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THE POSSIBLE ROLE OF ALLELOPATHY EXHIBITED BY ROOT EXTRACTS AND EXUDATES OF CHINESE CABBAGE IN HYDROPONICS

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Aqueous extracts from fresh and dried roots and root exudates of the Chinese cabbage collected on filter papers and in glass vials, besides reducing its own radicle growth, fresh and drymass, also inhibited the growth of mustard (*Brassica campestris*) in various experiments. Extracts from dried roots were more inhibitory than those from fresh root. Mustard was more susceptible than the Chinese cabbage. The inhibitory effects of root exudates or extracts suggested that allelopathy might play a significant role in reducing productivity in hydroponics.

Key words: Roots, Allelopathy, Hydroponics.

INTRODUCTION

Allelopathy is exhibited by many plants [11,17] to render the soil toxic either during the death and decay of plants or parts thereof and/or during their active growth period. Exudation of toxic substance is one of the possible methods in allelopathy. Benedict [2] and Rovira [18] reported inhibitory effects of root exudates. Root exudates from *Lolium* [12], *Dichanthium* [5], *Sorghum* [15], and *Datura* [7] inhibit germination and growth of test species. Root exudates from tobacco seedlings reduced the germination and growth of cultivated plants [6]. Recently more work on allelopathy has been reported [4,9,3,14,17,10].

Seedlings of the Chinese cabbage were raised on stony gravel during a trial experiment on hydroponics to test the working of the unit. Four rows of the unit were arranged in a stair stepway so that nutrients supplied to the topmost row dripped down to the lowermost 4th row in a series (Fig. 1). The plants in the 4th row received nutrient solution after circulation through the 1st, 2nd and 3rd rows. After 15 days the plants growing in the 4th row become yellow and unhealthy (Fig. 2). Every row was provided with 250 seeds and the germination count showed 141, 140, 100 and 81 plants respectively in the 1st, 2nd, 3rd and 4th rows. Since all the physical conditions were seemingly similar, therefore, the authors suspected an allelopathic mechanism in the Chinese cabbage operating through either death and decay of roots and/or its exudates.

Keeping in mind the aforementioned evidences concerning the phyto-toxicity of the root exudates and the observed autotoxicity of the Chinese cabbage, the present investigation was, therefore, conducted to test the hypothesis wheather the Chinese cabbage exhibits allelopathy.

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EXPERIMENTAL

1. *Aqueous extract bioassay.* 5 g. fresh or dried roots of the Chinese cabbage were separately soaked in 100 ml distilled water for 24 hrs. at 25°, and filtered and tested against twenty seeds of Chinese cabbage (*Brassica oleracea* Cv. *chinensis*) and mustard (*Brassica campestris*) using our standard technique [8]. There were 5 replicates and seedlings were dried at 65° for 24 hrs. for dry weight determination.

Radicle growth and dry-mass of both test species was reduced by the extracts (Table 1). Growth was reduced

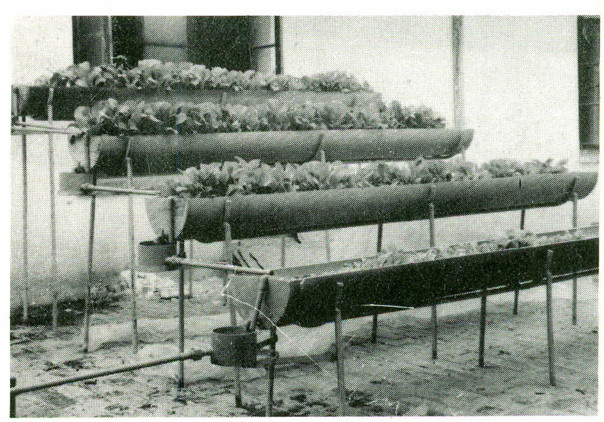

Fig. 1. General view of the set-up of stair-step hydroponic unit showing the flow of nutrients from the first uppermost tray to the lowermost 4th tray through the 2nd and 3rd trays. Compare the number of seedlings, growth and vigour of the Chinese cabbage in the different trays.

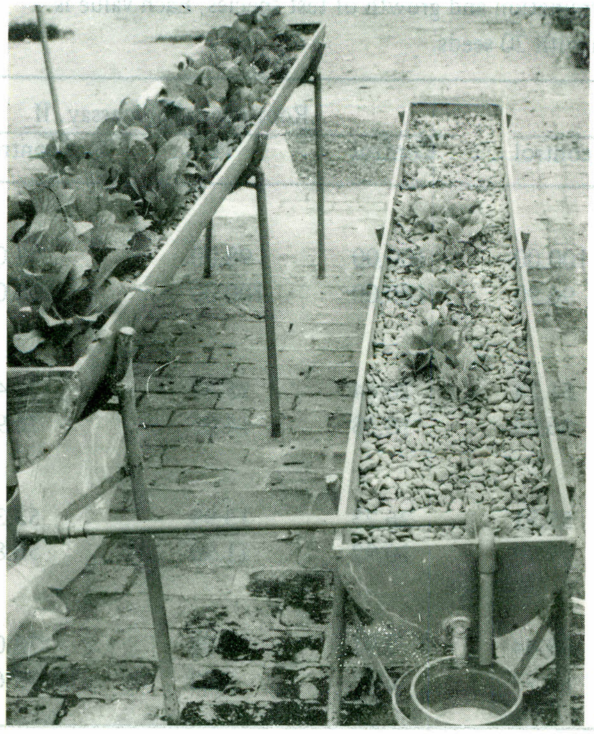

Fig. 2. Close-up view of the Chinese cabbage growing in the 3rd and 4th trays. Notice the inhibited growth of above ground parts in the lowermost 4th tray.

to 82.19 and 65.64 % by fresh root extract in Chinese cabbage and mustard respectively. Dried root extract decreased the growth of the Chinese cabbage and mustard respectively to 53.32 and 33.92 % of control. Drymass of the Chinese cabbage was respectively 81.15 and 74.87 % in the fresh and dried roots extract. Mustard exhibited 76.89 and 62.12 % drymass in fresh and dried roots treatments. Extract from dried roots was more inhibitory than fresh roots.

2. *Root exudate bioassay: I.* Five, 15-day old, healthy seedlings of the Chinese cabbage were rooted up; and their roots thoroughly washed with tap water followed by distilled water and placed on filter papers in a petri dish for one week. These filter papers were used as growth medium for the germination and growth of aforementioned test species following Haq and Hussain [6]. There were 5 replicates, each with 20 seeds. Germination, radicle growth and freshmass of the seedlings were determined after 48 hr incubation at 25°. Seedlings were dried at 65° for 24 hrs. for the determination of drymass.

3. *Root exudate bioassay II.* Root exudates of the Chinese cabbage were collected in glass vials following Dirvi and Hussain [5]. Twenty seeds of each test species were separately grown in 5 replicates using the exudates after Dirvi and Hussain [5] at 25°. Germination, redicle growth, fresh and drymass of the seedlings were determined.

Radicle growth, fresh and drymass of both the test species were retarded by the root exudates in both bioassays (Table 2). The inhibition ranged from 51.24 in Chinese cabbage to 79.91 % in mustard. The drymass of mustard was reduced to 83.71 and 75.66 % respectively in each of the bioassays. It was 88.44 and 78.00 % for the Chinese cabbage in both bioassays respectively.

DISCUSSION

Root exudates inhibit the growth of susceptible species under favourable physical conditions. The present

Table 1. Effect of fresh and dried root extracts of Chinese cabbage on germination and growth of test species. Each value is a mean of 5 replicates, each with 20 seeds.

Test species	Control	Fresh root extract		Dried root extract	
		Test	% of control	Test	% of control
a. *Germination (%)*					
Chinese cabbage	100.00	98.00	98.00	98.00	98.00
Mustard	100.00	100.00	100.00	100.00	100.00
b. *Radicle growth (mm)*					
Chinese cabbage	20.44	16.80	82.19	10.90	53.32
Mustard	18.28	12.00	65.64	6.20	33.92
c. *Dry weight (mg).*					
Chinese cabbage	3.82	3.10	81.15	2.86	74.87
Mustard	2.64	2.03	76.89	1.64	62.12

Table 2. Effect of root exudates of Chinese cabbage on the germination and growth of test species. Each value is a mean of 5 replicates, each with 20 seeds.

Test species	Root exudate bioassay. I			Root exudate bioassay. II		
	Control	Test	% of control	Control	Test	% of control
a. *Germination (%)*						
Chinese cabbage	98.00	98.00	100.00	100.00	98.00	98.00
Mustard	97.00	94.00	96.90	100.00	100.00	100.00
b. *Radicle growth (mm)*						
Chinese cabbage	17.23	8.83	51.24	20.44	15.82	77.40
Mustard	23.98	16.05	66.93	18.28	14.06	76.91
c. *Fresh weight (mg)*						
Chinese cabbage	28.71	15.88	55.31	26.23	13.99	53.33
Mustard	22.35	13.36	59.78	20.92	11.90	56.88
d. *Dry weight (mg)*						
Chinese cabbage	2.25	1.99	88.44	3.91	3.05	78.00
Mustard	2.21	1.85	83.77	2.67	2.02	75.66

study indicated that toxins present in root extracts reduced the growth of test species. The results agree with those of other workers [12,7,5,16,14,19,20] who reported upon the inhibitory effects of root extracts and exudates of many plants. The growth medium became unfavourable with the release of toxic root exudates in the presence of sufficient nutrients. Similar results were reported for tobacco [6], *Dichanthium* [5] and for *Sorghum* [15] which support our view. The findings also agree with these other workers [1,2,4,13,14,18,19].

The present findings reveal self-declining growth of seedlings in the lowermost 4th row was owing to its autotoxicity as it persisted in the presence of nutrient, water and growth medium. Allelopathic intensity is more severe under laboratory conditions like hydroponics where plants grow in sand, gravel or aqueous medium. In such cases a slight addition of toxic root exudates will affect the productivity of desired species. In nature, however, the allelopathic intensity is modified by a number of factors [8,10,13,3]. Like other species of *Brassica* [1] the Chinese cabbage exhibits allelopathy which might outweigh the benefits of hydroponics. An effort is, therefore, needed to avoid allelopathic species. It is also suggested that nutrient solutions should be directly supplied to each row or components of the unit instead of its sequential circulation in various rows or components and the re-use of nutrients solutions may be avoided.

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