ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

Design of Small Planter for Sprout Seedling Vegetable

Yi Guo[1*], Guiqin Zhang[2]

[1]Department of Horticulture Beijing Vocational College of Agriculture, Beijing, China
[2]Beijing Green Valley Sprouts Limited Liability Company, Beijing, China
**Corresponding author: guoyibvca@163.com*

Abstract: *In order to meet the demand for mechanized seeding of special vegetables such as sprout seedling vegetable, this paper designs a small sprout seedling vegetable planter based on the design experience of the existing suction seeder. the machine is mainly composed of a box, a seedling tray pushing device, a seed pushing device, a seeding device, and a control system. according to this design, the prototype of the small sprout seedling vegetable planter is made. the test results show that the machine can realize the mechanized seeding of sprout seedling vegetables, with reliable work and easy operation. at the same time, the machine also has the advantages of simple structure and easy maintenance. this machine fills the gap in the field of sprout seedling vegetable seeding, and has broad promotion value in the field of large-scale production of sprout seedling vegetables.*

Keywords: *Small Planter, Sprout Seedling Vegetable, Design, Agricultural Machinery*

1. Introduction

With the continuous development of the economy, people pay more and more attention to the quality of life and healthy diet, and they are more inclined to choose foods with high nutritional value. Many components in plant-derived vegetables not only have biological activity, but also participate in many important metabolic processes of the human body. Many studies have shown that edible seeds can significantly improve their nutritional value and function after germination [1]. Sprout seedling vegetable, refers to the use of plant seeds or other nutrient storage organs to directly grow edible shoots, shoots, sprouts, young shoots or young stems under light or dark conditions [2]. The texture of sprout seedling vegetables is crisp and tender, rich in nutrition, and unique in flavor. It has the effects of clearing away heat, detoxifying, diuresis and dehumidification, and is included in the "Shen Nong's Materia Medica" [3]. The growth of sprout seedling vegetables mainly depends on the nutrients of the seeds themselves, the growth cycle is short, and the occurrence of pests and diseases is less [4]. Since its production process basically does not involve the input of chemical fertilizers and pesticides, and is basically hydroponic, it is considered to be a new type of green, pollution-free and safe to eat [5]. Sprout seedling vegetable, as a kind of new vegetables with rich nutrition, health care and high economic value, has developed rapidly in recent years. With the improvement of people's living standards, people's demand for vegetables has risen from focusing on the number of vegetable varieties to paying more attention to the quality and edible safety indicators of vegetables [6]. From basic living needs to green and healthy needs, Sprout seedling vegetable has become the choice of more consumers [7]. Sprout seedling vegetable has very broad development prospects [8]. With the continuous increase in the demand for sprout seedling vegetables, the traditional hand-workshop production model can no longer meet people's demand for sprout seedling vegetables [9]. The mechanized and efficient production method of sprout seedling vegetables has become an inevitable trend before the development of the sprout seedling vegetable industry.

With the specialization and scale of vegetable production in my country, the application of factory plug seedling technology is becoming more and more common. Vegetable plug seeding machinery has become one of the core equipment for raising seedlings. Among them, air suction planter is the main form of vegetable plug planter [10]. The air-suction planter is a kind of air-suction principle that uses airflow to adsorb and separate the seeds from the seed pile to achieve the purpose of single-grain or double-grain precision seeding. Compared with the mechanical seeder, the air suction precision seeder has the advantages of saving seeds, not damaging the seeds, adapting to the shape of the seeds, easy to realize single seed precision seeding, and high operating speed. It is the focus of the development of precision planters at home and abroad [11]. Yang Wencai et al. addressed the problems of high seed damage rate of the mechanical panax notoginseng seedling seeding and metering device, and the need

ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

to pre-classify the seeds. Based on the working principles of negative pressure suction, brush rolling and positive pressure seeding, an air suction drum seed metering device is designed [12]. In order to realize the precision seeding technology of wheat, Zhao Jin et al. designed a circular tube cone-surface slot type wheat suction planter. The key design is the circular tube cone surface slot type wheat suction seed metering device [13]. Wang Chenjian, etc. aimed at leafy vegetables seeds with small particle size and irregular shapes, and traditional planters have problems such as low precision and low seeding success rate. Based on the air-suction needle type seeding method, an air-suction needle type swing leaf vegetable precision seeder was designed [14]. Chen Xinyu et al. designed an air suction carrot planter to solve the problems of small size, light weight, irregular shape and impurities in the seeds of carrot seeds [15]. Yang Changmin and others designed a pneumatic drum planter based on the physical characteristics of vegetables and other small-particle seeds, using the principle of vacuum adsorption. Complete the suction and planting of seeds, and realize the precise sowing of vegetable seeds [16]. Zhao Ping et al. designed a whole-pan, air-suction plug seedling and seeding device for small-scale greenhouse planting farmers [17]. Aiming at the problems of low seeding efficiency during the operation of seedling planter equipment, and insufficient seeding and seeding process, Xu Mingtao designed an air-suction plug seedling precision planter and tested it [18].

According to market research, there is currently no report on seeding machinery specifically used for sprout seedling vegetables. Based on the design experience of the above-mentioned air-suction planter, this paper designs a small sprout seedling vegetable planter for the mechanized planting requirements of special vegetables such as sprout seedling vegetables, which fills the gap in this field. The machine can realize the mechanized seeding of sprout seedling vegetables, and is simple in structure, reliable in work, easy to operate, and easy to maintain. It has broad promotion value in the field of large-scale production of sprout seedling vegetables.

2. Main Structure

The machine is mainly composed of a box, a seedling tray pushing device, a seed pushing device, a seeding device, and a control system (Figure 1). The box is used to install various working devices. The nursery push device is used to push the nursery to the planting station. There are two sets of them, working alternately. The seed pushing device is used to push seeds to the seed taking station of the sowing device. The seeding device is used to take the seed from the seed box and transport it to the seeding station to complete the seeding. The control system is used to control the automatic operation of the seedling tray pushing device, the seed pushing device, the seeding device, etc.

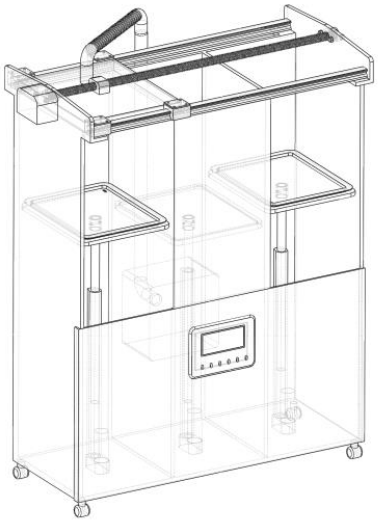

Fig. 1 Small sprout seedling vegetable planter

3. Design of Parts

3.1 The Design of the Cabinet

The box body is a hollow structure made of stainless steel plates (Figure 2). There are partitions

ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

inside to divide the box into three parts: the left and right sides are used to install seedling tray pushing devices. The upper part of the middle part is a seed box, which is composed of a box back panel, a front panel, and left and right partitions. Used to store sprout seedling vegetable seeds to be sown. The lower part of the middle part is used to install the seed pushing device, the vacuum pump of the seeding device and the control system. The lower half of the front part of the box body has a box door for closing the lower part of the box. The upper part of the box body is an opening, and there is a seeding device installation position above it. There are wheels at the four corners of the bottom of the box, which can be used to move the planter.

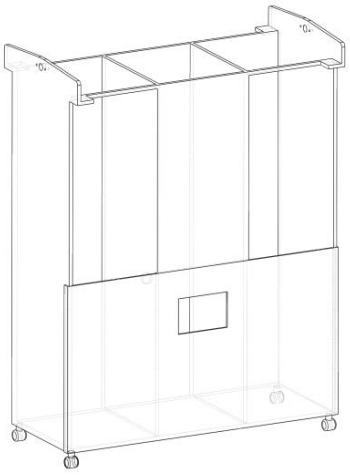

Fig. 2 Cabinet

3.2 Design of the Pushing Device of the Seedling Tray

There are two sets of seedling tray pushing devices, which are respectively installed on the left and right sides of the inside of the box. The seedling tray pushing device is composed of an electric push rod and a seedling tray tray (Figure 3). An electric push rod is an electric drive device that converts the rotary motion of a motor into a linear reciprocating motion of the push rod. It has the characteristics of small size, high precision, complete synchronization, and good self-locking performance. The electric push rod selected in this design is composed of a drive motor, a reduction gear, a screw, a nut, a guide sleeve, a push rod, a sliding seat, a spring, a casing and a turbine, and a micro-control switch. After the drive motor is decelerated by the gear, it drives a pair of screw nuts to turn the motor's rotary motion into a linear motion, and the forward and reverse rotation of the motor is used to complete the pushing action of the seedling tray. The bottom of the electric push rod is fixed on the bottom plate of the box by bolts. The seedling tray tray is a flat steel plate, the lower part is equipped with a mounting sleeve for the electric push rod, and the upper part is used to place the seedling tray. When working, the seedling tray is stacked on top of the seedling tray, and the raising of the seedling tray is realized by the ascending of the electric push rod, so as to realize the pushing of the seedling tray. When the last seedling tray is sowed, the electric push rod is contracted through the control system, and the seedling tray is stacked on the tray again.

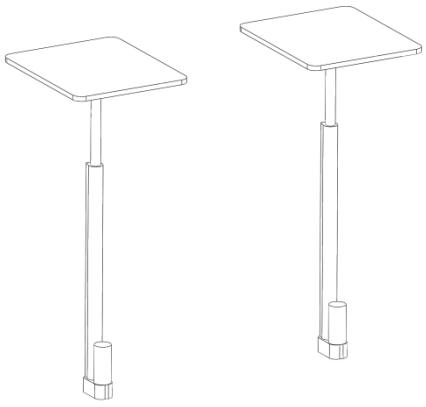

Fig. 3 Pushing Device of the Seedling Tray

ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

3.3 Design of Seed Push Device

The seed pushing device is installed in the middle of the inside of the box. The seed pushing device is composed of an electric push rod and a seed tray (Figure 4). The electric push rod is the same as the seedling tray pushing device. The seed tray is made of rectangular flat steel plate, the lower part is equipped with an electric push rod mounting sleeve, and the upper part is surrounded by a sealing ring. The sealing ring is made of rubber material to prevent the seeds in the seed box from falling. The back panel of the box body, the left and right partitions, the front panel and the seed tray form a seed box. Through the rise of the electric push rod, the raising of the seed tray is realized, so as to realize the pushing of the seeds.

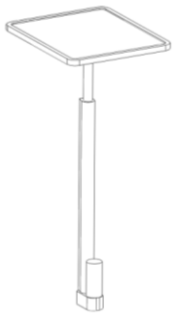

Fig. 4 Seed Push Device

3.4 Design of Seeding Device

The seeding device is composed of a seeding plate, a vacuum pump, a guide rail, a slider, an electric screw and so on (Figure 5). The seeding tray is composed of a shell, a seeding board, a sealing gasket and so on. The shell has a rectangular opening structure, and the upper part has a vacuum tube installation hole for installing the vacuum tube, and the inside is used for installing a seeding board. The seeding board is a flat steel plate, which is connected to the shell by bolts. The through holes are densely arranged, and there are three specifications for the through holes. The appropriate size can be selected according to the seed diameter and sowing density. The gasket is used to seal the gap between the shell and the seeding board. The seeding disc is installed on the top of the box through the guide rail and the sliding block, and the guide rail and the slideway are used to cooperate to realize the support and smooth movement of the seeding disc. The vacuum pump is installed inside the box, and the vacuum tube passes through the back wall of the box and is connected to the seeding tray. It is used to generate a vacuum in the seeding tray to suck the seeds in the seed box. When reaching the planting station, the vacuum pump is turned off. The vacuum in the seeding tray is lost, and the sucked seeds fall into the seedling tray. The electric screw is a transmission device that directly converts electrical energy into linear motion mechanical energy without any intermediate conversion mechanism. It has the advantages of simple structure, convenient realization of long stroke, high acceleration, fast response and high precision. In this design, there is an electric screw mounting hole on the upper part of the seeding tray shell, and there are threads inside. Under the action of the electric screw rod, the left and right of the seeding disc can be realized to reach the seed picker and the seeding station respectively.

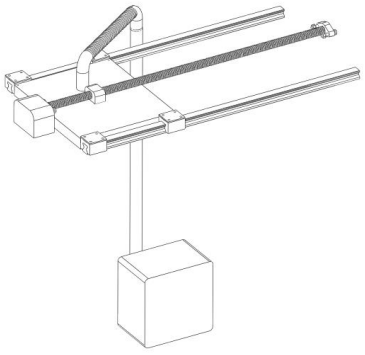

Fig. 5 Seeding Device

ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

When working, the seeding disc is driven by the electric screw rod to move left and right along the guide rail. When it reaches the top of the seed box, it stops, and the vacuum pump generates a vacuum in the seeding tray to adsorb the seeds in the seed box on the seeding tray. Then, driven by the electric screw rod, it reaches the planting station on the left. The vacuum pump stops working, and the seeds in the seeding tray fall into the lower seedling tray to complete the sowing of a seedling tray. Then. The electric screw drives the seeding plate back to the top of the seed box. The vacuum pump generates a vacuum in the seeding tray and adsorbs the seeds in the seed box on the seeding tray. Then, driven by the electric screw, it reaches the planting station on the right side, and the vacuum pump stops working. The seeds in the seeding tray fall into the lower seedling tray to complete the sowing of a seedling tray.

3.5 Design of Control System

The control system is used to control the automatic operation of the seedling tray pushing device, the seed pushing device, the seeding device, etc. and the switch of the machine. Mainly by the main control chip, position sensor, button switch and so on. It's working principle is that the main control chip controls the rotation of the electric screw of the seeding device, and drives the seeding disc to move along the guide rail. Through the position sensor, after sensing the seeding device to the top of the seed box, the electric screw stops and the vacuum pump starts. A vacuum is generated in the seeding tray, and the seeds in the seed box are adsorbed on the seeding tray. Then, the main control chip controls the rotation of the electric screw to drive the seeding disc to the left seeding station. After the position sensor senses that the seeding device reaches the seeding station, the main control chip controls the left seedling tray pushing device to push the seedling tray, the vacuum pump stops working, the seeds in the seeding tray fall into the lower seedling tray, and the seeding of a seedling tray is completed. Afterwards, the main control chip controls the rotation of the electric screw of the seeding device, and drives the seeding disc to move along the guide rail. Through the position sensor, after sensing the seeding device to the top of the seed box, the electric screw stops and the vacuum pump starts. A vacuum is generated in the seeding tray, and the seeds in the seed box are adsorbed on the seeding tray. Then, the main control chip controls the rotation of the electric screw to drive the seeding disc to the right seeding station. After the position sensor senses that the seeding device reaches the seeding station, the main control chip controls the left seedling tray pushing device to push the seedling tray, the vacuum pump stops working, the seeds in the seeding tray fall into the lower seedling tray, and the seeding of a seedling tray is completed.

4. Conclusion

Aiming at the demand for mechanized seeding of special vegetables such as sprout seedling vegetables, this paper designs a small sprout seedling vegetable planter based on the design experience of the existing suction seeder. The machine is mainly composed of a box, a seedling tray pushing device, a seed pushing device, a seeding device, and a control system. According to this design, the prototype of the small sprout seedling vegetable planter is made. The test results show that the machine can realize the mechanized seeding of sprout seedling vegetables, with reliable work and easy operation. At the same time, the machine also has the advantages of simple structure and easy maintenance. This machine fills the gap in the field of sprout seedling vegetable seeding, and has broad promotion value in the field of large-scale production of sprout seedling vegetables.

Acknowledgements

This work was supported by National Key Research and Development Program of China (2017YFE0118500)

References

[1] Li Lizhen, Liu Haijie, Nirasawa Satoru. Regulation of Sprouting and Changes in Active Substances in Sprouting Edible Seeds [J]. Journal of Chinese Institute of Food Science and Technology, 2018, 18(12): 326-334.

[2] Guo Sanhong, Li Yumin, Wu Zhongbo, Luo Yan.Anniversary Production Technology of Buckwheat Sprouts in Factory [J]. Vegetables, 2020(07): 36-38.

[3] Yu Bixia, Li Ping, Jiang Xiaobin. Effects of different light quality on nutritional quality of two kinds

ISSN 2706-6827 Vol. 3, Issue 6: 93-98, DOI: 10.25236/IJFS.2021.030618

of sprouts [J]. China Cucurbits and Vegetables, 2020, 33(10): 55-58.
[4] Zhang Jing, Xue Xiang, Lu Yan, Sun Changhui, Zhang Liwen. Effects of Different Substrates on Growth and Nutritional Quality of Radish Sprouts [J]. Modern Agricultural Science and Technology, 2020(19): 66-68+75.
[5] Lan Chengyun, Wang Junfeng, Sun Yang. Research Progress of Bud Seedling Vegetables in China [J]. Journal of Anhui Agricultural Sciences, 2018, 46(33): 5-7.
[6] Su Niangui, Han Wenqing, Shen Hufei. Study on Green Production of Small Black Bean Sprout [J]. Journal of Anhui Agricultural Sciences, 2019, 47(21): 48-50+76.
[7] Liu Jiajia, Jiang Nana, Xiao Meili. Cultivation Method for Seedling Sprouts of Brassica napus [J]. Journal of Changjiang Vegetables, 2020(10): 34-36.
[8] Ban Tiantian, Li Xiaohui, Ma Chao. Effect of Light Quality on the Growth and Quality of Pisum sativum Linn. Sprouts [J]. Northern Horticulture, 2019(13): 77-82.
[9] Wang Tongjun. Research and Application of Construction Technology of Cultivation Facilities for Seedling Vegetables [J]. Journal of Changjiang Vegetables, 2020(10): 16-19.
[10] Zhu Pan'an, Li Jianping, Lou Jianzhong, Han Zhiying. Design and Test of Portable Automatic Vegetable Seeding Machine [J]. Transactions of the Chinese Society for Agricultural Machinery, 2016, 47(08): 7-13.
[11] Yang Qiongfang. Design of Quality Monitoring System for Pneumatic Seeding Machine Based on Zig Bee Wireless Sensor Network [J]. Journal of Agricultural Mechanization Research, 2016, 38(11): 86-90.
[12] Yang Wencai, Kan Chenglong, Zhang Xiaowei, Wu Chong, Du Qian, Pan Wujian. Design and Test of Precision Seed Metering Device for Panax notoginseng Seedling and Seeding by Air Suction [J]. Transactions of the Chinese Society for Agricultural Machinery,2021, 52(06):95-105.
[13] Zhao Jin, Zhang Jinguo, Nian Yongkang, Zheng Chao. Design and Test of Wheat Seeder with Suction and Metering Device with Cone Surface of Circular Tube [J]. Transactions of the Chinese Society for Agricultural Machinery, 2020, 51(S1): 34-42.
[14] Wang Chenjian, Zhao Qian, Guo Wenzhong, Jia Dongdong, Wang Kunqi, Jia Haiyao. Design and Test of Precision Seeding Machine of Air Suction Needle Sowing for Leaf-vegetables [J]. Journal of Agricultural Mechanization Research, 2021, 43(07): 64-72.
[15] Chen Xinyu, Shi Yuliang, Chen Mingdong, Wang Jiasheng. Design and Experiment of Air Suction Carrot Planter [J]. Agricultural Engineering, 2021, 11(04): 106-109.
[16] Yang Changmin, Zhuang Wenhua, Xu Yi, Tang Bo, Wei Dingcai, Peng Xiaoqin. Study on vegetable tray precision seeder [J]. Journal of Chinese Agricultural Mechanization, 2020, 41(02): 13-18.
[17] Zhao ping, Jiang Mao, Liu yang, Huang Bing. Development and Performance Experiment of Air-suction Tray Seedling Growth and Seeding Device [J]. Journal of Jilin Agricultural University, 2016, 38(03): 374-378.
[18] Xu Mingtao, Chen Kun. Design and Test of the Breath Type Hole Plate Seeding Planter [J]. Journal of Agricultural Mechanization Research, 2022, 44(01): 161-164+182.