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Integrated weed management in elephant foot yam

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Abstract

The experiment was conducted at Krishi Vigyan Kendra, Bilaspur during 2017-18 and 2018-19 to find out alternatives to manual weeding in elephant foot yam. The manual weeding and herbicides alone and in combinations were tried. The results revealed that pre emergence application of alachlor @1.00 kg a.i./ha along with hand weeding after 60 days of planting is the most effective and economic treatment for weed management and getting highest return in elephant foot yam variety 'Palam Zimikand-1' under low hill condition of Himachal Pradesh.

Key words: Elephant foot yam, weed management, weed density, corm yield, economics.

Elephant foot yam [(*Amorphophallus paeoniifolius* (Dennst.) Nicolson)], locally called zimikand, is successfully grown from sea level up to 1800 m (Thangam *et al*., 2013). The optimum temperature for its successful cultivation is between 25 and 35 ^{0}C. It cannot tolerate frost and growth is affected adversely at temperature below 20^{o}C. Well distributed rainfall and warm climate during the growing season promotes vegetative growth and corm bulking (Singh *et al*., 2012). In Himachal Pradesh, elephant foot yam is gaining popularity as *kharif* crop in low and mid hill conditions. Since it is planted in the rainy season, its yield potential is seriously affected by weeds, owing to the slow initial canopy growth. Manual weeding is commonly practiced in elephant foot yam. Generally, one hand weeding followed by earthing up is practiced by most of the farmers of the state. But the high cost of manual weeding and non- availability of labour during peak season necessitates to find out an alternative methods of weed management in elephant foot yam (Singh *et al.,* 2014). Chemical method of weed control is an effective and economical as compared to mechanical method. The pre-emergence application of herbicides is common in vegetables like pea. However, the major requrement for the use of pre-emergence herbicide is the optimum soil moisture either through irrigation or rainfall (Rana *et al*., 2013; Mawalia *et al*., 2015). In this context, the present experiment was undertaken to find out an alternatives to manual weeding and to formulate an economical weeding schedule.

Materials and Methods

The present investigation was carried out at the Experimental Farm of Krishi Vigyan Kendra, Bilaspur, Himachal Pradesh for two consecutive kharif seasons of 2017-18 and 2018-19. The treatments were pendimethalin @ 1.5 kg a.i./ha, pendimethalin @ 1.0 kg a.i./ha, pendimethalin @ 1.0 kg a.i./ha + hand weeding (HW) 60 days after planting (DAP), alachlor @ 1.5 kg a.i./ha, alachlor @ 1.0 kg a.i./ha, alachlor @ 1.0 kg a.i./ha + HW 60 DAP, grass mulch , manual weeding twice 45 and 75 DAP, weed free and weedy check. The pre emergence herbicidal application was made within 48 hours of planting and hand weeding was done as per the treatment. The experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. The plot size was 2.5mx2.5 m with a plant to plant spacing of 75cmx75cm.

The planting of seed corms of 'Palam Zimikand-1' variety, weighing 250 g was done during first fortnight of June, before the onset of south west monsoon. All other cultivation practices were followed according to the recommended package of practices of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (Anon, 2018).The crop was ready for harvest after seven months of planting when the plants turned yellow and the aerial plant parts dried out. From each plot, five

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plants were selected randomly as the sample unit. The observations were recorded on weed density, dry weight of weeds, weed control efficiency, plant height, pseudo stem girth, canopy spread, corm yield and economics of different treatments. The weed density was recorded one month before crop harvest by counting number of weeds per quadrate i.e. one meter square area. After counting weeds, the fresh weight per quadrate was taken from each treatment and then sun dried. Sun dried samples were then oven dried at a constant temperature of 60°C till constant weight of sample arrived. The weight recorded at this stage was dry weight of weeds. The analysis of data was done following standard statistical procedures (Gomez and Gomez, 1984). The weed control efficiency, worked out as under:

$$\text{Weed control efficiency (\%)} = \frac{\text{Dry wt. of weed in unweeded plot} - \text{Dry wt. of weeds in treated plot}}{\text{Dry weight of weeds in unweeded plot}} \times 100$$

Net return = Gross return - Cost of cultivation

$$\text{B: C} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Results and Discussion

Effect of weeds: During both the years of investigation, the pre dominating weed flora in elephant foot yam crop were *Anagallis arvensis, Commelina benghalensis, Amaranthus viridis*, *Cyanodon dactylon, Cyperus rotundus.* The weed control treatments brought about significant variation in total weed control and all the treatments were significantly superior to weedy check in reducing weed density (Kumar *et al*., 2019, Nedunchezhiyan *et al*., 2013 and 2018). It was significantly lowest in treatment comprising of alachlor @ 1.0 kg a.i. per ha + HW 60 DAP followed by pendimethalin application @ 1.0 kg a.i./ha + HW 60 DAP and weed free treatment during both the years of investigation (Table1). Similar trend was observed when the data were pooled over two years. The dry weight of weeds was lowest in weed free treatment followed by alachlor @ 1.0 kg a.i. per ha + HW 60 DAP and pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP during both the years. In treatment comprising grass mulch recorded 78.7 g/m^2 as dry weight of weeds because some of the weeds like *Cyperus rotundus* cannot be suppressed by mulch material, whereas, in manual weeding twice 45 and 75 DAP, the dry weight of weeds was less, it is due to the fact that weeds appear at later stage of crop growth and have less biomass (Singh *et al.,* 2018; Sekhar *et al*., 2017). It was also observed that weed density and dry weight of weeds was also there in hand weeding and weed free treatments but they have not competed with the crop for space, light and nutrients as they emerged at later stage of crop growth and have established shallow root system (Singh *et al*., 2014 and Saravaiya *et al*., 2010). The weed control efficiency was highest in weed free treatment (89.3%) followed by alachlor at 1.0 kg a.i./ha + HW 60 DAP (88.7 %) and pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP (88.7 %).

Effect on crop: It is observed from pooled data of table 2 that the plant height, pseudo stem girth and canopy spread of elephant foot yam variety 'Palam Zimikand-1' were highest in weed free treatment (110.7 cm, 22.7 cm, 100 cm) followed by manual weeding at 45 and 75 DAP (104.0 cm, 20.5 cm, 92.0 cm) and alachlor application @ 1.0 kg a.i./ha + HW 60 DAP (101 cm, 19.6 cm, 78.5 cm), whereas, they were lowest in weedy check treatment (72.7 cm, 13.5 cm, 59.1 cm). It was due to the fact that manual weeding keep the crop weed free and there was least crop weed competition for space, light, nutrients and water. In treatment comprising alachlor application @ 1.0 kg a.i./ha + HW 60 DAP, keep the crop weed free at early stage of crop growth and further hand weeding after 60 days of planting prevents compactness of soil and roots get proper aeration. During 2017-18, the corm yield per plant was highest in alachlor application @ 1.0 kg a.i./ha + HW 60 DAP (2.8 kg) which was statistically at par with pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP (2.7 kg/plant) followed by weed free treatment, whereas, during 2018-19, it was highest in alachlor at the rate of 1.5 kg a.i./ha (3.5 kg/plant) statistically at par with alachlor @ 1.0 kg a.i./ha + HW 60 DAP (3.4 kg/plant). The pooled data for corm yield per plant showed highest yield in treatment comprising of alachlor application @ 1.0 kg a.i./ha + HW 60 DAP (3.1 kg/plant) which was statistically at par with alachlor at 1.5 kg a.i./ha (3.0 kg/plant) followed by pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP (2.8 kg/plant), weed free treatment (2.7 kg/plant) and alachlor application @ 1.0 kg a.i./ha (2.7 kg/plant). The pooled data for corm yield per hectare showed highest yield in alachlor treatment @ 1.0 kg a.i./ha + HW 60 DAP (442.8 q/ha) followed by alachlor at 1.5 kg a.i./ha (428.6 kg/ha), pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP (399.9 kg/ha), alachlor application @ 1.0 kg a.i./ha (385.7 kg/ha) and weed free treatment (385.7 kg/ha), whereas, it was lowest in weedy check treatment i.e. 242.8 kg/ha.

Economics: Among all the treatments, the highest yield was recorded in treatment comprising of alachlor @ 1.0 kg a.i./ha + HW 60 DAP, whereas, the cost of

Table1. Influence of various weed management treatments on weed dynamics of elephant foot yam

Treatment	Weed density (No. per m^2)*			Dry weight of weeds (g/m^2)			Weed control efficiency (%)
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	
Pendimethalin @ 1.5 kg a.i./ha	50.5	52.5	51.7	20.8	23.0	20.7	87.2
Pendimethalin @ 1.0 kg a.i./ha	51.0	53.0	52.2	21.2	23.0	20.9	87.1
Pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP	42.4	45.0	43.9	18.0	21.0	18.3	88.7
Alachlor @ 1.5 kg a.i./ha	48.0	48.8	48.6	21.6	23.0	21.1	86.9
Alachlor @ 1.0 kg a.i./ha	47.4	52.0	49.9	22.5	25.0	22.3	86.2
Alachlor @1.0 kg a.i./ha + HW 60 DAP	41.0	44.0	42.9	18.0	20.9	18.3	88.7
Grass mulch	168.8	176.8	172.5	78.8	81.0	78.7	51.4
Manual weeding 45 & 75 DAP	137.4	142.0	139.9	34.7	36.9	34.2	78.9
Weed free	42.6	45.0	44.2	17.5	19.6	17.4	89.3
Weedy check	496.6	501.6	499.3	161.5	164.8	161.9	-
CD (P = 0.05)	26.2	29.0	31.5	0.1	0.1	0.1	-

* Recorded one month before harvest, HW = Hand weeding, DAP = Days after planting, Herbicidal application as pre-emergence

cultivation was highest in weed free treatment followed by manual weeding at 45 and 75 DAP and alachlor @ 1.0 kg a.i./ha + HW 60 DAP (Table 3). But the gross return was highest in alachlor @ 1.0 kg a.i./ha + HW 60 DAP (INR664252/ha) followed by alachlor application @ 1.5 kg a.i./ha and pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP. It was due to the fact that manual weeding in weed free treatment and two hand weeding at 45 and 75 DAP, add to cost of cultivation as a result the gross return was less. Similarly, the net return and B:C ratio were highest in alachlor @ 1.0 kg a.i./ha + HW 60 DAP (INR408252/ha, 2.59) followed by alachlor @ 1.5 kg a.i./ha (INR390225/ha, 2.54), pendimethalin application @ 1.0 kg a.i./ha + HW 60 DAP (INR344250/ha, 2.35) and alachlor @ 1.0 kg a.i./ha (INR327550/ha, 2.30).

From the above investigation, it is concluded that elephant foot yam crop was heavily infested by weeds as it has to undergo rainy season during its vegetative growth period. Hand weeding treatments may be weed free or two weeding, increases the cost of cultivation of crop. So pre emergence application of alachlor with hand weeding after 60 days of planting is the most effective and economic treatment for weed management and getting highest return in elephant foot yam variety 'Palam Zimikand-1' under low hill condition of Himachal Pradesh.

Conflict of interest: There is no conflict of interest among the authors.

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

Treatment	Plant height (cm)			Pseudo stem girth (cm)			Canopy spread (cm)			Corm yield/ plant (kg)			Corm yield (q/ha)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
Pendimethalin @ 1.5 kg a.i./ha	93.6	98.0	95.8	17.6	20.0	18.8	70.0	76.0	73.0	2.4	2.8	2.6	342.8	400.1	371.4
Pendimethalin @ 1.0 kg a.i./ha	93.0	97.0	95.1	16.4	20.8	18.0	69.1	75.0	72.1	2.1	2.9	2.5	300.0	414.3	357.1
Pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP	94.0	100.0	97.0	17.0	21.0	19.0	74.5	77.5	76.0	2.7	2.9	2.8	385.7	414.3	399.9
Alachlor @ 1.5 kg a.i./ha	97.0	102.0	99.5	17.8	21.0	19.4	73.4	79.0	76.2	2.5	3.5	3.0	357.1	500.0	428.6
Alachlor @ 1.0 kg a.i./ha	97.4	102.0	99.7	17.4	21.2	19.3	74.4	79.2	76.8	2.4	3.0	2.7	342.8	428.6	385.7
Alachlor @ 1.0 kg a.i./ha + HW 60 DAP	98.0	104.0	101.0	18.2	21.2	19.6	76.8	80.2	78.5	2.8	3.4	3.1	400.1	485.7	442.8
Grass mulch	97.4	104.9	100.0	17.2	21.0	19.2	74.0	78.0	76.0	2.0	2.4	2.2	285.7	342.8	314.3
Manual weeding 45 & 75 DAP	101.0	107.0	104.0	18.8	22.2	20.5	89.0	95.0	92.0	2.4	2.6	2.5	342.8	371.4	357.1
Weed free	108.2	113.2	110.7	20.5	24.8	22.7	98.0	102.0	100.0	2.6	2.8	2.7	371.4	400.1	385.7
Weedy check	70.4	75.0	72.7	11.5	15.5	13.5	56.1	62.1	59.1	1.5	1.9	1.7	214.3	271.4	242.8
CD (P = 0.05)	0.21	0.28	0.30	0.10	0.11	0.12	0.10	0.12	0.13	0.21	0.22	0.24	27.2	31.5	33.6

Table 3. Economics of elephant foot yam as influenced by weed management treatments

Treatment	Corm yield (q/ha)	Cost of cultivation (INR)	Gross return (INR)	Net return (INR)	B:C
Pendimethalin @1.5 kg a.i./ha	371.4	252000	557115	305115	2.21
Pendimethalin @ 1.0 kg a.i./ha	357.1	250600	535687	285087	2.14
Pendimethalin @ 1.0 kg a.i./ha + HW 60 DAP	399.9	255600	599850	344250	2.35
Alachlor @ 1.5 kg a.i./ha	428.6	252600	642825	390225	2.54
Alachlor @ 1.0 kg a.i./ha	385.7	251000	578550	327550	2.30
Alachlor @1.0 kg a.i./ha + HW 60 DAP	442.8	256000	664252	408252	2.59
Grass mulch	314.3	254300	471405	217105	1.85
Manual weeding 45 & 75 DAP	357.1	256800	535688	278888	2.09
Weed free	385.7	266800	578550	311750	2.17
Weedy check	242.8	246800	364200	107400	1.48
CD (P = 0.05)	33.6	-	-	-	-

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