Acta Biologica Szeged. 26 (1—4), pp. 123—128 (1980)

EFFECT OF 2,4—D AND OF OIL-POLLUTED WATER ON THE GROWTH AND THE METABOLIC PROCESSES OF CUCURBITACEAE SEEDLINGS

M. MÁRIA HORVÁTH, JULIANNA KISS and IBOLYA BALOGH

Attila József University, Szeged
(Received 20 June, 1979)

Abstract

"Dikonirt", the 2.4-D sodium salt, portioned into the soil preemergently, had a toxic effect on Cucurbitaceae seedlings for 23 days. The damaging effect of the herbicide could be demonstrated, in a more and more decreasing degree, for about 50 days. After that, it did not induce any trouble in the growth and metabolism of plants.

The oil-polluted water, applied for watering preemergently, checked the growth of seedlings and the accumulation of dry matter but it did not destroy them. The oilcontaining water, applied for watering postemergently, had a toxic effect, shown well by the investigated indices of metabolism.

Introduction

In previous works (HORVÁTH—TAN VAN LE, 1976; HORVÁTH—KERESZTES, 1977) we investigated into the herbicide effect of "Dikonirt", an agent containing 2.4-D in different concentrations, exerted on cultivated plants and aquatic vegetation. We have observed that it the plants get more of the agent than the permitted concentration, they are damaged in different degrees. The degree of damage can be followed by the help of certain metabolism indices, as well as of the structural and numerical changes in chromosomes.

In this publication we are investigating into how long 2.4-D preserves its effect in the soil to such an extent that it still damages the cultivated plants. Apart from we are also investigating into the effect of engine-oil, got into the water, on plants watered pre- and postemergently. In these experiments we started from the fact that the water of the Tisza, serving for irrigation, from time to time contains 10 mg/l engine-oil as well (HORVÁTH—BALOGH, 1979).

Materials and Methods

Our experimental plant was the yellow flowered gourd, (Cucurbita pepo L. of the "tapering" sort). The plants were cultivated in the soil. The herbicide "Dikonirt" of 0.5 ad 1 g 2.4-D agent per cultivating vessel was, given in the time of sowing; i.e., we have applied a preemergent treatment, The 2.4-D-treated and the control plants were watered with tap water and, of course, raised in light. at a temperature of 25 °C. When investigating the use of tap water, polluted with engine-oil, for watering, we have also worked with Cucurbitaceae seedlings. For making watering, tap water, 10 and 30 mg engine-oil was given to 1 litre running tap water; as a control, clean tap water was used. At a

preemergent treatment, the Cucurbitaceae seeds were germinated on a filter-paper, sopped with oiled water, in a Petri dish, in a thermostat of 23 °C. The laboratory investigations were performed on the fifth or sixth day of germination. At the postemergent treatment, 3—4 days old seedlings were placed into the tap water, polluted with two kinds of motor-engine and the plants were raised in a light-thermostat (7000 lux).

The growth and the accumulation of dry matter were measured in both experimental series as a function of time.

Changes in metabolism were measured on the basis of a few indices. The quantity of the total soluble protein was determined with the method of LOWRY et al. (1951), the quantity of ascorbic acid by means of dichlorophenol-indophenol, the activity of peroxidase with the method of COLOWICK-KAPLAN (1955).

Results and Discussion

1) Effect of 2.4-D on Cucurbitaceae seedlings

Cucurbitaceae seedlings, treated with 2.4-D preemergently, were investigated [23 days old] and compared with controls. We have observed that a considerable damage was induced by the herbicide. Growth was strongly checked by 2.4-D, administered in a higher concentration, so that only 1 to 2 cm long, degenerate, chapped shoots developed. On the other hand, the lengthening of shoots was less reduced by chemicals of lower concentration.

After digging up the plants, there was not administered any herbicide into the soil of culture-vessels but gourd seeds were again planted into them in order to investigate the persistence of 2.4-D. Plants were again processed, 23-day old. Then we planted seeds for the third time into the culture-vessels and investigated and examined the plants sprouted from these, 18-day old. The formation of the dry matter content is summarized in Table 1.

At first planting, the stronger 2.4-D concentration resulted in deformed shoots of reduced growth in which the dry matter content was nearly the quadruple of that in the control. The lower herbicide concentration has checked the growth of shoots but in a lower degree, and resulted about twice as much dry matter accumulation as observed in the control.

In case of the second planting, the effect of 2.4-D was mostly eliminated because in the growth of the 23-day old plants only a little difference appeared, and the accumulation of dry matter was approximately identical with that in the control.

Plants from the third planting were processed 18-day old, i. e., on the 64th day after putting 2.4-D in the soil. In case of these plants no difference in growth was ob-

Table 1. Formation of the dry matter content in Cucurbitaceae seedlings, treated with 2.4-D preemergently (mg/g fresh weight).

2.4-D amount in the culture-vessel	Planting 1	Planting 2	Planting 3
	age of the plant in days		
	23	23	18
1 g	197	51	48
0.5g	100	47	42
0 g, control	51	44	48

served as compared with the control. The little difference in the dry matter content was also within the limits of standard deviation.

In our experiments, the plants treated with 2.4-D preemergently were, therefore, under the toxic effect of the herbicide for 23 days. In case of the seedlings of the second planting, hardly any damaging effect of the herbicide has appeared, although their growth was not equalized, as yet. The plants of the third planting already agree with controls both in their growth and in the dry matter content.

As an index of metabolism, the activity of peroxidase enzyme was measured in the 23-day old plants, preemergently treated with 2.4-D and coming from the first planting, as well as in controls (Table 2). According to the data, as a result of both 2.4-D concentrations, the peroxidase activity in shoots strikingly increased, which is referring to serious disorders of metabolism. The poisonous perishing of plants and the time-span of the toxic effect of the herbicide are indicated by the increased peroxidase activity as well.

Our observations were also supported by the formation of the ascorbic acid (AA) amount in shoots (Table 3). In the considerably damaged plants, from the culture-vessels containing 1 g herbicide, a large quantity of ascorbic acid can be measured, which refers to abnormally increased oxi-reductive processes. The ascorbic acid content increases already as a result of the 0.5 g herbicide but to a lower extent, which corresponds to a minor growth retardation and damaging.

Table 2. Peroxidase activity in Cucurbitaceae seedlings, treated preemergently and not-treated with 2.4-D (23rd day).

2.4- D content in the culture-vessels	Enzyme-units
1 g	150
0.5 g	131
0 g, control	69

Table 3. Quantity of ascorbic acid in Cucurbitaceae seedlings, treated preemergently and not-treated with 2.4-D (23rd day).

Treatments:	1 g 2.4-D	0.5 g 2.4-D	control
AA µg/g fresh weight:	180	130	95

We could, therefore, establish in our cultur-vessel experiments that the toxic effect of 2.4-D gets on for 23 days after being put in the soil. On the plants of the second sowing in the same soil (46th day), the herbicide effect can hardly be demonstrated and is hardly visible; and the plants of the third sowing (64th day) are equal to controls. 2.4-D preserves, therefore, its effect damaging the cultivated plant in the soil for about fifty days.

2) Effect of watering with oil-polluted water on Cucurbitaceae seedlings

The growth of Cucurbitaceae seedlings germinated in tap water of 10 mg/l and 30 mg/l oil concentration and in pure tap water is shown in Table 4, and their dry matter content in Table 5. According to the data, the water polluted by both

Table 4. Shoot and root growth of 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water.

Treatments	Shoot-length mm	Root-length mm
30 mg oil/l water	42	46
10 mg oil/1 water	49	57
tap-water control	56	75

Table 5. Dry matter content of 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water, (mg/g fresh weight)

Treatments	Shoot	Root
30 mg oil/1 water	41	58
10 mg oil/1 water	48	105
tap-water control	48	181

oil amounts considerably checks the growth of shoots and roots in seedlings, as well as the dry matter production. But the plants have not perished.

The ascorbic acid content of the Cucurbitaceae seedlings raised in oily water increases parallel with the quantity of oil (Table 6), which — as seen in the case of 2.4-D, as well — shows the irregularity of metabolism. The amount of ascorbic acid increases parallel with the degree of checking the grow.

Table 6. Ascorbic acid contcnt of Cucurbitaceae seedlings, treated preemergently with oil-polluted water, (μg/g fresh weight).

Treatments	Shoot		Root	
	5 days	6 days	5 days	6 days
30 mg oil/1 water	252	147	213	200
10 mg oil/1 water	195	145	175	188
tap-water control	158	139	125	185

The peroxidase activity of seedlings was not considerably affected by the preemergently applied oily water (Table 7).

In case of the postemergent application of the oil-polluted water, we have determined the total soluble amount (Table 8) and the peroxidase activity (Table 9) in the seedlings of Cucurbitaceae.

As it is to be seen, the total protein content increased, parallel with the degree of growth retardation and damaging by oil-pollution. The plants perished as a result of both oil concentrations.

Table 7. Peroxidase activity in 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water.

Treatments	Enzyme units in	
	Shoot	Root
30 mg oil/1 water	100	110
10 mg oil mg/1 water	104	105
tap-water control	98	103

Table 8. Quantity of total soluble protein in the shoots of Cucurbicaceae seedlings, treated postemergently with oily water.

Treatments	The age of plants in days		
	6	15	20
30 mg oil/1 water	499	594	855
10 mg oil/1 water	473	528	735
tap-water control	415	471	459

Table 9. Peroxidase activity in the shoots of Cucurbitaceae seedlings, treated postemergently with oily water (In enyme units).

Treatments	The age of plants in days					
	5	6	8	10	15	16
10 mg oil/1 water	110	101	113	116	116	perished
10 mg oil/1 water	97	95	113	117	108	119
tap-water control	71	73	74	75	88	85

By the increase in the activity of peroxidase the pathological changes in the metabolism of plants were similarly indicated, quasi predicting the perishing of plants to be expected as a result of the emergently applied two kinds of oil concentration.

We are grateful for the financial support under grant number 50—15—25—79 to the Ministry of Public Education and Hungarian Academy of Sciences.

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Address of the authors:
Dr. M. MÁRIA HORVÁTH
JULIA KISS
IBOLYA BALOGH
Department of Biophysics
A. J. University, H-6701 Szeged,
P. O. Box 428. Hungary