

Optimizing Soil Moisture, Mulching, and Spacing for Yield and Water Productivity in Irrigated Elephant Foot Yam (*Amorphophalluspaeoniifolius*)

ABSTRACT

Aims: To standardize crop spacing and irrigation requirements under different mulching situation for better yield and water productivity.

Study design: The experiment was designed in factorial RBD with two replications.

Place and Duration of Study: The experiment was conducted at Agronomic Research Station, Kerala Agriculture University (KAU), Chalakudy for three consecutive years from 2016 -17, 2017 – 18 and 2018 – 2019.

Methodology: Study conducted with 18 treatments, includes three levels of irrigation, three types of mulching and with two different crop spacing. Observations on weed count and weed dry matter production were also taken to study the effect of different mulches on weed growth. Biometric observations of crop growth and yield were recorded.

Results: Observations on biometric characters revealed that both the height and diameter of the crop canopy were significantly influenced by mulching and found to be highest in the plot where leaf was used as the mulching material and the yield of *Amorphophallus* during 2016 - 2017 showed that corm weight was greatly influenced by irrigation levels, mulching and spacing. Corm yield was lowest in the plot where irrigation frequency was once in three days (21.02 t/ha). Yield in leaf mulched plot was 38.11 t/ha while in plastic mulched and no mulched plots were 23.50 and 19.50 t/ha. Effect of treatments on water productivity and BC ratio showed that leaf mulching of the crop has significant effect. In leaf mulched plot, water productivity in 2016-17 was 2.03 while it was only 1.854 and 0.886 in 2017-18 and 2018-19. Similarly, BC ratio was highest for leaf mulched plot followed by no mulch and plastic mulch plot.

Conclusion: The experimental results from 2016 -17, 2017 – 18 and 2018 – 2019, showed that *Amorphophallus* planted at a spacing of 90 cm x 90 cm, irrigated at a frequency of once in three days along with leaf mulching can increase the yield and water productivity along with effective control of weed population.

Keywords: *Amorphophallus*, drip irrigation, mulch, agronomic practices

1. INTRODUCTION

Amorphophalluspaeoniifolius (Dennst.) Nicolson, known as the "king of tuber crops," or elephant foot yam, is a tropical and subtropical tuber crop grown as pure crop or inter crop [1]. Due to its increased yield, widespread use as a vegetable and therapeutic qualities, the crop has been evolved into a cash crop in modern times [2]. In India, elephant foot yam is cultivated commercially in Kerala, Andhra Pradesh, West Bengal, Karnataka and Tamil Nadu [3] and covering an area of 40,000 ha with a production of 1.0 million metric tonnes [4]. Generally, in Kerala, it is grown as a rainfed crop, planted one month before the onset of monsoon (February-March), and harvested by December. However, cultivating

Amorphophallus as an irrigated crop is the only way to meet the demand during the Onam festival season.

Weeds are the major constraint for both yield and quality in *Amorphophallus* cultivation [5]. The first five months after planting are the crucial stage in *Amorphophallus* characterized by intense crop weed competition due to significant crop growth and corm bulking (30 to 90 days for bud development, sprouting, and canopy expansion) [6]. Weed infestation during this critical period can lead to substantial yield losses, potentially reaching up to 100% [7]. An integrated weed management approach is necessary to protect the crop from weed for the first five months. Primarily mulching techniques are used in fields to manage weed growth. The selection of proper mulch depends on factors such as the specific types of weeds, soil characteristics, terrain, local weather conditions, crop type and the availability of mulching materials [8]. Along with weed control efficiency, mulching also has water and soil conservation properties [9]. Thus, this study also focuses on the effect of different mulches on water conservation efficiency, weed control efficiency and productivity of *Amorphophallus*.

Survey about the cultivation practices followed by farmers showed that many fungal diseases are associated with unscientific irrigation practices, hence there is a need for the standardization of irrigation practices. Compared to normal cultivation of *Amorphophallus*, the crop duration of irrigated *Amorphophallus* is much shorter, thus standardization of crop spacing also needs to be done to achieve profitable yields. Standardization of crop spacing and irrigation requirements under different mulching situations were the major objectives of the study. Provide a factual background, clearly defined problem, proposed solution, a brief literature survey and the scope and justification of the work done.

2. MATERIAL AND METHODS

The experiment was conducted for three consecutive years from 2016 -17, 2017 – 18 and 2018 – 2019 at Agronomic Research Station, Kerala Agriculture University (KAU), Chalakudy (10.3116° N, 76.3419° E). The experiment was designed in factorial RBD with two replications and the treatment details are given in Table 1.

Table 1. Experimental treatments

Treatments	
Irrigation levels – 3 Nos	
I ₁	Drip irrigation- daily
I ₂	Drip irrigation- once in two days
I ₃	Drip irrigation- once in three days
Crop spacing – 2 Nos	
S ₁	75 cm x 75 cm
S ₂	90 cm x 90 cm
Mulching- 3 types	
M ₁	No mulch
M ₂	Plastic mulch
M ₃	Leaf mulch

Seed tubers of *Amorphophallus* var. Wayanad local weighing one kg were planted in a plot of dimension 4.5 m x 3 m as per the recommended practices of KAU during the last week of December 2016. Drip irrigation system was installed with dripper discharge of 4 litres per hour and irrigation was done as per the treatments. Observations on soil moisture content and soil temperature were recorded. During the crop growth three weedings were done. Observations on weed count and weed dry matter production were also taken to study the effect of different mulches on weed growth. Biometric observations of crop growth and yield were recorded. Harvesting was done eight months after planting (MAP). The experimental trial was repeated for 2017 – 2018 and 2018 - 2019 for obtaining refined results.

3. RESULTS AND DISCUSSION

Observations on biometric characters revealed that both the height and diameter of the crop canopy were significantly influenced by mulching and found to be highest in the plot where leaf was used as the mulching material (Table 2). Germination per cent of the corm pieces were also affected by the type of mulching material. It was highest in leaf mulched plot (100%) followed by plastic mulch (90.4%) and no mulch (75%) (Fig. 1). The study conducted by [10] also shows the same result that in a mulched condition, the aerial parts of the plants were developed very well and the leaf surface area was also increased which promotes the overall assimilation process. A similar study was conducted by [11] on response of *amorphophallus* to irrigation and mulching and inferred that the height and canopy radius of the corm were strongly influenced by mulching. In the study of [12] canopy diameter among different mulching materials were compared and observed highest with plastic mulches to that of straw mulch.

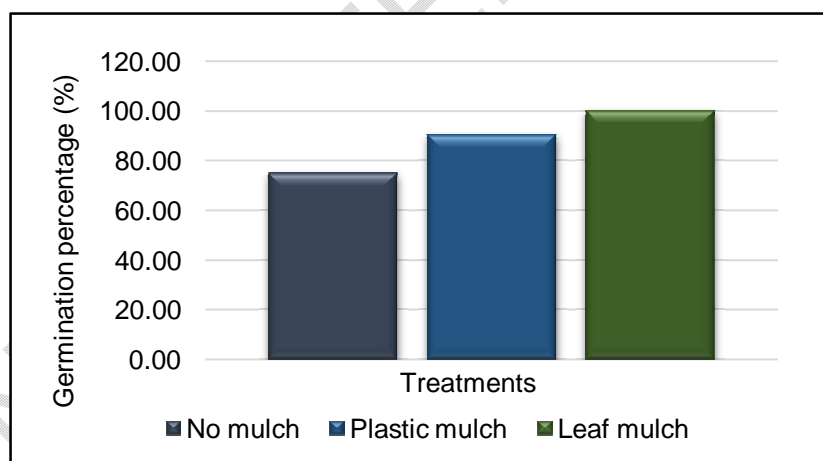


Fig. 1. Germination percent of corm pieces under different mulching conditions (%).

Table 2. Effect of treatments on growth of *Amorphophallus* in 2018 – 2019

Treatment	Height of plant (cm)	Diameter of plant (cm)
Irrigation levels (I)		
Daily (I ₁)	37.01	79.25
Alternate days (I ₂)	35.3	74.74
Once in 3 days (I ₃)	35.93	70.19
CD (0.05)	NS	NS
Mulching (M)		
No Mulch- M ₁	31.47	67.33
Plastic Mulch- M ₂	31.97	64.91
Leaf Mulch- M ₃	44.8	91.94
CD (0.05)	7.66	16.36
Spacing (S)		
S ₁ - 75 X 75 cm	37.09	74.68
S ₂ 90 X 90 cm	35.07	74.77
CD (0.05)	NS	NS
I X M		
I ₁ X M ₁	36.08	76.41
I ₁ X M ₂	31.12	66.75
I ₁ X M ₃	43.83	94.58
I ₂ X M ₁	28.74	68.5
I ₂ X M ₂	32.41	62
I ₂ X M ₃	44.75	93.74
I ₃ X M ₁	29.58	57.08
I ₃ X M ₂	32.37	66
I ₃ X M ₃	45.83	87.5
CD (0.05)	NS	NS
I X S		
I ₁ X S ₁	38.27	80.72
I ₁ X S ₂	35.75	77.77
I ₂ X S ₁	36.38	74.33
I ₂ X S ₂	34.22	75.16
I ₃ X S ₁	36.61	69
I ₃ X S ₂	35.24	71.38
CD (0.05)	NS	NS
M X S		
M ₁ X S ₁	32.55	67.77
M ₁ X S ₂	30.38	66.88
M ₂ X S ₁	33.55	67.61
M ₂ X S ₂	30.38	62.22
M ₃ X S ₁	45.16	88.66
M ₃ X S ₂	44.44	95.22
CD (0.05)	NS	NS
I X M X S		
I ₁ X M ₁ X S ₁	40	83.33
I ₁ X M ₁ X S ₂	32.16	69.5
I ₁ X M ₂ X S ₁	36.16	75.33
I ₁ X M ₂ X S ₂	26.08	58.16

I ₁ X M ₃ X S ₁	38.66	83.5
I ₁ X M ₃ X S ₂	49	105.66
I ₂ X M ₁ X S ₁	27.83	64.66
I ₂ X M ₁ X S ₂	29.66	72.33
I ₂ X M ₂ X S ₁	29.16	57.5
I ₂ X M ₂ X S ₂	35.66	66.5
I ₂ X M ₃ X S ₁	52.16	100.83
I ₃ X M ₃ X S ₂	37.33	86.66
I ₃ X M ₁ X S ₁	29.83	55.33
I ₃ X M ₁ X S ₂	29.33	58.83
I ₃ X M ₂ X S ₁	35.33	70
I ₃ X M ₂ X S ₂	29.41	62
I ₃ X M ₃ X S ₁	44.67	81.66
I ₃ X M ₃ X S ₂	47	93.33
CD (0.05)	NS	NS

Results of the study revealed that weed infestation in the plot was influenced by irrigation levels, mulching and spacing (Table 3). Weed count and weed dry matter production was highest in once in 3 days irrigated plot followed by alternate day and daily irrigated plot. There was significant difference between the various mulching treatments on weed infestation. Under plastic mulching situation weed infestation was lowest and it was highest in no mulched plot. Spacing did not influence weed infestation. [13] conducted a study on effect of irrigation on dry matter production of different weeds and reported that while increasing the irrigation intervals, the dry matter content in the weed decreases significantly hence, weed dry matter production is influenced by irrigation. [14] showed that mulching was very useful to control weeds than the other methods and have a significant influence on weed management.

Table 3. Effect of treatments on weed infestation in the experiment plot (6 sq.m) during 2018- 2019.

Treatment	Weed count (No.) 2 MAP*	Dry matter production (g) 2 MAP	Weed count (No.) 6 MAP	Dry matter production (kg) 6 MAP
Irrigation levels (I)				
Daily (I ₁)	69.16	106.93	143.25	0.55
Alternate days (I ₂)	99.58	85.53	138.58	0.56
Once in 3 days (I ₃)	110.70	127.65	158.83	0.66
CD (0.05)	NS	NS	NS	NS
Mulching (M)				
No Mulch- M ₁	157.79	164.03	163.50	0.64
Plastic Mulch- M ₂	29.16	22.87	152.16	0.63
Leaf Mulch- M ₃	92.50	133.20	125.00	0.49
CD (0.05)	43.84	54.05	NS	NS
Spacing (S)				
S ₁ - 75 X 75 cm	105.44	94.72	109.00	0.43
S ₂ 90 X 90 cm	80.86	118.68	184.77	0.74
CD (0.05)	NS	NS	NS	NS
I x M				
I ₁ X M ₁	108.00	148.00	159.50	0.67
I ₁ X M ₂	23.25	11.84	93.00	0.31
I ₁ X M ₃	76.25	160.95	177.25	0.66

I ₂ X M ₁	173.25	141.52	92.00	0.31
I ₂ X M ₂	27.25	6.84	155.00	0.65
I ₂ X M ₃	98.25	108.22	168.75	0.71
I ₃ X M ₁	192.12	202.57	239.00	0.95
I ₃ X M ₂	37.00	49.95	208.50	0.94
I ₃ X M ₃	103.00	130.42	29.00	0.10
CD (0.05)	NS	NS	NS	NS
I x S				
I ₁ X S ₁	70.83	111.74	102.83	0.32
I ₁ X S ₂	67.50	102.12	183.66	0.77
I ₂ X S ₁	123.00	63.27	97.33	0.44
I ₂ X S ₂	76.16	107.79	179.83	0.67
I ₃ X S ₁	122.50	109.15	126.83	0.54
I ₃ X S ₂	98.91	146.15	190.83	0.78
CD (0.05)	NS	NS	NS	NS
M x S				
M ₁ X S ₁	206.00	163.41	126.50	0.47
M ₁ X S ₂	109.58	164.65	200.50	0.81
M ₂ X S ₁	32.33	11.59	108.00	0.47
M ₂ X S ₂	26.00	34.16	196.33	0.80
M ₃ X S ₁	78.00	109.15	92.50	0.36
M ₃ X S ₂	107.00	157.25	157.50	0.62
CD (0.05)	62.01	NS	NS	NS
I x M x S				
I ₁ X M ₁ X S ₁	119.00	140.60	151.50	0.64
I ₁ X M ₁ X S ₂	97.00	155.40	167.50	0.70
I ₁ X M ₂ X S ₁	15.00	17.02	43.50	0.03
I ₁ X M ₂ X S ₂	31.50	6.66	142.50	0.60
I ₁ X M ₃ X S ₁	78.50	177.60	113.50	0.30
I ₁ X M ₃ X S ₂	74.00	144.30	241.00	1.02
I ₂ X M ₁ X S ₁	232.50	105.45	94.00	0.32
I ₂ X M ₁ X S ₂	114.00	177.60	90.00	0.29
I ₂ X M ₂ X S ₁	33.00	6.66	65.50	0.39
I ₂ X M ₂ X S ₂	21.50	7.03	244.50	0.92
I ₂ X M ₃ X S ₁	103.50	77.70	132.50	0.61
I ₂ X M ₃ X S ₂	93.00	138.75	205.00	0.81
I ₃ X M ₁ X S ₁	266.50	244.20	134.00	0.46
I ₃ X M ₁ X S ₂	117.75	160.95	344.00	1.44
I ₃ X M ₂ X S ₁	49.00	11.10	215.00	0.98
I ₃ X M ₂ X S ₂	25.00	88.80	202.00	0.89
I ₃ X M ₃ X S ₁	52.00	72.15	31.50	0.18
I ₃ X M ₃ X S ₂	154.00	188.70	26.50	0.02
CD (0.05)	NS	NS	NS	NS

*MAP = Months after planting

Soil temperature and soil moisture of the field varied under different mulching conditions. Results on pooled analysis of the data for three years is given in the Table 4. Soil temperature was lowest in leaf mulched plot compared to plastic mulched and no mulched plot. Soil moisture content was highest in plastic mulched and lowest in no mulched plot. The study on influence of different mulch materials on soil temperature, soil water content and yield of three cassava cultivars and concluded that maximum daily soil temperature was

retained by polythene mulching especially black polythene mulch and lowest temperature was observed in the plot in which straw mulching was done which support the results of this study [15] and also the findings are in accordance with [16], [17] and [18].

Table 4. Effect of treatments on soil temperature and moisture in *Amorphophallus* during 2018 - 2019.

Treatment	Soil moisture (%)	Soil Temperature (°C)
Irrigation levels (I)		
Daily (I ₁)	7.14	37.75
Alternate days (I ₂)	7.73	37.91
Once in 3 days (I ₃)	6.86	39.00
CD (0.05)	NS	NS
Mulching (M)		
No Mulch- M ₁	7.11	38.75
Plastic Mulch- M ₂	7.51	38.75
Leaf Mulch- M ₃	7.11	37.16
CD (0.05)	NS	1.16
Spacing (S)		
S ₁ - 75 X 75 cm	6.14	38.41
S ₂ 90 X 90 cm	8.35	38.02
CD (0.05)	1.33	NS
I x M		
I ₁ X M ₁	6.21	38.62
I ₁ X M ₂	8.72	37.62
I ₁ X M ₃	6.49	37.00
I ₂ X M ₁	8.90	37.87
I ₂ X M ₂	6.77	39.12
I ₂ X M ₃	7.54	36.75
I ₃ X M ₁	6.21	39.75
I ₃ X M ₂	7.05	39.50
I ₃ X M ₃	7.32	37.75
CD (0.05)	NS	NS
I x S		
I ₁ X S ₁	6.39	37.75
I ₁ X S ₂	7.89	37.75
I ₂ X S ₁	5.95	37.66
I ₂ X S ₂	9.52	38.16
I ₃ X S ₁	6.09	39.83
I ₃ X S ₂	7.63	38.16
CD (0.05)	NS	NS
M x S		
M ₁ X S ₁	5.51	39.16
M ₁ X S ₂	8.70	38.33
M ₂ X S ₁	6.69	39.16
M ₂ X S ₂	8.33	38.33
M ₃ X S ₁	6.23	36.91
M ₃ X S ₂	8.01	37.41
CD (0.05)	NS	NS
I x M x S		

I ₁ X M ₁ X S ₁	5.35	39.50
I ₁ X M ₁ X S ₂	7.07	37.75
I ₁ X M ₂ X S ₁	7.45	37.25
I ₁ X M ₂ X S ₂	9.99	38.00
I ₁ X M ₃ X S ₁	6.38	36.50
I ₁ X M ₃ X S ₂	6.60	37.50
I ₂ X M ₁ X S ₁	5.89	37.25
I ₂ X M ₁ X S ₂	11.92	38.50
I ₂ X M ₂ X S ₁	5.95	39.50
I ₂ X M ₂ X S ₂	7.59	38.75
I ₂ X M ₃ X S ₁	6.01	36.25
I ₃ X M ₃ X S ₂	9.06	37.25
I ₃ X M ₁ X S ₁	5.30	40.75
I ₃ X M ₁ X S ₂	7.13	38.75
I ₃ X M ₂ X S ₁	6.69	40.75
I ₃ X M ₂ X S ₂	7.42	38.25
I ₃ X M ₃ X S ₁	6.29	38.00
I ₃ X M ₃ X S ₂	8.35	37.50
CD (0.05)	NS	NS

Observation on yield of *Amorphophallus* during 2016 - 2017 showed that corm weight was greatly influenced by irrigation levels, mulching and spacing (Table 5). Corm yield was lowest in the plot where irrigation frequency was once in three days (21.02 t/ha). Moisture stress has resulted in yield reduction. Mulching greatly influences yield of *Amorphophallus*; weight of corms in leaf mulched plot was higher than plastic mulched and no mulched plot. Yield in leaf mulched plot was 38.11 t/ha while in plastic mulched and no mulched plots were 23.50 and 19.50 t/ha (Figure 2).

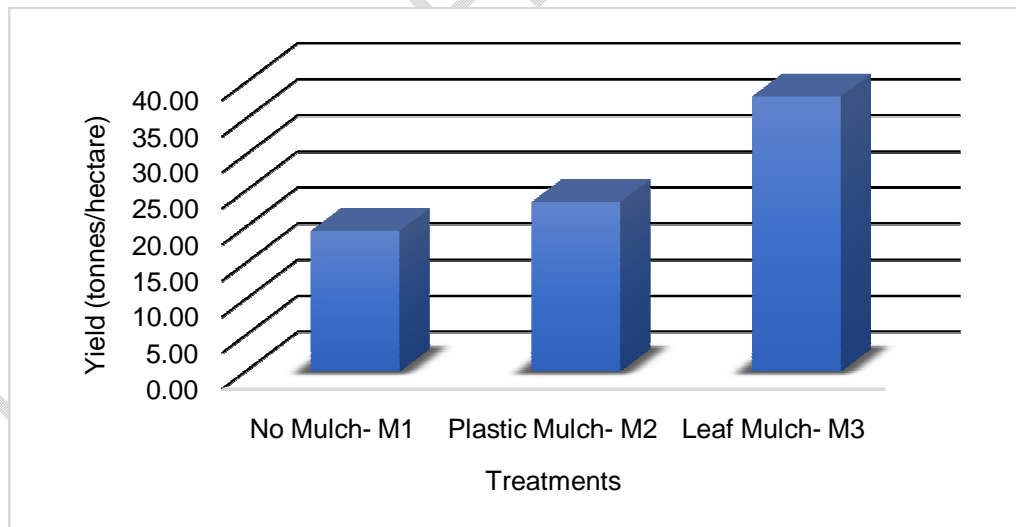


Fig. 2: Effect of different mulches on yield of *Amorphophallus*

Yield of the crop was not significantly influenced by spacing. Interaction effect of irrigation, mulching and spacing showed that yield of the crop was highest in daily irrigated plot with 90 cm x 90 cm spacing and leaf mulching even though it was not significant. This inference is supported from the results of [19] that *Amorphophallus* can yield more and

produce larger corms when the moisture is adequate. The results are also in confirmative with the results obtained by [11] the corm yield was significantly higher in mulched plots compared to the no mulched plots and highest yield was observed in the plot mulched using dried leaves. Effect of treatments on water productivity and BC ratio showed that leaf mulching of the crop has significant effect on these parameters. In leaf mulched plot, water productivity in 2016-17 was 2.03 while it was only 1.854 and 0.886 in 2017-18 and 2018-19. Similarly, BC ratio was highest for leaf mulched plot followed by no mulch and plastic mulch plot. [12] conducted an economic analysis among different mulching materials and found that highest cost of cultivation was incurred in white plastic mulch trial and lowest for no mulched trial. This could be the reason for the higher B:C ratio in the leaf mulched trial compared to the plastic mulched trial. Generally, yield of the crop was highest in daily irrigated plot. But in 2017-18, plots which were irrigated daily was infected by leaf blight disease, that reduced the crop yield. Considering B:C ratio and water productivity, irrigation in an interval of three days along with leaf mulching gives better yield and water productivity.

Table 5. Effect of treatments on yield, water productivity (WP) and BC ratio of *Amorphophallus*.

Treatment	2016- 2017			2017- 2018			2018- 2019			Pooled	
	Yield (t ha ⁻¹)	WP (kg m ⁻³)	BC Ratio	Yield (t ha ⁻¹)	WP (kg m ⁻³)	BC Ratio	Yield (t ha ⁻¹)	WP (kg m ⁻³)	BC Ratio	Yield (t ha ⁻¹)	BC Ratio
Irrigation levels (I)											
Daily (I ₁)	24.28	1.21	0.90	30.41	1.03	1.18	22.70	0.72	0.89	25.80	0.99
Alternate days (I ₂)	25.22	1.43	0.96	40.97	1.51	1.57	20.62	0.70	0.79	28.94	1.10
Once in 3 days (I ₃)	21.02	1.26	0.79	40.90	1.51	1.48	18.40	0.64	0.72	26.37	0.99
CD (0.05)	10.25	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mulching (M)											
No Mulch- M ₁	14.42	0.80	0.64	26.87	0.93	1.18	18.40	0.61	0.84	19.50	0.88
Plastic Mulch- M ₂	19.18	1.06	0.56	34.37	1.26	1.01	16.94	0.57	0.50	23.50	0.69
Leaf Mulch- M ₃	36.92	2.03	1.43	51.04	1.85	2.04	26.38	0.89	1.06	38.11	1.50
CD (0.05)	10.70	0.60	0.43	12.70	0.50	0.58	NS	NS	0.45	6.22	0.25
Spacing (S)											
S ₁ - 75 X 75 cm	26.21	1.44	0.92	41.38	1.22	1.14	19.12	0.64	0.66	19.50	0.90
S ₂ 90 X 90 cm	20.80	1.15	0.84	33.47	1.48	1.68	22.03	0.74	0.94	23.50	1.15
CD (0.05)	8.36	NS	NS	NS	NS	0.47	NS	NS	NS	NS	0.21
I X M											
I ₁ X M ₁	12.46	0.62	0.53	22.29	0.76	1.02	22.29	0.71	1.02	19.01	0.86
I ₁ X M ₂	18.21	0.90	0.53	21.66	0.73	0.65	18.75	0.60	0.54	19.54	0.57

I ₁ X M ₃	42.17	2.09	1.63	47.29	1.60	1.87	27.08	0.86	1.10	38.84	1.53
I ₂ X M ₁	18.08	1.03	0.81	33.95	1.25	1.56	18.33	0.62	0.83	23.45	1.06
I ₂ X M ₂	21.17	1.20	0.63	38.54	1.42	1.12	18.54	0.63	0.55	26.08	0.76
I ₂ X M ₃	36.42	2.07	1.43	50.41	1.86	2.03	25.00	0.85	0.98	37.28	1.48
I ₃ X M ₁	12.73	0.76	0.60	24.37	0.79	0.96	14.58	0.51	0.67	16.03	0.74
I ₃ X M ₂	18.16	1.09	0.54	42.91	1.63	1.28	13.54	0.47	0.40	24.87	0.73
I ₃ X M ₃	32.17	1.93	1.23	55.41	2.10	2.20	27.08	0.95	1.09	38.22	1.51
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I X S											
I ₁ X S ₁	29.45	1.46	1.03	34.02	0.91	0.94	19.58	0.62	0.67	25.27	0.88
I ₁ X S ₂	19.11	0.95	0.76	26.80	1.15	1.42	25.83	0.82	1.11	26.32	1.09
I ₂ X S ₁	25.17	1.43	0.89	44.30	1.39	1.27	21.25	0.72	0.74	28.02	0.97
I ₂ X S ₂	25.28	1.44	1.02	37.63	1.63	1.88	20.00	0.68	0.83	29.86	1.24
I ₃ X S ₁	24.02	1.44	0.83	45.83	1.36	1.22	16.52	0.58	0.57	25.50	0.87
I ₃ X S ₂	18.02	1.08	0.75	35.97	1.65	1.75	20.27	0.71	0.87	27.25	1.12
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M X S											
M ₁ X S ₁	17.11	0.93	0.70	31.66	0.80	0.90	17.08	0.57	0.70	18.75	0.76
M ₁ X S ₂	11.74	0.67	0.59	22.08	1.06	1.46	19.72	0.66	0.99	20.24	1.01
M ₂ X S ₁	18.41	1.02	0.51	34.72	1.25	0.94	18.88	0.63	0.52	23.77	0.65
M ₂ X S ₂	19.95	1.11	0.63	34.02	1.27	1.09	15.00	0.50	0.47	23.22	0.73
M ₃ X S ₁	43.11	2.38	1.55	57.78	1.61	1.59	21.38	0.72	0.77	36.27	1.30
M ₃ X S ₂	30.73	1.68	1.32	44.30	2.10	2.48	31.38	1.05	1.35	39.96	1.71
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I X M X S											
I ₁ X M ₁ X S ₁	20.42	1.01	0.83	25.00	0.66	0.80	19.58	0.62	0.80	19.86	0.81
I ₁ X M ₁ X S ₂	4.50	0.22	0.22	19.58	0.85	1.24	25.00	0.80	1.24	18.16	0.90
I ₁ X M ₂ X S ₁	19.08	0.95	0.52	25.83	0.59	0.48	22.91	0.73	0.63	19.83	0.54
I ₁ X M ₂ X S ₂	17.33	0.86	0.54	17.50	0.88	0.81	14.58	0.46	0.46	19.25	0.60
I ₁ X M ₃ X S ₁	48.84	2.42	1.75	51.25	1.47	1.55	16.25	0.52	0.58	36.14	1.29
I ₁ X M ₃ X S ₂	35.50	1.76	1.52	43.33	1.74	2.19	37.91	1.21	1.61	41.55	1.78
I ₂ X M ₁ X S ₁	21.33	1.21	0.87	38.75	1.07	1.19	18.33	0.62	0.75	22.94	0.93
I ₂ X M ₁ X S ₂	14.83	0.84	0.74	29.16	1.43	1.94	18.33	0.62	0.92	23.97	1.20
I ₂ X M ₂ X S ₁	16.83	0.96	0.46	30.41	1.72	1.28	18.33	0.624	0.50	27.27	0.75

I ₂ X M ₂ X S ₂	25.50	1.45	0.80	46.66	1.12	0.96	18.75	0.64	0.59	24.89	0.78
I ₂ X M ₃ X S ₁	37.34	2.12	1.34	63.75	1.37	1.33	27.08	0.92	0.97	33.83	1.22
I ₃ X M ₃ X S ₂	35.50	2.02	1.52	37.08	2.35	2.74	22.91	0.78	0.98	40.72	1.75
I ₃ X M ₁ X S ₁	8.55	0.57	0.39	31.25	0.66	0.71	13.33	0.46	0.55	13.47	0.55
I ₃ X M ₁ X S ₂	7.08	0.95	0.80	17.50	0.91	1.21	15.83	0.55	0.80	18.60	0.93
I ₃ X M ₂ X S ₁	12.96	1.16	0.53	47.91	1.44	1.05	15.41	0.54	0.43	24.21	0.67
I ₃ X M ₂ X S ₂	8.55	1.02	0.54	37.91	1.82	1.51	11.66	0.41	0.36	25.53	0.81
I ₃ X M ₃ X S ₁	27.83	2.58	1.55	58.33	1.99	1.89	20.83	0.73	0.75	38.83	1.40
I ₃ X M ₃ X S ₂	8.59	1.27	0.91	52.50	2.21	2.51	33.33	1.16	1.44	37.61	1.62
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

4. CONCLUSION

From the experimental results, it was concluded that *Amorphophallus* planted at a spacing of 90 cm x 90 cm, irrigated at a frequency of once every three days, along with leaf mulching, increased the yield and water productivity, along with effective control of weed population.

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Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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