ISSN: 2664-9640

Research progress of water-saving irrigation measures

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Abstract

Cultivated land is the basis of food source. Under the condition of ensuring the stability of cultivated land area, improving cultivated land production capacity is the fundamental to ensure food security. The implementation of agricultural water-saving measures is very important for the effective utilization of agricultural water. Under the condition of limited water resources, how to make efficient use of water resources is the core and key of regional sustainable development. Selecting low-cost and high-yield water-saving measures suitable for regional development, increasing the regional water-saving potential, improving the utilization efficiency of water resources, and providing a strong guarantee for high-standard farmland construction is of great significance to realize the simultaneous development of regional resource utilization and ecological environment protection It is of great significance to effectively promote the coordinated development of water and soil resources. This paper discusses the research progress of different water-saving irrigation measures.

Keywords

Agricultural irrigation; Water saving measures; Water saving potential; Utilization rate of water resources.

1. Introduction

With the great leap forward development of human society, human activities such as industrial production, agricultural farming and urban construction have resulted in the reduction of land quantity and quality degradation, soil erosion, land desertification, salinization and land pollution, which have an important impact on the ecological environment and social economy of all countries in the world. In the environment of water shortage, improving water-saving measures in agricultural water conservancy irrigation is the top priority. Due to the shortage of science and technology and funds, the utilization rate of water resources in agricultural water conservancy has been very low. The large-scale waste of water resources makes its scarce resources worse, so that agricultural production and development can not be guaranteed. Therefore, vigorously promoting modern water-saving irrigation technology in agricultural water conservancy is of great significance for agricultural development. The wide application of water-saving irrigation technology can greatly improve agricultural production efficiency, save the utilization of water resources, and put every drop of water into practice. Water-saving irrigation also indirectly improves the level of agricultural irrigation and makes agricultural water conservancy move towards the general direction of sustainable development.

ISSN: 2664-9640

Agricultural water-saving irrigation refers to the use of advanced scientific and technological means and the use of as few water resources as possible to obtain high yield of crops during agricultural irrigation. It is an important prerequisite for sustainable development in agricultural production. As an important part of the construction of the concept of sustainable development, the implementation of water-saving irrigation measures has considerable development significance and space. Water saving irrigation technology can avoid excessive waste of water resources in transportation and application during agricultural irrigation, and can greatly improve the utilization rate of water resources in agricultural irrigation. Compared with the traditional agricultural irrigation technology, the modern scientific and technological irrigation means have pushed through the old and brought forth the new on the basis of traditional experience, retained the advantages of traditional irrigation and eliminated the criticism in the tradition. The irrigation technology, which used to use only a small part of water resources, has been improved. Water saving irrigation has maximally alleviated the waste of water resources, which has become a major obstacle in the construction of agricultural science, promoted the sustainable development of agriculture, and promoted the adjustment of agricultural structure and the increase of farmers' income.

Make good use of water resources, maintain sustainable agricultural development, optimize the layout of economic and social development, optimize the industrial structure and water use structure, run water conservation through the whole process of economic and social development and ecological civilization construction, promote the transformation of water use mode from extensive to economical and intensive, and improve water use efficiency and efficiency. It is not only of great significance to realize the sustainable development of regional agricultural production and economy, but also of great strategic significance to solve the food problem, increase farmers' income and accelerate rural economic development.

2. Research progress of water saving measures

2.1. Research progress of underground drip irrigation

Underground drip irrigation technology is one of the drip irrigation technologies, that is, the drip irrigation capillary is laid in the farming layer to directly irrigate the water, fertilizer and medicine required by crops to the crop root area, which is conducive to crop growth, reduce soil water evaporation, prolong the service life of the drip irrigation pipe, reduce the laying and recovery of drip irrigation capillary during field crop cultivation, and reduce labor and operation management costs. The system can not only meet the requirements of different environmental climate, terrain, landform, water quality and water sources (even sugar factory wastewater and organic industrial wastewater) and pest control and precision fertilization, but also an agricultural industrialization investment project with less investment, quick effect, easy management and cost saving, which is of great practical significance to the development of agricultural industrialization and modernization. In October 2000, at the 6th International drip irrigation conference held in South Africa, underground drip irrigation technology was listed as one of the key technologies for drip irrigation development in the future.

The influence of drip irrigation on soil profile water and nitrogen distribution mainly comes from soil characteristics, drip irrigation system parameters and design irrigation and fertilization system. Because underground drip irrigation is buried in different crops at different depths, it is easy to be squeezed by the soil around the emitter and the suction of the soil near the emitter to capillary water, which will affect water infiltration [1]. The buried depth of underground drip irrigation zone is also affected by crop characteristics, soil characteristics and environmental climate. The hydraulic performance of soil itself affects the movement of water [2]. Ouyangmiao et al. [3] have shown that the different distribution of moisture content in the wet body is closely related to the flow of the emitter, that is, the initial moisture content.

Underground drip irrigation technology has a certain water-saving effect in the application of practical crop irrigation, which is beneficial to the stable yield and increase of crops, and has a certain improvement in quality. For example, improving the irrigation level of underground drip irrigation can increase lint yield and water use efficiency [4]; In tomato planting, when the buried depth of underground drip irrigation is 40cm, the yield, fruit length, vitamin C and sugar acid ratio of greenhouse tomato will increase with the increase of irrigation depth [5]. Sheng Tongmin et al. [6] showed that the daily underground drip irrigation method is conducive to the accumulation of dry matter mass and dry weight of cotton roots in Xinjiang, make the horizontal distribution of roots uniform and promote the growth of roots. By comparing several irrigation technologies, some scholars found that the corn yield under underground drip irrigation technology increased by 19% compared with sprinkler irrigation technology and 2% compared with surface drip irrigation technology; Compared with flood irrigation, the perimeter of cotton thin heel under underground drip irrigation is longer and the vigorous index of root life activity is better [7]; Compared with surface drip irrigation, underground drip irrigation technology enables phosphorus nutrients to be applied to the roots of crops with water, which improves the utilization rate of phosphorus fertilizer [8].

2.2. Research progress of trace irrigation

Trace irrigation means that on the premise of meeting the water demand of plants, low-pressure water is transformed into very small water flow through a special control head, which is evenly and continuously transported to the soil near plant roots at an extremely small speed (1 ~ 200ml/h). The constant irrigation we usually talk about is calculated by ton per hour, the micro irrigation is calculated by liter per hour, and the trace irrigation is calculated by ml per hour. Trace irrigation is a new water-saving irrigation technology based on the principle of soil capillary action and modern membrane filtration technology. Based on the soil capillary force, it directly transports water or nutrient solution near the plant roots at an extremely small rate, evenly, appropriately and continuously moistens the soil in the plant root layer, and provides long-term water supply for plants.

Trace irrigation has the characteristics of high efficiency, water saving, fertilizer saving and energy saving. The trace irrigation pipe is buried underground, and the water only moistens the soil near the crop roots to avoid deep leakage; The fertilizer used with water is retained in the soil or directly absorbed by plants. The results show that trace irrigation can save 40% ~ 60% water and 20% ~ 30% fertilizer than drip irrigation. The trace irrigation system can work under low voltage without electricity, which saves energy compared with drip irrigation.

At present, researchers have done a lot of qualitative research on the physiological characteristics of crop growth under different buried depths of mark irrigation pipes and water and fertilizer conditions, and there is no systematic quantitative research on the water and fertilizer management system of mark irrigation. Tang cunshi et al. [9] (2015) studied the effect of buried depth of trace irrigation pipe on the density, height and biomass of Elymus. Cong Lijun et al. [10] studied the effects of different buried depths of trace irrigation pipes on the quality and yield of tomato cultivated in solar greenhouse. Yang Zhiyuan [11] studied the effects of different water and fertilizer treatments on the growth of Cucumber in greenhouse under trace irrigation, and showed that the amount and frequency of fertilization under trace irrigation had different effects on the growth, yield and quality of cucumber. Liu Qiuli [12] studied the effects of different irrigation amounts of trace irrigation on Eggplant Growth and water use efficiency in greenhouse. It shows that the application of trace irrigation on eggplant can save water by 20%~40% and improve water use efficiency by 6.27~23.94 kg/m^3 compared with conventional drip irrigation under the condition of maintaining stable economic yield. Liu Qiuli [13] studied the effects of trace irrigation and different fertilization rates on the yield and quality of eggplant. The research shows that trace irrigation can save fertilizer by 20% ~ 40%

compared with conventional drip irrigation. Xia Xia et al. [14] made a comparative analysis of trace irrigation and micro moistening irrigation technology, and considered that it is urgent to carry out research on crop water demand, water-saving and yield increasing benefits and optimal irrigation schedule of trace irrigation, so as to verify the popularization value of trace irrigation system. Shanxi Province has "long coal and short water". The annual per capita water supply of the province is only 227m^3, less than 50% of the national per capita value. It is one of the most water deficient provinces in China. Today, when efficient water saving in Shanxi enters the stage of improving quality and efficiency, the research and promotion of trace irrigation technology as a means of water saving is in line with the provincial situation of extremely arid areas such as Shanxi.

2.3. Research progress of trace irrigation

Micro moist irrigation is a new underground irrigation method that uses a small amount of water to supply water to the soil in a slow infiltration way to keep the soil moist. Micro lubrication pipe is a hose like water feeder made of semi permeable membrane as the core material. It has a double-layer structure. It is a new water feeder made by making full use of the characteristics of semi permeable membrane and introducing membrane technology into the field of irrigation. The pore size on the membrane wall allows water molecules to pass through, but does not allow large molecular groups and solid particles to pass through. When the pipe is filled with water, water molecules migrate outside the pipe wall through these micropores. If the pipe is buried in the soil, the water will further migrate to the soil to wet the soil and play the role of irrigation. The irrigation system composed of micro lubrication pipe as water feeder is called micro lubrication irrigation system. The micro irrigation system consists of water delivery pipe, water source and water level control. Micro lubrication pipe is the main body and functional part of the system. It is both a water feeder and a water delivery pipe. When in use, the micro moistening pipe is buried under the ridge, and the embedding depth is generally 10-20cm, depending on the depth of main root layer of different crops; The water supply source can be a field water tank, a water tower or a tap water pipe. Different water sources have different water level control methods, but the control parameters are only water level.

This technology realizes continuous irrigation in agricultural production for the first time. It is a new irrigation method with high precision and strong regulation; An extreme water-saving irrigation method is created, which avoids or greatly reduces the three main losses of farmland water, and provides an extreme water-saving irrigation method for farmland irrigation, with a water consumption of about 20-30% of that of drip irrigation. More than 70% water saving than drip irrigation; There is no power consumption during operation, and the structure is very simple. There are no complex structures such as water pump, water meter, check valve and exhaust valve in the irrigation system. The only controller is automatic water level controller or pressure reducing valve.

Micro moistening irrigation technology was selected into the key promotion and guidance catalogue of advanced and practical water conservancy technology of the Ministry of water resources in 2010. It has been popularized and applied in many key projects in Qinghai, Shaanxi and Hubei and grassland degradation control in Chifeng City.

3. Conclusion and Prospect

In the weak areas of water resources supply, the shortage of water resources restricts the sustainable development of economy and society to a certain extent. Problem oriented, in view of the actual situation of water shortage, fragile ecological environment and backward agricultural economy, based on the limited water resources in the region, we should explore the impact of different water-saving measures on regional crop growth characteristics, clarify the water-saving potential of different water-saving irrigation measures, select water-saving

measures suitable for regional development with low cost and high output, and apply them to production practically, It maximizes the overall benefit of regional agriculture, more scientifically ensures the demand for agricultural water, improves grain production, and promotes the comprehensive production capacity of agriculture, so as to improve the social and economic benefits of agriculture and provide a strong guarantee for the construction of high-standard farmland. Realize the efficient and scientific utilization of water resources, and provide support for the sustainable utilization of regional resources, the benign improvement of ecological environment and the stable development of economy and society.

Acknowledgments

This work was financially supported by the Fund Project of Shaanxi Key Laboratory of Land Consolidation (2019-JC08) and the Fund Project of Shaanxi Provincial Land Engineering Construction Group Internal Research Project (DJNY2021-25). Sincere gratitude is extended to the editor and anonymous reviewers for their professional comments and corrections.

References

[1] Wang J W, Niuwq, Li Y, et al. Subsurface drp imigation enhances soil nitrogen andphosphorus metabolism in tomato root zones and promotes tomato growth. Applied soilEcology,2018,124:240-251.
[2] Pisaottaa, Lorenzo RD, Santalucia G, et al. Response of grapevine(cabernet sauvignon cvto above ground and subsurface dnp irn gation under arid conditions. agricultural WaterManagement, 2018,197:122-131.
[3] Ou Yangmiao, Li Zhenyu. Experimental study on water infiltration characteristics of red clay under indirect underground drip irrigation [J]. Water saving irrigation, 2020 (05): 38-42.
[4] Attia A, Rajan N , Ritchie G , et al . Yield , quality , and spectral reflectance responses of cotton under subsurface drip irrigation[J].Agronomy Journal , 2015 , 107 (04) 1355-1365.
[5] Stoleru V, Inculet S C , Mhalache G , et al . Yield and nutritional response of greenhouse growtomato cultivars to sustainable fertlization and irrigation management[J]. Plants , 2020 , 9 (08)1053-1068.
[6] Sheng Tongmin, Zhang Shengjiang, Gou Huanhuan. Effects of different irrigation methods on Cotton Root Distribution [J]. Water saving irrigation, 2020 (09): 100-105.
[7] Hai Xingyan, Zhang Ze, Ma Gexin, et al. Effects of different irrigation methods on dynamic changes of cotton fine roots [J]. Journal of irrigation and drainage, 2017, 36 (11): 1-6.
[8] He Hua, Kang Shaozhong, Cao Hongxia. Effects of buried pipe depth of underground drip irrigation on Root Cap Growth and water use efficiency of winter wheat [J]. Journal of agricultural engineering, 2001 (06): 31-33.
[9] Tang cunshi, Shi Qingdong. Effects of buried depth of trace irrigation pipe on density, height and biomass of Elymus Elymus [J]. Water saving irrigation, 2015 (10): 9-11.
[10] Cong Lijun, Wang Shenglin, Li Jianshe, et al. Effects of different buried depths of trace irrigation pipes on the quality and yield of tomato cultivated in solar greenhouse [J]. Northwest Agricultural Journal, 2017, 26 (7): 1062-1067.
[11] Yang Zhiyuan, Song Jian, Huang Chongwen, et al. Effects of different water and fertilizer treatments on cucumber growth in greenhouse under trace irrigation [J]. Journal of irrigation and drainage, 2017, 36 (1): 74-78.
[12] Liu Qiuli. Effects of trace irrigation on Eggplant Growth and water use efficiency in greenhouse [J]. China rural water resources and hydropower, 2018 (8): 27-30.
[13] Liu Qiuli. Effects of trace irrigation and different fertilization rates on Yield and quality of eggplant [J]. Water saving irrigation, 2018 (7): 43-45.
[14] Xia Xia, Tian Juncang. Comparative analysis of trace irrigation and micro moistening irrigation technology [J]. Water saving irrigation, 2017 (8): 96-99.