Effect of the Herbicides MCPA and Simazine on the Respiration Rate and Content of Glycides and Nitrogen in Bindweed

(Convulvulus arvensis L.)

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Abstract. The effect of the herbicides MCPA and simazine on some physiological processes in bindweed was studied. An enhanced respiration rate in roots was demonstrated when MCPA was added to the nutrient solution, and when the plants were later transferred to a solution without any herbicide. When overground parts of plants were treated with the herbicide their respiration rate was found to proceed at a higher rate than in controls, the opposite situation being found to prevail in roots. In this experimental variant the content of glycides and of nitrogen in the overground parts was found to be reduced. It seems probable that the glycides were consumed due to the more intensive respiration caused by the presence of MCPA.

In experiments with simazine a lower respiration rate as compared with the controls was demonstrated in the majority of cases, independent of the means of application of the herbicide. When simazine was applied to roots and the plants were transferred to a solution without the herbicide, the overground parts were found to contain less glycides than the controls. In roots the opposite was true; after 7 days of the experiment no difference between the treated and untreated plants was observed. The nitrogen content was rather variable in this experiment. The reduced respiration rate after simazine treatment may be explained by a lack of respiration substrates resulting from an impairment of photosynthetic assimilation.

The influence of herbicide treatment on the respiration process depends on the plant species, its developmental stage and sensitivity as well as on the type and concentration of the herbicide tested.

AVERY (1951) found that after application of 2,4-D to roots of bindweed the oxygen consumption in treated plants is markedly increased. A high concentration of the substance, however, inhibited respiration. According to some authors MCPA and 2,4-D are uncouplers of oxidative phosphorylation and hence they increase the respiration rate. MAŠTAKOV (1968) confirmed this conclusion for both sensitive and resistant varieties of maize and reported stronger effects taking place in the sensitive ones.

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Plant Cultivation

Bindweed (Convolvulus arvensis L.) was used in the experiments. The seeds were obtained by field collection.

The seeds were left to germinate 4 days in a constant temperature box at 24°C. Seedlings were planted in apertures in gauze impregnated with paraffin, 30 individuals being placed into each aperture. The gauze was tightly stretched over an experimental cylinder, containing 2700 ml of Knop’s nutrient solution and covered with black paper.

Cultivation conditions were as follows: average temperature 24 to 25°C, relative humidity 30 to 55%, illumination 4500 to 5000 lux (fluorescent tubes Tesla, 40 W), photoperiod 12 hours. During incubation the content of cylinders was kept constant by addition of distilled water. Larger seedlings were supported by wooden skewers.

Application of Herbicides

Herbicides were applied 3 weeks after planting into the nutrient solution. A leaf herbicide MCPA, effective on bindweed and a root herbicide simazine, without effect on bindweed in field conditions, were chosen for the experiments. MCPA was in the form of preparation Dikotex 40 and simazine in the form of preparation Simazin 50.

Experimental variants:

1) Root application of herbicide (henceforth denoted as R). MCPA was added to the cultivation cylinder in the amount giving a resulting concentration of 1.2 ppm, simazine in the amount giving a resulting concentration of the active substance of 4 ppm.

2) Root application of herbicide followed by transplantation (henceforth denoted as R-UT). MCPA was added to a final concentration of 0.88 ppm, simazine to a final concentration of 2.9 ppm. On the 2nd day (in the experiment with MCPA) or 8th day (in the experiment with simazine) the gauze supporting overground parts of plants was taken off the cylinder, roots were rinsed with distilled water and plants with the gauze transferred to nutrient solution without herbicide.

3) Leaf application of herbicide (henceforth L). Overground parts of plants were uniformly sprayed with herbicide at the same concentration as in the R-UT variant.

4) Untreated plants (henceforth UT). Plants were grown in nutrient solution without herbicide.

Determination of Respiration Rates, Content of Glycides and Nitrogen

Respiration rates were determined using Warburg manometers according to Kleinzeller and co-workers (1954) at 25°C at 60 strokes per minute. Readings were taken at 10 minute intervals for 120 minutes. Whole overground parts of both treated and untreated plants were put into Warburg vessels in the amount of 0.4 to 0.6 g; roots in the amount of 0.3 to 0.5 g. After the experiment the plants were removed from the vessels and their content of dry solids determined at 78°C. Respiration rates were expressed in µl O₂/g of dry solids/hour.