New Automatic Irrigation Apparatus for Pot Experiments

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Introduction

When a pot-experiment is carried out in relation, for example, to soil moisture content, it is necessary in many cases to keep the soil moisture content at a constant level. In such a case, either the classical auto-irrigator or the pot-weighing method is still commonly used.

In the former, however, it is very difficult to set the level of soil moisture content at a desired value. In addition, it generally occurs that the root system of the plant clings to the surface of the porous unit, forming a mat.

On the other hand, the pot-weighing method is superior in that it does not need any special apparatus and that the soil moisture content can be set at any desired level. However, its greatest disadvantage may be that it needs much and frequent labor.

Recently, two types of new automatc irrigation apparatus which utilizes a platform-scale have been devised[1] and are now gaining popularity in Japan.

Principle and Mechanism

1. Platform-scale type

This apparatus consists of the following four parts: a platform scale, a water tank, a magnetic valve, and a pot (Fig. 1). They are so arranged and connected with each other as the water in the tank is supplied to the pot via the magnetic valve.

When the weight of the pot has decreased beyond a certain limit, as a result of transpiration of the plant, the arm of the scale moves downward, turning the microswitch on and causing the magnetic valve to open so as to permit the water to run down into the pot from the tank. When, in this way, the pot has regained its initial weight, the arm moves upward, turning the microswitch off, closing the magnetic value, and finally stopping the water inflow. Thus, the weight of the pot, and consequently, the soil moisture content, is always kept constant.

In this apparatus, the soil moisture content can be set at any desired level by simply adjusting the poise. In addition, by the periodical readings of a water gauge attached to the tank,

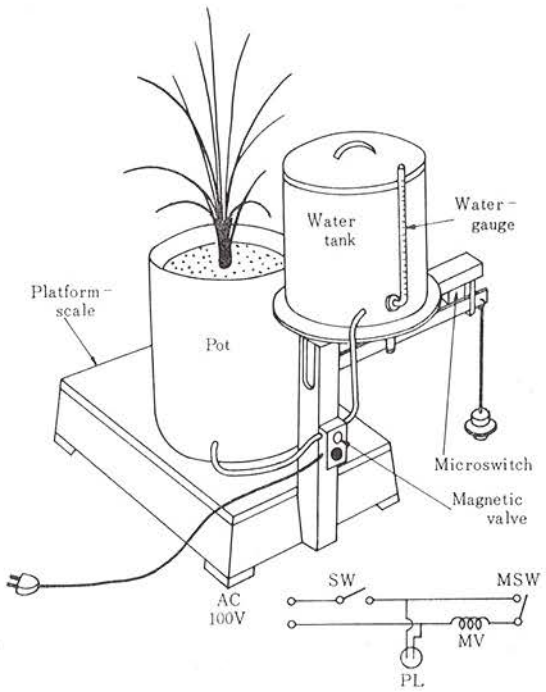

Fig. 1. The "Platform-scale type" automatic irrigation apparatus.

the amount of water supplied to the pot is known. About 100 grams of water are supplied by each operation. The fluctuation of the soil water content can be kept within one per cent of the total weight of the pot.

2. Packed type

This type consists of a main unit, 10–20 subunits, a pump, and a float chamber (Fig. 2). The main unit itself is actually an automatic irrigation apparatus of the plantform-scale type. Each subunit is composed of a pipette, a magnetic valve and a pot. They are so combined and arranged that whenever the main unit supplies water to the pot on it, all the subunits also supply exactly the same amount of water simultaneously to individual pots. The mechanism and operation are as follows:

When the main pot, which has been chosen from the whole pots as a representative one and placed on the main unit becomes lighter in its weight due to less of water, the arm of the scale comes down, turning the microswitch (Sm) on and starting the motor (M) to pump up water from the tank to the float chamber (Fig. 3). When the water-level reaches the first float (F_1), the corresponding microswitch (S_1) closes and, S_2 being still kept closed from the beginning, the magnetic valves (V_1, V_2) begin to open. However, no water yet comes out through them because at this time no water is poured into the pipette.

As the water-level rises further, pushing up the second float(F_2), the corresponding microswitch(S_2) opens, and the magnetic valves close.

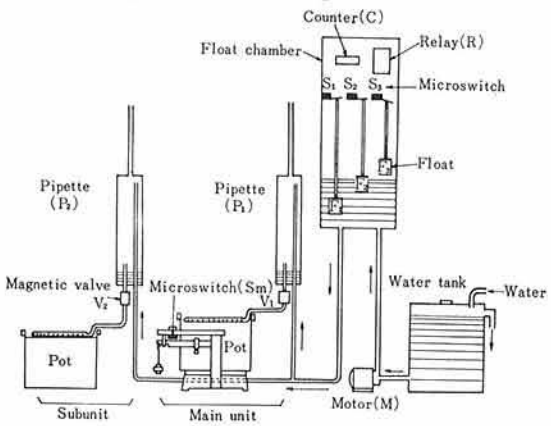

Fig. 2. Diagram of the "Packed type" automatic irrigation appratus.

About this time, the water in the float chamber begins to flow into each pipette. When the water-level in the float chamber reaches the third float(F_3), the corresponding microswitch(S_3) closes and this in turn operates the relay(R) to stop the motor.

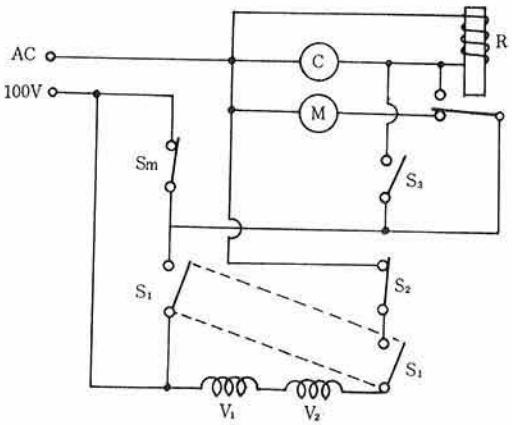

Fig. 3. Electric circuits for the "Packed type"

By this time, the pipettes have already become filled with water. With the stoppage of pumping, the water in the float chamber begins to return to the tank, leaving a definite amount of water in each pipette. As the water-level drops, F_3 comes down, switching S_3 off. However, this does not make the motor start anew because the motor circuit is still kept open due to the self-holding function of the relay circuit. With further drop in the water-level, F_2 comes down, switching S_2 on, opening V_1 and V_2, and supplying an equal amount of water to each pot simultaneously. And as a result, the main pot becomes heavier, making the arm of the scale rise, and switching Sm off.

With further drop in water-level, F_1 comes down, switching S_1 off, closing V_1 and V_2, and finally increasing the numerals of the counter (C) by one. In this way, one complete cycle is finished and everything returns to the state at the beginning.

To make the whole apparatus free from disturbance by the wind during the operation, a special device has been made. That is, the movement of the two S_1 switches is synchronized with each other. The amount of water to be supplied by one operation can be varied when desired within the range of 100-400 ml. Water supply to each pot is carried out through

a curved, perforated plastic tube, placed at the surface of the soil in each pot. Fluctuation in the amount of water supplied at a time is about ± 1%.

Application of the Apparatus

One of the largest advantages of the platform-scale type is that the level of soil water content can be independently regulated pot by pot. However, in this type the amount of water supplied to each pot is nearly equal to that consumed by the plants, so it follows that bigger plants receive more water than smaller ones, thus enlarging the difference in growth between individual plants. While on the contrary, in the second type, the amount of water-supply is always equal among individual plants regardless of the difference in their size. This will work for the direction to diminish the difference in growth among individuals. In other words, a sort of automatic regulation of growth will take place.

Having these features, it is natural that the two types have respective field of application: The former type will be most suitable for such experiments as directly related to the effect of soil moisture level, and the latter type is best suited for such purposes as growing uniform experimental materials under a constant soil moisture condition. Comparatively low cost, expressed per pot basis, of this type may also be mentioned as another merit.

References

1) Murata, Y., Iyama, J., and Honma. T. 1967. Automatic irrigation apparatus for pot-experiments, (in Japanese). New Techniques, No. 5, edited by the Research Council Secretariat, Ministry of Agiculture and Forestry, pp. 288-292, Ratis Co., Tokyo.