Influence of nitrogen fertilizer treatments on soft wheat starch characteristics.

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Introduction

Ideally sowed in the middle of October, winter wheat crops are usually fertilised with nitrogen (N) applications varying with the soil type, the soil fertility, the previous crop and the state of the crop. Generally, the N-fertilisation is equally distributed over three applications after the winter : the first during tillering, the second at beginning of stem elongation and the third at flag leaf emergence to assure the persistence of the photosynthetically-active flag leaf. Now the tendency is to postpone the first nitrogen application to the third fraction to increase the grain yield of wheat crops (about 2/3 of the dry matter is photosynthesised after the flag leaf stage).

The influence of nitrogen fertilizer treatments on the flour protein content and properties, which correlates with the efficiency on the gluten-starch separation and the gluten yield is well known. But the litterature is relatively scarce on the effect of this agronomic factor on the starch characteristics. Consequently, it is interesting to determine wether increasing N fertilizer rates induce variations in starch characteristics.

Wheat samples

The impact of N-fertilisation is investigated for wheat varieties Corvus and Folio in 2002 and 2003, and for wheat varieties Deben and Meunier in 2005. Wheat samples are grown in the experimental field at Lonzée (Belgium). Meunier is associated with the highest bread-making quality, Corvus and Folio with a good bread-making quality and Deben with a low bread-making quality. Moreover, Folio is known to be susceptible to preharvest sprouting.

Nitrogen was applied under solid form as NH_4NO_3. The total amount of N-fertilisation applied to the wheat varieties is ranged from 0 to 300 kg N/ha. These amounts are distributed over three split applications. Each sample is grown in four different plots of 16 m^2 in a fully randomised block design. Wheat kernels from 4 different plots are mixed to reduce location effect and to increase the homogeneity of the samples.

Starch isolation

Wheat grains are milled with a Quadrumat senior mill (Brabender, Duisberg, Germany).

Starches are isolated by 'Batter' procedure from 2.0 kg white flour (Figure 1).

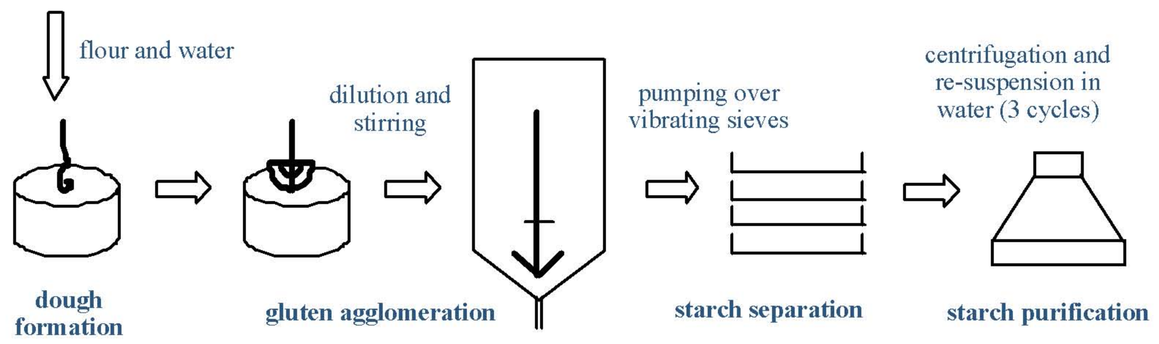

Figure 1: Starch isolation by Batter procedure

Results

Table 1: The influence of N-dose on grain yield, protein content (by NIRS), flour and starch characteristics

Wheat variety	N-dosage (kg N/ha)	N-split applications	Grain yield (kg/ha)	Protein content (%)	Water absorption of flour (%)	Damaged starch (CDU)	Starch B-granules content (%)	Starch viscosity at 95°C (BU)	Starch viscosity at 50°C (BU)
2002									
CORVUS	0	0-0-0	5942	9.2	52,0	17,9	23,6	292	472
	150	50-50-50	9572	10.9	53,5	18,4	22,7	301	472
	200	100-100-0	8991	11.3	53,5	18,8	21,6	295	467
	200	0-100-100	9448	11.7	53,5	18,4	22,1	303	479
	300	100-100-100	8805	12.2	53,5	18,8	22,0	297	470
FOLIO	0	0-0-0	5778	10.0	57,5	20,3	21,3	307	450
	150	50-50-50	9395	11.4	58,0	20,0	22,4	302	448
	200	100-100-0	9388	12.1	58,5	20,1	22,3	296	440
	200	0-100-100	9151	12.7	59,5	19,9	24,4	305	446
	300	100-100-100	9214	13.1	60,0	19,5	24,1	303	452
2003									
CORVUS	0	0-0-0	5182	8.2	50,5	18,0	20,9	284	453
	150	50-50-50	10042	9.6	53,5	18,5	20,7	290	457
	200	100-100-0	10164	10.2	53,5	18,6	21,3	287	465
	200	0-100-100	9923	11.0	54,5	19,4	20,1	280	468
	300	100-100-100	10162	11.9	55,0	19,3	21,4	281	461
FOLIO	0	0-0-0	5206	9.9	58,5	21,5	22,5	277	465
	150	50-50-50	9493	11.0	61,5	21,6	23,8	275	467
	200	100-100-0	9920	11.9	61,5	21,6	21,3	278	458
	200	0-100-100	9872	12.3	62,5	21,7	23,7	275	465
	300	100-100-100	10416	12.9	63,5	21,6	21,6	275	465
2005									
DEBEN	110	50-60-0	10726	9.2	46,0	14,4	22,4	269	426
	185	50-60-75	11256	9.9	46,5	15,5	20,6	270	430
	215	0-60-155	11586	10.5	47,0	16,0	18,7	273	437
MEUNIER	110	50-60-0	9617	10.2	48,0	14,1	16,8	333	447
	185	50-60-75	10673	12.0	50,0	15,6	15,4	328	439
	215	0-60-155	10393	12.9	51,0	15,8	14,7	333	448

N-fertilisation is well known to increase grain yields and protein levels and this is also observed in these trials for all the varieties and the growing seasons. Water absorption of flour, evaluated using a farinograph (Brabender, Duisberg, Germany), increases also with the N-doses.

Damaged starch values are determined amperometrically by the Chopin SD4 method (Villeneuve-la-Garenne, France). Starch damages increase slighlty with the N-doses for all the varieties except for Folio. This variety is associated with a very hard wheat grain, inducing always high values of starch damages.

Granule size distribution of starches is determined by using a laser granulometer (Malvern, Worcestershire, UK). The volume percentages of the small B-granules don't vary significatively with the N-doses.

Starch viscosity properties are evaluated with a micro visco-amylograph (Brabender, Duisberg, Germany). Starch suspensions are prepared with addition of 2 mM $AgNO_3$ to nullify alpha-amylase effects, and subjected to a determine time-temperature profile (increase at 95°C in 10 min, holding at 95°C for 10 min and decrease at 50°C in 10 min). The viscosity values, measured at 95 and 50°C, don't vary significatively with the N-doses.

Conclusion

Grain nitrogen level is one of the main quality parameters of wheat grains. N-fertilisation is known to increase grain yield and grain protein content. Although large variations are observed on these grain and protein parameters, the starch properties tend to be globally insensitive to applied N-fertilisation, suggesting that the protein and starch accumulations in wheat grains are probably independent events, controlled and influenced by different factors.

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