INFLUENCE OF FERTILIZATION ON SOME QUALITATIVE INDICES OF WHEAT YIELD

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ABSTRACT

The paper presents some aspects regarding the influence of N and P_2O_5 fertilization of winter wheat, cultivated in rotation with soybean and maize, in stationary long-term experiments under dry-land conditions at A.R.S. Turda. Crude protein content, protein yield, wet gluten, dry gluten and Pelshenke index are positively influenced by the applied nitrogen quantity. The maximum values of these indices were obtained by the application of 120 kg N/ha in the case of wheat-soybean rotation and 160 kg N/ha in the case of wheat-maize rotation, on a common basal dressing of 80 kg P_2O_5/ha. Phosphorus had a little influence on the analysed indices, its positive effect taking place only when this nutritive element was applied together with nitrogen. From among the wheat preceding crops (soybean and maize) soybean proved to be the most suitable.

Key words: breadmaking quality, nitrogen and phosphorus fertilizers

INTRODUCTION

The development of superior genotypes represents an efficient way for increasing the wheat yield level and quality. Besides the genetic factors, technological factors and first of all the mineral fertilization significantly influence the wheat qualitative indices. Depending on the pedoclimatic conditions, fertilization contributes to the increase of protein content in wheat with 4–6%. Also, for a good breadmaking quality, the flour should have 28–30% wet gluten and 14–6% protein. But, the increasing of protein content in kernel simultaneously with the obtainment of high yields, constitutes another difficult objective.

Sinclair and De Witt (1975) and Bhatia and Rabson (1976) showed that a simultaneous increasing of yield and protein concentration by breeding is incompatible from the energetic point of view.

On the world level, the data obtained till now (Destain and Guiot, 1991) show that it is possible to increase, under certain limits, the protein content in wheat by the application of nitrogen and phosphorus fertilizers, result confirmed also by the investigations carried out in Romania (Hera et al., 1986; Negrilã and Negrilã, 1995; Popescu et al., 1997).

The balanced fertilization with nitrogen and phosphorus improves not only the protein content from wheat grain, but also the gluten formation with valuable breadmaking qualities (Hera et al., 1986; Brucher and Moroy, 1988).

The data presented in this paper constitute the result of the determinations performed in 1993 and 1996 in wheat cultivated in rotation with soybean and maize, in long-term experiments placed at A.R.S. Turda.

MATERIALS AND METHODS

The investigations were performed under dry land conditions, on an argilo-iluvial vertic chernozem characterized by a neutral reaction (pH = 6.9–7.1, in water), middle content of assimilable phosphorus (15–20 ppm), great reserves of potassium (249 ppm), of organic matter (3.92%) and total nitrogen (0.196%).

The wheat with maize as preceding crop, was fertilized with rates of: 0, 40, 80, 120, 160 kg N/ha and in rotation with soybean as preceding crop, with rates: 0, 30, 60, 90, 120 kg N/ha, applied alone or associated with: 0, 40, 80, 120, 160 kg P_2O_5/ha.

The winter wheat cultivar Arieºan was cultivated.

The following analyses were carried out in the final yield: protein, by Kjeldahl method, wet and dry gluten content in flour with 70% extraction, obtained with Buhler laboratory mill, gluten deformation according with STAS 628-3-75, Phelsenke index according with STAS

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6283-5-76, farinographic note using Brabender farinograph.

RESULTS AND DISCUSSION

1. The fertilization effect on wheat yield quality with maize as preceding crop

1.1. Influence of fertilization on protein content

A first criterium for estimation of wheat grain quality is protein content. The application of nitrogen fertilizers, in rates between 40 and 160 kg N/ha, led to the increase of total nitrogen content in grains as well as in straws, with a high degree of statistical assurance. The per cent content of total nitrogen from wheat plants (grains and straws) was different in the two years of experimentation (1993 and 1996) due to variation of weather conditions, which differently determined the mobilization and utilization by plants, of nitrogen from fertili-zers and soil (Tables 1 and 2).

In 1993, at the non-fertilized variants with phosphorus, the nitrogen percentage from straws ranged between 0.44 and 0.60 and the protein quantity – between 50 and 110 kg/ha; in wheat grains – between 1.84 and 2.71 and the protein quantity – between 225 and 470 kg/ha (Table 1).

Significant increases of nitrogen content in grains as well as in straws, were obtained beginning with the rate of 40 kg N/ha but the greatest content was noticed at a rate of 160 kg N/ha, on all phosphorus basal dressings.

In 1996, the total nitrogen content in both straws and grains was lower (0.27–0.68% in straws and 1.60–2.76% in grains) (Table 2), due to the greater yields of vegetative mass achieved, which determined the diminution of this element concentration in plants.

The application of nitrogen fertilizers, in rates between 40–160 kg N/ha, had as effect not only the modification of nitrogen content in grains or straws, but even of crude protein percentage and quantity achieved per surface unit. The greatest protein content (4.25% in straws and 17.3% in grains) was obtained at the rate of 160 kg N/ha.

Table 1 . Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat, cultivated after maize (Turda, 1993)

Fertilizers kg/ha		Straws			Grains				
P_2O_5	N	N %	protein %	protein kg/ha	N %	protein %	gain %	protein kg/ha	gain kg/ha
0	0	0.44	2.75	50	1.84	11.5	-	225	-
	40	0.53	3.31	91	2.01	12.6	1.1	355	130
	80	0.54	3.38	102	2.28	14.3	2.8	426	201
	120	0.59	3.69	110	2.26	14.1	3.0	396	171
	160	0.60	3.75	105	2.71	16.9	5.4	470	245
40	0	0.49	3.06	57	1.88	11.8	0.3	226	1
	40	0.51	3.19	99	2.06	12.9	1.4	398	173
	80	0.68	4.25	154	2.22	13.9	2.4	488	263
	120	0.72	4.50	143	2.49	15.6	4.1	481	256
	160	0.73	4.56	146	2.65	16.6	5.1	515	290
80	0	0.50	3.13	66	1.82	11.4	-0.1	242	17
	40	0.53	3.31	109	1.93	12.1	0.6	389	164
	80	0.54	3.38	124	2.16	13.5	2.0	477	252
	120	0.54	3.38	122	2.50	15.6	4.1	549	324
	160	0.58	3.63	116	2.76	17.3	5.8	539	314
120	0	0.53	3.31	69	1.86	11.6	0.1	248	23
	40	0.54	3.38	108	1.97	12.3	0.8	395	170
	80	0.54	3.38	129	2.35	14.7	3.2	551	326
	120	0.68	4.25	161	2.69	16.7	5.3	618	393
	160	0.66	4.13	155	2.74	17.1	5.6	623	398
160	0	0.49	3.06	64	1.87	11.7	0.2	252	27
	40	0.51	3.19	101	1.96	12.2	0.7	403	178
	80	0.52	3.25	127	2.33	14.6	3.1	565	340
	120	0.55	3.44	133	2.51	15.7	4.2	590	365
	160	0.68	4.25	159	2.74	17.1	5.6	622	397
LSD 5%			N P 0.84 0.53	N P 51 23		N P 1.54 0.87		N P 154 81	

Table 2. Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat, cultivated after maize (Turda, 1996)

Fertilizers kg/ha		Straws			Grains				
P_2O_5	N	N %	protein %	protein kg/ha	N %	protein %	gain %	protein kg/ha	gain kg/ha
0	0	0.33	2.06	37	1.72	10.8	-	205	-
	40	0.35	2.19	69	1.97	12.3	1.5	398	193
	80	0.35	2.19	82	2.14	13.4	2.6	488	283
	120	0.37	2.31	99	2.30	14.8	4.0	745	540
	160	0.49	3.06	150	2.55	15.9	5.1	767	562
40	0	0.27	1.68	33	1.65	10.3	-0.5	224	19
	40	0.31	1.93	66	1.72	10.8	0	385	180
	80	0.35	2.19	103	1.91	11.9	1.1	596	391
	120	0.37	2.31	113	2.14	13.4	2.6	686	481
	160	0.37	2.31	116	2.53	15.8	5.0	789	584
80	0	0.29	1.81	37	1.86	11.6	0.8	258	53
	40	0.31	1.93	68	1.88	11.8	1.0	427	222
	80	0.35	2.19	106	2.02	12.6	1.8	632	427
	120	0.43	2.69	133	2.22	13.9	3.1	718	513
	160	0.43	2.69	128	2.58	16.1	5.3	799	594
120	0	0.29	1.81	40	1.60	10.0	-0.8	229	24
	40	0.31	1.93	61	1.67	10.4	-0.4	395	190
	80	0.45	2.81	136	2.15	13.4	2.6	674	469
	120	0.47	2.94	143	2.46	15.4	4.6	798	593
	160	0.49	3.06	151	2.76	17.3	6.5	893	688
160	0	0.43	2.68	61	1.58	9.9	-0.9	227	22
	40	0.47	2.94	110	1.83	11.4	0.6	436	231
	80	0.49	3.06	153	2.22	13.9	3.1	706	501
	120	0.53	3.31	160	2.56	16.0	5.2	820	615
	160	0.68	4.25	220	2.63	16.4	5.6	821	616
LSD 5%			N P 0.73 0.41	N P 45 18		N P 1.83 0.72		N P 214 71	

The crude protein yield/ha was strongly influenced by the nitrogen fertilization. Beginning with rates of 40 kg N/ha, by the application of nitrogen alone or together with phosphorus, significant gains were obtained.

By the unilateral application of nitrogen, the greatest protein yield (767 kg/ha) was obtained at the rate of 160 kg N/ha, with 562 kg/ha more than in unfertilized variant.The greatest values of crude protein yield were obtained by the application of 150 kg N/ha and 120 kg P_2O_5/ha, respectively 893 kg.

The mean results during the two years of experimentation (1993 and 1996) show that the winter wheat reacts to the applied nitrogen and phosphorus fertilizers by the increase of nitrogen and protein content from straws and grains (Table 3). The nitrogen effect on protein gain (2% in straws and 6.44% in grains, approximately) is obvious till 160 kg N/ha.The protein percentage from the wheat grain arrived at 17.19%, with a gain of 6.44% in comparison with the unfertilized control, fact that emphasizes the increased ability of Arieºan variety for nitrogen assimilation and protein synthesis.

As regards the phosphorus application, there is not a direct effect on protein synthesis. The great phosphorus quantities lead to the unfavourable accumulation of protein.

Hera et al. (1986) explain the strong interaction between nitrogen and phosphorus by the inhibition effect of excessive phosphorus accumulated in plant, on some biochemical mechanisms which influence the plant growth and development.

The low efficiency of phosphorus fertilization or even the negative influence of phosphorus fertilizers on the protein concentration in wheat are mentioned by other authors, too (Popescu et al., 1997) which underline that, under conditions of great phosphorus concentrations in the nutrition space, this element is absorbed and accumulated in plant as mineral

Table 3 . Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat, cultivated after maize (Turda, 1993–1996 mean)

Fertilizers kg/ha		Straws			Grains				
P_2O_5	N	N %	protein %	protein kg/ha	N %	protein %	gain %	protein kg/ha	gain kg/ha
0	0	0.39	2.44	44	1.72	10.75	-	207	-
	40	0.44	2.75	81	1.99	12.44	1.69	377	170
	80	0.45	2.81	95	2.21	13.81	3.06	458	251
	120	0.48	3.00	109	2.28	14.25	3.50	559	352
	160	0.55	3.44	133	2.63	16.44	5.69	625	418
40	0	0.38	2.38	46	1.76	11.00	0.25	225	18
	40	0.41	2.56	83	1.89	11.81	1.06	334	127
	80	0.52	3.25	135	2.07	12.94	2.18	551	344
	120	0.55	3.44	139	2.32	14.50	3.75	595	388
	160	0.55	3.44	142	2.59	16.19	5.44	655	448
80	0	0.40	2.50	52	1.84	11.50	0.75	250	43
	40	0.42	2.62	90	1.91	11.94	1.19	408	201
	80	0.45	2.81	119	2.09	13.06	2.31	558	351
	120	0.49	3.06	131	2.36	14.75	4.00	641	434
	160	0.51	3.19	157	2.67	16.69	5.94	674	467
120	0	0.41	2.56	54	1.73	10.81	0.06	239	32
	40	0.43	2.69	86	1.82	11.38	0.63	399	192
	80	0.50	3.12	135	2.25	14.06	3.31	617	410
	120	0.58	3.62	157	2.53	15.81	5.06	701	494
	160	0.58	3.62	157	2.75	17.19	6.44	756	549
160	0	0.46	2.88	63	1.73	10.81	0.06	240	33
	40	0.49	3.06	108	1.90	11.88	1.13	423	216
	80	0.51	3.19	142	2.28	14.25	3.50	638	431
	120	0.54	3.38	151	2.54	15.88	5.13	706	499
	160	0.68	4.25	189	2.69	16.81	6.06	727	520
LSD 5%			N P 0.78 0.47	N P 48 21		N P 1.68 0.80		N P 184 76	

form, which provokes the perturbation in synthesis processes of organic compounds.

The crude protein yield from grain was superior to the straw one. In unfertilized variant, the crude protein yield was 44 kg/ha in plant (straws) and 207 kg/ha in grains. The greatest values, 189 kg/ha in straws and 756 kg/ha in grains, were obtained by application of 160 kg N/ha.

1.2. Influence of nitrogen and phosphorus fertilization on breadmaking features

Qualitatively, in wheat, the bread-making features are very important. The fertilization, especially with nitrogen, has as direct effect the obtainment of some great yields as well as important protein gains on surface unit. Because 80% of protein is included in gluten composition as glutenin and gliadin, the protein positively influences the wet and dry gluten content.

In the case of wheat–maize rotation, the breadmaking features of flour were mostly influenced by the applied nitrogen quantity (Table 4).

Thus, the wet and dry gluten content progressively increases with the nitrogen rate, the highest values being obtained in variant fertilized with 120–160 kg N/ha and 80 kg P_2O_5/ha, namely 32.4–35.2% wet gluten and 10.6-11.5% dry gluten.

The mean values of these qualitative indices show an increase with 11.7 till 14.5%, 4.0–4.9% at dry gluten respectively, as compared with unfertilized variant.

Table 4. Influence of nitrogen and phosphorus fertilizers on technological flour indices of wheat, cultivated after maize. (Turda, 1996)

Basal dressing kg/ha		Wet gluten %	Dry gluten %	Phelsenke index min.	Deformation index mm	Farinographic note U.B.
P_2O_5	N					
0	0	20.7	6.6	25	10	39
	40	23.4	8.0	32	8	40
	80	27.4	8.9	36	9	40
	120	32.3	10.8	36	9	47
	160	32.4	10.9	41	9	49
40	0	20.3	6.6	27	8	40
	40	24.6	8.5	34	10	42
	80	30.3	10.1	36	10	42
	120	32.6	10.8	39	10	46
	160	34.4	11.3	53	10	50
80	0	19.6	6.5	29	10	40
	40	24.9	8.2	45	10	43
	80	30.8	10.2	45	10	44
	120	32.4	10.6	47	10	47
	160	35.2	11.5	58	10	49
120	0	19.2	6.6	27	8	41
	40	23.8	8.3	36	9	45
	80	30.5	10.3	47	8	45
	120	31.7	10.7	49	10	48
	160	35.2	11.5	58	10	53
160	0	23.1	7.8	29	10	41
	40	24.2	8.3	49	9	45
	80	27.9	9.2	50	9.5	46
	120	32.2	10.8	53	10	49
	160	35.7	11.7	60	10	50
LSD 5%		N P 1.3 0.7	N P 0.9 0.5			

Phosphorus had a more reduced influence on protein content as well as on wet and dry gluten. The positive effect of phosphorus is manifested in interaction with nitrogen.

In variants fertilized with 80–160 kg N/ha, the wet gluten content with values up to 30% and dry gluten content with values greater than 10% indicate a good breadmaking quality of Arieºan wheat cultivar, cropped in 1996, which suggests the possibility of obtaining superior raw materials under fertilization conditions.

Phelsenke index is greater under fertilization conditions.

Generally, the qualitative indices of flour are, also, confirmed by the farinographic note, a valorimetric index, favourably influenced by the fertilization, especially with nitrogen. Because of application of 120–160 kg N/ha rates, the farinographic note increased with 10–14 U.B.

Qualitatively and quantitatively, a balanced fertilization leads to the obtainment of higher yields.

2. The effect of fertilization on wheat yield quality with soybean as preceding crop

2.1. The influence of fertilization on protein content

The preceding crops have an important contribution as regards the effect of fertilizers on wheat protein yield. Wheat cultivated after a leguminous plant, as soybean, has a greater protein content in grains as well as in straws as compared with wheat cultivated after maize.

In this rotation, the nitrogen fertilizer application in rates between 30 and 120 kg a.i./ha led to important increases of nitrogen and pro-

tein content in wheat grain, in 1993 and 1996, too (Table 5).

The results obtained in 1993, year characterized by rainfall deficit and increased temperatures, show that the nitrogen fertilization determined the accumulation of greater protein quantities in wheat kernels as well as in straws, till 3.81% and 17.7% respectively. However, under these conditions, the possibi-lity of gluten quality depreciation should be considered, because of unbalances in phosphorus absorption and metabolizing, caused by the high nitrogen rates.

Table 5. Influence of nitrogen and phosphorus fertilization on protein content in wheat, cultivated after soybean (Turda, 1993)

Fertilizers kg/ha		Straws			Grains				
P_2O_5	N	N %	protein %	protein kg/ha	N %	protein %	gain %	protein kg/ha	gain kg/ha
0	0	0.45	2.81	53	1.89	11.8	-	232	-
	30	0.56	3.50	77	2.07	12.9	1.1	270	38
	60	0.56	3.50	85	2.34	14.6	2.8	339	107
	90	0.60	3.75	89	2.46	15.4	3.6	346	114
	120	0.61	3.81	89	2.83	17.7	5.9	398	166
40	0	0.49	3.06	69	1.94	12.1	0.3	273	41
	30	0.53	3.31	87	2.26	14.1	2.3	356	124
	60	0.69	4.31	120	2.60	16.3	4.5	435	203
	90	0.74	4.62	124	2.69	16.8	5.0	436	204
	120	0.74	4.62	121	2.77	17.3	5.5	442	210
80	0	0.51	3.18	79	1.90	11.9	0.1	287	55
	30	0.55	3.43	96	2.25	14.1	2.3	373	141
	60	0.55	3.43	109	2.56	16.0	4.2	486	254
	90	0.58	3.62	107	2.63	16.4	4.6	471	239
	120	0.59	3.68	106	2.74	17.1	5.3	473	241
120	0	0.53	3.31	86	1.89	11.8	0	307	75
	30	0.55	3.43	100	2.16	13.5	1.7	389	157
	60	0.56	3.50	110	2.36	14.8	3.0	449	217
	90	0.70	4.38	138	2.73	17.1	5.3	517	285
	120	0.70	4.38	131	2.81	17.6	5.8	509	277
160	0	0.50	3.13	88	1.90	11.9	0.1	337	105
	30	0.54	3.38	109	2.16	13.5	1.7	423	191
	60	0.54	3.38	111	2.41	15.1	3.3	481	249
	90	0.68	4.25	138	2.57	16.1	4.3	498	266
	120	0.68	4.25	135	2.80	17.5	5.7	537	305
LSD 5%			N P 0.86 0.55			N P 1.56 0.89		N P 149 73	

Significant increases of nitrogen content in grain, were obtained beginning with 30 kg N/ha rate, but the greatest content was achieved at 120 kg N/ha rate, on all the common basal dressings.

The phosphorus applied alone, did not influence the nitrogen and protein content of wheat grain, though this element is necessary during all protein synthesis stages.

The wheat cultivated on an vertic argilo-iluvial chernozem utilized more efficiently the nitrogen from fertilizers in organic compound synthesis. The protein quantity accumulated in kernel was 17.6% in 1993 and 16.4% in 1996, adequate values in breadmaking process. The percentage as well as the protein yield on surface unit varied depending on the climatic conditions.

The protein percentage from wheat kernel exceeded the values registered in unfertilized variants with nitrogen till 6%, emphasizing the nitrogen role in protein content increasing as well as of yields achieved on surface unit.

The contribution of phosphorus fertilizers to the modification of protein content was less pronounced, with its diminution tendency at the same time with the increasing of applied rates.

In 1996, year in which the rainfall, especially during the grain filling period, was close

to the normal value, the nitrogen content and protein percentage were smaller in grain as well as in straws (Table 6).

greater in wet years, when the grain yields were also higher.

Table 6 . Influence of nitrogen and phosphorus fertilization on protein content in wheat, cultivated after soybean (Turda, 1996)

Fertilizers		Straws			Grain				
P_2O_5	N	N %	protein %	protein kg/ha	N %	protein %	gain %	protein kg/ha	gain kg/ha
0	0	0.36	2.25	73	1.72	10.8	-	334	-
	30	0.38	2.38	98	1.95	12.2	1.4	465	131
	60	0.40	2.50	108	2.17	13.6	2.8	568	234
	90	0.54	3.37	174	2.36	14.8	4.0	769	435
	120	0.51	3.19	154	2.62	16.4	5.6	830	496
40	0	0.25	1.56	51	1.70	10.6	-0.2	343	9
	30	0.36	2.25	94	2.11	13.2	2.4	549	215
	60	0.38	2.38	117	2.41	15.1	4.3	699	365
	90	0.38	2.38	130	2.50	15.6	4.8	839	505
	120	0.36	2.25	120	2.59	16.2	5.4	849	515
80	0	0.27	1.68	56	1.79	11.2	0.4	377	43
	30	0.31	1.93	81	2.03	12.7	1.9	539	205
	60	0.36	2.25	110	2.37	14.8	4.0	723	389
	90	0.45	2.81	158	2.46	15.4	4.6	858	524
	120	0.45	2.81	156	2.57	16.1	5.3	858	524
120	0	0.31	1.93	66	1.81	11.3	0.5	390	56
	30	0.38	2.38	106	2.06	12.9	2.1	566	232
	60	0.38	2.38	122	2.17	13.6	2.8	681	347
	90	0.38	2.38	135	2.43	15.2	4.4	846	512
	120	0.45	2.81	153	2.50	15.6	4.8	826	492
160	0	0.31	1.93	69	1.87	12.3	1.5	424	90
	30	0.36	2.25	96	2.01	12.6	1.8	540	206
	60	0.43	2.69	137	2.20	13.8	3.0	701	367
	90	0.43	2.69	148	2.48	15.5	4.7	852	518
	120	0.45	2.81	149	2.57	16.1	5.3	852	518
	LSD 5%		N P 0.87 0.49			N P 2.1 0.9		N P 186 69	

The nitrogen content of wheat grain increased proportionally with the raising of applied nitrogen rates, from 1.70% (common basal dressing control) to 2.62%, as a result of maximum rates application (120 kg N/ha).

Neither in this case, phosphorus application had not a direct effect, because of increased phosphorus content in soil (60.80 ppm) accumulated by the annual fertilization system used in experimental plots, with rates of 40–60 kg P_2O_5/ha. In this case, phosphorus effect from fertilizers on protein accumulation in grain, decreases.

In 1993, the crude protein yield from wheat grain was between 232 and 537 kg/ha and in 1996 between 334 and 858 kg/ha.

Although the nutrients are absorbed in greater quantity in the presence of water, the protein per cent content is greater in droughty years, but the crude protein quantity/ha is

The variability of protein content depends on the fertilization system (especially depending on the nitrogen rates), preceding crop, climatic conditions. The protein content of straws was of four-five times smaller than in grains, after both preceding crops.

2.2. Influence of nitrogen and phosphorus fertilization on breadmaking features in wheat cultivated after soybean

One of the most important factors for increasing the protein percentage in wheat grain as well as of wet and dry gluten content is the optimum supply with nutrients.

The technological quality and breadmaking features of flour are mostly influenced by the nitrogen quantity and by the preceding crop.

The quality analyses, performed with the above mentioned methods, regarding the wet and dry gluten, Ihelsenke index, deformation

index and farinographic note in wheat cultivated after soybean are presented in table 7.

The maintenance of an optimum balance between nutrients as part of fertilization systems

Table 7. Influence of nitrogen and phosphorus fertilizers on technological flour indices of wheat, cultivated after soybean (Turda, 1996)

Basal dressing kg/ha		Wet gluten %	Dry gluten %	Phelsenke index min.	Deformation index mm	Farinographic note U.B.
P_2O_5	N					
0	0	21.3	7.5	27	10	40
	30	24.1	8.9	33	8	42
	60	29.5	9.1	37	10	45
	90	32.4	10.7	37	9	47
	120	32.5	10.9	42	9	50
40	0	20.9	7.6	29	9	39
	30	25.3	9.4	35	10	43
	60	31.1	9.9	37	10	47
	90	32.8	10.9	39	10	47
	120	34.2	11.2	48	10	51
80	0	20.3	7.7	30	10	39
	30	25.4	8.6	47	10	43
	60	31.2	10.3	47	10	49
	90	32.2	10.8	48	10	49
	120	33.6	11.4	51	10	52
120	0	20.7	7.8	30	9	40
	30	24.2	8.9	37	8	44
	60	30.7	10.4	48	10	48
	90	31.6	11.1	48	9	49
	120	33.5	11.3	53	10	53
160	0	22.7	8.3	31	10	40
	30	24.6	9.2	49	9.5	44
	60	29.1	9.4	51	9.5	48
	90	33.0	10.8	52	10	48
	120	33.6	11.4	58	10	53
LSD5%		N P 1.4 0.8	N P 0.8 0.6			

The value of a breadmaking wheat is determined by the gluten quantity and quality. The gluten quality is especially determined by the genetic factors and the gluten quantity is influenced by the climatic conditions and by the nitrogen from soil. On the basis of the results from table 7, the mean values of wet gluten show an increase, depending on the applied rates, from 21.3% in unfertilized variant till 32.5% in fertilized variant with 120 kg N/ha. Greater increases of this index have been registered beginning with 60 kg N/ha rate, where values between 29.1–31.2% wet gluten, with 7.8–9.9% more than unfertilized variant (N_0P_0) were registered.

The dry gluten content is strongly influenced by the nitrogen rates. Thus, by fertilization with 30–120 kg N/ha, the dry gluten content increased from 7.5% till 11.3%.

leads to the obtainment of some quantitatively and qualitatively increased yields.

The small difference achieved in the qualitative indices (wet and dry gluten) at nitrogen rates greater than 90 kg/ha, emphasizes that this rate is optimal for these qualitative indices in wheat cultivated after soybean.

Phosphorus less influenced the gluten content, but the Phelsenke index was positively influenced by the nitrogen fertilization.

The breadmaking features of flour are confirmed by the farinographic note, with values up to 40 U.B., meanning a good gluten quality. Under nitrogen fertilizer action (120 kg/ha), the farinographic note increased with 10–13 U.B.

A comparison of qualitative indices between wheat cultivated after soybean and wheat cultivated after maize under the same environmental conditions shows that the soybean is a

better preceding crop as regards the yield quality.

CONCLUSIONS

The balanced application of nitrogen and phosphorus fertilizers leads to the quantitative and qualitative increasing of wheat yield, the nitrogen being the chemical element with the strongest influence.

The nitrogen fertilizer application (120 kg/ha and 160 kg/ha respectively) under the conditions of a good supply with phosphorus, determines the increase of protein content till 6%, in comparison with the unfertilized control.

The protein content was maximum by the application of 120 kg N/ha rates in wheat-soybean rotation (16.4–17.5%) and 160 kg N/ha in wheat – maize rotation (15.8–17.3%).

The protein yield progressively increased with the nitrogen application, but under the soil conditions from Turda, the phosphorus applied in up to 40 kg/ha rates, did not modify the protein yield or its concentration.

The technological indices of flour: wet gluten, dry gluten, Phelsenke index had the greatest values at the nitrogen maximum rates, in the both rotations. In wheat after soybean the mean values of wet gluten content, indicate an increase depending on the nitrogen rates, from 20.3 (unfertilized variant) to 43.2% and for dry gluten, from 5.5 to 11.4%. In wheat cultivated after maize, the wet gluten content increases from 19.4 to 35.7% and the dry gluten content from 6.5 to 11.7%.

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Table 1. Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat - maize rotation (Turda, 1993)

Fertilizers		Straws			Grains				
Kg/ha P_2O_5	Kg/ha N	N (%)	Protein (%)	Protein (kg/ha)	N (%)	Protein (%)	Gain (%)	Protein (Kg/ha)	Gain (Kg/ha)
1	2	3	4	5	6	7	8	9	10
0	0	o.44	2.75	50	1.84	11.5	-	225	-
	40	0.53	3.31	91	2.01	12.6	1.1	355	130
	80	0.54	3.38	102	2.28	14.3	2.8	426	201
	120	0.59	3.69	110	2.26	14.1	3.0	396	171
	160	0.60	3.75	105	2.71	16.9	5.4	470	245
40	0	0.49	3.06	57	1.88	11.8	0.3	226	1
	40	0.51	3.19	99	2.06	12.9	1.4	398	173
	80	0.68	4.25	154	2.22	13.9	2.4	488	263
	120	0.72	4.50	143	2.49	15.6	4.1	481	256
	160	0.73	4.56	146	2.65	16.6	5.1	515	290
80	0	0.50	3.13	66	1.82	11.4	-0.1	242	17
	40	0.53	3.31	109	1.93	12.1	0.6	389	164
	80	0.54	3.38	124	2.16	13.5	2.0	477	252
	120	0.54	3.38	122	2.50	15.6	4.1	549	324
	160	0.58	3.63	116	2.76	17.3	5.8	539	314
120	0	0.53	3.31	69	1.86	11.6	0.1	248	23
	40	0.54	3.38	108	1.97	12.3	0.8	395	170
	80	0.54	3.38	129	2.35	14.7	3.2	551	326
	120	0.68	4.25	161	2.69	16.7	5.3	618	393
	160	0.66	4.13	155	2.74	17.1	5.6	623	398
160	0	0.49	3.06	64	1.87	11.7	0.2	252	27
	40	0.51	3.19	101	1.96	12.2	0.7	403	178
	80	0.52	3.25	127	2.33	14.6	3.1	565	340
	120	0.55	3.44	133	2.51	15.7	4.2	590	365
	160	0.68	4.25	159	2.74	17.1	5.6	622	397
	DL5%		N P	N P		N P		N P	
			0.84 0.53	51 23		1.54 0.87		154 81	

Table 2
Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat - maize rotation (Turda, 1996)

Fertilizers		Straws			Grains				
Kg/ha P_2O_5	Kg/ha N	N (%)	Protein (%)	Pro-tein (kg/ha)	N (%)	Protein (%)	Gain (%)	Protein (kg/ha)	Gain (kg/ha)
0	0	0.33	2.06	37	1.7	10.8	-	205	-
	40	0.35	2.19	69	2	12.3	1.5	398	193
	80	0.35	2.19	82	1.9	13.4	2.6	488	283
	120	0.37	2.31	99	7	14.8	4.0	745	540
	160	0.49	3.06	150	2.1	15.9	5.1	767	562
					4				
					2.3				
					0				
					2.5				
					5				
40	0	0.27	1.68	33	1.6	10.3	-0.5	224	19
	40	0.31	1.93	66	5	10.8	0	385	180
	80	0.35	2.19	103	1.7	11.9	1.1	596	391
	120	0.37	2.31	113	2	13.4	2.6	686	481
	160	0.37	2.31	116	1.9	15.8	5.0	789	584

					1				
					2.14				
					2.53				
80	0	0.29	1.81	37	1.86	11.6	0.8	258	53
	40	0.31	1.93	68		11.8	1.0	427	222
	80	0.35	2.19	106	1.88	12.6	1.8	632	427
	120	0.43	2.69	133		13.9	3.1	718	513
	160	0.43	2.69	128	2.02	16.1	5.3	799	594
					2.22				
					2.58				
120	0	0.29	1.81	40	1.60	10.0	-0.8	229	24
	40	0.31	1.93	61		10.4	-0.4	395	190
	80	0.45	2.81	136	1.67	13.4	2.6	674	469
	120	0.47	2.94	143		15.4	4.6	798	593
	160	0.49	3.06	151	2.15	17.3	6.5	893	688
					2.46				
					2.76				
160	0	0.43	2.68	61	1.58	9.9	-0.9	227	22
	40	0.47	2.94	110		11.4	0.6	436	231
	80	0.49	3.06	153	1.83	13.9	3.1	706	501
	120	0.53	3.31	160		16.0	5.2	820	615
	160	0.68	4.25	220	2.22	16.4	5.6	821	616
					2.56				
					2.63				
	DL		N P	N		N		N P	
	5%		0.73	P		P		214 71	
			0.41	45		1.83			
				18		0.72			

Table 3.
Influence of nitrogen and phosphorus fertilization on nitrogen and protein content in wheat-maize rotation (Turda, 1993-1996 mean)

Fertilizers		Straws			Grains				
Kg/ha P_2O_5	Kg/ha N	N (%)	Protein (%)	Pro-tein (kg/ha)	N (%)	Protein (%)	Gain (%)	Protein (kg/ha)	Gain (kg/ha)
0	0	0.39	2.44	44	1.72	10.75	-	207	-
	40	0.44	2.75	81	1.99	12.44	1.69	377	170
	80	0.45	2.81	95	2.21	13.81	3.06	458	251
	120	0.48	3.00	109	2.28	14.25	3.50	559	352
	160	0.55	3.44	133	2.63	16.44	5.69	625	418
40	0	0.38	2.38	46	1.76	11.0	0.25	225	18
	40	0.41	2.56	83	1.89	11.81	1.06	334	127
	80	0.52	3.25	135	2.07	12.94	2.18	551	344

	120	0.55	3.44	139	2.32	14.50	3.75	595	388
	160	0.55	3.44	142	2.59	16.19	5.44	655	448
80	0	0.40	2.50	52	1.84	11.50	0.75	250	43
	40	0.42	2.62	90	1.91	11.94	1.19	408	201
	80	0.45	2.81	119	2.09	13.06	2.31	558	351
	120	0.49	3.06	131	2.36	14.75	4.00	641	434
	160	0.51	3.19	157	2.67	16.69	5.94	674	467
120	0	0.41	2.56	54	1.73	10.81	0.06	239	32
	40	0.43	2.69	86	1.82	11.38	0.63	399	192
	80	0.50	3.12	135	2.25	14.06	3.31	617	410
	120	0.58	3.62	157	2.53	15.81	5.06	701	494
	160	0.58	3.62	157	2.75	17.19	6.44	756	549
160	0	0.46	2.88	63	1.73	10.81	0.06	240	33
	40	0.49	3.06	108	1.90	11.88	1.13	423	216
	80	0.51	3.19	142	2.28	14.25	3.50	638	431
	120	0.54	3.38	151	2.54	15.88	5.13	706	499
	160	0.68	4.25	189	2.69	16.81	6.06	727	520
	DL5%		N P	N		N P		N P	
			0.78	P		1.68		184 76	
			0.47	48		0.80			
				21					

Table 4. **Influence of nitrogen and phosphorus fertilizers on technological indices of wheat flour cultivated after maize (Turda, 1996)**

Agrobackground (kg/ha)		Wet gluten (%)	Dry gluten (%)	Phelsenke index (min)	Deformation index (mm)	Farinographic note (U.B.)
P_2O_5	N					
0	0	20.7	6.6	25	10	39
	40	23.4	8.0	32	8	40
	80	27.4	8.9	36	9	40
	120	32.3	10.8	36	9	47
	160	32.4	10.9	41	9	49
40	0	20.3	6.6	27	8	40
	40	24.6	8.5	34	10	42
	80	30.3	10.1	36	10	42
	120	32.6	10.8	39	10	46
	160	34.4	11.3	53	10	50
80	0	19.6	6.5	29	10	40
	40	24.9	8.2	45	10	43
	80	30.8	10.2	45	10	44
	120	32.4	10.6	47	10	47
	160	35.2	11.5	58	10	49
120	0	19.2	6.6	27	8	41
	40	23.8	8.3	36	9	45
	80	30.5	10.3	47	8	45
	120	31.7	10.7	49	10	48
	160	35.2	11.5	58	10	53
160	0	23.1	7.8	29	10	41
	40	24.2	8.3	49	9	45
	80	27.9	9.2	50	9.5	46
	120	32.2	10.8	53	10	49
	160	35.7	11.7	60	10	50
DL5%		N P	N P			
		1.3 0.7	0.9 0.5			

Table 5

Influence of nitrogen and phosphorus fertilization on protein content in wheat cultivated after soybean (Turda, 1993)

Fertilizers		Straws			Kernels				
P_2O_5 kg/ha	N kg/ha	N (%)	Protein (%)	Protein (kg/ha)	N (%)	Protein (%)	Gain (%)	Protein (kg/ha)	Gain (Kg/ha)
0	0	0.45	2.81	53	1.89	11.8	-	232	-
	30	0.56	3.50	77	2.07	12.9	1.1	270	38
	60	0.56	3.50	85	2.34	14.6	2.8	339	107
	90	0.60	3.75	89	2.46	15.4	3.6	346	114
	120	0.61	3.81	89	2.83	17.7	5.9	398	166
40	0	0.49	3.06	69	1.94	12.1	0.3	273	41
	30	0.53	3.31	87	2.26	14.1	2.3	356	124
	60	0.69	4.31	120	2.60	16.3	4.5	435	203
	90	0.74	4.62	124	2.69	16.8	5.0	436	204
	120	0.74	4.62	121	2.77	17.3	5.5	442	210
80	0	0.51	3.18	79	1.90	11.9	0.1	287	55
	30	0.55	3.43	96	2.25	14.1	2.3	373	141
	60	0.55	3.43	109	2.56	16.0	4.2	486	254
	90	0.58	3.62	107	2.63	16.4	4.6	471	239
	120	0.59	3.68	106	2.74	17.1	5.3	473	241
120	0	0.53	3.31	86	1.89	11.8	0	307	75
	30	0.55	3.43	100	2.16	13.5	1.7	389	157
	60	0.56	3.50	110	2.36	14.8	3.0	449	217
	90	0.70	4.38	138	2.73	17.1	5.3	517	285
	120	0.70	4.38	131	2.81	17.6	5.8	509	277
160	0	0.50	3.13	88	1.90	11.9	0.1	337	105
	30	0.54	3.38	109	2.16	13.5	1.7	423	191
	60	0.54	3.38	111	2.41	15.1	3.3	481	249
	90	0.68	4.25	138	2.57	16.1	4.3	498	266
	120	0.68	4.25	135	2.80	17.5	5.7	537	305
	DL5 %		N P			N P		N P	
			0.86 0.55			1.56 0.89		149 73	

Table 6. **Influence of nitrogen and phosphorus fertilization on protein content in wheat cultivated after soybean (Turda, 1996)**

Fertilizers		Straws			Grains				
P_2O_5 Kg/ ha	N Kg/ha	N (%)	Protein (%)	Protein (kg/ha)	N (%)	Protein (%)	Gain (%)	Pro-tein (kg/ha)	Gain (kg/ha)
0	0	0.36	2.25	73	1.72	10.8	-	334	-
	30	0.38	2.38	98	1.95	12.2	1.4	465	131
	60	0.40	2.50	108	2.17	13.6	2.8	568	234
	90	0.54	3.37	174	2.36	14.8	4.0	769	435
	120	0.51	3.19	154	2.62	16.4	5.6	830	496
40	0	0.25	1.56	51	1.70	10.6	-0.2	343	9
	30	0.36	2.25	94	2.11	13.2	2.4	549	215
	60	0.38	2.38	117	2.41	15.1	4.3	699	365
	90	0.38	2.38	130	2.50	15.6	4.8	839	505
	120	0.36	2.25	120	2.59	16.2	5.4	849	515
80	0	0.27	1.68	56	1.79	11.2	0.4	377	43
	30	0.31	1.93	81	2.03	12.7	1.9	539	205
	60	0.36	2.25	110	2.37	14.8	4.0	723	389
	90	0.45	2.81	158	2.46	15.4	4.6	858	524
	120	0.45	2.81	156	2.57	16.1	5.3	858	524

120	0	0.31	1.93	66	1.81	11.3	0.5	390	56
	30	0.38	2.38	106	2.06	12.9	2.1	566	232
	60	0.38	2.38	122	2.17	13.6	2.8	681	347
	90	0.38	2.38	135	2.43	15.2	4.4	846	512
	120	0.45	2.81	153	2.50	15.6	4.8	826	492
160	0	0.31	1.93	69	1.87	12.3	1.5	424	90
	30	0.36	2.25	96	2.01	12.6	1.8	540	206
	60	0.43	2.69	137	2.20	13.8	3.0	701	367
	90	0.43	2.69	148	2.48	15.5	4.7	852	518
	120	0.45	2.81	149	2.57	16.1	5.3	852	518
	DL5%		N P			N P		N	
			0.87			2.1 0.9		P	
			0.49					186	
								69	

Table 7. **Influence of nitrogen and phosphorus fertilizers on technologi cal indices of wheat flour cultivated after soybean (Turda, 1996)**

Common basal dressing - kg/ha		Wet gluten (%)	Dry gluten (%)	Phelsenke index (min)	Deformation index (mm)	Farinographic note (U.B.)
P_2O_5	N					
0	0	21.3	7.5	27	10	40
	30	24.1	8.9	33	8	42
	60	29.5	9.1	37	10	45
	90	32.4	10.7	37	9	47
	120	32.5	10.9	42	9	50
40	0	20.9	7.6	29	9	39
	30	25.3	9.4	35	10	43
	60	31.1	9.9	37	10	47
	90	32.8	10.9	39	10	47
	120	34.2	11.2	48	10	51
80	0	20.3	7.7	30	10	39
	30	25.4	8.6	47	10	43
	60	31.2	10.3	47	10	49
	90	32.2	10.8	48	10	49
	120	33.6	11.4	51	10	52
120	0	20.7	7.8	30	9	40
		24.2	8.9	37	8	44
	30	30.7	10.4	48	10	48
	60	31.6	11.1	48	9	49
	90	33.5	11.3	53	10	53
	120					
160	0	22.7	8.3	31	10	40
	30	24.6	9.2	49	9.5	44
	60	29.1	9.4	51	9.5	48
	90	33.0	10.8	52	10	48
	120	33.6	11.4	58	10	53
DL		N P	N P			
5%		1.4 0.8	0.8 0.6			