International Journal of Horticultural Science 2005, 1, (11): 105–107.
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Translocation of diquat dibromide

Mikulás J.[1], Lázár J.[1] and Kazinczi G.[2]

[1]Research Institute for Viticulture and Enology of the Ministry of Agriculture and Rural Development, Kecskemét, Hungary
[2]Office for Academy Research Groups Attached to Universities and Other Institutions, Virological Group, University of Veszprem, Georgikon Faculty of Agricultural Sciences, Keszthely, Hungary

Summary: The aims of our work were to answer the following questions: 1. Diquat dibromide at different concentrations is a contact or systemic herbicide? 2. if translocation occurs what is the extent and direction of it. 3. by what concentration it is translocated in hydroponics. It has been stated that diquat dibromide at different dilutions (40-5%) had systemic effect in *Robinia pseudo-acacia* in the fields. Its translocation has been occurred apically first, and later basipetally. The extent of translocation depended on the concentration. In hydroponics diquat dibromide has crytallized on the leaf surface of *Galinsoga parviflora* and all concentrations (40-0.078%) proved lethal. Recognition and application of systemic characteristics of diquat dibromide is reported here for the first time. Improvement of application method is in the focus of our future work.

Key words: diquat dibromide, translocation, *Robinia pseudo-acacia, Galinsoga parviflora*

Introduction

Herbicides are used for the effective control of weeds all over the worlds. For the effective and safety use it is necessary to know their mode of action and the effect of environmental factors on their biological activity. With full knowledge of these facts proper uses of herbicides could be worked out.

A lot of herbicides are known which inhibit photosynthetic electron flow. Among them bipyridyliums require to be activated by photosynthetic processes before their toxic action is realized. These herbicides divert electron flow at the terminal end of photosystem 1 *(Preston,* 1994). The action of these herbicides is therefore dependent upon light to promote electron flow and also oxygen to yield toxic radicals *(Dodge,* 1990). They act by accepting electrons from photosystem 1, to produce a radical ion which is reoxidized back to the original ion by molecular oxygen with the production of the superoxide radical (O_2-). The superoxide radical is a powerful oxidant which attacks plant tissues itself but also generates other active oxigen species, singlet ($^1O_2$) and triplet ($^3O_2$) oxygen, hydrogen peroxide (H_2O_2) and the hydroxide radical (·OH) which do the same *(Hance & Holly,* 1990).

Bipiridylium herbicides, including diquat dibromide were synthetized first in England by ICI in 1957 *(Tomlin,* 1997). Former, it has been stated that bipiridyliums cause rapid scorch and desiccation of treated foliage the speed of which usually limits translocation. They are considered as non-selective contact herbicides and desiccants, absorbed by the foliage *(Hunyadi,* 1972; *Tomlin,* 1997).

Asclepias syriaca L. (common milkweed) – due to its considerable vegetative and generative propagation as well as allelopathy – is considered to be a serious weed of arable lands foresty and plantations, especially in vineyards on sandy soil near Kecskemét *(Kazinczi* et al. 1999, 2004). Its sprouting time coincides with that of vine, therefore selective herbicides applied without injury of vine can not be used. In opposition to our previous knowledge, we have stated the translocation of diquat dibromide applied at high concentration on *A. syriaca* (common milkweed). We have proved that the treatment of the upper two leaves of *A. syriaca* shoots (8×10^{-2}g a.i. shoot^{-1}) caused not only the death of the treated shoots but also the death of the untreated ones, which were in contact with the treated shoots through the rhizome *(Mikulás* et al., 2002, 2003).

Material and method

Experiments were carried out in order to study translocation of diquat dibromide. *R. pseudo-acacia,* an invasive woody and transformer species, and *Galinsoga parviflora* Cav. (gallant soldier), a troublesome annual weed in vegetables were used as model species in the field experiments and hydroponics, respecively.

Field experiments

Under field conditions diquat dibromide (Reglone, 40 g a.i. l^{-1}, Syngenta) at different concentrations (40, 20, 10 and 5%) were applied on *R. pseudo-acacia* test plants. Acacia sprouts were 1 m high at the time of treatments. Diquat dibromide were smeared with a paint-brush on the left lower leaflets of the compored leaf of *R. pseudo-acacia* on the 9th Oct 2002. Treated plants were visually checked every day and one week after treatments the number of the dead (dried) leaflets were counted. The number of dried leaflets were expressed in percentage of total leaflets as mean values of five replicates ± SE.

Hydroponics

Hydroponic experiments were set up after *Brian* et al, (1958) & *Mees* (1960). Under glasshouse conditions, water solutions of diquat dibromide at different concentrations (40, 20, 10, 5, 2.5, 1.25, 0.625, 0.312, 0.156 and 0.078%) were placed in test tubes at five replications. One *G. parviflora* shoot at 8 leaves stage was placed into each test tube. Shoots were visually checked daily and the number of the dead shoots were determined one week after the beginning of the experiments.

Results and discussion

Field experiments

When the right lower leaflets of acacia foliage were treated, upper leaflets at the same side began to decay. When tranlocation reached apical leaflet, the direction of translocation has changed, it happened from the apical leaflets to the lower ones at the opposite (leftt) side. Translocation occurred apically first, and later basipetally *(Figure 1 A,B,C,D.)*. At higher concentrations (40–10%) all leaflets of a compoted leaf died a week after treatments *(Figure 2)*. Over one week after treatments, the death of the whole *R. pseudo-acacia* shoot could be observed. At lower (5%) concentration of diquat dibromide the proportion of the dried leaflets were only 71% *(Table 1)*.

Table 1. The effect of diquat dibromide on the death of *Robinia pseudo-acacia* leaves

Diquat dibromide concentrations (%)				
40	**20**	**10**	**5**	**Control**
Dried leaflets in percentage (%) of all leaflets				
100±0	100±0	100±0	71±29	0±0

Figure 1. A Translocation of 40% diquat dibromide in *Robinia pseudo-acacia* leaflets, right lower leaflets of the composed leaf of *R. pseudo-acacia* 2 hours after treatments

Figure 1. B Translocation of 40% diquat dibromide in *Robinia pseudo-acacia* leaflets, translocation of diquat dibromide 2 days after treatments

Figure 1. C Translocation of 40% diquat dibromide in *Robinia pseudo-acacia* leaflets, 5 days after treatments

Figure 1. D Translocation of 40% diquat dibromide in *Robinia pseudo-acacia* leaflets, translocation of diquat dibromide 7 days after treatments

Figure 2. Translocation of 20 % diquat dibromide in *Robinia pseudo-acacia* leaflets 5 days after treatments

Hydroponics

On the leaf surface of *G. parviflora* plants greenish-grey crystals could be observed. On the basis of spectrophotometrical, sodium dithionite colour-producing method and the wavelenght correction of absorption, it could be determined that crystals contained diquat dibromide in 79.2%.

Slower translocation of diquat dibromide could be observed from solutions at lower concentrations to *G. parviflora* shoots, but all shoots died one week after placing them in test tube independently on diquat dibromide concentration.

It has been stated that diquat dibromide is able to translocate in test plants. The extent of translocation seemed to be dependent on the dosage. From the point of environmental plant protection the development of translocation of diquat dibromide has a great importance. Nevertheless, application of diquat dibromide as systemic herbicide seems to be economical only against perennial weeds, due to its considerable manual labour required. Improvement of its application as systemic herbicide is in the focus of our future work.

References

Brian, R. C., Homer, R. F., Stubbs, J. & Jones, R. . (1958): Nature **181**, 446.

Dodge, A. D. (1990): The mode of action and metabolism of herbicides. In: Weed Control Handbook: Principles (eds. Hance, R. J. & Holly, K.), 201–215. Blackwell Scientific Publications, Oxford, United Kingdom.

Hance, R. J. & Holly, K. (1990): The properties of herbicides. In: Weed Control Handbook: Principles (eds. Hance, R. J. & Holly, K.), 75–125. Blackwell Scientific Publications, Oxford, United Kingdom.

Hunyadi, K. (1972): Mode of action of paraquat. Thesis, University of Agricultural Sciences, Keszthely, Hungary.

Kazinczi, G., Mikulás, J., Horváth, J., Torma, M. & Hunyadi, K. (1999): Allelopathic effect of *Asclepias syriaca* roots on crops and weeds. Allelopathy Journal 6: 267–20.

Kazinczi, G., Béres, I., Mikulás, J. & Nádasy, E. (2004): Allelopathic effect of *Cirsium arvense* and *Asclepias syriaca*. Zeitschrift für PflKrankheiten und PflSchutz Sonderheft 19: 301–308.

Mees, G.C. (1960): *Annals of Applied Biology* 8, 601.

Mikulás, J., Kazinczi, G. & Lázár, J. (2002): Research on the translocation of Reglone (diquat dibromide) herbicide and using for weed control in environmentally benign management. In: Procedings 7th Tiszántúli Plant Protection Days (ed. Kövics J.), 195–199. Debrecen, Hungary.

Mikulás, J., Lázár, J. & Kazinczi, G. (2003): Translocation of Reglone (diquat dibromide) and its application in integrated weed management. Növényvédelem 39: 495–498.

Preston, C. (1994): Resistance to photosystem I disrupting herbicides. In: Herbicide Resistance in Plants: Biology and Biochemistry (eds.) Powles, S.B. & Holtum, J.A., 61–82. Lewis Publishers, Boca Raton, FL.

Tomlin, C. D. (1997): The Pesticide Manual. British Crop Protection Council Farnham, United Kingdom.