WETTABLE POWDER DUSTS

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Wettable powder formulations of fungicides, insecticides and miticides have been used as dusts in greenhouses for more than 40 years. The practice has slowly gained popularity even though little research has been published and chemical companies have not included this usage on their labels.

For a few years, such a use of wettable powders was considered illegal since it was not labelled. This now appears to have been resolved with the FIFRA (Federal Insectice, Fungicide and Rodenticide Act) interpretation of 1979 (10,11,12). Aplying a rate of less than that on the label in conjunction with air as the conveyance medium instead of water is now considered to be legal.

Advantages of wettable powders as dusts:

1. Less pesticide is consumed.
2. Exposure time for the applicator is less than 5% of that required for spraying.
3. Residues on plants are decreased and spray spotting is not present.
4. Plant coverage is excellent.
5. Residual activity of the pesticide is enhanced.
6. Labor requirement is lower.
7. Costs of pest control are greatly reduced.

The procedure is simple. Mix equal parts of materials selected from the following incomplete list. Then dust weekly at a rate of only 1 to 2 oz. of the mixture per 1000 sq. ft.

<u>General Contact</u>

Bendiocarb (Ficam) 76 WP
Malathion 25 WP
Endosulfan (Thiodan) 50 WP
Diazinon 50 WP

<u>Miticide</u>

Dienochlor (Pentac) 50 WP (use 1/2 part)*
Cyhexatin (Plictran) 50 WP
Fenbutatin-oxide (Vendex) 50 WP
Propargite (Omite) 30 WP
Dicofol (Keltnane) 18.5 WP

Stomach and Contact Poison

Carbaryl (Sevin) 50 WP
Methoxychlor (Marlate) 50 WP

Fungicide

Captan 50 WP or 80 WP
Ferbam 76 WP
Mancozeb (Fore) 80 WP
Chlorothalonil (Daconil 2787) 75 WP
Zineb (Dithane Z-78) 80 WP
Folpet (Phaltan) 50 WP
Sulfur WP or dust
Maneb (Dithane M22) 80WP

Aphicide

Pirimicarb (Pirimor) 50 WP (use 1/2 part)*
Lindane 25 WP

* These materials are effective at lower concentrations in the mixture.

Some common materials cannot be used. Benomyl (Benlate) clogs the duster. Many pesticides are not formulated as wettable powders that can be used as dusts.

Once the mixture is made, it is blown into the greenhouse atmosphere over the crops. The particles are so fine that they remain suspended in the air for hours. The tiny particles appear to acquire a positive charge as they leave the duster and as a result, or since they remain suspended so long, the lower surfaces of the leaves are also protected. Uniform coverage is enhanced in greenhouses equipped with horizontal air flow. No research has been reported on the individual components to ascertain whether or not all the wettable powders listed above provide the same coverage on both upper and lower plant surfaces.

To reduce exposure to personnel, most greenhouse operators prefer to use wettable powder dusts prior to a relatively inactive day each week, possibly the last thing Friday or Saturday. They find that it is essential to dust every week since this is a minimal pesticide application used only as a preventative measure. Less material is generally required for exclusion than for eradication of a pest.

During the summer, when temperatures are high, it may be necessary to dust late at night since ventilators should be closed for at least 4 hours.

The usual application rate is 1 to 2 oz. of the mixture per 1000 square feet. This means that one ounce may be enough during winter months while 2 oz. is more appropriate during the summer. Likewise, if a house contains only one layer of bedding plants, it will require less than a house filled with plants from top to bottom.

The rate is low enough so that the residue is not noticeable except on glossy leaves such as gardenia.

Control is not necessarily complete. Most of the time, 95-99% control is anticipated. But, on occasion with this method, one hears of a greenhouse operator who obtains sufficient control and has not sprayed, smoked, gassed or bombed in years. When a problem occurs, a localized spray is usually all that is needed to eradicate the problem.

Formulations labelled as "dusts" should not be used. They contain relatively low concentrations of active ingredient. The particles are larger than those in wettable powders and they settle out too fast. Furthermore, the fillers (usually talc) serve no useful purpose and simply make the plants dirty.

Exercise caution with wettable powder dusts. The application of the dust is so fast that the pesticides seldom come near the persons distributing them. They become careless and stop using masks or respirators even with highly toxic pesticides. Full protective gear must be used as when applying any toxic chemical. And, as with smokes and bombs, an observer or a second duster should be present to guard against an unusual accident. Follow safety precautions such as locking and posting doors and ventilating before resuming work in the house.

Although wettable powder dusts are in common use across the country (and in foreign countries), some states may have regulations precluding their use. If you have any doubts about the legality in your state, contact your regulatory officials.

References

1. Koths, J. S. 1958. Commercial Chrysanthemum Culture. University of Connecticut, Extension Report 43. 6 p.

2. Koths, J. S. 1961. Commercial Carnation Culture. University of Connecticut, Extension Report 38. 6 p.

3 Koths, J. S. 1967. Dusting Greenhouses. Connecticut Greenhouse Newsletter 3(6):8-9.

4. Ridgway, Henry W. 1969. Pesticide Application Equipment. Chapter 30 in Mastalerz, John W. and Robert W. Langhans, editors. Roses. PA Flower Growers, New York State Flowers Assn., Inc. and Roses, Inc. . 331 p.

5. Maisano, J. J., Jr., C. A. Salsedo, R. W. Judd, Jr., and J. S. Koths. 1976. A Cultural Guide for Commercial Geraniums. University of Connecticut Bulletin 76-32. 8 p.

6. Koths, J. S. 1977. An Illegal Practice: Wettable Powder Dusts. Conn. Greenhouse Newsletter 82:1-5.

7. Lindquist, R. K. 1978. On the New Amendments to the Pesticide Law. Florists Review 163(4226):40-41. Nov. 30.

8. Koths, J. S. 1979. Dr. Lindquist on Wettable Powders. Conn. Greenhouse Newsletter 90:12.

9. Editors. 1979. Wettable Powders. Connecticut Greenhouse Newsletter 93:7-8.

CONTROLLING WEEDS IN OR NEAR THE GREENHOUSE

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Dr. Ahrens has conducted many herbicide trials in the greenhouse over the years. The last issue (#120) summarized the control aspects of herbicide use in the greeenhouse as interpreted by Mr. Maisano. The following article presents details of Dr. Ahrens' research.

Numerous experiments have been conducted at the Valley Laboratory over the past 10 years to evaluate the usefulness and potential hazards of herbicides in and around greenhouses. In addition, many grower problems involving herbicides in greenhouses have been investigated. The following is a brief summary of our findings.

To use herbicides effectively in or around greenhouses, it is essential to understand their potential hazards. These hazards include:

A. Production of vapors toxic to plants.
B. Contamination of ground water wells.
C. Injury to plants in flats or pots from root uptake.
D. Mistaking herbicides for other pesticides.
E. Use of field soils that contain residues for potting mixes.
F. Misuse of herbicides by gross overapplication or by sabotage or vandalism.

A. To be safely used under benches or under flats or pots in greenhouses, a herbicide should not produce phytotoxic vapors. Herbicides that we or others have found to produce phytotoxic vapors include:

2,4-D		Spike	- tebuthiuron
Casoron		Treflan	- trifluralin
Diclomec	dichlobenil	Goal	- oxyfluorfen
Norosac		Pramitol	- prometon
Tordon	- picloram	Vapam	- metham
Lasso	- alachlor	Dowfume	- methyl bromide
Dual	- metolachlor	Pentachlorophenol	- PCP
Aatrex	- atrazine		

Scott's Ornamental Herbicide II - oxyfluorfen+pendimethalin

Other herbicides in our tests that produced vapors that were mildly toxic to plants included:

Chloro IPC, Furloe	chlorpropham	Ronstar, Scott's Ornamental Herbicide I	oxadiazon
Devrinol - napropamide			

All of these would be hazardous to use in greenhouses with live plants other than those listed on the labels.

B. Contamination of ground water can occur from soluble hebicides applied too heavily or dumped in the vicinity of wells. Two herbicides that have contaminated wells supplying greenhouses are Tordon (picloram) and Banvel (dicamba). Both are highly toxic to annual plants, highly water soluble and neither has any place in or near greenhouses. Water from ponds or streams where Tordon is used on the watershed is best not used to irrigate plants without testing.

C. Applicaton of many residual herbicides in ground beds is hazardous to flats or pots of plants placed on the treated areas. Problems occur as roots grow into treated soil and absorb the herbicide or as ponding occurs and the herbicides dissolve in the water and penetrate the containers. Safe herbicides for pretreatment of ground beds include Diquat, Paraquat and Roundup for preplant control of established weeds, and Surflan at 2 to 3 teaspoons per 100 ft^2 for preemergence control under flats or containers. Surflan inhibits roots but does not translocate in the plant. Tilling soil treated with Diquat, Roundup or Paraquat before plants are planted in the soil reduces danger of root uptake.

A current experiment indicates that at least one week should elapse after Roundup application and placement of flats or pots with exposed roots. However, Roundup sprays on soilless potting mixes such as peat, perlite and sand may seriously injure herbaceous plants for several weeks after application. Roundup is not rapidly detoxified in such mixes as it is in soil. Spraying of weeds growing on stored piles of soilless potting mixes is therefore dangerous.

D. Mistaking herbicides for other pesticides can be minimized by storing herbicides apart from other pesticides and by reserving a separate sprayer for herbicides.

E. Contaminated field soil. If field soil is obtained for greenhouse use, it could be contaminated with herbicide residues such as atrazine or simazine that are used on corn fields. If the cropping history of the soil is unknown, it can be bioassayed, using seeded and transplanted annuals as test plants. Oat is a good test plant for simazine or atrazine. For a control planting, one can thoroughly mix 3 tablespoons of activated carbon (such as Gro-Safe) into a flat of the same soil. The carbon detoxifies most field residues of herbicides. If growth is much better in the carbon-treated flat than in the untreated one, herbicide contamination is suspected.

F. Misuse of herbicides by gross over-application or by sabotage can occur with any herbicide. Sabotage has occurred with disgruntled (or fired) employees, where herbicides were readily available. Diagnosing the problem is often difficult. Herbicides are best stored under lock and key and out of the greenhouse area.

In the case of the soil fumigants (Vapam, methyl bromide), sufficient time and warmth of soil is necessary before planting to allow the vapors to dissipate. Cold soils in the late fall or early spring greatly delay dissipation. Plants placed in treated houses or soil under these conditions are killed. Using 2,4-D herbicides around greenhouses is hazardous because of potential drift of vapors and spray droplets into the houses.

Herbicides that we have found to cause no injury to plants in tests in plastic enclosures included:

Asulox	- asulam	Princep	- simazine
Dacthal	- DCPA	Roundup	- glyphosate
Diquat	- diquat	Surflan	- oryzalin
Paraquat	- paraquat	Tenoran	- chloroxuron
Gramoxone	- paraquat	Karmex	- diuron

It is possible even these could be hazardous if sprayed onto heating pipes, which would greatly increase vaporization. Many other herbicides have not been evaluated for indoor use and should be considered hazardous until proven otherwise.

If a greenhouse is contaminated with a herbicide producing phytotoxic vapors, it may be possible to decontaminate it with activated carbon (Gro-Safe or Aqua Nuchar). Our earlier research showed that 100 to 200 lbs of activated carbon will detoxify 1 lb of most organic herbicides. Thus, if a herbicide were applied at 4 lbs/A, up to 800 lb/A of activated carbon would be required. The carbon can be mixed with water and sprayed on. Sometimes it is necessary to incorporate the carbon into the soil.

Effective treatments to control established weeds and prevent regrowth under benches include:

Herbicide	Per Gal of Water
Princep 80W	3 tablesoons
plus	plus
Diquat*	2 tablespoons

An alternative treatment:

Herbicide	Per Gal of Water
Surflan 75W	2-3 tablespoons
plus	plus
Diquat*	2 tablespoons

Apply about 1 qt of mix per 100 sq. ft.
Avoid spraying of heat pipes.

* Roundup at 2 tablespoons may be substituted for Diquat.

OUR APOLOGIES

This issue is late - it should have been labelled "May." Instead, it is "June, #121".

We hope that it will be possible to bring the Newsletter back into schedule so please remember that your subscription is not truly on a yearly basis. Each "year" will consist of six issues no matter how long the year is.

ALL-AMERICA FIELD DAYS, COMSTOCK, FERRE & CO., WETHERSFIELD
TAKE AN ALL-AMERICA FIELD TRIP THIS SUMMER

By Walter L. Harper
Assoc. Professor of Floriculture

Each year several new garden flowers and vegetables are chosen to receive the All-America Awards for their outstanding qualities. They are picked by the All-America Selections which is an educational nonprofit organization for testing new flower and vegetable seed. This organization was established in 1932.

Each year entries are submitted to All-America Selections from private, commercial and government plant breeders. Plants are grown and tested against a "comparison" trial representing the nearest equivalent existing variety or cultivar.

Trial flower and vegetable grounds are located throughout the United States and Canada. There are about 60 trial grounds in all.

Trials are judged by directors of botanical gardens, professors of leading universities and research directors of America's leading seed companies.

Entries are grown under a code number so the judges have no knowledge of who submitted the entry. Only those entries that score well over most of the country have a chance of winning sufficient points for an award. The awards are gold, silver and bronze.

Flowers are evaluated for the following characteristics:

1. Flower display
2. Earliness of bloom
3. Uniformity of habit
4. Disease and insect resistance
5. Garden performance

Vegetables are evaluated for:

1. Flavor, texture and appearance
2. Space efficiency
3. Yield potential
4. Earliness
5. Disease and insect resistance

Needless to say, the All-America Selections are the cream of the crop and home gardeners look forward to growing the newest selections each year. It is interesting to note that once chosen, some selections remain popular for many years. Some are still being grown today that were selected in the thirties and forties.

Because the All-Americas have been around for over 50 years, it would seem that producers and consumers would be aware of their unique contribution to gardening. Some are, but unfortunately many are not. There are new people, and even new generations of people, becoming interested in gardening. They must be educated and made aware of the All-Americas.

Growers must also continue their education and become familiar, not only with the new All-America Selections, but with the large numbers of new varieties and cultivars introduced by seed companies each year.

An excellent way to do this is to visit an All-America trial or display garden each summer. Although vegetables are tested at the University of Connecticut in Storrs and flowers at the University of Massachusetts in Waltham, MA, the only location in New England where both flowers and vegetables are tested is at the Comstock, Ferre & Co. trial grounds in Wethersfield, CT.

The All-America trials in Wethersfield are located on a three-acre site near I-91. This will be the fourth year of the trials. Vegetables are judged by Mr. Richard (Dick) Willard and the flowers by Mrs. Corinne Willard. Both are graduates of the University of Connecticut.

The plants being tested are grown in rows next to one or more existing cultivars for comparison. Although the trial plants are only numbered at this time, it is possible to check with the trial grounds after February 15 of the following year for the names of those designated as winners.

With the current trials a number of All-America award winners from previous years are grown for display purposes. Other outstanding cultivars are also included. For the first time this year, demonstration gardens are being added to suggest the use of vegetables and flowers in the home garden.

Fortunately it will be possible for us to see all of these trials and displays this summer. Field days are being planned for Saturday, August 11 and Sunday, August 12 from 10:00 a.m. to 3:00 p.m. Both Corinne and Dick Willard as well as their staff will be on hand to guide you and answer your questions. The Willards suggest taking exit 26 from I-91 and following the signs. Or, stop at the store at 263 Main Street, Wethersfield for directions to the farm.

The field days are open to all home gardeners as well as growers. If these dates are inconvenient, it is possible to see the grounds by appointment by calling Comstock, Ferre and Co.

We are fortunate to have the display and trials at such a central location within our state. Don't miss the opportunity to see what you have been growing, or might be growing in the future. Encourage your customers to come out and learn more about gardening.

About Your Subscription

Your address plate carries an identification signal which gives the issue number through which your subscription will be honored. For instance, if it reads 132, you have about two years coming, or the middle of 1986.

If, on the other hand, it contains letters, you may be special. RCPL means that a reciprocal mailing is made in return for the many publications we receive to maintain the best library on greenhouse culture in New England. CNTR means that you have contributed significantly to our research or extension effort. OK, on the other hand, means that your status is in doubt and that you may be dropped if we don't hear from you.

A sincere regret is the dropping of schools and extension agents from our mailing list. More than two hundred will no longer receive the newsletter. Perhaps some day we will have an endowment fund which will enable us to once again support these educational activities.

weekly fert = daily
15-0-18 Ca NO3 + KNO3 → greener plants & heavier but not a big diff.

PULSE AND CONTINUAL FERTILIZATION OF BEDDING PLANTS

By Michael Arisco, Student and
Jay S. Koths, Extension Floriculturist

In the 1950's and 60's fertilizer injectors came into widespread use. They are quite accurate and a large area can be fertilized with one batch of concentrated stock solution. By varying the concentration, fertilizer may be applied every irrigation (continuous) or pulsed, a more concentrated solution being applied at a give time interval such as every week or 10 days.

In an experiment conducted at the University of Connecticut, pulsing and continual fertilizaton were compared. A literature survey disclosed no definitive information on the subject. The purpose of the experiment was to ascertain which method would give better plant growth.

Experiment #1; February 20 - April 2. Four bedding plants were grown; statice, ageratum, dahlia and verbena. Three soils were used: ProMix BX, UConn 3(compost):2(peat):1(sand) and a typical Connecticut bedding plant soil mix (Arisco). Six seedlings of each were planted in each of six packs under two fertilizers and 3 root media and under continual or pulse fertilization and grown for 6 weeks.

Along with the two fertilizer practices, two types of fertilizers were used; 15-0-18 (3:2 calcium:potassium nitrates) and 20-20-20 (Peters). Under continual fertilization, plants were irrigated daily with 150 ppm nitrogen beginning two weeks after planting. With pulsing, a weekly application of 800 ppm nitrogen was applied due to an error in calculation (normal application is 600 ppm nitrogen).

No significant difference in plant size (Table 1) was found in Exp. 1, due to continual or pulsing fertilization. In general, the plants receiving 15-0-18 appeared to be darker green. 'Dahlia' and Verbena' grown in the Arisco medium bloomed earlier in both fertilization treatments.

Table 1. Bedding plant growth in 3 root media as influenced by continuous or pulse fertilization with 20-20-20 or 15-0-18.

		Experiment 1.				Experiment 2.		
	Crop	Arisco	Pro Mix	UConn	Crop	Arisco	Pro Mix	UConn
Continuous 15-0-18	Ageratum	137.7*	121.3	171.5	Kale	123.1	114.4	96.0
	Dahlia	208.2	158.1	293.4	Peppers	39.3	29.1	38.4
	Statice	265.0	254.0	383.5	Savoy	221.1	266.8	254.2
	Verbena	167.9	120.1	107.1	Tomatoes	314.2	335.6	294.5
Continuous 20-20-20	Ageratum	157.7	124.1	181.0	Kale	176.6	93.0	101.9
	Dahlia	153.8	155.8	203.2	Peppers	32.2	29.6	34.8
	Statice	262.5	186.7	285.2	Savoy	172.3	168.4	159.7
	Verbena	134.5	103.8	117.7	Tomatoes	194.7	216.3	224.1
Pulse 15-0-18	Ageratum	161.7	124.3	122.9	Kale	207.4	116.0	161.7
	Dahlia	178.6	192.3	284.3	Peppers	27.1	29.9	26.1
	Statice	269.3	232.3	347.3	Savoy	243.1	256.7	210.8
	Verbena	145.8	89.5	105.2	Tomatoes	308.2	295.0	312.6
Pulse 20-20-20	Ageratum	122.1	153.5	157.7	Kale	112.2	107.1	78.9
	Dahlia	153.8	136.6	153.8	Peppers	28.3	20.8	27.7
	Statice	168.8	165.6	262.5	Savoy	160.5	171.0	143.7
	Verbena	107.2	119.1	134.5	Tomatoes	260.2	193.4	173.2

* Grams fresh weight of 36 plants from 6 packs, severed at ground level.

Experiment #2; April 9 - May 7. Tomatoes, peppers, Savoy cabbage and kale were grown for four weeks in the same root media and under the same fertilizer treatments as in Exp. #1. Even less difference was noted in plant growth (Table 1). With pulse feeding the kale plants were shorter and stronger while with continual fertilization tney were taller and more spindly.

with the pulse treatment, fertilization was started a week after the seedlings were planted while continual fertilization began the day after planting.

Fertilizer usage was in the ratio of 7(continual): 4(pulsing). This should have been 7:3 with 600 ppm N. This means that less than half the nitrogen would have been used with pulsing. In these experiments, all the root media had sufficient background nutrition to provide good initial growth (Table 2). This may explain the lack of difference in growth. It may be concluded that it is not feasible to use continuous fertilization on bedding plants since the same results are obtained while using less fertilizer and that 20-20-20 (ca $.75/lb) gave results equal to 15-0-18 (ca $.22/lb).

If we average the values for all plants similarly treated (an invalid statistical procedure), the following values are obtained.

1. 15-0-18 produced plants 28% heavier than 20-20-20.
2. Continual fertilization plants were 5% heavier than pulse application.
3. Plants grown in the UConn soil were 16% heavier than in ProMix BX; those in Arisco soil 11% heavier.

While we might conjecture that 15-0-18 is better than 20-20-20 and that the soil mixes produced larger plants than the peat-lite, even a complete statistical analysis would not convince the authors that any particular treatment was superior to another.

Table 2. Spurway Soil Tests, before planting seedlings.

Exp. 1.	pH	Salts	Ca	P	K	NO_3-N	NH_4-N	Mg
Arisco	6.0	75	085	4.9	18	30	04	44
Pro Mix	5.9	36	080	03.0	02	07	04	20
UConn	7.0	55	070	15.0	29	02	30	32

Exp. 2	pH	Salts	Ca	P	K	NO_3-N	NH_4-N	Mg
Arisco	6.0	80	090	05.1	16	30	06	48
Pro Mix	5.9	65	130	06.4	04	18	04	19
UConn	7.1	36	075	12.3	22	05	10	37

Table 3. Root media components

Arisco Mix: 3 loam, 2 sphagnum peat, 1 sand and 1 perlite plus 7^+ lbs./dolomitic limestone, 5 lbs. 0-20-0 and 3^+ lbs. 5-10-3 Electra per cubic yard.

Pro-Mix BX: a commercial soilless mix containing peat moss, Vermiculite, perlite and limestone. It contains some background nutrition listed as a starter fertilizer.

UConn Mix: 3 loam, 2 sphagnum peat and 1 sand plus 10^+ lbs. dolomitic limestone, 5 lbs. 0-20-0 and 2 lbs. 5-10-3 Electra per cubic yard.

1984 HERBACEOUS PERENNIAL SYMPOSIUM

July 24-26, 1984
Ohio State University

Perennials are finally gaining the national recognition they deserve! The Perennial Plant Association was formed last year after the 1983 Symposium which attracted 300 participants from 28 states and Canada. A bouquet to Connecticut's own Pierre Bennerup, Sunny Border Nurseries, Kensington, one of the organizers of the association.

This three day Symposium sponsored by the Perennial Plant Association covers a wide variety of subjects by speakers from Oregon to Minnesota to Massachusetts to Virginia, not to mention Ohio, and of course, Connecticut. Pierre says that the popularity of perennials is cyclic and that we are on an upswing. Perhaps the Perennial Plant Association will perpetuate the rise in popularity and these plants will continue to be a more significant segment of the horticultural industry.

For more information and a registration form, contact Steven Still or Elton Smith (a former Conn. County Agent) at the Dept. of Horticulture. 2001 Fyffe Court, Columbus, OH 43210. Or call Steve who is Interim Secretary-Treasurer of PPA on 614-422-6027.

THE EFFECT OF NUTRIENT SPRAY ON THE PROPAGATION OF CHRYSANTHEMUM CUTTINGS

By Barbara A. Stiehl
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Abstract

Unrooted cuttings* of Chrysanthemum morifolium 'Bright Golden Anne' were subjected to fertilizer (KNO_3, NH_4NO_3 and 20-20-20) and a water spray control to determine if there would be any difference in root weight, total cutting weight, leaf number and linear cutting height. A solar controlled (Solatrol) water mist system was used before and after treatment application. Nutrient sprays, especially NH_4NO_3, positively influenced the growth and rooting response of the cuttings.

Introduction

It is generally recognized that the propagation of plants under a water mist causes leaching of metabolites, both organic and inorganic, from the exposed plant surfaces. Long (1956) found a ten percent reduction in calcium, potassium, magnesium, nitrogen and phosphorus in green beans when exposed to mist. Tukey (1962) surveyed an assortment of plant species for leachability under mist. He found leaching to be greater in mature leaves and in herbaceous cuttings than in immature leaves and in hardwood cuttings. Tukey also related leachability to the nutrients' function within the plants' metabolic processes and to environmental factors such as light intensity and humidity.

As a means of reducing nutrient losses through leaching, nutrients can be applied to cuttings during propagation through intermittent mist (Wott and Tukey, 1967). Dick (1960) found faster and greater root formation, increased weight, better color and faster growth of chrysanthemums under nutrient mist resulting in an increase in productivity.

This paper studies the effect on the rooting and vigor of chrysanthemum cuttings when sprayed on the cuttings rather than in the mist.

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* Supplied through the courtesy of Stafford Conservatories, Stafford Springs, Connecticut.

Methods and Materials

The 'Bright Golden Anne' cuttings were graded to a uniform fresh weight (between 2.3 and 2.9 grams) and leaf number in October, 1983.

Three fertilizer treatments plus a control were replicated three times with 10 cuttings per treatment for a total of 120. A 14 x 20" greenhouse wooden flat was used with cuttings stuck two inches apart in rows (other species in the flats are not reported here). The rooting medium was 1:2 sand:perlite. Before sticking into the medium, the cuttings were dipped in Hormodin 1.

The flats were placed under mist in a greenhouse where temperatures ranged from $60^{o}F$ at night to 70^{o}-80^{o} in the daytime. Overhead incandescent lights provided an extended photoperiod.

Treatments were intiated two days after sticking the cuttings. They were as follows: Treatment 1, tap water contol; Treatment 2, 100 ppm N from 20-20-20; Treatment 3, 130 ppm N from potassium nitrate and Treatment 4, 264 ppm N from ammonium nitrate.

The dilution of .01 mole of fertilizer per liter of water was used because it approximated the strength of fertilizer solution (ounces per gallon) used in the experiments in the literature. Because potassium and nitrogen are two of the nutrients most easily leached from plant tissue it was decided to use KNO_3 and NH_4NO_3 mono-nutrient fertilizer sprays. A complete fertilizer spray was also applied as a second form of control.

The treatments were randomized in each replication. Each treatment was applied with a plastic trigger spray bottle and amounted to about 1 ml per cutting. One hour before each treatment, a plastic canopy was placed over each flat to intercept the water mist and allow the foliage to dry. This prevented dilution of the treatment sprays with water from the mist system. The plastic sheets were removed during treatments and replaced until the plant surfaces were dry once again. To prevent spray drift between treatments, a cardboard barrier was held between each treatment during spray application.

The cuttings received one treatment per day at random times (from 9:00 a.m. to 4:00 p.m.) five days a week.

The temperature of the propagation medium was maintained at about $70^{o}F$ with bottom heat during the experiment.

Results and Discussion

Fifteen days after treatment, the chrysanthemum cuttings were lifted and measured for total weight, root weight, height (not including roots) and leaf number.

Immediately after the data was recorded, the cuttings were recut above the roots and stuck back into the rooting medium and the treatments were continued for thirty additional days when they were evaluated on the same basis.

The data was evaluated by finding the mean ± the standard error for each treatment in both trials. By comparing this information significant statistical difference between groups was determined (See Table 3).

Table 3. Effect of Nutrient Sprays on the Total Weight, Height and Root Weight of *Chrysanthemum morifolium* Cuttings Under Propagation

Treatments	Total Cutting Weight (gms.)	Root Weight (gms.)	Height of Cutting (cm.)
		First Trial	
1) Tap water (Control)	4.75±0.19[1]	0.98±0.05	12.41±0.30
2) Complete Fertilizer	5.03±1.00	1.15±0.58	13.60±0.30*
3) KNO_3	5.14±0.13	1.16±0.05	14.1±0.18*
4) NH_4NO_3	5.09±0.20	1.33±0.10*	14.01±0.40*
		Second Trial	
1) Tap water (Control)	3.12±0.14	1.02±0.09	7.42±0.39
2) Complete Fertilizer	3.24±0.15	1.04±0.06	8.00±0.21
3) KNO_3	3.01±0.13	1.16±0.05	7.99±0.22
4) NH_4NO_3	3.81±0.22*	1.42±0.07*	9.33±0.30*

[1] Each datum represents the mean ± SE of three replications for a total of thirty cuttings in each treatment.

* Datum significantly varied from the control.

In this experiment the results indicated that nutrient sprays made a positive difference in the growth and rooting of the cuttings.

The treatment most effective was the ammonium nitrate spray. In both trials it significantly enhanced root weight and height of cuttings and in trial 2 it also increased total cutting weight. Leaf numbers were also counted with the other data. Fertilizer treatments averaged seven or eight leaves while the control averaged six leaves per cutting.

Literature Cited

Carney, Michael and Carl E. Whitcomb. 1983. Effects of 2 Slow-Release Fertilizers on the Propagation and Subsequent Growth of 3 Woody Plants. J. Environmental Hort. 1(3):55-58.

Deen, J. L. W. 1973. Nutrition of Cuttings Under Mist. Proc. Inter. Plant Prop. Soc. 23:137-147

Dick, James E. 1960. The rooting and subsequent growth of Chrysanthemum morifolium as influenced by nutrient solutions applied in low pressure mist propagation systems. M.S. Thesis, Univ. of Connecticut, Storrs.

Good, G. L. and H. B. Tukey, Jr. 1964. Leaching of Nutrients From Cuttings Under Mist. Proc. Inter. Prop. Soc. 14:138-142.

Long, W. G., D. U. Sweet and H. B. Tukey, Jr. 1956. The Loss of Nutrients From Plant Foliage by Leaching as Indicated by Radioisotopes. Science. 123:1039-1040.

Sorenson, D. C. and G. D. Coorts. 1968. The Effect of Nutrient Mist on the Propagation of Selected Woody Ornamentals. Proc. Amer. Soc. Hort. Science. 92:696-703.

Tukey, H. D., Jr. 1962. Leaching of Metabolites From Above-Group Plant Parts, with Special Reference to Cuttings Used for Propagation. Plant Prop. Soc. Proceed. 12th Annual Meeting. pp. 63-70.

Wott, J. A. and H. B. Tukey, Jr. 1967. Influence of Nutrient Mist on the Propagation of Cuttings. Proc. Am. Soc. Sci. 90:454-461.

Wott, J. A. and H. B. Tukey, Jr. 1968. Propagation of Chrysanthemums Under Nutrient Mist. Proc. Intern. Plant Prop. Soc. 18:292-302.