

# Development of automatic irrigation system for effective selection of carrot cavity spot disease tolerance

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## Abstract

Cavity spot disease of carrots caused by *Pythium* species is one of the most serious diseases in Japan. It is known that too much soil moisture elevate the risk of this disease. Because Japan has much rain in the harvest season, carrot varieties which are tolerant to cavity spots are needed. To screen disease tolerant varieties easily, a cost-effective automatic irrigation system has been developed by using planters and soil moisture measuring sensors. The sensor-based auto-irrigation facilitated the selection of tolerant varieties to cavity spot. This system will contribute to evaluating not only tolerance to cavity spots but also other traits which are affected by soil moisture.

## Sensor-based Auto-irrigation System

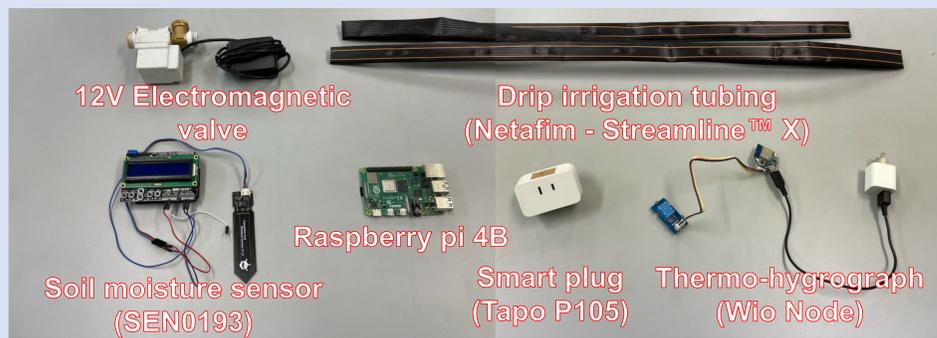


Figure 1. Main parts for the automatic irrigation system.

Rustproof capacitive sensors were used to monitor soil moisture rather than resistive sensors which rust under high moisture condition. Electromagnetic valve and submersible pump were connected to smart plugs, which were controlled by micro-computer “Raspberry pi”. You can get all the parts at home improvement stores or e-commerce websites. This system is cost-effective (about \$500) and easy to construct.

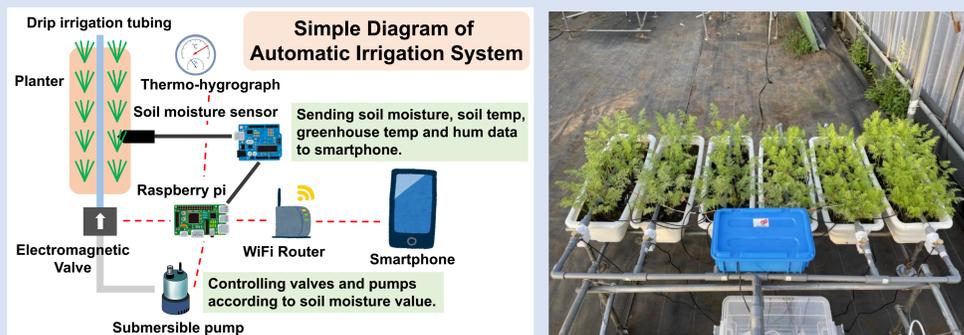


Figure 2. Simple diagram and a photo of the system.

Up to 6 planters can be managed individually by controlling valves and a pump according to soil moisture values. Just storing water in a tank is needed.

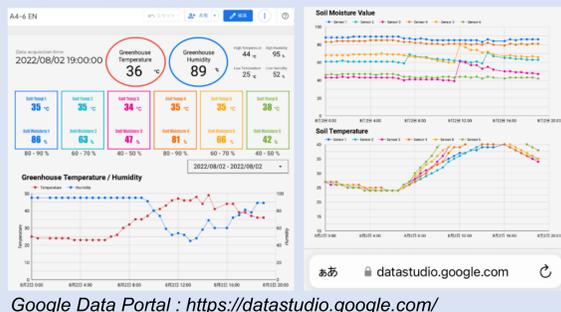


Figure 3. Visualized data. Greenhouse temperature, humidity and soil temperature data (current & historical) can be seen on smartphones by using Google Data Portal. The data is updated every 30 minutes.

## About us



Sumika Agrotech Co., Ltd belongs to Sumitomo Chemical Agro Group. We aim to provide comprehensive support for agriculture not only in Japan but also overseas. Irrigation materials, seed processing and seeds (vegetables and flowers) are our main products. Please keep in touch if you are interested in our company ! URL : <https://www.sumika-agrotech.com/english/>

## Experimental Results and Discussion

Variety	Field Test	Event	Date	Condition	Sensor Value
A	Tolerant	Sowing	11-Mar	Dry	40 - 50
B	Intermediate	Introducing irrigation system	6-May	Damp	60 - 70
C	Susceptible	Harvest	5-Jul	Wet	80 - 90

Figure 4. The conditions of the experiment.

Three carrot varieties with different sensitivity to cavity spots at field tests were used. The disease-contaminated soil was obtained from a farm with spontaneous occurrence of cavity spots. To confirm an appropriate soil condition for the screening, soil moisture had been kept in a dry, wet and damp condition. Evaluation had been done about 120 days after sowing.

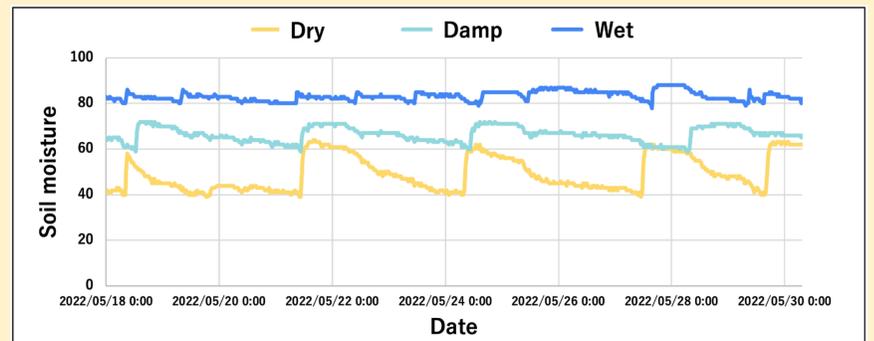


Figure 5. Soil moisture data during the experiment.

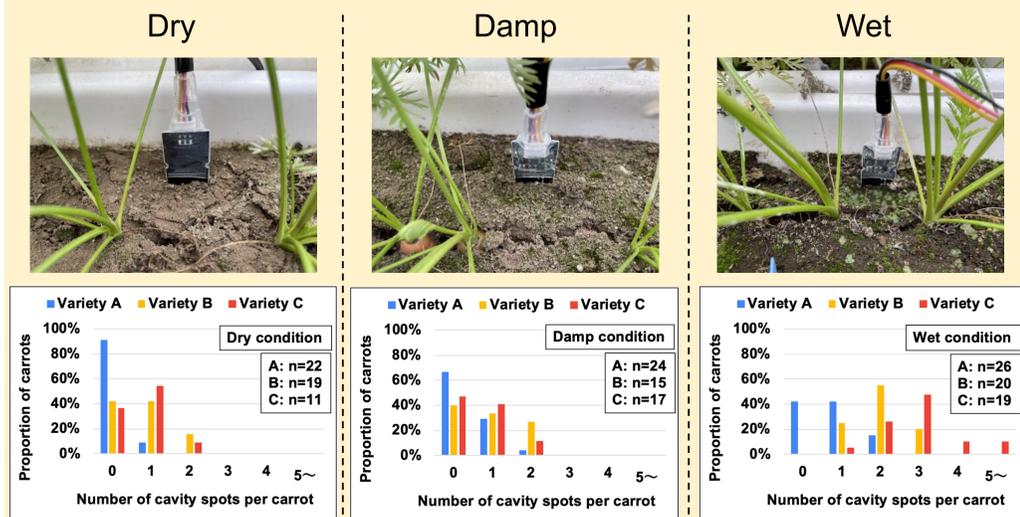


Figure 6. Soil appearance and the number of cavity spots.

By using the system, the soil moisture of each planter was controlled according to the setting (Figure 5). It led to the differences in soil appearance of the planters as shown in Figure 6.

Under dry and damp conditions, cavity spots were rarely seen in any tested varieties. This suggested that dry and damp soil were not suitable for the development of cavity spot disease in the planters. On the other hand, under wet condition, many cavity spots were seen in variety B and C (Figure 6). As a result of this test, variety A was most tolerant to cavity spot among the tested varieties, and variety B was more tolerant than variety C. This result was consistent with field tests, suggesting that the cultivation by using this system would be useful for the selection of disease tolerant varieties.



Figure 7. Cavity spot symptom and isolated fungus.

There are many important traits which are affected by soil moisture such as drought injury, shoulder deformity and root cracking. This irrigation system may contribute to evaluating these traits easily and cost-effectively in carrot breeding.

## Conclusion

- The sensor-based auto-irrigation facilitated the testing for tolerance to cavity spot in planter cultivation.
- This system may be used as easy and cost-effective testing for carrot traits adversely affected by soil moisture.