Light Attenuating Dyes

ANS Control: Light Attenuating Dyes

Targeted Species: This is an effective control method for algae and some aquatic vascular plants. ANS of Concern – CAWS[1] that may be controlled include red macro-algae (*Bangia atropupurea*), diatoms (*Cyclotella cryptica*, *C. pseudostelligera*, and *Stephanodiscus binderanus*),[2] and grass kelp (*Enteromorpha flexuosa*). The growth of water chestnut (*Trapa natans*) may be suppressed if light attenuating dyes are applied pre-emergent (prior to plant germination).

Varying concentrations of light attenuating dye in water. The product labels for Aquashade® and Admiral® recommend doses between 0.5 and 2.0 parts per million for suppressing growth of submersed aquatic plants and algae.

Selectivity: Light attenuating dyes were designed to control algae and some vascular plants. They can be selective or non-selective. Selectivity of algae and plants to light attenuating dyes will vary by species, rate of dye application, and timing of application.

Developer/Manufacturer/Researcher: Aquashade® is manufactured by Applied Biochemists in Germantown, Wisconsin. Admiral® is manufactured by Becker Underwood, Inc. in Ames, Iowa.[3]

Pesticide Registration/Application: Pesticides, including light attenuating dyes, must be applied in accordance with the full product label as registered by the U.S. Environmental Protection Agency (USEPA). Users must read and follow the pesticide product label prior to each application. The registration status, trade name, and availability of pesticides are subject to change. The listing of a pesticide in this fact sheet or Appendix B does not represent an endorsement by the U.S. Army Corps of Engineers or the USEPA regarding its use for a particular purpose.

Brief Description: Light attenuating dyes are concentrated synthetic colorants that can be applied to water for the purpose of reducing the growth of submersed aquatic plants and algae (Bellaud 2009; Lembi 2009; Lynch 2006, Glomski & Netherland 2005; Madsen 2000; Spencer 1984). The dyes act to reduce light penetration into the water column, thereby inhibiting the ability of submersed plants and algae from capturing the necessary light needed for photosynthesis. Light attenuating dyes do not directly kill plants or algae, but can reduce or suppress their growth.

There are only two light attenuating dyes that are currently registered by the USEPA for use in water for the purposes described above: Aquashade® (Applied Biochemists 2009) and Admiral® (Becker Underwood, Inc. 2007). Both Aquashade® and Admiral® are a blend of blue and yellow dyes (Acid Blue 9 and Acid Yellow 23), which filter out specific portions of the sunlight spectrum required for

[1] For a complete list of the 39 specific ANS of Concern – CAWS, please see Table 1 of the main report.
[2] Cryptic algae (*Cyclotella cryptica*), cylindrical algae (*C. pseudostelligera*), and diatom (*Stephanodiscus binderanus*) are three (3) species of algae that belong to the algal subcategory of diatoms. For the purpose of this fact sheet, they will be referred to collectively as diatoms.
[3] Manufacturers and products mentioned are examples only. Nothing contained herein constitutes an endorsement of a non-Federal entity, event, product, service, or enterprise by the U.S. Army Corps of Engineers or its employees.

photosynthesis by underwater aquatic vegetation, namely red-orange and blue-violet light. The products vary slightly in the percent concentration of each dye in their respective formulations. Water treated with these dye formulations will retain a blue tint following application. As these dyes will degrade and dilute over time, reapplication is necessary to maintain long-term effectiveness.

Light attenuating dyes are intended for use in natural and manmade contained lakes and ponds (ornamental, recreational, fish rearing and fish farming water bodies) with little or no outflow of water.

Prior Applications: The product labels for Aquashade® and Admiral® specify that dosage rates of 0.5 to 2.0 parts per million (ppm) can suppress the growth of submersed plants, such as leafy pondweed (*Potamogeton foliosus*), slender naiad (*Najas flexilis*), watermilfoil (*Myriophyllum* spp), hydrilla (*Hydrilla verticillata*), muskgrass (*Chara* spp.), filamentous green algae (*Spirogyra* spp) and many bluegreen algae species (Applied Biochemists 2009; Becker Underwood, Inc. 2007). Going and Purdue (1985) reported that the use of Aquashade® in a 215-acre lake in New York resulted in significant suppression of nuisance levels of broad-leaved pondweeds.

Laboratory studies showed that photosynthetic rates of five algae species (*Pediastrum tetras*, *Selenastrum capricornutum*, *Anabaena flos-aquae*, *A. cylindrical*, and *A. falcatus* var. *acicularis*) were reduced by at least 50% with the use of Aquashade® dye (Spencer 1984). Glomski and Netherland (2005) demonstrated in outdoor mesocosm studies that varying rates of Aquashade® (0.5 to 1.5 ppm) reduced growth (measured as shoot biomass) of sago pondweed (*Stuckenia pectinata*) by 59 to 73% over a 9-week period. In another study, hydrilla grown at two different depths (1.4 m and 3.0 m) was reduced by 50 to 84%, respectively, when exposed to 1.0 ppm Aquashade® (Glomski & Netherland 2005).

Dyes alone are seldom effective for controlling submersed aquatic vegetation, but they can be used in conjunction with an algaecide or herbicide treatment to reduce regrowth (Lembi 2009; Osborne 1979).[4] Osborne (1979) reported that the use of Aquashade® after an autumn application of the herbicide Hydrothol 191® was successful for long-term control of hydrilla in a Florida pond; the addition of dye prevented re-infestation of hydrilla from vegetative propagules (tubers and turions).

General Effectiveness: As mentioned in the prior applications section, the growth of certain algal species and submersed aquatic plants can be suppressed with light attenuating dye products. Light attenuating dyes are not effective on floating or emergent aquatic plants. While there is no published information on the use of light attenuating dyes against water chestnut, the growth of this plant may be suppressed if dyes are applied early in the growing season, before plants germinate. There are no published reports in the literature on the effectiveness of light attenuating dyes against the five algae species included in the ANS of Concern – CAWS.

Light attenuating dyes can be applied in conjunction with herbicides and algaecides to enhance plant growth suppression (Osborne 1979; Applied Biochemists 2009; Lembi 2009).

[4] For more information on algaecide and herbicide Control technologies, please see the fact sheets titled “Algaecides” and “Aquatic Herbicides.”

Operating Constraints: Aquashade® and Admiral® are for use only in natural or contained lakes and ponds with little or no outflow of water (Applied Biochemists 2009; Becker Underwood, Inc. 2007). Neither product can be applied to waters that are used for human consumption; however, there are no restrictions for animal or livestock drinking water, irrigation, swimming, or fish consumption, when recommended product rates (0.5 to 2.0 ppm) are applied.

To achieve optimal results, light attenuating dyes should be applied pre-emergent (prior to plant or algal spore germination) or before the growing season begins (March or early April) to prevent early season growth (Applied Biochemists 2009; Lynch 2006). Because these dyes photodegrade over time, reapplication throughout the growing season is necessary to maintain product effectiveness. Light attenuating dyes are not effective for suppressing growth of floating aquatic plants, floating algal mats, or emergent shoreline vegetation. Dyes have reduced effectiveness in waters less than 2 feet deep and on matured submersed aquatic plants (Applied Biochemists 2009). The color and effectiveness of these dyes will be lost in waters containing active chlorine.

Cost Considerations:

Implementation: Implementation costs will vary with the size and volume of the dye treatment area and method of application; the effective rate of application is usually in the range of 0.5 to 2.0 ppm. Product cost will vary depending on volume of purchase and distributor. Planning and design activities in this phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: Dye degradation will occur at some rate over time. Operations and maintenance activities would include an effectiveness monitoring program and reapplication of the product as necessary for the desired effect.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

Citations:

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