ISSN: 2472-3703 DOI: 10.6911/WSRJ.202009_6(9).0039

Research Progress of Irrigation Schedule on the Growth Characteristics and Yield of Wheat and Corn

Jiaxiang Fu[1, a], Hongquan Liu[1, b, *]

[1]Hebei Agricultural University, Baoding 071001, China.

[a]15076816887@163.com, [b]lhq@hebau.edu.cn

Abstract

Wheat and corn are the main food crops in my country, and they play a pivotal role in agricultural production. For dry and water-deficient areas, irrigation systems for critical periods of irrigation, quota irrigation, or insufficient irrigation can be formulated to achieve the highest increase in output per unit of water or the highest total output value of the irrigation area. Establishing a reasonable irrigation system plays an important role in the sustainable development of wheat and corn production and the improvement of crop water use. The effects of different irrigation systems at home and abroad on the morphological and physiological characteristics, yield and water use efficiency of wheat and corn were reviewed.

Keywords

Irrigation system; wheat; corn; growth characteristics; yield.

1. INTRODUCTION

The national grain output in 2019 was 663.84 million tons, of which wheat output was 133.59 million tons and corn output was 260.77 million tons[1]. The sum of the two accounts for about 60% of the national food output. Most of the main wheat producing areas are concentrated in the semi-humid and semi-arid areas of northern my country. Water and fertilizer conditions are an important factor restricting wheat production [2-5]. The cultivation of wheat and corn consumes a lot of water resources every year, so it is very important to develop an appropriate irrigation system for wheat and corn.

The irrigation system under adequate irrigation conditions refers to the irrigation system designed and formulated to fully meet the water requirements of each growth stage of the crop. A proper irrigation system can significantly improve water use efficiency and irrigation water use efficiency on the basis of stable production [6-8]. Under the condition of full irrigation, the annual average unilateral irrigation water output of sorghum and wheat is 0.45 kg/m3 and 0.24 kg/m3. After quota irrigation is adopted, this value is increased to 1.4 kg/m3 and 0.55 kg/m3, respectively, which is the original utilization rate. 3.1 and 2.3 times [9]. The physiological and ecological characteristics of crops under different irrigation systems will be directly or indirectly affected, thereby affecting crop yields. This article summarizes the effects of irrigation systems on the growth characteristics and yields of wheat and corn, and discusses the future research and development of irrigation systems.

2. DEFINITION OF IRRIGATION SYSTEM

Irrigation system is an irrigation plan based on the characteristics of crop water demand and local climate, soil, agricultural technology and irrigation. The main content includes irrigation frequency, irrigation time, irrigation quota and irrigation quota. Irrigation system is the basic

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data for planning and designing irrigation projects and the operation and management of irrigation districts, and it is an important basis for the preparation and implementation of irrigation district water plans [10]. The irrigation system has a certain guiding role in irrigation management, but the actual operation of the irrigation system is greatly affected by accidental factors such as weather and water source conditions. It must be revised according to the current weather, soil and crop conditions in the irrigation area, and its irrigation quota and irrigation water The time cannot be completely determined according to the irrigation system planned in advance. For example, if there is a shortage before the rainy season, a small fixed amount of water can be used; when there are signs of frost or dry hot wind, the water can be filled in advance; when the wind is blowing, the water can be postponed to prevent the crop from falling. Water should be irrigated in time during the critical period of crop water demand, while other periods can be handled flexibly according to water sources and other conditions. Insufficient irrigation, as a new irrigation system, does not pursue the highest yield per unit area, but allows a certain limit of yield reduction. In areas with limited water resources, establish a reasonable model of the relationship between water volume and output, and achieve a balanced increase in large-area total output by increasing the irrigation area, and strive to achieve an effective unity of water use efficiency (WUE)-output-economic benefits.

3. THE IMPACT OF IRRIGATION SYSTEM ON CROP PHYSIOLOGY AND ECOLOGY

3.1. The Impact of Irrigation System on Wheat and Corn Ecological Indicators

Liu Pei et al. [11] researched that mild water stress can be applied to wheat during the jointing stage, sufficient water supply should be ensured during the wheat filling stage, and the amount of irrigation water should be appropriately reduced during the entire growth period of the wheat, which is not only for water use. The increase in the rate will not significantly affect the wheat yield. Run Yongkui et al. [12] showed that with the increase of water stress in the jointing stage, the quality of wheat leaves, stems, roots and total dry matter decreased, and the dry matter accumulation in different organs of wheat was compensated to a certain extent after rewatering. Molz et al. [13] proved that any measurable changes in the stalk under water stress conditions are due to the loss of water in living cells in the phloem and related tissues. Crop leaf curling is caused by the decrease of leaf cell turgor pressure, which is the external morphological performance of internal water potential and osmotic adjustment results, and can intuitively reflect the sensitivity of crops to soil water stress [14]. Li Biao [15] pointed out through experiments that full irrigation can significantly increase the degree of impact, from small to large, from seedling stage to jointing stage, jointing to tasseling stage, and tasseling to filling stage. This shows that the seedling stage-tasseling stage is the main stage of corn vegetative growth. Water deficit in this period is likely to have an adverse effect on plant growth; after the tasseling stage, corn changes from vegetative growth to reproductive growth, and water deficit at this time affects plant height And leaf area have little effect.

3.2. Effect of Irrigation Schedule on Physiological Indexes of Wheat and Corn

Studies have shown that the photosynthetic products produced by functional leaves in the later stages of wheat growth can contribute more than 80% to the grain yield. Under water stress, the intercellular CO2 concentration of wheat flag leaves increased after anthesis, and the flag leaf transpiration rate, stoma limit value, net photosynthetic rate and stoma conductance decreased [16,17]. Meng Zhaojiang et al. [18] conducted in-depth studies on the mechanism of summer maize and winter wheat under regulated deficit irrigation, and believed that moderate water stress would significantly inhibit transpiration rate, but the photosynthetic rate did not decrease significantly, and the photosynthetic rate after rewatering had a super-compensating

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202009_6(9).0039

effect. The stomata of winter wheat leaves are closed, and the daily changes of net photosynthetic rate and transpiration rate show "double peaks", and photosynthetic "noon break" phenomenon occurs, which avoids extravagant transpiration and reflects the good self-regulation mechanism of crops. The pot experiment of Zhao Wensai et al. [19] showed that under drought-rehydration-re-drought conditions, severe drought treatment significantly reduced the photosynthesis of maize leaves. Zhang Qide et al. [20] believed that irrigation at the jointing stage was beneficial to maintaining good photosynthesis in the later growth period of wheat; Sheng Yu et al. [21] showed that the water stress at the jointing stage had a greater impact on photosynthesis during the filling stage than that at the filling stage. ; Tan Niantong et al. [22] believe that the jointing-filling period is a very important period affecting wheat photosynthesis. Liu Fan et al. [23] conducted water stress field experiments on summer maize. The study showed that the decline in soil moisture will reduce the photosynthetic rate and transpiration rate of maize leaves, but it will significantly increase the water use efficiency of the leaves. The impact is significantly greater than the jointing period.

Chlorophyll is the material basis of photosynthesis. The chlorophyll content of leaves directly affects the photosynthetic capacity of leaves, and it is also an important indicator of drought-induced plant senescence. Water stress reduced the chlorophyll content of wheat leaves. After a plant is exposed to drought, the premature aging and yellowing of the leaves means that the leaf pigments are destroyed. Wei Yanli et al. [24] studied the effects of five irrigation schemes on the chlorophyll content of the flag leaf after Xiaoyan 22 flowering. They believed that the flag leaf chlorophyll was the lowest when treated with no irrigation and the highest was treated with 2 irrigation. Research by Yang Lijuan et al. [25] showed that the chlorophyll content of flag leaves is greatly affected by the genotype of the variety, and less affected by irrigation, chemical control and their interaction. Abd El-Halim et al. [26] pointed out that SPAD readings have a high Pearson correlation coefficient with crop evapotranspiration ($r = 0.95$; $P \le 0.001$) and wheat grain yield ($r = 0.90$; $P \le 0.001$), indicating that SPAD readings are available To reliably estimate when to irrigate.

4. IMPACT OF IRRIGATION SYSTEM ON WHEAT AND CORN YIELD

The economic output of wheat and corn is coordinated by factors such as the number of ears, grains per ear, and grain weight. Different irrigation periods and irrigation quantities in the growth and development stages of winter wheat and summer corn have significant effects on their yield [27]. The results of Cao Caiyun et al. [28] showed that: with the increase of irrigation, the output increases nonlinearly, and the output is affected by the amount of rainfall and the stage distribution. Yang Yonghui et al. [29] pointed out that with the increase of irrigation volume, wheat yield and water use efficiency both increase first and then decrease, while biomass and thousand-grain quality both increase. The research of Guo Xiaowei et al. [30] concluded that, except for the greening period, water stress in the rest of the growth periods (without water stress during the wintering period) caused different levels of yield reduction, among which the jointing period was the most obvious, with a yield reduction of 18.5%. However, the water stress in the returning green period had almost no effect on winter wheat yield. Xue Xuzhang et al. [31] found that under the premise of full base fertilizer, Lumai 21 changed from no irrigation, one irrigation, two irrigation, to four irrigation after sowing, the conversion rate, conversion amount, And the contribution rate of grain yield decreased. Ju Hui et al. [32] concluded that under the condition of sufficient soil moisture, spring irrigation with two waters will increase the yield of spring irrigation with one water than spring irrigation with one water, but the marginal benefit of spring irrigation with one water is higher than spring irrigation with two water treatments; the yield of spring irrigation with two waters and spring irrigation with three waters Similar, but the water use efficiency is improved. Dong Pingguo et al. [33] pointed out that under the same irrigation quota conditions, irrigation time affects the

ISSN: 2472-3703 DOI: 10.6911/WSRJ.202009_6(9).0039

number of ear rows and the number of rows and grains yield characteristic values of seed production maize. Wang Yinghui et al. [34] obtained maize based on 3-year field test at Fengtian Irrigation Experimental Station in Tongliao City The yield reduction rate of water stress treatment in the seedling stage and jointing stage in dry years is relatively small, and the yield reduction caused by water stress in the tasseling stage is the largest, with an average of more than 10% in many years.

5. IMPACT OF IRRIGATION SCHEDULE ON WATER USE OF WHEAT AND CORN

Water consumption is related to natural precipitation, irrigation water and soil water storage. The time and amount of natural precipitation are uncontrollable, making it available and unreliable. Farmland water management interventions, such as improved irrigation and soil management practices for corn planting, can result in substantial water consumption reductions [35]. Meng Zhaojiang [36] conducted a detailed study on regulated deficit irrigation and worked out the appropriate upper and lower limits for water control. The results showed that the implementation of water deficit adjustment for winter wheat before turning green and summer corn before jointing both increased production and saved water, and formulated corresponding The lower limit of water deficit is 50%-55% FC for winter wheat (50%-55% of field water holding capacity), and the suitable lower limit for summer maize is 60%-65% FC. Cai Huanjie et al. [37]'s research on wheat and cotton showed that moderate water deficit has little effect on crop yield, but water use efficiency will increase significantly. Feng Huiling et al. [38] concluded that the water control method of mild deficit regulation at the seedling stage or mild deficit regulation at the jointing stage is suitable for corn, which reduces water consumption by 7.96%-11.02% and WUE increases by 2.68 when the yield reduction is not significant. %~4.41%. Kong Cuozin et al. [39] believed that when there is no irrigation or less irrigation, winter wheat mainly uses deep soil water, and when the number of irrigation increases, it mainly uses surface soil water. Guo Jianwen et al. [40] used corn as the experimental material to study the influence of different irrigation schedules on water use during corn growth. The results show that soil moisture is an important indicator that affects the distribution of corn root systems. The extent of early water shortage on the extension of corn roots to the deep soil layer is greater than that of water shortage treatment only in the middle of corn growth; the water demand in the early stage of corn growth is very strong, which will directly affect the overall corn The growth period affects crop yield; water deficit in the later period can increase the water use efficiency of corn, and has a small impact on crop yield. Research by Peng Shizhang et al. [41] showed that crop yield is in direct proportion to irrigation water volume within a certain range, but when it is increased to a certain amount of irrigation water, the increase in yield becomes small or does not increase. High irrigation water volume may not necessarily increase yield. Therefore, it is imperative to produce more food or improve water efficiency (WUE) when water resources are limited, especially in arid and semi-arid areas with fragile ecosystems and severe water shortages [42]. The more irrigation, the longer the wheat growth period (especially the longer the filling-harvesting period), and the greater the water consumption and intensity of water consumption, resulting in lower water use efficiency. This shows that in the production of winter wheat, a more scientific and reasonable low quota irrigation scheme is adopted, and the results obtained are significantly higher than the yield of conventional irrigation [43]. According to previous research conducted by researchers, irrigation will affect the yield of crops, and the degree of impact varies in different growth periods. Suitable water stress will increase water use efficiency without reducing yield. Zhang Jianheng et al. [44] pointed out that under the background of increasing water deficit in the future, ensuring the water demand of wheat and corn at seedling stage and wheat jointing stage,

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that is, an effective irrigation measure that takes into account both yield and water use efficiency is a total irrigation volume of 225 mm for three waters throughout the year.

6. CONCLUSION

A reasonable irrigation can effectively solve the problem of water shortage for agricultural production in arid areas and maintain the stability of crop yields. The method of formulating the irrigation system includes summarizing the people's rich irrigation experience, formulating an irrigation system based on irrigation test data, and analyzing and formulating crop irrigation systems based on the principle of water balance. In order to adjust the irrigation system in a timely and reasonable manner, it is necessary to strengthen the irrigation forecasting work, focusing on forecasting and forecasting precipitation, crop water consumption and soil moisture changes. At the same time, it is necessary to further study the water-saving irrigation system of major crops to adapt to the increasingly tense relationship between the supply and demand of agricultural water resources and the development of irrigation.

ACKNOWLEDGMENTS

Project Fund: Scientific Research Fund of Hebei Water-saving Irrigation Equipment Industry Technology Research Institute (SC2018005), National Key Research and Development Program (2018YFD0300503), Hebei Province Key Research and Development Project (19227003D), Shangqiu Agricultural Environmental Science Observation and Experimental Station Open Fund (FIRI2019- 02-0102).

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