THE INFLUENCE OF APPLYING DIFFERENT FERTILIZER RATES ON THE FLOUR OF WHEAT CULTIVATED ON THE CAMBIC CHERNOZEM FROM A.R.D.S. CARACAL

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Abstract
In order to establish the influence of different nitrogen, phosphorus and potassium fertilizers rates as well as of their interaction on wheat flour there was set up an experiment in 2011 where there were applied several fertilizer rates with the wheat crop on the cambic baticalcaric chernozem from A.R.D.S. Caracal, District Olt. There were determined the following indicators: wet gluten, falling number, Zeleny sedimentation test, gluten formation index, glutemic index, pharinograph test and alveograph test. This way, the wet gluten content has determined to the obtaining of values that show a flour of good quality when moderate rates of nitrogen (N100 – N150) along with moderate rates of phosphorus, reaching 24.8-25.3% wet gluten. The same way, the other quality indicators of the wheat flour as Zeleny sedimentation test has recorded values of 61-63 ml, the falling number of 234-244 second and the pharinograph and alveograph tests have conducted to obtaining of flour of good quality when rates of N100-N150P80 were applied. So, after determining these indicators there was established that the best quality of flour was given by moderate rates of nitrogen, N100 – N150 on moderate rates of phosphorus, P80. The applying of nitrogen, phosphorus and potassium fertilizers alone does not ensure a proper quality of the flour.

Key words: wheat flour, quality indicators, fertilizers, chernozem

The nutritional value and the baking quality of the wheat depend on the following factors (Toma, 2009):
- starch content of the endosperm;
- fats content of the embryo and inner shell;
- mineral substances from the shell;
- vitamins from the inner shell and shell;
- protein content that range between 8 and 26%.

In general, the wheat quality is defined by Carver by (Craver, 2001):
- physical properties: hectolitric mass (HM), mass of a thousand grains (MTG), grain strength;
- Protein related properties: total protein and gluten content, glutenic index, sedimentation volume, protein and aminoacids composition;
- Rheological properties: pharinograph test, alveographic values, extensograph test;
- Enzyme properties: falling number, mycotoxines content, pesticide residues.

The wheat quality, especially the protein content and the baking quality are influenced by the soil type, climate conditions, nitrogen fertilization, pests and disease control and crop genotype (Reltem, 1992).

The main objectives of a breeding program are high yielding potential and good baking quality. There is well known that with the wheat crop the baking quality is influenced by both genetically and clime conditions (Nicolescu, 2005; Ana Maria Dodocioiu, 2009).

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

In order to research the quality of flour of wheat cultivated on the cambic chernozem from ARDS Caracal, within 2009-2011 period we have carried out experiments regarding the quality indicators for baking.

MATERIAL AND METHOD

The trials were located on the cambic 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 below the tilled horizon, the texture is loam-clayey on the whole soil profile;
- the chemical properties are summarized as follows: the soil reaction is low acid/moderate acid/low alkaline (deeper); in the shallow horizon a low content of mobile aluminum is present, the humus content is moderate, the mobile phosphorus is average, the

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available potassium is good and the bases content is moderate;
- the clime conditions during experimentation indicates that the 2008-2009 year was less favorable for the wheat crop, the 2009-2010 was, also, less favorable and the 2010-2011 was favorable.

The experiment pattern was divided plots model, with three factors and three replications:
- the A factor was phosphorus fertilization, with four treatments: a1- P_0, a2 – P_{40}, a3 – P_{80}, a4 – P_{120};
- the B factor was potassium fertilization, with three treatments: b1 – K_0, b2 – K_{40}, b3 – K_{80};
- the C factor was nitrogen fertilization, with five treatments: c1 – N_0, c2 – N_{50}, c3 – N_{100}, c4 – N_{150}, c5 – N_{200}.

In order to appreciate the quality of the wheat flour there were determined the following indicators:
- the content of wet gluten;
- the falling number;
- the index of gluten deformation (mm);
- the glutenic index (mm);
- the pharinograph test (time of developing (minutes), stability (thousands);
- the alveograph test: the energy absorbed by the dough during stretching (Joule);
- the Zeleny sedimentation test (ml).

RESULTS AND DISCUSSIONS

The results in function of phosphorus, potassium and nitrogen rates are presented in tables 1-4.

The data presented in these tables show how the fertilizer type and rates influence the quality of the wheat flour for baking.

The A factor (phosphorus rate) has influenced the flour quality indicators as follows:
- the wet gluten content has been directly influenced by the phosphorus rate. This way, with the P_0 rate it was 20.8% (unsatisfactory flour) and after applying P_{40}, P_{80} and P_{120} it increased to 21.5, 22.3 and 22.8%;
- the falling number has, also, been favorably influenced by phosphorus rate. With P_0 it was 116 seconds and with P_{40}-P_{120} it reached 128-166 seconds;
- the test of sedimentation had values of 22-31 ml (average - satisfactory quality flour), in comparison with P_0 (inappropriately flour);
- the index of gluten deformation has decreased as a result of phosphorus applying from 22.3 mm with P_0 to 18.7 mm with P_{120};
- the glutenic index has been favorably influenced by phosphorus rates; it increased from 18.1% (P_0) to 24.9 and 31.9% with P_{80} and P_{120};
- the alveograph test has been improved as a result of phosphorus applying, reaching 77 Joul with P_0 and 84-151 with P_{40}-P_{120};

The B factor (potassium rate):
- the wet gluten content has little influenced by potassium rates: with K0 it was 19.8% and with K80 of 21.7%, the flour being unsatisfactory;
- the falling number has increased as a result of potassium applying from 114 seconds with K0 to 124-134 seconds with K40-K80, the flour switching from unusable to satisfactory;
- the sedimentation test has increased after potassium applying from 17 ml (K0) to 22-33 ml (K0-K80), the flour switched from low quality to proper;
- the index of gluten deformation has been less influenced by potassium fertilizer;
- the glutenic index is favorably modified by potassium yet the flour remained in unsatisfactory category.

Table 1

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

The A factor, P rate, kg a.i./ha		Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten deformation index (mm)	Gluten index (%)	Pharinograph test		Alveograph test	
							Developing time (min)	Stability (min.)	Joule W	P/L
A_1	P_0	20.8	116	16	22.3	18.1	1.3	0.7	77	0.3
A_2	P_{40}	21.5	128	22	22.0	23.4	1.6	0.8	89	0.4
A_3	P_{80}	22.3	144	27	19.1	24.9	2.7	2.6	134	0.4
A_4	P_{120}	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 few quality indicators of flour

The B factor, K rate, kg a.i./ha		Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten deformation index (mm)	Gluten index (%)	Pharinograph test		Alveograph test	
							Developing time (min)	Stability (min.)	Joule W	P/L
B_1	K_0	19.58	114	17	23.8	17.2	1.4	0.8	62	0.3
B_2	K_{40}	20.17	124	22	22.7	21.5	1.5	0.8	71	0.3
B_3	K_{80}	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 few quality indicators of flour

The C factor, N rate, kg a.i./ha		Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten deformation index (mm)	Gluten index (%)	Pharinograph test		Alveograph test	
							Developing time (min)	Stability (min.)	Joule W	P/L
C_1	N_0	20.5	118	19	21.6	20.0	1.8	0.9	78	0.3
C_2	N_{50}	21.7	124	21	20.2	19.6	2.1	2.5	113	0.3
C_3	N_{100}	22.6	141	27	18.9	26.2	2.4	2.6	131	0.4
C_4	N_{150}	23.54	164	33	17.6	30.5	3.2	3.6	144	0.5
C_5	N_{200}	23.1	152	44	17.9	32.3	3.5	4.0	152	0.5

Table 4

The influence of nitrogen-phosphorus interaction on few quality indicators of flour

Researched factors		Wet gluten %	Falling number (seconds)	Zeleny test (ml)	Gluten deformation index (mm)	Gluten index (%)	Pharinograph test		Alveograph test	
							Developing time (min)	Stability (min.)	Joule W	P/L
P_0	N_0	21.2	118	18	24.2	19.5	1.8	0.6	81	0.3
	N_{50}	21.5	127	20	22.3	22.8	1.8	0.8	110	0.4
	N_{100}	22.8	138	26	18.6	26.4	2.2	1.4	128	0.5
	N_{150}	23.0	146	34	18.0	28.9	2.5	2.1	136	0.5
	N_{200}	23.6	152	42	17.5	31.3	3.1	2.3	145	0.5
P_{40}	N_0	21.9	131	23	21.2	24.6	2.0	1.1	92	0.3
	N_{50}	22.3	150	26	18.7	31.3	2.3	1.7	125	0.4
	N_{100}	23.5	152	44	17.6	36.5	2.6	1.9	141	0.4
	N_{150}	24.2	167	56	15.4	41.2	3.2	2.5	156	0.6
	N_{200}	24.3	211	58	15.5	39.0	3.2	2.5	160	0.5
P_{80}	N_0	22.1	137	28	20.3	25.8	2.3	2.6	113	0.3
	N_{50}	23.6	176	42	15.8	34.2	2.5	3.0	134	0.4
	N_{100}	24.8	224	61	15.0	42.8	3.5	3.2	155	0.4
	N_{150}	25.3	238	63	14.4	48.6	4.6	4.4	180	0.5
	N_{200}	25.6	244	60	14.1	46.3	4.8	4.5	182	0.5
P_{120}	N_0	22.9	149	29	19.4	36.1	3.0	3.0	121	0.2
	N_{50}	24.0	184	48	15.8	38.5	4.0	3.6	146	0.5
	N_{100}	25.1	229	59	14.0	51.3	5.4	4.5	174	0.5
	N_{150}	25.3	242	64	13.6	54.8	5.2	4.5	184	0.6
	N_{200}	25.4	251	66	14.2	56.7	5.8	4.3	181	0.6

- the alveograph test was less influenced by potassium rates, the flour remaining in the low category of quality.

The C factor (nitrogen rate):

- the wet gluten is favorably modified by nitrogen rates increasing from 20.5% (N0) – unsatisfactory flour, to 21.7-23.4% (N50-N200) – satisfactory flour;
- the falling number increases as a result of nitrogen applying from 118 second with N0 to 124-133 second with N50-N200, the flou switching from unsatisfactory to satisfactory;
- the sedimentation test is favorably modified when nitrogen rates are applied, it increasing from 19 ml (N0) to 21-44 ml (N50-N200), the flour switching from unsatisfactory to satisfactory;
- the index of gluten deformation is favorably modified only by high nitrogen rates of N100 – N200 increasing both the stability and the time of the dough;
- the alveograph test had values of 131-152 Joul and 0.4-0.5 mm with N100-N200 rates as compared with 78 Joul and 0.3 mm with N0, the flour becoming good for bread.

The interaction between nitrogen and phosphorus has a very good influence on all analyzed indicators, the quality of the bread being significantly improved more than individual fertilizers. This way, a good quality of the bread is obtained when both nitrogen and phosphorus are applied in rates of P40N150, P80N100 or P120N100 due to a higher content of wet content of 24.3-25.8%, a falling number of 224-260 second, sedimentation test of 64-68 ml, deformation index of 14.1-14.4 mm, glutenic index of 51.3-56.7%, pharinograph test determines a very good quality of the flour and the alveograph test makes the flour good for bread.

CONCLUSIONS

The analysis of wheat flour quality indicators demonstrates the favorable effect of fertilization on them; they were: wet gluten, falling number, Zeleny sedimentation test, gluten formation index, glutemic index, pharinograph test and alveograph test;

The wet gluten content has been favorably modified by moderate nitrogen rates of N_{100} and N_{150}, along with moderate rate of phosphorus, P_{80}, when this value reach 24.8-25.3%, the flour being of good quality as compared with values under 24% when nitrogen, phosphorus or potassium are applied alone;

The falling number reaches values for a good flour (234-244 second) when moderate rates of nitrogen (N_{100}-N_{150}) are applied along with P_{80};

The Zeleny sedimentation test has recorded the best values when different rates of nitrogen were applied along with phosphorus; these values reached 61-63 ml (good quality flour);

The index of gluten deformation has less influenced by phosphorus and potassium rates yet it reached proper values when N_{150} and N_{200} rates were applied;

The glutenic index is favorably influenced by phosphorus and nitrogen rates when the flour has a satisfactory quality; the applying of moderate rates of nitrogen (N_{100}, N_{150}) along with phosphorus (P_{80}) have determined the obtaining of good quality flour;

The pharinograph and alveograph tests have, also, been favorably influenced by moderate rates of nitrogen along with phosphorus, determining flour of good quality.

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