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Identification of Vulnerable Growth Stage and Suitable Techniques to Suppress Sprouting of *Cyperus rotundus* L. Tubers

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To know the growth pattern, vulnerable growth stage, effect of herbicide combination and application technique for effective control of *Cyperus rotundus* experiments were conducted in field and pot culture conditions. By 30th day, planted tuber reserves are completely depleted and bulk of photosynthates are diverted to shoot and root development. During 60-120 days after sowing (DAS), tuber biomass constituted 40-73% of total biomass, suggesting that after 40 DAS photosynthates was used for tuber development. Ethephon pre-treatment for 24 hr at 100 and 500 ppm did not enhanced the efficacy of different forms of 2,4-D and glyphosphate compared to herbicides alone. While 5000 ppm ethephon concentration had significantly increased the herbicide efficacy compared to herbicide alone thus it is not economical. Hence, programmed herbicide application of 2,4-D (30 DAS) followed by pre-emergent herbicide spray (Imazethapyr, anilophos + 2,4-D formulation or pretilachlor or atrazine) to control growth of *Cyperus rotundus* seems to be most effective.

Key Words: Growth stage, Translocation, Ethephon pre-treatment, Herbicides, *Cyperus rotundus*

Introduction

Established *Cyperus rotundus* have a complex system of aerial shoots, basal tubers (fresh and old) and large number of rhizomes. Each rhizome ends up in a tuber with or without aerial shoot (Anon 1987). Its effective control depends on rate of entry, translocation and persistence of herbicides to bring in mortality of the dormant underground plant parts. Maximizing the entry and transport of foliar applied herbicide (post emergent) is the current topic of interest. Post emergent herbicide must be phloem mobile and ensure optimum delivery to the target site. Phloem mobility is regulated by callose, 1,3-glucons, is deposited on cell wall by perturbed plasma membrane. Callose is known to form at sieve plate pores (Groussol et al. 1986). Ethephon pretreatment reduce callose accumulation thus enhanced entry and translocation of labelled 2,4-D (Chykalink 1982, Anon 1987).

2,4-D, 2,4,5-T, MCPA, dalapon and glyphosate herbicides are predominantly phloem mobile. However, small quantities of glyphosate appear to exit from phloem, enter xylem and thus distribute along with water (Dewey & Appleby 1983). The reduced glyphosate mobility may be attributed to a decreased sucrose availability in treated leaves, lowered assimilate entry into phloem and leakage from phloem transport system (Geiger & Bestman 1990). About 73-84% of foliar applied ^{14}C 2,4-D remains in foliage and only 16-27% of applied herbicide reaches the underground bulbs in *Oxalis latifolia* 24 hr after feeding (Anon 1987). Similarly, 98.18% of ^{14}C fluazifop-butyl remained in leaf and only 0.64% moved to apical meristem 72 hr after feeding in case of *Setaria viridis* (Carr et al. 1986).

With this background an attempt was made to identify most vulnerable growth stage for herbicide application, influence of ethephon pre-treatment on foliar applied herbicide and to assess the effect of post and pre emergent herbicide combination on effective control of this weed.

Materials and Methods

Growth Pattern Studies

Cyperus rotundus plants were raised in pots (30 × 15 × 20 cm) from a single medium size tuber. In one set of pots, at five days interval emerging leaves were defoliated continuously up to 175 DAS, whereas in another set, plants were intact. In both the sets, at regular intervals of 10 days, ten plants were harvested and various growth parameters were recorded up to 175 DAS.

Per cent dry matter (DM) distributed to different plant parts was computed at each growth stage. Pooled data on leaf area and total biomass of control and defoliated sets at various growth stages were subjected to polynomial regression in order to identify the functions which can predict growth pattern of these parameters. Correlation co-efficients amongst various growth parameters were assessed in order to identify most important growth parameter which reflects sprouting ability of tubers at a given time by utilizing pooled data of all growth stages.

Techniques to Suppress Sprouting

Three experiments were conducted to study the effect of different herbicides, two in pot culture and one in the field. Ethephon in plant enhance ethylene level and causes reduced callose deposition in phloem sieve elements, dehydration of tissue and loss of membrane integrity thus induces senescence effect in foliage. This may facilitate enhanced translocation of assimilates to underground tubers. Hence the effect of ethephon pretreatment on enhanced efficacy of herbicide was examined.

Pot Culture Experiments

These experiments were conducted on *C. rotundus* plants raised using single tuber/pot at 30 DAS.

Expt. 1: Several post emergent herbicides were sprayed with or without ethophan pretreatment (24 hr).

Expt. 2: Post emergent spray of 2,4-D (2 kg/ha) followed by preemergent application of different herbicides (16 days after 2,4-D spray). Treatment details are given in figure 3 and tables 3 and 4.

Field Experiment

A field experiment was also conducted to assess the effect of ethephon pretreatment on the efficacy of post emergence application of different 2,4-D formulation and glyphosate to control *C. rotundus*.

Results and Discussion

Growth Pattern of ***Cyperus rotundus***

Dry matter present in various plant parts at different growth stage showed that up to 40 days, biomass in the tuber decreased and reached a value of 6.59% by 40 DAS. Later on. tuber biomass gradually increased and reached a value of 72.9% at 120 DAS and remained stable thereafter (table 1). Shoot biomass reached a maximum of 31.3% of total by 50 DAS and remained stable thereafter. Whereas, root biomass reached maximum of 72.9% at 40 DAS and started declining there after till 175 DAS. Thus, planted tuber lost its reserves for the development of root and shoot up to 40 DAS.

Table 1 *Per cent dry matter distribution in various plant parts of **C. rotundus** during different growth stages*

Growth stages (DAS)	Plant part			
	Shoot	Inflores-cence	Tubers	roots
10	3.60	–	54.40	42.00
20	17.23	–	31.76	51.01
30	20.45	–	11.51	68.04
40	20.47	–	6.59	72.94
50	31.39	–	30.39	38.22
60	20.10	4.46	45.40	34.50
70	18.06	2.13	41.97	39.97
80	16.64	1.84	50.00	33.36
90	25.03	1.08	49.18	25.79
100	20.30	–	54.24	25.49
115	27.56	0.72	53.15	19.29
120	6.83	1.68	72.94	20.23
145	17.09	–	65.76	17.15
175	14.67	–	66.03	19.30

Two peaks of foliar growth were observed by Cox and Kerr (1981) and they explain this phenomenon as the first flush of foliage arose from parent bulbs which then produced bulbs which in turn sprouted and contributed to the late season flush of leaves in *Oxalis latifolia*. This may be true even in *C. rotundus* (figure 1).

Photosynthates are essential for development of new tubers and propagation which is reflected in defoliation where there is no increase in biomass from 30 DAS (figure 2). Though leaf area reached maximum at 70 DAS (figure 1), leaf area development between 40-70 DAS is very essential, as at this stage, leaf photosynthates contributed for the formation of new tubers and overall development of plant. From 30th day onwards photosynthates contributed more towards the growth of shoot. Thus, 30 to 40 DAS may be the most vulnerable growth stage for the effective control of *Cyperus rutundus.*

Relationships amongst various growth parameters indicated that total biomass was related to tuber number and tuber weight compared to other parameters (table 2). Tuber biomass was highly correlated with tuber number. In *Oxalis latifolia* strong relationship was observed between tuber

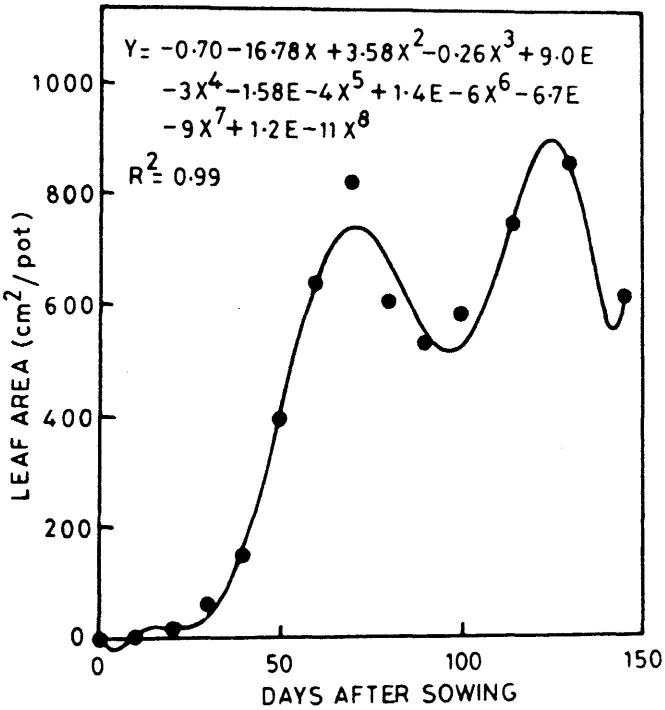

Figure 1 Leaf area at different growth stages of *Cyperus rotundus*

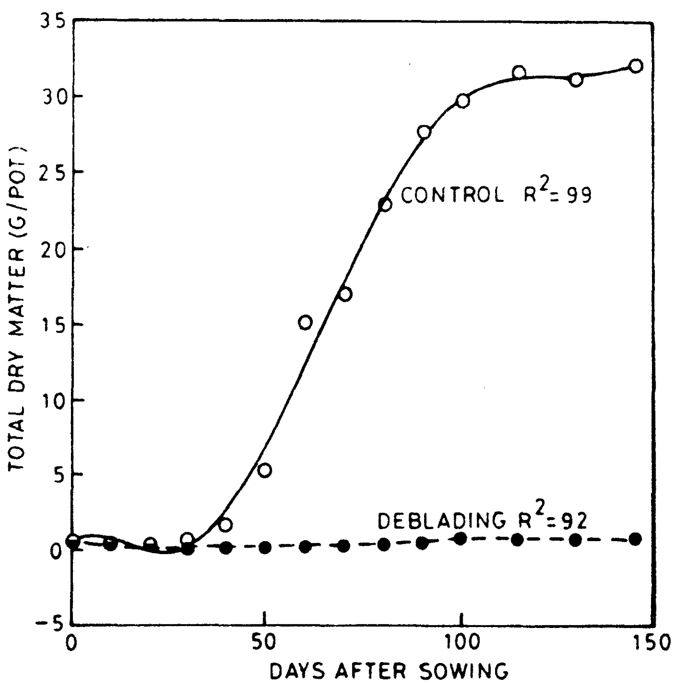

Figure 2 Periodic total biomass production both in control and deblading (defoliation)

Table 2 *Correlation co-efficient values between various parameters during entire growth span of* ***Cyperus rotundus***

Growth parameters	Total dry matter	Root weight	Tuber weight	Shoot weight	Tuber number	Shoot number
Leaf area	0.852	0.900	0.782	0.664	0.787	0.831
Total biomass	–	0.903	0.970	0.866	0.982	0.640
Root biomass	–	–	0.815	0.775	0.860	0.674
Tuber biomass	–	–	–	0.767	0.977	0.650
Shoot biomass	–	–	–	–	0.841	0.288
Tuber number	–	–	–	–	–	0.607

Table 3 *Effect of ethephon pre-treatment* (24 *hr followed by post-emergent herbicides on* 30 *days old* ***Cyperus rotundus*** *total biomass* (*g/pot*) *at different intervals after spray* (*Field experiment*)

Treatments	Days after spray		
	90	180	270
Control	25 (5.04)	37 (6.13)	81 (8.99)
Etherphon (100 ppm)	25 (4.95)	26 (4.60)	75 (8.64)
(500 ppm)	32 (5.75)	35 (5.87)	83 (9.05)
2,4-D (3 kg/ha)	3 (1.82)	5 (2.54)	43 (6.65)
Ethe. (100 ppm) fb 2,4-D	15 (4.00)	15 (3.90)	35 (5.76)
Glyphosate (2 kg/ha)	16 (3.85)	3 (2.04)	35 (5.99)
Ethe. (100 ppm) fb glyph.	6 (2.22)	7 (2.69)	12 (3.06)
2,4-D amine salt (3 kg/ha)	7 (2.81)	6 (2.68)	38 (5.42)
Ethe. (500 ppm) fb 2,4-Da.	8 (2.51)	8 (2.58)	22 (3.43)
2,4-D EE (3 kg/ha)	10 (3.38)	12 (3.46)	43 (6.64)
Ether (500 ppm) fb 2.4-DE	10 (3.29)	5 (2.50)	30 (4.76)
CD (P = 0.05)	(1.88)	(2.41)	(4.09)

2,4-D: 2,4-D sodium salt, 2,4-Da.: 2,4-D amine salt, 2,4-DE.: 2,4-D ethyl esters, Ethe.: Ethephon, glyph.: glyphosate.

Values in paranthesis are square root transformed data (X + 1).

fb: followed by.

fresh weight and leaf biomass production up to 70 DAS (r = 0.879). This indicates that more the dry weight of the bulb, more the sprouting ability of the bulb (Anon 1987). Hence tuber weight or total biomass of *C. rotundus* at a given time may reflect its sprouting ability.

Techniques to Suppress Sprouting

In the pot culture experiment the effect of different herbicides was tested following pretreatment with different concentration of ethephon. Though at all concentrations of ethephon the efficacy of both 2,4-D and glyphosate increased. Significant control of

Table 4 *Effect of 2,4-D (2 kg/ha) followed by pre-emergent herbicides spray on* 30 *days old* ***C. cotundus*** *total biomass (g/pot) at different intervals (days) after spray*

Experiment 1: Treatment		Days after treatment		
	(kg/ha)	20	60	100
Control		7.3 (2.82)	11.4 (3.22)	14.5 (3.65)
2,4-*D fb Imazethapyr*	0.1	6.4 (2.67)	2.3 (1.81)	1.2 (1.50)
Pretilachlor	2*	6.6 (2.63)	4.8 (2.40)	2.1 (1.70)
Metalachlor	2*	4.6 (2.22)	3.4 (2.10)	4.5 (2.30)
2,4-*D*	2	3.2 (2.04)	3.5 (2.10)	5.7 (2.60)
Anilophos + 2,4-*D EE*	2*	4.8 (2.37)	2.0 (1.70)	2.2 (1.80)
CD (*P* = 0.05)		*NS*	(1.40)	(1.50)

Experiment 2:		Days after treatment			
	(kg/ha)	20	50	80	150
Control		5.7 (2.5)	11.1 (3.3)	18.3 (4.3)	53.6 (7.4)
2,4-*D fb* 2,4-*D*	2	2.3 (1.8)	2.6 (1.8)	5.2 (2.5)	31.4 (5.5)
fb Atrazine	1	2.7 (1.9)	1.9 (1.7)	2.4 (1.8)	23.8 (4.8)
fb Pendimet.	2	2.2 (1.7)	1.8 (1.7)	15.2 (4.0)	35.9 (6.0)
fb Benthio.	2	1.9 (1.7)	2.0 (1.7)	5.2 (2.2)	36.2 (6.0)
fb Metoxuron	1	2.8 (1.9)	4.9 (2.4)	14.1 (3.7)	35.9 (5.9)
CD (*P* = 0.05)		(0.6)	(0.8)	(1.3)	(1.8)

Anilophos + 2,4-*D EE*: (240 + 320 *EC*) *Gharda Chemicals.*
Benthio.: *Benthiocarb.*

fb: followed by

Imazethapyr: (*AC* 263,499, *Pursuit*) (+)-5-*ethyl*-2-(4-*isopropyl*-1-4-*methyl*-5-*oxo*-2-*imidazolin*-2*yl*)*nicotinic acid—American Cyanamid Co.*

Metalachlor: (*Dual* 500 *EC*) 2-*ethyl*-6-*methyl*-*N*-(2-*methoxy*-1-*methyl*-*ethyl*)*chloro-acetanilide*. (2*: 2 l*ts/ha*).
Pendimet: Pendimethalin.
Pretilachlor: (*Refit* 500 *EC*) 2-*chlro*-2,6-*diethyl*-*N*-(2-*propoxy ethyl*) *acetanilide—Hindusthan Ciba Geigy Ltd.* (2* 2 l*ts/ha*).

the weed was recorded only at 5000 ppm of ethephon (figure 3). In general, 2,4-D had more effect compared to glyphosate.

In field experiment the efficacy of different formulation of 2,4-D was tested following pretreatment of different concentration of ethephon (table 3). The extent of effectiveness of these treatment was assessed by the extent of resprouting up to 270 days after spray. The results clearly indicate that efficacy of the herbicide enhanced by ethephon pretreatment. However, ethephon was effective in significant control of the weed only at high concentrations (5000 ppm).

In the second pot culture experiment, the effectiveness of some preemergent herbicides was tested followed by post emergent 2,4-D application (16 days after 2,4-D

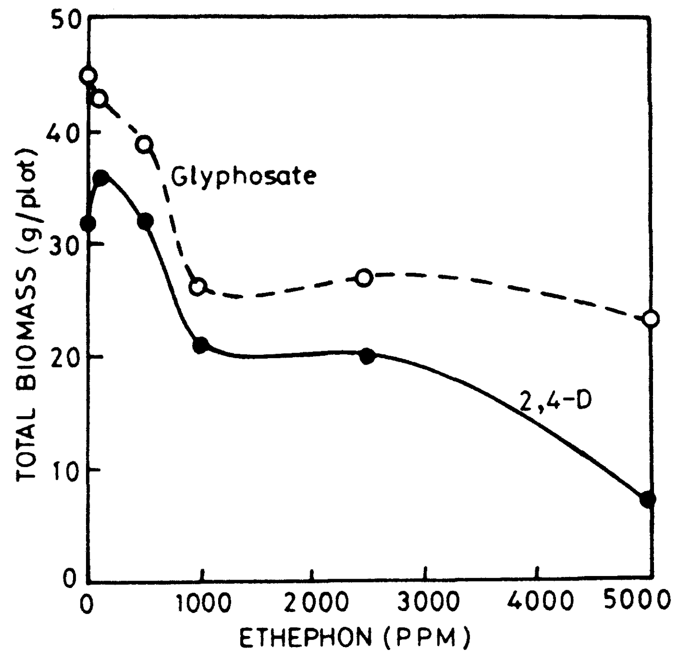

Figure 3 Ethephon pretreatment affect on herbicide efficacy

application). This post and pre-emergent herbicide combination was tried with an idea of killing the existing foliage and exposure of soil surface. Effect of these herbicide mixtures on the sprouting of tuber was assessed at different time intervals. 2,4-D followed by imazethapyr or anilophos + 2,4-DEE formulation application showed significant suppression of tuber sprouting (table 4). Similarly, 2,4-D followed by 2,4-D or atrazine application also was effective in reducing sprouting ability as assessed by low total biomass recorded on 20, 50, 80 and 150 days after spray. It has been shown by earlier studies that imazethapyr was relatively selective against *C. iria* with a least toxic effect against soybean, wheat, maize and transplanted rice (Ding et al. 1989). Glyphosate followed by oxadiazon application significantly reduced the sprouting of *Oxalis latifolia* (Cox & Kern 1981).

These data indicated that, a suitable phloem mobile herbicide application at 30 days after sprouting (2,4-D/glyphosate) followed by a pre-emergent herbicide spray during 20 days after post emergent herbicide may be effective in checking sprouting of *C. rotundus*.

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