

Research Article

The Effects of Potassium Silicate Hydrate Mixing Urea on the Growth and Development in Winter Wheat

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Abstract: In order to increase the fertilizer use efficiency, the effects of Potassium Silicate Hydrate (PSH) mixing urea on the growth and development in winter wheat are rarely to be studied. So the effects of the same amount of PSH mixing different quantity of urea on the growth and development in winter wheat have been done to investigate the role which PSH plays during the fertilizer of urea working. The results indicate that the effect on root-shoot ratio in wheat display dissimilarly among different treatments, on root activity is more effective than without urea, on malondialdehyde (MDA) is to reduce its content and on proline content is conducive to the accumulation. Overall, the effects of treatment 2 (T2) which 5 kg/667 m² PSH mixing 30 kg/667 m² urea are better than other treatments, so T2 can be taken as the suitable application. This will be of great significance for the efficient and safe application of PSH and urea.

Keywords: Potassium silicate hydrate, the growth and development, urea, winter wheat

INTRODUCTION

Currently, crops obtain nutrients from the fertilizer which is still the main source. As one of many fertilizer species, urea mainly provides nitrogen which crops need for the growth (Jian *et al.*, 2004). Wheat is cereal crops and nitrogen is demanded largely during its growth and development (Dandan and Yan, 2013). Urea can achieve the requirements of nitrogen, but it still exists issues of low fertilizer utilization, resulting in soil harden and others (Gang *et al.*, 2010; Liang *et al.*, 2008; Ning *et al.*, 2010). To some extent, the silicon has the ability to loose soil and enhance the capability of ventilation and permeable. So it is necessary to do the research of effects about PSH mixing urea for wheat growth and soil environment.

Urea applied into the soil can cause hydrolysis, nitrification process and generate nitrate. Eventually convert nitrate into nitrogen to be absorbed by wheat (Deming *et al.*, 2002). This process will inevitably lead soil environment to change and then have some impacts on the growth of wheat. Zhaohui *et al.* (2009) has done the research that urea has effects on soil pH and urease activity. The research of Dongyun *et al.* (2007) has shown that urea can change the number of wheat rhizosphere microorganisms and enzyme activity. But people seldom do the research on the effects which are caused by silicate potassium fertilizer mixing urea. The role which PSH plays during the fertilizer of urea working is important to be investigated.

The effects of the same amount of PSH mixing different quantity of urea on the growth and development in winter wheat have been done. By measuring the changes of wheat root activity, root-shoot ratio, MDA content and proline content, we entirely balance the performance of each index to provide a reference for its efficient and safe application.

MATERIALS AND METHODS

Experiment materials: The experiment material is the wheat variety "Jimai 22". The PSH is produced by Sinopharm Chemical Reagent Co., Ltd. The content of K₂O is 47.0~51% and the ratio of K₂O and SiO₂ is 1.49~1.65. Nitrogen content of urea is 46%.

Experiments design: The experiment set up 4 treatments, contrast check (CK), treatment 1 (T1), treatment 2(T2) and treatment 3 (T3) and each treatment has 4 repeats in Table 1. The length, width and height of pots are 20 cm, 13.5 cm and 7 cm, respectively. After the germination process in standard germination box, transplant 6 wheat seedlings which grow consistently into the pot. Then place them into artificial climate chamber in Qingdao Agricultural University and do some management. Start to take sample at four-leaf stage. Then take sample every 10 days and three plants each time. Measure the changes of root-shoot ratio, root activity, MDA content and proline content.

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Table 1: Design of treatments (unit: kg/667 m²)

Treatments	CK	T1	T2	T3
Urea	0	20	30	40
PSH	5	5	5	5

RESULTS

Effects of PSH mixing urea on the root-shoot ratio in winter wheat: We can see from Table 2, the overall trend of wheat root-shoot ratio is consistent. The root-shoot ratio is gradually decreasing, but the extent is different. And root-shoot ratios of 4 treatments change differently in the same growth periods. Contrasting zero days after four-leaf stage, root-shoot ratios of CK, T1, T2 and T3 decline 33.3, 30.4, 55.3 and 67.3%, respectively at 10 days after four-leaf stage, namely T3>T2>CK>T1. From 0 to 30 days after four-leaf stage, the overall reducing extent is still T3>T2>CK>T1. The root-shoot ratio of 20 days after four-leaf stage changes larger than 30 days after four-leaf stage at which T2 is the smallest, next to being T1, T3, CK.

Effects of PSH mixing urea on the root activity in winter wheat: As is showed in Fig. 1, the root activity of different treatments performs and changes differently in the same growing season. From 0 to 10 days after four-leaf stage, the root activity is T3>T2>T1>CK. The root activity is T2>T3>T1>CK at 20 days after four-leaf stage. From 0 to 30 days after four-leaf stage, root activity of CK is always at the lowest level. But root activity of T2 is at the highest level from 20 to 30 days after four-leaf stage. In addition, the increasing extent of root activity is T2>T1>CK>T3 from 10 to 20 days after four-leaf stage. From 20 to 30 days after four-leaf stage, the decreasing extent of CK is basically same with T1, though T2>T1>T3.

Effects of PSH mixing urea on the MDA content in winter wheat: We can make it out from Fig. 2 that MDA content of four treatments has a different trend with the date prolonged of wheat and the change extent performs differently within certain period. MDA content of T1 and T3 are gradually increasing, but of CK and T2 appear to reduce at 20 days after four-leaf stage. Furthermore, the increasing rate of CK is biggest, followed by T3. T1 and T2 is nearly same from 0 to 10 days after four-leaf stage. MDA content is T2<CK<T1<T3 at 30 days after four-leaf stage.

Effects of PSH mixing urea on the proline content in winter wheat: We can find out from Fig. 3 that the proline content of all treatments performs differently and the same treatment has differences in the different growth periods too. Proline content of each treatment is

Table 2: Effects of different treatments on the root-shoot ratio of days after four-leaf stage

Treatments	0	10	20	30
CK	0.36	0.24	0.13	0.13
T1	0.23	0.16	0.12	0.11
T2	0.38	0.17	0.11	0.09
T3	0.52	0.17	0.19	0.12

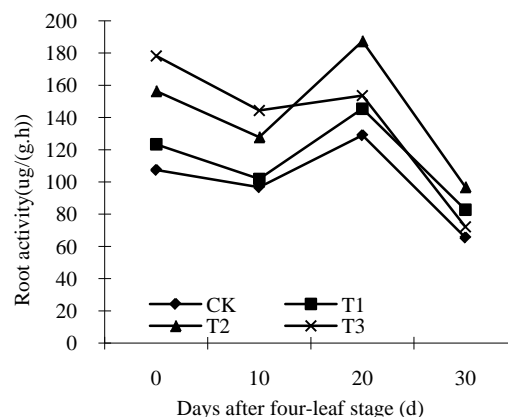


Fig. 1: The change of root activity

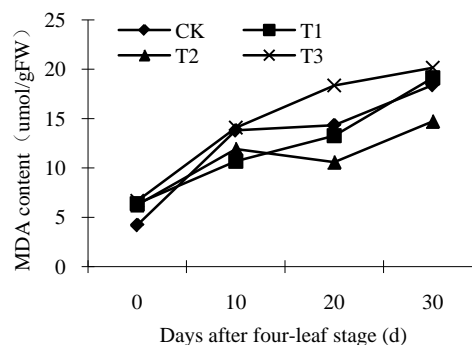


Fig. 2: The change of MDA content

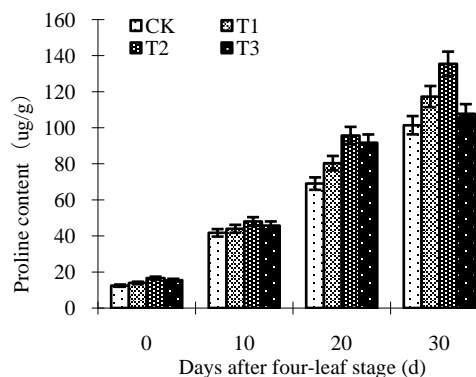


Fig. 3: The change of proline content

basically same from 0 to 10 days after four-leaf stage. Subsequently, the difference is increasing and T2, CK is at the highest and lowest level respectively. Proline content is T2>T1>T3>CK at 30 days after four-leaf stage.

DISCUSSION AND CONCLUSION

The root-shoot ratio in winter wheat: The root-shoot ratio mainly reflects the coordination of wheat underground and above-ground. Its suitability not only will be more conducive to run the life for plant, but also is an important factor to affect the wheat field (Shujie *et al.*, 2003). In this experiment, the declining extent of root-shoot ratio is $T3 > T2 > CK > T1$ at 10 days after four-leaf stage. The root-shoot ratios of 30 days after four-leaf stage change smaller than 20 days after four-leaf stage. The reason may be that PSH plays weaker role than urea in promoting growth of wheat, but PSH has some positive effects on the fertilizer of urea working. This will be more beneficial to transport nutrients to aboveground and make growth rate of aboveground faster than underground. Moreover, the root-shoot ratio of T2 at 30 days after four-leaf stage is the smallest, next to being T1, T3, CK. This illustrates that the effects of PSH mixing different amounts of urea on root-shoot ratio is different among all treatments and T2 decreases root-shoot ratio more significantly than others.

The root activity in winter wheat: The root activity can be taken as the standard to balance the growth of root being good or bad. Generally, high root activity will help nutrients to be absorbed, develop root system and increase wheat yield (Chunmei *et al.*, 2012). In this experiment, the root activity is $T3 > T2 > T1 > CK$ from 0 to 10 days after four-leaf stage. The root activity is $T2 > T3 > T1 > CK$ at 20 days after four-leaf stage. From 0 to 30 days after four-leaf stage, root activity of CK is always at the lowest level. However, root activity of T2 is at the highest level from 20 to 30 days after four-leaf stage. Furthermore, the increasing extent of root activity is $T2 > T1 > T3$ from 10 to 30 days after four-leaf stage. This states that PSH mixing urea can promote root activity to some extent. But the effect on root activity is different or even causes suppressive phenomena which resulted from the amount of urea. It may well that PSH is able to improve the soil structure damage caused by urea. But the damage on the capability of ventilation and permeable resulting from an excess of urea is so serious that permeable silicate can't to repair it. Then root breathing and water absorbing are hindered. This results in root to poison and thus kills the root cells to hold back root growth.

The MDA content in winter wheat: MDA content can reflect the level of cell membrane peroxidation in wheat. High MDA content indicates that a high degree of cell membrane peroxidation and cell membrane is broken severely (Shugang *et al.*, 2011). MDA content of T1 and T3 is gradually increasing, but of CK and T2 appears to reduce at 20 days after four-leaf stage. This may show that PSH mixing urea does damage on cell

membrane, but the appropriate amount of urea can also reduce the harm. In addition, the increasing rate of CK is biggest, followed by T3 and T1 and T2 is nearly same from 0 to 10 days after four-leaf stage. MDA content is $T2 < CK < T1 < T3$ at 30 days after four-leaf stage. It may only when urea reaches the appropriate amounts that will the effect on MDA content be reduced.

The proline content in winter wheat: To some extent, proline content is a reflection of the resistance to stress (Shuyi *et al.*, 2013). In this experiment, proline content of each treatment is basically same from 0 to 10 days after four-leaf stage. Subsequently, the differences are increasing and T2, CK are at the highest and lowest level, respectively. This shows that PSH mixing urea is beneficial for the accumulation of proline content in wheat. Moreover, proline content is $T2 > T1 > T3 > CK$ at 30 days after four-leaf stage. This can be interpreted by that appropriate quantity what urea need.

Pretest results show that the amount of PSH being $5 \text{ kg}/667 \text{ m}^2$ is the best. The results indicate that PSH mixing different amount of urea plays a coordinating role on shoot ratio. But the role is different among treatments. The effect on root activity is more effective than without urea, on MDA is to reduce its content and on proline content is conducive to the accumulation. At the same time what it needs is the appropriate amount of urea to get each index well. This will be more beneficial for the growth of wheat. In this experiment, the effects of T2 which $5 \text{ kg}/667 \text{ m}^2$ PSH mixing $30 \text{ kg}/667 \text{ m}^2$ urea are better than other treatments, so T2 can be taken as the suitable application.

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