Effects of Water and Fertilizer Integration Technology on the Growth and Yield of Hybrid Garlic

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Abstract: The effects of water and fertilizer integration on the growth and yield of hybrid garlic are studied. Methods: One planting area is selected for hybrid garlic planting with traditional technology as the control group, and two planting areas are selected for hybrid garlic planting with integrated water and fertilizer technology as the experimental group. Growth and yield of hybrid garlic are compared between the two groups. Results: the soil moisture in the experimental group always remains between 63.3% and 70.8%, while that in the control group ranges from 29.7% to 46.5%. The dry weight and fresh weight of hybrid garlic in the experimental group are both higher than that in the control group. Conclusion: the water and fertilizer integration technology can provide a good growing environment for hybrid garlic, which is conducive to the healthy growth of hybrid garlic and can increase the yield of garlic effectively.

Keywords: Water and fertilizer integration technology; Hybrid garlic; Production; Soil moisture

1. Introduction

Water and fertilizer integration technology is a modern agricultural technology integrating irrigation and fertilization that has gradually developed with drip irrigation technology. In recent years, with the continuous development of internet of things technology, water and fertilizer integration technology is becoming more intelligent and can automatically monitor soil information, calculate the amount of irrigation and fertilization independently, start the irrigation device intelligently, and realize precise irrigation and fertilization [1]. As an important cash crop in China, garlic requires a large amount of water and fertilizer. Ditch irrigation is mostly used in production, and flood irrigation is mainly used with low water utilization ratio. At the same time, a large amount of chemical fertilizers and pesticides are applied, resulting in soil hardening, large amount of pesticide residues and potential groundwater pollution [2]. The research of Wang Fei, Wang Chunxia et al. show that water and fertilizer integration technology of garlic is more effective than conventional planting in saving water and fertilizer and increasing production [3]. At present, water and fertilizer integration technology of garlic is developing rapidly, and the popularization area is expanding continuously. However, the most critical water and fertilizer irrigation system of garlic in this technology still lags behind the actual planting process, and the intelligent degree and penetration rate of irrigation process are not high. Most hybrid garlic growing areas still adopt the traditional planting technology, which is mainly sprinkler irrigation and foliar fertilization. Since hybrid garlic is different from ordinary garlic, it has certain requirements for the growth environment. This planting technology is not conducive to the growth of hybrid garlic and the yield is lower. Therefore, the research on the effects of water and fertilizer integration technology on the growth and yield of hybrid garlic is proposed. It provides important theoretical basis and practical guidance for realizing the intelligentization of garlic water and fertilizer integrated planting process.

2. Materials and Methods

This experiment has studied water demand regulation of garlic in different growth periods under the water-fertilizer integration technology, the influence of irrigation amount, soil moisture, fertilizing amount and fertilizer types on garlic growth, thus to build a more complete garlic water and fertilizer irrigation system. The effects of water and fertilizer integration technology on the growth and yield of hybrid garlic are analyzed by comparing with the traditional technology.

2.1. Selection of experimental materials

The tested garlic variety is hybrid garlic, which is the main cultivar in Laiwu district of Jinan. The experiment is conducted in the planting base of Jinan Anxin Agricultural Science and Technology Co., LTD in Fangxia Town, Nonggao District, Laiwu from October 2018 to June 2019. The planting area is divided into 10 plots (each plot is 667m2), and the planting area 1-8 is drip irrigation area (experimental plot of water and fertilizer integration

technology) for various experimental studies, and the planting area 9-10 is flood irrigation area (experimental plot of traditional technology) as a control. Each plot of 667m2 is 100 meters in length and 6.67 meters in width. The planting width of each rectangular piece is 1.3 meters, and the ridge width is 10 cm. Each plot of 667m2 has five rectangular pieces. The row spacing of garlic planting plants is 12cm×10cm, referring to other planting specifications.

2.2. Experimental method

Planting area 1, planting area 2, and planting area 9 are used as irrigation volume test areas, and among which planting area 1 and planting area 2 are drip irrigation areas, and planting area 9 is flood irrigation area. Planting area 1 and 2 are used as the fertilizer application experimental blocks of hybrid garlic, both of which are drip irrigation areas with water and fertilizer integration. The bolting period is a critical top dressing period for garlic, so we choose this period to add 15kg compound fertilizer in planting area 1, planting 2 and planting area 9. Among them, we adopt root drip fertilization for planting area 1 and planting area 2, and foliar fertilization for planting area 9 [4]. Referring to the method of Strasser (1995), the OJIP curves of the second or third fully expanded leaves of garlic are determined by the Handy PEA plant efficiency instrument (Hansatech, UK). The saturated light of 3000 μmol m-2s-1 induces the curve. The fluorescence signal recording starts from 10 μs and ends at 1s. In the first 2 ms, data is recorded at 105 points per second, and after 2 ms, data is recorded at 103 points per second, with 50μs fluorescence signal as initial fluorescence Fo [5]. The determination is carried out in a large field in two meteorological environments, sunny and cloudy days. Five garlic plants are selected for treatment in each plot. The dark adaptation of garlic leaves is 15min before the determination, and the determination time is from 10:00 a.m. to 2:00 p.m...

When garlic is harvested in each plot, cut off the root of garlic, keep the garlic stem 2-3 cm, bag it and store it, weigh it, that is, fresh weight. After storage, we shall dry it in time. When it reaches the standard of dried garlic, we bag and weigh it, that is, dry weight. Each treatment shall be repeated for three times [6]. After reaching the standard for dried garlic, each plot will randomly select dried garlic for various levels of garlic quantity statistics. Garlic with a diameter of 6 cm or more are considered as Grade 1 garlic, and 5-6 cm are considered as Grade 2 garlic and those below 5 cm are considered as Grade 3 garlic. Each treatment is repeated 3 times, and the fresh weight, dry weight and the quantity of garlic at various levels are determined.

During each experiment, we use a computer or mobile phone to look up the current and historical soil water content data [7]. We login the server to check irrigation flow and irrigation time data to calculate irrigation volume and irrigation time. The growth and yield of hybrid garlic in the experimental group and the control group are compared.

3. Experimental Result

According to the ratio method and test method given above in this paper, the corresponding test results are obtained. The following is the soil moisture statistical table of hybrid garlic.

Table 1. Soil moisture statistics of hybrid garlic(%)

Garlic growth cycle	Experimental group		Control group	
	Cloudy	Sunny	Cloudy	Sunny
Germination stage	65.8	75.4	46.5	35.4
Seedling stage	62.5	74.6	42.6	39.5
Differentiation stage of bulbil and bud	63.4	71.6	42.8	38.3
Garlic sprout growing period	64.5	72.6	41.6	36.4
Bulbus expansion period	68.4	69.4	42.8	39.4
Dormancy period	64.2	67.4	43.9	29.7

There are five watering times in the garlic planting process. The specific irrigation methods and calculation statistics of irrigation volume are in Table 2.

Table 2. Statistics of irrigation water in garlic planting process

Planting area	Irrigation method	Irrigation before planting /m³	First irrigation after planting/m³	Second irrigation after planting/m³	Third irrigation after planting/m³	Fourth irrigation after planting/m³
Planting area9	Flood irrigation	40	39.8	38.4	37.6	30
planting area 1	Integrated drip irrigation with water and fertilizer	40	10.2	10.8	10.7	10.7
Planting area 2		40	13.8	13.9	13.6	13.8

From the above table, it is calculated that the planting area 9 adopts flood irrigation, and the total irrigation amount is 154.2M3. Both planting area 1 and planting area 2 adopt the integrated drip irrigation method with

water and fertilizer, and the total irrigation amount is 82.7M3 and 95M3 respectively. Compared with planting area 9, the irrigation volume of planting area 1 and planting area 2 is decreased by 46.37% and 38.39% respectively. In order to understand the impact of water and fertilizer integration technology on the yield of hybrid garlic better, we have drawn the garlic yield maps of the experimental group and the control group, as shown in the Figure 1.

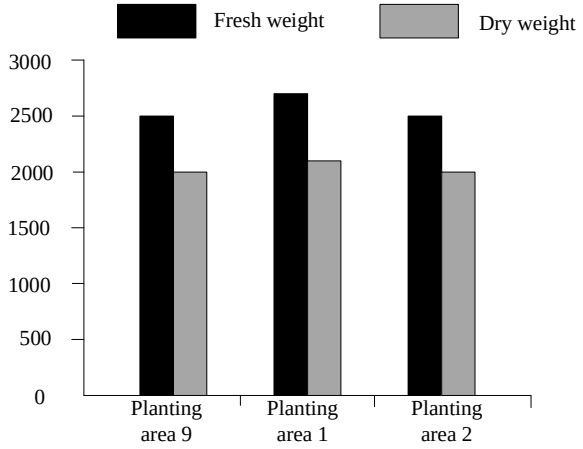

Figure 1. Influence of different irrigation amount on garlic yield

As can be seen from figure 1, compared with that of planting area 9, garlic fresh weight in planting area 1 increases by 7.14%, garlic dry weight increases by 9.04%. Garlic fresh weight in planting area 2 increases by 1.59%, garlic dry weight increases by 4.02%.

4. Result Analysis

Because the humidity requirements for hybrid garlic growth are different in cloudy and sunny environments, the soil moisture for photoinhibition of garlic leaves is 70.8% on cloudy days, and 63.3% for garlic leaves on sunny days. It shows that when the soil moisture is constant, with the increase of light intensity, the degree of photoinhibition of garlic leaves also gradually increases. Due to the alternation of cloudy and sunny days in the later stage of garlic growth and development, the light intensity is constantly changing. It is recommended that the soil moisture should be maintained between 63.3%-70.8% in the later stage of garlic growth and development, especially after the bolting period. If the soil moisture is too high, the degree of photoinhibition of garlic leaves will increase, and if it is too low, the photosynthetic function of garlic leaves will not fully play a role. It can be seen from table 1 that the water and fertilizer integration technology can effectively keep the soil moisture between 63.3% and 70.8%, which is beneficial to the growth of hybrid garlic. Under the traditional technology, the soil moisture during the growth cycle of hybrid garlic is relatively low in both cloudy and sunny days, which is not conducive to the growth of garlic. The water and fertilizer integration technology uses a dropper instead of large-area sprinkler irrigation. The fertilizer can penetrate into the garlic roots with water, which can effectively improve the utilization efficiency of hybrid garlic fertilizer, and can maintain soil moisture for a long time.

It can be seen from table 2 and figure 1 that drip irrigation of water and fertilizer integration technology can significantly reduce the amount of irrigation while garlic yield does not decrease. Planting area 1 and planting area 2 are both drip irrigation areas. Compared with planting area 2, the drip irrigation volume of planting area 1 reduces by 12.95%, but the fresh weight of garlic is 5.47% higher and the dry weight 4.83% higher than that in planting area 2. It indicates that the yield of hybrid garlic does not increase with the increase of irrigation amount, but has a certain irrigation range, beyond which the yield of garlic does not increase, and the water utilization ratio decreases accordingly. The dripper irrigation method adopted by the water and fertilizer integration technology can irrigate the hybrid garlic at a moderate amount.

In summary, the water and fertilizer integration technology uses a dropper as the irrigation method, and the amount of irrigation is moderate. By incorporating fertilizers in the irrigation process, the fertilizer utilization efficiency can be effectively improved, making the hybrid garlic absorb the fertilizer better. It can provide high quality growing environment for hybrid garlic, and the dry weight and fresh weight of hybrid garlic are obviously improved. Through the above experiments, we compare the growth environment and yield of hybrid garlic under the water and fertilizer integration technology and traditional technology, and complete the effect of water and fertilizer integration technology on the growth and yield of hybrid garlic.

5. Conclusions

Combined with relevant literature and information, this paper has studied the effect of water and fertilizer integration technology on the growth and yield of hybrid garlic. Water and fertilizer integration technology is conducive to improving and optimizing hybrid garlic planting methods, and improving the quality of hybrid garlic, so this experiment has a certain promotion effect on the application of water and fertilizer integration technology in hybrid garlic planting. This research also has good practical significance, and it has specific reference significance for the application of water and fertilizer integration technology in hybrid garlic. At the same time, it has a good reference value for related research on the impact of water and fertilizer integration technology on the growth and yield of hybrid garlic. Due to the limited research time and reference materials, although some research results have been obtained, there are still some deficiencies in the research content. In the future, further research will be conducted on the effects of water and fertilizer integration technology on the growth and yield of hybrid garlic.

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