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Research Article

Effects of Super Absorbent Resin on Leaf Water Use Efficiency and Yield in Dry-land Wheat

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Abstract: The effect of Super Absorbent Resin (SAR) on soil characteristics and production of wheat was conducted to study in a potted cultivated experiment, with Jimai 22 as experimental material and adopted single factor block design under the dry farming condition. The results show that: the application of SAR in dry-land wheat, increases degree of soil Relative water content among the whole growth period, especially in tiller stage, heading stage, grain-filling stage, but in Jointing stage and mature stage (require less water), it effected less obviously. Within a certain range, SAR can increase leaf water use efficiency in dry-land wheat and the more SAR, the bigger soil water content and leaf water use efficiency. But litter effect on Wheat Soil hydrogen ion concentration (pH). The SAR has positive impact on wheat yield component factors and yield.

Keywords: Dry-land wheat, leaf water use efficiency, SAR, yield

INTRODUCTION

Water is one of the important factors for which limit crop growth and development (Yang *et al*., 2005) and the SAR, the soil "micro-reservoirs" which is a super absorbent polymer to water, has the capacity of holding water (Yonghui *et al*., 2010). It can quickly absorb and maintain water hundreds more times, even thousands more times, than itself to make the soil moisture, which could use repeatedly and release slowly (Yangyang and Zhanbin, 2001). Furthermore, reducing the loss of soil moisture, the SAR can significantly improve soil structure and the utilization ratio of water resources to promote water-holding capacity and the growth of crop. Under drought conditions, the 85%-90% production of wheat is from photosynthesis (Yan and Hongyi, 2008), so water is important to photosynthetic characteristics, especially during later growth, the number will be 85% (Hui-wen *et al*., 2012). To promote photosynthetic efficiency, SAR can regulate the physiological process of photosynthesis by improving water status in soil and adjusting relative water or water potential in leaves. Moreover, it is significant to reducing the hurts of crops under drought. At present, there are some studies about the SAR in soil moisture, plant growth, crop yield, physiological and biochemical characteristics (Shu-yun *et al*., 2007; Yang *et al*., 2009; Ji-cheng *et al*., 2007), but most of them confined to the crop seedlings or a growth period, lacking of systematic research (Guoqing and Yan, 2012a, b, c). Therefore, we can study the effect of the SAR on dynamic changes of soil moisture at different growth stages of winter wheat, leaf relative water content, photosynthetic and physiological characteristics of the response of the system and providing a strong basis on water use of winter wheat, photosynthetic physiological characteristics and reasonable application of mechanisms.

MATERIALS AND METHODS

Varieties: Jimai 22, the SAR: provided by Dongguan city Anxin the SAR. Ltd. The experiment was conducted at experiment field of Qingdao Agriculture University (N36.32° E120.39°).

A pot experiment: There are 5 treatments (T) with 20 replicates of each treatment and all were 100 pots (diameter is 20cm), 2 Plants per pot, the SAR content is 0.5g/pot (T1), 1.0g/pot (T2), 1.5g/pot (T3), 2.0g/pot (T4), the treatment without the SAR was the Control (CK), the compound fertilizer（N-P_2O_5-K_2O: 12-8-4）was applied 8g in each pot.

Relative water content (RWC): Relative water content in soil is soil absolute moisture content as a percentage of their saturated water content (Jing-sheng and Yun-zhu, 1996). Leaf Water Use Efficiency (L-WUE) is equal to the ratio of photosynthetic rate and

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transpiration rate (Tezara *et al*., 1999). We measured the Photosynthetic rate, transpiration rate by the LI-6400 of photosynthetic apparatus United States LI-COR produced (Chamgliang and Fucang, 2010).

Yield components: wheat spike number of wheat, grain and wheat thousand grain weight.

The soil pH: Measured the pH meter (Yonghui *et al*., 2009).

RESULTS

Effects of the SAR on relative water content in dry-land wheat: In the experiment, each process is at the same level of Relative Water Content (RWC). In the whole growth period of wheat, measurements recorded at different growth stages of wheat respectively relative water content of the soil: tiller stage, the jointing stage, heading stage, grain filling stage and maturity (Jingtian and Yan, 2012; Liyuan and Yan, 2012). Results after processing are as follows:

The Fig. 1 showed that: the SAR can improve the RWC of the dry-land wheat's soil. And within a certain range, the RWC increase with the increasing application rate of the SAR. Particularly at tiller stage, heading stage grain filling stage.

Effects of the SAR on pH of soil in dry-land: The SAR change the water content of the soil, change the content of soil microorganism and content of soil organic matter (Zhanbing *et al*., 2004; Wenhua and Pute, 2007), which might effect the PH of soil, change the soil environment of the wheat growth and may be not suitable for wheat growing (Fig. 2). To test the application of the SAR in wheat production for the above problems, we conduct some experiments, the results are as follows:

There are no significant difference among treatment and control, with pH values around up and down very tiny irregular fluctuations, so the experiment results show that the SAR has litter impact the soil pH.

Effects of the SAR on L-WUE in dry-land wheat: As to the leaf- water use efficiency, grain filling stage of leaf- water use efficiency is the highest, followed at booting stage, the jointing stage is the lowest and reach a significant level ($p<0.05$).At the jointing stage, with the increasing of amount of the SAR, the L-WUE increase processing between different but not significant; And at booting stage, the L-WUE with the SAR dosage of increased performance for first increased then reduction but significantly than controlled ($p<0.05$), the SAR improve the winter wheat the reproductive period of light collection rate and transpiration rate and the L-WUE and we can see that T3 was the highest from the Table 1.

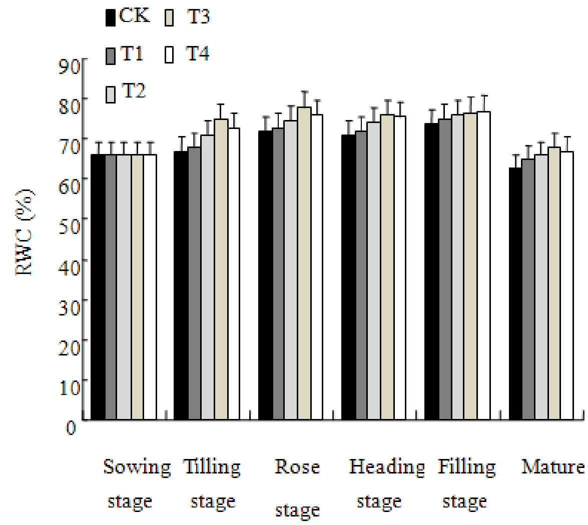

Fig. 1: Effect of the SAR on RWC wheat in dry-land

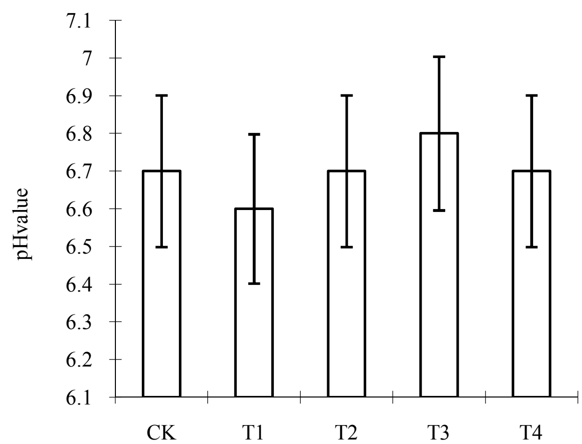

Fig. 2: Effect of the SAR on pH of soil in dry-land

Effects of the SAR on wheat yield components and yield in dry-land wheat: Spike NO., grains weight of 1000 and grains weight/pot impact the yield (Yonghui *et al*., 2009). Effect of the SAR on wheat yield constitute factors are as follows in the Table 2: The experimental results show that: the SAR have a beneficial impact on wheat yield constitute factors. Set at the experiment within the scope of the SAR, as the SAR application rate increasing, spike NO., grains weight of 1000 and grains weight/pot into a growth trend; from CK to T3 within the grain number is increment as the SAR application rate increases, however, the T4, the grains weight/pot is decline, in other words, within a certain range, wheat production is increased with the increase of the SAR, exceeding a certain range, yield is rather than reduction. The results show: under the test's range of the SAR, T3 was the best.

Table 1: Effect of the SAR on L-WUE of wheat in dry-land

	Pn(μmol/m^2.s)			Tr (mmol/m^2.s)			L-WUE (μmol/mmol		
Treatment	Jointing stage	Heading stage	Grainfilling	Jointingstage	Heading stage	Grain filling	Jointingstage	Heading stage	Grain filling
CK	4.33	11.36	9.89	1.84	2.61	1.88	2.35	4.34	5.26
T1	5.29	13.98	13.21	2.13	2.75	2.17	2.48	5.08	6.07
T2	6.01	14.99	14.05	2.38	2.81	2.21	2.52	5.33	6.34
T3	6.22	17.02	15.69	2.41	3.10	2.29	2.58	5.48	6.85
T4	5.86	15.26	5.89	2.24	2.80	0.95	2.61	5.45	6.21

Table 2: Effects of the SAR on wheat yield components and yield in dry-land wheat

Treatments	Spike no/pot	Grain no/pot	Grains weight of 1000 (g)	Grains weight/pot (g)
CK	12	568	39.43	22.18
T1	14	609	41.21	25.51
T2	15	625	43.16	27.99
T3	18	740	46.24	33.66
T4	15	605	45.49	26.47

DISCUSSION AND CONCLUSION

According to this experiment, Based on the record of relative soil water content of wheat's whole growth period, it shows that the relative soil water content of dry-land wheat varies from different growth stages, which indict the SAR can adapt to wheat's demand for water at different growth stages and can release water stored before reasonably. Otherwise, the SAR can obviously improve water use efficiency of dry-land wheat. The SAR can improve the relative soil water content of dry-land wheat during the whole growth stage, especially at tillering stage, heading stage and filling stage. It obviously improves the relative soil water content from the T1 to T3 and within the certain range, T3 is the highest.

The results show that: The SAR has a beneficial impact on wheat yield. within the scope of the SAR application amount in this experiment, as the SAR application rate increasing, spike NO., grains weight of 1000 and grains weight/pot into a growth trend; from CK to T3 within the grain number is increment as the SAR application rate increases, however, as to the T4, the grains weight/pot is decline, in other words, exceeding a certain range, yield is reduction instead. The results show: Within a certain range, wheat production is increased as the addition of the SAR. Different amount of the SAR have different effects on increasing the spike numbers of dry-land wheat. As the use of the SAR increasing, the 1000-grain weight of dry-land wheat increases steadily, while grain number per spike increased firstly, reaching the highest value, then decreasing and remaining steady in the end.

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