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Research Article

Effects of Super Absorbent Resin on Quality and Yield in Dryland Wheat

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Abstract: In order to find an appropriate Super Absorbent Resin (SAR) application amount and improve the quality and yield in dryland wheat. The effects of SAR on quality and yield in dryland wheat had been studied with Jimai 22 as the experimental material. The results proved that, under the condition of this experiment, SAR improved the crude protein content and sedimentation value of wheat. It extended the developing time of wheat dough and shortened the settling time. Within a certain range, with the increase of application rate of SAR, the wet gluten value decreases. When the application amount of SAR was 1 kg/667 m^2, we got a better quality of wheat with the highest yield.

Keywords: Dryland wheat, quality, super absorbent resin, yield

INTRODUCTION

Wheat is one of the most important crops in northern China, with the northern dry-land area wider distribution, there are differences in the precipitation affected by time, space and so on in law of water demand (Jicheng *et al*., 2005). Water is important to the growth of wheat. Excessive lack of water will have serious effects on wheat growth and great impact on wheat yield. Many scholars (ZhiJuan *et al*., 2006) focus on research directions of conserving soil moisture and providing adequate water fertilizer for wheat.

As a new polymer material, SAR has a strong ability to absorb water and to better maintain it. At the same time it can overmaster the release of maintaining water which is in line with growth and development of crops (Guanghua *et al*., 2004). The growth of roots wheat on the above and below ground can be regulated by SAR. It affects the distribution status of dry matter accumulation in different growth stages of wheat in many aspects and ultimately affected the yield of wheat. There were some researches relatively in this field (Huien, 1988), SAR can promote the accumulation of dry matter in different growth stages of wheat and improve its water use efficiency, improve the distribution of dry weight on the above and below ground and promote the increasing of wheat yield. SAR can absorb moisture well which is able to provide adequate moisture for the growth of wheat.

Crude protein content of wheat has some relationship with the enzyme activity, within a certain range, the higher the content the higher the enzyme activity. The sedimentation value of wheat had relationship with genetic proteins which could reflect genetic differences deeply (Liyuan and Yan, 2013). Wet wheat gluten and dough formation and stabilization time were in connection with its nutritional quality. Wheat grain weight was an important factor which reflects the full extent of wheat grain, which was composed of wheat yield. The above indicators had relationship with each other and wheat quality reaction conditions could be better.

SAR has some influence on the quality and yield of crops. There were (Yonghui *et al*., 2011) researches showed that SAR could improve the quality and yield of sugarcane. Ren's (Yongxin and Chunxi, 1989) study indicated that SAR had some impact on protein of wheat. There is few research of SAR on wheat quality and yield. This experiment measured wheat crude protein, sedimentation value, wet gluten, grain weight and yield and other indicator to investigate the effect of retaining agent on wheat yield and quality indicators. And it would improve the quality and yield of wheat and provide a theoretical basis to find the optimal amount of SAR application.

MATERIALS AND METHODS

Experimental materials: The experiment was carried out from October, 2013 to June, 2014 in the open field in experimental base of Qingdao Agricultural University (35°46'N, 119°56'E) with “Jimai 22” as experimental material. The Conventional Complex Fertilizer (CCF) labeled YAN NONG complex fertilizer whose formula was of 22-8-12 ($N:P_2O_5:K_2O$)

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Table 1: Experimental design (kg/667 m^2)

Treatments	SAR (kg/667 m^2)	Complex fertilizer (kg/667 m^2)
CK	0.0	50
T1	0.5	50
T2	1.0	50
T3	1.5	50
T4	2.0	50

produced by the YAN-NONG-Weifang Agricultural Chain Co., Ltd. The SAR was produced by Anxin Company.

Experimental methods: According to Table 1, there were 5 treatments with different amounts of SAR which were Control Check (CK, 0 kg/667 m^2), Treatment 1 (T1, 0.5 kg/667 m^2), Treatment 2 (T2, 1 kg/667 m^2), Treatment 3 (T3, 1.5 kg/667 m^2) and Treatment 4 (T4, 2 kg/667 m^2) and each treatment with complex fertilizer of 50 kg/667 m^2. All fertilizers were applied disposable for basal fertilizer. We took a randomized block design in the field. The experimental design was repeated 3 times. Leaving a road of 1 m wide to observe plots and the isolation region was 1.5 m among districts. Locate protected area around experimental plot. The plot area was 12*15 m. There was no more fertilizer and irrigation treatment during the growth and development of wheat. Wheat was sowed on October, 15 2013 and the seeding quantity was 12 kg/667 m^2.

Items and methods:

Crude protein of wheat: Grain protein content was measured by Kjeltec2300 automatic nitrogen azotometer and grain protein content was multiplied by 5.7.

Sedimentation value of wheat: The Sedimentation value was measured by AACC56-63ZELENY settlement value instrument produced by Germany Brabender Company.

Wet wheat gluten: First of all, the wheat grain should be removed impurities and grinding flour with Brabender Quadrumal Junior. The gluten content was measured by the Swedish company Falling Number 2200 gluten instrument with reference of GB/TI4608-93.

Grain weight of wheat: Five hundred wheat seeds were selected by Chopin partical-counter instrument, each treatment repeated twice (difference of repeat less than 0.5 g) and then converted them into thousand kernel weight.

Data processing: Experiment data was statistical analyzed by the EXCEL and related mathematical statistics software (DPS).

RESULT ANALYSIS

Effect of different application amount of SAR on the crude protein content of wheat: As Fig. 1 showed, different application rates of Water-retaining agent could affect crude protein content of wheat. The crude protein content of wheat of CK was lower than that of wheat that applied the SAR. And with the increasing application of the SAR, the crude protein content of wheat increased. Among them, T1 was 6.6% higher than that of CK, the overall performance of the trend was T4>T3>T2>T1>CK. Figure 1 showed that SAR could increase the crude protein content of the wheat. We could see from the figure, applied SAR content like T4 could best improve the content of crude protein in wheat.

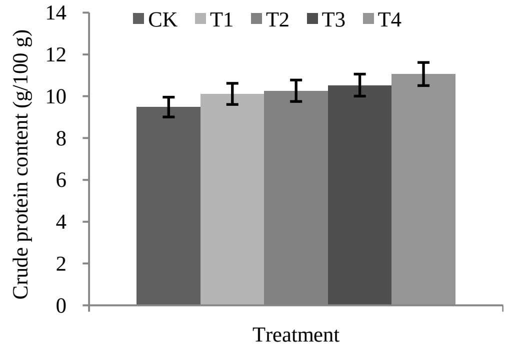

Fig. 1: Effect of different treatments on the crude protein content of wheat

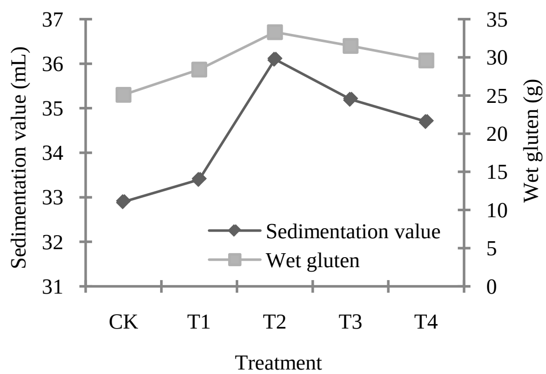

Fig. 2: Effect of different treatments on sedimentation value and wet gluten values in wheat

Effect of different application amount of SAR on wheat sedimentation value and wet gluten values: The application rates of different SAR had different effects on the settlement value of the wheat from the Fig. 2. T2 has the highest settlement value and CK the minimum. The overall performance of the trend was T2>T3>T4>T1>CK. However, the settlement value did not increase with the increase of amount of SAR. Sedimentation values began to decline from T2. But the overall performance of the Sedimentation value of wheat that applied water-retaining agent was higher than that of CK. From Fig. 2, the Sedimentation value of T2 was the best.

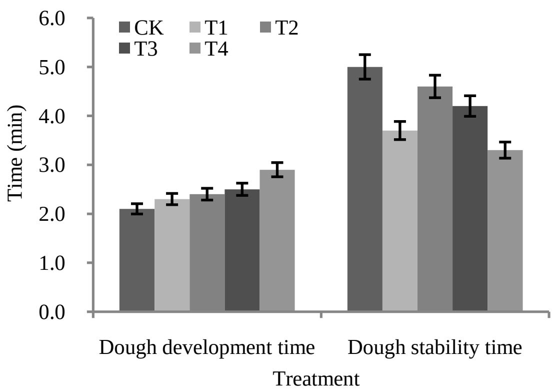

Fig. 3: Effect of different treatments on wheat dough formation and stabilization time

Table 2: Effect of SAR on wheat yield and its components

Treatments	Kernel per spike (kernel)	1000-kernel weight (g)	Spikes (10^4/667 m^2)	Grain yield (kg/667 m^2)
CK	30.00b	41.10b	33.76b	353.82a
T1	31.50a	42.92a	34.32b	394.44a
T2	32.00a	44.00a	40.64a	486.38b
T3	31.84a	43.98a	40.32a	479.84a
T4	31.67ab	43.90a	39.68a	468.89a

Different lowercase letters indicate significant differences between treatments ($p<0.05$)

There were differences in wet gluten values of wheat among different amount of treatments of SAR in Fig. 2. The value of wet gluten in T2 was the highest and the wet gluten of CK the lowest. Wet gluten value of T3, T1 and T4 were not significantly different from the value of CK. The Fig. 2 reflects that, the SAR improved the value of their wet wheat gluten. However, from wet gluten value of T2, T3 and T4, with the increase of the water retention agent application rate, the value of wet gluten in wheat reduced. This showed that to some extent, wet wheat gluten was not positively correlated with SAR application rate.

Effect of different application amount of SAR on wheat dough formation and stabilization time: Figure 3 showed the effect of different treatments on wheat dough formation and stabilization time. There was no significant difference in wheat dough formation time of different treatment, with T4 the highest and CK the minimum. The dough stability time of wheat in different treatment showed some differences, with CK the highest, T4 the lowest. The overall dough stability time of wheat in different treatment was in sequence CK>T2>T3>T1>T4 and the difference was significant. With the increase of SAR application rate, wheat dough formation time prolonged and wheat dough stability time shortened.

Effect of different application amount of SAR on wheat yield: Table 2 showed that different SAR treatment had different effects on the wheat yield and its components; there were significant differences among different treatments. There were significant differences in wheat spikes in SAR treatment and the sequence was T2>T4 = T3>T1>CK. The wheat spike of T2 was the highest which was 21.4% higher than the CK. The spikes of T3 and T4 were in different levels, but the performance of spikes was consistent. It showed that with the increase in SAR the effects on spikes of wheat reduced. But the overall performance showed that water retaining improved spikes of wheat.

From heading stage to flowering stage, vegetative growth in wheat turned to reproductive growth. This period affected the number of kernels per spike in wheat. The wheat under adequate nutrient supply would have a higher number of wheat kernels per spike. From Table 2, the kernels per spike of wheat in T2 was the highest, CK the lowest. T1, T2, T3 and T4 showed significant difference in the table which was in sequence T2>T3>T4>T1>CK. Table 2 showed that SAR could increase the number of kernels per spike of wheat. But from T2, T3, T4, with the increase of application rate in SAR, the differences of the number of kernels per spike in wheat was not significant.

In the grain filling stage of wheat, the wheat accumulates dry matter by continuous photosynthesis to increase grain yield. 1000-kernel weight of wheat was in the order of T2>T3>T4>T1>CK and SAR could increase wheat 1000-kernel weight. T2 was 4.4% higher than CK, the grain weight of T3 and T4 remained the same and the difference was not significant. Different SAR had different effects on the final yield of wheat, the performance of the overall wheat yield was in sequence T2>T3>T4>T1>CK. The yield of CK and T1, T2, T3 and T4 showed that the yield was significantly different and the difference between T1 and T2 were significantly. T1 had no significant difference between T3 and T4. This indicated that to a certain extent, the SAR application can improve wheat yield. The yield of T2 treatment was 37.7% higher than CK, which was 23.3% higher than the T1 treatment. The yield of wheat didn’t increase with the increase of SAR application rate.

DISCUSSION AND CONCLUSION

SAR can increase wheat yield and improve its quality. The formation of wheat quality was not only affected by genotype but also affected by soil moisture, in which the fertility of soil conditions and the water supply affected its quality extremely significantly (Jichen *et al.*, 2009). Promotion of SAR on wheat was mainly achieved by improving soil moisture conditions. Experiments showed that the crude protein value, sedimentation value and wet gluten value in the case of application SAR had increased (Liqiu, 1994). Storage proteins were in the composition of gluten and gliadin which determined the viscoelastic dough. Content of crude protein in wheat was into a significant positive correlation with development time of dough, stability time and settling value (Rui and Gangshuan, 2012). We can learn from the analysis of the test data that the crude protein content of wheat was in upward trend. The sedimentation value showed a first increase and then decrease trend which explained that SAR can improve the protein quality of wheat effectively. The indicators of T2 were better than other treatments and the settlement value of T3, T4 had declined which indicated that excessive application of SAR may be not conducive to improving the quality of wheat protein. The previous researches have been studied in this aspects whose results had no significant differences (Shi and Liyuan, 2013). The stability time of dough was the overall performance for the flour protein and gluten quality which had an important effect on food processing quality (Huling *et al*., 2005). Experimental data indicated that development time of wheat dough under SAR showed a downward trend and settling time upward trend. In the experiment, there was no significant difference in dough stability time and the value was steady which showed that SAR could improve the processing quality of wheat (Gangshuan *et al*., 2012). The above indicators showed that SAR played a certain role in quality improvement of wheat.

Studies had shown that SAR could guarantee the stability of soil moisture by absorbing moisture when the soil has sufficient water and releasing it when the soil was lack of water. SAR could effectively increase the yield of wheat (Xiangxuan *et al*., 2005). In this experiment, the spikes, grain number and 1000-kernel weight under different treatments had first increase and then decrease trend and the best performance was T2. The SAR was able to release moisture quickly and promote wheat heading and increase the number of tillers of wheat, thereby enabling the yield of wheat improved. In this experiment, 1000-kernel weight of CK was less than others maybe dues to the lack of water supply in the growth period of wheat. The highest yield of this experiment was T2, which was mainly because the amount of SAR can not only maintained the moisture in the early growth stage, but also it ensured the demand for water of wheat in the late growth stage. The spikes, kernel number per spike and 1000-kernel weight reached a higher level; therefore, the final yield could be improved.

Many studies showed that SAR can improve fertilizer nutrient utilization and it had a significant effect on maintaining soil moisture. To explore the effect of SAR on quality and yield of wheat was an important direction of fertilizer researches in the future. And it had important practical significance to research the optimal amount of SAR for solving the low utilization rate of fertilizer nutrients and the lack of water.

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