

Status Report On Diquat and Paraquat As Aquatic Herbicides

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The two bipyridyl compounds, Diquat and Paraquat, can hardly be called new aquatic herbicides. Diquat is now going into its sixth year of testing with Paraquat coming only shortly behind, and we have had Federal Label Registrations for the sale of Diquat for three years now. After this length of time in the field and on the market, it is interesting to look at the status of these two herbicides.

These materials have shown differences in:

- a. Spectrum of weeds controlled.
- b. Persistence in treated water.
- c. Toxicity to mammals and fish.
- d. Speed of absorption by plants.

It is essentially these differences that have determined the present status of these two herbicides.

Let's consider first the general characteristics of Diquat.

1. It is a water soluble salt.
2. It is rapidly absorbed by plants.
3. Its toxicity rating on rats shows an LD50 of 430 mg. per kilogram.
4. The general average threshold toxicity to fish is about 20 ppm.
5. It shows a broad spectrum of activity on weeds.
6. It is deactivated on contact with soil or soil particles suspended in water.

Now let us consider the characteristics of Paraquat:

1. It is also a water soluble salt.
2. It is rapidly absorbed by plants.
3. Its toxicity rating on rats shows an LD50 of 157 mg. per kilogram.
4. The general average threshold toxicity to fish is about 10 ppm.
5. It shows a broad spectrum of activity on weeds.
6. It is deactivated on contact with soil or soil particles suspended in water.

Now let us compare the two chemicals — Diquat and Paraquat directly:

1. In water solubility, they are the same — completely water soluble salts.
2. Diquat is more rapidly absorbed by aquatic plants than is Paraquat.
3. Mammalian toxicity — Diquat with an LD50 of 430 is approximately three times as safe as Paraquat with an LD50 rating of 157.
4. For fish, Diquat with an average threshold toxicity of 20 ppm, is approximately twice as safe to use as Paraquat with a threshold toxicity of about 10 ppm.
5. Activity on weeds — both chemicals show some degree of specificity in control of plants. Test results have shown Diquat to be better on duckweed (*Lemna spp.*)⁴ and water hyacinth (*Eichhornia crassipes*)¹ than Paraquat. Both chemicals perform about the same on water lettuce (*Pistia stratiotes*) and water fern (*Salvinia rotundifolia*). Generally Diquat and

Paraquat have given very similar results on most susceptible submersed weeds, while Paraquat has performed better on most of the rooted emergent weeds, as will be seen later in the report.

Some other differences which must be considered in determining the status of these chemicals are as follows:

Laboratory tests by Slade³ of Plant Protection, Limited, were conducted to determine the persistence of Diquat and Paraquat in aqueous solutions exposed to sunlight. No diquat could be detected after five weeks, but there was very little degradation of the Paraquat in the test solution. Solutions held in the dark showed very little degradation of either Diquat or Paraquat. Some of the field results in the Southeastern United States have been conflicting, but the bulk of the data generally confirm the findings that Paraquat has about twice the persistency of Diquat in treated waters under natural environmental conditions².

Another very important consideration is the fact that Diquat is already registered as an aquatic herbicide, and we all know that new registrations are difficult and costly. There must be a big advantage in order to justify registration of a new herbicide for the same job an old one can do.

On the basis of the previous information, it was decided by Chevron Chemical Company management that Diquat would be our prime aquatic herbicide and be promoted actively as such. Continued testing of Paraquat for special problems would be and is being encouraged. It is felt that there are many instances where the greater persistency of Paraquat in water would not be a limiting factor; however, Paraquat will be developed primarily as a terrestrial herbicide and desiccant. It is also felt that as soon as food crop clearances are obtained for Paraquat, it will make other registrations, such as for special aquatic weed problems, a much easier task.

It would be natural to wonder at this point just how does Diquat look as an aquatic herbicide. Briefly I can say that we are well pleased with the results we have had in the aquatic weed control market. Diquat has been widely accepted and we have noticed substantial increases in the volume used each year for control of aquatic weeds. We recognize that Diquat is not a cure-all in the aquatic weed control market; however, when you consider the factors of safety to applicator and fish, broad spectrum of control, length of control that can be expected, and annual cost of the aquatic weed control program, Diquat is a top notch aquatic herbicide. To illustrate the broad spectrum of activity of Diquat on aquatic weeds, I will list the weeds upon which we have registration. Under weeds classified as floating weeds, we have registrations for the control of water hyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*), water fern (*Salvinia rotundifolia*), and duckweed (*Lemna spp.*). In the classification of submersed weeds, we have registration for

control of southern naiad (*Najas guadalupensis*), coontail (*Ceratophyllum demersum*), bladderwort (*Utricularia spp.*), elodea (*Elodea canadensis*), pondweed (*Potamogeton spp.*), water milfoil (*Myriophyllum spp.*), and water pennywort (*Hydrocotyle umbellata*). Other weeds on which Diquat has given good results, but which we do not have enough research data to obtain registration for the labels, would be bulrush (*Scirpus spp.*), burreed (*Sparganium spp.*), frogbit (*Limnobium spongia*), spikerush (*Eleocharis spp.*), water-buttercup (*Ranunculus spp.*), watercress (*Nasturtium officinale*), watermeal (*Wolffia columbiana*), waterprimrose (*Jussiaea spp.*), and waterstargrass (*Heteranthera dubia*).

Some of the special problems on which Paraquat is being tested and has shown a great deal of promise are southern watergrass (*Hydrochloa*), alligatorweed (*Alternanthera philoxeroides*), torpedograss (*Panicum repens*), and maidencane (*Panicum hemitomon*). These are all pest situations in which Diquat has proven to be relatively poor.

Now to briefly summarize the present status of Diquat and Paraquat — Diquat is considered a general aquatic herbicide. Paraquat is being developed as the general terrestrial herbicide and desiccant, and for special aquatic weed control problems. It is felt that the specific characteristics of these two chemicals warrant this approach to the marketing of these herbicides.

LITERATURE CITED

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