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Management of *Cyperus rotundus* L. in Turf

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Abstract
An experiment was conducted during 2016-17 at Regional Horticultural Research Station, ACHF, NAU, Navsari, Gujarat to study the effective method to control *Cyperus rotundus* L. with appropriate concentration. The experiment was laid out in Randomized Block Design with ten treatments *viz.* Halosulfuron Methyl 75% WG @ 2.4 and 3.3 g/10 l foliar spray, Ammonium Salt of Glyphosate 71% SG @ 75 and 100 g/10 l foliar spray, Glyphosate 41% SL @ 110 and 150 ml/10 l foliar spray, 2,4-D Ammonium Salt @ 30 and 40 g/10 l foliar spray, Manual Management and Control with three replications. The results on growth attributes of lawn *viz.* leaf width (mm), leaf length (cm), number of runners per 100 cm^2 area, number of leaf on runner were found maximum with Manual Management which was statistically at par with Halosulfuron Methyl 75% WG @ 3.3 g/10 l and Halosulfuron Methyl 75% WG @ 2.4 g/10 l. As per the ranking of aesthetic value of lawn, Manual Management and Halosulfuron Methyl 75% WG @2.4 and 3.3 g/10 l found more effective while, the lowest ranking was recorded in Glyphosate 41% SL @ 150 ml/10 l foliar spray. On the basis of visual phytotoxicity symptoms, Manual Management and Halosulfuron Methyl 75% WG @2.4 and 3.3 g/10 l was not observed with any phytotoxicity whereas, highest phytotoxicity and least visual ranking was observed in plot treated with Glyphosate 41% SL @ 150 ml/10 l foliar spray. Highest population density of *Cyperus*, weed control efficiency and minimum weed biomass was found in Halosulfuron Methyl 75% WG @ 3.3 g/10 l foliar spray.

Keywords: *Cyperus rotundus* L., turf, halosulfuron methyl, manual management

Introduction
A turf is of soil-covered land planted with grasses or (rarely) other durable plants such as clover which are maintained at a short height with a lawn mower and used for aesthetic and recreational purposes. They belong to a class monocotyledons or monocots and family Poaceae. They are narrow-leaved grass species that form a uniform, long lived ground cover that can tolerate traffic as well as low mowing heights. In tropical and sub-tropical region very few species are suitable for turfgrass use and they include the Bermuda grass (*Cynodon sp*. Rich), Zoysia grass (*Zoysia sp*. Wild), St. Augustine grass (*Stenotaphrum secundatum* [Walt.] Kuntze), Bahia grass (*Paspalum notatum* Flugge), Centipede grass (*Eremochloa ophiuroides* [Munro.] Hack) and Carpet grass (*Axonopus sp*.) (Jankiram *et al.* 2015) [6].

Weeds are unwanted plants which grow in a place where these are not desired and compete with cultivated plants for space, sunlight, air, water, food and nutrition. Purple nutsedge (*Cyperus rotundus* L.) is one of the most noxious perennial weeds of the world, which causes 30-80% reduction in crop yield (Holm *et al.* 1977) [5]. Purple nutsedge has a grass-like appearance but is actually a true member of the sedge family Cyperaceae.

Herbicides are the synthetic chemicals, which kills the target plant by interfering with the growth of the weed and often synthetic "limitation" of plant hormone. Management practices which reduce tuber production include use of herbicides (Pereira *et al*. 1987 and Edenfield *et al.* 2005) [10, 3]. A combination of systematic post emergence herbicides are effective in reducing the population of purple nutsedge. Herbicide applications are most effective when applied to purple nutsedge plants having three to eight leaves. And most commonly used herbicides are Halosulfuron Methyl, Ammonium Salt of Glyphosate, 2, 4-D Ammonium Salt, 2, 4-D Sodium Salt, Paraquat, Atrazin *etc*.

Materials and Methods
The present investigation was carried out during 2016-17 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari.

The experiment was laid out in Randomized Block Design (RBD) with three replications. The experiment comprised of then treatments *viz*. Halosulfuron Methyl 75% WG @ 2.4 and 3.3 g/10 l foliar spray, Ammonium Salt of Glyphosate 71% SG @ 75 and 100 g/10 l foliar spray, Glyphosate 41% SL @ 110 and 150 ml/10 l foliar spray, 2,4-D Ammonium Salt @ 30 and 40 g/10 l foliar spray, Manual Management and Control. Lawn springs with healthy appearance and free from disease were planted on the distance of 10×10 cm whereas, tubers of *Cyperus* with 1 to 1.5cm height were planted on 5 days after planting of lawn. Observations of lawn like leaf length, leaf width and number of leaves were observed on 15 days after treatment application. Number of runners and chlorophyll content were recorded on 5 days before treatment application and 15 days after treatment application. In case of visual appearance and visual phytotoxicity of lawn, it was observed 15, 30 and 60 days after treatment application. Population density of *Cyperus rotundus* L. were recorded on 30 days after planting and 5 days before treatment application and weed biomass was noted on 30 and 60 days after treatment application. The data recorded during the course of investigation were subjected to statistical analysis following standard procedure described by Panse and Sukhatme (1967) [9].

Results and Discussion

Effect on turf attributes

The effect of various weed management treatment, it was observed that turf attributes *viz.* leaf length (cm) and width (mm), number of leaves on runner of the lawn and number of runners per 100 cm^2 area were significantly influenced. Among different weed management practices, manual management have significant effect on leaf length (5.95 cm) and leaf width (1.31 mm) and number of runners per 100 cm^2 area (215.40) and it was at par with Halosulfuron Methyl 75% WG @ 2.4 and 3.3 g/10 l. In case of number of leaves on the runner of the lawn, Manual Management has significant effect and it was found at par with Control and Halosulfuron Methyl 75% WG @ 2.4 and 3.3 g/10 l whereas, minimum number of leaves on runner of the lawn (0.53), leaf width of the lawn (0.05 mm) and number of runners per 100 cm^2 area (166.73) was found in Glyphosate 41% SL @ 150ml/10 l.

Application of different weedicides and manual management practices for *Cyperus rotundus* L. in turf would ensure suppression of weed. At the same time manual management of *Cyperus rotundus* L. in turf has less chances of disturbance of lawn attributes. There was no formidable competition for nutrition, sunlight and water, which is the most plausible reason for better establishment of lawn. Similar finding was observed by Kulmi and Tiwari (2005) [7] in Asgandh (*Withania somnifera* Dunal) crop. But this method was quite time consuming and labour intensive. With respect to all herbicide treatments, Halosulfuron Methyl with different concentrations is found at par with manual management practices to control *Cyperus rotundus* L. The major reason behind this, Halosulfuron Methyl is selective herbicide so when it was applied, it affects targeted areas only (Davi and Nawamaki 2006) [2]. There are very less chances of lawn to get affected with Halosulfuron Methyl application. Halosulfuron Methyl had diminutive effect on lawn and deplete the effectiveness of *Cyperus rotundus* L.

Effect on visuality of turf

Visual appearance is important parameter for good turf establishment. Phytotoxicity can adversely affect the appearance of the turf (Jankiram *et al.* 2015) [6]. During study, selective as well as non-selective herbicides were used. Effect of that herbicides was also seen on the appearance of the lawn which showed phytotoxicity symptoms in lawn. During whole experimentation, visual phytotoxicity was different at different intervals. At all the intervals (15, 30 and 60 days after treatment application), plots which were treated with Glyphosate 41% SL @ 150 ml/10 l of foliar spray showed highest phytotoxicity. Plots which were not applied any weedicides (Manual Management and Control) showed lower phytotoxicity followed Halosulfuron Methyl 75% WG @ 2.4 and 3.3 g/10. In case of 2,4-D Ammonium salt 80% WP @ 30 and 40 g/10 l, recovery was started which ultimately improved the appearance of the lawn at 30 days after treatment application. Almost similar result was observed by Hammerton (1974). Visual appearance was showing vise versa effect with phytotoxicity. Almost all experimental period, Manual Management and Control were found with good appearance as they were not treated with any weedicide. Plots which were treated with different doses of Halosulfuron Methyl were also found with good aesthetic appeal, because it is selective herbicide and it kills targeted area of *Cyperus* only (Davi and Nawamaki 2006) [2].

Effect on population of *Cyperus rotundus* L.

As far as concerned about population of *Cyperus rotundus* L. by herbicidal application, there was variation at the initial stage. During experiment, artificial inoculation of tubers of *Cyperus rotundus* L. was done. On 30 days after planting, plants of *Cyperus rotundus* L. were counted which was found non-significant. But rate of multiplication is too much faster in *Cyperus* as compare to other weed species. Thus, to identify the multiplication rate, population was again counted on 5 days before treatment application, and that was also observed non-significant. After treatment application at 4 to 6 leaves stage, *Cyperus* plants were killed but its profound capacity to re-emerge, the treatment showed significant effect. The lowest re-emergence was observed in treatment Halosulfuron Methyl 75% WG @ 3.3 g/10 l of foliar spray because of its capacity to penetrate up to pith tissue of tuber which is clearly seen in transverse section of *Cyperus* tuber. Thus, lower re-emergence of *Cyperus* occured in Halosulfuron Methyl 75% WG @ 3.3 g/10 l while, maximum re-emergence was observed in manual management.

Effect on biomass, weed control efficiency and re-emergence of *Cyperus rotundus* L.

Biomass was found minimum (3.42 g) in higher dose of Halosulfuron Methyl on 30 days after treatment application. Highest weight of dry weed of *Cyperus* (36.33 g) was observed in untreated plot. In case of 60 days after treatment application, minimum biomass (9.06 g) was also noted in Halosulfuron Methyl 75% WG @ 3.3 g/10 l and this was at par with in Halosulfuron Methyl 75% WG @ 2.4 g/10 l (11.04 g) whereas, highest weed biomass was found in Control (41.20 g) as no practices were done in that plots. For lower biomass mode of action of Halosulfuron Methyl is responsible. When Halosulfuron Methyl was applied at 4 to 6 leaves stage to the *Cyperus rotundus* L., within 10-14 days leaves of *Cyperus* started yellowing and rotting took place and ultimately it led to drying of the leaves of *Cyperus*. Similar results were found by Rathika *et al.* 2013 [13], Dash and Mishra 2014 [1] in bottle gourd, Poddar *et al.* 2014 [11] in cotton and Norsworthy *et al.* 2007 [8] in pepper.

Maximum weed control efficiency and lower rate of re-emergence on 30 and 60 days after treatment application was found in Halosulfuron Methyl 75% WG @ 3.3 g/10 l while, lowest weed control efficiency was recorded in manual management (T_9).

Based on the results, Halosulfuron Methyl appears to have the potential for selective control of purple nutsedge. It caused severe damage to young foliage and significantly reduced the plant population. Halosulfuron Methyl caused chlorosis symptoms in leaves and furthermore, damage the tubers which might be the reason for higher weed control efficiency and weed biomass without any phytotoxicity symptoms on lawn. Similar kind of results were recorded on purple nutsedge by Rahaman *et al.* 1998 and Rathika *et al.* 2013 [13] and Webster and Coble 1997 [14].

Table 1: Effect of herbicides on different parameters of lawn

Treatments	Leaf length (cm) on 15 DAT	Leaf width (mm) on 15 DAT	No. of leaves on the runner of the lawn on 15 DAT	Number of runners per 100 cm^2 area	
				5 DBT	15 DAT
Halosulfuron Methyl 75% WG @ 2.4 g/10 l	5.72	1.25	13.20	164.87	209.27
Halosulfuron Methyl 75% WG @ 3.3 g/10 l	5.43	1.26	12.86	166.22	204.53
Ammonium salt of Glyphosate 71% SG @ 75 g/10 l	3.35	0.07	4.17	154.00	176.33
Ammonium salt of Glyphosate 71% SG @ 100 g/10 l	2.27	0.05	1.80	154.07	173.53
Glyphosate 41% SL @ 110 ml/ 10 l	3.35	0.06	3.23	154.93	171.27
Glyphosate 41% SL @ 150 ml/ 10 l	2.31	0.05	0.53	160.60	166.73
2,4-D Ammonium salt 80% WP @ 30 g/10 l	4.87	0.10	9.63	160.80	184.13
2,4-D Ammonium salt 80% WP @ 40 g/10 l	4.14	0.09	8.90	158.60	186.67
Manual Management	5.95	1.31	15.17	160.33	215.40
Control	5.10	1.20	13.40	159.60	187.40
S.Em. $\pm$	0.24	0.03	0.78	2.98	4.50
C.D. at 5 %	0.73	0.09	2.32	NS	13.38
C.V. %	9.95	9.89	16.34	3.24	4.16

DBT- Days before treatment DAT- Days after treatment

Table 2: Visual appearance and visual phytotoxicity of lawn (Scoring out of 10)

Treatments	Visual appearance (Min.=1, Max.=10)			Visual phytotoxicity (Min.=10, Max.=1)		
	15 DAT	30 DAT	60 DAT	15 DAT	30 DAT	60 DAT
Halosulfuron Methyl 75% WG @ 2.4 g/10 l	9	9	9	9	10	10
Halosulfuron Methyl 75% WG @ 3.3 g/10 l	9	9	9	9	10	10
Ammonium salt of Glyphosate 71% SG @ 75 g/10 l	4	5	5	6	5	5
Ammonium salt of Glyphosate 71% SG @ 100 g/10 l	3	3	4	6	6	6
Glyphosate 41% SL @ 110 ml/ 10 l	4	4	5	4	4	5
Glyphosate 41% SL @ 150 ml/ 10 l	3	3	4	3	4	5
2,4-D Ammonium salt 80% WP @ 30 g/10 l	5	6	7	6	7	8
2,4-D Ammonium salt 80% WP @ 40 g/10 l	5	5	6	5	6	7
Manual Management	9	9	9	10	10	10
Control	8	7	6	10	10	10

Table 3: Effect of herbicides on different parameters of *Cyperus rotundus* L.

Treatments	Population density of *Cyperus*/ m^2		Weed biomass (g)		Re-emergence		Weed control efficiency (%)	
	30 DAP	5 DBT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT
Halosulfuron Methyl 75% WG @ 2.4 g/10 l	15.67	29.00	5.31	11.04	5.80	12.07	85.36	73.11
Halosulfuron Methyl 75% WG @ 3.3 g/10 l	16.00	29.33	3.42	9.06	3.74	9.90	90.58	77.95
Ammonium salt of Glyphosate 71% SG @ 75 g/10 l	14.67	27.67	7.62	19.92	8.33	21.77	78.99	51.55
Ammonium salt of Glyphosate 71% SG @ 100 g/10 l	15.00	28.33	6.39	16.59	6.98	18.13	82.38	59.69
Glyphosate 41% SL @ 110 ml/ 10 l	15.33	27.00	5.58	14.97	6.10	16.36	84.66	63.79
Glyphosate 41% SL @ 150 ml/ 10 l	15.00	28.33	4.77	12.96	5.21	14.16	86.87	68.62
2,4-D Ammonium salt 80% WP @ 30 g/10 l	14.67	27.00	9.93	17.13	10.85	18.72	72.74	58.37
2,4-D Ammonium salt 80% WP @ 40 g/10 l	14.33	28.33	8.67	14.16	9.48	15.48	76.10	65.59
Manual Management	15.33	28.67	12.00	20.43	13.11	22.33	67.02	50.51
Control	15.33	27.67	36.33	41.20	39.70	45.02	--	--
S. Em. $\pm$	0.77	0.75	0.52	0.86	0.57	0.94	--	--
C.D. at 5 %	NS	NS	1.55	2.55	1.69	2.79	--	--
C.V. %	8.87	4.62	9.03	8.39	9.03	8.39	--	--

Conclusion

The result of present investigation inferred that the prudent application of Halosulfuron Methyl 75% WG @ 3.3 g/10 l foliar spray at 4 to 6 leaf stage of *Cyperus rotundus* L. was found effective to reduce the awful competition of *Cyperus* population up to 60 days after application in lawn with maintained growth attributes *viz.* appropriate chlorophyll content and good aesthetic appeal in sense of better colour, texture, compactness and smoothness.

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