which can be used in various directions, for example, to protect plants from diseases and stimulate their growth.

Based on the data obtained during the execution of the work, we can draw the following conclusions:

1. Well-decomposed wood, fruiting bodies of mushrooms, as well as the soil are inhabited by mushrooms of the genus *Trichoderma*. The fruiting bodies of the present tinder fungus are the richest source of a variety of fungi of the genus *Trichoderma*.

2. The created collection of *Trichoderma* isolates has a significant diversity in the morphological characteristics of the mycelium. The distribution by morphological groups is heterogeneous.

3. The collection contains both slow and fast-growing isolates. At the same time, the growth rate of mycelium in isolates differs depending on the period from the beginning of growth. Isolate 35 has the highest growth rate, which is not inferior in this indicator to industrial strains from commercial preparations.

4. Isolates in the collection exhibit a different capacity for cellulose utilization. The best growth rate on the medium with cellulose was shown by isolate 22, which is not inferior to isolates from commercial preparations.

5. Wood, fruiting bodies of fungi, as well as soil are inhabited by fungi of the genus *Trichoderma.*

6. Some isolates from our collection are capable of synthesizing siderophores.

7. Many isolates are capable of inhibiting the growth of soil pathogens. Perhaps this is due to the fact that fungi of the genus Trichoderma are soil fungi. The pleasant result was that Trichoderma suppressed phytophthora well.

8. The growth of isolates at a temperature of 37 degrees Celsius shows the impossibility of using such isolates for the needs of crop production.

The main practical conclusion is the creation of a prototype of a commercially viable biological product that can be widely introduced into the practice of organic and conventional farming through its commercialization.

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AN AUTOMATIC CATCHMENT AND ROOT IRRIGATION DEVICE FOR DESERT TREES

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Summary. *Now, there are 36 million km^2 of deserts on the planet, a quarter of the land area, and expanding by 60,000 km^2 per year. To combat climate change and achieve the carbon peaking and carbon neutrality goals, China is engaged in afforestation. However, water scarcity, strong winds and shortcomings of current irrigation methods make afforestation a major challenge. Based on the problems, we design an automatic catchment and root irrigation device for desert trees.*

At present, the earth's deserts cover about 36 million square kilometres, or a quarter of the earth's land area, and are expanding at a rate of 60,000 square kilometres per year. To combat climate change and achieve the "double carbon" target, China is actively reforesting its deserts. However, the scarcity of water resources in desert areas, the strong winds and the inadequacy of current irrigation methods pose great difficulties for afforestation. Based on these problems, this paper proposes the design of an automatic water harvesting and root irrigation device for desert trees.

Water resources are scarce in desert areas, with annual rainfall of less than 50 mm, while at the same time evapotranspiration is extremely high and the air is rich in water. The wind is strong in desert areas, averaging up to seven winds a day, and there is a wealth of wind resources and a range of other conditions that offer the possibility of desert water harvesting. At present, the common methods of desert tree maintenance include manual sprinkler irrigation, diffuse irrigation, furrow irrigation and drip irrigation, but each of these methods has its own limitations. Drip irrigation, for example, requires the design of lines and the laying of pipes, which is costly in terms of upfront investment, maintenance and stability; ditch irrigation, which is commonly used in remote desert areas, requires upfront construction and a large investment in manpower, while the utilisation of water resources is extremely low; artificial diffuse irrigation and sprinkler irrigation, which are commonly used on desert roads or windbreaks, have a low utilisation of water resources, high transport and manpower costs, and inevitably generate Additional carbon emissions are inevitable in the process.

To overcome the shortcomings of current irrigation methods, Chinese agriculturalists have proposed root irrigation technology. Root irrigation watering is non-destructive irrigation, which has a significant increase in soil water content at a depth of 20–80 cm compared to traditional drip irrigation methods, and is able to convert all the irrigation water into effective soil moisture. The literature also shows that root irrigation can improve water, fertiliser, air and heat conditions in the root zone, allowing the root system to develop and promoting microbial activity and biological cycles in the inter-root soil. However, root irrigation is still not free from the dependence on additional resources (electricity, groundwater, etc.).

"Energy efficient green synthesized MOF – 801 for adsorption cooling applications" describes the special body structure evolved by desert nanobucco beetles and cacti in desert regions to obtain water (fig. 1–2) and proposes a design for a heterogeneous wettable cone surface (fig. 3).

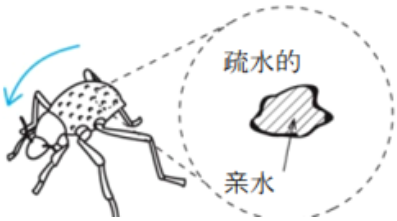

Figure 1 – Surface structure of the desert nanobu beetle

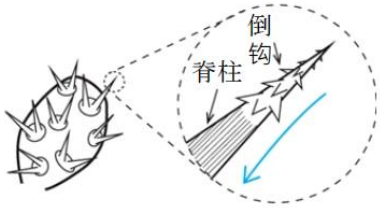

Figure 2 – Surface spine structure of the cactus

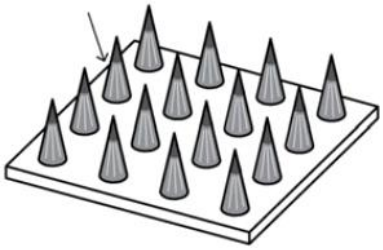

Figure 3 – Heterogeneous wettable cone surfaces

Based on the above, this paper proposes an automatic water harvesting root irrigation device for desert trees based on the bionic principle, using the rich wind resources of the desert without additional resource input (fig. 4, consisting of a wind energy conversion section, an air filtration section, a one-way conduction section and a condensation collection section.

a b

Figure 4 – An automatic water harvesting root irrigation device: a – Overall schematic; b – Effect

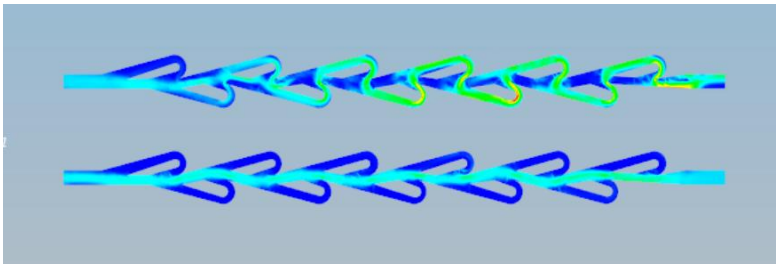

Figure 5 – Diagram of the Tesla valve

The wind energy conversion section adopts the new layout of the fan of the Darrieux wind turbine, with three blades, which are S-shaped in the projection direction, converting the wind energy in the desert into mechanical energy, which acts on the shaft to drive the rotation of the suction fan below, generating negative pressure in the cavity and allowing air to enter the interior of the device; the air filtration section is a detachable design, with a rosette filter cover in the lower part, so that a large amount of air can enter the device through the holes and the internal filter. The one-way conduction section is in the form of a Tesla valve (fig. 5), which uses the bionic principle, modelled on the structure of a blood vessel, to accelerate air flow according to aerodynamic principles and to avoid backflow of air into the device, in order to reduce losses caused by water loss. Below the Tesla valve is the condensation collection section of this device. In order to increase the efficiency of the water collection, this section has a spiral tubular structure that allows a constant flow of air to come into contact with the surface of the unit through the wind energy conversion device above, obtaining a constant flow of moisture. The interior of this section is based on the bionic principle of a heterogeneous wetting cone array surface to accelerate moisture collection.

The device proposed in this paper can be commercially cooperated with government agencies, relevant enterprises and university laboratories after further improvement, and is committed to the innovation of desert irrigation technology products combining industry, academia and research to create a complete industrial structure. Facing the demand of the desert greening cause in the society, through cooperation with the government to support the public welfare cause, in the process of continuously upgrading and polishing the product, our product will be included in the official recommended greening tool library; through cooperation with relevant enterprises to accelerate the application and promotion of the product on the ground, through the sale of the product, as one of the sources of profit; through cooperation with university laboratories industry-university-research "cooperation" to accelerate product innovation and iteration from multiple perspectives such as material, design and efficiency.

This paper describes the design of an automatic water harvesting root irrigation device for desert trees, which can provide new ideas for the development of subsequent devices.