RESIDUAL EFFECTS OF HERBICIDES ON SENSITIVE PLANTS

T. I. Cox

Research Division, Department of Agriculture, Levin

Summary

In order to gain information on the effects of herbicide residues on a susceptible horticultural crop, doses of MCPA, 2,3,6-TBA, dicamba and picloram ranging from 5 to 0.005 oz a.i./acre were soil applied to young tomato plants. The resulting symptoms were recorded and a photographic comparison made after 20 days. During the 34-day duration of the experiment, at 0.5 oz a.i./acre picloram-treated plants died, 2,3,6-TBA and dicamba caused severe distortion, and MCPA caused a reduction in vigour. Lower doses which caused occasional symptoms suggest a basis for further work.

INTRODUCTION

IN RECENT YEARS there has been mounting concern over the dangers of toxic herbicide residues in susceptible horticultural crops. Contamination may be through soil, straw or manure. In 1963, in the United Kingdom, damage occurring in glasshouse crops was attributed to the presence of a growth regulator herbicide in composting straw. Since then the hazards, particularly to tomatoes and cucumbers, have been generally recognized.

Extensive damage was caused to tomatoes recently at Blenheim. A chlorinated benzoic acid was detected in a soil sample taken from an affected glasshouse and the evidence in this instance suggested that the toxic residue was introduced in pulverized dried sheep manure. Since there were so many ways in which the manure, collected as "dags" from numerous farmers, could become contaminated, it was not possible to trace the source of the trouble.

It is clearly important to obtain information on chemicals which may cause damage if introduced accidentally during the production of sensitive crops. In this investigation, known doses of four common growth regulator type herbicides were applied to the soil immediately before planting tomatoes. Three of these materials are used to control weeds in cereal crops. MCPA has been a standard treatment for many years and 2,3,6-TBA and dicamba have more recently found a place as additives for particular weed problems. The fourth material, picloram, which is being used for an increasing extent in agriculture for the control of woody weeds, was included because of its known persistence in the soil.

EXPERIMENTAL DETAILS

Tomato plants of the variety Potentate were used as test plants and the investigation, which was carried out in a greenhouse, was set up in early December, 1967. Plastic pots 3 in. square $\times$ 3 in. deep were filled with approximately 350 g of John Innes No. 2 potting mixture and each given 50 ml of water. After 24 hours, treatments of MCPA, 2,3,6-TBA, dicamba and picloram were applied at the dosages (a.i.) given

Fig. 1 (above and opposite): Effect of MCPA, 2,3,6-TBA, dicamba and picloram applied to the soil at 0.5 oz just before planting tomato seedlings, after 20 days.

in Table 1, in 100 ml of water per pot. Five replications were made and untreated control pots, four per replicate, were also each given 100 ml of water.

TABLE 1: TREATMENT DOSES OF MCPA, 2,3,6-TBA DICAMBA AND PICLORAM

<i>Dose per pot (mg)</i>	<i>Equivalent Dose, per acre (oz)</i>
0.2	5
0.02	0.5
0.002	0.05
0.0002	0.005

Two hours after application of the chemical solutions, two cotyledon stage tomato seedlings were transplanted into each pot. So that there would be no possibility of cross-contamination by water seepage, the pots were placed on racks above the usual greenhouse bench trays. Care was taken in the subsequent management of the experiment that the pots were watered equally. A record of daily temperatures and humidity was kept. Frequent observations were made as symptoms developed and, 20 days after treatment, one plant from each pot, chosen at random, was cut off at soil level and weighed and a photographic record was made. After 35 days, the remaining plant in each pot was weighed in the same way and the experiment terminated.

TABLE 2: ASSESSMENT OF PLANT VIGOUR AND OBSERVATIONS MADE 10 DAYS AFTER TREATMENT

(Figures are scores on 0 to 10 scale, where 0 = death, 10 = full vigour. Means of 5 replicates)

<i>Dose (oz)</i>	<i>MCPA</i>	<i>2,3,6-TBA</i>	<i>Dicamba</i>	<i>Picloram</i>
5	2 Cotyledon stage, no growth since planting.	2 Cotyledon stage, deformed growing point.	0 Dead.	0 Dead.
0.5	4 Slight twisting very stunted.	4 Stunted, first true leaf present malformed.	2 No true leaf development, moribund.	2 No true leaf development, moribund.
0.05	8 Normal.	6 Slight growth check.	7 Slight growth check.	6 Stunted.
0.005	7 Slight twisting.	8 Slight growth check	8 Normal.	9 Normal.

Untreated control means: 7,7,7,8.

Plants 2 in. tall 1½ leaves expanded.

TABLE 3: PLANT FRESH WEIGHTS AND OBSERVATIONS MADE
20 DAYS AFTER TREATMENT

(Stem + leaf weights, grams. Means of 5 replicates, log. transformation.)

Dose (oz)	g	MCPA	g	2,3,6-TBA	g	Dicamba	g	Picloram
5	0.08 fD**	Severely stunted, little deformity.	0.18 efCD**	Stunted, with main stem extension.	—	Dead.	—	Dead.
0.5	1.09 dB*	Growth checked, little deformity.	1.21 cdB	Twisted, with narrow leaflets.	0.25 eC**	Severely stunted, moribund.	0.17 efCD**	Very severely stunted, mori- bund.
0.05	2.00 abcAB	Normal.	1.54 bcdAB	Slight growth check.	1.77 abcdAB	Slight growth check.	1.73 abcd AB	Growth check.
0.005	1.64 abcd AB	Normal.	1.85 abcAB	Normal.	2.73 aA*	Normal.	2.12 abAB	Normal.
Control mean	...	...	1.81					
CV	...	...	7.1%					

Untreated control plants averaged 4 in. height, 6 in. across, with 2½ expanded leaves. Differences between control and chemical treatments are indicated by asterisks, * or ** at the 5% or 1% level of significance, respectively.

Effects began to develop after 48 hours. Both dicamba and picloram treatments at 5 oz showed stem bending and cotyledon leaf curl; a lesser effect was apparent at the same dose of 2,3,6-TBA. After 72 hours, when the plants had recovered from the transplanting check, the symptoms of damage shown by these three treatments had further developed and, in addition, several plants treated with 0.5 oz of picloram were beginning to curl. During the next few days, symptoms appeared at the 0.5 oz application of dicamba and the situation at 10 days after planting out is shown in Table 2. By this time the plants showing earliest symptoms had died. It was difficult to distinguish between the effects of dicamba and picloram and, at equivalent doses, 2,3,6-TBA was slower acting and caused characteristic stem extension with little leaf development. The main effect of MCPA was to check growth, with little apparent deformity; at 5 oz seedlings showed no growth since planting out and at 0.5 oz the plants were severely stunted. After 20 and 34 days, plant weights were recorded. These are summarized in Tables 3 and 4, respectively. At 0.5 oz 2,3,6-TBA, dicamba and picloram caused the development of severe damage, followed by plant death in the case of picloram; MCPA caused some growth check from which the plant seemed substantially to recover. The effect of the 0.5 oz dose of each chemical after 20 days is illustrated in Fig. 1.

A slight growth check not statistically different from control treatments was given by 2,3,6-TBA, dicamba and picloram treatments at 0.05 oz and the lowest dose, 0.005 oz may have caused a slight effect on occasional plants.

TABLE 4: PLANT FRESH WEIGHTS 34 DAYS AFTER TREATMENT

(Stem + leaf weights, grams. Means of 5 replicates)

<i>Dose</i> (oz)	<i>MCPA</i>	<i>2,3,6-TBA</i>	<i>Dicamba</i>	<i>Picloram</i>
5	—	—	—	—
0.5	6.20bcBC*	5.16cCD**	2.83dD**	—
0.05	8.35abAB	9.19aA	8.18abAB	8.30abAB
0.005	7.79abABC	8.24abAB	7.33abABC	8.12abAB
Control mean				8.39
CV				20.5%

Untreated control plants averaged 6 in. height, with 3½ expanded leaves. Differences between control and chemical treatments are indicated by asterisks, * or ** at the 5% or 1% level of significance, respectively.

DISCUSSION

All four chemicals killed the experimental plants at 5 oz and the presence in the soil of a 0.5 oz dose affected the growth of tomato seedlings in this experiment. The damage caused by MCPA was not spectacular, as it was in the case of the other chemicals, but there was a reduction in vigour compared with the untreated plants. This dose level enabled definite symptoms of damage caused by 2,3,6-TBA, dicamba and picloram to be recognized and will be a valuable aid to future diagnoses. The effect of lower doses is less clear cut. At 0.05 oz growth checks were detected on most plants during the period of assessment and even at 0.005 oz occasional damage was suspected.

This experiment gives no indication, of course, of the probability of such toxic residues occurring in practice. In normal use, MCPA is not likely to present a hazard to a following horticultural crop and there is no conclusive evidence of damage which can be attributed to the previous use of dicamba. However, the possibility of residues, particularly of 2,3,6-TBA and picloram, occurring in damaging amounts in soil, straw or manure cannot be excluded and this work shows that more precise knowledge is needed of the conditions under which extremely low doses can persist.

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