EVALUATION OF BIO - EFFICACY AND PHYTOTOXICITY OF GLYPHOSATE 41% SL AGAINST WEED FLORA IN GRAPE VINEYARDS

ABSTRACT:

The study was evaluated for the bio- efficacy and phytotoxicity of Glyphosate 41% SL against the complex weed flora in grapevines. The experiment was carried out at ICAR- NRC Grapes, Pune with seven treatments replicated thrice. The treatments were imposed at 3-4 leaf stage of weeds in vineyards. All the weed population were niformly distributed in vineyards. All the treatments significantly reduced weed density over untreated control. The highest weed density was recorded with untreated control while, the negligible weed density was recorded in hand weeding followed by Glyphosate 41 % SL @ 4000 ml/ha at 15th, 30th, 45th Days after application. Least dry weight (g/m^2) as recorded with Glyphosate 41 % SL @ 4000 ml/ha followed by Glyphosate 41 % SL @ 3000 ml/ha whereas, the maximum dry weight of weed (g/m^2) was recorded with untreated control at 45th Days after application. Highest weed control efficacy (%) was recorded with Glyphosate 41 % SL @ 4000 ml/ha followed by Glyphosate 41 % SL @ 3000 ml/ha whereas, negligible weed control efficacy (%) was recorded with untreated control. The highest yield (kg/vines) was recorded with hand weeding treatments followed by Glyphosate 41 % SL @ 4000. The highest benefit: cost ratio was recorded in the treatment Glyphosate 41 % SL (4000 ml/ha) (1:1.99), while least in control treatment (1:1.77). Applications of Glyphosate 41 % SL @ 4000 ml/ha in grapevines showed highest weed control efficacy (%) and yield per vine (kg/vine) in this investigation.

Key words: Glyphosate, Grapes, Phytotoxicity, Weed flora.

1. INTRODUCTION:

Glyphosate (N-(phosphonomethyl) glycine) is a broad-spectrum systemic herbicide and crop desiccant is an organophosphorus compound, specifically a phosphonate, which acts by inhibiting the plant enzyme 5-enolpyruvylshikimate-3-phosphate synthase. *Glyphosate* is a widely used herbicide that controls broadleaf weeds and grasses. Glyphosate is absorbed through foliage and minimally through roots and transported to growing points. It inhibits a plant enzyme involved in the synthesis of three aromatic amino acids: tyrosine, tryptophan

and phenylalanine. It is therefore effective only on actively growing plants and is not effective as a pre-emergence herbicide. Glyphosate is widely used on fruit, vegetable and cereal crops and it would only kill weeds. In India, grapes are grown under different soil and cultural conditions. Weed flora varies according to the climate and physio-chemical properties of the soil. Irrespective of the agro climatic conditions, *Parthenium hysterophorus, Cynodon dactylon, Cyperus rotundus* are the common weeds in Indian vineyards although as many as 378 species of weeds have been reported to infest the cultivated lands in Karnataka.(Sastry *et al*.1980) .

The variety of weeds and their intensity is more in vineyards where vines are trained to vertical trellises such as T, V, Y or tatura due to availability of uninterrupted sunlight (Patil. 2005). Uncontrolled weeds cause upto 75 % reduction in the yield (Rao *et al.* 2007). Therefore, timely weed control is imperative for realizing desired level of productivity. Therefore, an efficient and economic weed management protocols is necessary to manage different types of weeds throughout the year. So far various herbicides have been recommended for weed control in vineyards. There are number of problematic weed flora present as they are resistant to normal dosage of weedicides. As such, weed flora have to be managed using specific herbicide dose or mixture and timing. Hand weeding though an efficient method is laborious, costly, time consuming and unsuitable for large grape vineyards. In the past, majority of workers have tried either pre-emergent or post-emergent weedicides. Pre-emergence weedicides and post emergence is seen to offer a long lasting control of weeds in vineyards since grapevines are irrigated and the soil moisture is maintained throughout the year, which helps the weeds to grow almost throughout the year. Considering this, the present investigation was carried out to evaluate the bio-efficacy of Glyphosate 41% SL.

2. MATERIALS AND METHODS:

2.1 Experiment field conditions:

The experiment was conducted at research and developmental vineyards of ICAR-National Research Centre for Grapes, Pune during 2019-20. Pune is located in Midwest Maharashtra state (India) at an altitude of 559 m above the mean sea level. It lies in 18.32° N latitude and 73.51° E longitude. Thirteen year old Tas-A-Ganesh grapes grafted on Dogridge rootstock were selected for this study. The vines were planted at a spacing of 5 m between rows and 4 m between vines within a row. The plot size was 5 m^2 x 5 m^2in each replication was selected for the study. The experiments were carried out in a RBD design with seven treatments viz.

T1-Glyphosate 41 % SL @ 2000 ml/ha, T2- Glyphosate 41 % SL @ 3000 ml/ha, T3- Glyphosate 41 % SL @ 4000 ml/ha, T4- Glyphosate 71 % SG (3000 gm/ha), T5- Weed free check and T6- Reference standard Paraquat Dichloride 24 % SL @ 2000 ml/ha and T7- Untreated Control with 3 replications each. The row orientation was in the direction of North – South. The vines were trained to double cordon Y system. The soil of this region is black having pH 7.75 and EC 0.46 dS/m. However, water used for irrigation had EC 1.8 and pH 8.3.

Herbicides were applied at 3 to 4 leaf stage of weed in vineyard having seven treatment and three replications. (Spraying done only in rows and the use of HOOD with flat nozzle recommended to protect the crop). Observations were recorded for weed density (No/m^2) and dry weight of weed (g/m^2), WCE (%).Weed density was counted by taking a quadrate of 1 x 1 sq. m. placed at random inside the each treated plot. The total number of dicot and monocot weeds present in the quadrate frame was counted at pre spray, 15^{th}, 30^{th} and 45^{th} days after treatment. For dry weight, above ground portion of the weeds in the quadrant was collected from each plot at 45^{th} days after treatment. The weed samples were air dried and later oven dried to constant weight at 60^{o} C and dry weight was recorded 45^{th} DAA. Density of weed flora before different treatments i.e. initial count were also recorded and used for the calculations.

Percent weed control efficiency was calculated by using formula made by (Mani *et al*. 1976)

$$WCE = \frac{\text{No. of weed in control} - \text{No. of weed in treated}}{\text{No. of weed in control}}$$

Percent weed control efficiency was mentioned species wise at 45^{th} days after application.

2.2. Generally weed founds in grape vineyards:

Sr. No	Monocot weeds	Dicot weeds
1	*Commelia bengalensis*	*Argemone mexicana*
2	*Cyperous rotundus*	*Bidens biternata*
3	*Eragrostis major*	*Parthenium hysterophorous*
4	*Cynadon dactylon*	*Portulaca oleracea*
5	*Asphoidelus tenifolius*	*Amaranthus viridus*
6	*Cyanotis axillaris*	*Oxalis Corniculata*
7	*Ischaenum pilosum klein*	*Cassia tora*
		Lantana camera
		Amaranthus spinous
		Chinopodium album

		Euphorbia hirta

2.3. Assessment on Phytotoxicity

Number of treatments : Three (03)

Number of replications : Three (03)

Phytotoxicity treatment details:

Tr. No	Treatment details	Formulation (ml/ha)
1	Glyphosate 41 % SL @ 1.230 kg a.i./ha	3000
2	Glyphosate 41 % SL @ 2.460 kg a.i./ha	6000
3	Untreated control	Water spray

The Phytotoxicity observations for different treatments on weed flora were recorded on 10th DAA. The Phytotoxicity of herbicides was studied as per CIB guidelines on 0-10 scale by comparing the toxicity symptoms from the treated and untreated plots viz. leaf tip/surface injury, wilting, vein clearing, necrosis, epinasty and hyponasty were observed at 10 days after treatments.

Scale	Rating
0	0-00
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

3. RESULTS AND DISCUSSION

3.1 Bio-efficacy of weedicides:

Data on weed density (No. /m^2) was recorded at Pre spray, 15th, 30thand 45th days after

application (DAA). The data on weed control efficiency (%) and dry matter (g/m^2) was recorded at 45th days after application. The species wise weed count, weed density, weed control efficacy (WCE) was presented in Table 1, 2, 3, 4 and 6. The data was revealed that weed control treatments brought about significant variation in the count at all stages of observations in vineyard.

The observation was recorded on the individual weed count before the application of treatments and it was presented in Table 1. The total number of weed per meter square in each plot was uniform and statically non-significant. The data recorded on weed density (No. / m^2) at 15th, 30th and 45th days after application was significant and presented in Table 2 to 4.

The data was recorded on weed density (No. /m^2) at 15th days after application was significantly reduced by the application of herbicide treatments (Table 2).The minimum number of weeds per meter square was observed with the hand weeding followed by Glyphosate 41% SL at 4000 ml/ha. While highest weed density (No. /m^2) was recorded in control. The similar trends were observed for weed density (No. /m^2) after 30th days and 45th days after application respectively . After 30th days of spraying, the minimum number of weeds per meter square was observed in hand weeding followed by Glyphosate 41% SL at 4000 ml/ha. While highest weed density (No. /m^2) was recorded in control. The study was confirmed with the earlier works by Hebbethwaite and Schepens (1986), Bajwa *et al.* (1990 &1992), Rekha *et al* (2002) and Hussain *et al*. (2008), who reported Glyphosate was very effective for controlling both mono and dicot weeds in grapes vineyards. The treatment control was recorded highest weed density for all weeds like *Commelina benghalensis*(16.33), *Eragrostis minor* (13.67), *Amaranthus viridis L* (15.33), *Amaranthus spinosus* (30.00), *Parthenium hysterophorus* (18.33), *Cynadon dactylon L* (32.00), *Cyprus rotundus L* (27.00) followed by Paraquat dichloride 24% SL at 2000 ml /ha for all weeds (Table 3). The highest weed density was recorded in treatment T3- Glyphosate 41 % SL (4000ml/ha) at 45 days application for *Commelina bengalensis* (2.63) , *Ergrotis minor* (2.00), *Parthenium hysterophorus* (2.87), *Cynadon dactylon* (3.00), *Cyperus rotundus* (2.53), *Amaranthus viridus* (1.93), *Amaranthus spinous* (2.57). The lowest weed density was observed in treatment T1- Glyphosate 41 % SL (2000 ml/ha) for *Commelina bengalensis* (5.10), *Ergrotis minor* (4.63), *Parthenium hysterophorus* (5.00), *Cynadon dactylon* (6.00), *Cyperus rotundus* (5.00), *Amaranthus viridus* (3.83), *Amaranthus spinous* (6.00) in Table 4. However, the weed density (No. /m^2) was

increased in control and decrease with herbicide treatments. In the investigation, the least weed density (No. / m^2) was significantly reduced with the application of Glyphosate 41% SL at 4000 ml/ha.

3.2. Dry weight of weeds (g /m^2):

The data was recorded on the dry weight of weeds at 45th days after application of herbicides was presented in Table 5. The significant differences were observed for dry weight of weeds in the present investigation. The highest dry weight of all the weeds was recorded with control treatments. While it was lowest with weed free check (hand weeding) treatment followed by the application of Glyphosate 41% SL @ 4000 ml/ha and which was recorded at par with Glyphosate 41% SL @ 2000 ml/ha, Glyphosate 41% SL @ 3000 ml/ha and Paraquat dichloride 24 % SL@ 2000 ml/ha at 45th days after application. The results was obtained in this study might be due to the Glyphosate 41% SL which may persist for long time for controlling all weeds flora in grape vineyards and was at par in efficacy with its lower dose. Application of Glyphosate weedicides in grape vineyard significantly reduced the dry weight in all weeds at 45th days as compared to control. Similar result obtained by Ramteke et al (2012), who reported that Application of Glyphosate weedicides in '*Thompson Seedless'* grape vineyard significantly reduced the dry weight in all weeds as compared to hand weeding and control.The lower dry weight in treatment T3- Glyphosate 41 % SL @ 4000 ml/ha showed superiority than other treatment. Similar results were obtained by Bajwa et al., (1993b) and Muniyappa and Prathibha (1993).

3.3. Weed control efficacy (%) at 45th Days after application of grapevines

The treatment T3- Glyphosate 41 % SL @ 4000 ml/ ha was observed to be most effective to control weeds. However treatment T1-Glyphosate 41 % SL @ 2000 ml/ha, treatment T2-Glyphosate 41 % SL @ 3000 ml/ha both are proved to be non efficient than Paraquat Dichloride 24 % SL @ 2000 ml/ha at 45th DAA. The treatment T3- Glyphosate 41 % SL @ 4000 ml/ha effectively control weed like *Commelina benghalensis, Eragrostis minor, Amatanthus viridis* L, *Amaranthus spinosus, Parthenium hysterophorus, Cynadon dactylon* L, *Cyprus rotundus* L. This might be due to persistence of Glyphosate for–long period. Similar results were observed by Gaziev *et al*. (1985). The least weed control found in treatment T1-(Glyphosate 41 % SL@ 2000 ml/ha for *Commelina benghalensis (65.37%).* However, the highest weed control was found in manual/hand weeding for all weeds. These findings are in

agreement with Rekha *et al* (2002), who reported that twice hand weeding resulted in lower weed density compared to weedicides and untreated control.

From the present study the treatment T3 Glyphosate 41 % SL @ 4000 ml / ha was found better than other treatments (Market Standards). Result revealed that the WCE was found in *Commelina benghalensis* (83.03%), *Eragrostis minor* (88.00%), *Amaranthus viridis L* (80.56%), *Amaranthus spinosus* (88.10%), *Parthenium hysterophorus* (92.65%), *Cynadon dactylon L* (91.95%), *Cyprus rotundus L* (88.97%) at 45th days after application of Glyphosate 41% SL. Treatment (T6) Praquat dichloride 24% SL @ 2000 ml/ha found best for controlling all type of weeds in grape vineyard i.e *Commelina benghalensis* (79.90%), *Eragrostis minor* (83.90%), *Amaranthus viridis L* (78.22%), *Amaranthus spinosus* (83.33%), *Parthenium hysterophorus* (88.17%), *Cynadon dactylon L* (87.39%), *Cyprus rotundus L* (83.84%) at 45th days after application.(Table 6). The higher WCE with two hand weeding at 45th days after pruning followed by Glyphosate 41% SL at 4000 ml /ha compared to other herbicide treatments might be attributed to the increased lethal activity of herbicides on weeds. Similar reports are reported by Horowitz and Elmore (1991), Bajwa *et al.* (1992, 1997).

Glyphosate efficacy is influenced by air temperature and light intensity (Coupland and Masiunas 1983). Weed control efficiency at different stages of crop growth period in Tas- A - Ganesh grape vineyard showed an increasing trend with the two hand weeding at 10th and 30th Days during experiments. Improved WCE with Glyphosate 41 % SL was considered to be mainly due to the fact that application dosage/ ha makes it possible to target a larger proportion of weeds at the sensitive stage than single application and also dosage/ ha proved more stable with regard to efficacy. To be effective, herbicide should adequately contact, absorbed by the plants plants without losing their toxic effect till the site of action (Gunsolus and Curran 2007).

3.4. Yield per vine and Benefit Cost ratio:

The data recorded on yield per vine was presented in table 7. Significant differences were recorded in all the herbicide treatments. The highest yield per vine was recorded with the hand weeding treatment (14.67 kg/vine) and followed by T3- Glyphosate 41% SL (4000 ml / ha) 13.67 kg/vine, T2- Glyphosate 41% SL (3000 ml / ha) 12.33 kg/vine and Parquat dichloride 24% SL (2000 ml / ha) 12.38 kg/vine. While it was least in control and recorded 9.67 kg/vine. The increases in yield per vine in the present investigation might be due to decreased competition for moisture and nutrients between weed and grapevine which ultimately increase

quality and yield of grapes. Similar result reported by Bajwa *et al.* (1993b) and Bajwa *et al.* (1997). Whereas, higher Benefit: Cost ratio was recorded in the treatment Glyphosate 41 % SL (4000 ml/ha) 1:1.99 fallowed by Glyphosate 41 % SL @ (3000 ml/ha) and Glyphosate 71 % SG (3000 ml/ha) 1:1.97. The increase in benefit: cost ratio might be due to decreased competition for moisture and nutrients between weed and grapevine which ultimately increase quality of grapes.

3.5. Phytotoxicity study:

The phytotoxicity of herbicides was studied as per CIB guidelines on 0-10 scale by comparing the toxicity symptoms from the treated and untreated plots. No phytotoxic signs or symptoms *viz.*, leaf tip injury, yellowing, necrosis, wilting, vein clearing, hyponasty and epinasty were observed even at 10^{th} days after application of recommended dose i.e. Glyphosate 41% SL at 3000 ml/ha (Table 8).

4. CONCLUSION:

The Bio- efficacy and phytotoxicity of Glyphosate 41% SL in grape vine during 2019-2020 revealed that:

- The application of Glyphosate 41 % SL at the dose of 4000 ml / ha showed better efficacy for weed control in vineyards.
- No phytotoxicity symptoms in grape vineyard was observed in any of the doses of the testing herbicide Glyphosate 41% SL at 4000 ml/ha during experimental period.
- Among the herbicide application the glyphosate 41 % SL at 4000 ml / ha showed highest yield per vine fallowed by the application Glyphosate 41 % SL at 3000 ml / ha.

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Table 1. Weed count of different weeds in grape vineyard before application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amatanthus viridis*	*Parthenium hysterophorus*,	*Amaranthus sp.*	*Cynadon dactylon*	*Cyperus rotundus*
T1- Glyphosate 41 % SL	0.820 (2000 ml / ha)	12.33 (3.56)	7.67 (2.85)	10.00 (3.23)	12.67 (3.59)	20.00 (4.52)	25.00 (5.02)	20.33 (4.54)
T2- Glyphosate 41 % SL	1.230 (3000 ml / ha)	12.00 (3.51)	8.33 (2.92)	10.00 (3.23)	12.00 (3.52)	20.00 (4.53)	25.67 (5.11)	21.00 (4.62)
T3- Glyphosate 41 % SL	1.640 (4000 ml / ha)	12.00 (3.52)	8.00 (2.91)	10.00 (3.24)	12.33 (3.57)	20.67 (4.59)	25.33 (5.07)	21.00 (4.62)
T4- Glyphosate 71 % SG	(3000 ml / ha)	13.00 (3.67)	8.67 (2.99)	10.67 (3.31)	12.67 (3.62)	20.00 (4.49)	25.33 (5.06)	21.00 (4.62)
T5- Weed Free Check	-	12.67 (3.62)	8.33 (2.96)	10.00 (3.21)	12.00 (3.51)	20.33 (4.51)	25.00 (5.03)	21.33 (4.67)
T6- Paraquat Dichloride 24 %SL	0.5 (2000 ml / ha)	12.67 (3.61)	8.33 (2.93)	10.00 (3.17)	12.67 (3.49)	20.67 (4.58)	25.33 (5.05)	21.67 (4.68)
T7- Untreated Control	0.820 (2000 ml / ha)	12.33 (3.58)	8.33 (2.96)	10.67 (3.31)	12.33 (3.54)	20.67 (4.60)	25.67 (5.11)	20.33 (4.56)
SEm (±)		**0.22**	**0.28**	**0.26**	**0.36**	**0.29**	**0.32**	**0.28**
CD at 5 %		**0.70**	**0.88**	**0.80**	**1.10**	**0.92**	**1.00**	**0.80**

Values in the parenthesis indicates transformed value [√(x+0.5)] used for statistical analysis
*: Significant at P < 0.05
**: Significant at P< 0.01

Table 2. Effect of herbicide on weed density (no. /m^2) in vineyard at 15th days after application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amatanthus viridis*	*Parthenium hysterophorus*,	*Amaranthus sp.*	*Cynadon dactylon*	*Cyperus rotundus*
T1- Glyphosate 41 % SL	0.820 (2000 ml / ha)	3.80 (2.07)	2.00 (1.58)	2.03 (1.59)	2.03 (1.59)	2.17 (1.63)	2.53 (1.74)	1.63 (1.46)
T2- Glyphosate 41 % SL	1.230 (3000 ml / ha)	2.73 (1.80)	1.30 (1.34)	1.10 (1.26)	1.43 (1.38)	1.17 (1.29)	1.57 (1.43)	1.00 (1.22)
T3- Glyphosate 41 % SL	1.640 (4000 ml / ha)	2.60 (1.76)	1.10 (1.26)	0.87 (1.17)	1.10 (1.23)	0.93 (1.20)	1.40 (1.37)	0.83 (1.15)
T4- Glyphosate 71 % SG	(3000 ml / ha)	2.73 (1.80)	1.33 (1.35)	1.13 (1.27)	1.40 (1.38)	1.17 (1.29)	1.60 (1.45)	1.00 (1.22)
T5- Weed Free Check	-	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T6- Paraquat Dichloride 24 %SL	0.5 (2000 ml / ha)	3.60 (2.02)	2.00 (1.58)	2.00 (1.58)	2.07 (1.60)	2.25 (1.66)	2.53 (1.74)	1.67 (1.47)
T7- Untreated Control	-	14.33 (3.85)	10.67 (3.34)	13.00 (3.67)	15.00 (3.94)	25.67 (5.11)	28.00 (5.34)	24.00 (4.95)
SEm (+)		**0.04**	**0.07**	**0.07**	**0.11**	**0.08**	**0.07**	**0.05**
CD at 5 %		**0.13**	**0.24**	**0.24**	**0.33**	**0.25**	**0.20**	**0.17**

Values in the parenthesis indicates transformed value [√(x+0.5)] used for statistical analysis
*: Significant at P < 0.05
**: Significant at P< 0.01

Table 3. Effect of herbicide on weed density (No. /m^2) in vineyard at 30 th days after application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amatanthus viridis*	*Parthenium hysterophorus*,	*Amaranthus sp.*	*Cynadon dactylon*	*Cyperus rotundus*
T1- Glyphosate 41 % SL	0.820 (2000 ml / ha)	4.03 (2.13)	3.10 (1.90)	2.77 (1.81)	3.00 (1.87)	3.07 (1.89)	3.83 (2.08)	2.30 (1.67)
T2- Glyphosate 41 % SL	1.230 (3000 ml / ha)	2.40 (1.70)	1.33 (1.35)	1.63 (1.46)	1.93 (1.56)	2.07 (1.60)	1.90 (1.55)	1.27 (1.33)
T3- Glyphosate 41 % SL	1.640 (4000 ml / ha)	2.27 (1.66)	1.17 (1.29)	1.47 (1.39)	1.70 (1.48)	1.53 (1.42)	1.63 (1.46)	1.07 (1.25)
T4- Glyphosate 71 % SG	(3000 ml / ha)	2.43 (1.71)	1.30 (1.34)	1.63 (1.46)	1.93 (1.56)	2.07 (1.60)	1.90 (1.55)	1.30 (1.34)
T5- Weed Free Check	-	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T6- Paraquat Dichloride 24 %SL	0.5 (2000 ml / ha)	4.07 (2.13)	3.17 (1.91)	2.80 (1.82)	3.03 (1.88)	3.03 (1.88)	3.80 (2.07)	2.37 (1.69)
T7- Untreated Control	-	16.33 (4.10)	13.67 (3.76)	15.33 (3.98)	18.33 (4.34)	30.00 (5.47)	32.00 (5.69)	27.00 (5.24)
SEm (±)		**0.06**	**0.05**	**0.05**	**0.07**	**0.19**	**0.09**	**0.07**
CD at 5 %		**0.18**	**0.18**	**0.17**	**0.23**	**0.61**	**0.32**	**0.24**

Values in the parenthesis indicates transformed value [√(x+0.5)] used for statistical analysis
*: Significant at P < 0.05
**: Significant at P< 0.01

Table 4. Effect of herbicide on weed density (No. /m^2) in vineyard at 45th days after application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amatanthus viridis*	*Parthenium hysterophorus*,	*Amaranthus sp.*	*Cynadon dactylon*	*Cyperus rotundus*
T1- Glyphosate 41 % SL	0.820 (2000 ml / ha)	5.10 (2.37)	4.63 (2.26)	3.83 (2.08)	5.00 (2.34)	6.00 (2.54)	6.00 (2.54)	5.00 (2.34)
T2- Glyphosate 41 % SL	1.230 (3000 ml / ha)	2.83 (1.82)	2.23 (1.65)	2.13 (1.62)	3.07 (1.87)	2.93 (1.85)	3.23 (1.93)	2.83 (1.82)
T3- Glyphosate 41 % SL	1.640 (4000 ml / ha)	2.63 (1.77)	2.00 (1.58)	1.93 (1.56)	2.87 (1.83)	2.57 (1.75)	3.00 (1.87)	2.53 (1.74)
T4- Glyphosate 71 % SG	(3000 ml / ha)	2.84 (1.82)	2.23 (1.65)	2.13 (1.62)	3.07 (1.87)	2.94 (1.85)	3.25 (1.93)	2.83 (1.82)
T5- Weed Free Check	-	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T6- Paraquat Dichloride 24 %SL	0.5 (2000 ml / ha)	5.10 (2.36)	4.67 (2.27)	3.77 (2.06)	5.03 (2.35)	5.93 (2.54)	6.00 (2.55)	5.00 (2.34)
T7- Untreated Control	-	20.00 (4.53)	16.00 (4.06)	19.33 (4.45)	22.00 (4.74)	32.33 (5.73)	35.00 (5.96)	30.67 (5.58)
SEm (±)		**0.07**	**0.08**	**0.06**	**0.08**	**0.11**	**0.08**	**0.09**
CD at 5 %		**0.20**	**0.26**	**0.19**	**0.25**	**0.35**	**0.24**	**0.29**

Values in the parenthesis indicates transformed value [√(x+0.5)] used for statistical analysis
*: Significant at P < 0.05
**: Significant at P< 0.01

Table 5. Effect of herbicide on dry weight of weed (g/m^2) at 45 th days after application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amatanthus viridis*	*Parthenium hysterophorus*,	*Amaranthus sp.*	*Cynadon dactylon*	*Cyperus rotundus*
T1- Glyphosate 41 % SL	0.820 (2000 ml / ha)	1.43 (1.39)	1.13 (1.28)	1.37 (1.36)	1.13 (1.28)	0.57 (1.03)	0.75 (1.12)	0.87 (1.17)
T2- Glyphosate 41 % SL	1.230 (3000 ml / ha)	0.83 (1.15)	0.67 (1.08)	0.93 (1.18)	0.70 (1.09)	0.37 (0.93)	0.47 (0.97)	0.63 (1.06)
T3- Glyphosate 41 % SL	1.640 (4000 ml / ha)	0.70 (1.09)	0.50 (0.99)	0.83 (1.15)	0.50 (1.07)	0.23 (0.85)	0.30 (0.89)	0.43 (0.96)
T4- Glyphosate 71 % SG	(3000 ml / ha)	1.40 (1.38)	1.10 (1.26)	1.37 (1.37)	1.13 (1.28)	0.60 (1.05)	0.77 (1.13)	0.87 (1.17)
T5- Weed Free Check	-	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T6- Paraquat Dichloride 24 %SL	0.5 (2000 ml / ha)	0.83 (1.15)	0.67 (1.08)	0.93 (1.18)	0.70 (1.09)	0.37 (0.93)	0.47 (0.97)	0.63 (1.06)
T7- Untreated Control	-	4.13 (2.15)	4.17 (2.16)	4.27 (2.18)	4.20 (2.17)	3.13 (1.91)	3.73 (2.06)	3.90 (2.09)
SEm (±)		**0.04**	**0.05**	**0.06**	**0.06**	**0.06**	**0.05**	**0.08**
CD at 5 %		**0.13**	**0.17**	**0.21**	**0.20**	**0.19**	**0.17**	**0.22**

Values in the parenthesis indicates transformed value [√(x+0.5)] used for statistical analysis
*: Significant at P < 0.05
**: Significant at P< 0.01

Table 6. Weed control efficacy (%) at 45th Days after application of treatment.

Treatment details	Dose / ha (a. i. (Kg)	*Commelina benghalensis*	*Eragrostis minor*	*Amaranthus viridis L.*	*Amaranthus spinosus*	*Parthenium hysterophorus*	*Cynadon dactylon L.*	*Cyprus rotundus L.*	*Average WCE*
T1- Glyphosate 41% SL	0.820 (2000 ml / ha)	65.37	72.90	67.92	73.09	81.78	79.89	77.69	74.09
T2- Glyphosate 41% SL	1.230 (3000 ml / ha)	66.10	73.62	67.92	73.02	80.83	79.35	77.69	74.08
T3- Glyphosate 41% SL	1.640 (4000 ml / ha)	83.03	88.00	80.56	88.10	92.65	91.95	88.97	87.61
T4- Glyphosate 71% SG	(3000 ml / ha)	78.20	83.90	78.22	77.78	88.17	83.91	83.84	82.00
T5- Weed Free Check (Hand weeding)	-	100.08	99.92	99.92	100.00	100.00	100.00	100.00	99.99
T6- Paraquat dichloride 24 % SL	0.5 (2000 ml / ha)	79.90	83.90	78.22	83.33	88.17	87.39	83.84	83.54
T7-Control	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 7 : Yield per vine and Benefit Cost ratio:

Treatments	Dose / ha (a. i. (kg)	Yield per vine (kg)	Yield (t per ha) @ 1800 vines/ha	B:C Ratio
T1- Glyphosate 41% SL	0.820 (2000 ml / ha)	11.00	19.80	1:1.95
T2- Glyphosate 41% SL	1.230 (3000 ml / ha)	12.33	22.19	1:1.97
T3- Glyphosate 41% SL	1.640 (4000 ml / ha)	13.67	24.60	1:1.99
T4- Glyphosate 71% SG	(3000 ml / ha)	11.33	22.28	1:1.97
T5- Weed free Check (Hand weeding)	-	14.67	26.40	1:1.96
T6- Paraquat dichloride 24 % SL	0.5 (2000 ml / ha)	12.38	20.39	1:1.93
T7-Control	-	9.67	17.40	1:1.77
SEm (±)		**0.11**	-	**0.004**
CD 5%		**0.34**	-	**0.012**

*: Significant at P < 0.05
**: Significant at P< 0.01

Table 8: Evaluation of Phytotoxicity of Glyphosate 41% SL in Grape

Treatments	Dose a.i. (Kg) (l/ha)	Leaf tip injury						Yellowing & Vein clearing						Wilting & Necrosis						Epinasty & Hyponasty					
		Observation at different days after application (DAA) during 2019																							
		0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Glyphosate 41% SL	1.230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyphosate 41% SL	2.460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated control	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(Scale (0-10): 0= 00, 1= 1-10%, 2= 11-20%, 3= 21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9= 81-90%, 10= 91-100%)