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Fyfield, T. P.
National Vegetable Research Station Wellesburne Warwick

Hardwick, R. C.
National Vegetable Research Station Wellesburne Warwick

Cole, R. A.

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PLANT DAMAGE AND DEATH CAUSED BY PLASTICS CONTAINING THE PLASTICISER DI BUTYL PHTHALATE

T. P. FYFIELD, R. C. HARDWICK and R. A. COLE

National Vegetable Research Station, Wellesburne, Warwick, England

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FYFIELD T. P., HARDWICK R. C. and COLE R. A. *Plant damage and death caused by plastics containing the plasticiser di butyl phthalate.* BIOTRONICS **13**, 39–41, 1984. Various items made of flexible plastic contain the plasticiser di butyl phthalate (DBP). Vapours of DBP emitted by such plastics are toxic to certain plants, notably some varieties of Brassica and tomato. The symptoms may be particularly severe in an enclosed volume such as a controlled environment growth chamber.

INTRODUCTION

Problems of plastic phytotoxicity occurred at the National Vegetable Research Station (NVRS) in 1968 when damage to the leaves of plants in newly-installed growth chambers was traced to emissions from certain types of flexible plastics. The toxic principle at that time, however, was not identified (*2*).

Similar problems have arisen in Japan (*5*), Germany (*1*) and Scandinavia (*6*), where workers have separately and independently traced the cause of plant damage to particular items in the vicinity that were made of flexible polyvinyl chloride (PVC) and contained di butyl phthalate (DBP) as the plasticiser. However, this work did not receive wide attention and plastic items containing DBP continued to be manufactured for use in horticulture.

In 1982 severe leaf necrosis developed in Brassica seedlings grown in newly-erected glasshouses at NVRS. Typical symptoms were leaf greying and marginal necrosis followed by leaf collapse and the death of seedlings, and patchy bleaching and necrosis of leaves of older plants. Similar symptoms were reported in tomato crops also growing in new aluminium-frame glasshouses elsewhere in the United Kingdom. Following the work of Hannay (*3*) the problem was traced to vapours of DBP emanating from the flexible PVC glazing strip used to cushion the glass against the glazing bars. It was solved by reglazing the glasshouses using strip containing a less volatile phthalate plasticiser (*4*), and the UK manufacturers of PVC plastics and of phthalate plasticisers have taken steps to avoid a recurrence of the problem. However, following the publicity given to this work an unexpectedly large number of related instances of plastic phytotoxicity were encountered, involving a variety of different plastic items received from scientists and growers. Some of these were associated with poor plant growth in controlled environment chambers.

This paper reports the results of our tests on the phytotoxicity of several of these items, and draws attention to the dangers posed to plant growth by the phytotoxic vapours emitted from certain plastics.

MATERIAL AND METHODS

Samples of plastics were tested for phytotoxic effects in a simple bioassay with seedlings of the highly-sensitive summer cabbage (*Brassica oleracea* L. var. *capitata* cv. Derby Day). The plastic was suspended above the plants in a 1.5 *l* glass cuvette, which was ventilated at approximately 2.5 air changes hr^{-1}. The plants were exposed to these conditions for 4 weeks.

In conjunction with this assay a headspace analytical technique was used to measure the emission of DBP from these plastics. Weighed samples were held at 30°C and air passed over then at 2 ml sec^{-1}. Volatiles emanating from the plastics were collected and analysed using a gas chromatograph.

Both techniques are described in detail by Hardwick, Cole and Fyfield (*4*).

RESULTS AND DISCUSSION

The presence of DBP was confirmed in a number of 'suspect' plastic items; not only the original PVC glazing strip, but also in polypropylene plant pots, PVC hosepipe, PVC insulated wiring, and reflective polyester film, all of which had been associated with problems of poor plant growth and all of which proved toxic in the bioassay (Table 1). Several of these items are found in many growth chambers, in particular the aluminised plastic film used to reflectorise the walls. Samples of this film had been associated with poor growth of oil seed rape in certain controlled environment chambers. Our tests indicated that DBP was present in the backing strip, since the film was most toxic in the bioassay when the backing strip was not removed, whilst its toxicity declined with time when it was removed. Trace amounts of DBP in the film's adhesive may have caused the oil seed rape damage, since phytotoxic levels could soon be reached in controlled environment chambers with low air exchange rates. Similar problems could therefore arise from the use in these chambers of the plant pots, hosepipe and wiring listed in Table 1. It should be noted, however, that other apparently identical items were also found which did not contain DBP and were harmless in the bioassay.

Only certain species of plants appear to be affected by DBP, notably Brassicas and certain other cruciferae and tomatoes. Tomato (*Lycopersicun esculentum* Mill. cv. Sonatine and Abunda) seedlings were killed after 4 weeks in the bioassay by the same quantity of DBP-plasticised glazing strip which killed summer cabbage cv. Derby Day (Table 1). Even within a single species there can be a wide variation in susceptibility. Sixteen Brassica varieties tested at NVRS varied in response from the highly sensitive (*B. oleracea* var. *capitata* cv. Derby Day) through to the comparatively resistant Brussels sprout (*B. oleracea* var. *gemmifera* cv. Asmer Leander).

Since this work began many instances of plastic phytotoxicity have been reported to us from glasshouses and from controlled environment laboratories.

Table 1. Effect of various plastics on cabbage (*Brassica oleracea* var. *capitata* cv. Derby Day) seedlings, and estimates of the concentration of di butyl phthalate (DBP) emanating from those plastics.

Type of plastic	Bioassay			Headspace analysis
	Size of sample tested (mm)	Wt. of sample tested (g)	Effect on plants after 4 weeks exposure	DBP emission pg sec^{-1} g $plastic^{-1}$
DBP-plasticised glazing strip	1000	30	Killed	150
127 mm flexible pot	120×50	4.0	Growth restriction, chlorosis and cotyledon death	1.2
Reinforced hosepipe	100	55	Killed	48
Insulated thermocouple wire	1100	1.7	Severe growth restriction, chlorosis and cotyledon death	2.4
Aluminised plastic film (with backing)	110×60	1.6	Killed	18

Similar problems will continue to arise until all sources of DBP are removed from these environments. Where poor growth of Brassicas and tomatoes in particular occurs in enclosed conditions, the possibility that DBP is the cause should be seriously considered. Suspect plastics can be tested by enclosing a sample with seedlings of summer cabbage cv. Derby Day in a belljar. Symptoms take 3–4 weeks to appear.

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