Original Research Article

UTILIZATION OF *PARTHENIUM* LEAF EXTRACT FOR THE EFFECTIVE MANAGEMENT OF PURPLE NUTSEDGE (*Cyperus rotundus*)

Abstract

Quick emergence of *Cyperus* create competition in the crop production which reduces the crop yield. Nowadays, the more importance is given to sustainable agriculture. Application of allelochemicals can control the *Cyperus* sustainably. With this notion, field experiment was conducted at The Indian Agriculture College, Radhapuram during summer 2023 to evaluate utilization of *Parthenium* leaf extract (PLE) for the effective management of Purple nutsedge (*Cyperus rotundus*). The experiment was laid out in completely randomized block design (CRD) having three replications and seven treatments *viz.*, PLE @ 10%, 11%, 12%, 13%, PLE @ 10% + Glyphosate @ 1.5%, Glyphosate @ 1.5% alone and Control. Application of PLE @ 11% on 3, 10 and 20 DAP, significantly reduces the *Cyperus rotundus* germination percentage, dry weight, Vigour Index, total *Cyperus* length, tuber weight, moisture content, chlorophyll content and also improved the *Cyperus* control efficiency due to the presence of allelochemicals.

Keywords : *Cyperus rotundus, Allelochemicals, Parthenium leaf extract, Vigour Index, Cyperus Control Efficiency.*

Introduction

Purple nutsedge (*Cyperus rotundus*) is a perennial grasslike plant belonging to the family cyperaceae, it considered as a world worst weed. Cyperus gets propagated through tubers which having quick emerging capacity which creates competition with the crops especially at early development stage leads to reduction of yield. In agriculture, managing the weeds in crop field is a difficult task. Farmers primarily use chemical herbicides to suppress weeds because of their greater efficiency, reduced expenses and labour scarcity (Owen, 2016). On the other hand, overuse of synthetic herbicides can result in environmental pollution, health risks and a rise in herbicide-resistant weeds (Bashar *et al.,* 2023). However, the introduction of bioherbicides derived from allelopathic plants can serve as a valuable alternative to synthetic chemicals in sustainable agriculture when it comes to weed control (Arafat *et al*., 2015; Bashar *et al*., 2022). Allelopathic chemicals released into the environment or soil by some weed species have the ability to harm the competing plants. *Parthenium* is recognized as an allelopathic weed and can affect the germination and growth of different plants, weeds, and trees (Anita *et al.,* 2014). It contains numerous secondary metabolites in their hair, trichomes, and pollen (Pandey *et al.,* 2019). The concentration of secondary metabolite is highest in leaves followed by inflorescence, root and stem (Shafiq *et al*., 2020). Capitate-sessile trichomes are the primary source of parthenin in *P. hysterophorus*, as they have been shown to contain nearly 100% parthenin at a rate of 2.4% of fresh weight. Generally, leaves of *Parthenium* have high parthenin content because they have the majority of capitate sessile trichomes on their upper and lower surfaces (*Reinhardt et al*., 2004). Among the secondary metabolites present in the *Parthenium*, sesquiterpene lactone parthenin plays a major role in herbicidal action (Bashar *et al*., 2022).

Considering the importance of costs of weed in terms of yield reduction, expenditure on their control and successful utilization of weed allelopathic properties, the present study was designed to investigate the utilization of aqueous extract of *Parthenium* for effective management of *Cyperus rotundus.*

Material and Methods

A pot experiment was conducted in The Indian Agriculture College, Radhapuram during summer 2023. It is geographically located in the southern agro-climatic zone of the Tamil Nadu at 8°15' N latitude and 77° 39' E longitude at an elevation of 57 m above Mean Sea Level. The soil used for the experiment was well drained sandy clay loam in texture. *Parthenium* leaf extract were prepared by collected the *Parthenium* plants from The Indian Agriculture College, Radhapuram at pre-flowering stage, then washed and dried in oven for 72 hours at 65°C. The dried leaves were separated from stems and ground in the laboratory in a mechanical grinder. A ground material 100 g, 110 g, 120 g and 130 g of *Parthenium* leaves were soaked in 1 litre of distilled water to make the solution at different concentrations. The *Parthenium* leaf aqueous extract was obtained by filtering the materials that had been soaked in water using muslin cloth.

The experiment was conducted in pots using a completely randomized block design (CRD) having three replications and seven treatments *viz.*, PLE @ 10%, 11%, 12%, 13%, PLE @ 10% + Glyphosate @ 1.5%, Glyphosate@ 1.5% alone and Control. The pots were filled with soil and fifteen healthy tubers were planted in each pot. PLE was applied at 3, 10 and 20 DAP at different concentration as per the treatment requirement. The measured quantity of water used for spraying in a single pot was used to calculate the spray volume for each concentration, taking into account the total amount of spray volume needed for all of the pots for each treatment. Thus, calculated amount of herbicide was sprayed to each pot using hand sprayer. The experiment duration was 45 days after planting and the necessary data were recorded in this period.

Growth characters viz., *Cyperus* count, Germination Percentage, fresh and dry weight of root and shoot, length of root and shoot, chlorophyll content, were recorded at 15, 30 and 45 DAP. The vigour indices were calculated using the following procedure suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Cyperus Vigour Index I = Total seedling length (cm) x Germination (%)

Cyperus Vigour Index II = Dry matter production (grams) x Germination (%)

Moisture content was calculated using the following formula:

$$\text{Moisture Content (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Dry weight}} \times 100$$

Cyperus Control Efficiency (CCE) of different treatments was determined by using the following formula:

$$Cyperus\ \text{Control Efficiency (\%)} = \frac{Wc - Wt}{Wc} \times 100$$

Where, Wc = weed dry weight in weedy (control) plot and Wt = weed dry weight in treated plot. To determine differences between the treatment means, the data recorded for the observations for each parameter were individually subjected to an ANOVA using AGRES. The significant means were then subjected to an LSD test at P = 0.05 to further elucidate the differences between the treatment means.

Results and Discussion

Germination percentage

The germination count of *Cyperus* significantly varied with the application of PLE foliar spray (Table 1). Significantly lower *Cyperus* emergence was observed with the application of 11% PLE (T_2) at 10 DAP, 15 DAP, 30 DAP and 45 DAP (1.00, 1.67, 2.33, 4.00 respectively). This may be due to the ability of *P. hysterophorous* in inhibiting the germination and growth of weeds by metabolic identification and isolation of the major potential allelopathy, coupled with formulation techniques are also required to enhance the penetration of phytotoxic compound present in *Parthenium* (Motmainna *et al*. 2021). The germination percentage also lower with the 11% PLE spray (7, 11, 16 and per cent at 10 DAP, 15 DAP, 30 DAP and 45 DAP). Allelopathic plant residues are being shown the impact on germination of weeds and seedling growth. In addition to lowering the soil's available nutrient status, parthenium residues in the releases the phenolics, which impacts the emergence and growth of plant species (Batish *et al.* 2005). The similar observation was recorded by Shafiq *et al.,* 2020 in chickpea, Seema (2011) in *Eichornia crassipes.*

The *Cyperus* count and germination percentage were also significantly low when it was applied with PLE @ 10% + Glyphosate @ 1.5% (T_5) (1.33, 2.33, 3.67, 5.33 and 9, 16, 24, 36 per cent respectively). It may be due to the combination of *Parthenium* with reduced doses of herbicide as it suppresses weed density as suggested by Nadir *et al.* (2014). It was also found that Glyphosate reduces the sprouting of purple nutsedge tubers. Similar observation was also recorded by Agahiu (2021) in Purple nutsedge. The inhibitory effect of leaf extract of *Parthenium* increases with concentration (Srivastava *et al.*, 2010).

Seedling length (cm)

Application of 11% PLE (T_2) significantly reduced the length of both shoot and root at 15 DAP, 30 DAP and 45 DAP (3.00, 7.80 and 10.50 cm of shoot length; 1.00, 2.83, 3.07 cm of root length respectively) (Table 2). Similar observation was also studied by Anteneh and Esayas (2011) by applying *Parthenium* extract in various concentration level to observe complete inhibition of shoot and root growth of weeds. This could be as a result of inhibition of cell division due to parthenin's allelopathic action, which severely inhibits the function of gibberellin and IAA (Kumari, 2014; Shafiq *et al.,* 2020).

Fresh weight and Dry weight (g)

Variations in fresh weight of Cyperus is presented in Table 3. The lower fresh weight (0.06, 0.14, 0.23 g at 15 DAP, 30 DAP and 45 DAP) were found with 10% PLE spray. In the present study dry weight of shoot and root significantly reduced with the 11% PLE spray (T_2) at 15 DAP, 30 DAP and 45 DAP (0.01, 0.03 and 0.06 g of shoot DW; 0.02, 0.05, 0.07 g of root DW respectively) (Table 4). The total plant dry weight also recorded lower with 11% PLE spray (0.03, 0.08, 0.13 g at 15 DAP, 30 DAP and 45 DAP). This may be due to the reduced rate of photosynthesis in stomatal conductance and transpiration in *Cyperus sp.* (Motmainna *et al*., 2021). *Parthenium* can be used as potent herbicides and have inhibitory effects in shoot and root development (Khairul *et al*., 2021). Similar observation was also studied by Anteneh and Esayas (2011) by applying PLE in various concentration levels to observe complete inhibition of shoot and root growth of weeds. It was on par with application of PLE @ 10% + Glyphosate @ 1.5% (T_5) (0.02, 0.05 and 0.07 g of shoot DW; 0.02, 0.05, 0.08 g of root DW; 0.04, 0.10, 0.15 g

respectively). It may be due to the combination of *Parthenium* with reduced doses of herbicide as it suppresses weed fresh weight and weed dry weight as suggested by Nadir *et al.* (2014).

Moisture content

Moisture content is decreased after application of leaf extracts (Fig. 1). Among the treatments spraying of 10% PLE extract recorded lower moisture content (83, 76 and 75 per cent at 15 DAP, 30 DAP and 45 DAP respectively). The drying of plants leads to reduction of moisture status in plant. In contrary, higher moisture content recorded with the control (90, 93 and 82 per cent at 15 DAP, 30 DAP and 45 DAP respectively).

Chlorophyll content

Chlorophyll plays an important role in photosynthesis. Chlorophyll content was decreased with the application leaf extracts (Fig 2.). Application of PLE @ 11% (T_2) recorded lower chlorophyll content (0.186, 0.114, 0.074 g/100 mg at 15 DAP, 30 DAP and 45 DAP respectively) compared to other treatments. It can be attributed by the allelopathic effect of parthenium (Bashar *et al*., 2022)

Cyperus Control Efficiency

Application of PLE @ 11% (T_2) recorded *Cyperus* control efficiency of 83, 79 and 76% at 15 DAP, 30 DAP and 45 DAP respectively (Table 5). Reduction in weed dry weight due to effective weed control measures resulted in higher *Cyperus* control efficiency. PLE @ 10% + Glyphosate @ 1.5% (T_5) applied plot also shows the higher *Cyperus* control efficiency (83, 79 and 76 at 15 DAP, 30 DAP and 45 DAP respectively). This may be due to the translocation of glyphosate through the chains of purple nutsedge tubers which decreased the viability of the tubers (Krishna *et al*., 2004; Culpeper, 2006).

Cyperus Vigour Index I & II

Vigour index helps to analyses the effect of weed management practices on controlling the weeds. The lower vigour index indicates better control of weeds with the management practice. Significantly lower vigour index was recorded with the PLE 11% Spray (45, 165, 362 at 15 DAP, 30 DAP, 45 DAP with the consideration of plant length; 0.33, 1.24, 3.47 at 15 DAP, 30 DAP, 45 DAP with the consideration of dry weight) (Table 5)

Tuber weight (g)

The influence of application of PLE foliar spray treatment on difference between the initial and final tuber weight was recorded and the results are presented in the Table 6. The differences of tuber weight were lower with 11% PLE (T_2) (2.43 g) and 10% PLE + glyphosate @ 1.5% application (T_5) (2.55 g). The allelochemicals released from the parthenium may inhibit the nutrient uptake by interrupting the naturally occurring symbiotic relationship (Khan 2008; Safdar *et al*., 2014).

Conclusion

The application of *Parthenium* leaf extract @ 11% and application of *Parthenium* leaf extract @ 10% + Glyphosate @ 1.5% control the *Cyperus* effectively. Since the *Parthenium* leaf extract is environmentally safe and economically viable, it was concluded that the application of *Parthenium* leaf extract @ 11% is an effective *Cyperus* control option to achieve satisfactory and environment friendly weed control.

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Table 1. Germination count of *Cyperus* as influenced by the application of *Parthenium* leaf extract

Treatment	Germination Count				Germination Percentage			
	10 DAP	15 DAP	30 DAP	45 DAP	10 DAP	15 DAP	30 DAP	45 DAP
T_1 - PLE @ 10%	1.96 (3.33)	2.35 (5.00)	3.03 (8.67)	3.14 (9.33)	22	33	58	62
T_2 – PLE @ 11%	1.22 (1.00)	1.47 (1.67)	1.68 (2.33)	2.12 (4.00)	7	11	16	27
T_3 – PLE @ 12%	1.47 (1.67)	1.58 (2.00)	2.27 (4.67)	2.68 (6.67)	11	13	31	44
T_4 – PLE @ 13%	1.96 (3.33)	2.20 (4.33)	2.74 (7.00)	2.97 (8.33)	22	29	47	56
T_5 – PLE @ 10% + Gly.@ 1.5%	1.35 (1.33)	1.68 (2.33)	2.04 (3.67)	2.41 (5.33)	9	16	24	36
T_6 – Glyphosate @ 1.5%	1.87 (3.00)	2.04 (3.67)	2.61 (6.33)	3.03 (8.67)	20	24	42	58
T_7 – Weedy check	1.96 (3.33)	2.53 (5.92)	3.08 (9.00)	3.44 (11.33)	22	39	60	76
S. EM	0.12	0.20	0.32	0.38	0.83	1.31	2.13	2.52
CD (p = 0.05)	0.38	0.59	0.97	1.15	2.50	3.97	6.48	7.66
MEAN	2.43	3.56	5.95	7.67	16	24	40	51

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. – Glyphosate
*Transformed values [√(X+0.5)], Figures in the parantheses indicate original values

Table 2. Length of shoot and root as influenced by the application of *Parthenium* leaf extract

Treatment	Shoot Length (cm)			Root Length (cm)			Total *Cyperus* length (cm)		
	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP
T_1 - PLE @ 10%	11.53	16.28	19.42	8.50	10.15	12.30	20.03	26.43	31.72
T_2 – PLE @ 11%	3.00	7.80	10.50	1.00	2.83	3.07	4.00	10.63	13.57
T_3 – PLE @ 12%	9.10	11.97	12.90	4.40	5.50	6.74	13.50	17.47	19.64
T_4 – PLE @ 13%	12.53	13.63	17.00	7.00	8.43	8.90	19.53	22.06	25.90
T_5 – PLE @ 10% + Gly. @ 1.5%	6.53	11.00	12.20	3.50	4.80	5.50	10.03	15.80	17.70
T_6 – Glyphosate @ 1.5%	9.50	13.47	13.50	5.80	7.20	9.50	15.30	20.67	23.00
T_7 – Weedy check	15.70	18.45	21.50	10.50	13.83	14.50	26.20	32.28	36.00
S. EM	0.50	0.64	0.76	0.34	0.43	0.48	0.84	1.07	1.23
CD (p = 0.05)	1.51	1.95	2.30	1.02	1.29	1.45	2.53	3.23	3.74
MEAN	9.70	13.23	15.29	5.81	7.53	8.64	15.51	20.76	23.93

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. – Glyphosate

Table 3. Fresh weight of shoot and root as influenced by the application of *Parthenium* leaf extract

Treatment	Fresh Weight of Shoot (g)			Fresh Weight of Root (g)			Total fresh weight (g)		
	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP
T_1 - PLE @ 10%	0.160	0.244	0.400	0.090	0.169	0.244	0.160	0.244	0.400
T_2 – PLE @ 11%	0.035	0.085	0.135	0.020	0.056	0.093	0.035	0.085	0.135
T_3 – PLE @ 12%	0.060	0.148	0.204	0.140	0.080	0.127	0.060	0.148	0.204
T_4 – PLE @ 13%	0.145	0.260	0.355	0.095	0.124	0.218	0.145	0.260	0.355
T_5 – PLE @ 10% + Gly. @ 1.5%	0.055	0.119	0.157	0.020	0.063	0.112	0.055	0.119	0.157
T_6 – Glyphosate @ 1.5%	0.093	0.232	0.285	0.072	0.112	0.201	0.093	0.232	0.285
T_7 – Weedy check	0.253	0.397	0.589	0.090	0.340	0.398	0.253	0.397	0.589
S. EM	0.00726	0.01155	0.01753	0.00353	0.00895	0.0114	0.00726	0.01155	0.01753
CD (p = 0.05)	0.02202	0.03504	0.05316	0.01071	0.02713	0.03458	0.02202	0.03504	0.05316
MEAN	0.114	0.212	0.304	0.075	0.135	0.199	0.114	0.212	0.304

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. - Glyphosate

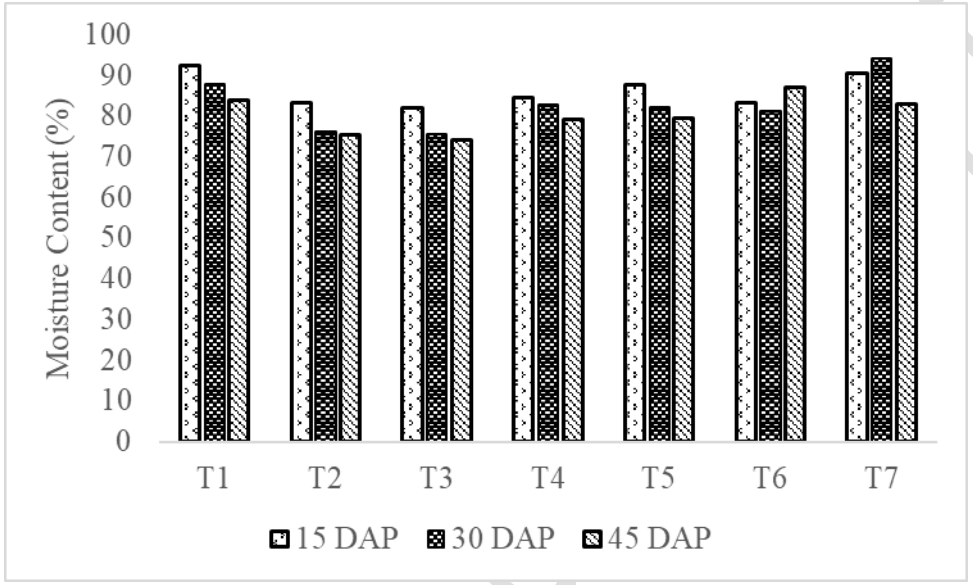

Fig 1. Effect of PLE spray on moisture content of *Cyperus*

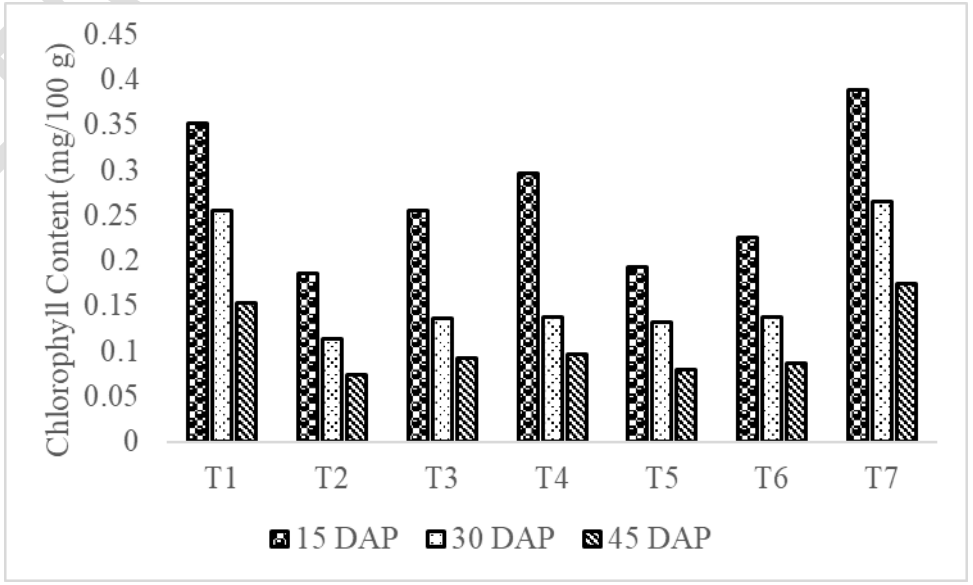

Fig 2. Effect of PLE spray on chlorophyll content of *Cyperus*

Table 4. Dry weight of shoot and root as influenced by the application of *Parthenium* leaf extract

Treatment	Dry Weight of Shoot (g)			Dry Weight of Root (g)			Total Dry weight (g)		
	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP
T_1 - PLE @ 10%	074 (0.05)	0.77 (0.09)	0.81 (0.16)	0.76 (0.08)	0.79 (0.13)	0.83 (0.19)	0.79 (0.13)	0.85 (0.22)	0.92 (0.35)
T_2 – PLE @ 11%	0.71 (0.01)	0.73 (0.03)	0.75 (0.06)	0.72 (0.02)	0.74 (0.05)	0.75 (0.07)	0.73 (0.03)	0.76 (0.08)	0.79 (0.13)
T_3 – PLE @ 12%	0.75 (0.06)	0.75 (0.07)	0.78 (0.11)	0.74 (0.05)	0.75 (0.06)	0.76 (0.08)	0.78 (0.11)	0.79 (0.13)	0.83 (0.19)
T_4 – PLE @ 13%	0.74 (0.05)	0.79 (0.12)	0.81 (0.15)	0.76 (0.08)	0.77 (0.09)	0.82 (0.17)	0.79 (0.13)	0.84 (0.21)	0.91 (0.32)
T_5 – PLE @ 10% + Gly. @ 1.5%	0.72 (0.02)	0.74 (0.05)	0.75 (0.07)	0.72 (0.02)	0.74 (0.05)	0.76 (0.08)	0.73 (0.04)	0.77 (0.10)	0.81 (0.15)
T_6 – Glyphosate @ 1.5%	0.74 (0.05)	0.77 (0.10)	0.79 (0.12)	0.73 (0.04)	0.77 (0.09)	0.80 (0.14)	0.77 (0.09)	0.83 (0.19)	0.87 (0.26)
T_7 – Weedy check	0.75 (0.07)	0.82 (0.18)	0.89 (0.29)	0.78 (0.11)	0.84 (0.20)	0.87 (0.25)	0.82 (0.18)	0.94 (0.38)	1.02 (0.54)
S. EM	0.002	0.005	0.008	0.003	0.006	0.008	0.006	0.011	0.016
CD (p = 0.05)	0.007	0.015	0.024	0.010	0.018	0.024	0.017	0.032	0.048
MEAN	0.04	0.09	0.14	0.06	0.10	0.14	0.10	0.19	0.28

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. - Glyphosate

*Transformed values [√(X+0.5)], Figures in the parantheses indicate original values

Table 5. *Cyperus* Control Efficiency (%) as influenced by the application of *Parthenium* leaf extract

Treatment	*Cyperus* Control Efficiency (%)			*Cyperus* vigour Index (Length)			*Cyperus* vigour Index (Mass)		
	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP	15 DAP	30 DAP	45 DAP
T_1 - PLE @ 10%	28	42	35	668	1528	1973	4.33	12.72	21.77
T_2 - PLE @ 11%	83	79	76	45	165	362	0.33	1.24	3.47
T_3 - PLE @ 12%	39	66	65	180	544	873	1.47	4.05	8.45
T_4 - PLE @ 13%	28	45	41	564	1029	1438	3.75	9.80	17.77
T_5 - PLE @ 10% + Gly. @ 1.5%	78	74	72	156	387	629	0.62	2.45	5.33
T_6 – Glyphosate @ 1.5%	50	50	52	374	872	1329	2.20	8.02	15.03
T_7 - Weedy check	0	0	0	1034	1937	2719	7.10	22.80	40.79
S. EM	NA	NA	NA	30	60	82	0.20	0.62	1.09
CD (p = 0.05)				90	183	249	0.60	1.87	3.32
MEAN	44	51	49	431	923	1332	2.83	8.72	16.09

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. – Glyphosate, NA – Not Analysed

Table 6. Tuber weight differences as influenced by the application of *Parthenium* leaf extract

Treatment	Initial Tuber Weight (g)	Final Tuber Weight (g)	Initial – Final Weight (g)
T_1 - PLE @ 10%	4.52	11.47	6.95
T_2 – PLE @ 11%	4.86	7.29	2.43
T_3 – PLE @ 12%	5.46	9.26	3.8
T_4 – PLE @ 13%	5.56	11.88	6.32
T_5 – PLE @ 10% + Gly. @ 1.5%	4.47	7.02	2.55
T_6 – Glyphosate @ 1.5%	4.53	9.77	5.24
T_7 – Weedy check	5.29	14.02	8.73
S. EM	NA	NA	0.28
CD (p = 0.05)			0.85
MEAN	4.96	10.10	5.15

PLE – *Parthenium* Leaf Extract, DAP – days after planting, Gly. – Glyphosate, NA – Not Analysed