Advance Journal of Food Science and Technology 5(5): 646-649, 2013
DOI:10.19026/ajfst.5.3141
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: January 31, 2013 Accepted: February 25, 2013 Published: May 05, 2013

Research Article

Effects of Different Nitrogen Fertilizer on Quality and Yield in Winter Wheat

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Abstract: This experiment aimed to study the effects of different nitrogen fertilizer with wheat variety Jimai 20 as experimental material on the content of total protein and percentage of its component content to total protein content, wheat flour wet gluten content and sedimentation value and the sources of dry matter after anthesis as well as the yield and its components in winter wheat. The results showed that, under the conditions of this experiment, it was conducive to the simultaneous increase in the quality and yield with the increase of nitrogen fertilizer in winter wheat when the amount of nitrogen fertilizer was in the range of 0 and 225 kg/hm^2; once the amount of nitrogen fertilizer reached 300 kg/hm^2, the winter wheat showed the best quality and decline both in the percentage of weight gain in grain filling stage to kernels and the kernels yield. Therefore, taking yield and the quality of nitrogen fertilizer into account, we thought that the best nitrogen application level was 225 kg/hm^2.

Keywords: Kernels, protein, sedimentation value, wet gluten content, winter wheat

INTRODUCTION

Nitrogen is one of the important factors that affecting the yield and quality of wheat. If there is no enough amount of nitrogen fertilizer, the yield and quality of wheat will become worse and on the contrary, excessive nitrogen application will result in lower use efficiency of nitrogen in wheat and more environmental pollution. Given the fertilizer significant effect of improving wheat yield, how to apply the nitrogen fertilizer reasonably to improve both yield and quality has become a hot research topic today. There have been some researches about effect of fertilizer mode on wheat yield (Yan *et al*., 1999, 2001; Rashid *et al*., 2008) and researches on the effect of nitrogen fertilizer on wheat yield and grain protein components (Wang *et al*., 2003; Abad *et al*., 2004; Liu *et al*., 2007) and researches on nitrogen fertilizer on yield and processing quality of different wheat genotype (Shi *et al*., 2010; Shi-Zhao *et al*., 2011; Zhongzhi *et al*., 2012; Feng-Jiao *et al*., 2012) and researches about nitrogen application rate on the flag leaf photosynthesis (Jun-Ye and Zhen-Wen, 2006; Zhang *et al*., 2007; Mei-Ling *et al*., 2009) and the nitrogen application rate on wheat nitrogen metabolism and yield (Xing-Mei *et al*., 2006; Zong-Bin *et al*., 2007; Wen-Xue *et al*., 2012; Wei-Wei *et al*., 2012).

The wheat variety Jimai 20 is a new variety of high-quality bread in Shandong province, with little research about nitrogen fertilizer of it. Thus, it will make difference to do research about reasonable nitrogen application rate on strong gluten wheat variety Jimai 20 to improve the wheat quality and yield.

The experiment studied the effect of nitrogen fertilizer on the content of total protein and percentage of its component content to total protein content, wheat flour wet gluten content and sedimentation value and the sources of dry matter after anthesis as well as the yield and its components in winter wheat so as to provide a theoretical basis for the rational application of nitrogen fertilizer to achieve higher yield and better quality of wheat cultivation.

MATERIALS AND METHODS

Experimental materials: This experimental was carried out in the plots of Qingdao Agricultural University base (latitude 35°44'N and longitude 119°47'E) in the years 2011-2012 with variety Jimai 20. The soil was sandy loam soil with PH of 6.7; soil organic matter content in the soil layers of 0-20 cm was 1.16%, available nitrogen 95.3 mg/kg, available phosphorus 28.6 mg/kg and available potassium 106.2 mg/kg.

Experimental design: This experiment set of 4 different treatments according to the amount of pure nitrogen that were N0 (0 kg/hm^2), N150 (150 kg/hm^2), N225 (225 kg/hm^2) and N300 (300 kg/hm^2) with urea as nitrogen fertilizer. All the plots were fertilized with 3000 kg/hm^2 of organic fertilizer, 225 kg/hm^2 of P_2O_5

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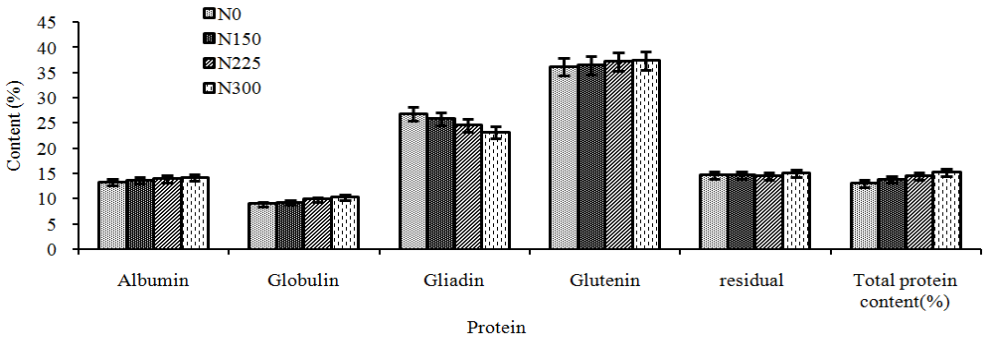

Fig. 1: Effects of nitrogen fertilizer on kernel protein content in winter wheat (%)

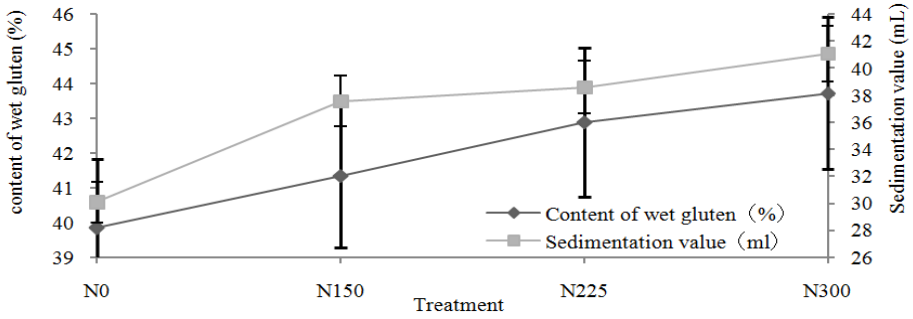

Fig. 2: Effect of nitrogen fertilizer on wet gluten content and sedimentation value of wheat flour

and 150 kg/hm^2 of K_2O. All fertilizers were applied as basal fertilizer. There were 3 replicates for each treatment, a total of 12 experiment plots and each plot of 120 m^2. These treatments were arranged in a randomized block design with a basic seedling number of 1.8 million/hm^2.

Measurement items and methods: Kernel total nitrogen content was measured by Kjeltec2300 automatic azotometer measurement, which multiplied by 5.7 to be the kernel protein content.

Protein components were washed successively with distilled water, sodium chloride of 10%, alcohol of 75% and alkaline solution of 0.2% for sequential extraction of albumin, globulin, gliadin and gluten.

Weighed 2 g of flour into a graduated cylinder of 50 mL and added 25 mL bromophenol blue solution of 10 mg/L into it and then shocked 5 min. Shocked 15 min immediately after adding into 25 mL lactic acid-SDS operating fluid and measured the sedimentation value after stationary for 20 min.

Measured the wet gluten content according to GB/T 5506.1-2008 (China).

Measured the dry matter in flowering stage and harvest stage and determined the panicles, number of kernels per spike, weight per thousand kernels and the kernel yield at harvest time.

All the data were processed by using EXCEL and further analyzed with the Date Processing System (DPS).

RESULTS AND ANALYSIS

Effects of nitrogen fertilizer on kernel quality in winter wheat: The wheat kernel total protein content gradually increased with the increase of nitrogen fertilizer and its component showed different trend (Fig. 1). The content of albumin, globulin and glutenin in kernel total protein content gradually increased with the increase in the amount of nitrogen while that of gliadin showed an opposite trend; the residual protein content showed no obvious changes among different treatments, with the residual protein content of N225 the lowest and N300 the highest. These results indicated that within a certain range, the increase in the amount of nitrogen was conducive to the increase in kernel protein content.

Figure 2 showed that, wheat flour wet gluten content and sedimentation value tended to increase with the increase of the amount of nitrogen fertilizer. When the nitrogen amount was in range of 0 and 225 kg/hm^2, the magnitude of increase in wet gluten content was very large and then became smaller when the nitrogen amount was more than 225 kg/hm^2. When the nitrogen amount was in range of 0 and 150 kg/hm^2, the magnitude of increase in the sedimentation value was the largest and smallest in range of 150 and 225 kg/hm^2.

Effects of nitrogen fertilizer on kernel yield in winter wheat: From Table 1, the percentage of weight gain in grain filling stage to kernel in different

Table 1: Effects of nitrogen fertilizer on sources of dry matter after anthesis in winter wheat

				Grain filling stage		Prophase		
	Kernel yield (kg)	Dry matter after anthesis (kg)	Dry matter in harvest stage (kg)	Gaining weight of grain filling stage (kg)	Percentage in flowering stage	Storage from prophase (kg)	Percentage in kernel%	Percentage of weight gain in grain filling stage in kernel%
N0	7263d	11816.4d	16890.5d	5074.10d	48.60	2188.90d	30.14	69.86
N150	8356.4c	13155.92c	19105.4c	5949.48c	49.80	2406.92c	28.80	71.20
N225	9135.6a	13507.88b	20302.8b	6794.92a	58.60	2340.68b	25.62	74.38
N300	8745.7b	14614.51a	20936.5a	6321.99b	59.80	2423.71a	27.71	72.29

N0, N150, N225 and N300: 0, 150, 225 and 300 kg/hm^2 of nitrogen fertilizer respectively; Lower case letters represented significant differences at $p<0.05$ level

Table 2: Effects of different treatments on yield components and yield of wheat

Treatment (kg/ha)	No of spikes ($\times10^4$/hm^2)	No of kernel per spike	Weight per 1000 kernels (g)	Kernel yield (kg/hm^2)	Biology yield (kg/hm^2)	Harvest index
N0	654.00d	35.80c	35.50b	7263.0d	16890.5d	0.43
N150	697.35c	38.15b	36.75a	8356.4c	19105.4c	0.44
N225	725.85b	39.40a	36.70a	9135.6a	20302.8b	0.45
N300	756.90a	38.40b	35.31b	8745.7b	20936.5a	0.42

N0, N150, N225 and N300: 0, 150, 225 and 300 kg/hm^2 of nitrogen fertilizer respectively; Lower case letters represented significant differences at $p<0.05$ level

treatment was in the sequence: N225>N300>N150>N0; the percentage of operation matter from prophase storage organs to kernel performed that: N225<N300<N150<N0. When the nitrogen amount increased from 0 to 225 kg/hm^2, the weight gaining in grain filling stage increased significantly with increasing amount of nitrogen; however, the weight gaining in grain filling stage of N300 declined, but still significantly higher than that of N150.

It was very obvious that, the number of spikes and biology yield all increased significantly with increasing amount of nitrogen fertilizer and the differences between each treatment were significant (Table 2). When the amount of nitrogen fertilizer increased from 0 to 225 kg/hm^2, the number of kernel per spike and kernel yield increased significantly with nitrogen fertilizer increasing, while that of N300 declined, but still higher than that of N150; the number of kernel per spike in treatment N150, N225 and N300 were all significantly higher than N0, but the differences between treatment N150 and N300 were not significant. The law of the weight per 1000 kernels for these treatments was that: N150>N225>N0>N300 and the weight per 1000 kernels in N150 and N225 were significantly higher than that of N0 but there was no significant difference between N0 and N300. Additionally, N225 had the highest harvest index while N300 the lowest.

DISCUSSION AND CONCLUSION

Nitrogen has great influence on wheat yield and quality and different amount of nitrogen fertilizer has different effects on wheat kernel quality, yield and yield components. But generally speaking, within a certain range, the higher nitrogen application rate, the better the quality of wheat kernel and higher yield.

There has been a considerable amount of researches about nitrogen levels on wheat protein components with different conclusions. Researchers (Wang *et al*., 2003) proved that the albumin and gluten gradually reduced with the increase in the amount of nitrogen, while globulin and gliadin all gradually increased; some researchers believed that the protein each component content increased significantly with the increasing amount of nitrogen fertilizer, among which the proportion of albumin, globulin and glutenin increased while gliadin decreased; some researchers (Rashid *et al*., 2004) proved that gliadin and gluten increased slowly with the increasing amount of nitrogen fertilizer, but globulin and albumin decreased. In fact, regulation of nitrogen on kernel protein had association with characteristics of wheat varieties and also with the ecological environment and cultivation (Shi *et al*., 2010). This study proved that with the increasing in the amount of nitrogen fertilizer, the proportion of wheat albumin, globulin, glutenin gradually increased while the proportion of gliadin reduced.

The results of this experiment showed that under this the conditions of this experiment, when the nitrogen application rate was in the range of 0-225 kg/hm^2, with the increasing amount of nitrogen fertilizer, the wheat quality gradually improved and the percentage of weight gain in grain filling stage in kernel increased and got higher kernel yield; the wheat with nitrogen fertilizer rate in 300 kg/hm^2 gained the best quality and decreasing percentage of wheat gain in grain filling stage in kernel and lower yield. Therefore, under this experimental condition, taking yield and quality into consideration, the best nitrogen level was 225 kg/hm^2.

ACKNOWLEDGMENT

Supported by the program of "The research on the efficient use technology and demonstration of nitrogen fertilizer in main crops (201203079)"; "Integrated research and demonstration of the balanced increase in winter wheat and summer maize in Shandong Province (2012BAD04B05)"; the innovation team in wheat of Shandong province "cultivation and soil fertilizer (621135)" and The Taishan Mountain Scholar Constructive Engineering Foundation of Shandong Province.

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