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ROLE OF DEW IN THE SURVIVAL AND PHENOLOGY OF *GOSSYPIUM HIRSUTUM* L. CV. QALANDRI.

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Abstract

Twelve-week-old cotton plants (*Gossypium hirsutum* L. cv. Qalandri) were placed in a dew simulation chamber (12 h/night), after bringing the pot soil to permanent wilting percentage. Defoliation and concomitant shedding of flowers was noticed. Subsequently, however, the plants replenished, reflowered and produced new leaves. The so-called negative transpiration was also recorded.

Introduction

Drought resistant plants have been reported to survive in soils below permanent wilting percentage by absorbing dew from aerial parts of plants during night (Stone *et al*., 1950) Moreover it has been shown that dew considerably supplements the moisture absorbed from soil under water stress conditions (Waisel, 1958; Fritschen & Doraiswamy, 1973).

Not all plants are capable of utilizing dew. Among the cultivated species that possess this virtue, cotton is remarkable, since it has been reported to give higher yield in areas where dew fall is frequent (Monteith, 1962). This finding was strengthened by Nieman & Poulson (1967) who demonstrated that cotton plants also utilize atmospheric humidity which contributes towards their hydrologic balance.

An interesting phenomenon relevant to dew absorption is the so-called negative transpiration. Stone *et al*., (1950) found that the dew absorbed by the leaves of *Pinus coulteri*, under moisture stress conditions was conducted downwards from the shoot to the root system and was subsequently exuded into the soil. In addition, Breazeale & Breazeale (1950) demonstrated that the moisture oozed out by the roots under such conditions, owing to downward transport, could be so substantial as to increase the soil moisture around the rhizosphere to field capacity.

The role of dew in the survival and phenology of cotton (*Gossypium hirsutum* L. cv. Qalandri) was, therefore, studied. In addition the occurrence of the so-called negative transpiration in cotton plants was ascertained under water stress conditions.

Material and Methods

One-week-old cotton seedlings (*G. hirsutum* L. cv. Qalandri) of uniform height were transplanted into earthen pots (30 cm. diameter) containing sandy-loam mixed with cattle manure (20:1). The pots contained five seedlings of uniform height. Watering was discontinued when the seedlings were eleven weeks old. The soil reached its permanent wilting percentage within a week.

Measurement of permanent wilting percentage (PWP):

Pressure-membrane extractor (Soil Moisture Equipment Co., California) was used to determine the PWP of the soils following the method of Richards (1947). Once the PWP was determined the successive observations were made simply by oven-drying the soil samples from the rhizhosphere at 105°C for 24h., and comparing the moisture contents with the PWP estimated for each pot.

Construction and working of dew simulation chamber:

In a growth room a 1 × 2 × 1 meter polythene chamber was constructed. The atmosphere of the chamber was humidified upto 85% RH., four times in an hour for five minutes duration with the aid of a Defensor 505 humidifier using cool distilled water.

The chamber was equipped with a Honeywell thermohygrograph to indicate dew point. Conditions prevailing outside the chamber were recorded by wet and dry bulb thermometer.

At night (in dark) radiant cooling of the plant surfaces occurs with the result that free moisture condenses on these surfaces. Simultaneously, convection currents were set up in the adjacent atmosphere as cooler and humid air from the humidifier displaced that close to the leaf surface effectuating the lowering of leaf temperature to below that of the atmosphere thus facilitating the formation of dew.

Assessment of the role of natural and artificial dew

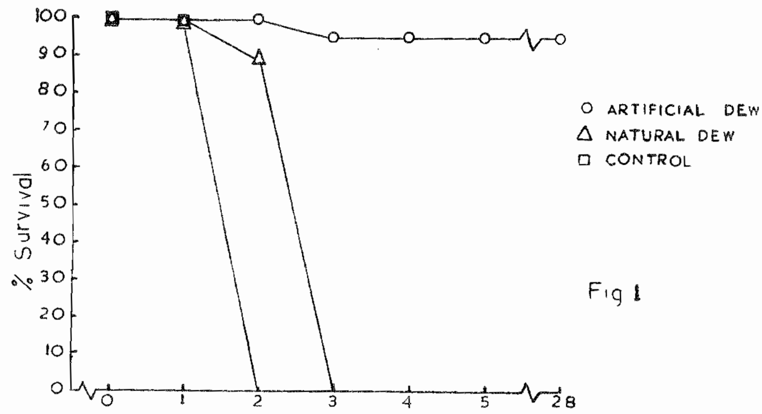
The plants which served as controls were maintained in a growth room illuminated with flourescent tubes and incandescent lamps (total light intensity=7K Lux) at 32°C during day (12 h photoperiod) and 26°C during night. Moisture was not supplied to these plants either through soil or in the form of dew. The pots of second set were sealed with polythene sheets and water repellant wax. During day this set was kept in the growth room under the same conditions as those of the first set. Artificial dew was supplied for 12 h at night by subjecting them to dew simulation chamber. The third set was kept in field conditions and remained unirrigated.

Number of living seedlings were recorded weekly in all the treatments after the soil reached its PWP.

Results

(i) *Survival of cotton plants on natural and artificial dew:*

The results are presented in Table 1 and Fig. 1. The plants kept as control showed no wilting symptoms upto the 7th day but no signs of active growth were seen either. Subsequently, however, the leaves were seen to be drying; in addition, curling of the leaf margins was clearly noticeable (Table 1). Severe wilting was apparent on the 10th day and all the control seedlings were dead by the end of 2nd week after the soil reached its PWP (Fig. 1). The plants exposed to naturally occurring dew followed similar pattern as the controls. In this set of plants slight drying and curling was apparent on 10th day, severe wilting was noticed at the beginning of third week and the eventual mortality followed by the end of 3rd week.



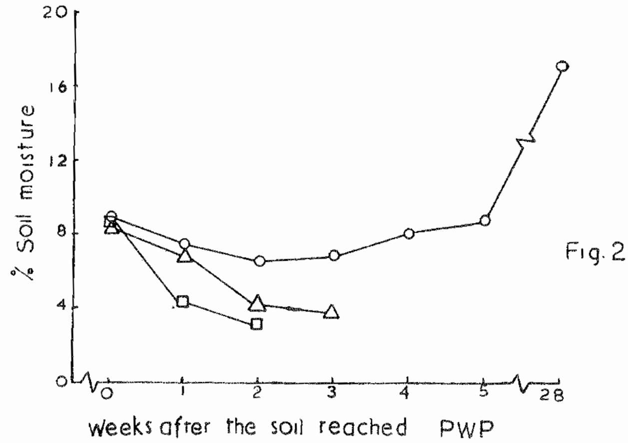


Fig 1 Effect of artificial and natural dew on the survival percentage of *Gossypium hirsutum* plants, after the soil reached its PWP. Controls were not supplied with any form of moisture.

Fig. 2 Changes in soil moisture content in various treatments (control, artificial and natural dew) after the soil reached its PWP. For key to the symbols see Fig. 1.

Plants subjected to artificially produced dew showed healthy normal growth upto the commencement of second week. During second week, the plants were severely affected in terms of leaf shedding. Nevertheless, by the end of the third week, the lateral buds began to sprout and in the middle of the second month the plants resumed normal growth, and three plants produced flowers, though these were small and abscissed prematurely. Surprisingly enough, these plants survived on artificial dew upto seven months experimental period.

(ii) *Water out-flow from the roots:*

The moisture content of soil obtained from rhizosphere of cotton plants at the commencement of treatments (i.e. at the PWP of soil) ranged from 8 to 9% approximately. The percentage of moisture declined gradually in pots which received natural dew or those which did not receive precipitation in any form (Fig. 2). However, a sharp increase in moisture content was noticed in the soils obtained from the plants subjected to artificial dew. In such soils, the percentage of moisture reached as much as 17.23% when the plants resumed normal growth.

Table 1. Maximum number of days at which a given event occurred in most (80%) *Gossypium hirsutum* plants in various treatments after the soil was brought to PWP.

Event	1st set (no moisture supply)	2nd set (natural dew)	3rd set (artificial dew)
Leaf shedding, slight drying and curling of leaves	8	10	8—15
Severe wilting	10	14	—
Mortality	11	19	Resumed normal growth

Discussion

Survival of cotton plants on dew at PWP of soil, observed in this study, corroborates the findings of earlier workers (Stone *et al.*, 1950; Waisel, 1958; Stone, 1962). It would be interesting to note here that not only dew but moisture present in air at high relative humidity is also utilized by certain plants which not only compensates the stress due to high soil moisture tension (Breazeale and Breazeale, 1951; Haines, 1952; Muller-Stoll, 1965) but relieves, almost completely, the suppressive effect of salinity on plant growth (Neiman and Poulson, 1967; Mizrahi *et al.*, 1971).

Although no record has been made of the amount of dew absorbed by the aerial parts of *G. hirsutum* cv. Qalandri, yet it has been shown earlier that cotton plants have considerable capacity of utilizing atmospheric moisture (Neiman & Poulson, 1967; Akhtar, 1974). The technique for the estimation of dew absorbed by plants is not yet available.

The survival of cotton plants on dew for a period as long as seven months suggests that dew contributed a great deal to the water economy of the plants. This supports the view of Zohary (1962) who suggested that even minute quantities of dew absorbed by the shoots may be of utmost importance in keeping the water deficits within safe limits under the prevelance of low soil moisture regimes. However, another factor which is supposed to have contributed towards the hydrological balance is the reduced rate of transpiration resulting from increased water stress (Jarvis and Slatyer, 1970).

When the water stressed cotton plants were subjected to artificial dew, defoliation and concomitant shedding of flowers was noticed. This corresponds with the results of Mc Michael *et al.*, (1972) who found that when the rooting medium dried enough, the predawn leaf water potential dropped to around —8 bar, abscission of leaves and bolls of 2 months old cotton plants was potentiated and took place after rewatering.

Talli and Durgham (1968) reported that the dew absorbed by the growing points of naked buds and growing regions of stem and leaves enhanced the growth and meristematic activity. In the present study cotton plants gave rise to new leaves by making use of the artificially produced dew.

An increase of more than 8% soil moisture content was measured after the individuals of *G. hirsutum* cv. Qalandri resumed normal healthy growth as a consequence of absorption of artificial dew. This is in confirmation with the findings of several workers who obtained similar results with some other plant species (Breazeale *et al*., 1950; Stone, 1962; Muller-Stoll, 1965).

It has been suggested by Monteith (1961) that the direct uptake of atmospheric water through the cuticle is possible when the free energy in leaf cells (H_L) is less than the free energy of atmospheric water (H_A), moreover, when free energy of soil moisture (H_S) is less than that of leaf cells i.e. $H_S < H_L < H_A$, the water will be absorbed by the plant and will be secreted down into the soil through the roots. However, Muller-Stoll (1965) opined that the phenomenon of negative transpiration is analogus to guttation in opposite direction.

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