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INVESTIGATION OF PHYSIOLOGICAL CHANGES IN ROOTS AND SHOOTS AS A RESULT OF A HERBICIDE TREATMENT I

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Introduction

The application of compounds of auxin effect as herbicides has been rendered possibly by the observation that the compounds, stimulating the growth in low concentration, are exerting a hindering effect if applied in a high concentration. This compound group includes, e. g., α-naphthyl acetic acid (NES), β-naphtoxy acetic acid; 4-chlorine-2-methyl-phenoxinacetic acid (McPAA) applied widely like a herbicide, at present too, 2,4-dichlorine-phenoxin-acetic acid (sodium salt, the Dikonirt), and 2,4,5-tri-chlorinephenoxin-acetic acid (2,4,5-T).

A decisive property of the phenoxin-acetic acid as a herbicide substance is its selective effect. Several monocotyledonous plants are essentially less sensitive to these compounds than the dicotyledonous ones generally, the cause of which may be looked for first of all, in the different metabolism of plants; anyway, the morphologic difference is also important, manifested in the different position or shape of leaves and in their hydrophilous or hydrophobic (wax layer) character, too. Apart from these, the form in which these compounds are applied, is also decisive in regard to selectivity because, as a result of their different polarity, they can penetrate into the plant tissues in different degrees.

Applying chemical herbicides systematically, we have to reckon with an accumulation of these in the soil that can have an influence also on the development of culture plants. We have adjusted our experiments on the basis of this reasoning, under conditioned circumstances, applying different concentrations of the sodium salt of 2,4-dichlorine-phenoxin-acetic acid (Dikonirt).

Material and Method

During our investigations we have treated the spring sort of barley MK 42, the yellow corn MV 530 of simple hybridization as monocotyledonous plants; the feeding peas IP and the striped sunflower from „Ireg" as dicotyledonous plants in an artificial plant experimental apparatus (HOR-

VÁTH—LASZTITY, 1965). sowing them into washed river sand and watering them with KNOPP's solution and Dikonirt solution of different concentrations, simultaneously with sowing (preemergent treatment).

Treatments:

Ist: untreated control
IInd: 0,125 g Dikonirt/growing vessel
IIIrd: 0,25 g Dikonirt/growing vessel
IVth: 0,5 g Dikonirt/growing vessel
Vth: 1,00 g Dikonirt/growing vessel
VIth: 2,00 g Dikonirt/growing vessel

The surface of one growing vessel is 0,12 sq. m.

The investigations were carried out in case of the monocotyledons after the first, resp. second leaves of the untreated plants had developed. In the artificial plant growing apparatus we used these dates were in case of barley the 7th and 14th days, of yellow corn the 11th and 17th days after sowing.

The growing vessels containing the grains of dicotyledons have been kept for 21 days in the artificial plant growing apparatus.

Measurings were performed for establishing the length of roots and shoots, resp. the number of roots and leaves; the fresh and dry weight of samples was determined as well as, after corroding with sulphuric acid, according to Nessler, the total nitrogen content and total phosphorus content of the leaves (FISKE—SUBAROW, 1925): finally, we established the change of plant respiration as a result of the treatment, with a manometric method.

Results

During our investigations, the pre-emergent Dikonirt-treatment had an intensive effect both on the monocotyledons and the dicotyledons. This effect has been manifested in a hundred percent inhibition of sprouting on both species of the dicotyledons investigated by us. The germination was thoroughly inhibited even by the treatment with a Dikonirt solution of low concentration applied in our experiments. On the

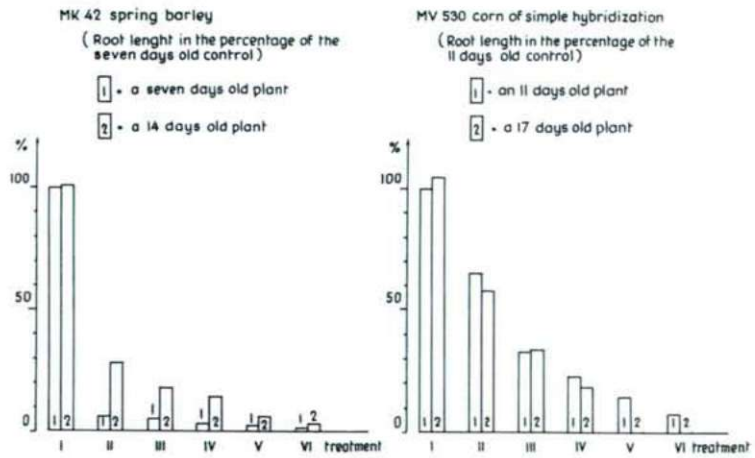

Fig. 1. Influence of pre-emergent Dikonirt treatment on the formation of root length of monocotyledonous culture plants.

21st day after sowing, opposite to the normally developed control, the germination still failed to start, resp. the seeds damped off.

An inhibition of germination of such a character and degree could not be demonstrated at either species of the two sorts of monocotyledons investigated by us, although a damaging effect could obviously be demonstrated in these plants, too. Increasing the Dikonirt concentration, the degree of the malformation of plants increased in parallel, as well. It could be well characterized with the results of phenologic measurements, the formation of the total phosphorus and nitrogen content, as well as with the intensity of breathing being increased.

As a result of the pre-emergent treatment, the increase in length both of yellow corn and of barley roots in inhibited, the degree of inhibition being a function of the Dikonirt concentration (Fig. 1). Anyhow, the two plants behave differently in course of time, as at the barley roots a definite increase in length could be demonstrated, as compared with the seven days old ones, in the 14th day of sprouting, while in case of the corn investigations, opposite to the control, we have found specimens with shorter roots at the second date than on the eleventh day of sowing.

In the formation of the number of roots there is similarly a difference between the Dikonirt-tolerance of barley and yellow corn (Fig. 2).

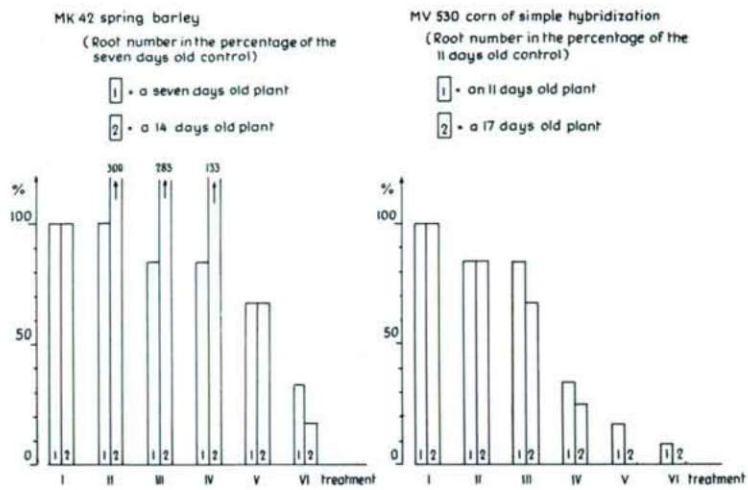

Fig. 2. Influence of pre-emergent Dikonirt treatment on the formation of the number of roots of monocotyledonous culture plants

0,125—0,5 g Dikonirt increased the number of barley roots on the 14th day after sowing, in a degree decreasing with raising concentration. The number of corn roots was always lower than that of untreated specimens although we can observe also here a high degree of cell proliferation and several shoot formations at samples treated with lower concentration.

In the longitudinal growth of barley shoots similar to the root increase, a significant increase can be demonstrated in every case, at the second date of investigation, while in case of corn this is caused only by the two solutions of thinnest concentration. As a result of concentrated solutions, we found smaller plants on the 17th day of sowing than on the 11th day (Fig. 3).

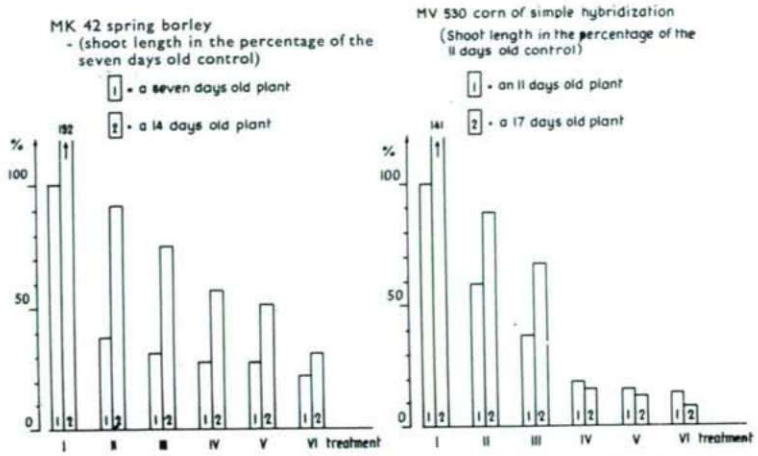

Fig. 3. Influence of pre-emergent Dikonirt treatment on the formation of the shoot length of monocotyledonous culture plants

It is shown also by the formation of the number of leaves (Fig. 4) that the development of both barley and yellow corn is inhibited by Dikonirt, at a low concentration, however, this influence can by mastered by the plant in some degree. As a result of 0,5—2 g Dikonirt, the number of the leaves of barley does not increase; owing to the inhibited development, a leaf is possibly formed from the epicotyle; at the corn, however, there cannot be found the leaves stage on the 17th day after sowing, only on the 11th day.

The Dikonirt treatment has an influence also on the development of fresh weight of the plants investigated, since as a result of treatment the fresh weight

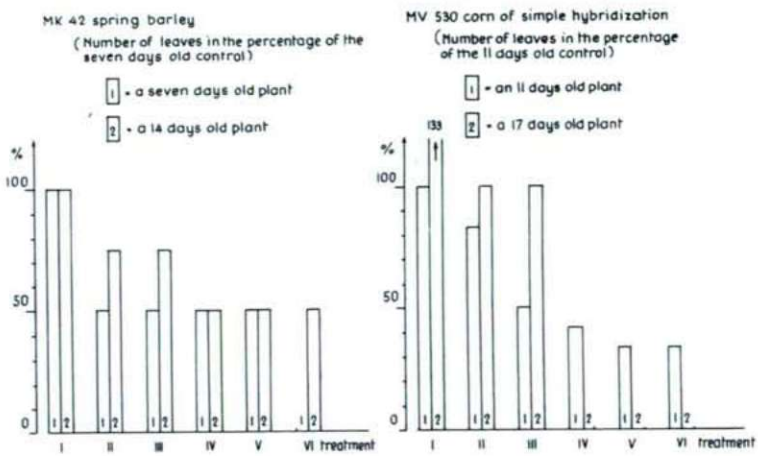

Fig. 4. Influence of pre-emergent Dikonirt treatment on the formation of the number of leaves of monocotyledonous culture plants

of barley is, always essentially lower than that of control. The same can be observed at the corn, as well. The difference between the Dikonirt tolerance of both plants is shown by the fresh weight of barley which increases in every case depending on time, while that of corn is decreasing (Fig. 5).

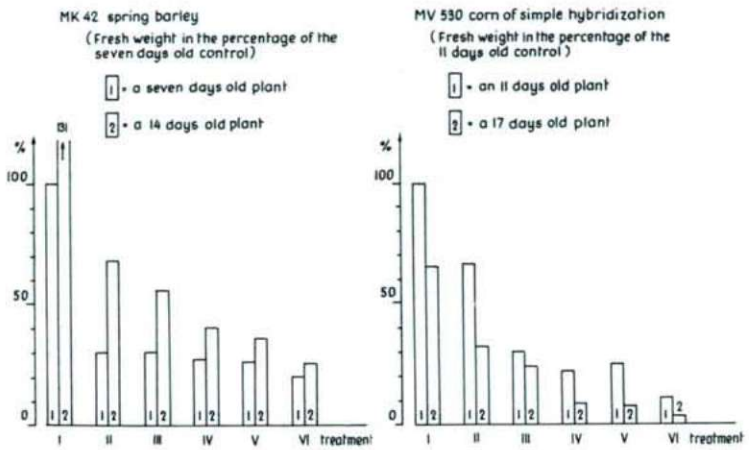

Fig. 5. Influence of the pre-emergent Dikonirt treatment on the formation of the fresh weight of monocotyledonous culture plants

As a result of treatment the dry weight of barley, is higher in every case than that of control, and at the second date of investigation it is higher than at the first one. The latter phenomenon can be observed also in case of corn; in this case, however at the first date of investigation, the dry weight content is nearly the same as, or lower than, that of control; and at the second date, it is nearly identical or higher, (Fig. 6).

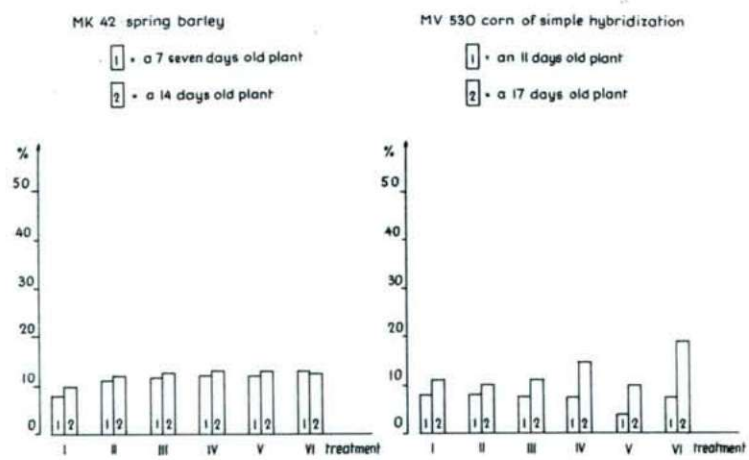

Fig. 6. Influence of the pre-emergent Dikonirt treatment on the formation of the dry weight o monocotyledonous culture plants
(Dry weight content in the percentage of the fresh weight)

The total nitrogen content referred to one plant increases in barley, except the VIth treatment, depending upon time, without reaching in any case the value of the corresponding control; in yellow corn we measured on the 17th day after sowing a total nitrogen content higher than on the 11 th day, as a result of treatment III and IV, in other cases we have noticed a decrease.

Taking into consideration the formation of percentages, it is obvious how very low the level of the total nitrogen content of the yellow corn is as compared with that of barley (Fig. 7).

The total phosphorus content in barley increases in every case till the 14th day after sowing, while in the corn it decreases (Fig. 8).

As a result of treatment the intensity of respiration increases in both plants. The oxygen uptake of barley leaves increases with age, while that of corn shows a changing tendency (Fig. 9).

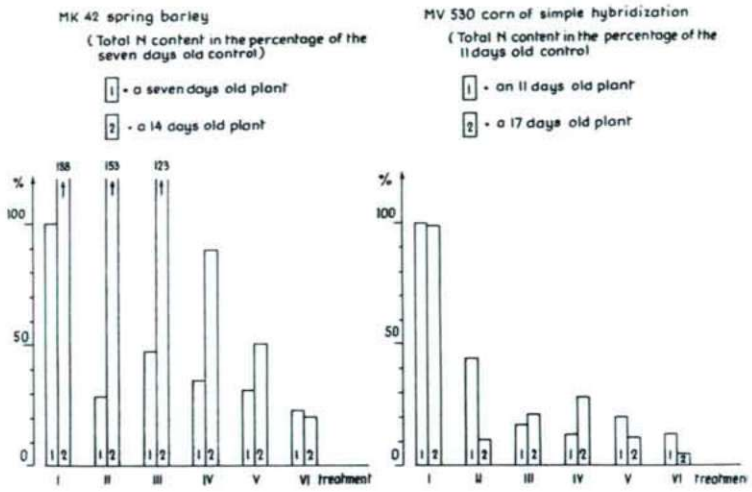

Fig. 7. Influence of the pre-emergent Dikonirt treatment on the total nitrogen content of monocotyledonous culture plants
MK 42 spring barley

Discussion

It may be established, therefore, on the basis of the results recited that Dikonirt, even in a quantity of 0,125 g/growing vessel, has an influence, with a pre-emergent treatment, on the development of both the monocotyledonous and the dicotyledonous plants. This effect causes, in case of the dicotyledons, the loss of grain vitality, thus bringing about the full inhibition of sprouting.

This cannot be observed on monocotyledonous plants, although during our investigations a characteristic damage could be demonstrated as a result of any treatment.

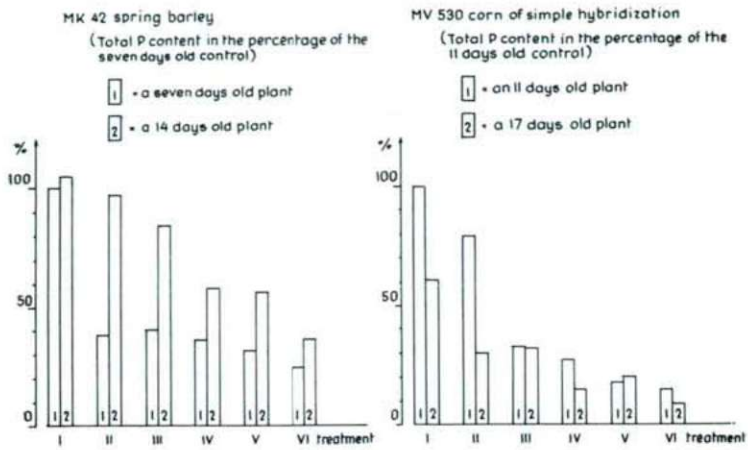

Fig. 8. Influence of the pre-emergent Dikonirt treatment on the total phosphorus content of monocotyledonous culture plants

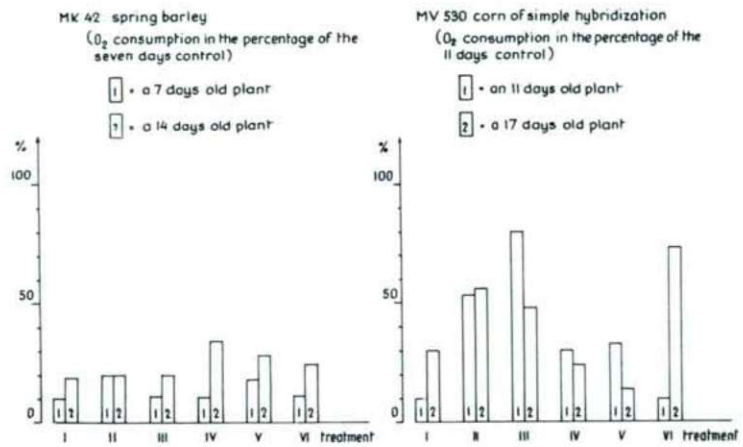

Fig. 9. Influence of the pre-emergent Dikonirt treatment on the respiration of monocotyledonous culture plants

Both monocotyledons showed characteristic differences concerning Dikonirt tolerance, and an increase of damage as a result of a raised concentration can be demonstrated, similarly to the results of the investigations of LIDER et al. (1966) carried out with simazine and diuron.

The rooting-inhibitory influence of the triazine derivatives is discussed by LEONARD et al. (1964) and BINGHAM (1967). It is emphasized by IVENS (1964) in connection with applying these derivatives, that this effect influences much less a further development of plants with already fully developed roots.

The present work has demonstrated an effect of this character of Dikonirt. In this way, Dikonirt with a growing concentration inhibits the formation of roots resp. the longitudinal growth more and more. Simultaneously it can be observed that, as a result of a treatment of low concentration, an intensive tissue proliferation is starting under the influence of auxin.

The total phosphorus and nitrogen contents of the samples decreases considerably owing to the treatments, similarly to the observations of EASTIN and DAVIS (1967) on different species treated with triazine derivatives. Simultaneously we can notice the decrease of fresh weight, together with the relatively increasing value of dry weight. On the basis of results the water circulation, i. e., water content of plants seems to decrease, owing first of all to the decreased root function. It is remarkable that, compared on a percentage basis, in corn both the nitrogen and the phosphorus contents were lower than is barley.

According to literary data, the herbicides inhibit the synthesis of chlorophyl (HERRETT—BERTHOLD, 1965), resp. the oxygen production of the isolated chloroplasts (HURTER et al., 1968). These results are not contradicted by our observation according to which the oxygen uptake is increased by Dikonirt treatment.

The conclusion can be drawn from our results that the pre-emergent Dikonirt treatment has a damaging influence, in this way, not only on the two investigated dicotyledonous species but also on the monocotyledons, by inhibiting the development of roots and disturbing the balance of metabolism; this effect can be demonstrated by the increase of respiration and the different fertilizer supply, as well. Also the yellow corn and barley behave in a different way if treated with Dikonirt, as barley — even if in a low degree — develops in the course of time, while corn perishes in case of a high concentration. Thus we could find at the second date of investigation specimens of smaller size and without leaves that developed, owing to the antigerminative effect of Dikonirt, while the plants that had developed earlier perished.

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