	22.7b	42.1b	1.7b	42.45b	68.39b
	120	4.43c	107.5c	10.9c	2.50c	23.7c	45.6c	1.9c	41.36a	68.42b
	180	4.70d	109.1d	11.3d	2.59d	24.4d	48.8d	2.0d	41.70a	67.48c
	Average (60-180)	4.41	106.5	10.8	2.45	23.6	45.5	1.9	41.84	68.10

Table 1. (Continued)

Predecessor	Nitrogen fertilization, kg/ha	Weight of stem, g	Height of stem, cm	Length of spike, cm	Weight of spike,g	Number of spikelets in spike	Number of grains in spike	Weight of grain in spike, g	Weight of 1000 grain, g	Hectoliter mass, kg
5. Tritica le	0	3.82a	97.3a	9.6a	2.07a	21.1a	38.3a	1.5a	40.39a	67.43c
	60	4.28b	102.6b	10.4b	2.32b	22.1b	41.3b	1.8b	41.73b	67.19c
	120	4.65c	105.9c	11.0c	2.52c	23.5c	45.0c	1.9c	41.82b	66.71d
	180	4.95d	108.4d	11.6d	2.73d	24.0d	48.5d	2.0d	40.62a	67.52c
	Average (60-180)	4.63	105.6	11.0	2.53	23.2	44.9	1.9	41.39	67.14
Average legume predecessor (1-2)	0	3.72	98.5	9.7	2.06	22.5	40.5	1.6	42.54	69.69
	40	4.12	101.7	10.4	2.30	23.0	43.4	1.8	41.93	69.71
	80	4.52	104.5	10.9	2.52	23.3	44.9	1.8	42.06	69.75
	120	4.77	106.9	11.3	2.64	23.9	47.0	2.0	41.60	69.39
	Average (40-120)	4.47	104.4	10.9	2.49	23.4	45.1	1.9	41.86	69.62
Average other predecessors (3-5)	0	3.66	97.8	9.7	2.03	21.6	38.7	1.5	41.59	68.25
	60	4.14	101.6	10.4	2.28	22.3	41.9	1.7	42.09	68.03
	120	4.56	106.4	10.9	2.54	23.5	45.4	1.9	41.59	67.71
	180	4.85	108.5	11.4	2.69	24.1	49.3	2.0	41.03	67.57
	Average (60-180)	4.52	105.5	10.9	2.50	23.3	45.50	1.9	41.57	67.77
Average - N=0		3.69	98.12	9.68	2.04	21.96	39.42	1.54	41.97	68.82
Average fertilized N=(40-180)		4.50	105.06	10.86	2.50	23.34	45.36	1.88	41.68	68.51
Mean		4.29	103.31	10.58	2.38	22.99	43.92	1.80	41.80	68.59
% N40-180/N 0		122.06	107.07	112.19	122.07	106.28	115.07	122.08	99.32	99.55
SD		0.69	13.84	1.08	0.33	1.54	5.50	0.26	4.41	2.82
SE		0.04	0.89	0.07	0.02	0.10	0.35	0.02	0.28	0.18
Min		2.77	78.10	8.42	1.72	18.60	30.20	1.26	32.40	61.10
Max		5.60	125.80	13.20	3.30	27.50	61.50	2.55	50.00	73.90

*Differences among the variants in the column for the specific parameters are statistically significant at P<0.05 if have not equal letter

Structure parameters of yield of triticale were influenced in different degree from the fertilization and predecessor. N fertilization has a bigger effect on the parameters than predecessor. Statistical analyses demonstrate that the differences among the levels of fertilization for each predecessor are significant at $P<0.05$. There are not differences among the equal fertilization levels after the different predecessors. The influence of fertilization is different depending on the specific parameter and the potential possibilities for its variation. Fertilization has a higher effect on the weight of stem, weight of spike and weight of grain in spike – more than 20 % increasing of the values compared to non fertilization. Other weight parameter weight of 1000 grains and Hectoliter mass are relatively stable and are not changed from fertilization and the predecessors.

Good correlations exist among the yield structure characteristics. Weight of stem correlates with height of stem, number of spikelets in the spike, weight and number of grain in the spike – r=0.427-0.865 (Table 2). Weight of spike correlates with length of spike (r=0.875), number of grain in spike (0.850), weight of grain in spike (r=0.645) and number of spikelets (R=0.627). Weight of grain correlates with number of grains in the spike (r=0.655), weight of spike (r=0.645) and weight of stem (r=0.569). Specific weight of 1000 grain and hectoliter mass do not correlate positively with other parameters. Even it is established that Hectoliter mass is in negative correlation with weight and height of stem. The reason is because N fertilization increasing the weight, height of stem and number of grain has no effect on the specific characteristics of grain - size and volume mass.

Table 2. Correlations among the parameters, average for 2010 – 2012, n=240

	Weight of stem, g	Heigth of stem, cm	Length of spike, cm	Weight of spike, g	Number of spikelets in the spike	Number of grain In the spike	Weight of grain, g	Hectolitr masa, kg	Weight of 1000 grain, g
Weight of stem, g	1.000	0.865	0.301	0.465	0.511	0.427	0.569	-0.674	-0.229
Heigth of stem, cm	0.865	1.000	0.091	0.116	0.397	0.187	0.236	-0.848	-0.335
Length of spike, cm	0.301	0.091	1.000	0.875	0.614	0.799	0.392	0.090	-0.607
Weight of spike, g	0.465	0.116	0.875	1.000	0.627	0.850	0.645	0.081	-0.410
Number of spiklets	0.511	0.397	0.614	0.627	1.000	0.676	0.493	-0.112	-0.358
Number of grains	0.427	0.187	0.799	0.850	0.676	1.000	0.655	-0.009	-0.498
Weight of grain, g	0.569	0.236	0.392	0.645	0.493	0.655	1.000	-0.014	0.076
Hectoliter mass, kg	-0.674	-0.848	0.090	0.081	-0.112	-0.009	-0.014	1.000	0.349
Weight of 1000 grains, g	-0.229	-0.335	-0.607	-0.410	-0.358	-0.498	0.076	0.349	1.000

Nitrogen fertilization, predecessors and year as factors have different effect on the yield structure characteristics. Weight of stem depends from year – 50.19 % and N fertilization – 38.01 % (Table 3). Height of stem depends mainly from the year – 88.33 %. N fertilization effect for this parameter is very low – 7.37 %. Length of spike is influenced from the year 53.59 % and 35.20 % from N fertilization. Oppositely on the weight of spike the bigger effect has N fertilization – 53.52 % and 25.32 % from the year. Number of spikelets depends on the N fertilization, year and interaction predecessor*year.

Predominant effect is for fertilization but the power of expression is very low compared to other parameters. Number of grain is influenced in equal degree from N fertilization

and year. N fertilization is a main factor influencing the weight of grain. Hectoliter mass and specific weight of 1000 seeds depends mainly from the year – 75.53 – 84.09 % respectively. Predecessor as a factor and interaction among the factors have not substantial effect on the yield structure characteristics.

Table 3. Influence of factors on the parameters, average for 2010 – 2012, n=240

Parameters/Factors	SS	DF	MS	F	p	%
Weight of stem, g						
Predecessor	1.504	4	0.376	10.8	0.000000	1.31
N fertil	43.565	3	14.522	417.8	0.000000	38.01
Year	57.526	2	28.763	827.5	0.000000	50.19
Predecessor*N fertil	0.503	12	0.042	1.2	0.281429	0.44
Predecessor*Year	3.291	8	0.411	11.8	0.000000	2.87
N fertil*Year	1.163	6	0.194	5.6	0.000025	1.02
Predecessor*N fertil*Year	0.810	24	0.034	1.0	0.505906	0.71
Error	6.256	180	0.035			5.46
Height of stem, cm						
Predecessor	143	4	36	7.8	0.000008	0.31
N fertil	3373	3	1124	244.7	0.000000	7.37
Year	40440	2	20220	4402.1	0.000000	88.33
Predecessor*N fertil	115	12	10	2.1	0.020220	0.25
Predecessor*Year	553	8	69	15.1	0.000000	1.21
N fertil*Year	230	6	38	8.4	0.000000	0.50
Predecessor*N fertil*Year	102	24	4	0.9	0.564355	0.22
Error	827	180	5			1.81
Length of spike, cm						
Predecessor	0.70	4	0.17	1.8	0.138050	0.25
N fertil	97.38	3	32.46	329.2	0.000000	35.20
Year	148.25	2	74.13	751.8	0.000000	53.59
Predecessor*N fertil	1.31	12	0.11	1.1	0.356069	0.47
Predecessor*Year	5.65	8	0.71	7.2	0.000000	2.04
N fertil*Year	2.77	6	0.46	4.7	0.000190	1.00
Predecessor*N fertil*Year	2.85	24	0.12	1.2	0.244863	1.03
Error	17.75	180	0.10			6.42
Weight of spike, g						
Predecessor	0.156	4	0.039	2.06	0.087403	0.60
N fertil	13.920	3	4.640	244.87	0.000000	53.52
Year	6.586	2	3.293	173.79	0.000000	25.32
Predecessor*N fertil	0.215	12	0.018	0.95	0.502477	0.83
Predecessor*Year	1.128	8	0.141	7.44	0.000000	4.34
N fertill*Year	0.273	6	0.045	2.40	0.029586	1.05
Predecessor*N fertil*Year	0.320	24	0.013	0.70	0.842976	1.23
Error	3.411	180	0.019			13.11
Number of spikelets						
Predecessor	14.4	4	3.6	5.2	0.000553	2.54
N fertil	147.2	3	49.1	70.9	0.000000	26.01
Year	123.8	2	61.9	89.4	0.000000	21.87
Predecessor*N fertil	16.8	12	1.4	2.0	0.025089	2.96
Predecessor*Year	117.5	8	14.7	21.2	0.000000	20.76
N fertil*Year	5.8	6	1.0	1.4	0.220853	1.02
Predecessor*N fertil*Year	16.0	24	0.7	1.0	0.520988	2.82
Error	124.6	180	0.7			22.02

Table 3. (Continued)

Number of grains						
Predecessor	99.6	4	24.9	2.98	0.020520	1.38
N fertil	2618.1	3	872.7	104.46	0.000000	36.24
Year	2391.0	2	1195.5	143.09	0.000000	33.09
Predecessor*N fertil	180.4	12	15.0	1.80	0.051133	2.50
Predecessor*Year	292.7	8	36.6	4.38	0.000075	4.05
N fertil*Year	45.3	6	7.5	0.90	0.494165	0.63
Predecessor*N fertil*Year	94.3	24	3.9	0.47	0.983944	1.31
Error	1503.8	180	8.4			20.81
Weight of grain from spike						
Predecessor	0.1974	4	0.0493	1.80	0.130519	1.25
N fertil	6.9996	3	2.3332	85.16	0.000000	44.21
Year	0.0729	2	0.0365	1.33	0.266882	0.46
Predecessor*N fertil	0.3895	12	0.0325	1.18	0.296999	2.46
Predecessor*Year	2.3933	8	0.2992	10.92	0.000000	15.11
N fertil*Year	0.1762	6	0.0294	1.07	0.381197	1.11
Predecessor*N fertil*Year	0.6739	24	0.0281	1.02	0.437155	4.26
Error	4.9316	180	0.0274			31.14
Hectoliter mass, kg						
Predecessor	210	4	53	117	0.000000	11.09
N fertil	9	3	3	7	0.000201	0.49
Year	1431	2	716	1592	0.000000	75.53
Predecessor*N fertil	15	12	1	3	0.001441	0.80
Predecessor*Year	111	8	14	31	0.000000	5.88
N fertil*Year	15	6	3	6	0.000020	0.81
Predecessor*N fertil*Year	21	24	1	2	0.006569	1.12
Error	81	180	0			4.27
Weight of 1000 grain, g						
Predecessor	17.3	4	4.3	2.5	0.043158	0.37
N fertil	22.4	3	7.5	4.3	0.005593	0.48
Year	3905.6	2	1952.8	1133.1	0.000000	84.09
Predecessor*N fertil	37.4	12	3.1	1.8	0.049412	0.81
Predecessor*Year	233.2	8	29.1	16.9	0.000000	5.02
N fertil*Year	26.9	6	4.5	2.6	0.019271	0.58
Predecessor*N fertil*Year	91.2	24	3.8	2.2	0.001825	1.96
Error	310.2	180	1.7			6.68

* N fertil=Nitrogen fertilization

Principle Component analyses for establishing the power and contribution of the yield structure parameters to the grain yield demonstrate that for principle components could be defined which have effect above 1 (Table 4). Eigen value varies from 1.11 to 4.22 and is higher for the first and second factor. These components describe 46.94% and 25.69 % of the variations. Weight of spike and weight of stem are parameters with the highest power effect influencing with the highest degree on the yield (0.964 - 0.932-respectively).

Table 4. Principle component analyses, average for 2010 – 2012, n=240

Characters	P C 1	P C 2	P C 3	P C 4
Eigenvalues	4.22	2.31	1.35	1.11
% of variance	46.94	25.69	15.00	12.37
Cumulative %	46.94	72.63	87.63	100.00
Factor loading				
Stem weight, g	0.932	-0.244	0.267	0.010
Stem height, cm	-0.082	-0.802	-0.549	0.218
Spike length, cm	0.426	-0.355	0.651	0.518
Weight of spike, g	0.964	0.180	0.080	-0.176
Spikelet number per spike	-0.885	-0.449	-0.114	-0.046
Grain number per spike, n	-0.187	0.690	-0.141	0.685
Grain weight per spike, g	-0.461	-0.746	0.481	-0.014
1000 grains weight, g	-0.874	0.236	0.300	0.300
Hectoliter mass, kg	-0.666	0.400	0.439	-0.452
Factor Scores				
Winter pea	-0.908991	0.73822	1.22083	0.58166
Spring pea	-0.130985	-0.31593	0.26520	-1.73571
Sunflower	0.823895	1.33433	-0.86033	0.02441
Wheat	-0.999757	-0.75198	-1.17983	0.49296
Triticale	1.215837	-1.00465	0.55413	0.63668

The weight of spike is the most important because is positive for first and second factors (Figure 1). Number of grain - 0.690 and spike length – 0.651 are the other parameters with the significant effect in PC 2 and PC 3 respectively. Other parameters have not substantial effect and contribution to the grain yield. Integrated PC analyses for the effect and contribution of the parameters to the yield demonstrated that the parameters could be separate in four groups as follows:

-first – spike weight - positive for F 1 and F 2;

-second – stem weight and spike length – positive for F1 , negative for F2;

-third – number of grain, hectoliter weight, and weight of 1000 grain- negative for F1 and positive for F2 ;

-fourth – number of spikelets, weight of grain, stem height – negative for F1 and F2.

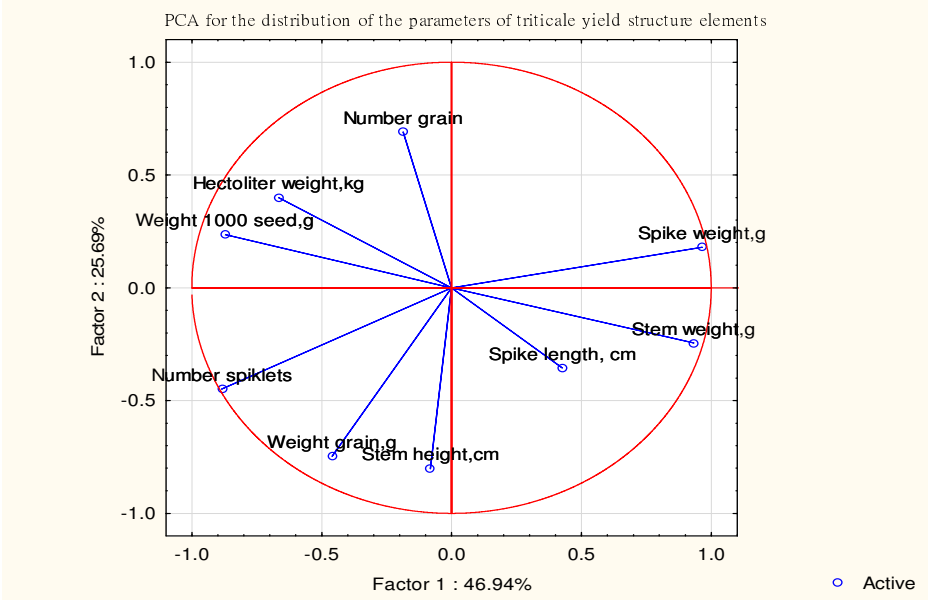

Figure 1. P C Analyses for the distribution of the parameters of triticale yield structure elements.

P C Analyses for the influence and contribution of predecessors to triticale yield structure components define that sunflower is the predecessor with the highest effect. Sunflower is positive for the two factors – F1 and F2 (Fig. 2). Triticale is the second predecessors which is positive for F1 and negative for F2. Winter pea is positive for F2 and negative for F1. Spring pea and Wheat are the fourth group and are with negative effect for F1 and as well as for F2.

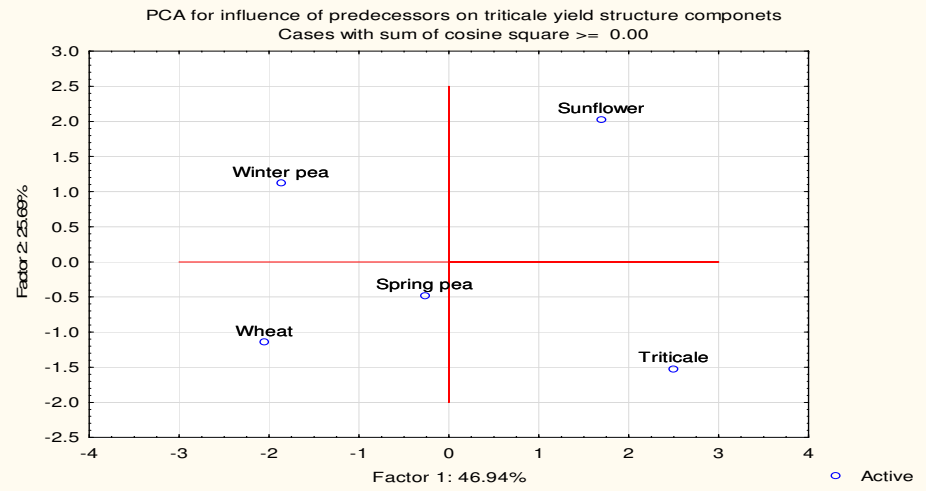

Figure 2. P C Analyses for influence of predecessors on triticale yield structure components.

Conclusion

The effect of Nitrogen fertilization on the triticale yield structure characteristics is different depending on the separate parameters. The highest positive effect of N fertilization – about 22 % increasing compared to non fertilization is obtained for weight of stem, weight if spike and weight of grain in spike. Fertilization has a lower effect on the height of stem, length of spike, number of spikelets and number of grains. Fertilization does not change hectoliter mass and the weight of 1000 seeds.

Weight of stem correlates with height of stem. Weight of spike correlates with length of spike, number of grains in spike, weight of grain in spike and number of spikelets. Weight of grain correlates with number of grains in the spike, weight of spike and weight of stem. Specific weight of 1000 grain and hectoliter mass do not correlate positively with other parameters.

Climate conditions and combination of rains and temperature during the years are factor influencing on higher degree on the parameters – weight and height of stem, length of spike, hectoliter mass and specific weight of 1000 seeds with power impact 50 – 88 %. Nitrogen fertilization as a factor has a bigger effect on the weight of spike, number of spiklets, number of grains and weight of grain from spike.

Weight of spike is the most important parameter with highest contribution to yield structure and is positive in F1 and F2. Weight of stem and length of spike are the next parameters positive in F1 and negative in F2. Number of grain, hectoliter weight, and weight of 1000 grains are negative for F1 and positive for F2. Number of spikelets, weight of grain, stem height are negative for the two F1 and F2.

References

Baychev, V., 1996. Genetic correlations between the productivity of spike and some other signs in hybrid Triticale forms. *Plant science*, 33, 5, 32-36 (Bg).

Buraczyńska, D., Ceglarek, F., 2011. Previous crop value of post harvest residues and straw of spring wheat, field pea and their mixtures for winter triticale. II. Winter triticale yield. *Acta Sci. Pol., Agricultura* 10(2) 19-32.

Dimitrova-Doneva, M., 2007. Optimization of some cultivation factors in winter cereals for the Strandja. *Dissertation for PhD* (Bg).

Dimova, R., 1983. Tiller forming ability and yield of triticale, rye and wheat. *Plant Sciences*, 20, 1, 3-8 (Bg).

Furdgev, I., Kosturski, N., 1984. Testing of triticale and rye after predecessor rice. *Plant Sciences*, 21, 3, 17-21 (Bg).

Kabanova, S.N., Chaika M.T., 2001. Correlation analysis of triticale morphology, chlorophyll content and productivity. *J. of Agr. and Crop Sci.*, 186, 4, 281-285.

Kirchev, H., Penkov, D., Terziev, G., Tonev T., 2006. Energy productivity of triticale varieties depending on growing conditions and nitrogen fertilization. *Field Crops Studies*, 3, 289-295 (Bg).

Popov, P., Macov, B., 1980. Study of the biological and economic qualities of Mexican Triticale in view of the possibilities for their implementation in the country. Plant science, 17, 2, 24-29 (Bg).

Popov, P., Dimitrov, D., Gvozdiev K., 1981. Results of the study on triticale in Elena region. *Plant Sciences*, 18, 4, 44-51. (Bg).

Popov, P., Stankova, P., Stankov I., 1982. Photosinthetic area and NAR in hexaploid triticale forms. *Planti science*, 19, 3, 83-87 (Bg).

Shtereva, L., Tsvetkov S., 1985. Influence of its predecessor on the yield of triticale (2n = 6 x = 42). Problems of contemporary Bulgarian agriculture Sofia, BAS, 145-149. (Bg).

Statisitica for windows 6. Statsoft corporation.

Tanchev, D., 2007. Comparative test on varieties of Triticale grain in the Strandzha region. *Journal of Mountain Agriculture on the Balkans*, 10, 3, 491-498. (Bg).

Tsankova, D., Todorov, T., Dimitrov, L., Zdravkova, I., Lukipudis S., 1986. Productive capacity of triticale. *Plant Sciences*, 23, 7, 54-58. (Bg).