INFLUENCE OF MIST ON FLORAL INITIATION OF *PHARBITIS NIL**

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INTRODUCTION

Rain, dew, fog, and mist may have a modifying influence upon plant growth and development. Some modifications can be attributed directly to leaching of substances from plants, a phenomenon which has been reported previously by a number of workers (Arens, 1934; Le Clerc and Breazeale, 1908; Mes, 1954; Stenlid, 1958; Tukey, 1970). Losses by leaching of mineral nutrients, carbohydrates, amino and organic acids, and growth regulating substances influence plant size, nutrient content and nutritive value, crop yield and quality, and certain metabolic processes such as flower and root initiation, leaf abscission, and dormancy (Cholodny, 1932; Kozel and Tukey, 1968; Tukey, 1970; Tukey et al., 1969).

However, in some cases it is not apparent whether modifications induced by rain and mist are due to leaching, or to other factors associated with the treatment itself. Thus, Lees (1956) observed that considerable rainfall during one year reduced the number of flowers and fruit on *Malus domestica* Bork. the following year, but the mechanism was not elucidated.

The experiments described herein investigated the influence of water mist on floral initiation of *Pharbitis nil* Chois as a first step in separating the leaching and physiological effects of the mist treatment.

MATERIAL AND METHODS

The material, *Pharbitis nil* Chois, "Violet", used in the present research is known as one of the most sensitive short day plants. It initiates floral primordia following application of a single dark period of adequate length.

In all the experiments presented herein, plants were cultured on a medium of fine silica sand in a plastic tray. All plants were grown for 4 days after germination under continuous illumination in a controlled environment chamber and were then subjected to various photoperiod and mist treatments. The light source in the chamber consisted of both incandescent and fluorescent lamps with an intensity of 15, 000 $\mu w/cm^2$. Water was atomized at an air pressure of 30 psi to form a fine mist which was applied continuously to the plants throughout the treat-

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ment period at the rate of 3 m*l*/cm²/hr using an overhead mist apparatus.

After the treatments of photoperiod and misting, the plants were transferred to a greenhouse under continuous illumination (artificial incandescent light during the night) with maximum day temperature at 25°C and night temperature of 20°C. The plants were fertilized once per week with a 20—20—20 fertilizer. Twenty days after the treatment, they were dissected under a binocular microscope to observe floral primordia. The experiments were repeated several times and always gave similar results. Typical results from at least 24 plants per treatment are given in the present paper.

RESULTS

I. *Mist preceding photoinductive period.*

Plants were misted for 12 consecutive hours in the light. Immediately after misting, the plants were subjected to a dark treatment for 12, 14, and 16 hours at 27°C, and then grown on for 20 days in the greenhouse. As shown in Table 1,

TABLE 1.

Flowering response of *Pharbitis nil* "Violet" subjected to water mist for 12 hours in the light preceding various photoinductive periods.

Hours of darkness	Treatment	% of plants with flower buds	Flower buds per 10 plants	% of plants with terminal flower bud
12	No mist	29.2	3.0	0
	Mist	0	0*	0
14	No mist	95.8	15.2	0
	Mist	87.5	9.2*	0
16	No mist	100	32.0	0
	Mist	100	23.3*	0

* Significantly lower than values from non-misted plants at the 1 % level.

flowering was induced by all 3 dark treatments, and the intensity of the response was greatly increased as the hours of darkness increased from 12 to 16 hours. The flowering responses were suppressed by 12 hours of mist immediately preceding the dark treatment, particularly in the 12-hr dark treatment, when the photoperiod effect was completely negated by the mist treatment. The effect of the mist on the percentage of plants with flower buds decreased as the length of the dark period was increased, and at 16 hours of darkness, the effect of the mist was greatly reduced. The number of flower buds was decreased in all 3 dark treatments by the mist treatment.

In a second experiment, plants were misted for 0, 4, 8, 12, and 24 hours in the light and subsequently exposed to darkness for 16 hours. The results are

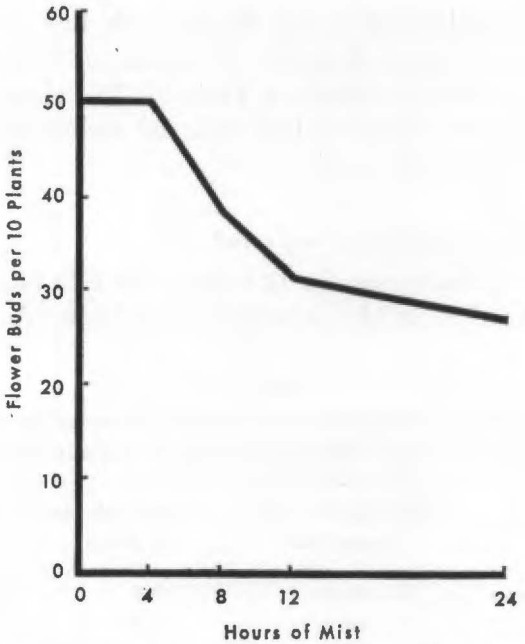

Fig. 1. Flowering response of ***Pharbitis nil*** "Violet" subjected to water mist for various durations preceding a photoinductive period of 16 hours darkness.

shown in Fig. 1. Plants exposed to mist for 4 hours prior to darkness initiated the same number of floral primordia as plants which were not misted (controls), but as the exposure to mist was increased, the number of flower buds was decreased up to almost 50 %.

These results indicate that misting immediately prior to a photoinductive period is inhibitory to flowering in *Pharbitis nil* "Violet".

II. *Mist during photoinductive period.*

TABLE 2.

Flowering response of *Pharbitis nil* "Violet" subjected to water mist during various photoinductive periods.

Hours of darkness	Treatment	% of plants with flower buds	Flower buds per 10 plants	% of plants with terminal flower bud
12	No mist	36.6	4.0	0
	Mist	93.3	10.0*	0
14	No mist	100	19.3	0
	Mist	100	23.6**	0
16	No mist	100	39.4	0
	Mist	100	40.2	6.6

* or ** differs from values of non-misted plants at the 1 % or 5 % levels, respectively.

Plants were exposed to mist during the photoinductive period of 12, 14, and 16 hours of darkness. Twenty days after the treatment flowering responses were examined and the results are shown in Table 2. The plants subjected to mist initiated a larger number of flower buds than did the non-misted plants, particularly during the 12-hr dark period.

III. *Mist following photoinductive period.*

Plants were subjected to mist for 12 hours in the light immediately following a photoinductive period of 12, 14, or 16 hours of darkness. As shown in Table 3,

TABLE 3.

Flowering response of *Pharbitis nil* "Violet" subjected to water mist for 12 hours in the light following various photoinductive periods.

Hours of darkness	Treatment	% of plants with flower buds	Flower buds per 10 plants	% of plants with terminal flower bud
12	No mist	79.2	9.3	0
	Mist	58.3	5.8**	0
14	No mist	100	20.0	0
	Mist	95.8	13.5*	0
16	No mist	100	44.8	25.1
	Mist	100	20.8*	0

* or ** differs from values of non-misted plants at the 1 % or 5 % levels, respectively.

plants under the mist treatment initiated a smaller number of flower buds than did plants which were not misted. As in the other experiments, the effect of the mist on the percentage of plants with flower buds was increased as the length of the photoinductive period was decreased. The number of flower buds was decreased in all 3 dark treatments by the mist treatment.

In another experiment, mist treatments were applied for 4 to 24 hours in the light following a photoinductive period of 16 hours darkness. The flowering response (Fig. 2) was suppressed by all the mist treatments. Regardless of the length of the mist treatment, the number of flower buds per plant subjected to mist was about half that of the non-misted controls.

To amplify this experiment, plants were exposed to mist for 24 hours in the light at daily intervals following a photoinductive period of 16 hours of darkness. As shown in Table 4, when the plants were misted on the 1st and 2nd day after the photoinductive treatment, flowering response was greatly decreased. However, after the 3rd day, there was no apparent difference in number of flower buds. Thus, for up to 2 days following photoinduction, flowering response seems to remain in an unstable state which is affected by the mist treatment.

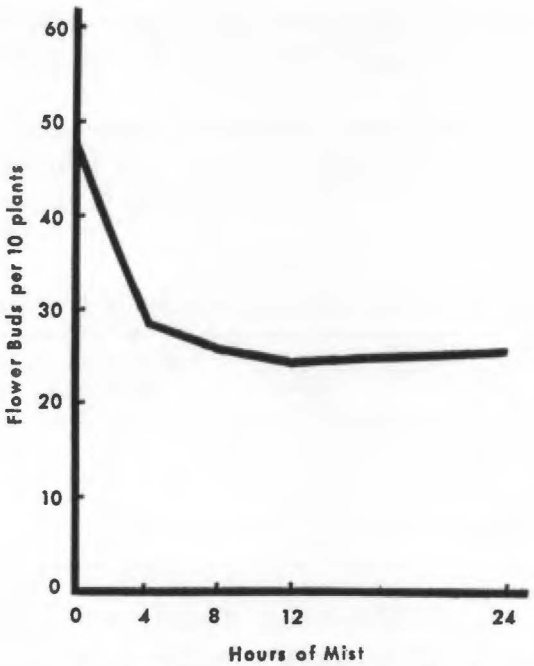

Fig. 2. Flowering response of *Pharbitis nil* "Violet" subjected to water mist for various durations following a photoinductive period of 16 hours darkness.

TABLE 4.

Flowering response of *Pharbitis nil* "Violet" subjected to water mist for 24 hours in the light at intervals following a photoinductive period of 16 hours darkness.

Days following photoinduction	% of plants with flower buds	Flower buds per 10 plants	% of plants with terminal flower bud
No mist	100	42.3	36.6
1	100	19.8*	0
2	100	33.3*	16.6
3	100	38.4	24.1
4	100	39.2	43.5
5	100	37.2	40.0
7	100	38.1	30.0

* Significantly lower than values from non-misted plants at the 1% level.

IV. *Effect of temperature on photoperiodic induction.*

One of the possible influences of the mist treatment is to reduce leaf and air temperatures, perhaps so much as to have a temperature effect upon photoinduction. The optimal temperature for photoperiodic induction of floral initiation in *Pharbitis nil* is ranged from 20° to 30°C (Imamura, 1967). Therefore, the plants were grown in controlled environment chambers at a constant 27°C, and

the misting water was incubated at 30°C before misting. Measurements of temperatures within the chambers showed 27°C with no mist and 24°C with misting conditions.

In a supplemental experiment, plants were exposed to 23°C and 27°C without mist at various periods preceding, during, and following a photoinductive period of 14 hours of darkness. As shown in Table 5, no significant differences

TABLE 5.

Effect of temperature on photoperiodic induction in *Pharbitis nil* "Violet".

Temperature (°C)			% of plants with flower buds	Flower buds per 10 plants
Light (12 hrs.)	Dark (14 hrs.)	Light (12 hrs.)		
23	27	27	100	21.4
27	23	27	100	21.8
27	27	23	100	23.0
27	27	27	100	24.5

were found in the number of flower buds of plants which were exposed to these temperature treatments. Thus, the effect on flower initiation noted in these experiments is apparently an effect of the mist itself rather than an effect of the conditions produced by mist treatment.

DISCUSSION

In the present experiment, flowering responses were suppressed when plants were misted in the light either immediately preceding or following a photoinductive period. In contrast, the flowering response was promoted slightly when the plants were misted during a photoinductive period.

In explanation, Tukey et al. (1957) demonstrated that carbohydrates were leached from leaves by water mist in relation to the light intensity present during the leaching period. In addition, Kozel and Tukey (1968) reported that gibberellins were leached in far greater quantities from *Chrysanthemum morifolium* in darkness than in light. Since many workers have reported that carbohydrates and gibberellins have some relationship with flower induction, these findings suggest that the differences between the flowering response of misted and non-misted plants of *Pharbitis nil* may arise in part from the leaching of these substances by mist. Although both carbohydrates and gibberellins are leached from *Pharbitis nil*, a direct relationship between leaching and flowering has not been established.

Many factors other than leaching effect of mist may influence flower initiation, such as oxygen deficiency, decreasing temperature, and change of sensitivity of leaves to photoperiodic induction by misting.

From the results in Table 5, temperature does not seem to be a factor in these experiments. Further, oxygen deficiency does not seem to be a factor, inasmuch

as air at a pressure of 30 psi was used to form the atomized water mist with which the plants were treated. But to make the relationship clear, more detailed experimants will be required especially to separate the influence of leached carbohydrates and growth regulating substances.

SUMMARY

Plants of *Pharbitis nil* "Violet" were subjected to an atomized water mist treatment preceding, during, and following photoinduction of floral initiation. Mist treatment in the light immediately preceding photoinduction suppressed flowering responses. Mist treatment during photoinduction promoted floral initiation. Flowering responses were suppressed by mist of 4 hours or more immediately following photoinduction. On the 1st and 2nd day following photoinduction, flowering responses seem to be in an unstable state which can be affected by mist. However, after 3 days following photoinduction, floral initiation was not inhibited by subsequent exposure to mist.

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