Bio-efficacy of different herbicides on control of purple nutsedge (Cyperus rotundus L.) in turf

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***Abstract*—An experiment was conducted to evaluate the efficacy of different herbicides to control the *Cyprus rotundus L.* in Bermuda grass (*Cynodon dactylon L.*) in Culcutta grass var. Sel.-1 turf. The experiment consisted different eight herbicides such as Metasulfuron methyl 20%WP 5g/ha (T_1), Carfentrazone 40%DF 20g/ha (T_2), Atrazine 50%1000g/ha (T_3), 2,4-D amine salt 58% SL 580 g/ha (T_4), Halosulfuron methyl 75%WG 67.5g/ha (T_5), Metribuzin 70%WP 300g/ha (T_6), Sulfosulfuron 75%WG 25g/ha (T_7), and combinations like Metasulfuron methyl 10% + Chlorimuron ethyl 10% WP (RM) 45g/ha (T_8), 2,4-D amine salt 58% SL 580g/ha + Halosulfuron methyl 75%WG 67.5g/ha (Tank mix) (T_9), Carfentrazone 40% DF 20g/ha + Atrazine 50%1000g/ha (Tank mix) (T_{10}) along with hand weeding (T_{11}) and weedy check (T_{12}). Result demonstrated that application of Halosulfuron methyl (T_5) exhibited minimum weed density (2.3 /m^2) after 80 days. Likewise, Halosulfuron methyl (T_5) showed highest weed control efficiency and the lowest dry matter of *Cyperus rotundus L.* during different days intervals. Thus, application of Halosulfuron could be used to control weed population of nutsedge grass in turf.**

***Index Terms*—Weed control efficiency; Dry matter; Hand weeding; Halosulfuron.**

I. INTRODUCTION

A lawn is essential to any beautiful landscape and plays a significant role in environmental refinement. It is a basic feature of home garden, formal garden, Informal garden. (Singh *et al.* 2022). The lawn is drived from the Brittonic word "Landa" (ancient French: "Launde"), which denotes coarse grass and arid country is where the name "Lawn" originates. (Singh *et al.* 2023).

The bermuda grass (*Cynodon dactylon* L. 2n=18) belongs to family Poaceae has originated from the North and East Africa. Bermuda grass is also known as Doob grass and Durva grass. Doob grass is major truf species for sports field, lawn, parks, golf courses, and general utility truf in india, Australia, Africa, America and southern reagion of united states.

Purple nutsedge (*Cyperus rotundus L.*) is a common perennial sedge which has a grass like appearence but it is actually true member of the sedge family Cyperaceae in trufgrass system. Purple nutsedge is locally known as nutgrass is one of the most difficult weeds to control in lawn which causes 30-80 % reduction in crop yield. It is found in cultivated field, farmland, neglected areas, wasteland, grassland, at the edges of forest and roadside, sandy or gravelly shores, riverbank and irrigation canal bank. Most of *Cyperus rotundus L.* are C_4 plant one of the most troublesome invasive weed in tropical and subtropical climate which possess specialized leaf anatomy to allowing increased growth and efficiency under high light and temperature regime. (Teeri and Stowe 1976, Hattersley 1983, Bryson and Carter 2008).

Cyperus rotundus L. is a highly competitive plant and difficult to control beacause of its upright growth habit, rhizomatous root system and can rapidly form colonize in truf, ornamental areas, pastures and cultivated fields. Cyperus possess a basal bulb normally around 15 cm below ground surface which produce a horizontal tuber chain where several tuber (2-6 or more) are connected together by means of slender rhizome like thread of vascular tissue. Under favorable conditions, a single tuber can produce 99 tubers in 90 days. (Silveira *et al.* 2010, Gosh *et al* 2017, Mathukia *et al.* 2018). Nutsedge is reproduce

by basal bulb, rhizome, tubers which allow to grow it to wide range of conditions. (Hazard and Palu 1986).
The hand weeding and tillage operations are traditional practiced to manage weed control and is being followed since ancient time. Recently application of chemical-based herbicides has been used to control weeds in various fields and turf. The herbicide are the synthetic chemicals which kills the target plant by interfering with the growth of the weed and often synthetic limitation of plant hormone. Herbicide application as postemergence is one of the common and effective approach. Certain post emergence herbicides such as metasulfuron methyl, atrazine, 2,4-D, carfentrazone, halosulfuron methyl, chlorimuron ethyl etc. are commonly used for managing weeds in the crop fields. Halosulfuron is promising for the control of *C. rotundus* as this herbicide translocate into the tubers and reduce their viability (Norsworthy et al. 2007). Halosulfuron methyl (3-chloro-5-4-6 dimethoxy pirimidin-2-ylcarbomayl sulfamay II-I metbyl-pyrosole-4-carboxylate) is a selective, post emergence new orgenic sulfonyurea herbicide used for control of *cyperus rotundus L.* (Gosh *et al.* 2017). Halosulfuron methyl is known to be very effective against sedges. (Rathika *et al.* 2013). The combination of one or more herbicides could enhance the efficacy of weed management. The different herbicide applications alone or in combinations has not been attempt so far for controlling of nutsedge in turf. Thus, objective of this study was to assess the efficacy of different herbicides alone or in combination to control of purple nutsedge.

II. MATERIALS AND METHODS

The present investigation was carried out during two consecutive years 2024-25 at Department of Floriculture and Landscaping, Dr. PDKV, Akola over well esatablished lawn of Bermuda grass var. culcutta selection No-1 lawn (Geo-coordinates 220 42’ N latitude and 770 02’ N longitudes). The experiment site was selected based on the representation of moderate density of weed *Cyperus rotundus* L. in winter season. The altitude of place is 300 m above mean sea level. The experiment was laid out in randomized block design (RBD) with the three replication. The experiment comprised of twelve treatments as per the detailes given in table 1.

Table 1. Details of the treatments along with treatment code and concentration used for experimentation

S. No.	Code	Details
	T_1	Metasulfuron methyl 20% WP @ 5 g/ha
	T_2	Carfentrazone 40% DF @ 20 g/ha
	T_3	Atrazine 50% @ 1000 g/ha
	T_4	2,4-D amine salt 58% SL @ 580 g/ha
	T_5	Halosulfuron methyl 75%WG @ 67.5 g/ha
	T_6	Metribuzin 70% WP @ 300 g/ha
	T_7	Sulfosulfuron 75% WG @ 25 g/ha
	T_8	Metasulfuron methyl 10% + Chlorimuron ethyl 10% WP (RM) @ 45 g/ha
	T_9	2,4-D amine salt 58% SL @580 g/ha + Halosulfuron methyl 75% WG @ 67.5g/ha (Tank mix)
	T_{10}	Carfentrazone 40% DF @ 20g/ha + Atrazine 50% @ 1000 g/ha (Tank mix)
	T_{11}	Hand weeding
	T_{12}	Weedy check

Lawn was mowed mechanically with a lawn mower one month before application and later plot were irrigated intervally. The herbicides were applied then immediately weed count was done.The herbicide were applied on clear, sunny and calm day by using knapsack sprayer attached with the flat fan nozzle.

The observations recorded were weed density of *Cyperus rotundus L*. per meter square from fixed spot in each of the treatments at before spray and after 20, 40, 60 and 80 DAS of herbicide application.

Dry weight of *Cyperus rotundus L.* was recorded from two random spot at 20, 40, 60 and 80 DAS respectively which was expressed in gram (g) per meter square. The weed control efficiency was calculated to determine the percentage of weed reduction beacause weed control efficiency is derived from weed dry weight.

The phytotoxicity rating was adjudged on 0 to 10 scale and it was recorded at 3, 5 and 8 days after application of herbicide to know the extent of toxicity on Bermuda grass truf in case of chlorosis, necrosis, epinasty. (Rao 1986).

III. RESULTS AND DISCUSSION

Weed density (m^2)

Weed density (m^2) of *Cyperus rotundus L.* at various stages before and after herbicide application is presented in Table 2. Weed density of *Cyperus rotundus* was significantly ($p \leq 0.05$) influenced by weed management practices and herbicide application during all observed intervals durations except 20 days. The results revealed that density of *Cyperus rotundus* at 40 DAS was lowest (0.1 and 0.0) in halosulfuron methyl (T_5) and hand weeding (T_{11}) which was significantly lower than all other herbicide treatments. Likewise, at 60 & 80 DAS, the minimum density (1.3 & 2.3) of *Cyperus rotundus* was recorded under halosulfuron methyl (T_5) which was significantly lower than the other treatments.

The use of Halosulfuron methyl provided better control of weeds upto 45 DAS and new emergence when observed at 60 DAS. This is in conformity with the earlier finding of Rathika *et al*. (2013), Meher *et al*. (2013) and Ghosh *et al.* (2017), and Desai *et al.* (2017). According to the Gannon *et al. (*2012) soil plus foliar application of halosulfuron provided the highest level of growth suppression and its capacity to penetrate up to pith tissue of tuber which is clearly seen in transverse section of *Cyprus* tuber. Halosulfuron methyl belong to the sulfonylurea group of herbicide which blocked the normal function of acetolactate enzyme which is essential in amino acid (protein synthesis). Similar results were also reported by Reddy and Bendixen *et al*. (1988), Vencill *et al*. (1995) and Webster and Coble (1997). In case of tank mix combination of both 2,4-D amine salt + halosulfuron methyl, 2,4 D is selective, systematic, post emergence herbicide control the annual dicot weed and halosulfuron control sedges so both combination resulted highest reduction in total weed density was recorded by Breck *et al.* (2006), Chaturvedi (2020) in Sugarcane and Singh *et al. (*2018).

Dry weight (g/m^2)

The dry weight of *Cyperus rotundus* at various stages after herbicide application is presented in Table 3. Dry weight of *Cyperus rotundus* was significantly influenced by application of different herbicide application at all intervals. It was interesting to note that at 20 and 40 days after spray, application of T_5 treatments did not show any weed population thus recorded no dry weight and this was statistically at par with hand weeding (T_{11}). These two treatments were significantly superior over all the other treatments.

At 60 and 80 DAS, T_5 and T_{11} demonstrated similar pattern of the weed check. For this, the minimum dry weight of *Cyperus rotundus* (0.1 g) was observed both in halosulfuron methyl (T_5) and hand weeding (T_{11}), both of which were statistically at par with each other but significantly different with other treatments. Halosulfuron is rapidly absorbed by the foliage as well as by the roots of plants and translocated throughout the plant. Halosulfuron has been found control of *Cyprus rotundus* very effectively by Etheredge *et al*. (2010) and Vencill *et al* (1995). Halosulfuron works systemically, being absorbed into the plant in 24 to 48 hours then begins moving through the plant to the roots and nutlets underground, resulting in a quick death after a few weeks. Halosulfuron is labeled for nutsedges and horsetail only and is unable to control other grassy or broadleaf weeds. Similar results were also reported by Breck *et al.* (2006), Desai *et al.* (2017) and Maurya *et al.* (2021). Isaacs *et al.* (2006) reported that Halosulfuron can be easily mixed with 2,4-D.

Result from these studies inferred that Halosulfuron and 2,4-D were generally control the mixed flora.

Weed control efficiency (%)

Weed control efficiency of *Cyperus rotundus* at various stages after herbicide application is graphically illustrated in Figure 1. Significant lowest weed control efficiency was recorded in T_{12}- weedy check (0.0 %) whereas it was highest in herbicide application and hand weeding during all sorts of interval. At 40 DAS, T_{5}- halosulfuron methyl and T_{11}- hand weeding recorded significantly highest weed control efficiency of cyperus 100 and 95.88% respectively. These two treatments were found significantly superior over all the other treatments. Moreover, at 60 DAS, the treatment with T_{11}- hand weeding and T_{5}- halosulfuron methyl recorded the highest weed control efficiency (90.73% and 89.49%, respectively) and at 80 DAS (84.01% and 83.13%, respectively) also exhibited similar trends.

The weed control efficiency (WCE) of different treatments was higher during the initial stages of application (20 DAS) and it was declined with days of application. Similar kind of result were recorded by Rahama *et al*. (1998) and Webster and Coble (1997), Rathika *et al.* (2013), Singh *et al.* (2017). When halosulfuron methyl was applied at 4 to 6 leaves stage to the *Cyprus rotundus* within 10-14 days leaves of Cyprus started yellowing and translocation to roots took place and ultimately it led to drying of the leaves. Similar results were found Van Biuon *et al*. (1996), Norsworthy *et al.* (2007), Poddar *et al.* (2014) and Dash and Mishra (2014).

Phytotoxicity

The visual appearance is important parameter for good truf establishment. Phytotoxicity can adversely affect the appearance of the truf. (Janakiram *et al.* 2015). The phytotoxicity rating on turfgrass was recorded periodically at 3, 5 and 8 DAS of herbicides. During the course of experiment no phytotoxicity symptom were visible in the truf out of Halosulfuron methyl, 2,4-D amine salt + Halosulfuron methyl used implying the suitable dose of application which was not harmful for the turfgrass and also found with the good aesthetic appeal because halosulfuron methyl is a selective herbicide and kills only targeted areas of *Cyperus rotundus L.* The result are in conformity Devi and Nawamaki (2006), Anonymous (2014), Desai *et al*. (2017), Singh *et al.* (2022).

Table 2. Effects of different herbicide application on weed density (m^2) *Cyperus rotundus* L. in turf

Treatments	Before	20 DAS	40 DAS	60 DAS	80 DAS
T_{1}- Metsulfuron methyl 5g/ha	5.0 (2.34)	6.3 (2.61)	8.3 (2.97)	9.7 (3.18)	11.0 (3.39)
T_{2}- Carfentrazone ethyl 20g/ha	4.7 (2.26)	5.7 (2.48)	6.3 (2.61)	8.3 (2.97)	9.7 (3.19)
T_{3}- Atrazine 1000g/ha	4.0 (2.11)	6.0 (2.55)	7.3 (2.79)	9.3 (3.13)	10.3 (3.29)
T_{4}- 2,4-D amine salt 580g/ha	3.3 (1.94)	5.7 (2.48)	6.7 (2.68)	8.7 (3.03)	10.3 (3.29)
T_{5}- Halosulfuron methyl 67.5g/ha	5.7 (2.48)	0.0 (0.71)	0.0 (0.71)	1.3 (1.34)	2.3 (1.68)
T_{6}- Metribuzin 300g/ha	3.7 (2.00)	6.3 (2.61)	7.7 (2.86)	9.7 (3.19)	11.0 (3.39)
T_{7}- Sulfosulfuron 25g/ha	5.7 (2.48)	5.3 (2.42)	6.7 (2.67)	7.7 (2.85)	9.3 (3.14)
T_{8}- Metsulfuron methyl + Chlorimuron ethyl (RM) 45g/ha	6.0 (2.54)	5.7 (2.48)	6.7 (2.67)	7.7 (2.85)	9.0 (3.08)

T_{9}- 2,4-D amine salt + Halosulfuron methyl (Tankmix) 580g/ha+67.5g/ha	4.3 (2.18)	1.3 (1.35)	2.7 (1.77)	3.3 (1.95)	4.3 (2.20)
T_{10}- Carfentrazone ethyl + Atrazine (Tank mix) 20g/ha +1000g/ha	4.7 (2.27)	5.3 (2.42)	6.3 (2.60)	7.3 (2.79)	8.7 (3.03)
T_{11}- Handweeding	5.7 (2.48)	0.0 (0.71)	0.1 (0.88)	2.00 (1.05)	4.00 (1.34)
T_{12}- Weedy check	4.3 (2.20)	8.7 (3.03)	9.7 (3.19)	12.3 (3.58)	14.3 (3.85)
SE (m) ±	0.18	0.11	0.14	0.15	0.16
CD (P≤0.05%)	NS	0.33	0.41	0.44	0.48

*Values outside the parentheses represent original means (No./m^2). Values in parentheses as subjected to square root transformation √(x+0.5).

Table 3. Effects of different herbicide application on dry weight (g/m^2) of *Cyperus rotundus L.* in turf

Treatments	20 DAS	40 DAS	60 DAS	80 DAS
T_{1}- Metsulfuron methyl (5g/ha)	0.5 (0.98)	0.6 (1.06)	0.9 (1.17)	1.0 (1.22)
T_{2}- Carfentrazone ethyl (20g/ha)	0.4 (0.95)	0.5 (1.02)	0.7 (1.08)	0.7 (1.11)
T_{3}- Atrazine (1000g/ha)	0.5 (0.99)	0.6 (1.07)	0.8 (1.15)	0.9 (1.19)
T_{4}- 2,4-D amine salt (580g/ha)	0.3 (0.92)	0.4 (0.97)	0.6 (1.07)	0.7 (1.11)
T_{5}- Halosulfuron methyl (67.5g/ha)	0.0 (0.71)	0.0 (0.71)	0.1 (0.77)	0.2 (0.84)
T_{6}- Metribuzin (300g/ha)	0.5 (0.99)	0.6 (1.05)	0.8 (1.12)	0.8 (1.15)
T_{7}- Sulfosulfuron (25g/ha)	0.3 (0.91)	0.5 (1.02)	0.7 (1.08)	0.8 (1.14)
T_{8}- Metsulfuron methyl + Chlorimuron ethyl (RM) (45g/ha)	0.4 (0.93)	0.5 (1.00)	0.7(1.09)	0.8 (1.13)
T_{9}- 2,4-D amine salt + Halosulfuron methyl (Tank mix) (580g/ha+67.5g/ha)	0.1 (0.80)	0.2 (0.85)	0.3 (0.89)	0.4(0.96)
T_{10}- Carfentrazone ethyl + Atrazine (Tank mix) (20g/ha +1000g/ha)	0.3 (0.91)	0.6 (1.03)	0.7 (1.09)	0.9 (1.19)
T_{11}- Handweeding	0.0 (0.71)	0.0 (0.73)	0.1 (0.79)	0.2 (0.84)
T_{12}- Weedy check	0.7 (1.08)	0.8 (1.16)	1.1 (1.27)	1.3(1.33)
SE (m) ±	0.02	0.02	0.03	0.04
CD (P≤0.05%)	0.06	0.08	0.11	0.12

*Values outside the parentheses represent original means(g/m^2). Values in parentheses was subjected to square root transformation √(x+0.5).

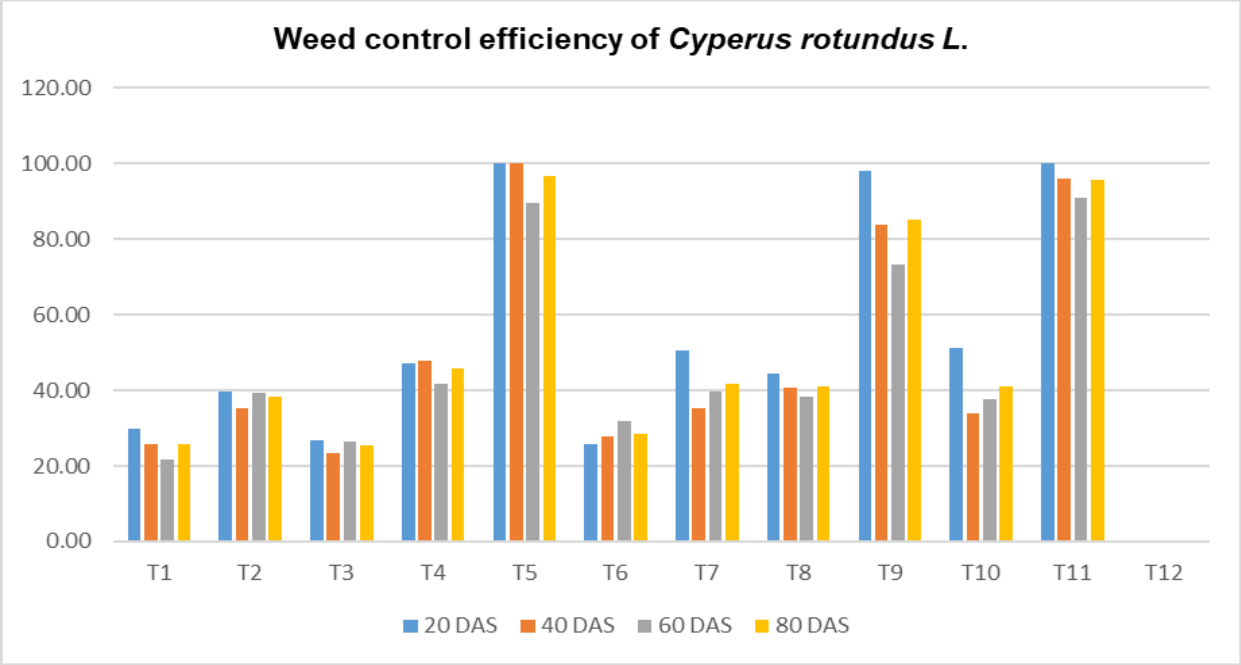

Figure 1. Weed control efficiency (%) of *Cyperus rotundus L.* in lawn

IV. CONCLUSION

In conclusion, application of (T_5) Halosulfuron methyl 75% WG 67.5 g/ha foliar spray at 4 to 6 leaf stage of *Cyperus rotundus L.* showed excellent results such as least weed density, maximum weed control efficiency and highest weed control. Apart from that, the T_5 treatment also did not show any phytotoxicity symptoms. Therefore, treatment T_5 proven best for control of *Cyperus rotundus L.* effectively.

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