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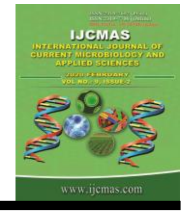

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Climatic Effect on Weed Management Practices in Elephant Foot Yam under High Rainfall Sub-Humid Zone

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A B S T R A C T

A field experiment was conducted during 2016 and 2017 at the Regional Centre of Indian Council of Agricultural Research-Central Tuber Crops Research Institute, Bhubaneswar, Odisha to study the effect of climate on weed management practices in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]. Higher average monthly maximum temperature was noticed during early crop growth period (vegetative phase) in 2017 compared to 2016. The mean minimum temperature was higher during the cropping period of 2017 compared to 2016. During 2017, *Celosia argentea* was observed more number and grown more vigourously compared to 2016. The weed biomass was higher during the year 2017 compared to 2016 in all weed management treatments. Higher average monthly maximum and minimum temperatures during early crop growth period (vegetative phase) favoured for more number of weeds to grow vigourously during 2017. The effect of weather was noticed more in pre (1 DAP) and post emergence (45 DAP) herbicide application treatments and weedy check. During 2016 recorded higher corm yield than 2017 irrespective of weed management practices. The weedy check treatment resulted in lower corm yield in 2017 than 2016. It can be concluded that higher rainfall and average monthly maximum temperature during crop growing period led to lower herbicide efficacy or weed management efficiency under high rainfall sub-humid zone.

Introduction

Elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] is a starchy tuber crop. Its modified underground stem 'corm' is consumed as vegetable. The corm is used in preparation of various cuisines and reported to have medicinal properties (Misra *et al*., 2002; Dey *et al*., 2010). The corms 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 (a flavonoid) from corms.

Weeds are potentially a major constraint on crop production. In humid and sub-humid tropics, weeds are major pests where adequate rainfall, temperature, and humidity favour their growth (Melifonwu, 1994). They compete with crops for natural and applied resources and are responsible for reducing quantity and quality of agricultural products (Rao *et al*., 2015). Elephant foot yam is susceptible to weed growth throughout the crop growth period because of little coverage by the leaf canopy.

Weeds often germinate and grow earlier than the elephant foot yam because of slow sprouting of corm setts (Nedunchezhiyan *et al*., 2018). Elephant foot yam is planted at wider spacing because of the canopy orientation (erect single pseudo stem with umbrella shaped canopy spread).

Weed infestation at early stage of the crop development causes severe yield reduction; up to 100% in wide spaced plantings. Weeds in elephant foot yam compete for water, nutrients, light and space below and above ground, and inhibit growth and development of the crop. Manual weeding is expensive, tedious and time consuming. Application of herbicides for weed control at pre- or post-emergence can reduce dependency on manual weeding and reduce cost per weeding.

Currently very few herbicides are available for weed control, and most provide a narrow weed control spectrum (Patel *et al*., 2006). Information on suitable weed control for elephant foot yam in high rainfall area is not available. The investigation was therefore undertaken to study the effects of weed management practices on the yield of elephant foot yam in high rainfall areas.

Materials and Methods

A field experiment was conducted at the Regional Centre of Indian Council of Agricultural Research-Central Tuber Crops Research Institute (20º 14' 50" N and 85º 47' 06" E), Bhubaneswar, Odisha 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 arranged with 3 replications in a randomized complete block design. Treatments consisted of: T_1 - Pendimethalin @ 1000 g/ha [1 day after planting (DAP)]+Glyphosate @ 2000 g/ha (at 90 DAP); T_2 - Metribuzin @ 525 g/ha (at 1 DAP)+Glyphosate @ 2000 g/ha (at 90 DAP), T_3 - Pendimethalin @ 1000 g/ha (at 1 DAP)+tank mix of Pyrithiobac sodium @ 62.5 g/ha and Propiquizafop @ 62.5 g/ha (at 90 DAP), T_4 -Metribuzin @ 525 g/ha (at 1 DAP)+tank mix of Pyrithiobac sodium @ 62.5 g/ha and Propiquizafop @ 62.5 g/ha (at 90 DAP), T_5 - Pendimethalin @ 1000 g/ha (at 1 DAP)+2 manual weedings (at 60 and 90 DAP), T_6 - Metribuzin @ 525 g/ha (at 1 DAP)+2 manual weedings (at 60 and 90 DAP), T_7 - 2 manual weedings (at 30 and 60 DAP)+Glyphosate @ 2000 g/ha (at 90 DAP), T_8 - 2 manual weedings (at 30 and 60 DAP)+tank mix Pyrithiobac sodium @ 62.5

g/ha and Propiquizafop @ 62.5 g/ha (at 90 DAP), T_9 – Weed control ground cover (WCGC), T_{10} - 4 manual weedings (at 30, 60, 90 and 120 DAP), and T_{11} - Control (weedy check). Farmyard manure @ 10 t/ha was uniformly incorporated before levelling in all treatments and ridges were formed at the spacing of 90 cm.

Healthy whole corm of elephant foot yam, cv. Gajendra, weighing 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 pyrithiobac sodium and propiquizafop, were applied directly on weeds. 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 using a spray volume of 500 L/ha of water. The WCGC is a polypropylene woven fabric (100 g/m^2) which allows air and water to pass through to the soil, but suppresses weed growth.

The ground cover 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 fertilizers @ 120-60-120 kg/ha of N-P_2O_5-K_2O was applied. The crop was planted 1st May and harvested 31 December both the years.

Weeds were removed from 2 locations each measuring 50×50 cm 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.

Data on weeds were subjected to square root transformation before statistical analysis. Data were analyzed using SAS (ver. 11.0, SAS Inc., Cary, NC). The data were subjected to analysis of variance. Treatment means were separated with least significant difference (LSD) (Gomez and Gomez, 1984).

Results and Discussion

During the cropping period, though there was no difference in mean maximum temperature (32.8°C), but average monthly maximum temperature was varied between months in the year 2016 and 2017 (Table 1). Higher average monthly maximum temperature was noticed during early crop growth period (vegetative phase) in 2017 compared to 2016, whereas lower average monthly maximum temperature was observed during late crop growth period (maturity phase) in 2017 compared to 2016.

The average monthly maximum temperature ranged 30.1-38.8°C and 28.2-38.8°C during cropping period of 2016 and 2017, respectively (Table 1). The mean minimum temperature was higher during the cropping period of 2017 compared to 2016. The average monthly minimum temperature was between 15.2 and 26.4°C in 2016, and between 14.4 and 27.3°C in 2017.

A total rainfall of 1529.2 mm was received during the cropping period of 2017, whereas 1241.0 mm in 2016 (Table 1). Mean relative humidity was 76.3% in 2016 and 76.1% in 2017. The evaporation was relatively higher in 2016 (1005.9 mm) compared to 2017 (989.8 mm) during the cropping period (Table 1).

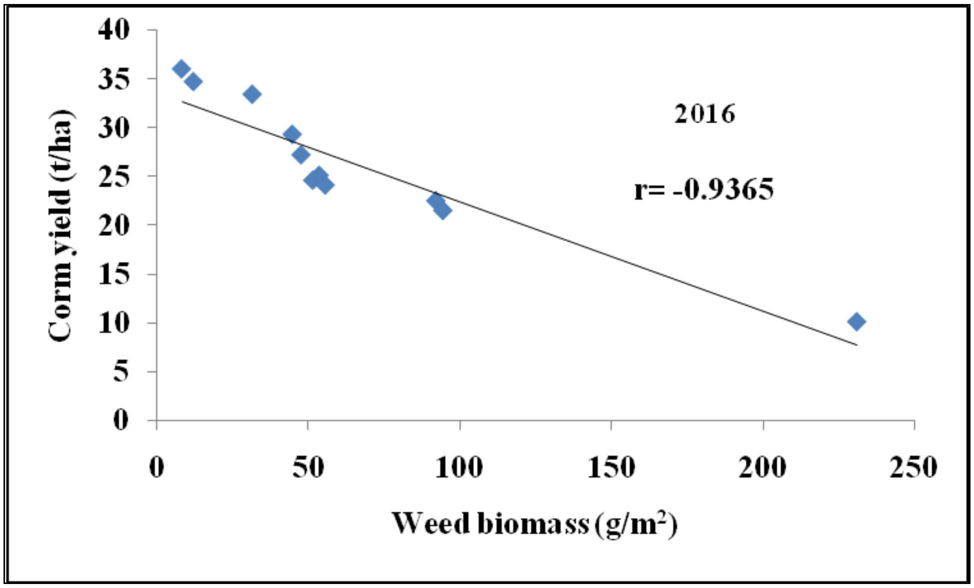
Table.1 Weather during the crop growing period

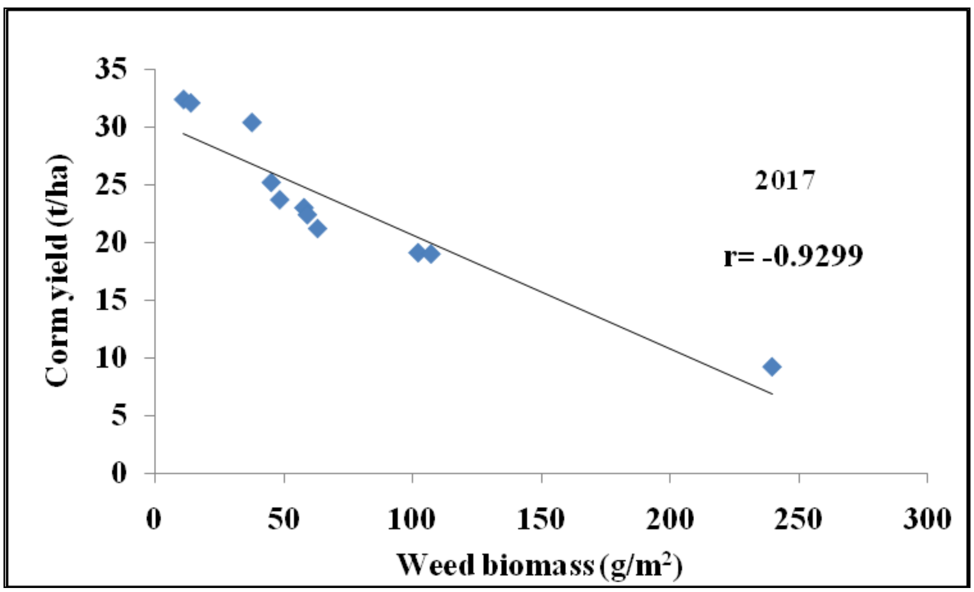
Months	Average maximum temperature (°C)		Average Minimum temperature (°C)		Total rainfall (mm)		Average relative humidity (%)		Average evaporation (mm)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
May	38.8	38.8	26.4	27.3	114.9	43.1	63.8	64.0	221.6	236.9
June	34.8	35.2	26.4	26.5	264.8	122.0	78.4	72.8	150.5	164.8
July	32.2	31.9	25.8	25.9	222.2	445.9	85.3	85.1	109.6	94.8
August	31.8	32.9	25.5	25.8	247.8	377.0	86.3	83.3	98.4	91.6
September	31.4	33.6	25.4	25.7	238.2	245.2	86.4	80.9	99.4	94.7
October	32.2	32.2	22.6	24.3	132.8	204.5	78.7	81.1	107.8	100.1
November	31.0	29.6	17.4	18.7	20.3	55.2	69.0	72.1	107.5	100.1
December	30.1	28.2	15.2	14.4	0.0	36.3	62.8	69.7	111.1	106.8
Mean/Total	32.8	32.8	23.1	23.6	1241.0	1529.2	76.3	76.1	1005.9	989.8

Table.2 Weed biomass, weed control efficiency and yield of elephant foot yam as influenced by weed management practices

	Weed biomass (g/m^2)		Weed control efficiency (%)		Corm yield (t/ha)	
	2016	2017	2016	2017	2016	2017
Pendimethalin (1 DAP) + Glyphosate (45 DAP)	92.1	102.2	60.1	57.3	22.5	19.1
Metribuzin (1 DAP) + Glyphosate (45 DAP)	94.4	107.2	59.1	55.3	21.5	19.0
Pendi (1 DAP) + Tank mix of 2,4-D amine salt and Quizalofop ethyl (45 DAP)	53.6	57.9	76.8	75.8	25.1	23.0
Metribuzin (1 DAP) + Tank mix of 2,4-D amine salt and Quizalofop ethyl (45 DAP)	55.6	63.2	75.9	73.6	24.1	21.2
Pendimethalin (1 DAP) + 2 rounds of manual weeding (60 and 90 DAP)	44.7	45.2	80.6	81.1	29.3	25.2
Metribuzin (1 DAP) + 2 rounds of manual weeding (60 and 90 DAP)	47.6	48.5	79.4	79.8	27.2	23.7
2 rounds of manual weeding (30 and 60 DAP) + Glyphosate (90 DAP)	31.5	37.7	86.4	84.3	33.4	30.4
2 rounds of manual weeding(30 and 60 DAP) + Tank mix of 2,4-D amine salt and Quizalofop ethyl (90 DAP)	51.5	59.2	77.7	75.3	24.6	22.4
Weed control ground cover (WCGC)	8.2	11.2	96.4	95.3	36.0	32.4
4 rounds of manual weeding (30, 60, 90 and 120 DAP)	12.1	14.0	94.7	94.3	34.7	32.1
Control (No weeding)	230.9	239.6	-	-	10.1	9.2
CD @ 5%	4.5	3.4	-	-	4.4	4.4

Fig.1 Correlation between weed biomass and corm yield in elephant foot yam





During 2016 and 2017, the major weed species observed in the elephant foot yam fields were *Cyperus rotundus* L. (purple nutsedge), *Dactyloctenium aegypticum* (L.) P. Beauv. Willd. (crowfoot grass), *Digitatia sanguinalis* (L.) Scop. (large crabgrass), *Cyanodon dactylon* (L.) Pers. (bermudagrass), *Echinochloa crusgalli* Beauv. (barnyard grass), *Borreria hispida* (L.) Schum. (shaggy button weed), *Celosia argentea* L. (white cockscomb), *Ageratum conyzoides* L. (billgoat weed), *Commelina benghalensis* L. (tropical spiderwort), *Cleome viscosa* L. (tick weed), *Mimosa pudica* L. (touch-me-not), and *Phyllanthus niruri* L (stonebreaker weed). *Celosia argentea*, *Digitatia sanguinalis* and *Cleome viscosa* dominated the other weed flora throughout the crop growth period.

During 2017, *Celosia argentea* was observed more number and grown more vigourusly compared to 2016 due to higher rainfall especially during the month of July and August (Table 1).

The data presented in Table 2 revealed that weed biomass was higher during the year 2017 compared to 2016 in all weed management treatments. This was due to prevailing of more favourable weather for weed growth. During 2017 crop growing period, 323 mm higher rainfall was received than 2016 (Table 1). Further higher average monthly maximum and minimum temperatures during early crop growth period (vegetative phase) favoured for more number of weeds to grow vigourously (Table 1). Kumar *et al*. (2016) also reported that several flushes of weeds to emerge and grow vigourously in higher rainfall years.

The effect of weather was noticed more in pre (1 DAP) and post emergence (45 DAP) herbicide application treatments and weedy check. High rainfall in July and August months during 2017 might be reduced the efficiency of herbicides and induced multiple fleshes of weed establishment.

Weed control ground cover (WCGC) resulted in lowest weed dry matter accumulation. This was due to suppression of weed germination and emergence by WCGC owing to complete cover of the ground. The next best treatment was 4 manual weeding at 30, 60, 90 and 120 DAP. Maximum weed biomass occurred in the control treatment where weeds were not controlled.

Marked variation in weed control efficiency (WCE) was noticed among weed management practices (Table 2). The WCE was higher during 2016 than 2017 irrespective of weed management practices. This might be due to lower weed biomass production. Kumar *et al*. (2016) also reported that less effectiveness of weed management practices during high rainfall year due to higher weed growth under favourable weather conditions. The WCGC treatment and 4 manual weedings at 30, 60, 90 and 120 DAP, resulted in higher WCE because of lower weed biomass in both the years.

Weed management practices affected corm yield (Table 2). During 2016 recorded higher corm yield than 2017 irrespective of weed management practices owing to lower weed biomass. A higher corm yield occurred with the WCGC compared to other treatments. This was due to lower weed biomass production and higher weed control efficiency in both the years. The next best treatment was 4 manual weeding at 30, 60, 90 and 120 DAP followed by 2 manual weeding at 30 and 60 DAP+glyphosate (at 90 DAP). The 4 manual weedings at 30, 60, 90 and 120 DAP and 2 manual weeding at 30 and 60 DAP+glyphosate (at 90 DAP) resulted in higher yields over the control but were lower than the ground cover treatment. Higher corm yield in these treatments indicated less interference due to weeds (Table 2). There was a negative correlation between weed biomass and corm yield during both the years of study (r= -0.9365 and r= -0.9299 during 2016 and 2017, respectively) (Fig.1). Keeping weed free for longer periods may improve growth, development, and yield of elephant foot yam. The weedy check resulted in lower corm yield owing to season long crop-weed competition, which was indicated by higher weed biomass and lower WCE (Table 2). The weedy check treatment resulted in lower corm yield in 2017 than 2016.

Elephant foot yam is required well distributed optimum rainfall. Higher rainfall and average monthly maximum temperature during crop growing period led to lower herbicide efficacy or weed management efficiency and corm yield of elephant foot yam under high rainfall sub-humid zone.

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