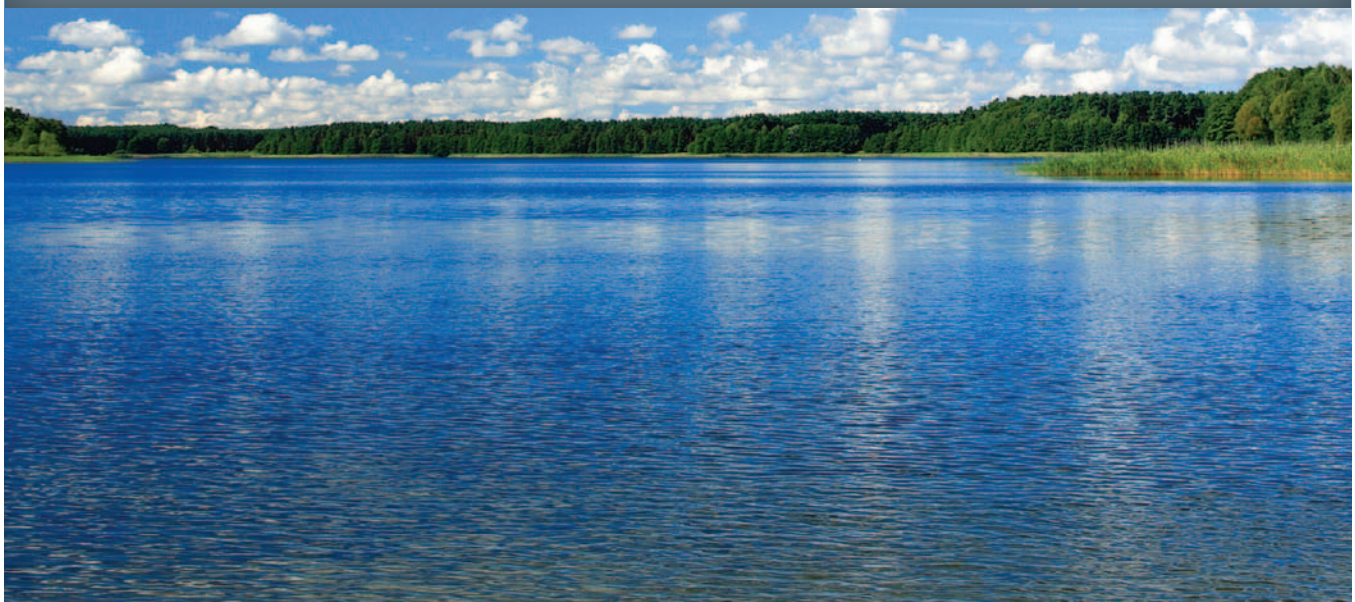




{AQUATIC HERBICIDE WHITE PAPER}

New Chemistry for Aquatic Weed Management

Technical Findings on Clipper™ (flumioxazin) and Tradewind™ (bispyribac-sodium) Herbicides



Introduction

Invasive and nuisance aquatic plant species are a significant and increasing problem in water bodies throughout the United States. Invasive weeds such as hydrilla, cabomba (fanwort), Eurasian watermilfoil, water lettuce, water hyacinth and watermeal are damaging fish and wildlife habitats, blocking previously navigable areas, restricting recreation and decreasing property values. Nationwide, costs associated with the chemical and mechanical management of these weeds exceed \$150 million per year in public funds, according to a June 2008 article in *Outlooks on Pest Management*.¹

In 2010, Valent Professional Products plans to launch a new portfolio of aquatic products offering new solutions to help control aquatic weeds. These new products—Clipper™ Herbicide (flumioxazin) and Tradewind™ Herbicide (bispyribac-sodium)—are intended to provide aquatic plant managers with new treatment options at a time when herbicide resistance, variable response and environmental concern issues loom large.

Clipper and *Tradewind* are currently being evaluated under Federal Experimental Use Permits (EUPs) in various states throughout the country, and this document cites some of the key findings from these studies.

CURRENT AQUATIC HERBICIDE SITUATION

As recently as 15 years ago, the number of aquatic herbicides available for use in U.S. waters was extremely limited. To control hydrilla, aquatic plant managers used diquat, endothall and fluridone. For filamentous algae, copper was the product of choice. “In 1995 we had six products registered for aquatic use and we were pretty happy,” said Dr. Bill Haller, acting director of the University of Florida’s Center for Aquatic and Invasive Plants. In those days, Dr. Haller said, fluridone could be expected to control hydrilla, a submersed weed, for one or even two years. Magnacide (acrolein) was used liberally to clear agricultural irrigation canals of unwanted weeds, but Dr. Haller said there were environmental concerns associated with this product.

“For the longest time we only had six or seven active ingredients for aquatics.”

— Joe Bondra, vice president and general manager of Cygnet Enterprises, Inc.

“For the longest time we only had six or seven active ingredients for aquatics,” said Joe Bondra, vice president and general manager of Cygnet Enterprises, Inc., the largest single-source distributor of aquatic management products in the country. “Until recently, there hadn’t been many new tools in the toolbox for the lake manager to pick from.”

As environmental concerns increased and resistance issues emerged, a market for new herbicides with different modes of action developed and continues to grow. The

state of Florida alone, Dr. Haller said, is now spending \$25 million per year on aquatic weed control.

“I’ve been in aquatic plant management over 20 years and have really seen the market expand in the last 10 years,” said Chip Davis of Santee Cooper’s Analytical & Biological Services Division in South Carolina. “There’s always room for more products in terms of selectivity. We’re at the point now where we’ve got selective control. We can take out the undesirable weeds but still keep the desirable plant species, which is especially important in some of our habitat enhancement projects.”

However, aquatic resource managers do not have control over all invasive plant species. “Despite public programs for containment and prevention of the spread of aquatic weeds, the exotic submersed species hydrilla has spread from Florida to Maine on the East Coast, across the Gulf Coast states, and to California and Washington on the West Coast,” according to the aforementioned 2008 *Outlooks on Pest Management* article.

An article in the 2008 edition of the *Journal of Aquatic Plant Management* advises readers that “the invasive exotic plants hydrilla and Eurasian watermilfoil continue to spread and remain the plant species of greatest concern for aquatic resource managers at the national scale.”

The difficulty in controlling these weeds, and the increasing resistance of some species, underscores the need for a continual flow of products with new modes of action into the marketplace. “Having different modes of action is important for lake managers,” Bondra said. “Agriculture has rotated treatments for decades, due in part to the limited number of choices available. We have not rotated in aquatics. Now that there will be more products with different modes of action and active ingredients, the aquatic manager will have the flexibility to rotate products as deemed appropriate.”

CLIPPER HERBICIDE (FLUMIOXAZIN)

Expected availability: Q1 2010

A fast-acting, contact herbicide, the active ingredient in *Clipper*, flumioxazin, controls aquatic weeds such as cabomba, watermeal, water lettuce, duckweed, and, as part of a tank mix, hydrilla. *Clipper*, which works best during the early-growth stage of most weeds, also shows promise for control of some species of algae. Because studies show *Clipper* dissipates quickly from the water column and does not accumulate in the sediment, Valent Professional Products research and development manager Mike Riffle said it is less of an environmental concern than other, more persistent herbicides. *Clipper* can also be applied to control floating or submersed weeds, providing flexibility to applicators.

Besides providing aquatic resource managers with a new mode of action, *Clipper* also has low use rates of 6 to 12 ounces of product per surface acre on floating and emergent weeds and 100 to 400 parts per billion (ppb) on submersed weeds, according to Riffle.

Key Treatment Target:

Cabomba/Fanwort: A fast-growing, submersed weed, cabomba thrives in slow-moving waters and, because of the limited number of herbicides available, is difficult to eradicate once it becomes established. Bondra of Cygnet worked on EUP trials with *Clipper* and said he was “extremely excited about flumioxazin.” His enthusiasm is most evident in relation to *Clipper’s* activity on cabomba.

“We know from the EUP work that *Clipper* has great efficacy on cabomba,” Bondra said. “Some applicators have told me you can run over cabomba with a truck and still not kill it.”

“There is a real need for a predictable cabomba treatment,” he added. “*Clipper* on cabomba was, in a word, awesome. The EUP trials seem to indicate that flumioxazin doesn’t need as much contact time (as other products).”

Indiana EUP trial

Conducted by Cygnet Enterprises, Inc.

Target weed: Cabomba

Rate: 200 ppb



Pretreatment



7 days after treatment with *Clipper*

Indiana EUP trial

Conducted by Cygnet Enterprises, Inc.

Target weed: Cabomba

Rate: 200 ppb, Water pH: 7.8 to 8.0



Pretreatment



14 days after treatment with *Clipper*

Davis, meanwhile, said that “we have had a big problem with cabomba in our lake system over the years with limited success in controlling it. Flumioxazin consistently gave us excellent control in the EUP trials.”

In treating an 11-acre canal at Old Santee Canal Park that was “pretty much 100% cabomba and basically impassable for canoeists, prior to the trial” Davis said “it was amazing the results realized [with *Clipper*].” Applied in late July 2008 at a rate of 200 ppb, *Clipper* provided 100% control of cabomba—as well as duckweed

and watermeal—within three weeks of a subsurface application. By fall, Davis said, “it was absolutely perfect for the remainder of the year.”

In mid-September 2008, Davis treated a 20-acre section of a 150-acre impoundment on Lake Marion with *Clipper* and said it “completely removed the cabomba from the treatment site.” The early assessment this year is that there is still no cabomba present. “It selectively controlled the cabomba very quickly with control extending, so far, into this year,” Davis said.

Key Treatment Target:

Watermeal: A small, free-floating rootless plant, watermeal thrives in quiescent waters. An aggressive pond invader, it forms dense colonies and depletes oxygen, often resulting in a fish kill.

Kevin Tucker, owner and president of Virginia Lake Management Co., has been a cooperator in multiple EUP trials in each of the last two years. In 2008, at a concentration of 200 ppb, Tucker applied *Clipper* to a pair of small ponds that were nearly 100% contaminated with watermeal.

In one pond, Tucker said, “all the watermeal was gone within a few days to a week, and we never saw it again.” In the other pond, he added, the majority of the watermeal was gone within a week. After some apparent regrowth, a second treatment wiped the watermeal out for good.

In all, Tucker treated eight ponds with *Clipper* and saw good control in all eight upon the initial application. Only once was Tucker forced to make a second application, and he said that was because of new plant material flowing in rather than previously treated plants coming back.

Virginia EUP trial
 Conducted by Virginia Lake Management Co.
 Target weed: Watermeal, Rate: 200 ppb



Pretreatment



18 days after treatment with *Clipper*

“It looks like a miracle product for watermeal from what I’ve seen,” Tucker said.

Tucker added that *Clipper* “seemed to take out the watermeal and leave the desirable native plants behind.”

Surface applications of *Clipper* resulted in “great activity” on watermeal, according to Bondra. Watermeal can be problematic in lakes, ponds and reservoirs across the United States.

“I assisted with some of the plots myself and saw with my own eyes,” Bondra said. “Watermeal is a huge problem and it’s hard to kill, but we saw great activity with flumioxazin. Typically, watermeal treatment results with other products can be very inconsistent. In my

opinion, we have never really had a good go-to option to control watermeal each and every time.” Bondra also saw activity on sago pondweed, a plague of irrigation canals in several Western states.

“It looks like a miracle product for watermeal...”

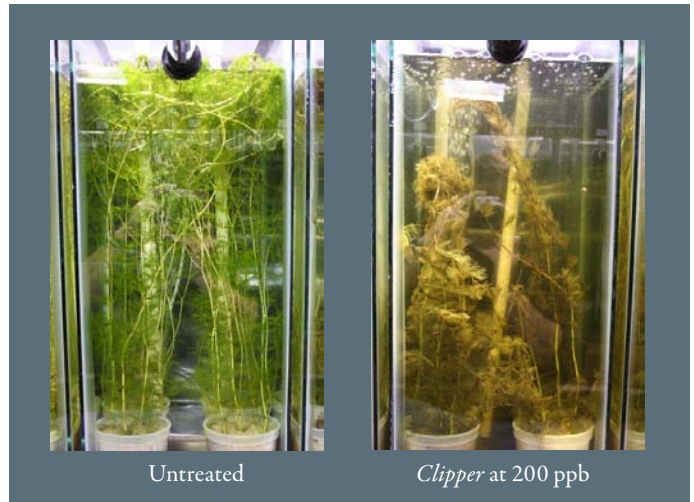
— Kevin Tucker, owner and president of Virginia Lake Management Co.

EUP Trial Results—Watermeal

Trial location	Applicator	App. method	App. rate	Target weed	Results
Virginia Beach, Va.	Kevin Tucker	Sub-surface	400 ppb	Watermeal	100% covered at application. Less than 1% coverage within three weeks of application.
Virginia Beach, Va.	Kevin Tucker	Sub-surface	200 ppb	Watermeal	100% covered at application. Less than 1% coverage within three weeks of application.

Filamentous algae: Citing the “huge need for a non-copper algaecide,” Bondra said he saw results with *Clipper* on algae despite not really targeting it. “In most of the EUP work, algae was not the target, but I did see activity on it,” he said. The University of Florida’s Dr. Haller said, “It looks like flumioxazin has some activity on algae. We’ve written up a research grant proposal to the EPA to investigate this finding with flumioxazin on algae further.”

**Target Weed: Eurasian Watermilfoil
Rate: 200 ppb**



Riffle said, “There is some evidence that *Clipper* is controlling filamentous algae. That’s important because right now there is no alternative except copper, which is under a bit of fire right now due to environmental fate issues.”

Other invasive weeds: While Bondra said *Clipper* is probably best used as a tank mix with diquat to combat hydrilla, he said there’s no need to mix *Clipper* in order to deal with Eurasian watermilfoil. Difficult to remove once it becomes established, Eurasian watermilfoil can be treated, upon registration, with contact herbicides like *Clipper*.

“It has great activity on Eurasian watermilfoil,” Bondra said of *Clipper*. “That’s one of the most exciting things about it—it works very quickly and doesn’t stay around long.” That’s particularly true, Bondra added, since milfoil seems to be starting to show some variable response issues to granular 2,4-D treatments, forcing aquatic managers to apply 2,4-D at the higher labeled rates.

Tests performed by third-party research groups in association with the Aquatic Ecosystem Restoration Foundation (AERF), such as the U.S. Army Engineer Research and Development Center (ERDC) in Vicksburg, Miss., found that *Clipper* can provide an alternate mode of action for controlling giant salvinia. Studies have also indicated that *Clipper* is efficacious against giant salvinia via broadcast and subsurface application techniques, providing acceptable plant control.

The addition of another effective product, along with glyphosate and diquat, promises to diversify the choice of chemical strategies for giant salvinia management and play an important role in resistance management.

Clipper is also effective against hydrilla when used as a tank mix with other herbicides. A mixture of *Clipper* and diquat, in particular, has shown promise against hydrilla, one of the more problematic invasive weeds for aquatic managers to deal with today. When mixed at use rates of 100 ppb (*Clipper*) and 375 ppb (diquat) at five hours of exposure, *Clipper* and diquat provided 81% control of hydrilla, according to a third-party mesocosm study conducted in association with the University of Florida’s Center for Aquatic and Invasive Plants. With 20 hours of exposure, control increased to 90%.

“*Clipper* and diquat together do a good job as a contact herbicide on hydrilla,” Riffle said. “Because of the resistance issues with fluridone, it is important to have alternatives, and this appears to be one.”

TRADEWIND HERBICIDE (BISPYRIBAC-SODIUM) Expected availability: Q2 2010

A systemic herbicide with long-lasting residual control, the active ingredient in *Tradewind*, bispyribac-sodium, is an acetolactate synthase (ALS)-inhibiting herbicide that controls floating and submersed aquatic weeds. Mostly stable in the water column, *Tradewind* studies point toward an excellent toxicology profile with minimal impact on native species.

Key Treatment Target:

Hydrilla: A submersed aquatic weed introduced into the U.S. around 1960, hydrilla has since spread throughout much of the country. An aggressive, invasive plant, hydrilla adversely affects freshwater lakes, canals, reservoirs and rivers.

Based on EUP field, mesocosm and chamber observations, *Tradewind* provides excellent control of hydrilla.

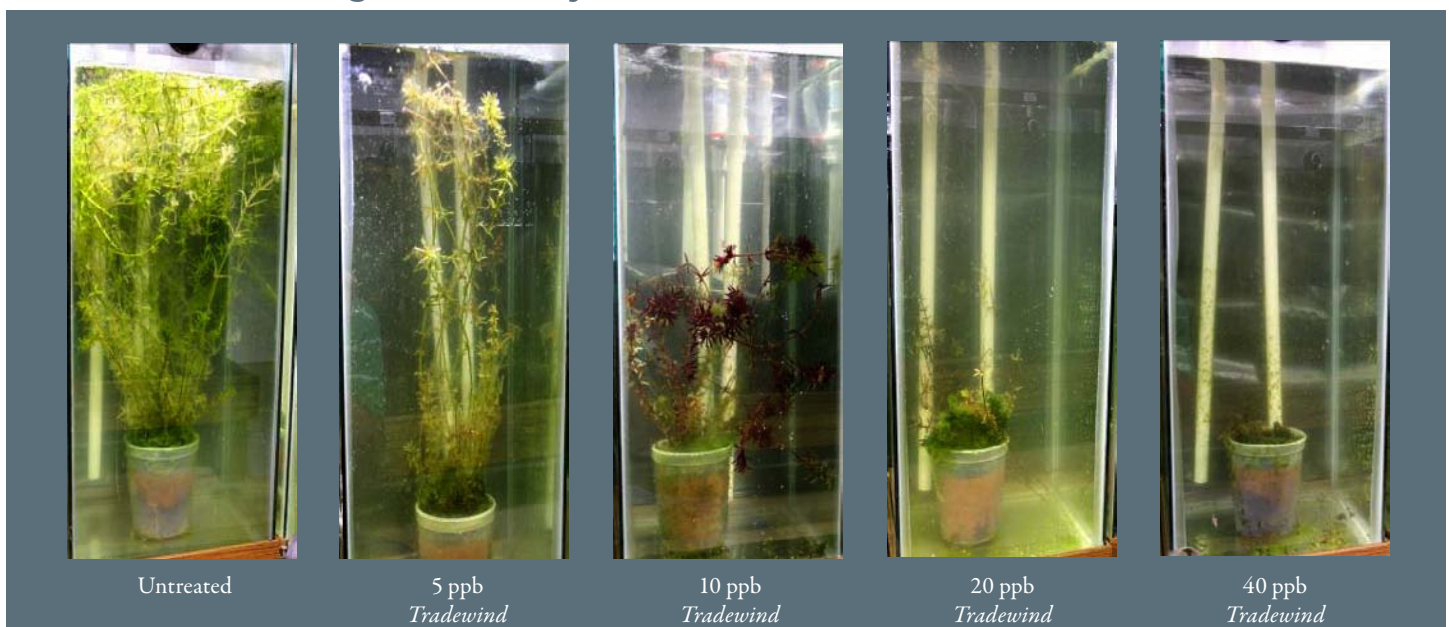
According to a joint study by the University of Florida's Center for Aquatic and Invasive Plants and the U.S. Army Engineer Research and Development Center, *Tradewind* applied at a concentration of 20 ppb and with eight or more weeks of exposure resulted in greater than 90% biomass reduction and growth inhibition in both hydrilla and Eurasian watermilfoil in growth chamber studies.³

A separate report by researchers at the Center for Aquatic and Invasive Plants on the efficacy of *Tradewind* on hydrilla in ponds, meanwhile, determined that "a single application of 45 ppb bispyribac-sodium will provide one year of hydrilla control depending upon the time of year in which the herbicide is applied."⁴

"You can get six to 12 months of control of hydrilla consistently with bispyribac," Dr. Haller said. "I think bispyribac is as good as or better than other ALS-inhibitors. We want to kill hydrilla; we don't want to kill any native species. Bispyribac has advantages in terms of selectivity."

Dr. Haller said *Tradewind* was "safe" with regard to non-target aquatic plants such as maidencane, Kissimmee grass and sagittaria plants based on EC50 ($\mu\text{g/L}$) values. Additionally, Dr. Haller said, *Tradewind* has "greater selectivity than [fellow ALS-inhibitor] penoxsulam on sagittaria." When tested at 27 ppb at Florida's Sand Mine Lake, Dr. Haller said, *Tradewind* did not adversely affect cattail or coontail.

Target Weed: Hydrilla, 16 Weeks After Treatment



University of Florida EUP Trial
Sand Mine Lake, Eustis, FL
Target Weed: Hydrilla, Rate: 27 ppb

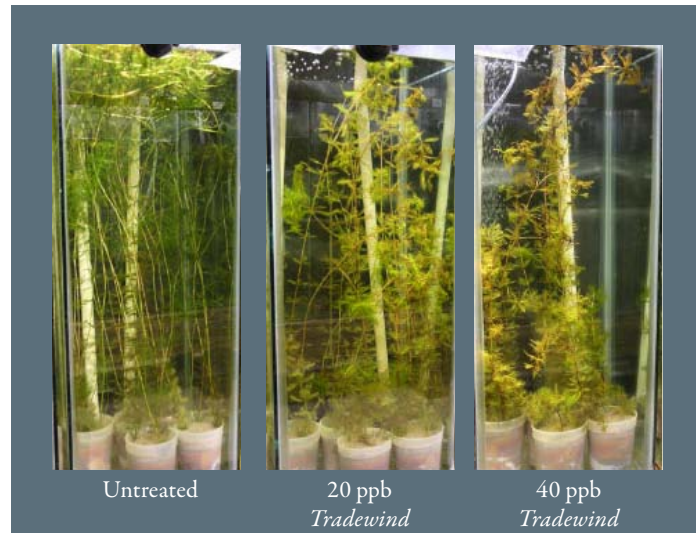


In other studies, Dr. Haller said *Tradewind* had no adverse impact on southern naiad when applied at 50 ppb or on *Vallisneria americana* (wild celery) at 100 ppb.

Other invasive weeds: *Tradewind* shows promise against a number of aquatic weeds in addition to hydrilla. According to EUP field, mesocosm and chamber observations performed by third-party research groups, *Tradewind* provides good-to-excellent (70% or better) control of such troublesome weeds as Eurasian watermilfoil, sago pondweed, water hyacinth and water lettuce when applied as a submersed treatment. As a foliar application, *Tradewind* provided excellent (85% or better) control of water hyacinth and water lettuce.

Also according to tests conducted by third-party researchers, *Tradewind*-treated plants displayed visual herbicide symptoms within two weeks of treatment.

Target Weed: Eurasian Watermilfoil
2 Weeks After Treatment



CONCLUSION

Providing aquatic resource managers with new tools in the fight against invasive weeds, *Clipper* and *Tradewind* are complementary products that can be used as combination partners or in rotation with other products. By bringing new treatment options to an industry in need of them, *Clipper* and *Tradewind* will also help the increasingly important battle against resistance and, hopefully, help reclaim more of the nation's waters and wetlands from noxious, invasive weeds.

Disclaimer

Some of the data presented in this technical guide are from results of studies conducted by the U.S. Army Engineer Research and Development Center (ERDC), under a Cooperative Agreement with the Aquatic Ecosystem Restoration Foundation. Citation of trade names does not constitute an official endorsement or approval of the use of such products by the ERDC.

Footnotes

- 1) Parochetti, James; Arsenovic, Marija; Getsinger, Kurt D.; Stubbs, Donald; and Haller, William T. "Addressing the Need for Herbicides for Aquatic Weeds in Irrigation Waters in the U.S.," *Outlooks on Pest Management*, June 2008, 19(3):112-16
- 2) Getsinger, Kurt D.; Netherland, M.D.; Grue, C.E.; and Koschnick, T.J. "Improvements in the Use of Aquatic Herbicides and Establishment of Future Research Directions," *Journal of Aquatic Plant Management*, January 2008, 46:32-41.
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