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**IR-4 Ornamental Horticulture Program
Quinoclamine Crop Safety**

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Abstract

Mogeton 25WP (quinoclamine) at 2, 4 and 8 oz product per gallon (1X, 2X and 4X rates) provides excellent control of liverworts in ornamental horticulture crops grown in containers in greenhouses or nurseries. Mogeton 25WP provided good to excellent control of liverworts and exhibited excellent crop safety on most plants tested at the 2 oz per gallon rate. Several plant species exhibited some transient phytotoxicity possibly dependent upon crop stage, and some plant species will need additional testing to clarify response to over the top applications of Mogeton 25WP. However, in the 2005 research conducted through the IR-4 Ornamental Horticulture Program, only four crops demonstrated unsatisfactory injury after Mogeton 25WP application at the 2 oz per gallon rate: columbine (*Aquilegia*), Japanese painted fern (*Athyrium nipponicum var pictum*), lily turf (*Liriope muscari*), and vervain (*Verbena*).

Introduction

Liverworts (*Marchantia sp.*) have become more of a problematic weed in container-grown ornamental plants. No products are currently registered to effectively manage this weed. Therefore, IR-4 in 2004 established a high priority project to examine the crop response of various herbaceous and woody ornamental after over the top applications of Mogeton 25WP (quinoclamine), a chemistry that has demonstrated excellent control of liverworts in Europe.

Materials and Methods

Two applications of Mogeton 25WP were made approximately 30 days apart. The application rates were 2 oz, 4 oz, and 8 oz per gallon, plus a water treated control. A minimum of four plants (replicate treatments) were required with most researchers exceeding this minimum.

Phytotoxicity was recorded on a scale of 0 to 10 (0 = No phytotoxicity; 10 = Complete kill) at 1, 2, 4, 8, and 12 weeks after initial application. Some researchers also included readings 3 to 4 days after the initial and second applications. For more detailed materials and methods, please see Appendix 1: Protocol.

Mogeton 25WP was supplied to researchers (See list of researchers in Appendix 2) by Chemtura.

Results and Summary

Efficacy

Several researchers also examine efficacy in addition to crop safety. Good to excellent liverwort control was achieved (Ahrens/Mervosh, Beste/Frank, Freiburger, Smith).

Ahrens/Mervosh, Altland and Lieth observed orange spray residue on leaves which Lieth recommended should be washed off prior to sale to enhance marketability. Altland observed that there was no correlation between visible plant residue and phytotoxicity occurrence. Growers should be notified of this residue prior to application so they can choose whether to apply Mogeton 25WP under conditions where rinsing flowers and foliage prior to sale is not practical.

Phytotoxicity

Based on the type and nature of injury seen with Mogeton 25WP applications in the research conducted in 2005, tested plant species were placed into four categories: 1) no significant phytotoxicity or growth differences from the untreated check or any injury was transitory, 2) injury was seen but additional research is warranted to clarify response, 3) no or minimal transitory injury seen at the 1X rate, but the 2X and/or 4X rates did cause significant phytotoxicity, 4) Significant injury sufficient to recommend growers not utilize this product.

In general, Mogeton 25WP exhibited no or minimal negative impact on a wide range of plant species (Table 1). Some minimal injury may be acceptable for growers if applications are made several weeks to months in advance of crop sale particularly for woody ornamental crops. With some plant species, it is recommended additional trials be conducted to clarify their response under various environmental conditions because major differences were seen among research

locations (Table 2). For a small subset of crop species, there was no or little injury exhibited at the 2 oz per gallon rate, but significant phytotoxicity occurred at the 4 oz per gallon rate (Table 3). It may be prudent to either conduct additional trials or place language on the label indicating applications of Mogeton are considered safe at the 2 oz per gallon rate but any higher rate may cause unacceptable injury.

Only four crops in the 2005 testing exhibited damage sufficient to recommend growers not utilize Mogeton 25WP as an over-the-top treatment for liverwort control: *Aquilegia*, *Athyrium*, *Liriope*, and *Verbena* (Table 4). *Aquilegia* plants did visually grow out of the phytotoxicity over time with the production of new leaves, but the damage was considered both statistically significant and a negative impact on salability.

Please see Table 5 for a list of all researchable studies for Mogeton 25WP and the summary of the trials conducted in 2005.

Table 1. List of Mogeton 25 WP treated crops with no or minimal transitory injury.

<u>Herbaceous Ornamentals</u>	<u>Woody Ornamentals</u>
<i>Achillea</i>	<i>Amelanchier</i>
<i>Agapanthus</i>	<i>Buxus</i>
<i>Aster</i>	<i>Camellia</i>
<i>Carex</i>	<i>Cotoneaster</i>
<i>Coreopsis</i>	<i>Deutzia</i>
<i>Echinacea</i>	<i>Euonymus</i>
<i>Helleborus</i>	<i>Hydrangea macrophylla</i>
<i>Heuchera</i>	<i>Ilex</i>
<i>Iris</i>	<i>Itea</i>
<i>Leucanthemum</i>	<i>Lavandula</i>
<i>Pennisetum</i>	<i>Magnolia</i>
<i>Pieris</i>	<i>Perovskia</i>
	<i>Rhododendron</i>
	<i>Syringa</i>
	<i>Viburnum</i>

Table 2. List of Mogeton 25WP treated crops where more research is needed to clarify response

<u>Herbaceous Ornamentals</u>	<u>Woody Ornamentals</u>
<i>Agastache</i>	<i>Buddleia</i>
<i>Heuchera</i>	<i>Clethra</i>
<i>Hosta</i>	<i>Rosa</i>
<i>Penstemon</i>	<i>Ternstoemia</i>
<i>Polemonium</i>	

Table 3. List of Mogeton 25WP treated crops with no or minimal transitory injury seen at the 1X rate, but the 2X or 4X rate did cause significant phytotoxicity

Herbaceous Ornamentals

Dryopteris
Miscanthus
Polystichum

Woody Ornamentals

Berberis
Hydrangea

Table 4. List of Mogeton 25WP treated crops exhibiting significant injury.

Herbaceous Ornamentals

Aquilegia
Athyrium nipponicum var pictum
Liriope muscari
Verbena

Table 5. Detailed Summary of 2005 Crop Safety Testing with Mogeton

Notes: Table entries are sorted by crop Latin name. All researchable studies for Mogeton 25WP are included in this table. Only those that were researched in 2005 and were received by 1/9/2006 have summaries.

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
21479	Abelia	<i>Abelia sp.</i>	Field Container		
08308	Abelia	<i>Abelia sp.</i>	Greenhouse	Neal	Slight injury at all rates on new growth contacted by spray.
24140	Yarrow	<i>Achillea millefolium</i>	Field Container	Altland	No injury
				Lehnert	No injury
				Mathers/Case	No significant injury at all rates
				Neal	<i>A. filipendulina</i> : No injury at 2 oz per gallon rate. Injury on new growth at 4 and 8 oz per gallon rates, but plants grew out of it by 10 weeks after initial treatment.
				Smith/Tjosvold	All rates caused no injury
24058	Yarrow	<i>Achillea millefolium</i>	Greenhouse	Lehnert	No injury
24819	Lily-Of-The-Nile	<i>Agapanthus sp.</i>	Field Container	Altland	No injury at any rate after first application, but after second application minor marginal necrosis at base of leaves occurred with 4 and 8 oz per gallon rates, but plants recovered within 4 weeks.
24868	Lily-Of-The-Nile	<i>Agapanthus sp.</i>	Greenhouse	Lieth	No significant injury or growth differences at all rates.
24131	Hyssop species	<i>Agastache sp.</i>	Field Container	Altland	<i>A. barberi</i> : No injury at any rate after first application, but after second application white spots occurred with 4 and 8 oz per gallon rates, but plants recovered within 4 weeks.
				Smith/Tjosvold	<i>A. mexicana</i> : All rates caused slight but not statistically significant injury.
24049	Hyssop species	<i>Agastache sp.</i>	Greenhouse		
23729	Serviceberry	<i>Amelanchier sp.</i>	Field Container	Altland	<i>A. laevis</i> : Minor to moderate injury, increasing with rate, but plants recovered by 8 weeks after initial application.
23713	Serviceberry	<i>Amelanchier sp.</i>	Greenhouse		

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
13569	Columbine	<i>Aquilegia sp.</i>	Field Container	Altland	<i>A. vulgaris</i> : Minor to severe phytotoxicity, increasing with rate. Plants exhibited yellow and white spotting on leaves, bleached areas of leaf, and some burned edges.
				Lehnert	Moderate to severe phytotoxicity, increasing with rate.
				Mathers/Case	Minor to moderate injury increasing with rate, but plants recovered by 12 weeks after initial treatment.
				Smith/Tjosvold	Moderate phytotoxicity consisting of marginal chlorosis and necrosis. Symptoms masked by formation of new leaves.
23694	Columbine	<i>Aquilegia sp.</i>	Greenhouse	Lehnert	Moderate to severe phytotoxicity, increasing with rate
				Lieth	No injury at 2 oz per gallon rate; slight injury (leaf necrosis) at 4 oz and 8 oz per gallon rates.
24137	Aster	<i>Aster sp.</i>	Field Container	Altland	<i>A. dumosus</i> : No injury
				Lehnert	No injury
				Mathers/Case	No injury at 2 oz and 4 oz per gallon rate. 4 oz per gallon rate caused very slight injury with plants recovering by 14 days after first application. No apparent injury was observed after second application.
				Smith/Tjosvold	<i>A. chilensis</i> : Slight injury after first application, but plants recovered and no additional injury was observed after second application.
24055	Aster	<i>Aster sp.</i>	Greenhouse	Lehnert	No injury
24965	Fern, Japanese Painted	<i>Athyrium goeringianum</i>	Field Container		
25726	Fern, Lady	<i>Athyrium nipponicum</i>	Greenhouse	Smith/Tjosvold	All rates caused significant injury (leaf burn)
24870	Barberry	<i>Berberis sp.</i>	Greenhouse	Ahrens/Mervosh	<i>B. thunbergii</i> : Slight to moderate injury, increasing with rate. Note: single outlier plant in 2 oz rate per gallon exhibited increasing phytotoxicity throughout experiment. Other plants recovered fully from very slight injury by 8 weeks after initial treatment.
				Lieth	<i>B. thunbergii</i> : No injury at 2 oz per gallon rate; moderate to severe phytotoxicity at 4 oz and 8 oz per gallon rates.
23730	Birch, River	<i>Betula nigra</i>	Field Container		
21480	Butterfly Bush	<i>Buddleia davidii</i>	Field Container	Gilliam	No significant phytotoxicity
				Lehnert	Moderate to severe phytotoxicity, increasing with rate; 8 oz per gallon rate caused severe flower necrosis
				Neal	No injury

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
08310	Butterfly Bush	<i>Buddleia davidii</i>	Greenhouse	Lehnert	Moderate to severe phytotoxicity, increasing with rate; 8 oz per gallon rate caused severe flower necrosis
22984	Boxwood	<i>Buxus sp.</i>	Field Container	Neal	<i>B. sempervirens</i> : No injury
23701	Boxwood	<i>Buxus sp.</i>	Greenhouse	Beste/Frank	<i>B. macrophylla</i> : All rates caused no injury; higher rates reduced plant size but all treated plants were marketable at end of trial.
24873	Camellia	<i>Camellia sp.</i>	Field Container		
24874	Camellia	<i>Camellia sp.</i>	Greenhouse	Lieth	<i>C. oeilifera</i> : No significant injury or growth differences at all rates.
24821	Sedge	<i>Carex conica marginata</i>	Field Container		
24930	Sedge	<i>Carex sp.</i>	Field Container	Altland	<i>C. morrowii</i> : No injury at all rates.
				Mathers/Case	No significant injury at any rate.
24876	Sedge	<i>Carex sp.</i>	Greenhouse	Lieth	<i>C. morrowii</i> : No significant injury at 2 oz and 4 oz per gallon rates; 8 oz per gallon rate caused slight injury that plants outgrew
24535	Lilac, Wild	<i>Ceanothus gloriosus</i>	Field Container		
24934	Lilac, Wild	<i>Ceanothus gloriosus</i>	Greenhouse		
24877	Cedar	<i>Cedrus deodara</i>	Field Container		
25268	Yellowwood	<i>Cladrastis kentukea</i>	Field Container	Freiberger	No injury at the tested rate (2 oz per gallon) Excellent control of liverwort.
23648	Summersweet	<i>Clethra alnifolia</i>	Field Container	Altland	Minor to severe injury, increasing with rate, but some recovery by 8 weeks after initial application. Plants exhibited discolored and distorted growth, foliar wrinkling, some cupping and burned tissues.
				Neal	No injury, but researcher recommends repeating this trial when plants are vigorously growing.
23699	Summersweet	<i>Clethra alnifolia</i>	Greenhouse		
24882	Tickseed	<i>Coreopsis sp.</i>	Field Container	Smith/Tjosvold	<i>C. auriculata</i> : All rates caused no injury
24130	Pampas Grass	<i>Cortaderia</i>	Field Container		
24048	Pampas Grass	<i>Cortaderia</i>	Greenhouse		
23645	Cotoneaster	<i>Cotoneaster sp.</i>	Field Container	Gilliam	No significant phytotoxicity
				Lehnert	<i>C. dammeri</i> : No injury
				Neal	<i>C. horizontalis</i> : No injury at 2 oz per gallon rate; slight injury to new growth at 4 oz and 8 oz per gallon rates with plants recovering

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
23698	Cotoneaster	<i>Cotoneaster sp.</i>	Greenhouse	Beste & Frank	<i>C. salicifolia</i> : No injury at 2 oz per gallon rate; slight injury at 4 oz and 8 oz per gallon rates with plants recovering.
				Lehnert	No injury
24817	Daphne, Pink	<i>Daphne odora</i>	Field Container		
22998	Pride-of-Rochester	<i>Deutzia sp.</i>	Field Container	Altland	<i>D. gracilis</i> : Minor to moderate injury, increasing with rate, but plants recovered fully at 2 oz and 4 oz per gallon rates by 8 weeks after initial application. Plants exhibited yellow spotting on leaves, and slight distortion.
				Lehnert	<i>D. gracilis</i> : No injury at 2 oz per gallon rate; slight at 4 oz per gallon rate; slight marginal and tip necrosis of mature leaves at 8 oz per gallon rate.
23700	Pride-of-Rochester	<i>Deutzia sp.</i>	Greenhouse	Lehnert	<i>D. gracilis</i> : No injury at 2 oz per gallon rate; slight at 4 oz per gallon rate; slight marginal and tip necrosis of mature leaves at 8 oz per gallon rate.
				Lieth	<i>D. gracilis</i> : Acceptable injury at 2 oz per gallon rate; higher rates caused significant injury but plants outgrew injury.
24534	Fern, Autumn & Wood	<i>Dryopteris sp.</i>	Field Container	Altland	<i>D. erythrosora</i> : No injury after single application, but second application of 4 oz and 8 oz rates caused significant injury (crispy dry frond edges) with significant reduction in plant height with increasing rate.
24926	Fern, Autumn & Wood	<i>Dryopteris sp.</i>	Greenhouse		
24135	Purple Coneflower	<i>Echinacea sp.</i>	Field Container	Altland	<i>E. purpurea</i> : Minor to moderate injury at all rates (cupped, deformed, distorted new growth). Plants treated with 2 oz rate recovered by 8 weeks after initial treatment.
				Mathers/Case	<i>E. purpurea</i> : Slight to moderate injury increasing with rate. Plants recovered within 1 month of each treatment.
				Smith/Tjosvold	<i>E. purpurea</i> : All rates caused no injury
24053	Purple Coneflower	<i>Echinacea sp.</i>	Greenhouse	Lieth	<i>E. purpurea</i> : Slight visible injury at the 2 oz and 4 oz per gallon rates, but plants were still marketable; moderate injury at the 8 oz per gallon rate rendered plants un-saleable.
23721	Heath	<i>Erica sp.</i>	Field Container		
24885	Euonymus	<i>Euonymus sp.</i>	Greenhouse	Lieth	<i>E. fortunei</i> : No visible injury; slight reduction in plant height increasing with rate
24129	Gaura	<i>Gaura lindheimeri</i>	Field Container		
25269	Honey locust	<i>Gleditsia sp.</i>	Field Container	Freiberger	No injury at tested rate (2 oz per gallon) Excellent management of liverwort

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
25267	Kentucky Coffee Tree	<i>Gymnocladus dioica</i>	Field Container	Freiberger	No injury at tested rate (2 oz per gallon) <i>Excellent management of liverwort</i>
23728	Sunflower	<i>Helianthus sp.</i>	Field Container		
23712	Sunflower	<i>Helianthus sp.</i>	Greenhouse		
24966	Hellebore, Christmas rose, Lenten Rose	<i>Helleborus niger</i>	Field Container		
24966	Hellebore, Christmas rose, Lenten Rose	<i>Helleborus niger</i>	Greenhouse	Smith/Tjosvold	All rates caused slight but not statistically significant injury <i>Excellent efficacy for liverwort management</i>
24847	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>	Field Container	Mathers/Case	All rates caused minor but transient injury; plants recovered by 12 weeks after initial application.
				Smith/Tjosvold	All rates caused no injury
24848	Coral Bells, Alumroot	<i>Heuchera sanguinea</i>	Greenhouse	Lieth	No significant injury or growth differences at all rates.
20925	Alumroot	<i>Heuchera sp.</i>	Field Container	Lehnert	Slight to moderate crop injury, increasing with rate.
23695	Alumroot	<i>Heuchera sp.</i>	Greenhouse	Lehnert	Slight to moderate crop injury, increasing with rate.
21477	Hosta	<i>Hosta sp.</i>	Field Container	Gilliam	No significant phytotoxicity
				Neal	No significant injury at 2 oz per gallon rate; slight injury at 4 and 8 oz per gallon rates
23686	Hosta	<i>Hosta sp.</i>	Greenhouse	Lehnert	Slight to moderate crop injury, increasing with rate.
21623	Hydrangea, French	<i>Hydrangea macrophylla</i>	Field Container	Altland	Moderate injury (white blotches, wrinkling, deformed new growth) at 2 oz per gallon rate with plants recovering by 8 weeks after initial treatment. Moderate to severe injury at 4 oz and 8 oz per gallon rate with significant height reduction at 8 oz rate.
23689	Hydrangea, French	<i>Hydrangea macrophylla</i>	Greenhouse	Beste & Frank	<i>H. macrophylla</i> : All rates injured newly emerged shoots (necrotic, chlorotic, and distorted growth) with severity increasing with rate. New foliage covered injured foliage as plants matured so that by the end of the experiment all plants were marketable.
				Lieth	No injury at 2 oz per gallon rate; slight injury (leaf chlorosis and necrosis and some stunting) at 4 oz per gallon rate, but plants recovered by 12 weeks after first application.

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
23571	Hydrangea	<i>Hydrangea sp.</i>	Field Container	Lehnert	Slight phytotoxicity at 2 and 4 oz per gallon rates; moderate to severe leaf necrosis at 8 oz per gallon rate.
				Neal	No injury at 2 oz per gallon rate; slight to moderate at 4 and 8 oz per gallon rates, but limited to new growth and plants recovered.
23688	Hydrangea	<i>Hydrangea sp.</i>	Greenhouse	Lehnert	Slight phytotoxicity at 2 and 4 oz per gallon rates; moderate to severe leaf necrosis at 8 oz per gallon rate.
24933	Holly, Japanese	<i>Ilex crenata</i>	Greenhouse		
25728	Inkberry	<i>Ilex glabra</i>	Greenhouse	Ahrens/Mervosh	No injury Good to great control of liverwort.
25323	Holly, Blue	<i>Ilex x meserveae</i>	Field Container	Altland	No injury
				Gilliam	No significant phytotoxicity
23696	Holly, Blue	<i>Ilex x meserveae</i>	Greenhouse	Beste/Frank	All rates caused slight injury but treated plants outgrew injury and were marketable at end of trial.
25313	Siberian Iris	<i>Iris sibirica</i>	Field Container	Mathers/Case	No injury at any rate.
24967	Iris, Douglas	<i>Iris sp.</i>	Greenhouse	Smith/Tjosvold	<i>I. douglasiana</i> : All rates caused slight but not statistically significant injury.
24896	Virginia Sweetspire	<i>Itea virginica</i>	Greenhouse	Beste/Frank	All rates caused temporary bronze coloration of foliage; plants recovered by 2 weeks after treatment and were saleable. Good to excellent liverwort control.
16506	Laurel	<i>Kalmia sp.</i>	Field Container		
23690	Laurel	<i>Kalmia sp.</i>	Greenhouse		
24537	English Lavender	<i>Lavandula angustifolia</i>	Field Container	Altland	No injury at all rates.
				Lehnert	All rates caused slight to severe foliar necrosis and slight to moderate floral necrosis.
				Mathers/Case	Very slight injury at 2 oz and 4 oz per gallon rates. Virtually no injury at 8 oz per gallon rate. By 12 weeks after initial application, no injury noted on any plants.
				Smith/Tjosvold	All rates caused no injury
24853	English Lavender	<i>Lavandula angustifolia</i>	Greenhouse	Lieth	No significant injury or growth differences at all rates.
24854	Daisy	<i>Leucanthemum sp.</i>	Field Container	Mathers/Case	No significant injury at all rates
24932	Daisy	<i>Leucanthemum sp.</i>	Greenhouse		

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
21627	Fetterbush, Drooping Leucothoe	<i>Leucothoe sp.</i>	Field Container		
23692	Fetterbush, Drooping Leucothoe	<i>Leucothoe sp.</i>	Greenhouse		
24855	Lilyturf, Big Blue;Giant	<i>Liriope muscari</i>	Greenhouse	Smith/Tsojvold	Significant injury at all rates. Chlorosis and necrosis at base of leaves which moved up as leaves expanded. Newly emerged leaves eventually hid this damage.
23727	Magnolia, Southern	<i>Magnolia grandiflora</i>	Field Container	Gilliam	No significant phytotoxicity
23725	Sweet Bay	<i>Magnolia virginiana</i>	Field Container		
23722	Silver Grass	<i>Miscanthus sp.</i>	Field Container	Smith/Tjosvold	<i>M. sinensis</i> : 2 oz per gallon rate caused no injury; 4 and 8 oz per gallon rates caused significant injury (leaf burn).
24818	Chinese Pennisetum	<i>Pennisetum alopecuroides</i>	Field Container	Altland	No injury at all rates.
24927	Chinese Pennisetum	<i>Pennisetum alopecuroides</i>	Greenhouse	Lieth	No significant injury or growth differences at all rates.
23707	Fountain Grass	<i>Pennisetum setaceum</i>	Greenhouse	Lieth	No visible injury at all rates; higher rates caused significant stunting.
24136	Beard-Tongue	<i>Penstemon sp.</i>	Field Container	Altland	Minor injury increasing with rate (very slight foliar distortion and twisting, outer foliage slightly burned) but plants recovered by 8 weeks after initial application. Some reduction in plant height but not statistically significant.
				Mathers & Case	Slight to minor injury increasing with rate, but plants fully recovered by 12 weeks after initial treatment
24054	Beard-Tongue	<i>Penstemon sp.</i>	Greenhouse	Lieth	<i>P. X mexicali</i> 'Red Rocks': No visible injury, but plant growth was suppressed at all rates. Researcher recommends Mogeton not be used on this crop.
24132	Sage, Russian;Blue Spire	<i>Perovskia sp.</i>	Field Container	Altland	<i>P. atriplicifolia</i> : Very slight, transitory phytotoxicity after second application (some upper leaves curling with burned edges), but plants did exhibit significant reduction in plant height with 4 oz and 8 oz per gallon rates.
				Mathers/Case	<i>P. atriplicifolia</i> : Very slight transitory injury at all rates, increasing with rate. Plants recovered by 2 weeks after initial application and by 8 weeks after second application.

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
24050	Sage, Russian;Blue Spire	<i>Perovskia sp.</i>	Greenhouse	Lieth	<i>P. abrotanoides</i> : No injury at 2 oz per gallon rate; higher rates caused slight injury (leaf necrosis and dead stems) that did not affect marketability.
23733	Andromeda	<i>Pieris sp.</i>	Field Container	Lehnert	No injury
23717	Andromeda	<i>Pieris sp.</i>	Greenhouse	Beste/Frank	<i>P. japonica</i> : No injury at 2 oz per gallon rate; but significant injury with 4 oz and 8 oz per gallon rate. However, no additional injury was observed after second application and all plants were marketable by 12 weeks after initial treatment.
				Lehnert	No injury
24141	Jacob's Ladder	<i>Polemonium sp.</i>	Field Container	Altland	<i>P. boreale</i> : Minor to moderate injury at all rates (white blotches and yellow spotting, mostly on inner part of leaves), but plants treated with 2 oz per gallon rate recovered by 8 weeks after initial application.
				Mathers/Case	<i>P. caeruleum</i> : No to very slight injury at 2 oz and 4 oz per gallon rate. Minor transient injury with 8 oz per gallon rate: after first application plants recovered within 2 weeks; after second application plants recovered within 4 weeks.
24059	Jacob's Ladder	<i>Polemonium sp.</i>	Greenhouse		
24820	Fern, Western sword	<i>Polystichum munitum</i>	Field Container	Altland	Minor injury, increasing with rate (yellow to white spotting on new growth). Only plants at 2 oz per gallon rate completely recovered by 8 weeks after initial application.
24928	Fern, Western sword	<i>Polystichum munitum</i>	Greenhouse		
25266	Pin Oak	<i>Quercus palustris</i>	Field Container	Freiberger	No injury at tested rate (2 oz per gallon) <i>Excellent management of liverwort</i>
23718	Azalea, & Rhododendron	<i>Rhododendron sp.</i>	Field Container	Gilliam	<i>R. sp</i> 'Midnight Flare': No significant phytotoxicity
				Lehnert	<i>R. sp</i> 'Boudoir' (azalea): No injury at 2 oz per gallon rate; slight at 4 oz per gallon rate; slight foliar necrosis at 8 oz per gallon rate.

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
23702	Azalea, & Rhododendron	<i>Rhododendron sp.</i>	Greenhouse	Ahrens/Mervosh	<i>R. sp</i> 'Orchid Lights' (azalea): Minimal to moderate injury but plants recovered completely at 2 oz and 4 oz rate per gallon by 8 weeks after initial application.
				Beste/Frank	<i>R. obtusum</i> 'Hino Crimson' (azalea): No injury at 2 and 4 oz per gallon rates; significant phytotoxicity at 8 oz per gallon rate. <i>Excellent efficacy for liverwort management.</i> <i>Researchers noted some suppression of powdery mildew.</i>
				Lehnert	<i>R. sp</i> 'Boudoir' (azalea): No injury at 2 oz per gallon rate; slight necrosis on lower leaves at 4 oz and 8 oz per gallon rates.
				Neal	<i>R. sp</i> 'Girard's Rose' (azalea): No injury at 2 oz per gallon rate; very slight injury at 4 and 8 oz per gallon rates with recovery by 10 weeks after treatment.
23716	Azalea, & Rhododendron	<i>Rhododendron sp.</i>	Greenhouse	Ahrens/Mervosh	<i>R. sp</i> 'Nova Zembla' (rhododendron): No injury.
				Lehnert	<i>R. catawbiense</i> 'Roseum Elegans' (rhododendron): No injury at 2 oz per gallon rate; slight at 4 oz per gallon rate; slight foliar necrosis at 8 oz per gallon rate. All treated plants were marketable at end of trial.
24139	Rose	<i>Rosa sp.</i>	Field Container	Lehnert	<i>R. sp.</i> 'Gypsy Sunblaze': Moderate foliar necrosis and moderate to severe floral necrosis.
24057	Rose	<i>Rosa sp.</i>	Greenhouse	Lehnert	<i>R. sp.</i> 'Gypsy Sunblaze': Moderate foliar necrosis and moderate to severe floral necrosis.
				Lieth	<i>R. X</i> 'Meidomonac': No significant injury or growth differences at all rates.
24134	Sage, Mexican	<i>Salvia leucantha</i>	Field Container		
24138	Sage, Ramona	<i>Salvia sylvestris</i>	Field Container		
24056	Sage, Ramona	<i>Salvia sylvestris</i>	Greenhouse		
24133	Little Blue Stem	<i>Schizachyrium scoparium</i>	Field Container		
21629	Stonecrop	<i>Sedum sp.</i>	Field Container		
24887	Bird-Of-Paradise	<i>Strelitzia sp.</i>	Field Container		
21481	Lilac	<i>Syringa sp.</i>	Field Container	Altland	<i>S. vulgaris</i> : Slight phytotoxicity (new growth slightly yellowed and distorted, puckered on edges), increasing with rate. Plants recovered by 8 weeks after initial application.
08307	Lilac	<i>Syringa sp.</i>	Greenhouse	Ahrens/Mervosh	<i>S. vulgaris</i> : No injury. <i>Great control of liverworts.</i>

PR #	Crop		Production Site	Researcher(s)	Results Summary
	Common Name	Latin Name			
24816	Eugenia	<i>Syzygium paniculatum</i>	Field Container		
25674	Ternstroemia	<i>Ternstroemia sp.</i>	Field Container	Neal	<i>T. gymnanthera</i> : No injury at the 2 oz per gallon rate. At the 4 oz and 8 oz per gallon rates, phytotoxicity on young tissue was observed. No impact on older growth or subsequent new growth, but mottled chlorotic spots did remain on affected tissues.
25312	Spiderwort	<i>Tradescantia sp.</i>	Field Container	Mathers/Case	Minor transitory injury increasing with rate, but plants recovered by 12 weeks after initial treatment.
23703	Cranberry (Non-Bearing)	<i>Vaccinium macrocarpon</i>	Greenhouse		
23697	Vervain	<i>Verbena sp.</i>	Greenhouse	Lehnert	Moderate to severe foliar and floral necrosis.
19285	Viburnum	<i>Viburnum sp.</i>	Field Container	Neal	<i>V. x pragensense</i> : No injury
23693	Viburnum	<i>Viburnum sp.</i>	Greenhouse	Beste/Frank	<i>V. plicatum tomentosum</i> : Slight injury at all rates about 2 weeks after each treatment; 2 oz per gallon rate was marketable throughout experiment. Good to excellent control of liverworts.

Label Suggestions

It is suggested based upon data accumulated through the IR-4 research program in 2005 that Chemtura consider listing crops where Mogeton 25WP has exhibited no or minimal transitory injury as well as listing those crops exhibiting unacceptable injury.

If this is not practical given other label constraints it is suggested the final label utilize something similar to the following language:

Mogeton 25 WP has been tested on a number of ornamental horticulture species. In general this testing has demonstrated plant safety. However, prior to applying on an entire crop, make applications on a small number of plants to ensure safety under your growing conditions. The following plants have demonstrated unsatisfactory responses to Mogeton 25WP application: columbine (*Aquilegia*), Japanese painted fern (*Athyrium nipponicum var pictum*), lily turf (*Liriope muscari*), and vervain (*Verbena*).

It is also suggested that Chemtura consider adding language indicating applications of Mogeton are considered safe at the 2 oz per gallon rate but any higher rate may cause unacceptable injury for barberry (*Berberis sp.*) silver grass (*Miscanthus sinensis*), hydrangea (*Hydrangea sp.*), and certain ferns (*Dryopteris sp.* and *Polysticum sp.*).

Appendix 1: Protocol

Phytotoxicity to herbaceous perennial plants with applications of Mogeton 25WP

Ornamental Protocol Number: 05-004

REVISED DATE: 05/05

Objective: Determine phytotoxicity of Mogeton 25WP to perennial plants commonly grown in greenhouse and/or nurseries.

Experimental Design:

Plot Size: Must be adequate to reflect actual use conditions.

Replicates: Minimum of 3 replications (preferably 4) with 3 pots per replicate

Application Instructions: Two applications made approximately 4 weeks apart. Plant materials must be established in containers and have broken dormancy prior to first application. Use 2 qts of final spray solution per 100 sq ft or about 218 gal per acre. Applications should be made over the top of the plants using application equipment consistent with conventional commercial equipment. Please see table below for instructions for post-application irrigation.

Plant Materials: See attached list of plant materials. Plants must be growing in containers and not field grown.

Evaluations: Record phytotoxicity on a scale of 0 to 10 (0 = No phytotoxicity; 10 = Complete kill) at 1, 2, 4, 8, and 12 weeks after initial application. If appropriate, also include ratings for chlorosis, defoliation, stunting or other growth effects on a scale of 0 to 10 (0 = No effect; 10 = Complete plant affected). If any phytotoxicity is observed in treated plants, take pictures comparing treated and untreated plant material.

Recordkeeping: Keep detailed records of weather conditions including temperature and precipitation, soil-type or soil-less media, application equipment, application volume per acre, irrigation, liner size, plant height & width, and plant growth stage at application and data collection dates.

Treatments:

Product	Rate	Post-Application Irrigation Instructions
Mogeton 25WP (quinoclamine)	2.0 oz/gal	Do not overhead water for 24 h after application.
	4.0 oz/gal	
	8.0 oz/gal	
Untreated	--	--

For labels, materials, and any required adjuvants contact:

Mogetan - Crompton, Kevin Donovan, 203-393-2163 x 2028, kevin.donovan@cromptoncorp.com

Reports:

Report must include a brief summary paragraph of results, a summary table with appropriate statistical analyses, a section on experimental design and materials and methods, with raw data and recordkeeping information as listed above included as appendices. If pictures were taken, please include them.

An electronic report is preferred but not required. If the report is provided electronically, the basic report can be sent in MS Word or WordPerfect, the recordkeeping information as pdf or other electronic documents, and the raw data in MS Excel or other suitable program such as ARM.

Please direct questions to: Cristi Palmer, IR-4 HQ, Rutgers University, 681 US Hwy 1 S, North Brunswick, NJ 08902-3390, Phone 732-932-9575 x629, palmer@aesop.rutgers.edu OR Ely Vea, 308 Aston Forest Lane, Crownsville, MD 21032, Phone & FAX#: 410-923-488, E-mail: evvea@comcast.net.

Phytotoxicity to herbaceous perennial plants with applications of Mogeton 25WP

Ornamental Protocol Number: 05-004

REVISED DATE: 05/05

Latin Name	Common Name	Site/Production	# Trials Needed in 2005
Abelia	Abelia	Greenhouse	4
Achillea millifolium	Yarrow, Common	Greenhouse	4
Adiantum spp.	Fern, Maidenhair	Nursery/Field Container	3
Agastache spp.	Hyssop species	Greenhouse	4
Aquilegia	Columbine	Greenhouse	3
Aster spp.	Aster	Greenhouse	3
Astilbe spp.	False Spirea	Greenhouse	3
Coreopsis spp.	Tickseed	Greenhouse	2
Cortaderia spp.	Pampas Grass	Greenhouse	4
Dryopteris spp.	Fern, Autumn and Wood	Nursery/Field Container	3
Echinacea spp.	Purple Coneflower	Greenhouse	3
Helianthus spp.	Sunflower	Nursery/Field Container	3
Heuchera sanguinea	Coral Bells	Greenhouse	3
Lavandula angustifolia	English Lavender	Greenhouse	3
Lewisia spp.	Lewisia	Greenhouse	3
Liriope muscari	Liriope	Greenhouse	3
Miscanthus spp.	Maiden grass	Greenhouse	3
Monarda spp.	Beebalm	Greenhouse	2
Nandina domestica	Sacred Bamboo	Greenhouse	3
Phlox	Phlox	Greenhouse	2
Polemonium spp.	Jacob's Ladder	Greenhouse	4
Rudbeckia fulgida	Orange Coneflower	Greenhouse	3
Verbena spp.	Vervain	Greenhouse	3

Note: PR Numbers to be assigned and posted to web site.

Appendix 2: Contributing Researchers

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Appendix 3: Submitted Data

Data on following pages are in order of PR number with the exception of the reports from Dr. James Altland, Dr. Charles Gilliam, Dr Hannah Mathers/Mr. Luke Case and Drs. Richard Smith and Steve Tjosvold. These reports cover multiple PR numbers and are at the beginning of this Appendix.