INFLUENCE OF NITROGEN FERTILIZER TREATMENTS ON SOFT WHEAT STARCH CHARACTERISTICS.

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Abstract

Different nitrogen treatments were applied on winter wheat crops during several growing seasons (2002, 2003 and 2005). The starch was isolated and the impact of the nitrogen fertilization on the starch properties was evaluated. The comparison of the three harvest seasons shows globally the same observations. A significant impact of the N-fertilization on the grain yield and flour properties was measured for all studied varieties. The starch damages increased slightly with the N-doses but the other measured starch characteristics tended to be insensitive to applied N-fertilization. These results suggest that protein and starch accumulations in wheat grains are probably independent events.

1. Introduction

Ideally sown in the middle of October, winter wheat crops are usually fertilized with nitrogen (N) applications varying with the soil type, the soil fertility, the previous crop and the state of the crop. Generally, the N-fertilization 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 (Daniel and Triboi, 2000; Boehm et al., 2004). But the literature is very scarce on the effect of this agronomic factor on the starch characteristics (Kelfkens and Hamer, 1991). Consequently, it is interesting to determine whether increasing N fertilizer rates induce variations in starch characteristics.

2. Wheat samples

The impact of N-fertilization was investigated for wheat varieties Corvus and Folio in 2002 and 2003, and for wheat varieties Deben and Meunier in 2005. 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.

Wheat samples were grown in the experimental field at Lonzée (Belgium), normally sown in October and harvested in August. Two fungicide treatments were applied, good weed and insect control were achieved in all trials by applying appropriate herbicides and insecticides.

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

3. Starch isolation

Wheat grains were milled with a Quadrumat senior mill (Brabender, Duisberg, Germany).Starches were isolated by the 'Batter' procedure from 2.0 kg of white flour (Fig. 1).

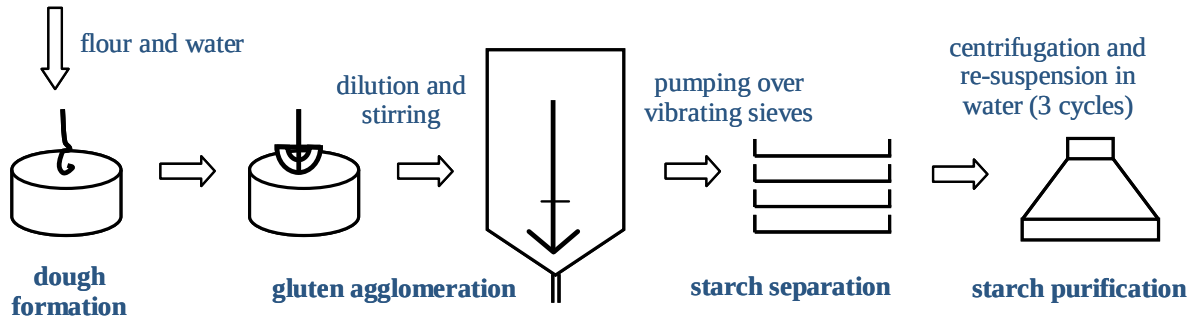

Figure 1: Starch isolation by the Batter procedure

4. Results

Table I shows the influence of N-doses and N-split applications on grain yield, protein content, flour and starch characteristics.

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-fertilization is well known to increase grain yields and protein levels. These results are also observed in our trials for all the varieties and the growing seasons. For example, grain yields for Folio (2003) ranges from 5200 to 10400 kg/ha, and protein content vary from 9.9 to 12.9% with the increase of the N-doses. Water absorption of flour, evaluated using a farinograph (Brabender, Duisberg, Germany), increases also with the N-doses.

Damaged starch values were determined amperometrically by the Chopin SD4 method (Villeneuve-la-Garenne, France). Starch damages increase slightly 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 during milling. The 2005 results show a more important increase of the starch damage, associated with the increased N-doses and the later N-applications.

Granule size distribution of starches was determined by using a laser granulometer (Malvern, Worcestershire, UK). Different tendencies (increase, constancy or decrease) are observed as function of the varieties and the growing seasons. From these results, we can not conclude that the volume percentages of the small B-granules are influenced by the N-doses.

Starch viscosity properties were evaluated with a micro visco-amylograph (Brabender, Duisberg, Germany). Starch suspensions, prepared with addition of 2 mM $AgNO_3$ to remove the effect of alpha-amylase, were subjected to a time-temperature profile (increase to 95°C in 10 min, holding at 95°C for 10 min and decrease to 50°C in 10 min). For a same variety, the viscosity values, measured at 95 and 50°C, do not vary significantly with the N-doses. It is interesting to note that the starches isolated from wheat samples grown with 0 or 300 kg N/ha present the same viscosity behavior.

5. Conclusion

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

Acknowledgments

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