Effect of some Chemical, Mechanical and Cropping Methods of Weed Control on the Food reserves of underground organs in *Cyperus rotundus* L.

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Nutgrass (*Cyperus rotundus* L.) family Cyperaceae is a troublesome, perennial weed of agricultural lands throughout the country. It is very prolific in propagation through the underground rhizomes. During adverse conditions of drought and hot summers these rhizomes lie buried under soil which sprout and multiply profusely on getting favourable temperature and moisture conditions. This is the aggressive weed in *kharif* and rainy season and supresses the crop at its initial stages.

Hauser (1962) observed that tubers of *Cyperus rotundus* planted at one foot interval, produce 30, 90, 000 plants and 44, 20, 000 tubers and bulbs per acre in one single season.

The nutrient losses due to nutgrass alone are stupendous. Rochecouste (1966) observed a depletion of nutrients to an extent of 69 kg nitrogen, 110 kg phosphorus and 74 kg potash per hectare in sugarcane fields due to nutgrass infestation.

Gupta (1960) observed that nutgrass removed 61 kg nitrogen, 8 kg phosphorus and 78 kg potash per hectare during a period of about 4 months growth in a sugarcane field. Bhardwaj (1965) reported that more than 50 per cent of the nutrients removed by unchecked growth of nutgrass accumulated in the tubers, the depletion being in the order of 95.6 kg nitrogen, 11.6 kg phosphorus and 49.3 kg potash per hectare

In case of Cyperus rotundus tubers, Le Baron (1960) observed considerable reduction in fructose from dalapon treatment at 7.5 and 15.0 kg per hectare.

Weinman and Goldsmith (1948) found exceptionally high carbohydrate reserves in the roots of Bermudagrass mainly as starch. The total available carbohydrates with combined roots and rhizomes ranged from 1,500 to 3,000 kg per ha to a depth of 6½ inches. They further reported that shoot growth in the spring utilizes but a fraction of the total underground food reserves.

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Schirman and Buckholtz (1960) observed that increasing the rate of application of atrazine in autum from 0-4 kg per ha decreased the total dry weight of *Agropyron repens* rhizomes from 6,000 to 2,600 kg per ha and the total soluble carbohydrates in the rhizomes from 2,700 to 400 kg per ha.

Baron (1962 b) reported that cultivations caused continuous and serve reduction in nutrient reserve. Simazine application caused a pronounced fall in nutrient reserve. Baron (1962 a) reported that atrazine at 8 lb per acre in 30 gallons of water reduced the nutrient reserve in quackgrass by 95-90 per cent.

MATERIALS AND METHODS

Experiments were conducted in the Division of Agronomy at the Indian Agricultural Research Institution, New Delhi during the crop year 1964-65 and 1965-66. The experiment comprised nine treatments viz. no ploughing and no chemical application (P_0C_0), 2 times ploughing and no chemical application (P_2C_0), 4 times ploughing and no chemical application (P_4C_0), no ploughing and two times chemical application (P_0C_2), no ploughing and 4 times chemical application (P_0C_4), 2 times chemical application in conjunction with 2 ploughings (P_2C_2), 4 times chemical application in conjunction with two ploughings (P_2C_4), 2 times chemical application in conjunction with 4 ploughings (P_4C_2) and 4 times chemical application in conjunction with 4 ploughings (P_4C_4). The chemical application involved a combination spray of dalapon* and 2, 4-D** each at 2 kg a.e./ha immediately after ploughing. The experiment was run in a randomized block design with five replications. The treatments commenced in 1964 and repeated in the same plots in 1965 were applied in May and June. Hybrid maize (Ganga 101) and wheat (NP 718) were grown in *kharif* and *rabi* season, respectively, in both the years.

Infestation of nutgrass was judged by the number of tubers. The counts were taken at random by placing 60.9x60.9 cm quadrates at two places in each plot and the number of tubers in that area upto a depth of 0-15 cm and 15-30 cm were counted separately. In addition to number data, their dry weight (constant oven dry weight at 95° C) was also recorded. The observations were made on the following dates :

(i) At the time of starting the experiment (3-10-1964).
(ii) One and half month after starting the experiment (23-6-1964).
(iii) At the time of harvesting of maize (26-10-1964).
(iv) At the time of sowing of maize crop (24-6-1965).
(v) At the time of harvesting of maize crop (30-10-1965).

*Dalapon 2-2, Dichloropropionic acid, **2, 4-Dichlorophenoxyacetic acid.

Starch analysis in nutgrass tubers :

Starch analysis in the nutgrass tubers was carried out from the samples collected on 23-6-1964, 26-10-1964 and 14-6-1965 to determine the starch content in the tubers immediately after the treatment application and after one year. The starch analysis was conducted by colorimetric methods described by Nielsen (1943) and Nielsen and Gleasons (1945).

RESULTS AND DISCUSSION

Observations on dry weight, mean percentage of starch and starch contant were recorded 12 and 125 days after the completion of treatments in the first year and repeated during the second year. The data are presented in Table 1 to 3.

Table I :— Mean tuber dry weight in grams of *Cyperus rotundus* in 60.9 cm² area (0–15 cm and 15–30 cm depth)1

Treatments	0—15 cm				15—30 cm			
	12*	125*	12**	125**	12*	125*	12**	125**
P_0C_0	5.80	6.88	7.56	5.60	4.60	3.00	3.12	2.96
P_2C_0	2.10	2.34	3.06	0.50	4.00	0,44	1.36	0,34
P_4C_0	2,00	1.94	2.96	0,20	3.40	0.84	0.50	0,10
P_0C_2	1.10	2.00	2,98	0,08	3.90	1.33	0.30	0,02
P_0C_4	0.90	1.31	2.66	0,08	1.20	0,74	0.30	0,08
P_2C_2	1,90	1.66	2.24	0.40	1,70	0.50	0.08	0.16
P_2C_4	0 90	1.18	2.92	0,18	2.30	0 58	0,04	0.10
P_4C_2	0,70	1.46	2,18	0.12	1.50	0 54	0.08	0,08
P_4C_4	0,70	1.56	2.12	—	1.90	0.48	—	0.14
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
C D. at 1%	1.78	0 85	1,05	1,98	1.26	0.89	0.36	0.20

1. Data analysed by using $x + \frac{1}{2}$ transformation.

Table 2 :— Mean percentage of starch in nutgrass tubers

Treatments	0—15 cm			15-30 cm		
	12*	125*	12**	12*	125*	12**
P_0C_0	24.23	19.43	18.46	24.43	17.73	13.30
P_2C_0	15.33	14.96	14.76	16.06	13.90	14.03
P_4C_0	26.03	16.46	14.76	26.66	20.16	24.75
P_0C_2	19.63	17.93	7.36	23.50	11 10	10 67
P_2C_2	24.63	14.06	11,83	16.26	21.13	11.46
P_4C_2	24.80	13 70	12 56	19.40	22.40	14.76
P_0C_4	14.60	14.23	12.20	20.30	17.53	14.76
P_2C_4	22.03	12.96	11.83	14.80	20.93	11.43
P_4C_4	20.16	14.43	15.13	23.16	22.66	5.96

Table 3 :— Content of starch (in mg) in 60-9 cm^2 area

Treatments	0-15 cm depth			15-30 cm depth		
	12*	125*	12**	12*	125*	12**
P_0C_0	1400	1340	1390	1120	530	410
P_2C_0	320	340	450	640	50	190
P_4C_0	530	320	440	900	160	120
P_0C_2	160	340	220	910	140	30
P_0C_4	130	190	320	240	50	10
P_2C_2	460	230	510	280	110	10
P_2C_4	190	150	340	340	10	10
P_4C_2	170	200	270	290	110	10
P_4C_4	140	220	320	440	—	10

*Number of days after completion of treatment in 1964

*Number of days after the repetition of treatments in 1965.

1. *Effect of Individual applications of chemicals and ploughing in 1964-65.*

(a) Weight of rhizomes (0-15 cm depth) :

1964 :— There was a drastic reduction in tuber weight under 2 or 4 plough-

ings or 2 or 4 chemicals as compared to control, prior to maize sowing as well as at the time of maize harvest (P_2C_0, $P_4C_0 < P_0C_0$, P_0C_2 and $P_0C_4 < P_0C_0$) as evident from table—1.

1965 :— The nutgrass suffered drastically in the weight of the underground parts due to 2 and 4 times chemical application as compared to no ploughing or no chemical application at the both times.

Observations were recorded on the effectiveness of chemicals in conjunction with ploughing in controlling shallow rooted weed like *Agropyron repens* (couch grass) add *Sorghum halepense* (Johnsongrass) by Burt and Willard (1959). They reported that herbicides used without ploughing were only $\frac{1}{2}$ to $\frac{2}{3}$ effective as those used after ploughing in control of *Sorghum halepense*. Santelmann (1960) reported that ploughing 10 days before or after applying dalapon secured a good control of *Agropyron repens*.

(b) Weight of rhizomes (15-30 cm depth) :

The weight (12 days after completion of the treatment) of tubers located at this depth did not differ between 2 and 4 ploughings as compared to no ploughing; 2 times chemical application was also equal to no chemical application, whereas the reduction under 4 times chemical application was significant over no chemical application The reduction under 4 times chemical application was significant over 2 times chemical application, 2 and 4 times ploughing and no ploughing and no chemical application. The high dose of chemical applied 4 times drastical curtailed the dry matter production. The food reserves must have been used up in respirations.

In the observation recorded 125 days after the completion of treatments both 2 and 4 times ploughing or 2 and 4 times chemical application brought down the tuber weight as compared to no ploughing or no chemical application. This observation suggested that both ploughings and chemicals manifested their effect at a later time. This might have resulted by depleting this food reserves and preventing the accumulation of dry matter.

2. *Effect of 2 and 4 times chemical applications in conjunction with 2 ploughing in 1964 and 1965.*

Weight of rhizomes (0-15 and 15-30 cm depth) :

During 1964 the tuber weight (0-15 cm) at maize harvest was significantly reduced under 2 and 4 times chemical applications in conjunction with 2 ploughings as compared to no chemical application. However, in the second season, the tuber weight at maize harvest did not differ between these treatments. This

observation suggested that the effects observed in the first season were not carried out over to the second season. This equalizing effect between the chemical and no chemical application in conjunction with 2 ploughing might have resulted from a variety of reasons, most important of which was perhaps due to (equalizing effect of) hybride maize.

Maize which was sown three weeks after completion of the treatments, received a basal dressing of nitrogen. The application of nitrogen stimulated the growth of maize and also appeared to make the chemicals act more virulently on the depletion of food reserves in the rhizomes of nutgrass. Le Baron (1960) also got indication that application of nitrogen followed by dalapon led to efficient depletion of food material in nutgrass.

In the 15-30 cm depth 4 chemical applications in conjunction with 2 ploughings effected a significant reduction in tuber weight at both the times in the second season, whereas the effect was apparent in the first season before maize sowing. Four chemical applications in conjunction with two ploughings given in the first season and repeated in the second season together with raising of hybrid maize, therefore, appeared very useful in giving a setback to dry matter accumulation in nutgrass tubers located at 15-30 cm depth. Once again it became evident that the chemicals got translocated to the lower tubers and proved inhibiting.

3. *Effect of 2 and 4 times chemical applications in conjunction with 4 ploughings* :

Weight of rhizomes (0-15 and 15-30 cm depth) :

Two and four times chemical application in conjunction with 4 ploughings reduced the nutgrass tuber weight (15-30 cm depth) as compared to no chemical application (table 1), at the time of maize sowing, but this effect did not persist at maize harvest. This observation also indicated that hybrid maize itself offered such competition as to nullify the treatment differences. That is why the weight differences between 2 and 4 chemicals against no chemical could not be maintained at the later observation.

Starch content in the tubers located at 0-15 and 15-30 cm depth :

The per cent amount of starch in the tubers under various chemical and ploughing treatments as compared to no chemical and no ploughing treatment was worked out from table 2 and is presented in table 4.

Table 4 :— Per cent amount of starch in the *Cyperus rotundus* tubers under different treatments as compared to control 0-15 and 15-30 cm depth) (Percentage calculated from table 3)

Treatments	0—15 cm			15-30 cm		
	12*	125*	12**	12*	125*	12**
P_2C_0	22.9	25.4	32.4	57.1	9.4	46.3
P_4C_0	37.8	23.8	31.6	80.3	30.0	29.3
P_0C_2	11.6	25.4	15.8	81.2	26.4	7.3
P_0C_4	13.6	11.1	24.5	30.3	1.9	2.4
P_2C_2	9.3	14.1	23.0	21.4	9.4	2.4
P_2C_4	12.2	14.9	19.4	25.9	20.7	2.4
P_4C_2	32.8	17.1	36.7	25.0	20.7	2.4
P_4C_4	10.0	16.4	23.0	39.3	—	2.4
Mean	18.8	18.5	25.8	45.1	14.8	11.8

*Number of days after completion of treatment.
*Number of days after repetition of the treatment in the second season.

Two or four times chemical applications in absence of ploughing brought down the starch content appreciably in the tubers located at 0-15 cm depth below that of 2 or 4 ploughings in absence of chemicals in the observation recorded 12 days after the completion of the treatments, which meant that starch depletion was more severe in the chemical treatment as compared to ploughing. Addition of 2 or 4 ploughings to 2 or 4 chemicals appeared as effective as application of chemicals alone in the depletion of starch content in the tubers. In the tubers located at lower depth (15-30 cm) the differences between ploughings and chemicals was not as much as in the case of tubers located in the 0-15 cm depth. This meant that the chemicals scored over ploughing in their initial toxic effect on starch depletion in the tubers located in the upper depth (0-15 cm).

In the second observation recorded at maize harvest, the starch content under the various treatments did not appreciably differ from the first observation (record made 12 days after completion of the treatment). The dilution effect of the treatments with time might have been caused by a variety of factors, the

most potent of which being (1) leaching of the chemical from plot to plot (2) loss of residual toxicity of the chemical with time (3) hybrid maize growth (4) the spread of the underground tubers from plot to plot and (5) different locations of sampling at the two times.

In the tubers located at 15-30 cm depth the effect of the treatments which was not felt in the beginning manifested in the observation recorded at maize harvest. These results suggested that the chemical application brought about a depletion in starch reserves of the tubers in the lower layer at a later time.

On the whole it appeared that starch depletion in tubers located in the deeper layers was accounted to a greater extent by chemicals or their combination with ploughings in contrast to ploughings alone in absence of chemical application.

Depletion of food material by frequent tillage operations in perennial weeds have also been reported by Arny (1932), Barr (1940) and with combination of chemical and ploughing by Timmons (1941).

SUMMARY

Twelve days after the completion of the treatments in the first year the dry weight of nutgrass tubers under P_2C_2, P_4C_4 and P_2C_4 was reduced to 67.2, 87.9 and 84 4 per cent as compared to P_0C_0 in the 0-15 cm depth. The reduction in 15-30 cm depth was to the extent of 63.0, 58 7 and 50.0 per cent as compared to P_0C_0. At maize harvest in 1964 the reduction was 75.9, 77.3 and 82.6 per cent in the 0-15 cm depth and 83.3, 84.4 and 80 7 per cent respectively for P_2C_2, P_4C_4 and P_2C_4 as compared to P_0C_0.

Twelve days after repetition of treatments in 1965 the dry weight of nutgrass tubers under P_2C_2, P_4C_2 and P_4C_4 was reduced to 70.4, 71.2 and 71.9 per cent in 0-15 cm depth and 97.4, 97.4 and 100.0 per cent in 15-30 cm depth as compared to P_0C_0. At maize harvest in 1965 the reduction in tuber weight was 92.2, 97.8 and 100.0 per cent in 0-15 cm depth and 94.6, 97.3 and 95 3 per cent as compared to P_0C_0.

Amount of starch in the nutgrass tubers in the 0-15 cm depth under P_2C_2, P_4C_4 and P_2C_2 was brought down to 9 3, 10 0 and 12.2 per cent and 14 1, 16 4 and 14.9 per cent, respectively 12 days after the completion of the treatments and at maize harvest in 1964 as compared to P_0C_0.

The amount of starch in the nutgrass tubers in 15-30 cm depth under P_2C_2, P_4C_4 and P_2C_4 was brought down to 21.4, 39 3 and 25.9 per cent and 9 4, 0.0 and 20.7 per cent respectively, 12 days after completion of the treatments and at maize harvest in 1964 as compared to P_0C_0. Twelve days after the repetition of

the treatments in 1965 the per cent amount of starch was brought down to 2.4, 2.4 and 2.4 per cent under P_2C_2, P_4C_2 and P_4C_4, respectively, as compared to P_0C_0.

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