

Water Fertilizer Integration Equipment Research Status and Development Trend

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Abstract: Integrated water and fertilizer technology can accurately adjust the mix of water and fertilizer on demand, and then through the irrigation system, water and fertilizer are delivered to the roots of the crop in quantity, on time, and with precision. As an important part of the integrated system of water and fertilizer, the fertilizer has a critical influence on the quality of the fertilizing system. Nowadays, the development of intelligent agriculture has become a general trend of agricultural development. By exploring the development process of water and fertilizer mixing, this paper sorted out the research status of various kinds of fertilizers in China, compared different mixing methods of water and fertilizer, and analyzed and summarized the excellent working performance of different fertilizers. Secondly, the current research emphases were discussed, including precision fertilization technology, intelligent control, comprehensive utilization of resources and circular agriculture. Then, the development trend of integrated water and fertilizer equipment is put forward, including the improvement of precision fertilization, the development of multifunctional integrated equipment, and the application of data management and decision support system. Through continuous technological innovation and application, the integrated equipment of water and fertilizer is expected to play a greater role in the agricultural field.

Keywords: Water and fertilizer integration, Fertilizer applicator, Precision fertilization development trends, Development status.

1. Introductory

The shortage of freshwater resources is a major problem faced by the global community, and although China has a vast land area and many water resources, it has a large population base, uneven distribution of water sources, and agricultural water consumption still accounts for a large proportion of the total water consumption. Therefore, the rational and efficient use of water resources has become one of the most pressing problems in China[1-3]. China has been a large agricultural country since ancient times, with the development of planting industry, the use of fertilizers by growers has also revealed many problems, some growers due to the lack of knowledge of planting and green development awareness of the weak and thus excessive use of fertilizers, resulting in China's serious waste of fertilizers, planting pesticide residues are too much, environmental pollution is serious, soil sclerosis, and so on, a series of problems[4,5]! Water-fertilizer integration technology in the water-fertilizer ratio system can be based on crop needs, according to the proportion of water and fertilizer transported to the mixing system to achieve a precise ratio, in saving water and fertilizer at the same time, but also improve the efficiency of the use of water and fertilizer, the economic, ecological, and social benefits have played a benign effect[6].

At present, some developed agricultural countries on the water-fertilizer integration of irrigation and fertilization system research has been quite perfect, water-fertilizer ratio and fertilization precision, but most of the equipment is expensive, and part of the fertilizer applicator is not applicable to the actual terrain of China's planting area[7]. Domestic water-fertilizer integration irrigation system after decades of research, but also towards automation, intelligent direction of development, so as to achieve high precision and high efficiency standards.

By reviewing the literature published in this field, we understand the current research status of various scholars in this field, and analyze the functionality of each fertilizer applicator, so as to provide a reference for research scholars engaged in this field.

2. Fertilizer Application Equipment Research Status at Home and Abroad

Fertilizer applicator is a crucial part of the water-fertilizer integration system, fertilizer applicator performance affects the accuracy of fertilizer distribution and thus affect the effect of irrigation and fertilization. At present, in the water-fertilizer integration fertilization system often used in the type of fertilizer applicator are mainly venturi fertilizer applicator, differential pressure tank fertilizer applicator, proportional fertilizer applicator, gravity self-pressure fertilizer, intelligent fertilizer applicator and so on. Many scholars have also studied and attempted to improve and optimize the performance of different fertilizer applicators to achieve better results.

2.1. Venturi Fertilizer Applicator

Venturi fertilizer applicator is the use of external pressure will be fed from the water pipeline, flow through the contraction section, the pressure will be reduced to form a pressure difference, the fertilizer solution from the suction mouth, and then transported through the irrigation pipeline to the roots of the seed plants, the principle of operation is shown in Figure 1. At present, many scholars in order to optimize the performance of the venturi fertilizer applicator, through the experimental investigation of venturi fertilizer applicator fertilizer absorption performance, or simulation analysis to

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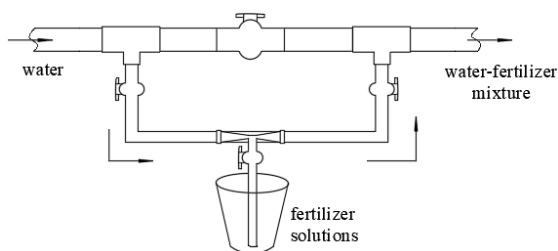


Figure 1. Venturi fertilization diagram

In the study of the venturi fertilizer applicator, our scholars are part of the performance of the fertilizer applicator itself for research and analysis, such as Kong Lingyang, etc[8] for the investigation of venturi fertilizer applicator fertilizer suction capacity for the equipment set up experiments, through the analysis of the experimental data and the results of the venturi fertilizer fertilizer applicator fertilizer suction capacity of the maximum limit of the venturi fertilizer applicator and venturi fertilizer applicator performance and the size of the structure is related to the inlet pressure and the suction of the flow rate of fertilizer will affect the suction of the fertilizer concentration. Cheng Qian et al [9] also verified the existence of limit fertilizer absorption flow rate of venturi fertilizer applicator through simulation, and established relevant flow rate model and cavitation model to analyze the generation of cavitation phenomenon and the change of fertilizer absorption performance. Wang Haitao et al[10] selected a unified specification of six different domestic and foreign venturi fertilizer applicator as the object of study, the use of control variables, change the parameters of the method, it is concluded that in the unified inlet pressure under the foreign fertilizer absorber suction are higher than the domestic suction fertilizer absorber, and under a certain pressure, the negative pressure in the throat affects the amount of suction fertilizer, with the vibration and cavitation phenomenon after the pressure difference becomes larger, is an important cause of the decline in the performance of the fertilizer absorber. Growers in the fertilization system should be based on the actual needs of a reasonable choice of venturi fertilizer applicator, in order to achieve the optimal fertilization effect.

Another part of scholars is to analyze and improve the structural construction of the fertilizer applicator, such as Xie Donghui[11] selected 14 kinds of venturi fertilizer applicators to test to study the effect of C, T, E-type throat construction on the performance of fertilizer suction, and through the comparative analysis concluded that the fertilizer suction performance of the T-type throat is stronger than the C-type and E-type throat. Two fertilizer suction ports of the same size are connected to both ends of the pipe horizontally and symmetrically, as shown in Fig. 2, and the results of simulation and analysis through CFD simulation show that the concentration of fertilizer suction can reach 13.6% when the value of the inlet pressure is 0.05MPa, which meets the conditions of low-pressure irrigation. And double suction mouth venturi fertilizer applicator than single suction mouth fertilizer applicator in the absorption of fertilizer, fertilizer absorption efficiency and other aspects have been

significantly improved, the enhancement effect can reach more than 80%. By constructing a model of asymmetric venturi fertilizer applicator, H. Wang[13] found that asymmetric venturi fertilizer applicator has reduced energy loss and can avoid 25%~35% pressure loss. Yan[14] et al. used orthogonal experimental design with CFD simulation to optimize the structure of the venturi fertilizer applicator, and the pressure loss of the fertilizer applicator was reduced by nearly one-third after the optimization, and the cavitation in the tube was reduced.

Venturi fertilizer applicator is widely used in China, and many scholars have designed and modified or simulated the performance and structural parameters of the venturi fertilizer applicator, aiming at obtaining better working performance. Although a large number of research and design, but still can not reach the working performance of foreign venturi fertilizer applicator, pressure loss, cavitation in the tube, the amount of fertilizer suction can not be accurately controlled, the structural parameters to be optimized and other issues are still the focus of the research. In addition, the manufacturing process and the choice of materials can also be a factor to consider.

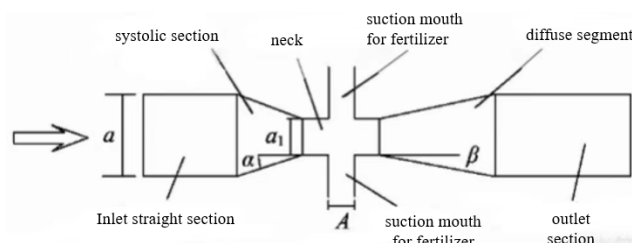


Figure 2. Double suction venturi fertilizer applicator structure diagram

2.2. Differential Pressure Tank Fertilizer Applicators

Differential pressure fertilizer applicator is mainly composed of a fertilizer storage tank, two thin tubes and a main pipe and regulator, through the installation of the throttle valve between the two thin tubes, which will produce a certain pressure difference, so that the water flow into the tank to dissolve the fertilizer through the outflow of the water fertilizer mixing pipe into the irrigation system, the fertilizer will be transported to the roots of the crop, as shown in Figure 3. Differential pressure fertilization tanks have been widely used in many countries, but the concentration of fertilizer applied by differential pressure fertilization tanks decreases with the increase of irrigation time[15], so it is not possible to accurately control the concentration of fertilizer, making it difficult to achieve accurate fertilization, and the tank volume is limited, which requires several times of fertilizer addition.

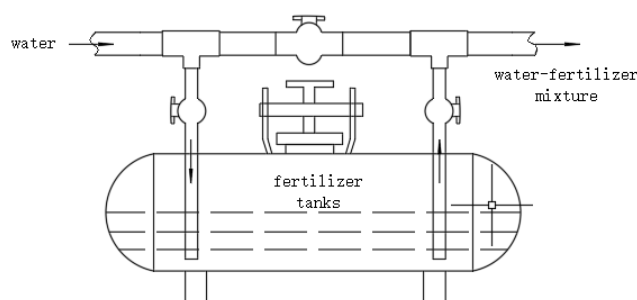


Figure 3. Schematic diagram of differential pressure fertilization tank

Meng Yibin[16] and so on through the construction of differential pressure fertilization tank concentration changes in the mathematical model to explore the differential pressure of different and different fertilizer application volume on the change of fertilizer concentration changes, through the experimental data concluded that the differential pressure fertilization tank in the first ten minutes of the fertilizer concentration decline faster, the differential pressure is the main factor affecting the decline of fertilizer concentration fast, the application of fertilizer is large enough to continue a certain amount of fertilizer application time. Deng Lansheng[17] and other experimental model by building a controlled variable approach to study the effect of different fertilizers, different differential pressure, different flow rate, etc. on the effect of fertilizer application, as long as there is a pressure difference in the fertilizer tank can be fertilizer application, the size of the flow rate and the differential pressure affects the length of time for fertilizer application, solid fertilizers compared to liquid fertilizers, there is a process of dissolution of fertilizers so that the fertilizer application time is longer, and at the same time, the differential pressure is indirectly through the effect of flow rate affects the concentration of fertilizer solution. Chen Jian[18] et al. further verified the characteristics of differential pressure fertilization tanks by conducting experiments to explore the relationship between differential pressure, fertilizer application rate, and fertilizer application time in agreement with the relationships derived by the above scholars. Han Qibiao[19] and other CFD simulation simulation to initially explore the pressure difference fertilization tank in the fertilizer changes, as only a preliminary exploration of the conclusions reached with the previous scholars are generally consistent with the specific details of the fertilizer attenuation law needs to be further explored. Fan Junliang[20] and others conducted experiments to study the effect of different piping arrangement and fertilization uniformity under drip irrigation system with different pressure differentials, and found that fertilization tanks with different pressure differentials have less impact on irrigation fertilization uniformity, and under the premise of using pressure differential fertilization tanks can be chosen to enhance fertilization uniformity by changing piping arrangement. Yang Xin[21] and others found that the flow rate and differential pressure is a power function of the mathematical relationship between the role of the increase in differential pressure leads to a subsequent increase in the flow rate, while the concentration of fertilizer out of the mouth of the fertilizer with the change in time is an exponential decrease, but also so that it is concluded that the amount of fertilizer applied to the case of too high and too low and small differential pressure is not conducive to the uniform distribution of fertilizer under the drip irrigation system. Hu Xinyu[22] and others pointed out that the traditional differential pressure fertilization tank fertilizer application process of about 70% to 80% of the fertilizer belongs to the range of over-fertilizer or insufficient fertilization, the team verified the feasibility of using computer control with the electric control valve to achieve the control of the uniformity of fertilizer, but there are cumbersome operation, the high cost of the problem.

Differential pressure fertilizer tank in China belongs to the earlier application of a class of fertilizer applicator, in many areas are used, but because of this type of fertilizer applicator working process of fertilizer concentration will gradually

attenuate the problem has not been well solved, consider the application of this type of fertilizer applicator growers are also gradually reduced.

2.3. Proportional fertilizer applicators

Water-activated proportional fertilizer applicator is a kind of fertilizer applicator driven by water power, which can add the fertilizer evenly into the water according to the set proportion, and the system pressure and flow rate have no effect on the proportional fertilizer applicator, as shown in Fig. 4. When working, the pressurized water flow enters into the water inlet chamber to make the driving piston reciprocate, and the driving piston is connected with the fertilizer absorbing piston through the connecting rod, thus completing the dissolution of water and fertilizer. Proportional fertilizer applicator works stably, can set the proportion of fertilizer according to the demand, and easy to control, at the same time compared with other fertilizer applicators have better fertilizer precision and uniformity and other characteristics.

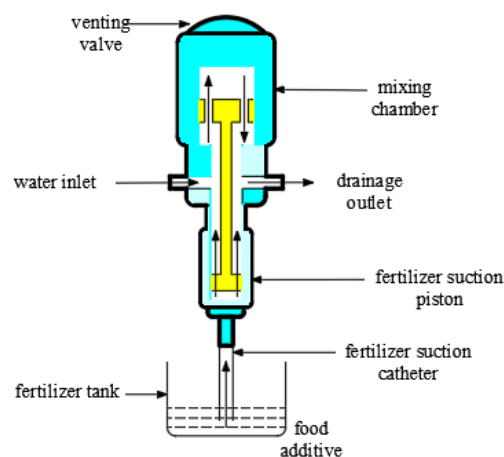


Figure 4. Diagram of proportional fertilizer applicator

Due to the domestic proportion of fertilizer applicator core size mastery is not perfect, resulting in the domestic fertilizer applicator in the same pressure difference in the case of imported flow rate is lower than foreign products[23,24]. Wu Xikai[25] and others studied the fertilizer suction performance test of hydraulically driven proportional fertilizer applicator under the condition of keeping the pressure of the first part of the capillary stable, the test found that the inlet flow rate will first increase and then decrease with the increase of the differential pressure, and it is not conducive to the stability of the working performance if the differential pressure is too large, so when selecting the proportional fertilizer applicator, it is necessary to control the differential pressure in the appropriate range. It is also found that the fertilizer application ratio is affected by the inlet flow rate, and in the case of large inlet flow rate and small fertilizer application ratio, the amount of fertilizer suction will be reduced, so the setting of the fertilizer application ratio should also be operated reasonably according to the performance of the fertilizer applicator. Han Qibiao[26] and others selected three different types of hydraulically driven proportional fertilizer pumps to carry out experimental investigation of the relationship between fertilizer performance, differential pressure, inlet flow, and the conclusions reached go to the previously described conclusions are basically the same.

In addition, another proportional fertilizer applicator for the valve-adjusted proportional fertilizer applicator, the fertilizer

applicator has a small size, low price, ease of use and other advantages, mostly for small-scale fertilization. Qiankun Zhang[27] and others made structural improvements to the valve-type proportional fertilizer applicator to improve the performance of the fertilizer pump. Li Hong[28] et al. found that by analyzing the performance of the valve-regulated fertilizer applicator, under a certain differential pressure, the angle of the three-way valve becomes larger, and the inlet flow rate shows a trend of decreasing and then increasing. When the angle of the three-way valve is certain, the differential pressure increases the frequency of piston movement increases.

Proportion of fertilizer apparatus has excellent performance, the proportion of fertilizer pumps in China is mainly designed after foreign structures, the core technology mastery has not yet reached the point of complete maturity, the performance indicators compared with foreign countries there are still some gaps, so the proportion of fertilizer pumps need to be further in-depth research.

2.4. Gravity self-pressure fertilization

Gravity self-pressure fertilizer application is a way of fertilizer application by realizing the difference in water level height and generating pressure, as shown in Figure 5. Because of the simple structure of this fertilization method, the cost of building a set of this type of fertilization system is low, but this type of fertilization method is similar to the differential pressure fertilization tank fertilization method, the concentration of fertilizer will gradually decrease with time, it is not suitable for controlling the concentration of fertilizer, and it is not possible to carry out precise fertilization, mainly used in some mountainous areas, the existence of the advantages of the height of the region, and some of the fruit growers in South China have also used gravity self-pressure fertilization[29]. For these reasons fewer domestic scholars have studied such fertilizer applicators. Guo Yanbiao[30] and others introduced the structural components and principles of gravity differential pressure fertilizer application system and the method of using it, which can be referred to by those who are interested in this type of fertilizer application. Sun Guoxin[31] and others designed a fertilizer application system using gravity self-pressure by adding floats, guide rods, levers, etc., which is suitable for implementation and application in greenhouse greenhouses.

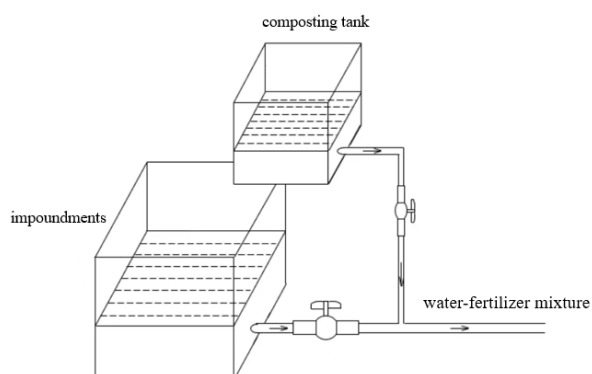


Figure 5. Gravity self-pressure fertilizer application diagram

2.5. Intelligent Fertilizer Applicator

Intelligent fertilizer applicator is a combination of hardware and software manipulation of powerful fertilizer applicator, this type of fertilizer applicator combined with the

Internet of Things can be through the weather station, soil sensors, humidity sensors, Ec/ph value measurement sensors and other devices will be collected by the data collected to the computer terminal, and through the analysis of the data can be based on the needs of the crop, the timely transmission of water and fertilizer, you can realize the high-precision fertilization, real-time monitoring, remote control, information alarms, and other functions for the growth of the crop to provide a suitable environment for the growth of the growth of the fertilizer applicator of the type of high degree of intellectualization and integration of the modernization of the application of technology to promote the crop's high-yield, high-quality quality.

Yu Weidong[32] et al. added four fertilizer-absorbing solenoid valves in the pipeline and controlled the switching of these solenoid valves by PLC to regulate how much fertilizer is absorbed to ensure the accuracy of fertilizer application. Two EC/ph detection circuits were utilized in the detection system, and according to the data derived from the experiment, the irrigation accuracy of this intelligent fertilizer applicator can be controlled within 0.5%, and the error of the control accuracy of the EC value is 0.03m S/cm, and the error of the control accuracy of the p H value is 0.01. Fang Junlong[33] and others developed a fertilizer controller that can be paired with any intelligent system, which can achieve multi-mode switching, is fully functional, and can increase and decrease the modules according to the demand, which has a good prospect of application promotion. Di Jiao[34] and other HIM touch system combined with embedded controllers to develop an intelligent fertilizer applicator, the fertilizer applicator is relatively small, convenient to use, mainly for greenhouse greenhouses, but the proportion of water and fertilizer can not be changed during the work, this function needs to be further improved. Niu Yin[35] et al. used two ph sensors for precise PH regulation, the functions of which are measurement and calibration, and then combined with the CV FPI control algorithm for the experiment to conclude that the systematic ph regulation of fertilizer using this method has better stability and anti-interference ability. Jiang Pioneer[36] and others have optimized and improved the internal electrical system of the fertilizer applicator, the improved circuit can control the steering of the motor and synchronously control the degree of valve opening and closing to meet the appropriate proportion of water and fertilizer, experimental validation of water resources and fertilizer resources to enhance the utilization of the effect is significant. Li Jixue[37] and other design of the fertilizer machine selected a jet pump as a fertilizer suction components and device wireless communication equipment to achieve remote control of the fertilizer machine operation stability and reliability, and finally through the actual verification of the equipment compared to the traditional fertilizer machine to ensure the precision of fertilizer application at the same time less of a local area of restriction, the planting household can be more convenient to manipulate the work of the equipment. Xu Can[38] and others based on the needs of facility horticulture planting crops designed a peristaltic pump to suck fertilizer and liquid fertilizer applicator, and through the test peristaltic pump and the main pump flow analysis found that the peristaltic pump and the flow of the main pump accuracy can reach more than 90%, can be fully water and fertilizer rationing, to realize the precise application of fertilizer. Chen Nannan[39] et al. designed a 3-channel fertilizer applicator with a bypass

mixing method, which is able to complete the preparation of multiple nutrient solutions. As shown in Figure 6 for the intelligent water and fertilizer integrated machine developed by a company in Shandong, the fertilizer machine suction capacity of 100-600L/H, head for 45-75 meters, can realize the timing and quantitative fertilization, EC / ph automatic adjustment, remote control operation, real-time status monitoring, watering records query and other functions. Xue Xiuyun[40] et al. made changes to the amount of fertilizer applied in time by controlling the frequency converter to change the speed of the spray pump motor, so that the average accuracy of the fertilizer application system was close to one hundred percent.



Figure 6. Intelligent water and fertilizer machine

Many scholars in China for intelligent fertilization machine for a large number of hardware and software research, fertilization machine system development, algorithm optimization, pipeline design and other aspects of a great deal of effort, although a certain degree of success, but the development of intelligent fertilization machine is basically similar to the same system algorithms there are still large gaps in the EC / ph value precision control, fertilizer concentration detection, etc., still can not reach the level of high precision, and most of the developed fertilizer machine intelligent degree is low, stay in the experimental improvement stage, can not achieve accurate quantitative fertilization, there is still a long way from the bulk into production use. High-precision level, and the function of perfect mature product is less, most of the research and development of fertilizer machine intelligence degree is low, stay in the experimental improvement stage, can not realize the accurate quantitative fertilizer, from the batch into production and use there is still a long way to go.

2.6. Plunger-type fertilizer injection pumps

At present, there are also scholars to consider the application of water fertilizer system in the application of plunger pumps for fertilizer, plunger pump is driven by the driving force to drive the plunger for reciprocating motion so as to complete the liquid suction and discharge, is a kind of reciprocating pump.

Wang Jingjing[41] and other plunger-type fertilizer injection pump structural design and experimental research using the way the reliability of the system operation, the analysis of the data obtained that the pressure of the irrigation

pipeline on the plunger pump has less impact on the flow rate of the work of the system can be adjusted by adjusting the frequency of the power supply to regulate the flow rate of the pump, able to achieve the effect of the stability of the flow rate of fertilizer injection. Yan Navy[42] and others designed a double-cylinder plunger-type fertilizer injection pump and tested the stability of the system, the gradual increase in the outlet pressure of the fertilizer injection pump will have a slight effect on the outlet flow rate, and the stroke of the plunger can be changed to regulate the flow rate can be obtained with high accuracy. Now the advantages and disadvantages of various types of fertilizer applicators list for comparison, but also a clear and intuitive indication of the applicability of various types of fertilizer applicators, as shown in Table 1.

3. Problems and Research Priorities and Development Trends

3.1. Existing problems

At present, with the arrival of the era of informationization and intelligence, countries are developing modern intelligent agriculture. Foreign structural design and performance optimization of various types of fertilizer applicator has been very mature, and the rate of popularization and application is also relatively high, while the domestic research on the fertilizer applicator there is still a certain gap between many enterprises and teams of fertilizer applicator core technology needs to be further researched and explored, so as to provide water-fertilizer integration technology with high-precision, high-efficiency, high-intelligence fertilizer applicator.

(1) Structure to be optimized China's various types of fertilizer applicator for a large number of experimental investigation, structural innovation and simulation analysis, but in the actual work process is still with the foreign fertilizer applicator in the performance of a certain gap between the key structural dimensions of the design of the difference will lead to the proportion of suction fertilizer and the fertilizer concentration of the error on the large, such as the Venturi fertilizer applicator fertilizer suction performance is unstable, there is a loss of pressure and the phenomenon of cavitation in the tube, the pressure difference between the fertilizer concentration of the fertilizer tank with the increase of the working time and the gradual reduction of the fertilizer concentration, which seriously affects the quality of fertilizer application work.

(2) Intelligence to be improved At present, with the rapid development of the information age, the Internet of Things and intelligent devices and a series of supporting products such as a large number of popularization and application, the fertilizer applicator should be how to better use with the combination of such products is also a number of scholars need to consider the issue.

(3) Geographical conditions and adaptation The application of water-fertilizer integration equipment is to a certain extent limited by geographical conditions and environmental factors, and factors such as the nature of the soil, climatic conditions and types of crops in different regions may all have an impact on the effectiveness and feasibility of water-fertilizer integration equipment. Therefore, it is necessary to carry out adequate research and evaluation to ensure that the input cost of the equipment matches the economic benefits.

Table 1. Advantages, disadvantages and applications of various types of fertilizer applicators

Fertilizer applicator type	Vantage	Drawbacks	Applications
Venturi Fertilizer Applicator	Low cost, easy to use, no need for additional power.	Higher pressure loss makes it difficult to apply fertilizer accurately.	It is generally suitable for irrigating small areas, such as in greenhouses and trellises.
Differential Pressure Fertilizer Tanks	Simple structure, low cost, easy maintenance, no need for additional power.	Limited volume, need to add fertilizer several times, the concentration of fertilizer is not easy to control, the degree of automation is low.	Because of the limited volume is generally suitable for small areas of low-pressure irrigation. Large size fertilizer tanks can be applied to large field irrigation.
Hydrodynamic Proportional Fertilizer Applicator	Unaffected by system pressure and flow rate, high accuracy of fertilizer distribution.	Requires regular replacement of wearing parts, high water quality requirements, strict filtration and removal of impurities.	It is generally suitable for fertilization, storage, and pest control of flowers, fruits and vegetables.
Valve-adjusted proportional fertilizer applicator	Inexpensive, easy to use, constant fertilizer concentration, no need for additional power.	Low fertilizer application rate for a single job, small adjustment range of fertilizer application rate.	Generally suitable for small garden irrigation.
Intelligent Fertilizer Applicator	Powerful function, can meet the requirements of different fertilizer concentration, high fertilizer precision.	High cost of construction, complexity of operation, and high maintenance costs.	Because of the high cost of input is generally applicable to the field crop fertilization, cash crop fertilization and other areas.
Plunger type fertilizer injection pump	High working efficiency, low head loss, stable flow rate and easy adjustment.	Maintenance is troublesome and automation is low.	Can be used for field crops, facility crops, fruit trees, vegetables and other micro-irrigation, sprinkler irrigation system for water and fertilizer integration operations.
Gravitational self-pressure fertilizer application	The structure is simple and easy to operate, low cost, without external pressurization equipment.	Fertilizer concentration is not easy to control, fertilization efficiency is low, and the degree of intelligence is low.	Mainly used in some mountainous areas with self-pressurization conditions.

(4) Low level of facility management and inadequate training Agricultural extension workers and growers lack knowledge of the system. The separation of fertilization and irrigation technologies has led to the fact that some users only know how to fertilize or only know how to irrigate, and most of the irrigation and fertilization systems are still operated based on past experience after they are built, so that when problems occur in the equipment, they cannot be diagnosed and repaired quickly, thus affecting the normal production of the farmland.

3.2. Research focus

Precise quantitative fertilization is the core of water-fertilizer integration technology, but also the direction of agricultural development in the current era. With the development of modern agriculture, China's requirements for fertilization equipment have also increased. How to achieve quantitative fertilization, precise control of the proportion of water and fertilizer, improve the performance of the fertilizer applicator and other aspects of the research all affect the quality of agricultural irrigation and fertilization work and income.

(1) Work performance Through the combination of experimental platform and simulation analysis for the study of the internal working state of the fertilizer applicator, further clarification of the fertilizer applicator in the working state of the water and fertilizer flow law over time, numerical simulation calculations of the fertilizer absorbing capacity of the fertilizer applicator, to identify the reasons for the emergence of various types of problems, such as the backsorption of the venturi fertilizer applicator, cavitation, and proportional fertilizer applicator dimensions of the design

of the fertilizer applicator with fertilizer absorbing performance of the relationship between the applicator and the structural parameters of the fertilizer applicator for the improvement of the optimization of the optimal working performance.

(2) Supporting products Fertilizer applicator is mainly used in water-fertilizer integration system, and with the matching of some products, such as moisture sensors, humidity sensors, EC/ph value sensors, and other electronic components of the measurement accuracy and the degree of intelligence also affects the fertilization system to make judgmental decisions, so it is necessary to accurately measure the value of the electronic components to control the error within the acceptable range, and to improve the degree of intelligence of the electronic components in order to achieve a balanced application of fertilizers, accurate rationing.

(3) Facility systems Optimize the system algorithm, shorten the lag of information transmission, so that the system is subject to environmental changes and the response time and decision-making time is shorter and faster, and can replenish water and fertilizer in time. Enhance the stability of system operation to ensure the accuracy of real-time information. Improve the functionality of the system, the establishment of the remote operating terminal and early warning alarm module, you can watch the real-time numerical information, through the intelligent equipment at any time and any place to replenish water and fertilizer operations. Ensure that information technology can be fully integrated with agricultural cultivation to realize intelligent agriculture.

(4) Comprehensive Utilization of Resources and Circular Agriculture Since different regions of China have different terrain and different environments, it is necessary to optimize

irrigation and fertilization methods and develop irrigation and fertilization strategies according to local conditions. Research on different crops, different climates, different growth stages of crop water and nutrient demand characteristics, to provide irrigation and fertilization recommendations, try to achieve the amount of water and fertilizer application and crop demand matching, while the agricultural waste and biomass energy reuse. Through various types of sensors real-time monitoring of crop growth status and environmental factors, changes in soil conditions, combined with intelligent system algorithms, to make timely adjustments to the irrigation and fertilization strategy to achieve sustainable agricultural production.

3.3. Development trends

China's fertilizer equipment after decades of research and development process, in the theoretical knowledge and technical level have made a certain degree of progress, but with today's world's agricultural powerhouse compared to the development of fertilizer applicators in the equipment performance, intelligence, control, precision and other aspects of the gap still exists. In recent years, China has been advocating a "resource-saving and agriculture-friendly" agricultural society, so the research and development of fertilizer applicators and their application to multi-plant cultivation is of extraordinary significance.

(1) With the development of intelligent agriculture, the fertilizer applicator should be combined with the integrated application of computer and network technology, Internet of Things technology, audio and video technology, 3S technology, wireless communication technology and expert wisdom and knowledge to establish a variety of water and fertilizer models and increase the development of information technology in crop cultivation. Build a well-functioning system platform, edit the corresponding water and fertilizer models for users to choose according to the different characteristics of different crops, optimize the system algorithms, provide farmers with decision-making support and precise farmland management suggestions, and improve the impact of water and fertilizer integration technology on the economic, social, environmental and other benefits.

(2) water-fertilizer integration technology is a full combination of micro-irrigation technology and fertilization technology, a new technology, China's fertilizer use rate is far lower than that of other developed agricultural countries, and fertilizer applicators supporting the use of water-soluble fertilizers and liquid fertilizers fertilizer utilization rate is much higher than the traditional fertilizer utilization rate, so for the development of water-soluble and liquid fertilizers need to continue to explore, and at the same time pay attention to the environmentally friendly and sustainable use of resources, to reduce the pollution of fertilizers on the environment to form the integration of water-fertilizer-pharmaceutical technology.

(3) The use of simulation software to simulate and analyze the water and fertilizer facilities, China's fertilizer applicator compared with foreign countries there are still some gaps. Therefore, simulation software can be used to simulate and analyze the fertilization work and test and compare, so as to optimize the structure of the fertilizer applicator and improve the performance. Simulation analysis can also be carried out on the irrigation system to explore the source of pressure loss in the irrigation process, and then improve the irrigation pipeline to reduce energy consumption, to form a set of

perfect function, excellent performance of water-fertilizer integration system.

4. Conclusion

China as the world's first agricultural country, vigorously develop water and fertilizer facilities undoubtedly has an unusual significance. Many scholars have also made a lot of research and efforts on the structural design, performance improvement, system optimization and other aspects of the fertilizer applicator, but overall China's fertilizer applicator is still in its infancy, the technical mastery is not mature, there are a number of shortcomings and difficult problems. With further exploration and research in this field, water-fertilizer integration equipment will certainly achieve more accurate fertilization and irrigation, while combining sustainable agriculture and environmental friendliness, to promote the comprehensive utilization of resources and the development of circular agriculture. Therefore, strengthening the research and application of water-fertilizer integration equipment is conducive to promoting the further development of agriculture, and completing the transformation of China from a major agricultural country to an agricultural powerhouse.

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