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Studies on the use of some antitranspirants for improving moisture status in mulberry under rainfed conditions

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Abstract
Mulberry is the sole food to silkworm (*Bombyx mori* L.) which produces silk. It is an important perennial crop grown primarily under rainfed conditions. Among many quality parameters, the moisture content in mulberry leaf and its retention for longer durations play an important role in the successful production of cocoons. In order to improve the moisture status of mulberry leaf, a study was conducted using 3 different antitranspirants (Kaolin, Phenyl mercuric acetate and Salicylic acid) with 3 different concentration on the mulberry genotype, Goshoerami, the most popular genotype in the region. Antitranspirants were sprayed on the plants after an interval of 15 days after 20th April and 15th July respectively during spring and autumn crops. Antitranspirants significantly influenced the moisture status of the mulberry leaf with the best effect through the use of Kaolin @ 0.25% which registered significantly higher values for moisture content and its retention capacity after 06 and 12 hours of harvest in both spring and autumn crops of silkworm rearing.

Keywords: Antitranspirants, mulberry, transpiration, leaf moisture

Introduction
Mulberry is an important plantation crop and is widely distributed in varied ecological and geographical zones from intensive cultivation in temperate, sub-tropical and tropical areas to natural occurrence in forests. This clearly indicates that mulberry has a high degree of morphological and physiological adjustments to changes in the environment. Mulberry leaf protein is the only source for silkworm to synthesize the commercial silk. It is impossible for the silkworm to complete the growth in the absence of mulberry. The host specificity of *Bombyx mori* L. is not only due to the nutritional superiority of leaves but primarily due to the presence of many chemical factors in the leaves to which the insect gets lured. These include attracting, biting and swallowing factors. The leaves are highly nutritious with high protein, sugar and mineral content. High leaf moisture content and moisture retention capacity of the mulberry genotypes have a positive influence on the growth and development of silkworm. For successful rearing the maintenance/retention of sufficient moisture content in the leaves for prolonged periods is of immense importance (Shivashankar, 2015) [6]. This gains more importance in an area like Kashmir, where mulberry is grown under rainfed conditions and there is sufficient gap between leaf harvesting and its feeding to the worms at farmers level. Availability of moisture content in leaves enhances feeding efficiency of silkworm larvae which in turn increases growth rate. Thus moisture retention capacity plays an important role because leaves with high moisture remain fresh and acceptable to silkworms for longer time. Among other strategies, the use of antitranspirants seems to hold promise in mulberry cultivation. Due to foliar application of antitranspirants in mulberry leaves there is reduced transpiration rate which in turn maintains a higher water content in plant tissues, thereby favouring plant metabolism and many other important functions. This will directly affect plant growth and the growth of silkworm. Paul *et al*. (1992) [10] reported that absolute consumption of feed and growth rate of larvae increased with increasing levels of leaf moisture content. It is important to mention that the antitranspirants overcome the adverse effects of water stress and have positive effect on the physiological activities and yield production of mulberry plants. The interaction between antitranspirants and the plant increases the effect on growth parameters, yield and moisture status in mulberry, silkworm growth and cocoon production if the antitranspirants are applied properly.

The present investigation was, therefore, an attempt to see the differences in moisture status in fresh leaf, as influenced by foliar spray of some antitranspirants.

Materials and Methods

The present work was carried out at College of Temperate Sericulture Mirgund, SKUAST-K. Three antitranspirants namely (Kaolin, Phenyl mercuric acetate (PMA) and Salicylic acid) were taken up for the study. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications using the most popular mulberry genotype of the region- Goshoerami. The experiment was conducted under open field conditions on established plantation. Antitranspirants were sprayed on the plants after an interval of 15days after 20th April and 15th July respectively during spring and autumn crops. All the antitranspirants were used in three concentrations, Kaolin (0.15%, 0.20% and 0.25%), PMA (50,100 and 150ppm) and salicylic acid (0.05%, 0.10% and 0.15%). Sprays were made during dry days.

For moisture content, the leaf was harvested early in the morning after the disappearance of dew. Moisture content was determined on dry weight basis. Samples of one hundred fresh leaves, comprising of tender, medium and coarse were taken and weighed immediately. They were then kept at room temperature and weighed again after 06 and 12 hours. The leaves were then dried in hot air oven at 60 °C for 48 hours (Ninge Gowda & Sudhakar, 2002) [9]. The dry weight was recorded and the moisture content and moisture retention capacity were calculated as per the following formulae:

Leaf Moisture Content (%): It was calculated as:

$$\text{Leaf Moisture content (\%)} = \frac{\text{(Fresh weight –Dry weight)}}{\text{(Fresh weight)}} \times 100$$

Moisture retention capacity after 6 hours

$$\text{MRC after 6 hours (\%)} = \frac{\text{(Weight after 6 hours–Dry weight)}}{\text{(Fresh weight – Dry weight)}} \times 100$$

Moisture retention capacity after 12 hours (%)

$$\text{MRC after 12 hours (\%)} = \frac{\text{(Weight after 12 hours –Dry weight)}}{\text{(Fresh weight –Dry weight)}} \times 100$$

Three samples were taken for each treatment of each replication to calculate the average values. Data recorded during the two years was pooled and analysed through standard statistical package (R software).

Results and Discussion

The observations recorded for two springs and two autumn crops during the study period were tabulated, pooled, analysed and are shown in Table-1 & 2.

Leaf moisture plays a very important role in improving the nutritional value of mulberry leaf and its palatability to silkworm. Higher moisture content in mulberry leaf is known to increase the amount of ingestion and digestion ability of silkworms as moisture acts as olfactory and gustatory stimulant (Ito, 1963) [4]. The antitranspirants have, in general, improved the moisture content in fresh leaf and its retention capacity as compared to the treatments involving no antitranspirants. In the present investigation highest moisture content in fresh leaf (76.59%), moisture retention capacity after 6 hours (93.07%) and moisture retention capacity after 12 hours (84.76%) was found in T_4 (Kaolin 0.25%) during spring being at par with T3 (Kaolin 0.20%). Likewise during autumn T_4 (Kaolin 0.25%) had the highest values for moisture content in fresh leaf (75.21%), moisture retention capacity after 6 hours (92.18%)and moisture retention capacity after 12 hours (84.53%) being again at par with T_3 (Kaolin 0.20%) and statistically significant over the rest of the treatments. In general the moisture status was better during spring as compared to autumn which may be attributed to the favourable climatic conditions especially better precipitation in the form of snow and rain in Kashmir during winter and spring. The results of the present investigation are in conformity with the findings of Misra *et al.* (2009) [7] who have worked on effect of antitranspirants on water status and growth pattern of mulberry and have recommended the use of antitranspirants in mulberry under limited water supply. Davenport *et al.* (1972) [2], Goode *et al*. (1978) [3], Jai Dayal *et al.* (1993) [5] and Reddy and Khan (2000) [11] reported similar results of increased water status by antitranspirants which might be due to reduced transpiration and increased stomatal resistance affecting membrane system and influx of water. Moreover use of antitranspirants have been reported to improve retention of water that led to improved growth rate and better plant establishment (Davenport *et al.* 1972) [2]. The application of Kaolin has also been reported to lead to an increase in growth traits, yield and its components besides mitigating the negative influences of water deficiency in wheat (Abdallah *et al*. 2019) [1]. Morsy and Mehanna (2022) [8] too have reported improvement in the phenology, growth traits, yield, and water use efficiency (WUE) of maize under optimum and limited water supply.

Table 1: Leaf moisture status of mulberry as influenced by foliar spray of various antitranspirants during spring season

Parameter / Treatment	Leaf Moisture Content (%)	Moisture Retention Capacity after 6 hours of harvest (%)	Moisture Retention Capacity after 12 hours of harvest (%)
T_1:A_1C_0; Distilled water spray	71.20	83.56	80.16
T_2:A_1C_1; Kaolin @ 0.15%	75.83	90.45	82.78
T_3:A_1C_2; Kaolin @ 0.20%	76.16	92.76	84.48
T_4:A_1C_3; Kaolin @ 0.25%	76.59	93.07	84.76
T_5:A_2C_0; Distilled water spray	71.85	83.63	80.64
T_6:A_2C_1; Salicylic acid @ 0.05%	73.48	85.19	80.88
T_7:A_2C_2; Salicylic acid @ 0.10%	74.17	87.57	81.62
T_8:A_2C_3; Salicylic acid @ 0.15%	74.57	86.04	81.68
T_9:A_3C_0; Distilled water spray	71.62	83.50	80.92
T_{10}:A_3C_1;PMA @ 50 ppm	75.28	89.38	82.28
T_{11}:A_3C_2;PMA @ 100 ppm	75.85	91.92	83.75
T_{12}:A_3C_3;PMA @ 150 ppm	75.18	90.67	83.22
C.D ($P \leq 0.05$)	0.463	0.434	0.289

Table 2: Leaf moisture status of mulberry as influenced by foliar spray of various antitranspirants during autumn season

Parameter / Treatment	Leaf Moisture Content (%)	Moisture Retention Capacity after 6 hours of harvest (%)	Moisture Retention Capacity after 12 hours of harvest (%)
T_1:A_1C_0; Distilled water spray	70.80	82.53	80.03
T_2:A_1C_1; Kaolin @ 0.15%	74.53	89.27	82.05
T_3:A_1C_2; Kaolin @ 0.20%	75.06	91.70	84.39
T_4:A_1C_3; Kaolin @ 0.25%	75.21	92.18	84.53
T_5:A_2C_0; Distilled water spray	70.97	82.70	80.43
T_6:A_2C_1; Salicylic acid @ 0.05%	72.23	84.58	81.11
T_7:A_2C_2; Salicylic acid @ 0.10%	72.43	85.13	81.75
T_8:A_2C_3; Salicylic acid @ 0.15%	72.73	85.12	81.32
T_9:A_3C_0 ; Distilled water spray	70.48	82.82	80.04
T_{10}:A_3C_1;PMA @ 50 ppm	72.95	88.58	82.03
T_{11}:A_3C_2 ;PMA @ 100 ppm	74.20	91.15	83.32
T_{12}:A_3C_3 ;PMA @ 150 ppm	74.59	90.13	82.41
C.D ($P \leq 0.05$)	0.384	0.613	0.302

Conclusion

The antitranspirants have, in general, improved the moisture content in fresh leaf and its retention capacity as compared to the treatments involving no antitranspirants. Kaolin being better than all other antitranspirants tested gave the best results with 0.25% concentration.

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