

THE INFLUENCE OF SEVERAL FERTILIZER RATES ON THE QUALITY OF WHEAT FLOUR ON CAMBIC CHERNOZEM FROM A.R.D.S. CARACAL

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Abstract

In order to establish the influence of several fertilizer rates (nitrogen, phosphorus and potassium) on the quality of flour obtained from wheat there was established a polifactorial experiment, in 2011 at Agricultural Research and Development Station Caracal on a baticalcric cambic chernozem. This trial has analyzed the following quality indicators of flour: wet gluten, falling index, Zeleny sedimentation test, the index of gluten formation, glutenic index, farinograph test, alveograph test. After analyzing these indicators there resulted that a good quality flour can be obtained when moderate nitrogen rates are applied, of N100-N150 kg/ha as well as phosphorus in a rate of 80 kg/ha. The single using of nitrogen, phosphorus and potassium fertilizers do not ensure a good quality of the flour. The mixed applying of fertilizers determines a better action as nutrients and crop requirements are fulfilled. Single applying of fertilizers creates disequilibrium in plant nutrition and, as a result, the flour has poor quality.

Key words: flour, wheat, fertilizers, gluten

The nutritional value and the quality of wheat crop depends on the following factors: starch content from the endosperm, fats from embryo and aleuronic layer, vitamins from pericarp and tegument, proteins whose content ranges from 8 and 26% (Toma, 2009).

In general, the wheat quality is defined by:

- physical properties: the hectolitical mass (HM), the mass of a thousand grains (MTG), grain hardness;

- protein related features: total protein content and gluten, glutenic index, the volume of sedimentation, protein composition, aminoacid types composition;

- technological features: pharinograph test, alveographic values, extensograph test;

- enzymatic properties: falling number, mycotoxines content, pesticides and insecticides residues (Carver, 2001).

The quality of wheat crop is given by protein content, in general, and by the bakery features. These characteristics are influenced by the soil type, climate conditions, nitrogen fertilization, plant protection against diseases, plant genotype (Relten, 1992; Sebillote, 2009).

High production capacity and the bakery quality are major objectives of the breeding programmes.

It is well known the fact that with the wheat crop the quality of bakery is given by both, genetic

features and climate conditions (Nicolescu M., 2005; Ana Maria Dodocoiu, 2009).

Other authors have shown that with the protein content the inheritance coefficients are small yet they are high for the sedimentation index (Carver, 2001).

In order to emphasize the quality of the wheat flour that was cropped on cambic baticalcric chernozem from ARDS Caracal within 2009-2011 period there have been made determinations of quality for bakery.

MATERIAL AND METHOD

The researches have been performed on cambic baticalcric chernozem from ARDS Caracal that has the following physical and chemical features:

- the soil profile has the following horizons: Ap (0-23 cm), Am (23-51 cm), A/B (51-70 cm), Bv (70-105 cm), B/C (105-140 cm), Cca (140-150 cm);

- the soil is low to moderate compacted under tilled shallow layer, the texture is loamy – clayey on whole soil profile;

- the chemical features show the following aspects: the soil reaction on soil profile is low acid/moderately acid/low alkaline (deeper); in the shallow horizon there is a low content of mobile aluminium, the humus content is average, the phosphorus content indicates a good supplying degree, the potassium content is, also, good, as supplying degree and as regard the status of soil concerning bases supplying, it is mesobasic.

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- the climate conditions when experiment took place have been as follows: 2008-2009 agricultural year was less favorable for cropping wheat, 2009-2010 has been less favorable for wheat and 2010-2011 was favorable for wheat crop.

The experiment was established after subdivided randomised block method, with three experimental factors and three replications, as follows:

- the A factor – fertilization by phosphorus: a1 – 0; a2 – P40; a3 – P80; a4 – P120;
- the B factor – potassium fertilization: b1 – 0; b2 – K40; b3 – K80;
- the C factor – nitrogen fertilization: c1 – 0; c2 – N50; c3 – N100; c4 – N150; c5 – N200.

In order to appreciate the quality of wheat flour there were determined the following indicators:

- wet gluten content;
- falling number;
- gluten deformation index (mm);
- glutenic index (mm);
- farinograph test: developing time (min), stability (mm);
- alveograph test (energy absorbed by the dough);
- sedimentary test (Zeleny test) (ml).

RESULTS AND DISCUSSIONS

The obtained results in function of three studied factors: phosphorus rate, potassium and nitrogen and the interaction between nitrogen and phosphorus are presented in tables 1-4. From these data we can determine how different fertilizer rates have influenced the studied indicators, respectively, the quality of wheat flour.

The A factor (phosphorus rate) has influenced the flour quality indicators as follows:

- the wet gluten content has been directly influenced by phosphorus rate. This way, with P0 rate it was of 20.8% (unsatisfactory quality of flour) and when P40, P80 or P120 rates have been applied it recorded values of 21.5%, 22.3% and, respectively, 22.8%;

- the falling number has, also, been favorably influenced by phosphorus rate: with P0 it is of 116 seconds and with P40-120 its values are 128-166 seconds;

- the sedimentation test has had values of 22-31 ml (flour of unsatisfactory to average quality) as compared with P0 = 16 ml (unproper flour);

- the gluten deformation index has decreased as a result of applying different phosphorus rates from 22.3 mm with P0 to 18.7 mm with P120;

- the glutenic index has been favorably influenced by phosphorus rates and it increased from 18.1% (P0) to 24.9% and 31.9% with P80-P120;

- the alveograph test has been improved by increasing phosphorus rates being of 77 Joul at P40-120.

The B factor (potassium rate) has influenced the flour quality as follows:

- the wet gluten content has been less influenced by potassium rate. With K0 it has 19.8% value and with K80 of 21.7% the flour staying unsatisfactory as quality;

- the falling number has increased as a result of potassium applying from 114 seconds with K0 to 124-134 seconds with K40-80, the flour quality switching from unusable to satisfactory;

- the sedimentation test has been higher when potassium has been applied, from 17 ml (K0) to 22-23 ml (K40-80) the flour quality switching from low to proper;

- the gluten deformation index has been less influenced by potassium fertilizer rates;

- the glutenic index is favorably modified as a result of potassium rates but the flour remained unsatisfactory as bakery quality;

- the alveograph test is less influenced by potassium rates, the flour quality remaining in low state;

The C factor, nitrogen rate has influenced the flour bakery indicators as follows:

- the wet gluten index was favorably influenced by nitrogen rates increasing from 20.5% (N0) – unsatisfactory flour to 21.7 – 23.4% (N50-N200) the quality switching to satisfactory;

- the falling number increases as a result of using different nitrogen rates from 118 seconds with N0 to 124-133 seconds with N50-200, the flour quality changing from unsatisfactory to satisfactory;

- the sedimentation test was favorably modified after applying nitrogen and it increased from 19 ml (N0) to 21-44 ml (N50-200), the quality of the flour changing from unsatisfactory to satisfactory;

- the gluten deformation index is favorably modified yet with high nitrogen rates, of N100 – N200, the quality of the flour switching from unsatisfactory (20.2-21.6 mm) to satisfactory (17.6 – 18.9 mm);

- the glutenic index is less modified by nitrogen rates;

- the farinograph test has been favorably modified by high nitrogen rates of N100 – N200 increasing both the stability and the time of the dough;

- the alveograph test has values of 131-152 Joul and 0.4-0.5 mm with N100 – N200 rates in comparison with 78 Joul and 0.3 mm, the flour acquiring bakery potential.

The interaction between nitrogen and phosphorus has a very favorable influence on all analyzed indicators and it improves the quality of the flour more than every fertilizer taken separately. This way, a good quality of the flour is obtained with P40N150, P80N100, P120N100 due to a good wet gluten content of 24.3-25.8%, a good

falling number of 224-260 seconds, a sedimentation test of 64-68 ml, an index of deformation of 14.1-14.4 mm, a glutenic index of 51.3-56.7%. the farinograph test classifies this flour as good quality and the alveograph test classifies this flour as bakery potential category.

Table 1

The influence of A factor (phosphorus rate) on flour quality indicators

A factor	Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten def. Index (mm)	Glutenic index (%)	Farinograph test		Alveograph test	
						Dev. Time (minutes)	Stability (minutes)	Joule	P/L
a1-P0	20.8	116	16	22.3	18.1	1.3	0.7	77	0.3
a2 – P40	21.5	128	22	22.0	23.4	1.6	0.8	89	0.4
a3 – P80	22.3	144	27	19.1	24.9	2.7	2.6	134	0.4
a4 – P120	22.8	166	31	18.7	31.4	3.1	2.9	151	0.5

Table 2

The influence of B factor (potassium rate) on flour quality indicators

A factor	Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten def. Index (mm)	Glutenic index (%)	Farinograph test		Alveograph test	
						Dev. Time (minutes)	Stability (minutes)	Joule	P/L
b1 – K0	19.58	114	17	23.8	17.2	1.4	0.8	62	0.3
b2 – K40	20.17	124	22	22.7	21.5	1.5	0.8	71	0.3
b3 – K80	21.05	133	23	19.6	23.6	2.2	2.0	111	0.3

Table 3

The influence of C factor (nitrogen rate) on flour quality indicators

A factor	Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten def. Index (mm)	Glutenic index (%)	Farinograph test		Alveograph test	
						Dev. Time (minutes)	Stability (minutes)	Joule	P/L
c1 – N0	20.5	118	19	21.6	20.0	1.8	0.9	78	0.3
c2 – N50	21.7	124	21	20.2	19.6	2.1	2.5	113	0.3
c3 – N100	22.6	141	27	18.9	26.2	2.4	2.6	131	0.4
c4 – N150	23.5	164	33	17.6	30.5	3.2	3.6	144	0.5
c5 – N200	23.1	152	44	17.9	32.3	3.5	4.0	152	0.5

Table 4

The influence of the interaction between nitrogen and phosphorus on flour quality indicators

A factor	Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten def. Index (mm)	Glutenic index (%)	Farinograph test		Alveograph test		
						Dev. Time (minutes)	Stability (minutes)	Joule	P/L	
P0	N0	21.2	118	18	24.2	19.5	1.8	0.6	81	0.3
	N50	21.5	127	20	22.3	22.8	1.8	0.8	110	0.4
	N100	22.8	138	26	18.6	26.4	2.2	1.4	128	0.5
	N150	23.0	146	34	18.0	28.9	2.5	2.1	136	0.5
	N200	23.6	152	42	17.5	31.3	3.1	2.3	145	0.5
P40	N0	21.9	131	23	21.2	24.6	2.0	1.1	92	0.3
	N50	22.3	150	26	18.7	31.3	2.3	1.7	125	0.4
	N100	23.5	152	44	17.6	36.5	2.6	1.9	141	0.4
	N150	24.2	167	56	15.4	41.2	3.2	2.5	156	0.6
	N200	24.3	211	58	15.5	39.0	3.2	2.5	160	0.5
P80	N0	22.1	137	28	20.3	25.8	2.3	2.6	113	0.3

	N50	23.6	176	42	15.8	34.2	2.5	3.0	134	0.4
	N100	24.8	224	61	15.0	42.8	3.5	3.2	155	0.4
	N150	25.3	238	63	14.4	48.6	4.6	4.4	180	0.5
	N200	25.6	244	60	14.1	46.3	4.8	4.5	182	0.5
P120	N0	22.9	149	29	19.4	36.1	3.0	3.0	121	0.2
	N50	24.0	184	48	15.8	38.5	4.0	3.6	146	0.5
	N100	25.1	229	59	14.0	51.3	5.4	4.5	174	0.5
	N150	25.3	242	64	13.6	54.8	5.2	4.5	184	0.6
	N200	25.4	251	66	14.2	56.7	5.8	4.3	181	0.6

CONCLUSIONS

The analysis of the quality indicators of flour have emphasized the positive influence of the researched fertilizer types and rates on these indicators. They were: wet gluten, falling number, Zeleny sedimentation test, the index of gluten deformation, glutenic index, farinograph test and alveograph test.

The content of wet gluten has been favorably modified by moderate nitrogen rates of N100 – N150 along with phosphorus, P80, when this indicator reaches 24.8-25.3%, the flour being of good quality as compared with values under 24% obtained when nitrogen, phosphorus or potassium are applied alone.

The falling number has proper values for a good flour (234-244 seconds) when moderate nitrogen and phosphorus rates are applied, N100 – N150 with P80.

Zeleny sedimentation test has recorded the best values when there were applied different nitrogen rates on phosphorus background, of 61-63 ml (good quality flour).

The index of flour deformation has little influenced by researched fertilizer rates of phosphorus and potassium yet it has proper values

for a flour of good quality when N150-N200 are applied on a P80 background.

The glutenic index is favorably influenced by phosphorus and nitrogen and the obtained flour is satisfactory. The applying of moderate nitrogen rates of N100-N150 on P80 background has contributed to the obtaining of a flour of good quality.

The farinograph and alveograph tests have been, also, favorably modified by fertilizer rates, the best results being recorded when nitrogen was applied along with phosphorus in moderate rates.

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