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Integrated weed management in elephant foot yam cv. Gajendra

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Abstract

The present investigation was undertaken at Shaheed Gundadhur College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Jagadalpur, Chhattisgarh during 2019 and 2020 to assess the effect of different weed management practices in *Amorphophallus* cv. Gajendra. The experiment was laid out in RBD with three replications with eightdifferent treatments based on the individual or combination of pre emergence herbicide, post emergence herbicides, hand weeding, ground cover and control. Among the treatments T_5 (Post-emergence herbicide at 30, 60 and 90 DAP) recorded the highest WCE (89.66%) followed by T_4 (Hand weeding at 45 DAP + Post-emergence herbicide at 90 DAP) 88.92%. Significantly higher yield, corm weight per plant and per hectare were recorded in T_5 treatment (Post-emergence herbicide at 30, 60 and 90 DAP) followed by T_1 (Pre-emergence herbicide (1DAP) + Post-emergence herbicide at 45 and 90 DAP).

Keywords: Elephant foot yam, weed, herbicide, yield, Economics.

Introduction

Elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.)] is a tropical tuberous vegetable crop grown in all India originated from South-East Asia. In India it is known as Suran or jimikand. In Chhattisgarh, it is cultivated in *Kharif* season for edible corms. The area and production of elephant foot yam in Chhattisgarh is 3518 ha and 40.83 lakh metric tons, respectively. Elephant foot yam is a highly nutritive vegetable (Gopalan et al*.,* 1999). Corm are cooked as vegetables, boiled or baked. Even the stem portion of the plant is used for preparing *badi* in Chhattisgarh, avalue added product of *colocasia* stem mixed with black lentilwhich can be stored in dried form. Because of its medicinal properties,corm is used in curing piles, dysentery, and acute rheumatism. Elephant foot yam, being a *Kharif* and long duration crop is liable to be highly infested with weeds which is extremely hazardous both in terms of crop health as well as productivity. It has been well established that the yield loss due to weeds is quite higher (45%) than the pests (30%) and diseases (20%) (Nedunchezhiyan et al., 2018). Sometimes weed roots penetrate into the underground storage organs of tuber crops and reduce the quality of produce (Suresh et al., 2019). Weeds compete for all available resources both below (water, nutrients, space) and above ground (space, light) and thereby reduce the crop growth and yield (Suresh et al., 2020). Yield losses of crops because of weed competition are estimated to be 40-90% in cereals, 50-60% in legumes, 50-53% in oilseeds, and 65-91% in root and tuber crops (Ado, 2007). Manual weeding in a crop is a labour-intensive process and other cultural practices are also affected. There is a need for technologies to make hand weeding more efficient to achieve acceptable weed control in

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production fields. Improvement in chemical control of weeds and the introduction of new weed management technologies to reduce cost of production is very much needed in elephant foot yam as it is a commercial tuber crop growing all over Chhattisgarh state. In this regard, present study was undertaken to find out the most efficient and economic integrated weed management practices in Elephant Foot Yam.

Materials and Methods

An experiment was carried out at the experimental field of All India Coordinated Research Project on Tuber Crops (AICRP TC), Saheed Gundadhur College of Agriculture and Research Station, Jagdalpur, during *Kharif* 2019 and 2020. The experiment was laid out in a randomized block design with three replications and eight treatments *viz*., T_1: Pre-emergence herbicide (Pendimethalin 30% EC) 1 day after planting (DAP) + Post emergence herbicide (Glyphosate 41% SL) at 45 and 90 DAP, T_2:Pre-emergence herbicide (1DAP) + hand weeding at 45 and 90 DAP, T_3:Raising green manure crop pea in interspaces along with planting and incorporation 45-60 DAP+Post emergence herbicide at 90 DAP, T_4: Hand weeding at 45 DAP + Post emergence herbicide at 90 DAP, T_5: Post emergence herbicide at 30, 60 and 90 DAP, T_6: Weed control ground cover, T_7: Hand weeding at 30, 60 and 90 DAP and T_8:Control no weeding. Planting distance for row to row and plant to plant was kept as 90×90 cm in a plot size of 4.5×4.5 m. The healthy cut corm pieces or whole corms of the *Amorphophallus* variety, 'Gajendra', weighing 500 g andtreated with Bavistin (fungicide 2.5 g @ per litre of water) before plantingwere used as planting materials. Pendimethalin used as pre-emergence herbicide and was applied oneday after the plantingof corms in optimal soil moisture condition. Glyphosate was used as post-emergence herbicide and applied in the plots asper treatments. To protect the main crop, herbicides were applied without drifton elephant foot yam plants with a manually operatedknapsack sprayer with a flat-fan nozzle attached to ahood using a spray volume of 500 lit ha^{-1}. Paddy straw was used as weedcontrol ground cover and immediately covered after planting.

All the recommended cultural practices were taken to grow a healthy crop. Data were recorded on five randomly selected plants with respect to characters *viz*., plant height (3 months after planting (MAP) & 5 MAP), girth of pseudo stem (3 MAP & 5 MAP), canopy Spread (3 MAP & 5 MAP), leaf area (3 MAP & 5 MAP), total yield, yield per plant, weed density, weed control efficiency, and dry weight. The data were recorded for growth, yield and economics and statistically analyzed. Weed control efficiency (WCE) was calculated on the basis of dry matter production of weeds. Analysis of variance was done as per Panse and Sukhtme (1967). As per the design of experiment, thedata on plant growth and weed parameters over the year were pooled and analyzed using PB tools, IRRI. Treatment means were compared using Turkey's studentized range (HSD) at 5% probabilities.

Results and Discussion

The analysis of variance revealed that all the characters measured were significantly different under the treatments (Table 1). During both the seasonsthe weed species were recorded (Table 2). Among broad leaves weeds *Spilanthes acmella*, *Celosia argentea, Commelina benghalensis*, *Euphorbia geniculata* were the major weeds. Grasses and sedges such as *Setaria gluaca, Cyperus rotundus, Digitaria sangunalis, Eleusine indica*, and *Echinochloa colona* were also dominant in the experimental plot.

Table 1. Analysis of variance for tuber yield and other characters of elephant foot yam

Sl. No.	Character	Mean Sums of Square		
		Replication	Treatment	Error
1	Plant height (cm) 3 MAP	1.5126	166.59**	7.84
2	Plant height (cm) 5 MAP	20.22	265.91**	6.15
3	Canopy Spread (cm) 3 MAP	9.60	106.05**	12.25
4	Canopy Spread (cm) 5 MAP	11.63	97.28**	10.12
5	Leaf area $(cm)^2$ 3 MAP	1155659.35	19775789.11**	4152209.95
6	Leaf area $(cm)^2$ 5 MAP	3008326.86	29173374.23**	6216478.04
7	Girth of Pseudo stem (cm) 3 MAP	0.98	3.80*	0.42
8	Girth of Pseudo stem (cm) 5 MAP	2.70	4.18*	0.46
9	Weed Density	0.10	1002.06**	0.84
10	Weed control efficiency	3.54	2668.50**	2.08
11	Dry Weight	6.63	3123.89**	23.45
12	Corm yield (t ha^{-1})	37.15	50.99**	4.30

*Significant at 5%; **Significant at 1%; MAP: Months after planting

Table 2. Weed Flora observed during 2018-19 and 2019-20 in the elephant food yam experimental field

Sl. No.	Weed Species	Weeds name
1	Broad leaved weed	Spilanthes acmella, Celosia argentea, Commelina benghalensis, Euphorbia geniculata.
2	Grasses and Sedges Weed	Setaria gluaca, Cyperus rotundus, Digitaria sangunalis, Eleusine indica, Echinochloa colona and others

Minimum weed density and dry weight were recorded in the treatment T_5 with post emergence herbicide (glyphosate) at 30, 60 and 90 DAP followed by the treatment T_2 *i.e.*, pre-emergence herbicide (1DAP) + hand weeding at 45 and 90 DAP. Herbicide application at specific intervals did not allow the weeds to emerge. Among the eight different treatments of weed management, the weed control efficiency ranged from 73.76-89.66 % (Table 3). The maximum WCE of 89.66% was observed in the treatment T_5, *i.e.*, post emergence herbicide (Glyphosate) at 30, 60 and 90 DAP (89.66 %), followed by T_4, (WCE-88.92%), *i.e.*, raising green manure cow pea in inter space along with planting and incorporation at 45-60 DAP followed by glyphosate application at 90 DAP because of the lower weed density. The weed density and dry weight of the weed were maximum in the weedy check (control) (Table 3). Singh et al., (2020) also reported that maximum WCE was seen in EFY when glyphosate was applied, or hand weeding was done. Singh et al., (2018) observed that combination of pre and post emergence application of herbicide was effective for reducing the number of weeds as compared to the control. Similar results were also reported by Sekhar et al., (2017) and Singh et al., (2020) in elephant foot yam.

Plant growth parameters such as plant height, leaf area, girth of pseudo stem and canopy spread were significantly influenced by the different weed control treatments (Tab. 4). All the treatments resulted in significantly taller plants, maximum leaf area, wide girth of pseudo stem and canopy spread than the control. Among all the treatments, at 3 MAP, maximum plant heightof 83.11 cm was recorded with weed control ground cover with paddy straw (T_6) followed by post emergence at 30, 60 and 90 DAP (T_5) with the height of 81.23 cm. The maximum leaf area and girth of pseudo stem were recorded with pre-emergence herbicide (Pendimethaline 30% EC) 1 DAP followed by glyphosate application at 45 and 90 DAP (T_1). Maximum canopy spread was recorded with pre- emergence herbicide (1 DAP) followed by hand weeding at 45 and 90 DAP (T_2). Briefly, in the initial crop growth stage, the four treatments, *viz.*, weed control ground cover with paddy straw, application of

Table 3. Effect of treatments on weed density, dry weight and weed control efficiency of elephant foot yam cv. Gajendra (pooled analysis of 2018-19 and 2019-20)

Treatment		Weed Density [No. $(m^2)^{-1}$]	Dry Weight [g $(m^2)^{-1}$]	Weed control efficiency (%)
T_1:	Pre-emergence herbicide (1DAP)+Post-emergence herbicide at 45 and 90 DAP	15.09^{b}	29.66^{b}	85.77^{a}
T2:	Pre-emergence herbicide (1DAP)+hand weeding at 45 and 90 DAP	7.42^{ef}	7.54^{c}	85.63^{a}
T3:	Raising green manure crop pea in interspaces along with planting and incorporation 45-60 DAP+Post-emergence herbicide at 90 DAP	10.47^{cd}	9.26^{c}	75.52^{bc}
T4:	Hand weeding at 45 DAP+Post-emergence herbicide at 90 DAP	8.52^{def}	30.25^{b}	88.92^{a}
T5:	Post-emergence herbicide at 30, 60 and 90 DAP	6.48^{f}	8.87^{c}	89.66^{a}
T6:	Weed control ground cover (Paddy straw)	12.80^{bc}	37.50^{b}	79.35^{b}
T7:	Hand weeding at 30, 60 and 90 DAP	9.47^{de}	10.16^{c}	73.76^{c}
T8:	Control (No weeding)	61.11^{a}	103.88^{a}	0.00^{d}
	HSD (α=0.05)	2.64	13.95	4.15
	CV (%)	5.59	16.34	1.99

* Values in each column with the same alphabets in the superscripts do not differ significantly

post-emergence herbicide thrice at 30, 60 and 90 DAP, pre-emergence herbicide (Pendimethaline 30% EC) 1 DAP followed by glyphosate at 45 and 90 DAP and pre-emergence herbicide (1 DAP) followed by hand weeding at 45 and 90 DAP suppressed weed growth and gave similar effect. Similar report observed by Singh et al., (2020) and Sekhar et al., (2020) in elephant foot yam.

At five months after planting, maximum plant height and leaf area were observed with weed control ground cover with paddy straw (T_6). Similar findings were also observed by Sekhar et al*.,* (2017) when black polythene mulch was used whereyield characters such as height, diameter, volume of corm increased. Girth of pseudo stem recorded maximum with post-emergence herbicide at 30, 60 and 90 DAP (T_5). The canopy spread was highest with pre-emergence herbicide (1 DAP) followed by hand weeding at 45 and 90 DAP (T2) (Table 4).

Yield was directly influenced by crop growth and crop growth of EFY was influenced by different treatments. Lower corm yield was recorded with weedy check (25.22 t ha^{-1}) as no control measure were adopted to controlthe weed in this treatment. Treatment with post-emergence herbicide at 30, 60 and 90 DAP has given higher yield (38.12 t ha^{-1}) which was at par with pre-emergence herbicide 1 DAP followed by glyphosate at 45 and 90 DAP (Table 5). This could be due to the high

Table 4. Plant growth parameters as affectedby integrated weed management treatments in elephant foot yam cv. Gajendra (pooled analysis of 2018-19 and 2019-20)

Treatment	Plant height (cm)		Leaf area $(cm)^2$		Girth of Pseudo stem (cm)		Canopy Spread (cm)	
	3 MAP	5 MAP	3 MAP	5 MAP	3 MAP	5 MAP	3 MAP	5 MAP
T_1	78.80^{ab}	86.03^{bc}	11086.15^{a}	12760.05^{ab}	11.93^{a}	14.19^{ab}	91.56^{abc}	102.92^{ab}
T_2	63.48^{d}	71.48^{d}	9330.89^{ab}	10475.49^{abc}	10.86^{abc}	13.51^{abc}	96.71^{a}	107.33^{a}
T_3	66.93^{cd}	73.16^{d}	9454.55^{ab}	10348.81^{abc}	9.48^{c}	12.09^{c}	80.00^{d}	91.73^{c}
T_4	73.83^{bc}	81.58^{c}	7451.12^{abc}	9191.08^{abc}	9.17^{c}	11.67^{c}	82.36^{cd}	93.05^{c}
T_5	81.23^{ab}	92.15^{ab}	8121.40^{abc}	9423.91^{abc}	11.75^{ab}	14.75^{a}	93.34^{ab}	103.28^{ab}
T_6	83.11^{a}	94.48^{a}	8780.03^{abc}	13534.12^{a}	9.89^{bc}	12.52^{bc}	82.74^{cd}	93.70^{c}
T_7	73.53^{bc}	80.43^{c}	4991.50^{bc}	6001.82^{bc}	9.38^{c}	12.37^{bc}	90.05^{abcd}	100.78^{abc}
T_8	65.42^{d}	69.31^{d}	3196.70^{c}	4288.60^{c}	9.36^{c}	11.57^{c}	86.33^{bcd}	96.73^{bc}
HSD (α=0.05)	8.06	7.14	5870.90	7183.52	1.86	1.96	10.08	9.16
CV (%)	3.81	3.06	26.12	26.24	6.32	5.30	3.60	3.22

*MAP: Months after planting

** Values in each column with the same alphabets in the superscripts do not differ significantly

Table 5. Yield and economics of elephant foot yam under different weed management treatments (pooled analysis of 2018-19 and 2019-20)

Treatment	Corm yield (t ha^{-1})	Gross return	Net return	B:C Ratio
T_1	36.89^{ab}	737800	454351	2.60
T_2	29.42^{cd}	588400	304711	2.07
T_3	30.11^{cd}	602200	317351	2.11
T_4	31.76^{bc}	635200	351511	2.24
T_5	38.12^{a}	762400	478391	2.68
T_6	32.57^{abc}	651400	369691	2.31
T_7	30.91^{cd}	618200	332851	2.17
T_8	25.22^{d}	504400	223701	1.80
HSD(α=0.05)	5.97	-	-	-
CV (%)	6.51	-	-	-

weed control efficiency and lower weed density that boosted crop growth and yield attributes and resulted in higher corm yield. Sekhar et al*.,* (2017) reported best weed management practices in elephant foot yam was mulching with black polythene and otherbetter treatments were combination of pre-emergence application of oxyfluorfen 0.2 kg ha^{-1} + manual weeding at 75 DAP or post-emergence application of glyphosate 0.8 kg ha^{-1} + manual weeding at 75 DAP.

Among all the different weed management practices adopted, significantly maximum B:C ratio was recorded with post-emergence herbicide at 30, 60 and 90 DAP with maximum gross return and net return. It was followed by pre-emergence herbicide 1 DAP followed by glyphosate at 45 and 90 DAP, due to higher corm yield and saving of labour wages in comparison to hand weeding. A maximum B:C ratio was reported in hand weeding at 30, 60 and 90 DAP with maximum corm yield of 41.54 t ha^{-1} (Singh et al*.,* 2020). In another study, the B:C ratio was highest when pendimethilin + Quizalofop-p-ethyl at 40 DAS was used to control weeds (Singh et al*.,* 2018).

Conclusion

The application of pre-emergence and post-emergence herbicide in wide spaced crops like elephant foot yam is an efficient and economic method for weed control and it also saves time. It may be used as an alternative way of weed control where labour availabilityfor agricultural operationsis a problem.

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