

Original Research Article

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## Polypropylene Fabric Ground Cover Effects on Weed Control and Profit in Elephant Foot Yam Cultivation

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### ABSTRACT

Elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] competes with weeds throughout its growing period owing to its canopy orientation and wider spacing. Manual weeding is the most popular weed control method adopted in elephant foot yam irrespective of drudgery and labourious. A field experiment was conducted for two consecutive years (2016 and 2017) at the Regional Centre of Indian Council of Agricultural Research-Central Tuber Crops Research Institute, Bhubaneswar, Odisha, India to study the effects of polypropylene fabric ground cover (PFGC) on weed control in elephant foot yam. The treatment PFGC resulted in greater corm yield (34.2 tha<sup>-1</sup>) which was 253% higher over the weedy check, and 2.4 and 7.2% higher over 4 manual weedings at 30, 60, 90 and 120 days after planting (DAP) (33.4 tha<sup>-1</sup>) and 2 manual weedings at 30 and 60 DAP along with post-emergence application of glyphosate at 90 DAP (31.9 tha<sup>-1</sup>), respectively. The treatment PFGC resulted in greater gross income (Rs 513000 ha<sup>-1</sup>) and profit (Rs287500 ha<sup>-1</sup>) compared to other treatments. Use of PFGC resulted in greater populations of fungi, bacteria and actinomycetes, and enzymes of dehydrogenase, fluorescein diacetate, acid and alkaline phosphatase activities in post harvest soil than initial value that indicated the treatment PFGC could be a good weed control option in elephant foot yam.

#### Keywords

Corm yield, Gross income, Soil microbes, Weed biomass, Weed control efficiency

#### Article Info

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## Introduction

Elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] is a starchy tuber crop grown in tropical, and subtropical regions, particularly in south-east Asia. Its modified underground stem 'corm' is consumed as vegetable by preparing various delicious cuisines. The corms are also reported to have medicinal properties (Misra *et al.*, 2002; Dey *et al.*, 2010). The corms are rich in minerals and vitamins (Nedunchezhiyan *et al.*, 2017a), and contain glucose, galactose and rhamnose, flavonoids, phenols, coumarins, terpenoids, sterols, tannins, steroids and alkaloids (Nataraj *et al.*, 2009; Yadu and Ajoy, 2010). Khan *et al.*, (2008) isolated amblyone (a triterpenoid) and 3, 5-diacetylambulin (aflavonoid) from corms.

Weeds are potentially a major constraint on crop production and reduce yields significantly if not controlled. Weeds are major pests in humid and sub-humid tropics where adequate rainfall, temperature, and humidity favour their growth (Melifonwu, 1994) and are responsible for reducing quantity and quality of agricultural products by competing with natural and applied resources (Rao *et al.*, 2015). If harvest is delayed, weed roots enter into the corms of elephant foot yam and reduce the quality and make unfit for consumption (Nedunchezhiyan and Misra, 2008). In elephant foot yam, crop-weed competition exists throughout crop growth period because of little coverage by the leaf canopy. Elephant foot yam plant produces erect single pseudo stem with umbrella shaped tripartite leaf canopy. Hence, it is planted at wider spacing to prevent overlapping of canopy from neighbouring plants. Further, elephant foot yam is propagated through corm sets, which takes long time (20-30 days) to sprout. Weeds often germinate and grow earlier than the elephant foot yam and smother the crop.

Weed infestation at early stage of the crop development causes severe yield reduction; up to 100% in wide spaced plantings (Nedunchezhiyan *et al.*, 2018). Weeds in elephant foot yam compete below ground for water and nutrients, and above ground for light and space, and inhibit growth and development of the crop. Weeding alone requires 150-200 man days<sup>ha</sup><sup>-1</sup> i.e. more than 30% of total labour (Ravindran *et al.*, 2010; Nedunchezhiyan *et al.*, 2013). Manual weeding is expensive, tedious and time consuming. However, application of herbicides for weed control at pre- or post-emergence can reduce dependency on manual weeding and reduce cost per weeding. But, herbicides applied to control weeds in the crop field have direct, or indirect, consequences on non-targeted organisms including soil microflora which are responsible for numerous biological processes essential for crop production (Riaz *et al.*, 2007; Latha and Gopal, 2010). It has been reported that some microorganisms are able to degrade herbicides, while others are adversely affected depending on type of herbicide used (Sebiomo *et al.*, 2011). Herbicides either stimulate, or depress, microbial growth depending on the type of chemicals, microbial species and environmental conditions (Zain *et al.*, 2013).

Mulching with organic materials suppresses weed growth and improves soil microbial population (Jung *et al.*, 2004; Chauhan *et al.*, 2012; Das *et al.*, 2012). However, availability of organic materials for mulching is a major constraint. Hence, polythene mulching is recommended in place of organic mulching for weed control in elephant foot yam (Sekhar *et al.*, 2017). However, the major problem in polythene mulching is, it does not allow infiltration of water into the soil. Thus, the crops grown under rainfed conditions suffer moisture stress. Now, polypropylene woven fabrics are available for mulching the crop

plants which will overcome the problems of water infiltration in to the soil. One year study during 2015 on polypropylene woven fabric mulching in elephant foot yam revealed positive effects on crop yield and soil health (Nedunchezhiyan *et al.*, 2018). Hence, present investigation was undertaken to study the effects of polypropylene fabric on weed control and profit in elephant foot yam cultivation.

## Materials and Methods

A field experiment was conducted at the Regional Centre of Indian Council of Agricultural Research-Central Tuber Crops Research Institute (20° 14' 50" N and 85° 47' 06" E), Bhubaneswar, Odisha, India during 2016 and 2017. The climate of the experimental site was warm and humid in summer and cool and dry in winter. The experiment was conducted in sandy clay loam soil with pH 6.67 (Table 1). The soil was low in organic carbon (0.36%) with available N, P and K content was 172.4, 25.1 and 178.2 kg ha<sup>-1</sup>, respectively (Table 1). The experiment was laid out in a randomized block design (RBD) with three replications. The treatments consisted of combinations of herbicides, manual weeding and polypropylene fabrics ground cover (PFGC): T<sub>1</sub> - Pendimethalin @ 1000 g ha<sup>-1</sup> [1 day after planting (DAP)]+Glyphosate @ 2000 g ha<sup>-1</sup> (at 90 DAP); T<sub>2</sub> - Metribuzin @ 525 g ha<sup>-1</sup> (at 1 DAP)+Glyphosate @ 2000 g ha<sup>-1</sup> (at 90 DAP), T<sub>3</sub> - Pendimethalin @ 1000 g ha<sup>-1</sup> (at 1 DAP)+tank mix of Pyriithiobac sodium @ 62.5 g ha<sup>-1</sup> and Propiquizaafop @ 62.5 g ha<sup>-1</sup> (at 90 DAP), T<sub>4</sub> -Metribuzin @ 525 g ha<sup>-1</sup> (at 1 DAP)+tank mix of Pyriithiobac sodium @ 62.5 g ha<sup>-1</sup> and Propiquizaafop @ 62.5 g ha<sup>-1</sup> (at 90 DAP), T<sub>5</sub> -Pendimethalin @ 1000 g ha<sup>-1</sup> (at 1 DAP)+2 manual weedings (at 60 and 90 DAP), T<sub>6</sub> - Metribuzin @ 525 g ha<sup>-1</sup> (at 1 DAP)+2 manual weedings (at 60 and 90 DAP), T<sub>7</sub> -2 manual weedings (at 30 and 60

DAP)+Glyphosate @ 2000 g ha<sup>-1</sup> (at 90 DAP), T<sub>8</sub> -2 manual weedings (at 30 and 60 DAP)+tank mix Pyriithiobac sodium @ 62.5 g ha<sup>-1</sup> and Propiquizaafop @ 62.5 g ha<sup>-1</sup> (at 90 DAP), T<sub>9</sub> -PFGC, T<sub>10</sub> -4 manual weedings (at 30, 60, 90 and 120 DAP), and T<sub>11</sub> -Control (weedy check). Farmyard manure @ 10 t ha<sup>-1</sup> was uniformly incorporated before levelling in all the treatments and ridges were formed at the spacing of 90 cm.

Healthy whole corm of variety Gajendra, weighing approximately 400 g, treated with cow dung slurry (10 kg of fresh cow dung dissolved in 10 L of water and mixed with 50 g *Trichoderma*) one day before were planted at a 90×90 cm spacing on ridges. The pre-emergence herbicides (pendimethalin and metribuzin) were applied one day after planting corms. The post-emergence herbicides (glyphosate, and a tank mix of pyriithiobac sodium and propiquizaafop) were applied directly on weeds at 90 DAP. Using a spray volume of 500 L ha<sup>-1</sup> of water, herbicides were applied without drift on elephant foot yam plants with a manually operated knapsack sprayer with a flat-fan nozzle attached to a hood. The PFGC is a polypropylene woven fabric (100 gm<sup>-2</sup>) which allows air and water to pass through to the soil, but suppresses weed emergence and growth. The PFGC was spread on the ridge and furrows and the ends covered with soil. Holes were made, and corms were planted using a 10 cm diameter pipe. The recommended dose of water soluble fertilizers @ 120-60-120 kg ha<sup>-1</sup> of N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O was applied through drip fertigation. The crop was planted 1<sup>st</sup> May and harvested 31<sup>st</sup> December in both the years.

Soil samples taken before and two years after experimentation were preserved in at 4°C in a refrigerator and used for estimation of microbial variables. Nutrient Agar, Potato Dextrose Agar and Starch Casein Agar media

were used for isolation of bacteria, fungi and actinomycetes, respectively. After serial dilution, 1.0 mL of required dilution ( $10^{-4}$  for fungi and actinomycetes and  $10^{-5}$  for bacteria) was inoculated in to respective Petri plates. The soil sample was spread over the media via a flame sterilized bent glass rod and all plates incubated in the dark at 37°C. After microbial colonies were readily visible (2-7 days for bacteria and fungi and 7-14 days for actinomycetes), numbers of colonies on each plate were counted. The number of cfu g<sup>-1</sup> dry soil was estimated by taking the soil dilution factor and soil moisture content into account. Dehydrogenase activity (DHA) and fluorescein diacetate hydrolysis assay (FDA) in soils was determined by the method described by Casida (1977) and Green *et al.*, (2006), respectively. Acid phosphomonoesterase (AcP) and alkaline phosphomonoesterase (AIP) activities were determined by following the procedure of Tabatabai and Bremner (1969).

Using quadrant (50×50 cm) weeds were removed from two locations before each manual weeding and post emergence herbicide application in the respective treatments and at harvest from all treatments. Weeds were separated by species, initially sun-dried and placed in a forced air oven at 70°C to dry until constant weight was attained. Weed control efficiency (WCE) was calculated by the following formula and expressed in percentage:

$$\text{WCE} = \frac{\text{Weed biomass in control plot} - \text{weed biomass in treated plot}}{\text{Weed biomass in control plot}} \times 100$$

The cost of cultivation was calculated by considering variable cost and interest rate and depreciation on capital cost of PFGC. The life period of PFGC is 5 years. The profit and benefit cost ratio were calculated as follows:

Profit (Rs ha<sup>-1</sup>)=

Gross income (Rs ha<sup>-1</sup>)-cost of cultivation (Rs ha<sup>-1</sup>)

$$\text{Benefit cost ratio} = \frac{\text{Gross income (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation(Rs ha}^{-1}\text{)}}$$

The data on weeds were subjected to square root transformation before statistical analysis. The data collected were subjected to analysis of variance (ANOVA) for RBD using SAS (ver. 11.0, SAS Inc., Cary, NC). The homogeneity of error variance was tested using Bartlett's  $\chi^2$ -test. As the error variance was homogeneous, pooled analysis was done. Comparison of treatment means for significance at  $P=0.05$  was done using least significant difference (LSD) (Gomez and Gomez, 1984).

## Results and Discussion

### Weather and weed flora

The weather parameters during the crop growing period of 2016 and 2017 were averaged. The average monthly maximum temperature was ranged 29.2-38.8°C; the average monthly minimum temperature was ranged 14.8-26.9°C. The average monthly relative humidity was ranged 63.9-85.2% during the crop growing period. The average annual rainfall received during the crop growing period was 1385.1 mm. Plants were irrigated through a drip system during dry spells at 80% of cumulative pan evaporation and an average of 285 mm water per year was applied.

In the experimental field 21 numbers of weed species were observed during cropping period (Table 1). Among them 16 broad leaved weeds, four grasses and a sedge were noticed.

The weed flora observed was specific to the location and climate of the experimental site. High rainfall and relative humidity during crop growing period resulted in emergence of more number of weed species. Kumar *et al.*, (2019) reported 24 weed species in elephant foot yam field in Thiruvananthapuram, Kerala, India. Nandan *et al.*, (2020) reported 33 weed species in the seed bank in Inceptisols of Patna, Bihar, India. Though multiple fleshes of weed species emerged from the seed bank, *Celosia argentea* L., *Digitaria sanguinalis* (L.) Scop. and *Cleome viscosa* L. were dominated the other weed flora throughout the crop growing period. However, in the shaded conditions at the later stage of crop growing period especially in treatment T<sub>10</sub>, *Euphorbia hirta* L., *Oldenlandia corymbosa* L. and *Phyllanthus niruri* L. were emerged in more numbers. Nandan *et al.*, (2020) reported that the most dominant weed flora in the cropped field was depending on the ecosystem in which the crop was grown.

### Weed biomass and WCE

Weed biomass production was influenced by weed control treatments (Table 2). Among all the treatments, T<sub>9</sub> resulted in lower weed biomass production (9.7 g m<sup>-2</sup>) which was 95.9% lesser than T<sub>11</sub>. This was due to suppression of weed germination and emergence owing to complete cover of the ground by polypropylene fabrics. The next best treatment was T<sub>10</sub> which resulted in 94.4% reduction in weed biomass production compared to T<sub>11</sub> owing to removal of weeds by manually 4 times (at 30, 60, 90 and 120 DAP) in a cropping season. The treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> resulted in relatively higher weed biomass production. In a long duration crop like elephant foot yam, pre- and post-emergence herbicides combinations alone were not sufficient for adequate weed control. Sekhar *et al.*, (2017) and Kumar *et al.*, (2019)

reported that herbicide application limit the weed growth but could not control the weeds appreciable level in elephant foot yam due to their short life in the soil. Greater WCE was achieved in treatments T<sub>9</sub>(95.9%) and T<sub>10</sub>(94.5%) compared to other treatments owing to lesser weed biomass production. The treatment T<sub>7</sub> resulted in 85.4% WCE. In this treatment 2 manual weeding (30 and 60 DAP) followed by glyphosate application (90 DAP) reduced the weed pressure.

### Yield

The treatment T<sub>9</sub> resulted in greater corm yield (34.2 t ha<sup>-1</sup>) compared to other treatments (Table 2), which was 252.6% higher yield than T<sub>11</sub>(9.7 t ha<sup>-1</sup>). The higher corm yield in this treatment was due to lower weed biomass production and higher weed control efficiency (Table 2). Sekhar *et al.*, (2017) reported that maximum corm yield was under black polythene mulching of elephant foot yam. Lamont (2005) reported that covering the soil with polythene increased the crop production efficiency and productivity by controlling weeds, improving soil conditions for plant growth through its influence on the root zone temperature, and providing better assimilates of nutrients by reducing the leaching of fertilizers. The treatments T<sub>10</sub> and T<sub>7</sub> resulted in 244.3% and 228.9% higher corm yield than T<sub>11</sub> (Table 2). These treatments also indicated that keeping field weed free for longer periods may be improving growth and development of elephant foot yam. However the corm yield in T<sub>10</sub> and T<sub>7</sub> was lesser than T<sub>9</sub> inspite of keeping field weed free conditions for considerable period of time. Under polythene mulched conditions, soil moisture and nutrients were conserved (Abu-Rayyen and Abu-Irmaileh, 2004) that resulted in 22.4-28.8% higher corm yield over exposed soil conditions (no mulch) in elephant foot yam (Goswami and Saha, 2006). Corm yield data

presented in Table 2 also indicated that application of herbicides alone was not having significant impact because of lower WCE. Sekhar *et al.*, (2017) and Kumar *et al.*, (2019) also reported lesser efficacy of herbicides if applied alone in elephant foot yam. Among pre-emergence application of herbicides, pendimethalin was more effective than metribuzine and among post-emergence herbicides glyphosate was more effective than the tank mix of pyriproxyfen sodium and propaquizafop. The treatment T<sub>11</sub> (weedy check) resulted in lower corm yield owing to season long crop-weed competition, which was indicated by higher weed biomass production and lower WCE (Table 2).

### **Economics**

Weed control methods influenced cost of cultivation, gross income, profit and benefit cost ratio (Table 1). Greater cost of cultivation was observed in treatment T<sub>9</sub> followed by treatment T<sub>10</sub>. However, the cost difference between both the treatments was just Rs 1000ha<sup>-1</sup>. Though initial cost of PFGC was higher, considering its longevity the variable cost was nearly equal to 4 manual weeding cost. The treatment T<sub>9</sub> resulted in maximum gross income (Rs 513000ha<sup>-1</sup>) and it was followed by treatment T<sub>10</sub> (Rs501000ha<sup>-1</sup>). Greater gross income in these treatments was due to higher corm yield. The treatment T<sub>9</sub> resulted in greater profit (Rs 287500 ha<sup>-1</sup>) (Table 2). Higher profit was also realized in treatments T<sub>10</sub>(Rs 276500ha<sup>-1</sup>) and T<sub>7</sub>(Rs 272200ha<sup>-1</sup>) due to higher corm yield in former case and lower cost of cultivation in latter case (Table 2). The treatment T<sub>9</sub> recorded 4.0 and 5.6% higher profit than T<sub>10</sub> and T<sub>7</sub>, respectively. The treatment T<sub>7</sub> resulted in greater benefit cost ratio (2.32) owing to lower cost of cultivation and moderate corm yield. The treatments T<sub>9</sub> (2.27) and T<sub>10</sub> (2.23) also resulted in higher benefit cost ratio than other treatments except T<sub>7</sub> owing to higher corm yield.

### **Soil organic carbon**

Weed control methods affected soil organic carbon content (Table 3). The post-harvest soil organic carbon content increased in all treatments except T<sub>10</sub> compared to initial status (Table 3). The treatment T<sub>7</sub> resulted in greater soil organic carbon. It was 33.3% higher over initial value after two years of experimentation. Application of post emergence herbicide glyphosate at 90 DAP resulted in drying and decomposition of weed biomass *in situ* that increased soil organic carbon content. The treatment T<sub>11</sub> also resulted in higher soil organic carbon content. In this treatment continuous presence of weeds (the highest biomass production) (Table 2) added higher organic carbon in to the soil. Organic amendments, and associated plant residues, may supply additional sources of labile C in soil (Carpenter-Boggs *et al.*, 2000).The treatment T<sub>9</sub> recorded moderately higher soil organic carbon than the treatment T<sub>10</sub> and initial value. This might be accumulation of organic carbon *in situ* due to dead microbial populations, organic exudates from the roots of crop plants and decaying of germinating weed seeds as well as prevention of decomposition of soil organic matter. Increasing number of manual weeding decreased soil organic carbon content. The treatment T<sub>10</sub> resulted in lower soil organic carbon. This might be due to clean cultivation. Continuous disturbing and exposure of soil enhances oxidative processes and respiration, and increases emission of CO<sub>2</sub> from the soil by faster decomposition of soil organic matter (Chatskikh and Olesen, 2007). The return of weed residue to the soil is negligible in this treatment. Elephant foot yam produces 3-4 leaves with petioles (pseudostem) per plant (Nedunchezhiyan *et al.*, 2017a), which were intact with corm till harvest of the corm. Crop residues were not available before harvest.

### Soil microbial populations

Post harvest soil microbial population was higher than initial soil (Table 3). Availability of sufficient soil moisture, favourable relative humidity along with substrates, released by dead and living roots of crop and weeds responsible for multiplication of microbes in the soil during cropping season in all the treatments. Weed control methods significantly influenced the post harvest soil microbial population (Table 3). In this present experiment, the increase of microbial population in post emergence application of glyphosate after two years might be due to increase of organic carbon by slow decomposition of dead weeds *in situ* and release of essential nutrients from weeds which act as substrate for microbial multiplication. Immediately after herbicide application the microbial population may be decreased and 15-20 days after application, the herbicide decomposes, and microbial populations start multiplying (Nedunchezhiyan *et al.*, 2017b).

The microbial multiplication can be due increased supply of nutrients available from weeds killed by herbicides, or to proto-cooperative influence of micro-organisms in the rhizosphere of (Lokose, 2017). Ghosh *et al.*, (2012) found that for all cases of herbicidal treatments, total bacteria recovered from initial loss and exceeded initial counts. Bera and Ghosh (2013) reported that herbicide treatments initially resulted in decreased microbial counts but with the degradation of the herbicides within a considerable time, the population exceeded the initial count. In the present investigation, due to high rainfall the glyphosate might have been leached out or converted into harmless secondary metabolites in the soil. When glyphosate binds to soil, it becomes inactive, losing its antimicrobial properties and can be readily degraded by microorganisms to CO<sub>2</sub>

and provide a source of phosphorus, nitrogen and carbon for microorganisms (Nedunchezhiyan *et al.*, 2017b). Haney *et al.*, (2000, 2016) reported increased soil microbial biomass, respiration, and carbon and nitrogen mineralization after glyphosate application. Application of glyphosate in short duration crops like maize (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] has decreased bacterial diversity at harvest (Barriuso *et al.*, 2010), but in long duration elephant foot yam crop bacterial diversity may be recovered. The treatment T<sub>9</sub> resulted in greater microbial populations than T<sub>10</sub> and initial value. The microclimate developed under PFGC might be favoured for microbial growth and multiplication.

### Soil enzyme activities

The treatment T<sub>7</sub> resulted in maximum dehydrogenase, fluorescein diacetate, acid and alkaline phosphatase activities in the soil (Table 3). Higher soil enzyme activities in these treatments might be due to higher organic carbon content and microbial activity in the soil. Increased soil dehydrogenase, fluorescein diacetate and phosphatase activities might be ascribed to greater availability of substrates that support these activities (Kremer and Li, 2003). Soil phosphatase activity was closely related to soil organic matter content, supporting reports that elevated organic matter levels promote soil phosphatase activity (Frankenberger and Dick, 1983; Jordan *et al.*, 1995). The treatment T<sub>9</sub> resulted in higher enzyme activities than T<sub>10</sub> and initial value. This might be due to higher soil organic carbon and microbial populations (Table 3). The lowest dehydrogenase, fluorescein diacetate, acid and alkaline phosphatase activities in the soils were noticed in T<sub>10</sub>. This might be ascribed to lower organic carbon content and microbial activity in the soil.

**Table.1** Weed flora in elephant foot yam field during crop growing period

Scientific name	Common name
<b>Sedges</b>	
<i>Cyperus rotundus</i> L.	Purple nutsedge
<b>Grasses</b>	
<i>Dactyloctenium aegypticum</i> (L.) Beauv.	Crowfoot grass
<i>Digitaria sanguinalis</i> (L.) Scop.	Large crabgrass
<i>Cyanodon dactylon</i> (L.) Pers.	Bermudagrass
<i>Echinochloa crusgalli</i> Beauv.	Barnyard grass
<b>Broad leaved weeds</b>	
<i>Ageratum conyzoides</i> L.	Billgoat weed
<i>Borreria hispida</i> (L.) Schum.	Shaggy button weed
<i>Cassia occidentalis</i> L.	Coffee senna
<i>Celosia argentea</i> L.	White cockscomb
<i>Cleome viscosa</i> L.	Tick weed
<i>Commelina benghalensis</i> L.	Tropical spiderwort
<i>Convolvulus arvensis</i> L.	Field bind weed
<i>Corchorus olitorius</i> L.	Jute mallow
<i>Euphorbia hirta</i> L.	Asthma-plant
<i>Melilotus indicus</i> L.	Sweet clover
<i>Mimosa pudica</i> L.	Touch-me-not
<i>Oldenlandia corymbosa</i> L.	Diamond flower
<i>Phyllanthus niruri</i> L.	Stonebreaker weed
<i>Portulaca oleracea</i> L.	Purslane weed
<i>Trianthema portulacastrum</i> L.	Giant pigweed
<i>Tridax procumbens</i>	Coatbuttons

**Table.2** Effects of weed control method on weed biomass, weed control efficiency, yield and economics in elephant foot yam

Treatment <sup>z</sup>	Weed biomass (g m <sup>-2</sup> )	Weed control efficiency (%)	Corm yield (t ha <sup>-1</sup> )	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross income (Rs ha <sup>-1</sup> )	Profit (Rs ha <sup>-1</sup> )	Benefit cost ratio
T <sub>1</sub>	9.9** (97.2)*	58.7	20.8	183300	312500	129200	1.70
T <sub>2</sub>	10.0 (100.8)	57.2	20.3	182400	303400	121000	1.66
T <sub>3</sub>	7.5 (55.8)	76.3	24.1	187400	360600	173200	1.92
T <sub>4</sub>	7.7 (59.4)	74.8	22.7	186700	339100	152400	1.82
T <sub>5</sub>	6.7 (45.0)	80.9	27.3	204000	408800	204800	2.00
T <sub>6</sub>	6.9 (48.1)	79.6	25.5	203000	382100	179100	1.88
T <sub>7</sub>	5.9 (34.6)	85.4	31.9	206400	478600	272200	2.32
T <sub>8</sub>	7.4 (55.4)	76.5	23.5	202100	352400	150300	1.74
T <sub>9</sub>	3.1 (9.7)	95.9	34.2	225500	513000	287500	2.27
T <sub>10</sub>	3.6 (13.1)	94.5	33.4	224500	501000	276500	2.23
T <sub>11</sub>	15.3 (235.3)	-	9.7	172800	145500	(-)27300	0.84
<b>LSD (P=0.05)</b>	0.6	-	4.3	22000	65400	26400	0.24

\*The data in the parenthesis are original; \*\*√ transformed values

**Table.3** Effects of weed control method on organic carbon, microbial population and soil enzyme activities in elephant foot yam

Treatment <sup>z</sup>	Organic carbon (%)	Fungi (x10 <sup>4</sup> cfu g <sup>-1</sup> )	Bacteria (x10 <sup>5</sup> cfu g <sup>-1</sup> )	Actinomycetes (x10 <sup>4</sup> cfu g <sup>-1</sup> )	Dehydrogenase (µg TPF hr <sup>-1</sup> g <sup>-1</sup> )	Fluorescein diacetate (µg g <sup>-1</sup> hr <sup>-1</sup> )	Acid phosphatase(µg PNP g <sup>-1</sup> h <sup>-1</sup> )	Alkaline phosphatase (µg PNP g <sup>-1</sup> h <sup>-1</sup> )
<b>Initial value</b>	0.36	10	10	8	0.545	1.182	33.16	25.23
T <sub>1</sub>	0.42	27	30	27	0.789	1.324	51.31	33.74
T <sub>2</sub>	0.40	28	32	26	0.777	1.256	48.52	32.03
T <sub>3</sub>	0.42	26	26	25	0.756	1.206	47.92	32.05
T <sub>4</sub>	0.43	27	24	24	0.749	1.238	45.59	30.63
T <sub>5</sub>	0.37	28	27	25	0.732	1.318	42.28	30.39
T <sub>6</sub>	0.38	25	26	25	0.856	1.226	40.95	28.63
T <sub>7</sub>	0.48	32	36	28	0.916	1.432	66.36	42.34
T <sub>8</sub>	0.42	28	28	25	0.842	1.328	53.72	34.60
T <sub>9</sub>	0.38	26	26	25	0.702	1.246	52.10	34.22
T <sub>10</sub>	0.32	21	24	20	0.556	1.126	37.55	26.12
T <sub>11</sub>	0.44	30	32	24	0.852	1.364	51.82	41.74
<b>LSD (P=0.05)</b>	0.12	0.2	0.2	0.2	0.073	0.095	2.98	2.16

In conclusion, the PFGC controlled the weeds efficiently and resulted in greater corm yield, income and profit in elephant foot yam. The PFGC also resulted in higher soil organic carbon, microbial population and soil enzyme activities than traditional and popular 4 manual weedings at 30, 60, 90 and 120 DAP. Hence, the PFGC could be a good weed control option in elephant foot yam. This study also revealed that in large farms where initial investment on PFGC was not possible and herbicide application was acceptable in that conditions, 2 manual weeding at 30 and 60 DAP+glyphosate (at 90 DAP) might be considered as an alternative method of weed control in elephant foot yam.

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