COMPETITIVE ABILITY OF THE PARAQUAT-RESISTANT BIOTYPE OF *ERIGERON PHILADELPHICUS*

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Summary. Competitive ability of a paraquat-resistant biotype of Philadelphia fleabane, *Erigeron philadelphicus* L., was evaluated by comparing the photosynthetic characteristics and population demography of sensitive and resistant biotypes. There was no significant difference in the photosynthetic characteristics between the two biotypes. In a 3-year experiment paraquat was sprayed 5-6 times each year on a mixed population which initially consisted of an equal number of individual plants of the two biotypes. The ratio of the number of individuals of the paraquat-resistant biotype to the sensitive one increased under repeated paraquat applications but remained constant under the control conditions. The study suggests that the paraquat-resistant biotype may be more competitive than the sensitive biotype when paraquat is continuously applied.

INTRODUCTION

A paraquat-resistant biotype of Philadelphia fleabane, *Erigeron philadelphicus* L., was first discovered in Japan in 1982 (4). The ratio of the number of individuals of the resistant biotype to the sensitive one seems to increase in Japan.

In this study, the competitive ability of the resistant biotype was investigated by comparing the light-photosynthesis curves in individuals of both biotypes and tracing the ratio of the number of the resistant biotype to the sensitive one under repeated paraquat applications and under the control conditions.

METHODS

Young plants of the paraquat-sensitive biotypes of Philadelphia fleabane were collected from the roadside in our Institute. Prior to transplanting, the sensitivity to paraquat was tested according to the method outlined in another paper (3). Young resistant plants were collected from a chestnut orchard where most of the plants were known to be resistant. Prior to transplanting, the resistance to paraquat was also tested, and the plants that were confirmed to be resistant were used in further experiments.

On 6 March 1990, sensitive and resistant plants were transplanted in plastic pots and grown to analyse the photosynthetic characteristics. Photosynthetic activity of the leaves from the sensitive and resistant biotypes was measured by enclosing a cut leaf in an assimilation chamber and by monitoring the CO_2 concentration of the air at the inlet and outlet of the chamber with an infrared gas analyzer (Fuji Electrics ZRC).

At the same time, the sensitive and resistant plants were transplanted alternately in 4 blocks in the field as shown in Fig. 1. In 2 blocks (1 and 2) each plant was planted 20 cm apart from the neighboring plant, while in the other 2 blocks (3 and 4) 30 cm. After the plants took root, paraquat (1,1'-dimethyl-4,4'bipyridinium dichloride) solution was sprayed to the 2 blocks (1 and 3) 3 times in 1990 at the rate of 28.8 g a.i./ha, which is equivalent to about 1/20 strength of the usual application rate. In 1991, paraquat was sprayed to the 2 blocks 5 times and in 1992 6

times, at a rate of 57.6 g/ha which is about 1/10 of the usual application rate. In the other 2 blocks (2 and 4) no paraquat solution was sprayed. A leaf was collected from each plant that appeared in a quadrat placed in 5 different areas of each block, and the resistance to paraquat was examined for each collected leaf by the method outlined in another paper (3), twice in 1990, 4 times in 1991 and 3 times in 1992. The percentage of resistant plants was calculated.

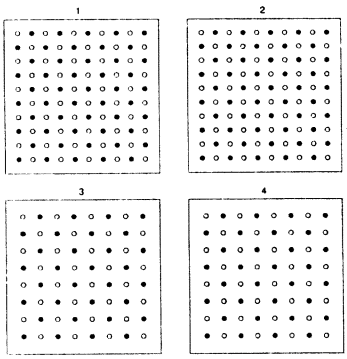

Figure 1. Diagram illustrating the planting scheme of Philadelphia fleabane. Open circles show the paraquat-sensitive plants, closed circles the resistant ones. In blocks 1 and 2 each plant was planted 20 cm apart from the neighboring one. In blocks 3 and 4 each plant was planted 30 cm apart. In blocks 1 and 3 the paraquat solution was sprayed repeatedly, while in blocks 2 and 4 paraquat was not sprayed.

RESULTS AND DISCUSSION

Photosynthesis. Light-photosynthesis curves of the leaves in the paraquat-sensitive and resistant biotypes are shown in Fig. 2. Under the photosynthetically active radiation of 540 $\mu mol/m^2/s$, the photosynthetic activity of a leaf of the sensitive biotype was 7.1 $\mu mol/m^2/s$ while that of the leaf of the resistant biotype was 6.5. The dark respiration of a leaf of the sensitive biotype was 1.9 $\mu mol/m^2/s$ while the value was 1.8 in the case of the resistant biotype. No significant differences were observed both in the value of the photosynthetic activity and dark respiration and in the shape of the light-photosynthesis curves.

The present results are not in agreement with the fact that leaves from plants resistant to triazine herbicides (e.g. atrazine), are known to display a much lower photosynthetic ability than the leaves of sensitive biotypes (1, 2).

Population demography. As the difference in the distance of each plant from the neighboring plant at the time of planting did not cause any appreciable differences in the rooting and population demography, the results for plots 1 and 3 and for plots 2 and 4 were pooled. Fig. 3 shows the relationship between the time of herbicide application and the ratio of the number of resistant plants to the number of total plants examined. In 1990, the ratio remained constant regardless of paraquat application, presumably due to the very low concentration of the herbicide. In 1991, 4 applications of the herbicide increased the proportion of resistant plants to

78% by the end of August. In 1992, the applications of the herbicide led to further increases. Throughout the 3 year period, the ratio under control conditions did not show any appreciable changes, values ranging between 42% and 60%.

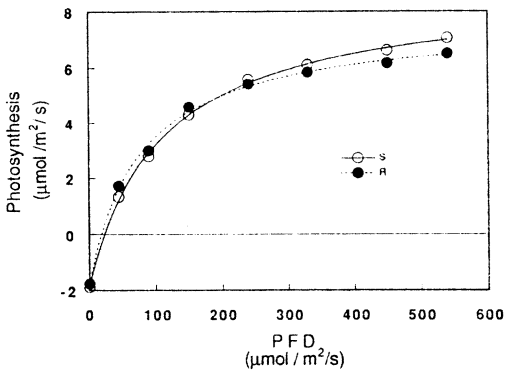

Figure 2. Light-photosynthesis curves of Philadelphia fleabane leaves from the paraquat-sensitive (S) and resistant (R) biotypes. PFD: Photon flux density.

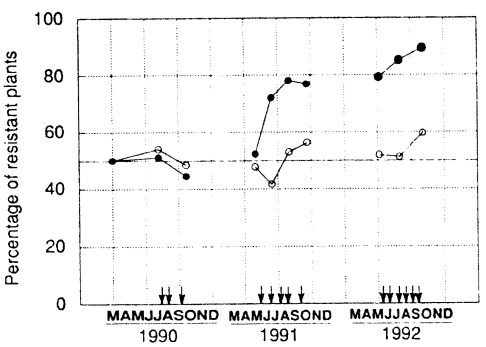

Figure 3. Changes in the percentage of paraquat-resistant plants to the total plants examined. Arrows at the bottom of the figure show the time when paraquat was applied. Open circles: percentage under the control conditions; closed circles: percentage under repeated paraquat applications.

These results indicate that the proportion of resistant ratio increased under the pressure of the herbicide at a much lower concentration than that of the usual application, but that the ratio remained fairly constant for at least 3 years without herbicide application. Therefore, it is assumed that the resistant biotype may dominate areas where paraquat is applied periodically and may co-exist with the sensitive biotype where paraquat is not sprayed.

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