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Effect of non selective herbicides on *Cyperus rotundus* in non-crop area

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Abstract
Field experiment was conducted during *kharif* season of 2019-20 on non-cultivated area available at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari entitled "Effect of Non selective herbicides on *Cyperus rotundus* in non-crop area". Among the different weed management practices, application of Glyphosate 41% SL (W_1 and W_2) cent per cent ruined the density and dry weight of *Cyperus rotundus* dry weight at 15 DAA with negligible dry weight at 60 DAA. Moreover, effect was more pronounced with higher dose i.e. 3.0 kg/ha and combined with 2,4-D salt 58% SL 2.0 kg/ha (W_6). Further, ready mixed application of Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (W_5) detected significantly at par and reduced the dry weight of sedge weeds. On the basis of results obtained, Glyphosate 41% SL found much better as compared to other herbicides and crumbed the *Cyperus rotundus* hundred percent within fortnight and checked the resurgence for a month with negligible resurgence at 60 days of application. Thus, it is advised to apply Glyphosate 41% SL 2.0 kg/ha for effective and economic control of weeds in non-cropped land.

Keywords: *Cyperus rotundus*, weed management, non-selective herbicides, non-cropped area

Introduction
India has 70.0 million ha area under non-crop, which is badly infested with perennial as well as annual monocot, dicot and sedge weeds. Gujarat has 19.6 million hectares geographical area of which nearly 1.41 million hectares is under non crop, which is badly infested with variety of the weeds. In India, most of the noxious weeds are of alien origin and have been introduced either negligently or accidentally and have occupied fallow and waste lands to a greater extent (Kohli and Rani.1994) [10]. Weeds under non-cropped situation not only reduce the value of lands, but also deteriorate the aesthetic look and cause many problems for movement of human beings as well as animals. Their presence in these vacant and uncultivated areas is highly undesirable as they provide food, shelter and reproductive sites for various pest organisms (Plant pathogens, insects, mites, nematodes etc.) and serve as alternate hosts for these harmful organisms which may spread to neighbouring fields during cropping season and adversely infest crop plants (Bhowmick, 2002; Bhowmick *et al*., 2012 and 2016) [6, 8]. Many alien species such as Cynodon dactylon, *Cyperus* rotundus and *Parthenium hysterophorus* are very invasive in nature and have significant impede on the ecosystem and human health because of their high reproductive capacity, diverse dispersal mechanisms, colonizing ability in new habitats, capacity to outcompete native species. Habitat disturbances and degradation, frequent introduction with high magnitude of the alien species and lack of predators or natural competitors in the new habitat are the factors that promote invasiveness of alien species.
Cyperus rotundus is one of the most noxious weed of cultivation and its spread is so great and no seriousness that in certain places, cultivation of field has been actually abandoned in despair. A single tuber produces 1900 plants and 8900 tubers per 31.6 sq.m within a year. Average tuber output per aerial shoot was 172 in May and 258 numbers in November and it's produce 60-80 tubers/season. It is a perennial weed which defying the normal methods of weed control including the application of herbicides. The failure of herbicide is mainly due to poor translocation and the dormant nature of the tuber which constitute predominant underground propagating plant parts and the chain of tubers present in various depths makes this weed to control very difficult.
In recent past, efforts were made to control the weeds through biological agents but so far spectacular success has not been achieved. Attempts have also been made to control weeds by mechanical means *i.e.* ploughs or cultivators are used to cut the underground parts into many bits, resulting in increased population of perennial weeds in the subsequent season/year.

Further, manual and mechanical measures of their control are not only costly and labour intensive, but also take more time. Under such situations, herbicides have been found very effective and economically viable too, for control of weeds in non cropped situation. Therefore, it has become imperative to use suitable herbicides to control weeds. *Cyperus rotundus* regenerate through their underground vegetative parts and again infest the same non-cropped area within a short time (25-35 days), if herbicide molecules did not reach in lethal concentration at the site of action. Therefore, it is imperative to find out the right dose of application with appropriate combination of post emergence herbicides, particularly Glyphosate and Paraquat combine with Oxyfluorfen or 2,4-D (ready or tank mixture) and alone for maximizing herbicidal activity. Practically no systemic research work has so far been done in past to standardize the weed management practices and herbicides sequential application for management of weeds in non-crop area for this region.

Materials and Methods

The present experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *kharif* 2019. The soil of the experimental field was clayey in texture (62.37%), moderately high in organic carbon (0.68%), low in available nitrogen (195.3kg/ha) and fairly rich in available phosphorus (51.3 kg/ha) and high in available potassium (480.2 kg/ha). The soil was slightly alkaline (pH 7.6) in reaction with normal electrical conductivity (0.70). The trial was laid out in randomized block design with three replications and comprised nine weed management treatments *viz*., Glyphosate 41% SL 2.0 kg/ha (W_1), Glyphosate 41% SL 3.0 kg/ha (W_2), Paraquat dichloride 24% SL 3.0 kg/ha (W_3), Paraquat dichloride 24% SL 4.0 kg/ha (W_4), Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix) (W_5), Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix) (W_6), Paraquat dichloride 24% SL 2.0 kg/ha + 2,4 D salt 58% SL 2.0 kg/ha (Tank mix) (W_7), Mowing (one weed flush) (W_8), Weedy check (control) (W_9). The spraying was done by using Knapsack sprayer with flat fan nozzle using 500 liters of water per hectare. Fresh solution for individual plot were prepared separately for each plot. Required quantity of herbicide was calculated and applied as per treatment. The prepared solutions were sprayed separately as per treatment in respective plot. All the herbicidal treatment was imposed after 25 days of normal session of monsoon. *Cyperus* population was recorded using 1 m^2 (1 m x 1 m) quadrate and then converted into number of weeds/m^2. Two representative spots in each plot were selected randomly. The *Cyperus rotundus* was separately counted at 7, 15, 21, 30 and 60 days after herbicidal applicaton. After uprooting of weeds, the weeds were sun-dried completely till reached to constant weight and finally the dry weight was recorded at 15, 30 and 60 days after herbicidal spraying for each treatment and expressed as g/m^2. As the data on weed population (No./m^2) and weed dry biomass (g/m^2) showed much variation, they were subjected to square root transformation (1+X) and (0.5+X) respectively, to reduce the range of variation then statistically analyzed by the standard method as described by Steel and Torrie (1960) [14]. Weed control efficiency was calculated by the formulae suggested by Kondap and Upadhya (1985) [11].

$$\text{Weed control efficiency (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where,
DWC = Dry weight of weeds in weedy check
DWT = Dry weight of weeds in treated plot.

Table 1: Influence of weed management treatments on *Cyperus* rotundus

Treatment			*Cyperus rotundus* population/m^2											
			Initial		7 DAA		15 DAA		21 DAA		30 DAA		60 DAA	
W_1	:	Glyphosate 41% SL 2.0 kg/ha	4.11	(16.00)	3.15	(9.00)	1.00	(0.00)	1.00	(0.00)	1.28	(0.67)	2.44	(5.00)
W_2	:	Glyphosate 41% SL 3.0 kg/ha	4.24	(17.00)	2.87	(7.33)	1.00	(0.00)	1.00	(0.00)	1.00	(0.00)	2.23	(4.00)
W_3	:	Paraquat dichloride 24% SL 3.0 kg/ha	4.00	(15.00)	1.72	(2.00)	1.49	(1.33)	1.99	(3.00)	2.76	(6.67)	4.04	(15.33)
W_4	:	Paraquat dichloride 24% SL 4.0 kg/ha	4.08	(15.67)	1.63	(1.67)	1.52	(1.33)	1.73	(2.00)	2.51	(5.33)	3.96	(14.67)
W_5	:	Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix)	4.16	(16.33)	2.63	(6.00)	1.14	(0.33)	1.14	(0.33)	1.82	(2.33)	2.64	(6.00)
W_6	:	Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix)	4.46	(19.00)	1.79	(2.33)	1.00	(0.00)	1.00	(0.00)	1.00	(0.00)	2.15	(3.67)
W_7	:	Paraquat dichloride 24% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix)	4.43	(18.67)	1.52	(1.33)	1.52	(1.33)	1.91	(2.67)	2.08	(3.33)	2.93	(7.67)
W_8	:	Mowing (one weed flush)	4.16	(16.33)	1.00	(0.00)	2.44	(5.00)	3.04	(8.33)	3.37	(10.33)	4.12	(16.00)
W_9	:	Weedy check (control)	4.24	(17.00)	4.43	(18.67)	4.47	(19.00)	4.71	(21.33)	4.86	(22.67)	5.10	(25.00)
		S.Em. ±	0.17		0.17		0.13		0.12		0.09		0.12	
		CD (p=0.05)	NS		0.51		0.38		0.37		0.26		0.36	
		CV%	7.05		12.76		12.73		11.08		6.65		6.35	

*Data in parenthesis indicate actual value and $\sqrt{X+1}$ transformed value of weeds those outside.

Table 2: Dry biomass of sedge weed at 15, 30 and 60 DAA as influenced by weed management treatments

Treatment			Dry biomass of sedge weed (g/m^2)						Weed Control Efficiency (WCE%)		
			15 DAA		30 DAA		60 DAA		15 DAA	30 DAA	60 DAA
W_1	:	Glyphosate 41% SL 2.0 kg/ha	0.71	(0.00)	0.78	(0.10)	1.16	(0.85)	99.87	99.51	97.05
W_2	:	Glyphosate 41% SL 3.0 kg/ha	0.71	(0.00)	0.71	(0.00)	1.07	(0.66)	100.00	100.00	97.84
W_3	:	Paraquat dichloride 24% SL 3.0 kg/ha	0.83	(0.20)	1.36	(1.37)	1.93	(3.25)	98.09	85.48	73.68
W_4	:	Paraquat dichloride 24% SL 4.0 kg/ha	0.85	(0.23)	1.34	(1.31)	1.86	(2.96)	98.56	87.59	75.41
W_5	:	Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix)	0.74	(0.05)	0.93	(0.37)	1.20	(0.96)	99.51	99.32	96.11
W_6	:	Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix)	0.71	(0.00)	0.71	(0.00)	1.08	(0.69)	99.21	99.71	97.11
W_7	:	Paraquat dichloride 24% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix)	0.87	(0.26)	1.03	(0.56)	1.36	(1.37)	98.17	90.62	81.70
W_8	:	Mowing (one weed flush)	1.14	(0.79)	1.92	(3.23)	2.14	(4.11)	93.83	64.31	58.48
W_9	:	Weedy check (control)	1.88	(3.05)	2.44	(5.48)	3.22	(9.92)	-	-	-
		S.Em. ±	0.04		0.07		0.08				
		CD (p=0.05)	0.13		0.20		0.23				
		CV%	8.09		9.49		7.81				

*Data in parenthesis indicate actual value and $\sqrt{X+0.5}$ transformed value of weeds those outside.

Results and Discussion

Effect on weed

Amidst all the weed management treatments Glyphosate 41% SL 3.0 kg/ha (W_2) and Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix) (W_6) were completely demolished the *Cyperus rotundus* (0.00/m^2), with negligible population at 60 DAA. Similar performance was also observed with application of Glyphosate 41% SL at lower rate i.e. 2.0 kg/ha (W_1:0.67/m^2), however, found significantly superior then rest of the treatments. Further, Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix) (W_5) was found statistically at par with above treatments only at 15 and 21 DAA. The significantly better reduction of *Cyperus* was observed with Glyphosate 41% SL alone or with 2,4-D salt because 2,4-D disrupts phloem tissues, which results in a disruption of normal food material translocation, whereas Glyphosate is translocated throughout the entire plant, it is able to eradicate the underground tubers connected to the leaves. The results are on the line with those of Prabhakaran *et al.* (2009) [12], Sukhadia *et al*. (2000) [15], Ameena and George (2004) [2], Beltrao *et al*. (1983) [5], (Anon., 2001) [3], Bhowmick *et al*. (2017) [7]. However, application of Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix) (W_5) found at par with treatment W_1, W_2 and W_6 because Glyphosate inhibiting the function of EPSP synthase enzyme (EPSPS), which is important in the biosynthesis of aromatic amino acids, thus resulting in phytotoxicity & eventually death of weeds and Oxyfluorfen inhibits protoporphyrinogen oxidase enzyme, leading to cell membrane disruption and kill of the plant. As expected, weedy check (W_9) recorded significantly the highest number of sedge weed population at 7, 15, 21, 30 and 60 DAA because weeds were free to allow and established in plot throughout the experiment. All the herbicidal treatments and mowing had curbed the dry weight of sedge weed significantly over weedy check. Application of Glyphosate 41% SL (W_1 and W_2) cent per cent ruined the sedges dry weight at 15 DAA with negligible dry weight at 60 DAA, however, effect was more pronounced with higher dose *i.e.* 3.0 kg/ha and combined with 2,4-D salt 58% SL 2.0 kg/ha (W_6). Moreover, ready mixed application of Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (W_5) detected at par significantly and reduced the dry weight of sedge weeds. The overall superior response was attained because Glyphosate altered the metabolism of phenolic compound by reducing phenyl alanine ammonia lyase activity in root coupled with distranslocation of photosynthate to growing points by the 2,4-D, led to death of weed and Oxyfluorfen also cause membrane disruption through lipid peroxidation. Different weed control methods reduce the weed population and growth considerably which might have reflected in reduced dry weight of weed under these treatments. These findings are in close conformity to that of Yadav *et al*. (2000) [17], Sukhadia *et al*. (2000) [15], Prabhakaran *et al.* (2009) [12], Sharma *et al*. (2007) [7], Ameena and George (2004) [2]. Further, Paraquat dichloride 24% SL at 3.0 or 4.0 kg/ha or with 2,4-D salt 58% SL 2.0 kg/ha significantly wrecked the dry weight of *Cyperus rotundus*, however effectiveness was reduced with time. As of now resurgence is considered, application of Glyphosate 41% SL 3.0 kg/ha (W_2) and Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix) (W_6) identified as the most effective method of preventing the re-emergence of sedge weeds up to 30 DAA, because of rapid detoxification of herbicide molecules in weeds and ultimately had poor activity on this weed at 60 DAA. These results also corroborated the findings of Ameena and George (2004) [2], Ahuja and Yaduraju (1995) [1].

Weed indices

Different weed management treatments exerted their remarkable effect on weed control efficiency. Amongst various weed management treatments, Glyphosate 41% SL 3.0 kg/ha (W_2) registered the higher weed control efficiency throughout the experiment. This was closely followed by Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 58% SL 2.0 kg/ha (Tank mix) (W_6), Glyphosate 41% SL 2.0 kg/ha (W_1) and Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix) (W_5) at 60 DAA. This variation in weed control efficiency is directly associated with the amount of weed dry matter accumulated under different treatments. The results indicated that Glyphosate alone or in combination with selective herbicides like 2,4-D and Oxyfluorfen proved better for excellent control of growth and development of *Cyperus rotundus* in non-cropped land. Efficacy of different herbicidal application has been recounted by Ammena and George (2004) [2] and Ahuja and Yaduraju (1995) [1] Yadav *et al*. (2007) [16], Arya and Singh (1997) [4].

Economics

Amongst the treatments the cost of weed control varied from ₹ 1068 to 5534/ha due to herbicides and their application rates. The minimum cost for weed control was observed with mowing (W8) treatment i.e. ₹ 1068/ha, however, Paraquat dichloride 24% SL 4.0 kg/ha (W4) fetched the maximum investment of ₹ 5534/ha but both were only effective up to 10-15 days. Whereas, Glyphosate 41% SL 2.0 kg/ha (W_1) needed less variable cost of ₹ 2046/ha and further increase the rate of application, the variable cost of treatments increased correspondingly at 3.0 kg/ha application. Similar, views were also endorsed by Sharma *et al*. (2007) [7]. However, the cost of weed control increased correspondingly with the increase in application rates or in combined application, thus, application of Glyphosate 41% + Oxyfluorfen 2.5% SC 2.0 kg/ha (Ready mix:W_5), Glyphosate 41% SL 3.0 kg/ha (W_2) and Glyphosate 41% SL 2.0 kg/ha + 2,4-D salt 2.0 kg/ha (Tank mix) (W_6), documented ₹ 2603, 2802 and 3011/ha, cost of treatments, respectively.

Summary and Conclusion

Based on experiment, it is concluded that application of Glyphosate 41% SL 2.0 kg/ha alone or along with 2,4-D salt 58% SL 2.0 kg/ha (Tank mix) completely destroyed the *Cyperus rotundus* upto 21 days, however effect was more acute with the higher rate of Glyphosate 41% SL i.e. 3.0 kg/ha which demolished the weeds upto 30 DAA. Overall, Glyphosate 41% SL found much better as compared to other herbicides which crumbed the sedge weeds hundred percent within fortnight and checked the resurgence for a month with negligible resurgence at 60 days of application. Thus, it is advised to apply Glyphosate 41% SL 2.0 kg/ha for effective and economic control of sedge weeds in non-cropped land.

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