Summary of Research and Application of Precision Seed-Metering Device

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ABSTRACT : *With the development of modern agriculture, agricultural planting to a high degree of mechanization direction, precision seeding technology to replace the traditional seeding technology, with the application of precision seeding technology, planting costs fell dramatically, production efficiency increased significantly, greatly improving the efficiency of agricultural production. The article from the precision seeding device and seed guide technology, combined with the current development trend of precision seeding device, working principle, advantage analysis and application of research, for the precision seeding device research and application to provide reference basis.*

KEYWORDS - *precision seeding technology， seeding device， seed guiding, mechanical precision seeddis charger, pneumatic precision seed discharger*

I. INTRODUCTION

Seeding is an extremely important part of the agricultural production process, and seeding technology is the key technology to realize mechanized seeding, which will directly affect the quality of machine seeding and crop yield [1]. Studies have shown that uniform spacing in line with agronomic requirements can effectively improve crop yield. To achieve this purpose it is necessary to carry out precision seeding through precision seeders. Precision seeding refers to the seed according to the agronomic requirements of row spacing, grain spacing and sowing depth sown into the seed furrow, the grain spacing of the qualified rate and consistency is an important indicator of seeding performance. Therefore, the seed dispenser is the core of the seeder [2], and its purpose is to transform the seed population into a uniform seed stream or continuous single seed. Scholars at home and abroad have carried out a lot of research on precision seeders, making them widely used in the planting of soybeans, corn, wheat, oilseed rape and other crops and vegetables, which greatly improves the yield of crops and vegetables and reduces the cost of agricultural production. According to the working principle, precision seed discharger can be divided into mechanical and pneumatic type, mechanical precision seed discharger mainly includes disc type, nesting eye wheel type, outer groove wheel type, finger clip type. Mechanical seed discharger structure is simple, cheap, but at the same time there is a single function, versatility is not strong, filling rate is not high, easy to cause mechanical damage to the seed and other shortcomings. Pneumatic precision seed discharger can be divided into air suction type, air blowing type and air pressure type according to the working principle [3], the pneumatic seed discharger can output stable airflow, form positive or negative pressure and seed discharging disk to cooperate with each other, to realize the taking, clearing and discharging of seeds.

II. MAIN CATEGORIES OF PRECISION SEED DISCHARGERS AND RESEARCH PROGRESS

2.1 MECHANICAL PRECISION SEED DISCHARGER

There are many mature models of foreign mechanical precision seeders. West Germany's BeeherCG-6 type nest eye wheel seeder: the United States of America's Jolm-Deere7000 finger clip

seeder: the United Kingdom's S-87 belt seeder and so on. The U.S. John Deere 7000 precision planter belongs to the mechanical precision seeder, characterized by the ability to be suitable for high-speed operations, which uses a finger-clamped seeder that can be used to precision seed corn at a speed of 11.3km/h, but its seeding performance is poor and the rate of breakage is high, and it can't be precision seeding of small-grain crops such as oilseed rape [4].M.R. Maleki et al. developed and developed the composite spiral seed pusher device for the seeders to solve the problem of the effect of the nesting wheel on the uniformity of seed discharge due to pulsation of the seed flow [5].MALEK MR developed a composite spiral seed pusher seed unloading device, which is mounted on the nesting seed discharger, with the aim of solving the problem of the effect of the flow of seed in the seed discharger on the uniformity of the seed discharge of the seed discharging wheel .Maschio designed a dual side seed cleaning device, with the aim of improving the purpose of this device is to improve the single seed filling rate of air-absorbent seed dischargers and to enhance the seed clearing of the seed dischargers. [SINGHRC et al. studied the performance of pneumatic seed dischargers under indoor and field conditions in order to optimize the design and operating parameters of cotton planters. JACK DS et al. determined the optimum operating parameters of the designed pneumatic suction seed discharger by carrying out a series of experiments, which laid the foundation for the subsequent studies. ZARE Z et al. studied the performance of pneumatic seed dischargers under different operating conditions with respect to the Corn seed dropping position, through the high-speed camera equipment for the test of the conditions corresponding to the maximum coefficient of variation between the seeds, and the obtained test data were fitted to obtain the required generalized trajectory equation, which provides a reference for the subsequent field trials [8].

TheIn the early 1950s of the last century, China began to carry out research on seeding machinery, at this stage, China's seeders are mainly borrowed and imitated from other countries, and popularized and used in the northeast of China, laying the foundation for the later independent research and development of seeders in China [9]. So far, our scholars have almost conducted relevant research on different forms of seed dispensers in the world, and have made great development progress in recent years. Ding Li [10] and others developed a combination of holes in the filling type of oil salsa bean seed displacer, which is mainly designed to solve the problems of poor seed mobility in the seed displacer due to the irregular shape of the oil salsa bean seeds and the uneven surface, poor filling performance of the seed displacer due to the compaction of the seed population, and axial dispersion of the seeds in the holes during sowing. In order to solve the problems of increased seed breakage rate, decreased reliability and wear of some more important parts when mechanical seed dischargers are operated under high-speed conditions, Dong Literature developed a magnetic fingertip-type precision seed discharger, which can realize precision sowing and satisfy the seed discharge requirements of the seed discharger [11].

Hengbang Zhang[12] used EDEM software for simulation and Design-Expert software for analysis to innovatively design a nest-eye type wheat precision seed discharger on the basis of the original seed discharger. At the same time, orthogonal rotary combination test was used to establish a mathematical model to finally determine the optimal combination of relevant parameters such as the number of nesting eyes, end face spacing, and the speed of the seed discharge wheel, to further reduce the rate of replanting leakage, and to successfully improve the phenomenon of uneven seed discharge and replanting. Cailing Liu[13] used EDEM simulation software to determine a series of key parameters, such as the inclination angle of the fossa, the number of fossa, the distribution form, the horizontal distance of the seed layer adjustment plate, etc., and used mathematical statistical methods to analyze the results of the experimental variance to determine the impact of each parameter on the single grain rate. After obtaining the relevant parameters, the designed hook type fossa eye wheel type wide seedling belt wheat precision seed discharger, the sowing effect is obviously improved, and the seed distribution is uniform. Xinxiao Shen[14] designed a 14-tooth external grooved wheel by optimizing the structure of the

external grooved wheel, which can significantly reduce energy consumption and improve production efficiency. Selection of nylon materials to manufacture the outer grooved wheel and blocking wheel, optimize the force problems in the seed discharge process, to achieve the work, the outer grooved wheel length adjustment, seeding volume adjustment more stable, improve reliability.

2.2 PNEUMATIC PRECISION SEED DISCHARGER

Pneumatic seed discharger has the advantages of small seed injury rate and strong adaptability compared with mechanical seed discharger, which is the focus of current research on precision seeding. According to the working principle of pneumatic seed discharger can be divided into air suction type, air pressure type and air blowing type.Pneumatic suction type high-speed precision seed discharger through the negative pressure air chamber on both sides of the seed discharging disk hole to form a difference in air pressure, the use of air pressure difference will be adsorbed in the seed hole, through the seed clearing device to clear off the excess adsorption of seeds to ensure the single-seeded nature of the final through the air-blocking device to eliminate the difference in air pressure, the seed by its own gravity to fall. Air-absorbent seed discharger has strong adaptability to the shape and size of seeds, good versatility and high operating speed. In recent years, domestic and foreign GPS, electric drive seeding, intelligent control, precise seeding and other technologies and air-absorbent seeder combination, further improve the air-absorbent seeder operating speed. At present, foreign gas-absorbent seed dispenser research is dominated by enterprises, and the relevant advanced technology has already formed products.

Italy Mascio (MASCHIO) company produced OLIMPIA air suction precision planter using the CHRONO seed discharger structure is reasonable, versatile, and can meet a variety of small particle size seed crops precision operation requirements [15]. CASE IH (USA) introduced the DV series of air suction precision planter. The machine is equipped with a seed disturbing device in the seed stacking area of the seed discharger, which can effectively enhance the mobility of the seeds in the seed discharger. The seed disks are made of stainless steel, which can be flexibly and conveniently replaced according to the change of sowing crops. The machine sows seeds evenly, with stable depth and high reliability. Karayel et al. determined the material properties of different types of seeds, and constructed a prediction model of the negative pressure value of the seed displacer and the sowing pass rate by using the theory of fluid dynamics[16].P. Guarella analyzed the relationship between the shape of the type hole, the size of the type hole and the performance of the seed suction, and constructed a mathematical model[17].

Ruixue Wang [18] carried out a structural design of the key components of the wheat air-absorbent seed discharger, and the best combination was obtained through the analysis of the factors affecting the seed discharging effect and optimized by regression equations. The improved precision seed displacing device has a simple structure and improves the seed displacing performance. This study has certain reference value for the next in-depth study of air-aspirated seed displacing device, but the field adaptability and feasibility of the seed displacing device need to be examined. Jinguo Zhang [19] and others designed a round tube eyelet type wheat air suction seeder with an eyelet suction structure, this structure enables the machine to continuously and uniformly supply seeds, improves sowing accuracy, and has good adaptability to different types of seeds, but it is easy to be clogged. And the same year the design and research of the slit type wheat air suction seeder, the use of double tube slit structure, solved the problem of clogging, and at the same time in the seed box to join the mixing mechanism, improve the mobility of wheat.

Due to the high seed breakage rate and eyelet clogging problems of round tube eyelet type seed discharger at work, Xiaoshun Zhao[20] proposed a slit type wheat air suction precision seed discharger and compared multiple forms of slit type slot seam structure, which concluded that trapezoidal slot slit type seed discharger has the best effect of sucking seeds. At the same time, the design of the multi-row negative pressure type wheat seeder using computer fluid dynamics and bench test optimized the structural parameters of

the seeder, the use of the test bench to verify the results of the simulation test proved that the seeder can be achieved under the premise of saving seed, water and fertilizer to achieve a good sowing effect and sowing uniformity. Chuzhou Tang and other scholars in order to study the impact of different shapes of holes on the performance of seed discharge, wax production of conical, elliptical conical, square cone-shaped three kinds of holes, and three kinds of holes model test, according to the results of the test showed that elliptical conical holes in the discharge of seed pass rate is higher [21]. Cheng Xiu Pei [22] and other scholars for the current wheat seed is small, sowing large, irregular shape, the traditional seed discharger is difficult to achieve precision seeding and other issues, set up a gas suction type hole combination of wheat precision seed discharger, according to the agronomic requirements of the parameters of the seed discharger, to determine the impact of different suction hole diameter on the airflow, and get the better combination of parameters.

III. PROGRESS IN RESEARCH ON SEED GUIDING TECHNOLOGY FOR PRECISION SEED DISCHARGERS

At this stage, precision seeding machine to high-speed, high efficiency, high quality development, some advanced precision seeding machine at home and abroad working speed of up to 12km / h, which puts forward a higher demand for precision seed guide technology of the seed discharger. Because in the higher forward speed, the seed in the seed guide tube will occur “collision ectopic” and “bouncing ectopic”, resulting in a rapid decline in the consistency of the grain spacing, and even leakage or replanting, which seriously affects the precision of the sub-high-speed operation conditions of the seeding.

In order to solve the problem of poor seeding accuracy due to collision of seeds, Sweden Vaderstad company designed a round seed guide tube composed of straight and curved segments, the use of positive pressure airflow to wrap the seeds, to achieve fast and accurate seeding. Speed Tube conveyor belt type seed guide device produced by Precision Planting Company in the United States, a pair of plucking fingers will be seed discharged from the seed discharger thrown to the partition of the conveyor belt, the seed with the conveyor belt movement to the seed casting mouth and casting to the seed furrow, the conveyor belt and the forward speed of the planter to match, which can ensure the uniformity of the spacing of grains under different operating speeds [23]. Ma Chengcheng et al. in response to the corn sowing in high-speed operating conditions, the seed into the seed guide device seed cavity of poor uniformity, low precision problems, the establishment of the nano seed, seed transport and seed casting process kinematic model, put forward in the toggle finger surface to add herringbone texture method [24], to increase the friction between the seed and toggle finger, so as to ensure the stability of the guide device nano seed process, in the use of high-speed video camera and target tracking technology to carry out a single-factor test, concluded that the use of high-speed video camera and target tracking technology for a single factor test, indicating that the seed spacing of the seed is not uniform. After the single-factor test using high-speed camera and target tracking technology, it was concluded that the seeding effect of the finger-pulling wheel with zigzag pattern was significantly better than that of the finger-pulling wheel without zigzag pattern. Han Jianfeng et al. for rice stubble field wheat mechanized sowing by the double impact of soil and straw return to the field, resulting in the seed guide Yong plug easy to break the stripes of the problem, designed a split-guide combination of two rows of wide stripes of the seed guide device [25], the establishment of the wheat seed guide and seed model, to determine the effect of the factors affecting the guide effect, through the EDEM discrete element simulation software to optimize it, through the field comparison test, compared with other seed guide devices, each of which has its own seed guide effect, and the seed guide effect is significantly better than that of the unmanned zigzag stripes. Through the field comparison test, comparing the inclined bottom plate type seed guiding device with other seed guiding devices, the coefficient of variation of the consistency of the row discharge can be reduced by 2.73% at most, and the coefficient of variation of the lateral uniformity within the row can be reduced by 10.61% at most, and the experimental results are similar to the simulation results, and the results are reliable to meet the agronomic requirements, which provide a basis for the optimal design of the seed

guiding device of wheat under the condition of rice stubble clay loam soil.

IV. CONCLUSION

With the development of agricultural mechanization technology and the improvement of mechanization level, large-scale, high-speed, precision, automation and intelligence have become the direction of the development of seeders. Scholars at home and abroad focus on improving seeding quality and efficiency as the goal, and innovate and optimize many types of precision seeders. Through the analysis of the research status of various types of precision seeders at home and abroad, combined with the development trend of mechanized seeding, the development direction of precision seeders is summarized as follows:

For crops with less stringent requirements for sowing grain spacing uniformity, it is recommended to apply mechanical precision seeders with a simple structure and strong applicability, and the main research is on how the seeding device can increase the seeding speed and improve the efficiency of seeding. At the same time, the simpler structure of unconstrained or gravity under constrained seed guide is used. For crops with large operating width, long seed transportation distance and limited transportation path, air-fed precision seeders should be used. For sowing precision requirements of high crops, when the seed quality and particle size is large, the seed orderly transport state is not easy to be disturbed by the destruction, can use the air suction type precision planter, at the same time to further carry out with the seed furrow opener, mulching suppression mechanism integrated design, through the optimization of the structure to reduce the seed casting height and seed casting speed.

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