SOME UREA DERIVATIVES AS GROWTH INHIBITORS

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ABSTRACT

Several urea derivatives have been tested for their plant growth inhibitory activity. Diphenyl urea has been found to have considerable plant growth inhibitory action against *Lactuca sativa* L and *Brassica juncea*, Hook and Thom.

INTRODUCTION

SOME urea derivatives have been found to inhibit tumour growth and some have been used as chemotherapeutic agents in cancer[1]. This prompted us to examine some urea derivatives for their inhibitory action on growth and seed germination activities in connection with our studies on molecular ecology in relation to secondary plant constituents. In the present communication, we report our results.

MATERIALS AND METHODS

(a) *Preparation of urea derivatives*: The urea derivatives tested were synthesized using the method of N-amino carbonylation of some amines with ethyl carbamate[2]. Amino substrate, (1, 2,3, 4, 5) (0.1 mol) and ethyl carbamate (6) 0.1 mol in 250 ml flask fitted with $CaCl_2$ guard tube were dissolved in appropriate solvent (table 1). To the reaction mixture aluminium chloride was added (14.7 g; 0.11 mol) in three portions with careful shaking in cold. The mixture was then refluxed until the evolution of HCl ceased at a sand bath temperature of 200°C. The reaction mixture was cooled and the solvent decanted off. The residue was treated with ice-cold aqueous hydrochloric acid (10%) and finally extracted with ethyl acetate. From the work-up of the ethyl acetate extract a solid was obtained which on recrystallization from an appropriate solvent, furnished the products (7, 8, 9, 10, 11). (Homogeneous to TLC) respectively. The results and the characteristics of the compounds are shown in table 1.

(b) *Bioassay with the compounds*: The resulting urea derivatives were tested on seeds of three species e.g. *Lactuca sativa* L, *Brassica juncea* Hook and Thom and *Amaranthus viridis* L, for their growth inhibitory activity. Different concentrations of the compounds (1000, 100, 50, 10 and 1 ppm) were prepared in appropriate solvents, as shown in table 2 and the experiments carried out both in light (425 lux) and dark conditions. Five ml of each test solution were administered to separate petridishes (11 cm dia) containing a disc of Whatman No. 1 filter paper and kept at room temperature until complete evaporation of the solvent. Sterilized distilled water (5 ml) was added to each petridish containing 25 seeds. Each experiment was replicated 5 times. They were kept in B.O.D. incubator at requisite temperature for 72 hr (for *Lactuca* 24 ± 1°C; *Brassica* and *Amaranthus* 32 ± 1°C). After 72 hr 40% formyldehyde solution was added to the dish to stop growth. Data were expressed as percentage of growth inhibition (both radical and hypocotyl) as compared to the controls set. The percentage inhibition of test seeds by the activity of 3 urea derivatives is shown in table 2, as other urea derivatives were devoid of substantial activity. Of the three urea derivatives, diphenyl urea (8) was the most active one. The inhibitory properties of diphenyl urea are detailed in table 3.

A recent report showed that at a concentration of 200 mg/l and higher (500 mg/l) (pH 6–7.5) urea inhibits germination and radical growth of *Striga* sp[3]. Germination inhibition with urea under the said condition was examined on test seeds, *Brassica juncea*, *Lactuca sativa* and *Amaranthus viridis* but no inhibitory action was noticed.

RESULTS AND DISCUSSION

The above data show that diphenyl urea is the most active growth inhibitor among the above urea derivatives, because this showed root and hypocotyl growth inhibition of *Lactuca sativa* at a concentration of 1 ppm. In *Brassica juncea* inhibition of root growth is seen at a concentration of 10 ppm. *p*-toluyl urea also showed root growth inhibition of *Lactuca sativa* and *Brassica juncea* at 10 ppm and N-α-napthyl urea

Table 1 *Properties of urea derivatives*

Substrate	Product	Solvent (time)	m.p. (solvent)	Mol. formula or lit m.p. (°C) (Product)	IR (KBr) cm^{-1}	^{1}H-NMR (ppm) (solvent)	M^+
Carbazole (1)	N-amido Carbazole (7)	O-xylene (16 hr)	226° (C_6H_6)	$C_{13}H_{10}ON_2$	3150,3320 1665,1615 1595,1580	8.06–8.4 (m, 4H) 7.74–7.9 (S, 2H) 7.33–7.73 (m, 4H) (DMSO-d_6)	210
Diphenyl amine (2)	N-N-di-phenyl urea (8)	O-xylene (12 hr)	184° (C_6H_6/PE)	$C_{13}H_{12}ON_2$ (189°)[4]	3325,3450 1640,1560 1490,1420	4.9–5.2 (Br. 2H) 7.2–7.5 (m, 10H) ($CDCl_3$)	212
N-methyl aniline (3)	N-N-phenyl methyl urea (9)	O-xylene (6 hr)	80° (C_6H_6/$CHCl_3$)	$C_8H_{10}ON_2$ (82°)[5] (ligroin)	3150,3450 1635,1585 1490,1465 1435	3.3(s.3H) 7.25–7.6 (m, 5H) 4.45–4.65 (Br, 2H) ($CDCl_3$)	150
α-napthyl amine (4)	N-α-napthyl urea (10)	Benzene/high boiling petroleum ether(200°13 hr)	278° (C_6H_6/PE)	$Cl_{11}H_{10}ON_2$ (270–80°)[6] (alcohol)	3250,3400 1650,1600 1545,1520	—	186
p-toludine (5)	N-p-tolyl urea (11)	O-xylene (4 hr)	247° (C_6H_6/$CHCl_3$)	$C_8H_{10}ON_2$ water, (180°)[5]	3250,3400 1635,1590 1560,1590	—	150

Table 2 *Effect of* 3 *urea derivatives on growth of test seeds*

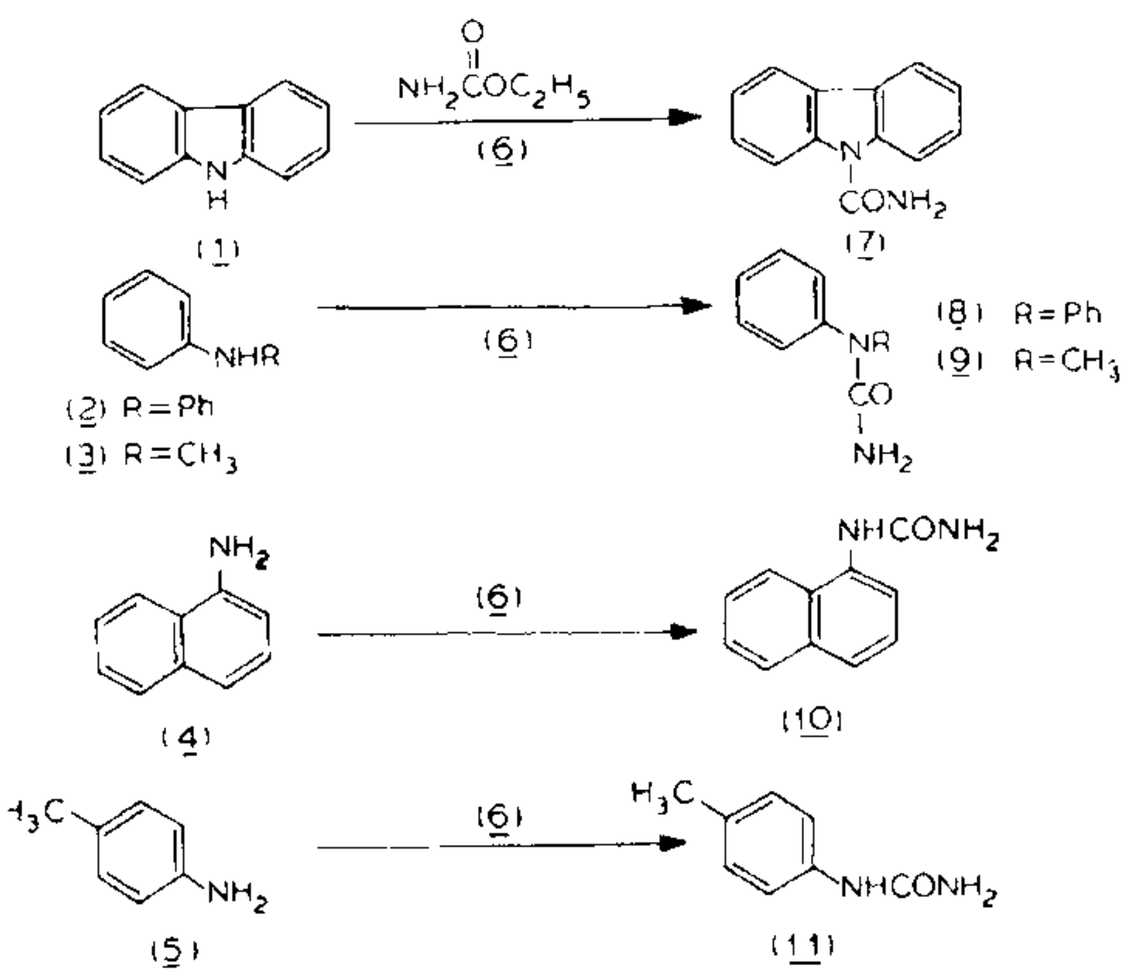
Seed plant used	Minimum inhibitory concentration (ppm) Light R	Light H	Dark R	Dark H	Compound
Lactuca sativa	10 (20%)	1000 (34.3%)	1(45.3%)	1 (41%)	Diphenyl urea (solvent benzene)
Brassica juncea	10(50%)	1000 (28.3%)	100 (45.2%)	100(54.5%)	
Lactuca sativa	1000 (50%)	1000 (62%)	1000 (50%)	1000 (70%)	
Brassica juncea	1000 (30%)	100 (45%)	1000 (27%)	10 (48.7%)	N-α-napthyl urea
Amaranthus viridis	100(36%)	–	1000(35.6%)	1000(41%)	(Solvent alcohol)
Lactuca sativa	10 (35.3%)	1000 (48%)	100 (45%)	1000 (35%)	N-*p*-tolunyl
Brassica juncea	10 (58%)	1000 (22.9%)	50 (43.3%)	1000 (44%)	Urea
Amaranthus viridis	10 (40%)	1000 (34.9%)	50 (40.9%)	1000 (52.6%)	(Solvent chloroform)

R = root, H = hypocotyl. ( ) = % of growth inhibition. – = nil.

Table 3 *Effect of diphenyl urea on the growth of root and hypocotyl (average length ± S.E.M.)*

Seed plant	Concentrations (ppm)								Light	
	1000		100		10		1		Control	
	R	H	R	H	R	H	R	H	R	H
Lactuca sativa	1.1 ±0.05	0.83 ±0.01	0.9 ±0.06	0.6 ±0.02	0.64 ±0.02	0.61 ±0.03	0.68 ±0.03	0.76 ±0.02	0.8 ±0.04	0.7 ±0.03
Brassica juncea	0.48 ±0.05	0.29 ±0.02	1.1 ±0.1	0.68 ±0.05	1.04⁺ ±0.01	0.7 ±0.05	1.48 ±0.1	0.76 ±0.04	1.91 ±0.1	0.81 ±0.04
	Dark									
Lactuca sativa	0.98 ±0.04	0.53 ±0.01	0.97 ±0.07	0.8 ±0.05	0.7 ±0.04	0.61 ±0.04	0.71* ±0.05	0.59* ±0.05	1.3 ±0.1	1.0 ±0.08
Brassica juncea	0.55 ±0.08	0.39 ±0.03	1.1 ±0.01	1.02 ±0.09	1.1* ±0.09	0.9 ±0.08	1.5 ±0.01	1.0 ±0.7	2.01 ±0.01	1.21 ±0.13

*$P < 0.001$; ⁺$P < 0.01$; R = root, H = hypocotyl.



inhibits hypocotyl growth of *Brassica juncea* at 10 ppm respectively. So these urea derivatives are inhibitors though urea itself is not in general a growth inhibitor except in a special case, as shown in *Striga* sp[3] at a very high concentration. It has been observed from the data that diphenyl urea, the most active of the urea derivatives, is less effective in the presence of light than in darkness against *A. viridis* while the reverse is the case with *B. juncea*. The effect of light on the inhibitory activity of diphenyl urea, appears to be dependent on the test species of the seeds.

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