Fig. 1—The Cabbage Looper. This picture was taken with the Exakta and the 100 mm Luminar lens. These caterpillars are "hams" and with a little coaxing will pose for you.

Fig. 2.—The Io Caterpillar. This is also an "easy to pose" subject . This picture was taken with the Contaflex I and a +10 supplementary lens.

Fig. 3.—The Wasp. This wasp was knocked out with CO_2, was photographed just as she recovered, and before she could fly away. My Exakta and 100 mm Luminar lens was used for this picture.

Fig. 4.—The Twig Girdler. This insect was photographed by the Contaflex I and a +5 supplementary lens.

Fig. 5.—The Whitefly and Pupa Cases. This picture was made with an Exakta and the 16 mm Luminar lens.

Fig. 6.—The Jumping Spider. This picture was made with the Exakta and a 100 mm Triotar lens.

Fig. 7.—The Boll Weevil. This picture was made with the Exakta and the 40 mm Luminar lens.

Fig. 8.—The Curvularia Conidia and Conidiophores. This picture was made with an Exakta attached to a microscope. It shows the fungus spores and spore stalks.

I hope that these ideas will be of some help to those of you who are interested in close-up photography.

THE EFFECT OF PHOSFON AND GIBBERELLIC ACID ON THE GROWTH AND CHEMICAL COMPOSITION OF CHRYSANTHEMUM MORIFOLIUM 'BLUE CHIP'

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2,4-Dichlorobenzyltributylphosphonium chloride (Phosfon) is a chemical "growth retardant," a compound that retards cell division and/or cell elongation without causing drastic formative changes in the growth habit of the plant. Chrysanthemum growers use Phosfon to produce compact pot-grown plants.

Certain growth characteristics are noticeable when a chemical growth retardant works successfully on a plant. The most striking effect caused by growth retardants is to decrease internode length, and therefore, total height of plants. Leaves of treated plants are usually darker green than those of untreated plants. The stem also thickens and the plant tends to become compact and sturdy (1, 2, 3, 10, 11).

Most experimental work on growth retarding chemicals has studied their effect on anatomical and morphological changes in the plant as reflected in plant size, form, color, rates of cell division and cell elongation, and the time of appearance of plant organs, particularly flowers. Relatively little is known about the mode of action of these compounds. This experiment was initiated to study effects of Phosfon and gibberellic acid (GA) on the growth and chemical composition of the chrysanthemum plant. There have been reports that the growth retarding effect of Phosfon could be nullified by application of suitable concentrations of gibberellic acid. A study of both Phosfon and gibberellic acid might give some additional insight into their possible mode of action in regulating plant growth.

MATERIALS AND METHODS

A 3 x 2 factorial experiment was established to test the effects of 3 levels of Phosfon and 2 levels of gibberellic acid on the growth and chemical composition of *Chrysanthemum morifolium* 'Blue Chip,' a short-day 9-week variety. A randomized block design was utilized with 3 replications and 3 plants to an experimental unit. Three rooted cuttings of this clone were planted February 18, 1964 in 6-inch plastic pots using a mixture of two-thirds sterilized sandy soil and one-third imported peat.

Plants were pinched February 23, and 60 watt incandescent lights placed 6 feet above the plants were turned on from 11:00 P.M. to 2:00 A.M. to keep the plants in a vegetative condition. Plants were pruned again to maintain a maximum of three laterals per stem.

Treatments were applied on March 19, 1964. Levels of Phosfon were 0, 0.3 ml and 0.6 ml per

pot of a 10 per cent active liquid material. Phosfon was mixed with 50 ml of water and applied as a drench. The plants had been watered thoroughly 24 hours prior to treatment. Gibberellic acid was applied as a foliar spray until runoff at concentrations of 0 and 150 parts per million.

Short day treatments were begun March 25, 1964, by placing black sateen cloth over the plants from 5:00 P.M. to 8:00 A.M.

Growth measurements and samples for chemicals analysis were taken at 5 sampling times from March 19-25. Plants were measured again at the termination of the experiment, 66 days after treatment. Chemical analyses were also made at the termination of the experiment.

Growth measurements included plant height, stem diameter and length of fourth internode from the break, fresh and dry weight of stems and leaves above the break.

Flower data included number of flowers opened 66 days after treatment, number of buds showing color and flower diameter.

Samples of leaves and stems taken for chemical analyses were harvested, dried, ground and analyzed for N, P, K, Mg and Ca (5).

The data were statistically analyzed by the analysis of variance method as described by Snedecor (9).

Results

Flowering

Phosfon and gibberellic acid influenced the diameter of flowers and number of buds showing color differentially (Table 1). Phosfon did not effect number of buds showing color but did reduce flower diameter and number of flowers fully opened. Gibberellic acid had no effect on flower diameter or number of buds showing color but did increase number of flowers fully opened.

Growth Measurements

Plant height—Gibberellic acid increased and Phosfon decreased plant height at 66 days (Table 2). The largest decrease in height occurred in plants treated with the high level of Phosfon.

Internode diameter—Phosfon and gibberellic acid had no effect on the diameter of the fourth internode (Table 2).

Internode length—Gibberellic acid and the

Table 1. Effect of Phosfon and GA on Flower Diameter, Number of Flowers Fully Opened and Number of Buds Showing Color

Treatment	No. Flowers Fully Opened	No. Buds Showing Color	Flower Diameter (cm)
0 Phosfon	29.1	44.4	6.0
Phosfon (0.3 ml)	18.5	42.0	4.9
Phosfon (0.6 ml)	14.8	45.0	4.3
0 Gibberellic Acid	19.1	43.6	5.3
Gibberellic Acid (150 ppm)	23.0	44.1	5.2

Table 2. Effect of Phosfon and GA on Plant Height and Length and Diameter of Fourth Internode at 66 Days.

Treatment	Plant Height (cm)	Internode Diameter (mm)	Internode Length (mm)
0 Phosfon	75	33	41
Phosfon (0.3 ml)	67	34	42
Phosfon (0.6 ml)	61	34	45
0 Gibberellic Acid	66	33	40
Gibberellic Acid (150 ppm)	70	35	45

high level of Phosfon increased length of the fourth internode.

Fresh and dry weights of stems and leaves—Phosfon had no effect on the fresh or dry weights of leaves (Table 3). There was a gibberellic acid-time interaction on fresh weight of leaves (Table 4). Gibberellic acid reduced fresh weight of leaves at the 66-day sampling time only.

Gibberellic acid did not affect dry or fresh weight of the stems (Table 3). Phosfon decreased fresh and dry weight of stems at the 66-day sampling time (Table 5). The fresh weight of stems shows a Phosfon-gibberellic acid interaction (Table 6). The 0.3 ml level of Phosfon decreased fresh weight of stems when added alone, but had no effect on fresh weight of stems when gibberellic acid was added. The high level of Phosfon decreased fresh weight of stems in the presence or absence of gibberellic acid.

Table 3. Effect of Phosfon and GA on Grams of Fresh and Dry Weight of Leaves and Stems (Average of All Sampling Times)

	Fresh Weight		Dry Weight	
Treatment	Stems	Leaves	Stems	Leaves
0 Phosfon	12.25	21.21	3.54	4.01
Phosfon (0.3 ml)	11.28	20.52	3.32	3.86
Phosfon (0.6 ml)	10.92	20.60	3.14	3.83
0 Gibberellic Acid	11.28	21.19	3.30	3.94
Gibberellic Acid (150 ppm)	11.69	20.37	3.37	3.86

Table 4. Interaction of Gibberellic Acid-time on Grams of Fresh Weight of Leaves

	Fresh Weight	
Treatments	First 5 Samplings*	66-Day Sampling
0 Gibberellic Acid	15	58
Gibberellic Acid (150 ppm)	15	52

*Average

Chemical Analysis

Potassium—Gibberellic acid and Phosfon had no significant effect on K in stems or leaves (Tables 7, 8).

Phosphorus—Gibberellic acid had no effect on leaf or stem P (Table 8). Phosfon decreased P in the leaves (Table 7).

Magnesium—Phosfon-time interaction on Mg content of leaves is shown in Table 9. Both levels of Phosfon decreased the Mg content of the leaves at the 66-day sampling time. Gibberellic acid had no effect on Mg content in the leaves.

There was a Phosfon-time-gibberellic acid in-

Table 7. Effect of Phosfon on Per Cent K, P, Mg, Ca and N of Stems and Leaves (Average of All Sampling Times)

Treatment	K	P	Mg	Ca	N
			STEMS		
0 Phosfon	3.78	0.29	0.19	0.27	1.30
Phosfon (0.3 ml)	3.78	0.27	0.20	0.28	1.36
Phosfon (0.6 ml)	3.78	0.27	0.20	0.28	1.40
			LEAVES		
0 Phosfon	3.32	0.44	0.29	0.22	2.99
Phosfon (0.3 ml)	3.20	0.40	0.25	0.22	2.93
Phosfon (0.6 ml)	3.16	0.40	0.26	0.25	2.94

Table 8. Effect of Gibberellic Acid on Per Cent K, P, Mg, Ca and N of Stems and Leaves (Average of All Sampling Times)

Treatment	K	P	Mg	Ca	N
			STEMS		
0 Gibberellic Acid	3.75	0.28	0.20	0.28	1.40
Gibberellic Acid (150 ppm)	3.81	0.27	0.19	0.27	1.30
			LEAVES		
0 Gibberellic Acid	3.15	0.41	0.26	0.22	3.01
Gibberellic Acid (150 ppm)	3.30	0.41	0.27	0.24	2.89

Table 5. Interaction of Phosfon-time on Grams of Fresh and Dry Weight of Stems

	Dry Weight		Fresh Weight	
Treatment	First 5 Samplings*	66-Day Sampling	First 5 Samplings*	66-Day Sampling
0 Phosfon	1.5	14	7.5	40
Phosfon (0.3 ml)	1.5	12	7.3	36
Phosfon (0.6 ml)	1.5	11	7.3	33

*Average

Table 6. Interaction of Phosfon-Gibberellic acid at 66 Days on Grams of Fresh Weight of Stems

Treatment	0 Phosfon	Phosfon (0.3 ml)	Phosfon (0.6 ml)
0 Gibberellic Acid	43	32	33
Gibberellic Acid (150 ppm)	37	40	34

Table 9. Interaction of Phosfon-time on Per Cent Mg and N of Leaves

Treatment	Mg		N	
	First 5 Samplings*	66-Day Sampling	First 5 Samplings*	66-Day Sampling
0 Phosfon	.18	.82	2.89	2.87
Phosfon (0.3 ml)	.16	.61	2.90	2.47
Phosfon (0.6 ml)	.18	.63	2.80	2.91

*Average

Table 10. Interaction of Phosfon-gibberellic Acid-time on Per Cent Mg In Stems

Treatment	Magnesium	
	First 5 Samplings*	66-Day Sampling
Untreated	.20	.19
Gibberellic Acid (150 ppm)	.19	.17
Phosfon (0.3 ml)	.19	.25
Phosfon (0.3 ml) + Gibberellic Acid (150 ppm)	.20	.22
Phosfon (0.6 ml)	.19	.25
Phosfon (0.6 ml) + Gibberellic Acid (150 ppm)	.20	.17

*Average

Table 11. Interaction of Phosfon-gibberellic Acid-time on Per Cent Ca of Stems

Treatment	Calcium	
	First 5 Samplings*	66-Day Sampling
Untreated	.18	.72
Gibberellic Acid (150 ppm)	.16	.79
Phosfon (0.3 ml)	.18	.81
Phosfon (0.3 ml) + Gibberellic Acid (150 ppm)	.19	.69
Phosfon (0.6 ml)	.19	.84
Phosfon (0.6 ml) + Gibberellic Acid (150 ppm)	.18	.69

*Average

teraction in Mg content of the stems (Table 10). Stems of plants receiving 0.3 and 0.6 ml of Phosfon and 0.3 ml Phosfon plus gibberellic acid increased the Mg content at the 66-day sampling time. Stems of plants receiving gibberellic acid or gibberellic acid plus the high level of Phosfon decreased in Mg content at 66 days.

Calcium—Ca in leaves was increased in plants treated with the high level of Phosfon (Table 7). Gibberellic acid also increased the Ca content in the leaves (Table 8).

A Phosfon-gibberellic acid-time interaction in the stems is shown in Table 11. Stem Ca was highest at 66 days in plants treated with the 0.3 and 0.6 ml Phosfon or gibberellic acid. Plants treated with Phosfon plus gibberellic acid were the same as untreated plants.

Nitrogen—Leaves of plants treated with 0.3 ml Phosfon decreased in nitrogen content at the 66-day sampling time (Table 9). There was no difference in nitrogen content of the leaves in untreated plants or in plants treated with the high level of Phosfon.

Gibberellic acid decreased (Table 8) and Phosfon increased nitrogen content of the stems (Table 7).

Discussion

Phosfon had no effect on the total number of chrysanthemum flowers produced but it did delay flower opening and reduce flower diameter. These results are in agreement with some of the work reported and different than the results found by others with different plant species (2). It is apparent that plants respond differently to Phosfon and that one species' response to a growth retardant is no indication of another species' response.

The effect of gibberellic acid on flowering of chrysanthemum was not opposite to that of Phosfon in all cases.

Reports (7, 8) indicate that growth retardants affect stem elongation by preventing cell division in the subapical meristematic zone of the stem. The apical meristem continues to function in the presence of the growth retardant. Stem elongation, a function of the subapical meristem, is retarded (8). However, in the present experiment Phosfon and gibberellic acid increased the length of the fourth internode. Thus the effects of gibberellic acid were not opposite. It should be pointed out that the stem section being measured was already present at the time of treatment. Since Phosfon did decrease plant height, it was probable that the response is confined to the tissues formed after treatment.

Sachs (8) reported that gibberellic acid and Phosfon are mutually antagonistic only with respect to stem elongation and not with other aspects of growth of chrysanthemum. However, Sachs used higher concentrations of Phosfon than those used by the author. Sachs also found that gibberellic acid-treated stems were considerably thinner than those of the controls, but such differences were not found in the present experiment. Probably the effect of Phosfon differs with the internode being measured. Therefore, a definite conclusion about Phosfon action on internode elongation and stem diameter must include a discussion of the various sections of the stem since it appears that the effect of the growth retardant will vary with the section and age of the stem. Concentration of the growth retardant is also important and only concentrations that do not severely injure plant tissue should be used.

Most of the previous experiments in the literature with chemical growth retardants have dealt with analysis of the entire plant; that is, leaves plus stems, and for this reason some of these results are not directly comparable to the results presented here. It is not enough to know that Phosfon reduced total fresh and dry weight of a plant and any test should be refined to separate leaf and stem analysis. Observations based on the tests conducted herein would indicate that attention should be focused on the tissues formed after treatment with the chemicals.

Kuraishi and Muir (6) reported that gibberellic acid increased fresh weight of *Raphanus sativus* L. var. Acanthiformis Makino. The results of the present work indicate that gibberellic acid reduces fresh weight of the leaves of chrysanthemum. However, gibberellic acid did not directly affect dry or fresh weight of stems. Gibberellic acid was antagonistic to one level of Phosfon but not to the other.

Gibberellic acid and phosfon exerted varied effects upon the inorganic constituents measured in the present work. Phosfon decreased P in the leaves but not the stems. The effect was similar in combination with gibberellic acid, which had no simple effect on phosphorus levels. Phosphorus is important in many plant reactions and the supply of this element would greatly affect plant metabolism. Phosphorus deficiency sometimes appears as a darkening of the green coloration of the leaves. The dark green color that is characteristic of plants that have been treated with Phosfon could be caused by a phosphorus deficiency.

Per cent Mg in chrysanthemum plants was shown to be affected by Phosfon. Mg is important not only because of its role in chlorophyll molecule but also because it is a necessary cofactor for a number of enzymes. Plants treated with Phosfon and other growth retardants characteristicly respond by producing a darker green plant and the present work was no exception. Humphries (4) found that chlorophyll content in the leaves was increased in tobacco plants grown in culture solutions containing CCC and the corollary could be that magnesium content also increased. The work reported herein showed that while magnesium content in the stems did increase in plants treated with Phosfon, the magnesium content in the leaves decreased. However, leaf area of plants treated with the recommended rates of the growth retardants usually increases over that of untreated plants so the decrease of magnesium in the leaves may be due to leaf expansion.

Both gibberellic acid and Phosfon increased the per cent Ca in the leaves and also affected stem calcium via an interaction. Plants which received Phosfon or gibberellic acid plus Phos-

fon decreased Ca content below that of untreated plants. Thus we have another example of gibberellic acid and Phosfon having similar direct effects upon an aspect of plant growth. The decrease in calcium of the stems caused by gibberellic acid-Phosfon combination does suggest, however, that their additive effects may be different in some instances.

The effect of Phosfon on leaf N is similar to the effect on Mg. The median level of Phosfon decreased tissue N while the higher level had no effect. These examples illustrate an important aspect of the role of growth retardants on plant growth. Effects of the chemical will vary depending upon concentration. Whereas the gross morphological effects of Phosfon levels are the same, e.g., reduction in plant height, their physiological effects vary.

The effect of gibberellic acid on stem N was opposite to Phosfon and adding gibberellic acid to Phosfon treated plants negated its effect. Thus, the growth promoter reversed the effect of the growth retardant on a specific element, indicating that gibberellic acid and Phosfon are antagonistic in some instances but not in others.

The sampling times selected for the present experiment were very arbitrary since the literature offered no information on the effect of Phosfon on inorganic or organic plant constituents. It is important to note that most of the morphological effect of Phosfon, as well as gibberellic acid, took place sometime during the 6-day and 66-day sampling time.

Phosfon is held tightly to soil particles and thus is taken up slowly by the plant when applied to the soil. Much of the work with growth retardants has been done using solution culture and results will definitely be different from experiments that are conducted using soil as the growing media. It is known that intact plants and plant parts absorb more Phosfon or CCC from water solutions than from soil cultures and thus the effects, at least to degree, will differ.

In many cases the effect of Phosfon on the elemental constituents of chrysanthemum was found to vary with concentration of the growth retardant.

There was no consistent evidence that Phosfon acted as an anti-gibberellin. In some instances gibberellic acid overcame the growth effects induced by growth retardants, but this is not unique and similar reports are available for maleic hydrazide, kinetin, IAA, coumarin and triiodobenzoic acid. Thus, many chemicals in addition to growth retardants, totally unrelated structurally, may be mutually antagonistic with gibberellin. Growth retardants exhibit no apparent structural similarities to each other or to gibberellic acid even though their morphological effects on the plant may be similar.

Summary

A study was made of effects of Phosfon and gibberellic acid on flowering, vegetative growth and chemical composition of *Chrysanthemum morifolium* 'Blue Chip.'

Effects on flowering, growth and levels of 5 elements gave some evidence of Phosfon-gibberellic acid antagonism and lack of antagonism. Data are presented to support the following conclusions:

1. Phosfon decreased flower diameter and delayed flower maturity. Gibberellic acid induced early opening of flowers without affecting flower diameter. Neither Phosfon nor gibberellic acid affected total number of flowers.

2. Phosfon reduced plant height and gibberellic acid increased it. Both chemicals increased length of the fourth internode but did not affect stem diameter.

3. Phosfon had no effect on fresh and dry weight of leaves; gibberellic acid reduced fresh and dry weight of leaves. Phosfon decreased fresh and dry weight of stems when applied alone but this effect was nullified by adding gibberellic acid.

4. Phosfon decreased and gibberellic acid had no effect on K content in stems or leaves.

5. Phosfon decreased leaf P and gibberellic acid had no effect.

6. Phosfon increased magnesium in stems and decreased it in leaves. Gibberellic acid and gibberellic acid plus the high level of Phosfon decreased Mg content in stems.

7. Phosfon and gibberellic acid applied separately increased Ca content in stems and there was no increase when Phosfon plus gibberellic acid were applied.

8. The low level of Phosfon increased leaf N while gibberellic acid and the high level of Phosfon did not affect N in the leaves. Gibberellic acid decreased stem N and the high level of Phosfon increased stem N in the absence of gibberellic acid.

9. The mode of action of Phosfon and growth retardants in general was discussed.

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POST-HARVEST FUNGICIDES TO CONTROL FUSARIUM DISEASE OF GLADIOLUS

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Gladiolus corms are treated with fungicides to control *Fusarium oxyporum f. gladioli* Snyder and Hanson which causes an annual loss of more than one million dollars in Florida. Most of the damage results from latent infections carried in corm stocks (1, 3). Fungicides are usually applied before planting but post-harvest and pre-storage treatments are also recommended (4, 5). To control new infections occurring through wounds made in harvesting and cleaning the corms, the post-harvest treatment is important, especially since increasing numbers of flower growers are cleaning corms as they are harvested. Only the less phytotoxic fungicides and low concentrations of the more effective ones are recommended for use after harvesting. Consequently, another treatment before planting is often advisable to obtain better control of the latent infections (2). The purpose of this investigation is to find a post-harvest treatment to take the place of the pre-planting treatment and to promote maximum production of flowers and corms.

EXPERIMENTAL METHODS

Corms of Valeria and Spic and Span varieties were harvested on June 4, 1963 and cleaned as lifted. Both corm stocks had been grown on Fusarium-infested soils for three successive seasons. Immediately after cleaning, the corms were sprayed with a dilute suspension of Fusarium conidia produced on potato-dextrose agar. Apparently sound corms, graded to approximately three inches in diameter, were divided into lots of 25 corms each, which constituted an experimental unit. Four lots were used for each treatment. Each lot was adjusted to a common mean weight by interchanging larger for smaller corms between lots of a variety.

The Valeria corms were used to compare post-harvest and pre-planting dip applications of fungicides and the Spic and Span to test the effectiveness of some new fungicides applied as post-harvest dips. The 25-corm lots held in mesh bags were soaked 15 minutes on June 6 in the freshly prepared fungicidal dip preparations listed in Table 1. The corms were cured in an open shed at a temperature range of about 74-88° F., then placed in 40° F storage until October 23. The pre-planting treatments (15 minutes) were made on October 27 and both varieties were planted on October 29 and 31 in the field using a completely randomized block design with 4 replicates. Sprout emergence data were taken November 11. Flowers were harvested between January 10 and 30 and corms were lifted on April 13, 1964.

RESULTS

In the first experiment (Table 2) flower and corm production were improved by the use of each fungicide except Nurelle. Corms treated after harvest with Morsodren or with captan plus Thylate produced as many or more quality flowers and corms than those that received the standard pre-planting treatments of Ceresan L and Dowicide B; and all post-harvest treatments

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