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Studies on multi-tier cropping systems in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] on weed parameters

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Abstract

A field experiment was conducted during summer, 2019 and 2020 to study the effect of multi-tier cropping systems in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] for efficient resource utilization and profitability in coastal Andhra Pradesh. The experiment was carried out with ten treatments in three replications. The experiment consist of different multitier cropping systems with elephant foot yam grown as main crop along with eighteen intercrops grown in different treatments. The results revealed that among the different multitier cropping systems elephant foot yam + sweet corn + cowpea (T7) recorded superior values for dry weight of weeds and weed smothering efficiency when compared to other multitier cropping systems during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis.

Keywords: Elephant foot yam, multi-tier cropping systems, dry weight, weed smothering efficiency

Introduction

India ranks first in world acreage (10.2 million hectare) and is the second largest producer of vegetables in the world, with an annual production of 105.40 million tonnes. Our requirement of vegetables has been increased to about 128.5 million tonnes to meet the nutritional requirement of an estimated 1220 million population expected by 2030-31 (Sankaranarayanan *et al.* 2011). Economy of the country is to be improved through agriculture and horticulture by better utilization of natural resources and other inputs. Thus, production per unit area of land, time and inputs should be increased by improving efficiency of the rate and extent to which natural resources are harvested for conversion to economic produce. This is possible through intensive cropping involving crop mixers wherever feasible. This will not only improve the crop production in sustainable way but also economize the crop production.

Multi-tier or Multi-storied or Multi-layer cropping system is the method of growing two or more crops of different heights simultaneously on same piece of land in a certain period. In multi-tier systems, the possibility of more efficient use of resources like sunlight, nutrients and water is leading to increased biological diversity and higher production stability. In addition, the root systems of the component crops are also located at distant zones so as to explore the soil for moisture and nutrients. Intercrops were observed to serve as an insurance against the menace of pests and diseases, vagaries of weather, market fluctuations and help to increase the net profit to growers. The objective of any cropping system is efficient utilization of all resources *viz.*, land, water and solar radiation, maintaining stability in production and obtaining higher net returns. The efficiency is measured by the quantity of produce obtained per unit resource used in a given time.

The most efficient practice would probably be to grow these crops in multi-tier cropping systems during summer season. An ideal elephant foot yam based multi-tier vegetable cropping should aim to produce higher economic returns and yield per unit area, offer greater stability in production to meet the domestic needs of the farmer and also ensure stable income per unit area. Growing the short duration crops with elephant foot yam are very useful because they supply food, additional income especially when the elephant foot yam crop cannot yet be harvested, they may fix nitrogen and supply other nutrients to the top soil, protect the soil from the direct impact of rainfall and reduce the speed of run-off water thus reducing soil erosion and they also reduces the weed growth during early stages of the elephant foot yam development. Hence the present study entitled "Studies on multi-tier cropping systems in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] for efficient resource utilization and profitability in coastal Andhra Pradesh"

Material and Methods

A field experiment entitled “Studies on multi-tier cropping systems in elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson] for efficient resource utilization and profitability in coastal Andhra Pradesh” was carried out during summer (2019 and 2020) seasons at College farm, College of Horticulture, Venkataramannagudem. The experiment was carried out with ten treatments with three replications in a randomized block design. The experiment consist of ten multi-tier treatments (T₁ - Elephant Foot Yam + Ridge Gourd + Green Chilli, T₂ - Elephant Foot Yam + Bitter Gourd + Coriander, T₃ - Elephant Foot Yam + Bottle Gourd + Fenugreek, T₄ - Elephant Foot Yam + Snake Gourd + Sorrel, T₅ - Elephant Foot Yam + Indeterminate Tomato + Radish, T₆ - Elephant Foot Yam + Yard Long Bean + Onion, T₇ - Elephant Foot Yam + Sweet Corn + Cow Pea, T₈ - Elephant

Foot Yam + Okra + Carrot, T₉ -Elephant Foot Yam + Cluster Bean + Palak, T₁₀ - Elephant Foot Yam (sole crop). The present investigation was carried out with variety Gajendra. The experimental area was divided into 5 m x 5 m sized plots. One meter wide irrigation channels were provided between two replications. After ploughing thoroughly and harrowing, the corms are planted vertically at a spacing of 60 cm x 60 cm and at a depth of 5 to 7.5 cm. Size of the corm weighing 500 g per pit was used. The cultivation practices of main crop and intercrops were given under table 1. The data recorded on various weed attributes were tabulated and were statistically analyzed by adopting the standard RBD procedures outlined by Panse and Sukatme (1985). The mean values were tested for significance at 5% level of probability. The critical difference values were calculated at 5% level of probability.

Table 1: Cultivation practices of main crop and intercrops

S. No	Crop	Time of sowing / Transplanting		Spacing
		2019	2020	
I.	Main crop			
	Elephant foot yam	15.02.2019	14.02.2020	60 cm x 60 cm
II.	Inter crops			
1.	Ridge gourd	15.02.2019	14.02.2020	1.5 m x 1.5 m
2.	Green chilli	15.02.2019	14.02.2020	30 cm x 30 cm
3.	Bitter gourd	15.02.2019	14.02.2020	1.5 m x 1.5 m
4.	Coriander	15.02.2019	14.02.2020	10 cm x 10 cm
5.	Bottle gourd	15.02.2019	14.02.2020	1.5 m x 1.5 m
6.	Fenugreek	15.02.2019	14.02.2020	10 cm x 10 cm
7.	Snake gourd	15.02.2019	14.02.2020	1.5 m x 1.5 m
8.	Sorrel	15.02.2019	14.02.2020	10 cm x 10 cm
9.	Indeterminate tomato	15.02.2019	14.02.2020	45 cm x 45 cm
10.	Radish	15.02.2019	14.02.2020	10 cm x 10 cm
11.	Yard long bean	15.02.2019	14.02.2020	45 cm x 45 cm
12.	Onion	15.02.2019	14.02.2020	15 cm x 15 cm
13.	Sweet corn	15.02.2019	14.02.2020	45 cm x 45 cm
14.	Cow pea	15.02.2019	14.02.2020	30 cm x 30 cm
15.	Okra	15.02.2019	14.02.2020	45 cm x 45 cm
16.	Carrot	15.02.2019	14.02.2020	10 cm x 10 cm
17.	Cluster bean	15.02.2019	14.02.2020	45 cm x 45 cm
18.	Palak	15.02.2019	14.02.2020	10 cm x 10 cm

Results and Discussion

The results from the field experiment during the summer season of the years 2019, 2020 and pooled analysis on dry weight of the weeds (25, 50 and 75 DAP) and weed smothering efficiency (25, 50 and 75 DAP) are given below.

Dry weight of weeds (g m⁻²)

As evident from the data (Table 2) that the significant variations were observed among different multi-tier cropping systems of elephant foot yam with respect to dry weight of weeds at 25, 50 and 75 DAP.

At 25 DAP, minimum dry weight of weeds (25.00 g m⁻², 23.33 g m⁻², 24.16 g m⁻²) was recorded with elephant foot yam + sweet corn + cowpea (T₇) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis. Maximum dry weight of weeds at 25 DAP (61.67 g m⁻², 60.83 g m⁻², 61.25 g m⁻²) was recorded with elephant foot yam when grown as sole crop (T₁₀) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis.

At 50 DAP, minimum dry weight of weeds (20.33 g m⁻², 19.33 g m⁻², 19.83 g m⁻²) was recorded with elephant foot yam + sweet corn + cowpea (T₇) during both the years of

experimentation (2019-20 and 2020-21) and in pooled analysis. Maximum dry weight of weeds at 50 DAP (48.33 g m⁻², 53.33 g m⁻², 50.83 g m⁻²) was recorded with elephant foot yam when grown as sole crop (T₁₀) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis.

At 75 DAP, minimum dry weight of weeds (20.00 g m⁻², 18.83 g m⁻², 19.41 g m⁻²) was recorded with elephant foot yam + sweet corn + cowpea (T₇) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis. Maximum dry weight of weeds at 75 DAP (52.33 g m⁻², 50.67 g m⁻², 51.50 g m⁻²) was recorded with elephant foot yam when grown as sole crop (T₁₀) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis.

Among the different cropping systems, elephant foot yam when grown as a sole crop is the poor competitor to weeds in the initial stages of the crop due its extremely slow growth during early stages enabling quick and rapid growth of the weeds. The denser canopy on intercropped plots reduced weed population and thus plant competition. Hence elephant foot yam when grown as sole crop recorded maximum dry weight of weeds. The least dry weight of the weeds was

recorded in elephant foot yam + sweet corn + cowpea (T₇) which might be due to the fact that cowpea ensured better coverage of soil surface from the beginning and diminished light penetration to the soil thus reducing the weed growth. Similar results were reported by Anim and Limbani (2007) [1]

in cucumber-okra cropping system; Leihner (2008) [4] in cassava cropping system; Brintha *et al.* (2012) [2] in chilli-onion cropping system and Krishna *et al.* (2018) [3] in chilli based cropping system.

Table 2: Effect of multi-tier cropping systems on dry weight of weeds (gm⁻²) in elephant foot yam

Treatments	Dry weight (gm ⁻²) of weeds at 25 DAP			Dry weight (gm ⁻²) of weeds at 50 DAP			Dry weight (gm ⁻²) of weeds at 75 DAP		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T ₁ -EFY+RG+GC	32.50	26.08	29.29	25.67	25.00	25.33	23.33	21.00	22.16
T ₂ -EFY+BiG+Co	29.35	27.75	28.55	23.33	21.67	22.50	30.00	28.40	29.20
T ₃ -EFY+BoG+Fg	25.17	24.73	24.95	25.67	24.67	25.16	20.67	19.50	20.08
T ₄ -EFY+SG+So	26.83	26.50	26.66	25.00	23.33	24.16	28.33	23.10	25.71
T ₅ -EFY+IT+Rd	33.33	30.67	32.00	25.33	23.00	24.16	27.33	25.00	26.16
T ₆ -EFY+YLB+O	44.00	33.52	38.75	25.67	24.33	25.00	22.67	21.00	21.83
T ₇ -EFY+SC+CP	25.00	23.33	24.16	20.33	19.33	19.83	20.00	18.83	19.41
T ₈ -EFY+Ok+Ca	50.00	48.33	49.16	30.00	26.17	28.08	30.00	28.33	29.16
T ₉ -EFY+CB+P	48.33	46.67	47.50	39.83	35.83	37.83	30.67	29.00	29.83
T ₁₀ -EFY	61.67	60.83	61.25	48.33	53.33	50.83	52.33	50.67	51.50
S.Em±	3.80	2.74	2.35	1.70	2.70	1.59	2.88	3.54	2.28
C.D. at 5%	11.29	8.16	6.73	5.07	8.01	4.58	8.56	10.50	6.54

Note: T₁:-Elephant Foot Yam + Ridge Gourd + Green Chilli, T₂:-Elephant Foot Yam + Bitter Gourd + Coriander, T₃:-Elephant Foot Yam + Bottle Gourd + Fenugreek, T₄:-Elephant Foot Yam + Snake Gourd + Sorrel, T₅:-Elephant Foot Yam + Indeterminate Tomato + Radish, T₆:-Elephant Foot Yam + Yard Long Bean + Onion, T₇:-Elephant Foot Yam + Sweet Corn + Cow Pea, T₈:-Elephant Foot Yam + Okra + Carrot, T₉:-Elephant Foot Yam + Cluster Bean + Palak, T₁₀:-Elephant Foot Yam (sole)

Weed smothering efficiency (%)

As evident from the data (Table 4.12 and Fig 4.11) at 25 DAP, 50 DAP and 75 DAP the highest weed smothering efficiency (59.46 %, 61.65 %, 60.56 %), (57.94 %, 63.75 %, 60.99 %) and (61.78 %, 62.84 %, 62.31 %) was recorded with multi-tier treatment elephant foot yam + sweet corn + cowpea (T₇) during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis.

Among the different cropping systems, highest weed smothering efficiency registered with elephant foot yam + sweet corn + cowpea (T₇) which might be due to the fact that cowpea has vigorous early growth habit and ensured better coverage of soil surface from the beginning and diminished light penetration to the soil reducing the weed growth and ensuring better weed smothering efficiency. Similar result was also reported by Leihner (2008) [4] in cucumber.

Table 3: Effect of multi-tier cropping system on weed smothering efficiency (%) in elephant foot yam

Treatments	Weed smothering efficiency % at 25 DAP			Weed smothering efficiency % at 50 DAP			Weed smothering efficiency % at 75 DAP		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T ₁ -EFY+RG+GC	47.30	57.13	52.18	46.89	53.12	50.17	55.42	58.56	56.97
T ₂ -EFY+BiG+Co	52.41	54.38	53.39	51.73	59.37	55.73	42.67	43.95	43.30
T ₃ -EFY+BoG+Fg	59.19	59.35	59.27	46.89	53.74	50.50	60.50	61.52	61.01
T ₄ -EFY+SG+So	56.49	56.44	56.47	48.27	56.25	52.47	45.86	54.41	50.08
T ₅ -EFY+IT+Rd	45.95	49.58	47.76	47.59	56.87	52.47	47.77	50.66	49.20
T ₆ -EFY+YLB+O	28.65	44.90	36.73	46.89	54.38	50.82	56.68	58.56	57.61
T ₇ -EFY+SC+CP	59.46	61.65	60.56	57.94	63.75	60.99	61.78	62.84	62.31
T ₈ -EFY+Ok+Ca	18.92	20.55	19.74	37.93	50.93	44.76	42.67	44.09	43.38
T ₉ -EFY+CB+P	21.63	23.28	22.45	17.59	32.81	25.58	41.39	42.77	42.08
T ₁₀ -EFY	-	-	-	-	-	-	-	-	-

Note: T₁:-Elephant Foot Yam + Ridge Gourd + Green Chilli, T₂:-Elephant Foot Yam + Bitter Gourd + Coriander, T₃:-Elephant Foot Yam + Bottle Gourd + Fenugreek, T₄:-Elephant Foot Yam + Snake Gourd + Sorrel, T₅:-Elephant Foot Yam + Indeterminate Tomato + Radish, T₆:-Elephant Foot Yam + Yard Long Bean + Onion, T₇:-Elephant Foot Yam + Sweet Corn + Cow Pea, T₈:-Elephant Foot Yam + Okra + Carrot, T₉:-Elephant Foot Yam + Cluster Bean + Palak, T₁₀:-Elephant Foot Yam (sole)

Conclusion

From the present study, it can be concluded that multi-tier cropping system elephant foot yam + sweet corn + cowpea (T₇) recorded superior values for minimum dry weight of weeds and maximum weed smothering efficiency when compared to other multi-tier cropping systems during both the years of experimentation (2019-20 and 2020-21) and in pooled analysis. With respect to yield, the elephant foot yam when grown with sweet corn and cowpea recorded on par values with elephant foot yam when grown as sole crop and hence can be concluded that weeds are not playing important role in affecting the growth of elephant foot yam thus the

yield was not reduced.

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