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Relationship of Disc Floret Anthesis and Capitular Diameter to Drooping of Ray Florets in the Vase-life of Chrysanthemum

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Anthesis of disc florets has been shown to adversely influence the drooping of ray florets. Although SADH and $Al_2(SO_4)_3$ delay ray floret drooping, a period of enhanced drooping towards the end of the experimental period occurs independent of the treatments. Linear regressions have been calculated for flower diameter and ray floret drooping. It has been demonstrated that the basic inverse relationship between diameter and ray floret drooping is similar for the three developmental stages used and the treatments.

Key Words: Chrysanthemum, Flower senescence, Post-harvest physiology, SADH, $Al_2(SO_4)_3$, Floret drooping

Introduction

Chrysanthemum is one of the most commonly grown floral crops. Studies made on the postharvest physiology of this flower (although botanically a capitulum, it is referred to as flower in horticultural terminology) deal either with the opening of young buds (Marousky & Nanney 1970, Nichols 1976) or extension of vase-life (Marousky 1969, Kofranek & Halevy 1972). The factors that govern the drooping of the ray florets on which the keepability of the flowers depends have not been studied so far, although loss of turgidity has been noted during storage. For example, Marousky (1969) has defined vase-life in chrysanthemum as "the day flowers were fully opened until the day the petals lost turgidity or decorative value or both".

Previous workers have standardized the stages of flower development on the basis of diameter. In the variety of chrysanthemum used by us, however, flowers with the same range of diameter represent different degrees of anthesis of the disc florets. The present work was taken up with two principal objectives: (i) to examine the relation between the extent of anthesis of disc florets on ray floret drooping, and (ii) to evaluate the reliability of flower diameter as a parameter for estimating keepability of the cut flowers. The latter has been done by determining the relationship of flower diameter with drooping of ray florets and the effect of SADH (succinic acid 2,2-dimethylhydrazide) and aluminium sulphate [Al or $Al_2(SO_4)_3$] on this relationship. SADH was chosen because of its efficacy in delaying senescence of flowers and other

plant organs (Halevy et al. 1966). Al has been reported to prolong the shelf-life of cut flowers (Weinstein & Laurencot 1963, Mohan Ram & Rao 1977).

Material and Methods

Flowers of *Chrysanthemum morifolium* Ramat. of the reflexed spoon type with light-mauve ray florets and yellow disc florets were harvested from potted plants raised in the departmental garden. This particular variety was chosen because it has a distinct demarcation between disc and ray florets. The flowers have about 5–7 whorls of ray florets and 9–11 whorls of disc florets. For experiments on the influence of the extent of anthesis of disc florets on ray floret drooping, flowers were harvested at three developmental stages. Stage I flowers (S I) were harvested when all the ray florets had opened out but the disc florets were still in bud condition; stage II flowers (S II) when half the total number of disc florets were open; and stage III flowers (S III) when all the disc florets had opened. In the S I flowers the inner whorls of ray florets had not elongated fully, whereas in S III, they had extended to more or less their maximal length. Only S I flowers were used for experiments involving SADH and Al. As the required number of flowers of this stage were not always available, flowers with 1 or 2 outer whorls of open disc florets were also included in the sample.

Thirty freshly harvested flowers were placed with their stalks dipping in glass tubes (2.5 × 15.0 cm) containing 50 ml of the test solution prepared in glass-distilled water. Experiments were conducted at 20±2°C with 14 hr daily illumination by cool white fluorescent tubes (500 lux). SADH was used at 100, 200, 400 and 800 ppm and Al at 100, 200 and 400 ppm. The diameter of the flowers and the number of ray florets drooping below the horizontal plane of the flower were recorded over a period of two weeks.

Regression equations were calculated by Bartlett's three group method for flower diameter and drooping of ray florets (Sokal & Rohlf 1969). Data for day 14 were excluded from calculation as they represented the period of excessive drooping.

Results

Drooping of Ray Florets Harvested at Three Stages

There is an initial increase in flower diameter in all the stages (figure 1 A). In S I this increase is maintained till day 10, whereas in S II and S III, the diameter decreases rapidly from day 4 to day 14. The reduction in diameter from day 14 to day 16 is, however, less marked.

It is of interest that no drooping of ray florets is observed on the day of harvest in any of the three stages. The drooping of the ray florets follows an inverse pattern as compared to the change in diameter (figure 1 B). In S I there is little drooping of the ray florets until day 6. This is followed by a period of gradual increase to 6.9% by day 10, leading to greatly enhanced drooping reaching 69.6% on day 16. This is still far less as compared to the extent of drooping attained by S II and S III on the same day. In S II, there is a period of gradual increase in drooping till day 4, followed by a rapid rise till day 12, after which the rate of drooping slows down, reaching 82.7% on day 16. In comparison to both S I and S II, there is a sharp increase in ray florets drooping in S III from the very start of the experiment, attaining 85% by day 12. On day 16 drooping in this stage is 90.3%.

Effect of growth regulators

In the control (held in water) as well as in different concentrations of SADH, a slight

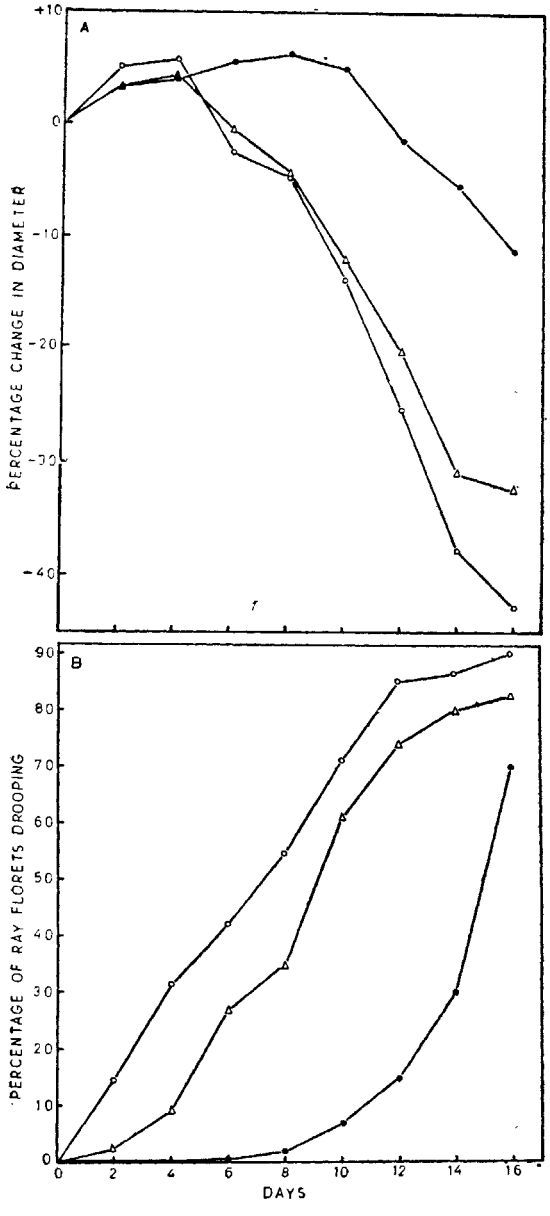

Figure 1 Relationship between stage of harvest of flower and percentage change in diameter (*A*) and percentage of ray florets drooping (*B*). (●—● SI; △—△ SII; ○—○ SIII)

increase in diameter was observed on the second day (figure 2 A). Maximal increase in diameter occurred on this day in 800 ppm of SADH. Following this, there was a decrease in diameter in all the treatments with time. With Al also, increase in diameter was observed on the second day but the maximum occurred in response to 100 ppm (figure 2 B). A gradual decrease in diameter ensued thereafter, the water control showing the maximum.

Al was quite effective as compared to the control in reducing the extent of drooping (figure 3 B). At 200 ppm Al caused a reduction in drooping to nearly one-third of that noticed with the controls between days 5 and 11. Thus the level of drooping in the control on day 5 was achieved in 200 ppm of Al after day 11. The order of effectiveness of other concentrations of Al was 400 ppm followed by 100 ppm. After day 11, however, there was a sharp increase in the extent of drooping in the control and all the treatments.

SADH was not as effective as Al in reducing the extent of drooping. This was due to increased initial drooping of ray florets till day 6 in the control and treatment with the former (figure 3 A). Subsequently, drooping was less marked in the treatments as compared to the control, maximum being at 400 ppm. Drooping of flowers treated with 800 ppm of SADH followed a similar pattern as that of the controls. After day 12, drooping was rapid in the control as well as treatments.

The slopes of the inverse regressions are comparable for the three developmental stages, and for the controls and treatments (figure 4 A-C). This indicates similarity in relationship between flower diameter and ray floret drooping in all cases.

Discussion

There was no initial drooping of the ray florets despite the fact that the three stages at which the flowers were harvested for

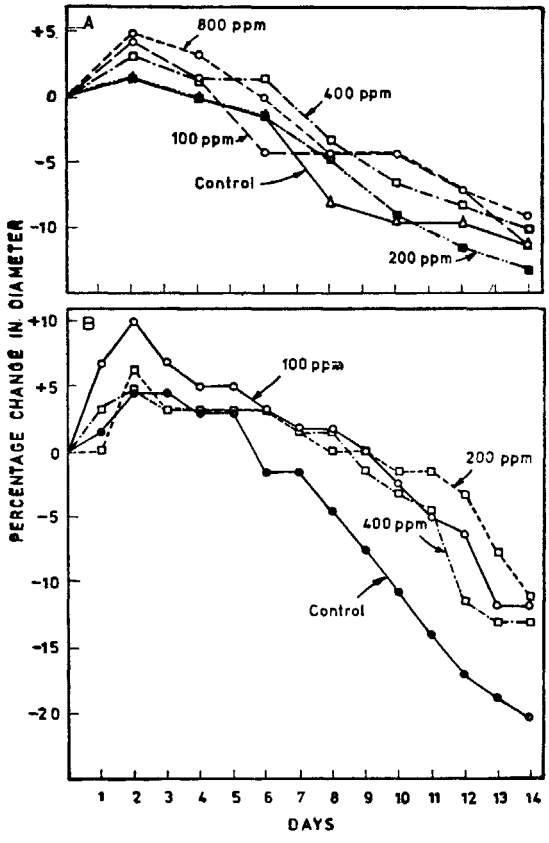

Figure 2 Percentage change in flower diameter in response to SADH (*A*) and Al (*B*)

study were quite distinct from one another (in S I there was no anthesis of the disc florets whereas in S III complete anthesis had occurred). Thus the anthesis of disc florets does not seem to influence the drooping of the ray florets in the intact flowers. In the excised condition, however, there is a direct effect of disc floret anthesis on the drooping of ray florets. The general similarity in the drooping pattern over time and final percentages of ray floret drooping in S II and S III (in which anthesis of disc florets had occurred) as compared to that in S I (in which there was no initial anthesis) supports this observation. This is also strengthened by the data on changes in diameter and linear regressions.

The differences in response observed between the S I flowers and the controls in the experiments using SADH and Al are probably due to the inclusion of flowers having some anthesized disc florets in the experiments. It is likely that in the intact plants, the effect of the anthesizing disc florets on the drooping of the ray florets is countered by the inflow of substances such as gibberellins, cytokinins or even assimilates from the rest of the plant. Jeffcoat and Cockshull (1972) have

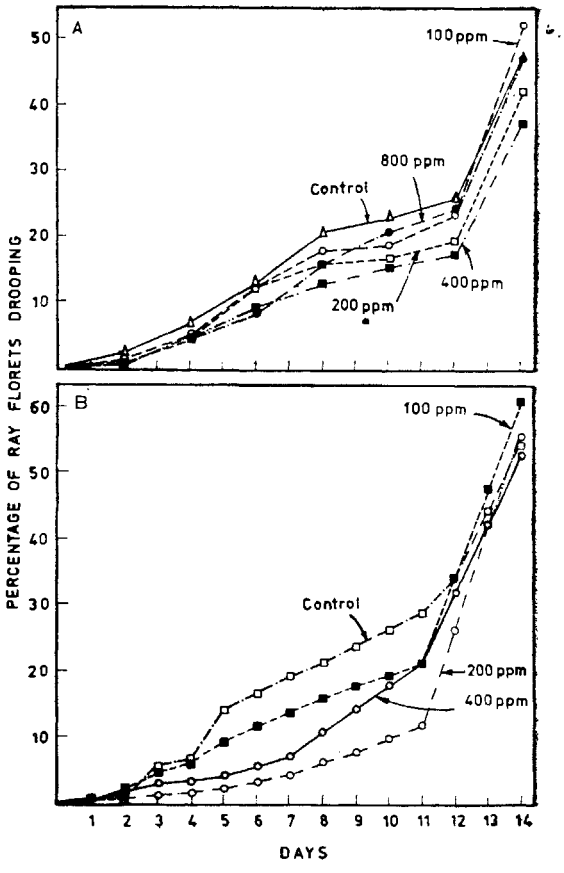

Figure 3 Effect of SADH *(A)* and Al *(B)* on the percentage of ray florets drooping

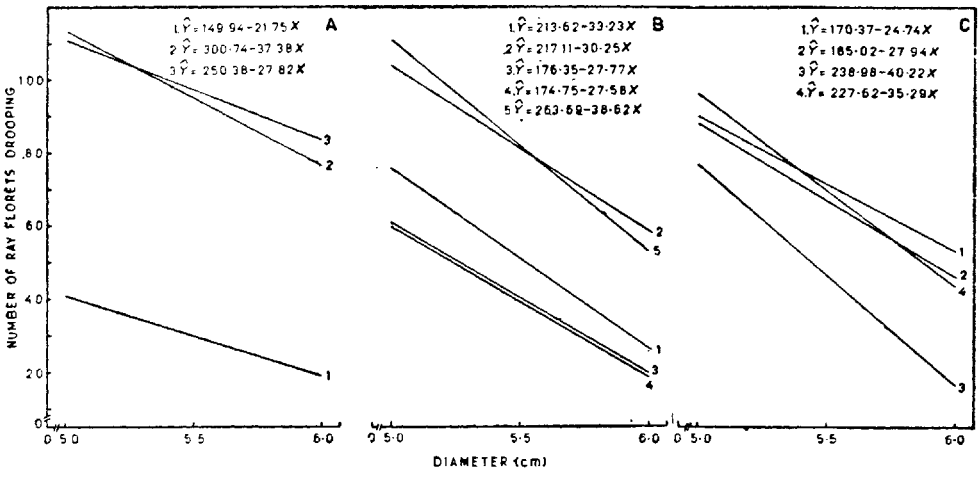

Figure 4 Regressions of flower diameter and drooping of ray florets: *A* Developmental stages (*1* = S I; *2* = S II; *3* = S III); *B*, Treatment with SADH (*1* = control; *2* = 100 ppm; *3* = 200 ppm; *4* = 400 ppm; 5 = 800 ppm); *C*, Treatment with Al (*1* = control; *2* = 100 ppm; *3* = 200 ppm; *4* = 400 ppm). (X = diameter of flowers; $\hat{Y}$ = number of ray florets drooping)

demonstrated that hormones are essential for flower growth in chrysanthemums. Cockshull and Hughes (1967, 1968) have shown that the developing chrysanthemum flower accumulates assimilates.

Al and SADH reduced the extent of drooping of the ray florets; increased floret drooping was, however, observed after day 11 and 12 in flowers treated with these compounds respectively. The controls also exhibited a similar response. This excessive drooping is independent of the treatments given and is therefore due to a factor affecting all ray florets at the same time. Besides, vascular blockage in the peduncle (by physiological or microbial plugging) may also contribute towards floret drooping (Marousky 1972). Further work is in progress to determine the cause of simultaneous ray floret drooping and to ascertain the nature of the stimulus triggered by the anthesizing disc florets on the receptacle, if any.

Reliable (although approximate) estimates of the extent of ray floret drooping can be made with flower diameter as the parameter using the linear regressions obtained for the three developmental stages and the treatments. This relationship holds good for almost the entire period of study except during the final phase of enhanced drooping. The similarity of the slopes of the regressions obtained for the three developmental stages, and for the controls and treatments suggests that the basic inverse relationship between diameter and ray floret drooping does not change. The differences in the intercepts of the regressions are due to differences in the total number of ray florets and flower diameter.

The present work establishes that for the variety of chrysanthemum used, flower diameter can be a valid criterion for evaluating keepability on account of its linear and consistent inverse relationship with ray floret drooping. It is necessary,

however, that the flower samples are graded according to the extent of anthesis of disc florets. In varieties having no clear difference between disc and ray florets, other parameters which take into account the actual age of the flower should be determined.

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