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Windflowers (*Anemone coronaria*) Roots Zone Cooling Case Study

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Abstract

Windflowers (*Anemone coronaria*) only begin budding when soil temperature is below 20°C. In September in Israel, the ambient temperatures average 31 °C, heating the soil as well. The ROOTS zone system can provide a controlled temperature in the soil or treated substrate to support Windflower growth. Windflower tubers were planted on 2.9.2021, and the ROOTS zone system maintained soil temperatures under 20°C. As a result, budding began after nine days, and flowering began after 30 days, even though air temperatures were above 25°C on average.

Introduction

Windflower (*Anemone coronaria*) is a plant of the Ranunculaceae family, originating from West Asia. Its distribution extends to the countries of the Mediterranean and Southern Europe. Windflower is a herbaceous perennial tuberous plant that is dormant during the summer. It is an agricultural crop in European countries and to a limited extent in America.

Cultivation of the Windflower in Israel began in the 1950s. For many years, cultivation was based on importing tubers from France and the Netherlands. Starting in 1978, cultivation has been based on locally produced tubers, the product of manual hybridization of selected parents.

The traditional planting timeframe is mid-September to early October. The optimal soil temperature range for germination of cultivated A. coronaria L. is 10-20°C[1]. If the soil temperature at this time is above 20°C, the planting must be postponed. It is recommended to cool the area on hot days after planting. However, high external temperatures at the time of planting may sabotage any cold treatment given to the tubers and delay the onset of flowering. Today's cooling recommendation of the Israeli Ministry of Agriculture Agronomic Advising Service, Flower Department, is: "By frequent bagging, shading in a shade net 30%-40% will prevent direct radiation and slightly lower the temperature." (From the Planting Guide for the Farmer, the Israeli Ministry of Agriculture Agronomic Advising Service).

[1] Bullowa, S., Negbi, M., & Ozeri, Y. (1975). Role of temperature, light and growth regulators in germination in Anemone coronaria L. *Functional Plant Biology*, *2*(1), 91-100.

Natural flowering occurs in early spring. If the Windflower tuber is kept in a dry state, it can survive for a long period, exceeding a year. To stimulate the tubers, the water that was in them before drying must be returned to them. Only in such a situation will the processes of awakening and germination take place. This process of preparing the tubers for planting is called "the lecturer."

For the benefit of this experiment, the tubers were transferred to the leading tuber growers in the country at Yodefat Nursery, who are partners in this experiment and provided the tubers and the protocol.

The purpose of the experiment undertaken at the Beit Halevi greenhouse was to try to get the Windflowers to bloom about a month or two before the "traditional" blooming date which corresponds to the seasonal winter cooling.

Methods

On August 1, 2021, a variety of tubers called Blue Galilee were rooted at Yodefat Nursery. The planting was carried out in the Beit Halevi greenhouse on September 2, 2021 (Photo 1), at a density of 18 tubers per square meter, with 90 tubers in total. The central cooling system was set for a temperature of 19°C without a shading net. It should be noted that the purpose of the experiment was not to test a treatment versus control, but rather the possibility of flowering when the air temperature is high and the soil below 20°C.

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Photo 1: The flower bed after planting, September 2, 2021

Results

Regulating the Soil Temperature

The cooling system worked continuously except for 3 days in October (14-16.10) when there was a technical malfunction. For the entire period, the system kept the ground cold at below 20°C (Figure 1), while the greenhouse temperature reached daytime temperatures of over 40°C both in September and October. In September, the average air temperature was 31.5°C, and the average ground temperature was 18.8°C. In October, the average temperature stood at 20.9°C and the ground at 17°C. Every day during September and October, the air temperature exceeded 30°C from late morning until the afternoon.

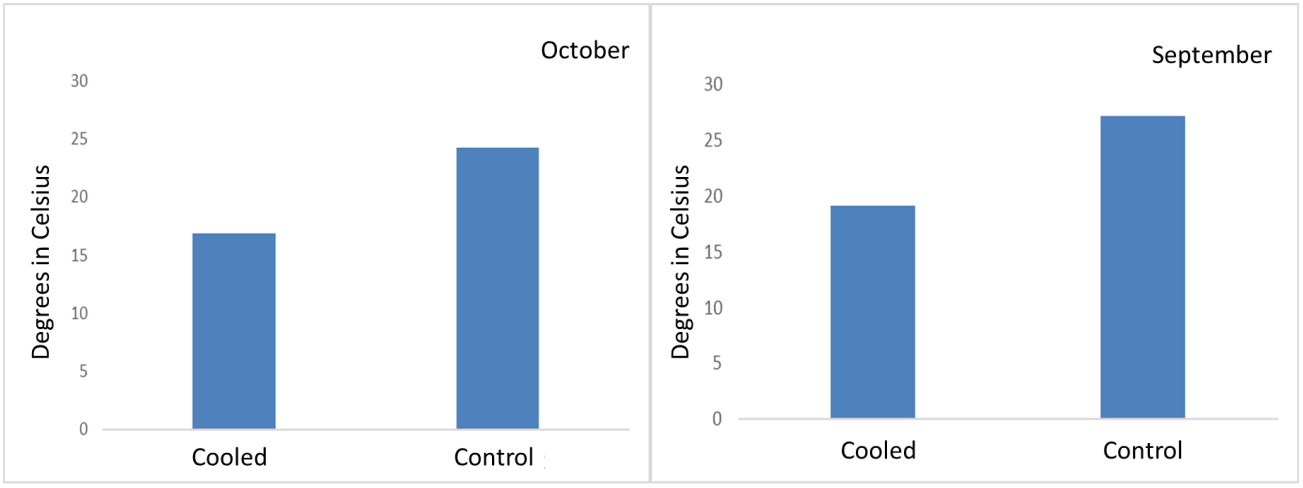

Figure 1: The average temperatures in September (right) and October (left) in the greenhouse soil and in the roots zone temperature optimization (RZTO). The average temperature during the entire experiment in the greenhouse air was 25.5°C and on the ground 18.8°C.

Germination

The first germination was observed on 9.9.21 after five days in the soil (Photo 2). About 12 tubers sprouted that day. The average temperature on the ground these days was 19.7°C (22°C at the peak of heat), and the air in the greenhouse averaged 28.5°C (over 36°C at the peak of heat).

Budding

Buds started to bloom on 3.10 (Photo 3), with 7 buds about 30 days after planting and 60 days after the beginning of tuber development. The first flowers bloomed after only 36 days. On 10.10,

about 27 flowers had bloomed (Photo 4).

Photo 2: Tuber germination after 5 days in the soil, 9.9.21

Photos 3 and 4: First bud on 3.10 days after planting and first Windflower bloom on 10.10

Flowering

After 2 months (on 1.11.2021), 106 flowers were counted in the bed. The average height of the headers was 38.5cm from ground level to the bottom of the inflorescence. This bloom developed during a period when the air temperature was high (above 25°C on average) and regularly

exceeded 30°C at the height of the heat.

At the end of the experiment, a total of 792 flowers were counted over 5 months of picking, 316 flowers per square meter, and an average height of 45cm per flower.

Photo 5: Blossoming in the Windflower bed in January 2022

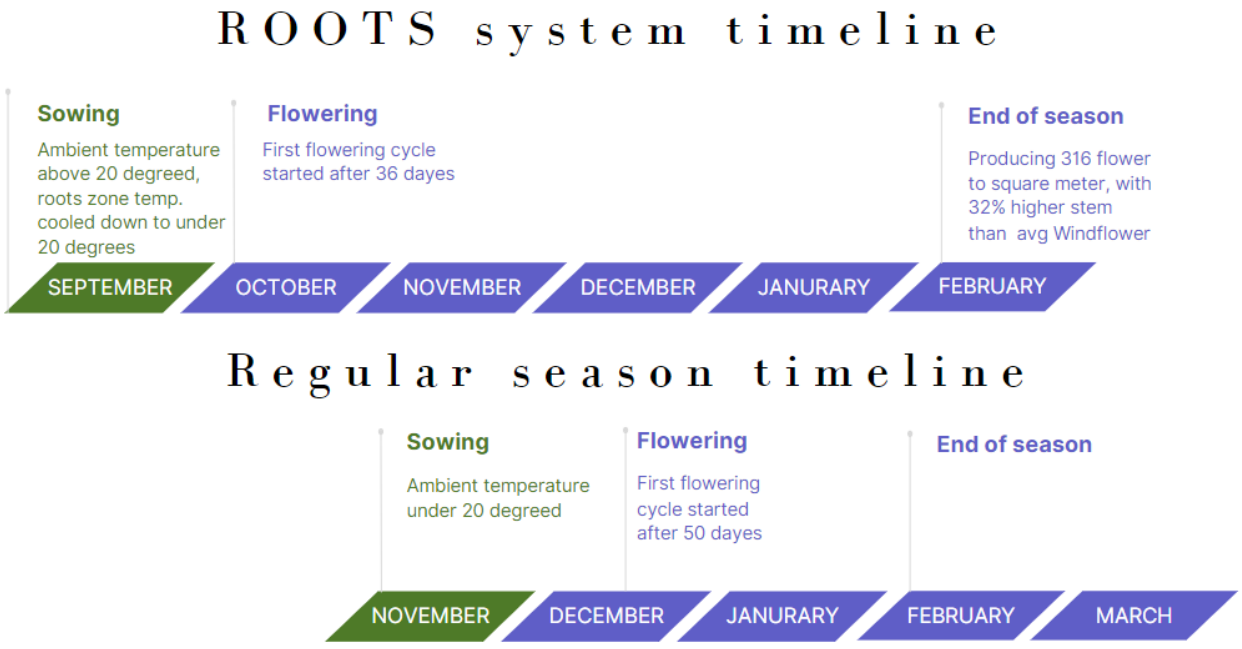

Figure 2: The timeline for the growing cycle with the ROOTS system (above) and without it (below). The growing cycle starts two months earlier using the ROOTS system and ends one month earlier.

Discussion and Conclusions

Compared to the results obtained in the experiment carried out in the Southern R&D Israeli ministry of agriculture farm in 1999[2], the yield was similar, but the flowering data in this experiment almost doubled the rate from planting to flowering (50 days compared to 36 days). This was done without additional lighting. The current results are similar to the results obtained in artificially illuminated beds.

In this ROOTS experiment, the length of the flowers was 32% higher than the results of the experiment in the Southern R&D Israeli ministry of agriculture farm. The experiment proved that Windflowers (*Anemone coronaria*) can bloom when the soil temperature is regulated to 19°C, even If the ambient temperature is higher than 25 °C. The flowering also thrived at extremely high air temperatures and provided extremely tall flowers.

In addition, cooling the soil before germination endorses rapid flowering. The soil cooling system provided flowering for 5 months with a high yield of 316 flowers per square meter, without shading. The experiment verified that during this period, using the ROOTS system enabled the Windflowers to bloom about a month and a half before average. It also supported rapid flowering within 38 days without any manipulation of light hours. In a world where the winter is getting warmer, the exact cooling solution is relevant, and given the results obtained, this solution is effective and provides excellent value for growing Windflowers.

[2] Choosing Windflower strains, 1999, Irit Dori et al. Southern R&D Israeli ministry of agriculture farm