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Research Article

Effects of Super Absorbent Resin on Soil Characteristics in Dry-land Wheat

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Abstract: In order to improve the water use efficiency of soil water in dry-land wheat, we carried out a research with a pot experiment. The pot experiment was conducted with the material of Jimai 22 to study the effects of different application amounts of Super Absorbent Resin (SAR) on soil characteristics in dry-land wheat. The results indicated that the application of SAR could maintain the soil water content and decrease the soil water evapotranspiration in dry-land wheat. Among the five treatments, the application of T2 was the most reasonable to maintain the soil water content for dry-land wheat. What's more, it had some effect on soil aggregate structure and soil pH in dry-land wheat. It not only had a certain role in promoting the formation of soil aggregate structure, but also it could reduce soil pH in dry-land wheat and made the pH value decrease into the suitable range for crop growth.

Keywords: Dry-land wheat, soil aggregate structure, soil pH, soil water content, soil water evapotranspiration, super absorbent resin

INTRODUCTION

Water is the source of living organisms and it is necessary for the development of agricultural production. With the development of society, drought and water shortage have become bottleneck factors and restrict agricultural development, especially water shortage is a serious problem for arable land in northern China. In recent years, SAR has been widely used in agriculture as a chemical water-saving material, the effects of drought and water-saving are remarkable. Nowadays, it has been widely applied to forestation, which has significantly increased reforestation survival rate and promoted the production of rainfed agricultural. It is widely considered to be the fourth largest agricultural green chemicals following chemical fertilizers, pesticides and plastic film. In the areas of agriculture, water conservancy and sand-control, it plays a significant role in seedling drought, increasing production, improving soil, wind prevention and sand fixation, soil and water conservation. SAR application is supported by the state as agricultural technology projects (Chaosheng, 2011).

SAR is a new high water absorption characteristic of functional polymer material, which has a strong water retention capacity. Its shape is mainly particles and powdered, white, pH value is neutral and it does not dissolve in water. SAR not only can absorb hundreds of times or even more than a thousand times its own weight in deionized water, the number of times to nearly a hundred times in the salinity of water, but also it has repeatedly absorbing function. SAR expands to be hydrogels after absorbing and can slowly release water for crop use in dry conditions (Taisheng *et al*., 2000; Zhanbin *et al*., 2003; Xinxi, 2002). SAR application can promote root development, increase seedling emergence and survival rate, improve water use efficiency (Dianhong *et al*., 2007; Fen and Yanbei, 1994; Jicheng *et al*., 2007). What's more, its can also promote the formation of soil aggregates, improve soil pore structure, prevent fertilizers, pesticides and soil erosion, improve fertilizer utilization efficiency (Tengbing *et al*., 1997), increase crop production. Thus, this experiment studied the relationship between the dry-land wheat soil characteristics and SAR application amount in the pot field with the variety wheat Jimai22. Explore the technologies and methods to enhance dry-land wheat soil drought. This study provides a new technical way to improve the yield of dry-land wheat.

MATERIALS AND METHODS

Experimental design: This experiment was carried out from October 2012 to June 2013 by pots in the open field of Qingdao Agricultural University (35.36°N, 119.56°E) with the wheat variety of Jimai22. The soil was sandy loam soil with soil organic matter content 1.1%, total N 1.2%, available nitrogen 89 mg/kg, available phosphorus 36 mg/kg, available potassium 105 mg/kg. The brand of SAR was produced by

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Table 1: Design of treatments (g/pot)

Treatment	Super absorbent resin (g/pot)
CK	0.00
T1	0.75
T2	1.50
T3	2.25
T4	3.00

Dongguan City Shun Water Holding Co., Ltd. The Complex Fertilizer whose Formula of N-P_2O_5-K_2O was 22-8-12 was produced by the YAN-NONG-Weifang Agricultural Chain Co., Ltd.

This experiment designed 5 treatments. Each treatment has 10 repeats, a total of 50 pots with each pot 3 seedlings. Fertilizers and SAR were applied into the pot once with diameter of 30 cm and a depth of 40 cm which was filled up with the air-dried soil transferred into it. The application amount of SAR is showed in Table 1. They were planted on October, 12th, 2012. Make sure that no water was supplied for the wheat.

When wheat seedlings grew to the Trefoil stage, beginning to sample. On Oct 27th, Nov 2nd, Nov 8th, Nov 14th, Nov 20th and Nov 26th, the five treatments were sampled to measure the soil characteristics indicators on dry-land wheat. Determination of the soil water content by Drying and weighing method (Tao *et al*., 2007). Determine the soil water evapotranspiration in accordance with the soil water content of each measuring time. It took Mechanical analysis of soils-Hydrometer method for rapid determination to determine the percentage of soil particle diameter. Determination of soil pH value with a pH meter.

RESULTS

Effects of different application amounts of SAR on soil water content in dry-land wheat: During the normal growth of wheat, wheat needs to absorb water from soil and the soil can evaporate by itself, thus, the soil water content of each treatment gradually decreased, but due to the different application amounts of SAR, the decreasing amplitudes of soil water content were different, which was shown in Fig. 1: T2<T3<T4<T1<CK. The decreasing amplitude of CK which was no SAR was the largest, while the decreasing amplitudes of soil water content in other four treatments T1, T2, T3, T4 which were applied SAR into, all were smaller than that of CK. In a word, the application of SAR is conducive to maintaining the soil water content in dry-land wheat. We could also found that the decreasing amplitude of T2 was the smaller than that of T1, T3, T4. Therefore, the application of T2 was the most reasonable to maintain the soil water content in dry-land wheat.

Effects of different application amounts of SAR on soil water evapotranspiration in dry-land wheat: We can find from the measurement results of October 27th to November 2nd in Fig. 2, there was little change of soil water evapotranspiration among the different treatments, this was because wheat plant was small and could absorb the soil original water in the early growth stage. From November 2nd, the soil water evapotranspiration of four treatments T1, T2, T3, T4 were lower than that of CK in each measuring period. It revealed that the SAP could reduce the soil water evapotranspiration in dry-land wheat. As we can see from the measuring results of October 27th to November 26th, the soil water evapotranspiration of T1 was 5.32 g lower than that of CK, T3 was 3.02 g lower, T4 was 0.08 g lower and T2 was 5.35 g lower than that of CK, so the soil water evapotranspiration was T2<T1<T3<

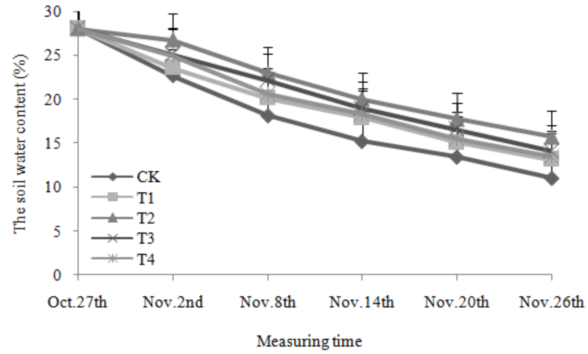

Fig. 1: Effects of different application amounts of SAR on soil water content in dry-land wheat

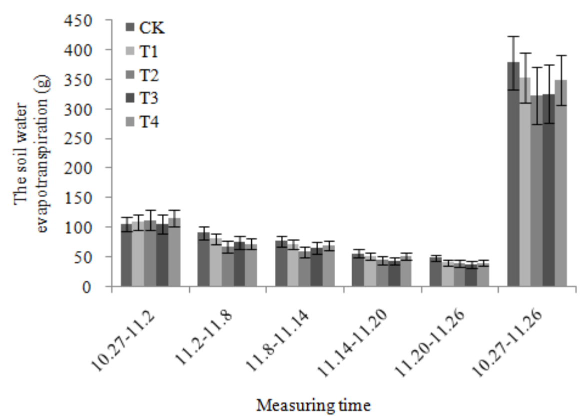

Fig. 2: Effects of different application amounts of SAR on soil water evapotranspiration in dry-land wheat

Table 2: Effects of different application amounts of SAR on soil aggregate structure in dry-land wheat

Particle diameter (mm)	The percentage of soil particle diameter (%) CK	T1	T2	T3	T4
>2	2.3	6.1	6.8	12.6	14.4
2-1	8.4	7.1	6.9	7.3	6.9
1-0.5	16.8	16.5	15.6	15.4	14.9
0.5-0.25	11.5	13.4	13.0	12.3	12.2
<0.25	61.0	56.9	57.7	52.4	51.6

Table 3: Effects of different application amounts of SAR on soil pH in dry-land wheat

Treatment	CK	T1	T2	T3	T4
pH	7.6	7.6	7.4	7.3	7.1

T4<CK. We can conclude that the application of T2 would lead a lowest water evapotranspiration in dry-land wheat.

Effects of different application amounts of SAR on soil aggregate structure in dry-land wheat: As is shown in Table 2, with the increase of SAR application amount, <0.25 mm particle diameter of soil aggregate content in the four treatments of T1, T2, T3, T4 gradually decreased compared with CK. That is to say, SAR was not conducive to the formation of soil micro aggregates and with the application amount increasing, the soil aggregate content of <0.25 mm gradually decreased. This table also showed that the soil aggregate content with the particle diameter 0.5~2 mm changed little and the soil aggregate content within the scope of 0.5~0.25 mm and >2 mm increased significantly. When particle diameter >2 mm, compared with CK, the treatment T1 soil aggregate content increased by 3.9%, T2 increased by 4.5%, T3 increased by 10.3% and T4 increased by 12.4% to reach the highest level. Meanwhile, with the increase of application amount, soil aggregate content within the particle diameter >2 mm gradually increased. The results indicated that SAR played a role in promoting the formation of soil aggregate structure in dry-land wheat.

Effects of different application amounts of SAR on soil pH in dry-land wheat: As can be seen from Table 3, the soil pH of dry-land wheat turned out to be a declining trend after SAR application. With the application amount change, the soil pH decreased in different extents. With the increase of SAR application, the soil pH decreased and the pH value decreased into the suitable range for dry-land wheat growth. We can conclude that, SAR could reduce soil pH in dry-land wheat and be conducive to the growth of wheat.

DISCUSSION

SAR has strong water absorption capacity and could absorb thousands of times its own weight of water and remain for long time (Su *et al*., 2013), which has also been proved in this experiment. The results indicated that the application of SAR is conducive to maintaining the soil water content and reducing soil water evapotranspiration in dry-land wheat. The experimental results have supported the research that super absorbent resin can improve the soil water holding capacity and utilization efficiency (Rui *et al*., 2013). If SAR is overmuch, soil water would be seriously bondaged, which inhibits the wheat roots from absorbing soil water and inhibits the growth of wheat. What's more, small wheat plants cover a small area and soil water would evaporate seriously by itself, which leads a big evapotranspiration and it isn't conducive to maintaining soil water content. However, when appropriate amount is applied into soil, wheat plants grow well to cover a large area, with a result of less soil evaporation and a small evapotranspiration. As we can find from Fig. 1 and 2 that T2<T3<T4. It indicated that the application of T2 was the most reasonable to maintain the soil water content and to promote the growth of wheat. The experimental results demonstrate and support the study: If SAR application is excessive, it will have a negative impact on crops, such as inhibition of root elongation and decrease on root physiological mechanism (Yanyan and Jicheng, 2009).

Soil aggregate structure has functions of loosing soil, improving air permeability, preserving moisture and fertility strongly and promoting crop growth (Chunliang and Xiaochen, 2012). From the results of this study, we could also find that the SAR application was not conducive to the formation of <0.25 mm soil micro-aggregates and it had little effect on the soil aggregate content with the particle diameter of 0.5~2 mm. However, the soil aggregates within the particle diameter of 0.5~0.25 mm and >2 mm increased significantly after the SAR applied into. In general, the application of SAR had increased the particle diameter of >0.25 mm soil aggregate content. To some extent that SAR had a certain role in promoting the formation of soil aggregate structure in dry-land wheat and it was conducive to the dry-land wheat growth and yield. The >0.25 mm soil aggregates increased gradually with SAR application amount increasing (Ruifeng *et al*., 2006). SAR could promote the formation of soil aggregate structure. For the yellow loess soils, SAR played a significant role in promoting the soil aggregate structure with the particle diameter of 2~0.25 mm and different SAR concentrations have little effect. For Beijing drab soils, SAR at low concentrations (≤0.5%) mainly promotes the formation of 1~0.25 mm soil aggregates, while at high concentrations (≥0.75%), it mainly promotes the formation of soil aggregates with the particle diameter of 2~0.5 mm (Hao, 2011). These experiments' conclusions above are different, which may be related to SAR types, soil types, crop types and different environment and different management measures, etc.

The experimental results also showed that SAR could reduce soil pH in dry-land wheat and make the pH value decrease into the suitable range (6.5~7.5) for crop growth. SAR could play a role in promoting dry-land wheat growth and yield. This experimental results have demonstrated and supported the study: SAR could reduce soil pH and improve soil aggregate structure (Ruifeng *et al*., 2006). The type of KD-1 SAR has little effect on soil pH (Chunsheng *et al*., 2003). The application of SAR could increase soil pH, which is opposite to the experimental conclusion (Yanyan and and Jicheng, 2009; Xin *et al*., 2013). These conclusions are different. The reasons may be related to different types of SAR, different types of soil, different crops and other related factors.

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REFERENCES

Chaosheng, Z., 2011. New technology of water retention agent declares war on drought. Sci. Technol. Daily, 5: 1.

Chunliang, S. and F. Xiaochen, 2012. To create good soil aggregate structure and to improve planting benefits of the soil. Modernization Agric., 390(1): 106-122.

Chunsheng, L., Y. Jihua and M. Yuzeng, 2003. Drought insurance agent in the orchard application effect. J. Soil Water Conserv., 17(2): 134-136.

Dianhong, L., H. Zhanbin and L. Dong, 2007. Effects of different applying methods of super absorbent Polymer on growth and water use efficiency of potato. Agric. Res. Arid Areas, 25(4): 105-108.

Fen, H. and J. Yanbei, 1994. Application of high water absorbent agent KH-841 in dry-land agriculture. Agric. Res. Arid Areas, 12(4): 83-86.

Hao, Y., 2011. Study on effects of super absorbent polymers on physical properties of loessial soil, cinnalmon soil and sandy soil. Ph.D. Thesis, Beijing Forestry University, 4: 1-139.

Jicheng, W., Z. Huiling and S. Fugang, 2007. Effect of water-retaining agent on wheat production and water utilization under different moisture conditions in dry-land. Acta Agr. Boreali Sinica, 22(5): 40-42.

Rui, Z., G. Guijun and B. Gangshuan, 2013. Effects of application rate of super absorbent polymers on soil moisture and solanum lycopersicum growth. Sci. Soil Water Conserv., 11(2): 108-113.

Ruifeng, L., Y. Hongshan and L. An, 2006. Effects of polyacrylic attapulgite super absorbent polymers composition on soil physical properties. Chinese J. Soil Sci., 37(2): 231-235.

Su, Y., Z. Jian and W. Ping, 2013. Progress in research on soil water holding capacity. China Agric. Sci. Bull., 29(14): 140-145.

Taisheng, D., K. Shaozhong and W. Hua, 2000. Present situation and prospect of application of aquasorb in water-saving agriculture. Res. Agric. Modernization, 21(5): 317-320.

Tao, W., Z. Rong-Biao and F. Youbing, 2007. Study on the determination of soil moisture content. Agric. Mech. Res., 12: 213-217.

Tengbing, H., Y. Kaiqiong and Z. Jun, 1997. Study on VAMA soil fertilizer supply performance impact. Chinese J. Soil Sci., 28(6): 257-260.

Xin, M., W. ZhanMin and Y. Jian, 2013. Study on absorbent on soil properties of long-term effect. J. Irrig. Drain., 32(3): 117-120.

Xinxi, Z., 2002. Super Absorbent Polymer. Chemical Industry Press, Beijing, pp: 473-635.

Yanyan, R. and W. Jicheng, 2009. Water retaining agent on the influence of soil properties and soil microorganism [J]. Henan Agric. Sci., 4: 13-15.

Zhanbin, H. and X. Xiaogui, N. Rongchang and Z. Guangfu, 2003. The application and development trend of aquasorb in agricultural production. Agric. Res. Arid Areas, 21(3): 11-14.