Short communication

Weed management in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicholson]

Lekshmi Sekhar, C. George Thomas and P.V. Sindhu

College of Horticulture, KAU P.O., Kerala Agricultural University, Thrissur 680656, Kerala, India.

Received 4 June 2017; received in revised form 16 June 2017; accepted 30 June 2017

Abstract

An experiment was conducted in elephant foot yam to find out alternatives to manual weeding and to formulate an economical weeding schedule. The experiment was laid out in RBD with 10 treatments and 3 replications, and conducted at the College of Horticulture, Thrissur. Chemical and non-chemical methods of weed management were compared. Among the treatments, mulching with black polythene displayed superior growth and yield characters such as height, diameter, volume of corm, and total weight of corm from unit area. Pre emergence application of oxyfluorfen 0.2 kg ha^{-1} plus manual weeding at 75 DAP and post emergence application of glyphosate 0.8 kg ha^{-1} plus manual weeding at 75 DAP were the other better treatments. Mulching with black polythene produced higher plant dry weight throughout the crop period irrespective of the crop growth stage. The treatments, mulching with dry grasses and intercropping with cowpea were not effective in suppressing weeds to any marked level as shown by less crop dry weight and yield characters throughout the growth period.

Keywords: Black polythene, Elephant foot yam, Glyphosate, Oxyfluorfen, Weed management

Elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] is an integral part of home gardens in Kerala. Due to high production potential, productivity and high net returns, elephant foot yam is greatly popular among tropical tuber crops. In Kerala, elephant foot yam is the second most important tuber crop after cassava, and in 2015- 16, it was grown in 7143 ha (GOK, 2017).

Weed competition is an important constraint in the production of root and tuber crops owing to the initial slow growth and wider spacing. Manual weeding is the most common method of weed control practiced in elephant foot yam. Two weedings, one at 45 days and the second at 75 days followed by earthing up is recommended in Kerala (KAU, 2011). Because of the high cost of manual weeding and non-availability of labour during peak season, it is essential to find out alternative methods of weed management in elephant foot yam. In this context, the present experiment was undertaken to find out alternatives to manual weeding and to formulate an economical weeding schedule.

The experiment was conducted during the period from March 2016 to December of 2016. Corm pieces were planted in March before the onset of the south west monsoon. 'Gajendra', a local selection from Kovuur area of Andhra Pradesh was used for the study. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments and 3 replications. The plot size was 5.4 m x 4.5 m with a plant to plant spacing of 90 cm x 90 cm. The treatments were: manual weeding twice 45 and 75 DAP (days after planting) (T_1); manual weeding thrice, 45, 75, and 105 DAP (T_2); manual weeding four times, 45, 75, 105, and 135 DAP (T_3); oxyfluorfen 0.2 kg ha^{-1} and manual weeding once,

*Author for correspondences: Phone: 91-9349759355 Email: georgethomas.c@kau.in

Table 1. Dry weight of elephant foot yam at different stages as influenced by weed management treatments

Treatments		Dry weight of plant (g)		
		90 DAP	180 DAP	Harvest
T_1	Manual weeding twice, 45 and 75 DAP	149.25^{bc}	545.35^{b}	475.70^{c}
T_2	Manual weeding thrice, 45, 75, and 105 DAP	180.57^{ab}	534.54^{b}	488.25^{bc}
T_3	Manual weeding four times, 45, 75, 105, and 135 DAP	189.81^{ab}	550.90^{b}	487.47^{bc}
T_4	Oxyfluorfen 0.2 kg ha^{-1} and MW once, 75 DAP	199.20^{ab}	504.51^{b}	526.51^{ab}
T_5	Pendimethalin 1.0 kg ha^{-1} and MW once, 75 DAP	144.48^{bc}	344.40^{c}	462.50^{cd}
T_6	Glyphosate 0.8 kg ha^{-1} , 30 DAP + MW 75 DAP	154.62^{ab}	555.74^{b}	528.00^{ab}
T_7	Mulching with black polythene	211.33^{a}	661.25^{a}	553.40^{a}
T_8	Mulching with dry grasses	149.06^{bc}	286.03^{c}	308.28^{e}
T_9	Intercropping with cowpea	149.36^{bc}	301.30^{c}	421.05^{d}
T_{10}	No weeding (control)	89.23^{c}	123.66^{d}	159.30^{f}

* In a column, means followed by common letters do not differ significantly at 5% level in DMRT
**DAP- Days after planting

75 DAP (T_4); pendimethalin 1.0 kg ha^{-1} and manual weeding once, 75 DAP (T_5); directed spray of glyphosate 0.8 kg ha^{-1} 30 DAP and manual weeding once, 75 DAP (T_6); mulching with black polythene (T_7); mulching with dry grasses (T_8); intercropping with cowpea (T_9); and unweeded control (T_{10}).

Cut corm pieces weighing about 750g were used for planting. Before planting, these cut pieces were dipped in cow dung slurry and allowed to dry under shade. Manures and fertilizers were applied according to the package of practices recommendations of Kerala Agricultural University (KAU, 2011). Weed management was done as per treatments. In the plots receiving treatment with pre emergence herbicides, pendimethalin (Stomp® 30 EC) at 1.0 kg ha^{-1} and oxyfluorfen (Goal® 23.5 EC) at 0.2 kg ha^{-1}, were sprayed after the receipt of the first rain after planting. Black polythene sheet of 50 gauge was used for the mulching treatment. The crop was ready for harvest after nine months of planting when the plants turned yellow and the aerial plant parts dried out.

From each plot, five plants were selected randomly as the sampling unit for biometric observations. Plant height, pseudostem girth, length of petiole and rachis, leaf area per plant and leaf area index were worked out from the selected five plants at 90 and 180 DAP. Estimation of leaf area was done according to the method developed by Ravi et al. (2010) and the leaf area index (LAI) of the plant was worked out as stipulated by Watson (1947).

Table 2. Growth and yield characters of elephant foot yam as influenced by weed management treatments

Treatments		Leaf area (dm^2) (90DAP)	Leaf area index (90DAP)	Height of corm (cm)	Diameter of corm (cm)	Volume of corm (dm^3)	Corm yield (Mg ha^{-1})
T_1	Manual weeding twice, 45 and 75 DAP	58.30^{d}	0.72^{d}	12.00^{a}	19.71^{abc}	2.51^{bc}	26.36^{cd}
T_2	Manual weeding thrice, 45, 75, and 105 DAP	58.44^{d}	0.72^{d}	11.45^{ab}	18.01^{c}	2.27^{bcd}	27.07^{bcd}
T_3	Manual weeding four times, 45, 75, 105, and 135 DAP	59.21^{d}	0.73^{d}	12.12^{a}	20.40^{abc}	2.56^{ab}	31.13^{abc}
T_4	Oxyfluorfen 0.2 kg ha^{-1} and MW once, 75 DAP	67.12^{b}	0.82^{b}	12.11^{a}	20.62^{ab}	2.73^{ab}	33.66^{ab}
T_5	Pendimethalin 1.0 kg ha^{-1} and MW once, 75 DAP	63.11^{c}	0.77^{c}	11.38^{ab}	18.70^{bc}	2.09^{bcd}	23.78^{d}
T_6	Glyphosate 0.8 kg ha^{-1} , 30 DAP + MW 75 DAP	67.11^{b}	0.82^{b}	12.16^{a}	20.58^{ab}	2.59^{ab}	33.08^{ab}
T_7	Mulching with black polythene	83.11^{a}	1.02^{a}	12.68^{a}	21.64^{a}	3.24^{a}	35.77^{a}
T_8	Mulching with dry grasses	54.88^{e}	0.67^{e}	10.44^{bc}	18.18^{bc}	1.70^{de}	23.15^{d}
T_9	Intercropping with cowpea	49.03^{f}	0.60^{f}	10.50^{bc}	17.98^{c}	1.85^{cd}	22.25^{d}
T_{10}	No weeding (control)	40.46^{g}	0.50^{g}	9.14^{c}	14.18^{d}	1.04^{e}	15.43^{e}

*In a column, means followed by common letters do not differ significantly at 5% level in DMRT.

Table 3. Dry weight of weeds as influenced by various weed management treatments in elephant foot yam

Treatments		Dry weight of weeds m^{-2} (g)			
		45 DAP	75 DAP	105 DAP	165 DAP
T_1	Manual weeding twice, 45 and 75 DAP	14.72^{a} (218.00)	7.45^{ef} (55.86)	10.44^{b} (109.06)	19.99^{cd} (411.86)
T_2	Manual weeding thrice, 45, 75, and 105 DAP	14.22^{ab} (203.73)	5.82^{ef} (35.73)	10.36^{b} (105.6)	14.91^{e} (224.80)
T_3	Manual weeding four times, 45, 75, 105, and 135 DAP	12.86^{ab} (165.60)	6.61^{ef} (43.73)	9.18^{bc} (83.3)	9.09^{f} (82.80)
T_4	Oxyfluorfen 0.2 kg ha^{-1} and MW once, 75 DAP	6.69^{c} (44.93)	8.32^{de} (69.80)	7.38^{c} (54.13)	18.56^{d} (350.13)
T_5	Pendimethalin 1.0 kg ha^{-1} and MW once, 75 DAP	6.93^{c} (48.13)	10.42^{cd} (112.53)	9.11^{bc} (82.2)	19.64^{cd} (386.40)
T_6	Glyphosate 0.8 kg ha^{-1}, 30 DAP + MW 75 DAP	12.62^{ab} (164.13)	6.09^{ef} (37.33)	7.54^{c} (57.3)	19.23^{d} (375.73)
T_7	Mulching with black polythene	0.70^{d} (0.00)	5.60^{f} (32.00)	6.53^{c} (41.8)	14.87^{e} (223.20)
T_8	Mulching with dry grasses	12.88^{ab} (165.73)	13.16^{b} (173.60)	14.0^{ab} (195.4)	22.61 c (513.30)
T_9	Intercropping with cowpea	10.28^{bc} (133.20)	12.56^{bc} (158.80)	14.16^{ab} (207.7)	27.38^{b} (750.20)
T_{10}	No weeding (control)	14.83^{a} (221.06)	17.23^{a} (302.93)	26.77^{a} (728.22)	40.93^{a} (1677.00)

*In a column, means followed by common letters do not differ significantly at 5% level in DMRT
**Original values, "X+ 0.5 transformed values are given in paranthesis

Dry weight of elephant foot yam plants at 90 DAP, 180 DAP and at harvest were also recorded and the data on dry weight at various stages are depicted in Table 1. Irrespective of the stage of crop, black polythene mulch (T_7) produced higher plant dry weight throughout the crop. The dry weight of single plants varied from 89.23 to 211.33 g, 123.66 to 661.25 g, and 159.30 to 553.40 g at 90 DAP, 180 DAP and harvest respectively. Ravi et al. (2011) reported that biomass production of shoots (leaf and pseudostem/petiole) increased up to 150 DAP and declined thereafter, whereas corm dry weight and total dry matter production showed a steady increase up to maturity.

The height, diameter, volume and fresh weight of harvested corms from each plot were recorded separately and the corm yield per hectare was worked out (Table 2). Leaf area at 90 DAP of elephant foot yam varied from 40.46 to 83.11 dm^2. Mulching with black polythene (T_7) recorded the highest leaf area of 83.11 dm^2 followed by the application of oxyfluorfen (67.12 dm^2) and glyphosate (67.11 dm^2). Leaf area index of elephant foot yam at 90 DAP varied from 0.50 to 1.02. Black polythene mulched (T_7) plots recorded the highest leaf area index of 1.02 followed by pre emergence application of oxyfluorfen (T_4) and post emergence application of glyphosate (T_6) and both recorded leaf area index of 0.82. Walker et al. (1988) stressed the importance of canopy structure, leaf area, and light penetration in determining the interference among plant species.

The corm height at harvest varied from 9.14 cm to 12.68 cm. Black polythene mulch (T_7) recorded the highest corm height of 12.68 cm. Directed spray of glyphosate (T_6), manual weeding four times (T_3) and pre emergence application of oxyfluorfen (T_4) were the next better treatments and were on par with black polythene mulch (T_7). The treatments showed significant influence on the diameter of corm at harvest and varied from 14.18 cm to 21.64 cm.

Black polythene mulch (T_7) greatly influenced the diameter of corm followed by manual weeding, directed spray of glyphosate (T_6) and pre emergence application of oxyfluorfen (T_4). Several studies revealed that intercropping could reduce the vegetative growth of component crops (Silwana and Lucas, 2002; Thirumdasu et al., 2015). The volume of corm at harvest showed almost similar results as that of height and diameter of corm. The volume of corm ranged from 1.04 dm^3 to 3.24 dm^3. Black polythene mulch (T_7) showed its superiority over other treatments with regard to the volume of corm. Among the herbicides used, pre emergence application of oxyfluorfen (T_4) and post emergence application of glyphosate (T_6) resulted in higher corm volume than the pre emergence application of pendimethalin.

Fresh corm yield varied from 15.43 Mg ha^{-1} to 35.77 Mg ha^{-1}. Among different treatments, mulching with black polythene (T_7) significantly influenced the corm yield of elephant foot yam with the highest value being 35.77 Mg ha^{-1}. Lamont (2005) reported that mulching the soil with plastic films 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 compaction of soil and leaching of fertilizers. Pre emergence application of oxyfluorfen (T_4) and directed spray of glyphosate (T_6) showed almost similar results with on par values. It seemed that increase in frequency of manual weeding caused significant effects on fresh weight of corm. Weed interference in unweeded plots resulted in lower leaf area, which might have affected the production of necessary assimilates for tuber bulking.

Mulching with dry grasses (T_8), intercropping with cowpea (T_9) and pre emergence application of pendimethalin (T_5) were not very effective in obtaining better corm yields. It was earlier reported that live mulch with cowpea did not improve the yield of elephant foot yam, as the main crop had to compete for moisture and nutrients with the mulch crop (Abu-Rayyen and Abu-Irmaileh, 2004). Goswami and Saha (2006) reported that black polythene mulches increased the corm yield of elephant foot yam by 22.4 to 28.8 per cent over control (no mulch situation).

The dry weight and the species wise composition of weeds in each plot was recorded at 45, 75, 105 and 165 days of plant growth. From the fields, 37 species of weeds were observed including grass weeds, broad leaf weeds, and sedges. Broad leaf weeds were the most dominant weed species during the whole crop growth phase irrespective of the treatment. The major broad leaf weeds were *Borreria hispida*, *Alternanthera bettzickiana*, *Commelina benghalensis* and *Cleome viscosa*. *Digitaria ciliaris*, *Panicum maximum* and *Cynodon dactylon* were the major grass weeds and *Kyllinga monocephala* was the major sedge weed found during the crop growth period.

Significant influence of weed control methods on weed dry weight throughout the crop period was evident as seen from Table 3. Black polythene (T_7) was the best option to manage weeds in elephant foot yam fields at all growth periods. Mulching with dry grasses (T_8) and intercropping with cowpea (T_9) could not effectively manage the weeds and produced greater weed dry weight after unweeded control (T_{10}) throughout the season. Due to low canopy development during the early stages of elephant foot yam, intercropping with cowpea might not have been able to suppress the weeds and failed to provide satisfactory weed control as also reported by Dwivedi and Shrivastava (2011). The plots in which manual weeding was done were able to maintain lower weed dry weight throughout the period and manual weeding four times recorded the lowest weed dry weight at 165 DAP. Application of herbicides also limited the weed dry weight largely but pre emergence application of pendimethalin was not that effective compared to oxyfluorfen and glyphosate.

References

Abu-Rayyan, A.M. and Abu-Irmaileh, B.E. 2004. Onion development and yield in response to manual cultivation, herbicides or coloured mulches. J. Veg. Crop Prod., 10 (1): 37-49.

Dwivedi, S.K. and Shrivastava, G.K. 2011. Planting geometry and weed management for maize (*Zea mays*)-blackgram (*Vigna mungo*) intercropping system under rainfed vertisols. Indian J. Agron., 56(3): 202-208.

Government of Kerala. 2017. Agricultural Statistics 2016 (on-line).Available: http://www.ecostat.kerala.gov.in (10-1-2017).

Goswami, S.B. and Saha, S. 2006. Effect of organic and inorganic mulches on soil-moisture conservation, weed suppression and yield of elephant-foot yam (*Amorphophallus paeoniifolius*). Indian J. Agron., 51 (2): 154-156.

Kerala Agricultural University. 2011. Package of Practices Recommendations: Crops 2011. Kerala Agricultural University, Thrissur, 360p.

Lamont, W.J. 2005. Plastics: modifying the microclimate for the production of vegetable crops. Hortic. Technol., 15: 477- 481.

Ravi, V., George, J., Ravindran, C.S., Suja, G., Nedunchezhiyan, M., Byju, G. and Naskar, S.K. 2010. Method for leaf area determination in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]. J. Root Crops., 36(1): 78-82.

Ravi, V., Ravindran, C.S., Suja, G., George, J., Nedunchezhiyan, M., Byju, G. and Naskar, S.K. 2011. Crop physiology of elephant foot yam [*Amorphophallus paeoniifolius* (Dennst. Nicolson)]. Adv. Hortic. Sci., 25(1): 51-63.

Silwana, T.T. and Lucas, E.O. 2002. The effect of planting combination, weeding and yield of component crops of maize-pumpkin intercrops. J. Agric. Sci., 138: 193-200.

Thirumdasu, R., Bijayadevi, A.K. and Thokchom, M. 2015. Analysis of growth, physiological aspects and yield of elephant foot yam, *Amorphophallus campanulatus* Roxb Blume cv Gajendra in spice intercropping system under slopy foothills of Imphal East. Int. J. Farm Sci., 5(4): 118-126.

Walker, G.K., Blackshaw, R.L. and Dekker, J. 1988. Leaf area and competition for light between plant species using direct sunlight transmission. Weed Technol., 2(2): 159-165.

Watson, D.J. 1947. Comparative physiological studies in the growth of field crops. I. Variation in net assimilation rate and leaf area between species and varieties, and within and between years. Ann. Bot., 11: 41-76.