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ENH1118

Selected Miticides for Use on Ornamental Plants[1]

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Mites are among the most difficult arthropod pests to control on ornamental plants. Adult mites have eight legs and piercing/sucking mouthparts that are used to suck fluids from the cells of host plants (Denmark, 1969). The first immature stage of a mite, referred to as the larva, has only six legs, like insects. The exceptions are the Eriophyid mites, which have four legs in all stages. Mites are not insects, but are more closely related to spiders and ticks. Thousands of species of mites feed on plants.

Spider mites, members of the Tetranychidae family, are perhaps the most important mite pests of ornamental plants. The name, spider mites, is due to the many members of this family that produce silk webbing. Spider mites are medium-sized mites that feed on a wide variety of host plants from many different plant families. Some spider mites are bamboo, Lewis, southern red, spruce, tumid and twospotted mites (Figure 1).

Members of the **false spider mites** family, Tenuipalpidae, do not produce silk webbing, but a number of these species feed on ornamental plants. False spider mites are generally smaller than spider mites. Examples of false spider mites are flat and red palm mites.

Some **Tarsonemid mites** (family *Tarsonemidae*) are smaller than even false spider mites. This family includes broad and cyclamen mites.

Eriophyid mites (*Eriophyidae* family) are too small to be seen with the naked eye (Figure 2) and include bud, gall, purple tea and rust mites, among others. As their names suggest, these mites can cause galls, rusts and other abnormal plant growth.

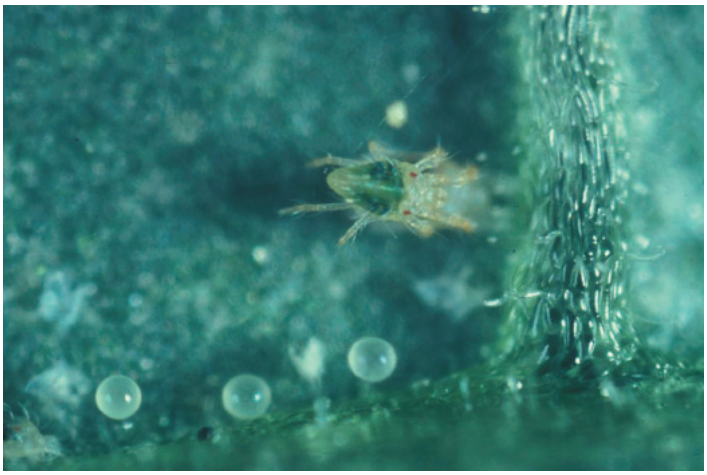

Figure 1. A male twospotted spider mite (*Tetranychus urticae*) and eggs on underside of a leaf
Credits: L. Osborne

There are other families of mites that have crop-damaging members, but the mites named above are the main mite pests of ornamental plants.

Mites of a given species can develop very rapidly when temperatures, relative humidities, host plants and other factors are optimal. In fact, for many, the time to develop from an egg to an adult can be less than a week. Generally, development occurs more rapidly at higher temperatures, up to a point. Due to mites' rapid development, scouting should be performed frequently (at least once per week), and miticide applications may need to be made on weekly

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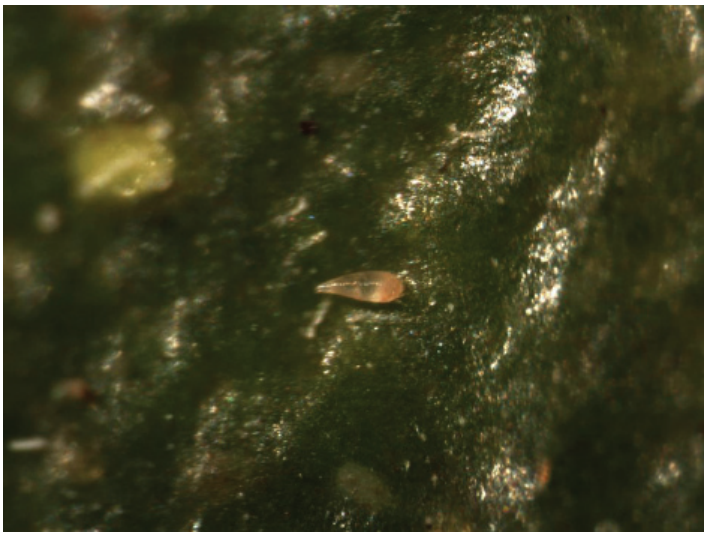

Figure 2. Eriophyid mites are cigar shaped, translucent, and very tiny.
Credits: L. Osborne

or more-frequent intervals (be sure to check the miticide labels for instructions and restrictions associated with spray intervals) during the summer.

Detection

Frequent, careful inspection of plants is necessary to detect mite infestations before they reach epidemic levels and cause severe plant damage. By the time plant symptoms become very obvious to the unaided eye, control of the mites will be difficult and potentially expensive. Early detection can limit damage and facilitate economical control of mites. Careful inspection is necessary because damage due to mites can, on some plants, resemble that from other causes. For example, symptoms can look similar to insect feeding, nutritional deficiencies, physiological stress, herbicide damage, etc.

Since many mites feed on the undersides of leaves, these are important sites to check. Spider mites can usually be detected on older leaves, whereas Tarsonemids are often found on young leaves. False spider mites often feed near the midrib or veins. Silvery speckling/stippling of the upper leaf surface is a characteristic symptom of leaf feeding (Figure 3). Fine thread-like webbing may also be present (spider mites). Mites may also feed on petioles, stems, buds and other plant parts. Mite feeding can cause a multitude of symptoms, such as leaf cupping, discoloration, distortion, spotting, speckling and stunting, stem russeting and discoloration, as well as distorted and discolored flowers.

Because mites are so small, the use of a magnifying hand lens (10x) will make it easier to observe them. Another technique frequently used to detect mites, especially on crops with fine foliage like ornamental asparagus, is to slap stems firmly on a light-colored surface, such as a white painter's palette or a sheet of white paper on a clipboard. If mites are present, they will be easily seen as small, moving spots.

Figure 3. Stippling due to flat mite feeding on an orchid leaf
Credits: L. Osborne

Control

Both biological control agents and miticides are available for controlling mites. For example, the predatory mites, *Neoseiulus californicus* and *Phytoseiulus persimilis* (Figure 4), can effectively control twospotted spider mites. At least 15 other predators are commercially available for control of this and other pests (Osborne and Peña, 1997; mrec.ifas.ufl.edu/lso/SpMite/Mites-Ornamentals.pdf). *P. persimilis* has been used successfully to control twospotted spider mites on many plants growing in protected culture (greenhouses and shadehouses). *N. californicus* is just as effective, and it tolerates pesticide residues better than *P. persimilis* and also feeds on broad mites [*Polyphagotarsonemus latus* (Banks)]. For more information on biological control of mites, refer to the following website: mrec.ifas.ufl.edu/lso/SpMite/

Figure 4a.

Figure 4. Predatory mites like *Neoseiulus californicus* (Figure 4a) and *Phytoseiulus persimilis* (Figure 4b) can be used to control plant-damaging mites.
Credits: L. Osborne

b853a1.htm. A listing of commercial suppliers of biological mite control agents is available at www.cdpr.ca.gov/docs/pestmgt/ipminov/bensup.pdf.

Besides frequently scouting crops to detect mite infestations early, growers should avoid using pesticides that are harmful to eggs, immatures and adults of predatory mites. Companies that supply mite predators furnish customers with lists delineating the effects of pesticides on the predators. (See "side effects" at www.biobest.be and www.koppert.nl/e005.shtml/).

For chemical mite control, the use of broad-spectrum insecticides/miticides (especially products with long-lived residual activity, such as the pyrethroids listed in Table 1) is generally not recommended. These insecticides/miticides may directly or indirectly harm beneficial insects and/or mites, and a rapid increase in existing plant-feeding mite populations may result. Use of the insecticide carbaryl is also known to occasionally increase twospotted spider mite infestations on susceptible plants. Therefore, selective chemicals that specifically target plant-feeding mites should be used.

Predatory mites must be released as soon as pest mites are detected, and the number of predatory mites released must be sufficient to ensure control of the pest mites (Osborne et al., 1985; mrec.ifas.ufl.edu/lso/SpMite/mite-bc.pdf). As mentioned previously, check with biological control suppliers for guidance and to find out which predatory-mite strains are resistant or susceptible to specific pesticides.

This information can help in making decisions regarding pesticide use. For more information on biological control, see Osborne and Peña, 1997 (mrec.ifas.ufl.edu/lso/SpMite/Mites-Ornamentals.pdf).

Although mites can become resistant to miticides; several techniques can reduce the likelihood of this happening. First, minimize miticide usage by incorporating biological and cultural methods into your pest management program. Practice good sanitation methods and use mite resistant crops and varieties. Scout frequently (at least once a week) and only apply miticides when necessary. Design growing areas so all areas can be easily and effectively treated. Mite populations should be monitored closely for at least a week after application to determine if the application was effective. Some materials can take at least a week before they will have an impact.

Do not use miticides with the same mode of action in succession. Rather, practice long-term rotations, using as many effective products with different modes of action as possible. For example, carbamates and organophosphates both work by inhibiting the enzyme acetylcholinesterase, which is important in the proper functioning of the nervous system. Most of the other classes of miticides have different modes of action. In the rotations, do not use inferior-performing products. Using them is wasteful and could slow or prevent the breaking of the mite population cycle. Table 1 lists miticides commonly used on ornamental crops and the mode of action groups for these miticides. Active ingredients, trade names, formulations and labeling (application locations, restricted use designations, restricted entry intervals [REIs] and manufacturer/distributors' names are also given). Users of any pesticide should make sure they have the current label since labels may change over time. In addition, users should read labels in their entirety and comply with the label's directions and restrictions. Table 2 lists the addresses of the manufacturers/distributors of the miticides listed in Table 1. Another useful strategy for controlling mites is to include products with a non-specific mode of action, where possible, into a rotation. This group includes insecticidal soaps and horticultural oils.

Miticides should only be used as labeled ("the label is the law"). Fortunately, some miticides have general labeling that allows them to be used, at the grower's risk, on a broad range of crops not specifically listed on the label. Prudent growers should test multiple applications of any miticide if it is likely that it will be used more than once. In addition, to enhance miticide efficacy, surfactants and adjuvants maybe included if there are no label restrictions.

Allow sufficient time after treating the test plants for phytotoxicity symptoms to develop. If a new miticide will be used in tank mixes or in close sequences with other pesticides, evaluate the potential for plant injury (phytotoxicity) on a small number (about 10) of plants of each species and cultivar before treating all the plants of each crop. These tolerance tests should take into consideration the potential interactions with other pesticides used in the pest control program.

It is essential to read pesticide labels since all restrictions related to where each product can be used (greenhouse, shadehouse, interiorscape, outdoor field nursery, outdoor nursery, landscape, residential landscape), how it can be applied (chemigation, spray, aerial, etc.), on what growing media it can be used, etc., must be observed. State and local labeling may differ from and be more restrictive than federal labeling. Pesticide applicators should always review product labels before using any pesticide and have all pertinent labels (including supplemental labels) in their possession prior to use of any pesticide.

Selected References

Denmark, H. A. 1969. Two-spotted spider mite on chrysanthemum. Fla. Dept. of Agr. and Consumer Serv., Div. of Plant Industry, Ento. Circ. No. 89.

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Sabelis, M. W. 1981. Biological control of twospotted spider mites using phytoseiid predators. I. Agric. Res. Report 910, Pudoc, Wageningen, the Netherlands.

Zhang, Z. 2003. Mites of Greenhouses: Identification, Biology and Control. CABI Publishing, Wallingford, Oxfordshire, UK.

Table 1. Selected products for use in controlling mites on ornamental plants

Mode of action group[z]	Active ingredient	Trade name(s)	Formulation(s)	Mites controlled[y]	Mite stages controlled[x]	Location[w]	Broad crop labeling	REI[v] (hours)	Manufacturer/ Distributor[u]	Comments
1A	Carbaryl	Carbaryl, Sevin®	80 S, 4 SL (43% ai[t]), 4 S (44.1%)	Eriophyid		O	Yes	12	Drexel, Bayer, Prokoz, others	Thorough coverage of upper- and lower-leaf surfaces is important. Use may increase twospotted spider mite populations.
1B	diazinon	☠[s] Diazinon® AG500	4 EC (48% ai)	Certain spider mites, cyclamen, mites, carnation bud and shoot mites		On	No	12	Helena	Only for certain labeled crops.
	dimethoate	Cygon®, Dimethoate	2 EC (23% ai); 4EC (43.5–44.8% ai)	Eriophyid, Tarsonemid, Tenuipalpid, Tetranychid	I, A	On	No	48	Southern Agricultural Insecticides, Cheminova, Drexel, Helena	Label lists only certain plant uses and for some kinds of spider mites.
	disulfoton	☠Di-Syston®	15 G			O	No	48	Bayer	Labeled only for use on firs (Christmas trees).
2A	endosulfan	☠Endosulfan, ☠Thionex®	3 EC (33.7–34.0% ai)	Taxus bud mite	I, A	On	No	48, 24	Drexel, Makhteshim-Agan	Shrubs and trees.
		☠Thionex®	50 W	Taxus bud mite, cyclamen		On	No	24	Makhteshim-Agan	
3[r]	bifenthrin	Attain® TR	aerosol (4% ai)	Spider		G	Yes	12	Whitmire Micro-Gen	Total release aerosol. Significant resistance has been detected in some populations of spider mites.

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		☠ Attain®, Bifenthrin, Broadcide™, Talstar®, UP-Star, etc.	0.67 F [SC] (7.9% ai)	Spider and broad		G, On, S	Yes	12	Whitmire Micro-Gen, Quali-Pro, Regal, FMC, United Phosphorus	Significant resistance has been detected in some populations of mites.
	cyhalothrin	☠ Scimitar®	0.88 GC (9.7% ai)	Spider		G, I, O, S	yes	24	Syngenta	Significant resistance has been detected in some populations of mites.
	fenpropathrin	☠ Tame®	2.4 EC (30.9% ai)	Spider		G, I, O, S	Yes	24	Valent	Significant resistance has been detected in some populations of mites.
	fluvalinate	Mavrik Aquaflow®	2 F (22.3% ai)	Spider		G, I, O	Yes	12	Wellmark International	Significant resistance has been detected in some populations of mites.
6	abamectin	Abamectin, Avid®	0.15 EC (1.9–2% ai)	Eriophyid, Spider, Tarsonemid, Tenuipalpid	E, I, A	G, O, S	Yes	12	Quali-pro, Syngenta	Translaminar, also suppresses aphids, thrips and whiteflies. Do not use on Shasta daisies or ferns. Resistance has been detected in some populations of twospotted spider mites
	milbemectin	☠ Ultiflora™	0.0775 EC (1% ai)	Eriophyid, Spider, Tarsonemid, Tenuipalpid	E, I, A	Of	Yes	12	Gowan	Apply no more than 128 fl oz per acre per year.

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10A[q]	clofentezine	Ovation®	1 SC (42% ai)	Spider	E, I	G, On, S	Yes	12	Everris NA	Only one application per crop cycle. Good residual control. Unstable in alkaline solutions. Useful in IPM programs. Bright magenta in color, residue may be noticeable.
	hexythiazox	Hexygon™	50 WP	Spider	E, I	G, I, O, S Can also be used in land-scapes	Yes	12	Gowan	Provides residual control.
10B	etoxazole	Beethoven™ TR	aerosol (5% ai)	Spider, Tenuipalpid	E, I	G	Greenhouse ornamentals	4+[p] to 24	Whitmire Micro-Gen	Translaminar activity, useful in IPM programs. Best used in early stages of infestations. Use no more than twice per cropping cycle. Sterilizes adult mites.
		TetraSan	5 WDG			G, I, Lr, O, S	Yes	12	Valent USA	
12B[q]	☠ fenbutatin-oxide (also known as hexakis)	ProMITE™ (formerly Vendex)	50 WP	Spider	I, A	G, O	Yes	48	SePRO	For best results, apply when mite populations are just beginning to build. Thorough and complete coverage is necessary for optimum control. Performs best when daily temperature at application averages above 70°F. May be applied when honeybees and beneficial mites are present.

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Mode of action group[z]	Active ingredient	Trade name(s)	Formulation(s)	Mites controlled[y]	Mite stages controlled[x]	Location[w]	Broad crop labeling	REI[v] (hours)	Manufacturer/ Distributor[u]	Comments
13	chlorfenapyr	Pylon®	2 SC (21.4% ai)	Eriophyid, Spider, Tarsonemid	I	G	No	12	OHP	Translaminar activity. Avoid applying to blooming flowers. No more than three applications (not more than the 41 fl oz of product per 100 gal per crop per season or 0.64 lb ai per 100 gal per crop per season) should be applied during a crop growing cycle (start to finish for one ornamental crop). Note sensitive plants on label.
20B[q]	acequinocyl	Shuttle™	15 SC (15.8% ai)	Eriophyid, Spider, Tenuipalpid	E (some), I	G, On, S	Yes	12	Arysta LifeScience	Compatible with IPM programs. Do not apply successive applications, rotate with treatments having different modes of action. Not for use on mini-roses.
21A	fenpyroximate	Akari®	5 SC	Eriophyid, Spider Tarsonemid	I	G, I, On	Yes	12	SePRO	Do not apply more than 48 fl oz per crop cycle or growing season.
	pyridaben	Sanmite®	75 WP	Spider, Tarsonemid, Tenuipalpid	I, A (some)	G, O, S	Yes	12	Everris NA	Do not exceed 21.34 oz per acre per year.
23	spiromesifen	Judo™	4 F [SC] (45.2% ai)	Eriophyid, Spider,	E, I, A (some)	G, On, S	Yes	12	OHP	Translaminar activity. Do not apply more than

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		Forbid™	4 F [SC] (45.2% ai)	Tarsonemid, Tenuipalpid		OI		na[o]	Bayer	three times per season and do not make successive applications. Check Judo Technical Bulletin at www.OHP.com for list of sensitive plants.
	spirotetramat	Kontos®	2 SC (22.4% ai)	Eriophyid, Spider, Tarsonemid	E, I	G, On	Yes	24[n]	OHP	Apply preventatively or as soon as mites are detected. Systemic, both downward and upward.
un[q]	bifenazate	Floramite®	2 SC (22.6%)	Spider	E (some), I, A	G, I, O, S	Yes	12	OHP	Compatible with IPM and resistance management programs. Do not apply more than 32 fluid oz per acre per year. Not effective against eriophyid or tarsonemid mites. Adjust spray water pH to below 7.
6 + un	bifenazate + abamectin	Sirocco™	4.2 SC (45.4% ai)	Eriophyid, Spider, Tarsonemid	E (some), I, A	G, I, O, S	Yes	12	OHP	
—oils[q]	oil; cottonseed, clove, garlic	GC-Mite™	70 LC	Spider	E, I, A		Yes		JH Biotech	Good coverage important. OMRI[m] listed.
	oil, neem	Triact®	70 EC	Spider	E, I, A	G, O	Yes	4	OHP	
	oil, paraffinic	Omni Oil, Omni Supreme Spray	6E (98% ai)	Eriophyid, Spider	E, I, A	O	No	4	Helena	Spray no more than 4 times during the growing season; use a two-week-minimum application interval.

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Mode of action group[z]	Active ingredient	Trade name(s)	Formulation(s)	Mites controlled[y]	Mite stages controlled[x]	Location[w]	Broad crop labeling	REI[v] (hours)	Manufacturer/ Distributor[u]	Comments
		Ultra-Fine® Oil	(98.8% ai)	Spider	E, I, A	G, I, O	Yes	4	Whitmire Micro-Gen	
	oil, petroleum	Saf-T-Side	EC (80.0% ai)	Eriophyid, Spider, Tarsonemid	E, I, A	G, O	No	4	Brandt Consolidated	Total coverage important.
		Omni Supreme Spray (paraffin base)	(98% ai)		E, I, A	O	No	4	Helena	For shade trees and shrubs.
		Target™	EC (80.0% ai)		E, I, A	G, O, Sh	Yes	4	Florikan E.S.A.	
		Damoil™, PureSpray™ Green, Ultra-Pure™ Oil	(98% ai)		E, I, A	G, O, S	Yes	4	Drexel, Petro-Canada, Whitmire Micro-Gen	OMRI listed except Damoil™.
	oil, rosemary and mint	EcoTrol®	EC (12% ai)	Eriophyid, Spider, Tarsonemid		G, I, O, S	Yes	0	EcoSMART	"Minimum-risk" pesticide, meets the requirements for the USDA National Organic Program. Good coverage very important, leaves an oily residue.
	oil, soybean	Golden Pest Spray Oil™	93% ai	Spider	E, I, A	G, O, S	Yes	4	Stoller	OMRI listed.
— **soap**	soap (potassium salts of fatty acids)	M-Pede®	LC (49% ai)	Eriophyid, Spider	E, I, A	G, I, O	Yes	12	Dow AgroSciences	OMRI listed. Thorough coverage very important. Do not use with sulfur or within three days of a sulfur application.
— **sulfur**	sulfur, micronized	Thiolux® Jet	80 DF	Spider, Tenuipalpid		G, On	No	24	Syngenta	OMRI listed. Do not use within two weeks of an oil treatment. Complete coverage important.

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Mode of action group[z]	Active ingredient	Trade name(s)	Formulation(s)	Mites controlled[y]	Mite stages controlled[x]	Location[w]	Broad crop labeling	REI[v] (hours)	Manufacturer/ Distributor[u]	Comments

[z] Mode of action classification scheme (version 6.1, Aug 2008) developed by the Insecticide Resistance Action Committee (IRAC) (http://www.irac-online.org/Crop_Protection/MoA.asp). 1 = Acetylcholinesterase inhibitors; 2 = Gamma-aminobutyric acid (GABA)-gated chloride channel antagonists; 3 = Sodium channel modulators; 5 = Nicotinic acetylcholine receptor agonists (allosteric) (not group 4), 6 = Chloride channel activators; 10 = Compounds of unknown or non-specific mode of action (growth inhibitors); 12 = Inhibitors of oxidative phosphorylation, disruptors of ATP formation; 13 = Uncoupler of oxidative phosphorylation via disruption of proton gradient, 20 = Mitochondrial complex III electron transport inhibitors, 21 = Mitochondrial complex I electron transport inhibitors; 23 = Inhibitors of lipid synthesis; un = Compounds with unknown mode of action; — = not IRAC listed but may control mites physically (i.e., desiccation, membrane disruption, suffocation, etc.).

[y] Eriophyid (bud, gall, purple tea, rust), Tarsonemid (broad, cyclamen), Tenuipalpid (flat mites, false spider mites, red palm mite), Tetranychidae [spider mites] (bamboo, clover, Lewis, southern red, spruce, tumid, twospotted).

[x] E = egg, I = immatures, A = adult

[w] Location: G = greenhouse; I = interiorscape; Lr = residential landscape; Of = outdoor field nurseries; Ol = outdoor landscapes; On = outdoor nurseries; O = outdoor (includes landscape and nurseries); S = shadehouse.

[v] REI = restricted entry interval.

[u] See Table 2 for complete names and addresses.

[t] ai = active ingredient.

[s] ☠ = restricted-use pesticide.

[r] Use of pyrethroids can disrupt biological control organisms (predatory beneficials, etc.) and thereby cause subsequent mite population increases following the use of these broad spectrum insecticide/miticides.

[q] Can be used in IPM programs where predatory mites are used.

[p] See label for ventilation requirements.

[o] na = not applicable.

[n] If applied to foliage, read label for REI when applied as a drench.

[m] OMRI = Organic Materials Review Institute (www.omri.org).

Table 2. List of miticide manufacturers/distributors.

Company/Division	Address	City	State/ Province	Zip Code	URL
Bayer Environmental Science	2 T.W. Alexander Drive	Research Triangle Park	NC	27709	http://www.bayerprocentral.com
Brandt Consolidated Industries	2935 S. Koke Mill Rd.	Springfield	IL	62711	http://www.brandtnews.com
Cheminova	One Park Drive, Suite 150	Research Triangle Park	NC	27709	http://www.cheminova.us.com
Dow AgroSciences	9330 Zionsville Rd	Indianapolis	IN	46268	http://www.dowagro.com
Drexel Chemical	1700 Channel Avenue	Memphis	TN	38113	http://www.drexchem.com
EcoSMART/EcoIPM	318 Seaboard Lane, Ste 208	Franklin	TN	37067	http://www.ecosmart.com
Everris NA	4950 Blazer Memorial Parkway	Dublin	OH	43017	http://everris.us.com
Florikan E.S.A.	1523 Edger Place	Sarasota	FL	34240	http://florikan.com
FMC/Agricultural Products Group	1735 Market Street	Philadelphia	PA	19103	http://www.fmcprosolutions.com
Gowan	370 Main Street	Yuma	AZ	85366	http://www.gowanco.com
Helena Chemical	225 Schilling Blvd.	Collierville	TN	38017	http://www.helenachemical.com
JH Biotech	4951 Olivas Park Dr	Ventura	CA	93003	http://www.jhbiotech.com
Makhteshim-Agan of North America (MANA)	4515 Falls of Neuse Toad, Suite 300	Raleigh	NC	27609	http://www.manainc.com
OHP	P.O. Box 230	Mainland	PA	19451-0230	http://ohp.com
Petro-Canada	P.O. Box 2844	Calgary	Alberta	T2P 3E3	http://www.petro-canada.ca
Prokoz	100 North Point Center East, Suite 330	Alpharetta	GA	30022-8242	http://www.prokoz.net/
Quali-Pro	4515 Falls of Neuse Toad, Suite 300	Raleigh	NC	27609	http://www.Quali-pro.com
Regal Chemical	600 Branch Drive	Alpharetta	GA	30004	http://www.regalchem.com
SePRO	11550 North Meridian Street, Suite 600	Carmel	IN	46032	http://www.sepro.com
Southern Agricultural Insecticides	P.O. Box 218	Palmetto	FL	34221	http://www.southernag.com
Stoller Enterprises	4001 W Sam Houston Pkwy N, Suite 100	Houston	TX	77043	http://www.stollerusa.com
Syngenta Professional Products	P.O. Box 18300	Greensboro	NC	27419	http://www.syngentaprofessionalproducts.com
United Phosphorus, Inc.	630 Freedom Business Center, Ste. 402	King of Prussia	PA	19406	http://www.upi-usa.com
Valent Professional Products	1701 Gateway Blvd., Suite 385	Richardson	TX	75080	http://www.valent.com/professional/
Wellmark International	1501 E. Woodfield Rd., Suite 200 West	Schaumburg	IL	60173	http://www.wellmarkinternational.com
Whitmire Micro-Gen Research Laboratories	3568 Tree Court Industrial Blvd.	St. Louis	MO	63122	http://www.wmmg.com