

Original Research Article

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Effect of Chemicals on Growth, Yield and Quality of Elephant Foot Yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]

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ABSTRACT

The present investigation entitled “Effect of chemicals on growth, yield and quality of elephant foot yam” was carried out at AICRP on Tuber Crops, Regional Horticultural Research Station, Navsari Agricultural University, Navsari (Gujarat) during the year 2017-18. The experiment was conducted in Randomized Block Design (RBD) with three replications and eleven treatments consisting of different chemicals (Thiourea: 200 and 300 ppm; KNO₃: 500 and 750 ppm; GA₃: 100 and 200 ppm; CCC: 50 and 75 ppm; MH: 250 and 500 ppm and water soaked *i.e.* control) with different concentrations. The sets of 250 g (± 50 g) were soaked in the solution for one hour as per the treatments. Among all soaking treatments, Thiourea 200 ppm was found most effective in days required for first emergence (20.00 days), plant height at 120 and 150 DAP (63.73 cm and 63.29 cm, respectively), culm girth at 120 and 150 DAP (15.57cm and 16.29 cm, respectively), petiole length at 120 and 150 DAP (52.80 cm and 53.67 cm, respectively), number of leaflets per plant at 90 and 150 DAP (297.53 and 311.93, respectively). Yield attributes *viz.*, corm diameter (14.82 cm), corm yield per plant (1.315 kg), yield per net plot (17.367 kg) and yield per hectare (30.15 t) were also recorded highest in T₁ treatment whereas, maximum number of cormels (3.13) per corm were found in T₃ (KNO₃ 500 ppm) treatment. Quality attributes *viz.*, dry matter content (32.60 %) and beta-carotene (Vitamin-A) content (147.13 IU) were found maximum in T₂ treatment whereas, the highest starch content (17.80 %) was found in T₁ treatment. Lowest amount of calcium oxalate content (0.0200 %) was found in T₁₀ (MH - 500 ppm) treatment.

Keywords

Plant growth regulators, Chemicals, Soaking treatment, Elephant foot yam

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Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* Dennst. Nicolson) is a tropical tuber crop belonging to family Araceae. It is

considered as a famine food in the Pacific Islands. It is gaining popularity as a cash crop among the farming community of our country due to its high production potential, higher biological efficiency, acceptable culinary

properties, medicinal utility and therapeutic values. It is commercially cultivated as annual, generally bearing one to few broad highly dissected leaf with long petiole and rhizomatous stem called corm (Nicolson, 1987). The corms are rich in starch and are used as staple food. The corm is consumed as a vegetable after boiling, baking and frying (Nedunchezhiyan *et al.*, 2002). In northern and eastern states, wild and local cultivars are generally grown for making pickles. It has high dry matter production capacity per unit area than most of the other vegetables.

The most popular variety for commercial cultivation in our country is “Gajendra”, which is a local selection from Kovvur, West Godavari district of Andhra Pradesh. It has high yielding potential with vigorous growing habit. The corms are smooth, hemispherical and depressed in the centre, 20-25 cm diameter and usually dull-yellowish brown colour at harvest. The corms are also free from acidity, produce less or no cormels and have better quality of flesh.

Plant growth regulators and some of the chemicals are synthetic organic compounds other than nutrients which modify or regulate or inhibit or promote, plant physiological processes in an appreciable measure when used in small concentrations. They are readily absorbed and these chemicals move rapidly through the tissues when applied to different plant parts. Many of these chemical compounds have been manufactured and tested and it is seen that the behaviour and response of each crop is highly variable according to the composition and concentration of the compounds. In other words, these compounds are specific in their action. These synthetic PGRs are put into several uses in horticulture, one of them is to increase crop yield and improve quality. The growth behaviour of many plants could be modified or controlled by applying small

amount of plant growth regulators, either by seed soaking, root dipping, spraying or drenching.

Commercially available plant growth regulators (PGRs) and plant growth enhancers (PGEs) are relatively recent agricultural advances. These products have the promise to increase crop production, fertilizer and water use efficiency and the profitability of agricultural production. They may play an ever increasing role in food and fibre production.

Materials and Methods

The present experiment was carried out at AICRP on Tuber Crops, Regional Horticultural Research Station, Navsari Agricultural University, Navsari (Gujarat) during the year 2017-18. The experiment was conducted in Randomized Block Design (RBD) with three replications. The setts of 250 g (\pm 50 g) were soaked for one hour in different solutions as per treatments *viz.*, Thiourea 200 ppm (T₁), Thiourea 300 ppm (T₂), KNO₃ 500 ppm (T₃), KNO₃ 750 ppm (T₄), GA₃ 100 ppm (T₅), GA₃ 200 ppm (T₆), CCC 50 ppm (T₇), CCC 75 ppm (T₈), MH 250 ppm (T₉), MH 500 ppm (T₁₀) and Water soaked *i.e.* control (T₁₁). The treated setts were shade dried for 3 days and planted at 60 cm x 60 cm distance on 22nd March, 2017. FYM (25 t/ha) was incorporated at the time of soil preparation. Recommended dose of 100: 50: 150 NPK kg/ha was applied out of which 50 % N, 50 % K₂O with 100% P₂O₅ was applied at the time of planting. At 30 DAP, 25% N and K₂O was applied immediately after first intercultural operation. Similarly, remaining 25% of N and K₂O were applied immediately after second intercultural operation at 60 DAP.

The bio-chemical analysis was done immediately after harvesting the corms. The starch and calcium oxalate content was

analyzed with the procedure given by Padmaja *et al.*, (2005) while dry matter content and β -carotene content was analyzed with respect to the procedure of (A.O.A.C., 1960).

Results and Discussion

Growth parameters like days required for first and 50 % emergence, plant height, culm girth, petiole length, number of leaflets per plant and days required for senescence were influenced by soaking of setts in different chemicals. Among different chemical treatments, thiourea treated corm setts produced better effect on emergence. The minimum number of days to first emergence (20.00 days) was recorded under T₁ (Thiourea - 200 ppm) treatment which was statistically remained at par with almost all the treatments in inducing early emergence except T₈, T₁₀ and T₁₁ treatments. The minimum number of days (31.33 days) to 50 per cent emergence was recorded under T₂ (Thiourea - 300 ppm) treatment which was statistically remained at par with T₁ and T₃ (Thiourea - 200 ppm and KNO₃ - 500 ppm, respectively) treatments which required 32.00 and 37.00 days, respectively for 50 % emergence. These results are in conformity with the findings of Nedunchezhiyan *et al.*, (2011) who reported that thiourea was most effective in inducing earliness in first sprouting. Naveen *et al.*, (2011) reported that reduction in the number of days for sprouting and sprouting percentage due to thiourea can be attributed to two reasons. The first being their effect in reducing the ABA levels, the prime factor imposing dormancy in corms and cormels and there by changing the endogenous hormonal balance in favour of promoters. Secondly, increase in quantum of alternate respiration due to these treatments. ABA is considered to be a principal endogenous regulator of dormancy in corms. The occurrence of alternate respiration mediated by alternate oxidase (AOX) and its positive correlation during seed germination has been

reported in crops like chickpea (Burguillo and Gregorio, 1997).

It is evident from table 1 that plant height, culm girth, petiole length showed non-significant difference at 90 DAP. Statistical analysis of the data revealed that at 120 and 150 DAP maximum plant height (63.73 cm and 63.29 cm, respectively) was recorded in treatment T₁ which was statistically remained at par with T₂, T₃, T₅, T₄ and T₆ treatments. The maximum petiole length (52.80 cm at 120 DAP and 53.67 cm at 150 DAP) was also measured in same T₁ treatment which was remained at par with T₂, T₃, T₅ and T₄ treatments at both growth stages (Table 1). Significant effect on culm girth was observed at both group stages. Maximum culm girth (15.57 cm at 120 DAP and 16.30 cm at 150 DAP) was recorded in T₁ treatment which was statistically remained at par with T₂, T₃, T₅ and T₆ treatments (Table 1). Similar results were reported by Ravi *et al.*, (2009) and Das *et al.*, (1995) in elephant foot yam. The taller plants under these treatments might be due to early sprouting observed under the present study. The grand growth period involving high physiological activity synchronized with maximum nutrient uptake may have aided to increase plant height and thereafter at 150 DAP marginal increase in plant height may be attributed to the rapid increase in corm growth and also because of diversion of more photosynthates from source (leaves) to sink (corm) which is most common phenomenon in almost all root and tuber crops Ravi *et al.*, (2009).

The effect of different treatments on canopy spread of elephant foot yam in both directions was measured and found that among all three growth stages *i.e.* 90, 120 and 150 DAP the significant result was obtained only at 120 DAP in E-W direction (Table 1) where maximum spread (72.13 cm) was recorded in T₂ (Thiourea 300 ppm) treatment.

Table.1 Effect of soaking treatments on growth parameters of elephant foot yam cv. Gajendra

Treatments	Growth parameters													
	Days required for emergence		Plant height			Petiole length			Culm girth			Canopy spread E-W		
	First emerg.	50 % emerg.	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP
T₁	20.00	32.00	51.00	63.73	63.29	36.20	52.80	53.67	13.23	15.57	16.30	69.73	70.00	70.60
T₂	20.33	31.33	49.07	63.17	62.53	35.06	51.87	52.73	12.23	14.67	15.50	65.00	72.13	69.33
T₃	20.67	37.00	49.00	60.67	62.03	34.60	49.13	52.67	12.37	14.43	15.30	64.33	69.27	66.67
T₄	21.67	39.33	46.27	59.00	59.67	32.20	48.73	49.93	12.10	14.20	14.90	60.93	67.00	64.33
T₅	20.67	38.00	47.33	59.80	60.23	32.06	48.80	50.60	12.23	14.40	15.07	62.80	68.13	65.33
T₆	21.67	40.67	45.27	58.07	57.80	30.30	47.73	48.27	11.87	13.70	14.40	60.40	67.00	64.00
T₇	22.67	42.33	41.67	52.07	52.83	28.03	41.47	43.53	11.17	12.33	13.10	55.33	63.27	63.33
T₈	32.67	47.33	38.80	49.80	50.13	25.80	37.73	39.73	10.63	11.97	12.77	54.13	59.20	61.13
T₉	22.33	40.67	40.93	53.47	53.67	30.60	42.90	44.80	11.40	12.53	13.43	57.00	63.47	63.67
T₁₀	24.67	46.00	38.93	51.87	52.60	28.00	39.00	43.33	10.77	12.03	12.80	55.20	59.47	61.67
T₁₁	32.67	49.33	43.27	54.27	54.47	26.00	43.77	44.80	10.60	13.20	14.00	54.06	64.40	63.67
SEm ±	1.23	2.12	2.83	2.86	2.82	2.38	2.82	2.59	0.66	0.73	0.73	4.30	2.73	2.72
C. D. (5%)	3.62	6.26	NS	8.44	8.33	NS	8.31	7.63	NS	2.16	2.16	NS	8.06	NS
CV %	8.98	9.10	10.98	8.70	8.55	13.40	10.65	9.40	9.84	9.36	8.84	12.45	7.19	7.25

Table.2 Effect of soaking treatments on growth parameters of elephant foot yam cv. Gajendra

Treatments	Growth parameters								
	Canopy spread N-S			Number of leaflets			Days required for senescence		
	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	1 st	50 %	Complete
T₁	68.33	71.40	73.00	297.53	301.00	311.93	190.33	199.67	205.00
T₂	63.60	70.93	72.87	294.67	310.80	303.93	191.00	200.67	204.33
T₃	64.93	70.00	72.00	293.47	285.53	288.93	187.67	197.33	204.00
T₄	62.13	66.47	69.67	241.00	279.33	283.87	188.67	198.33	201.00
T₅	62.20	68.67	70.33	286.13	283.93	286.33	185.67	195.00	202.67
T₆	60.87	68.47	68.67	252.40	275.07	283.87	186.33	196.00	201.33
T₇	54.80	64.47	67.13	233.00	246.33	253.27	188.00	197.33	202.00
T₈	54.46	61.33	65.33	204.47	242.27	244.53	188.67	198.33	202.67
T₉	56.93	64.80	67.67	233.60	258.40	262.47	188.33	198.00	203.00
T₁₀	54.80	62.87	65.33	211.13	242.33	250.60	189.00	198.67	203.33
T₁₁	53.53	65.60	68.33	199.47	274.67	271.87	185.00	194.67	200.67
SEm ±	3.84	2.72	2.94	15.07	14.94	13.49	0.32	0.35	0.40
C. D. (5%)	NS	NS	NS	44.47	44.08	39.80	0.94	1.04	1.19
CV %	11.14	7.06	7.38	10.46	9.49	8.45	0.29	0.31	0.35

Table.3 Effect of soaking treatments on yield and quality parameters of elephant foot yam cv. Gajendra

Treatments	Yield parameters					Quality parameters			
	Corm diameter (cm)	Number of cormels per corm	Corm yield per plant (kg)	Corm yield per plot (kg)	Corm yield per hectare (tonne)	Dry matter content (%) of corm	Starch content (%)	Calcium oxalate content (%)	Vitamin-A content (IU)
T ₁	14.83	3.00	1.315	17.367	30.15	32.43	17.80	0.0209	146.33
T ₂	14.73	1.47	1.237	16.367	28.41	32.60	17.57	0.0218	147.13
T ₃	13.80	3.13	1.208	16.167	28.07	31.40	16.97	0.0213	143.43
T ₄	13.50	1.93	1.130	15.700	27.26	31.33	16.97	0.0207	142.73
T ₅	13.69	2.00	1.151	16.167	28.07	29.73	16.43	0.0216	142.53
T ₆	13.17	1.73	0.940	15.600	27.08	29.93	15.83	0.0218	141.30
T ₇	12.17	1.93	0.898	14.600	25.35	26.93	15.83	0.0205	139.37
T ₈	11.50	1.87	0.830	14.067	24.42	27.80	15.80	0.0218	138.90
T ₉	12.43	1.20	0.906	15.000	26.04	28.50	15.83	0.0220	139.87
T ₁₀	11.97	1.33	0.888	14.567	25.29	28.20	15.57	0.0200	139.47
T ₁₁	11.30	0.67	0.818	13.667	23.73	27.26	13.97	0.0205	136.67
SEm ±	0.80	0.33	0.07	0.72	1.24	0.46	0.15	0.0004	0.80
C. D. (5%)	2.35	0.97	0.21	2.11	3.67	1.36	0.45	0.0012	2.37
CV %	10.63	30.92	12.14	8.06	8.06	2.69	1.65	3.36	0.98

Though the difference was non-significant at other growth stages, the overall impact of thiourea 200 ppm was positive to achieve maximum canopy spread in both directions. These results corroborate the findings of Mondal *et al.*, (2005) who recorded more canopy spread with various soaking treatments of thiourea, KNO₃ and cow dung slurry in elephant foot yam. Canopy spread was presumably due to early sprouting and better root ramification as reported by Sen and Das (1991).

The data depicted in table 2 revealed that different soaking treatment had significant effect on number of leaflets per plant at all three growth stages. At the age of 90 days the maximum number of leaflets (297.53) per plant was recorded with T₁ treatment but statistically remained at par with T₂, T₃ and T₅ treatments. After 120 DAP the maximum number of leaflets (310.80) per plant was obtained from T₂ treatment which was remained at par with T₁, T₃, T₅, T₄ and T₆ treatments. At 150 DAP the maximum number of leaflets (311.93) was recorded again in T₁ treatment. This was statistically remained at par with T₂, T₃, T₅, T₄ and T₆ treatments. Shanu *et al.*, (2013) observed that thiourea maintained more number of green leaves and this was supported by the results of Sahu *et al.*, (1993) also.

The data given in table 2 showed that the maximum number of days (191.00 days) required for first senescence was recorded in treatment T₂ (Thiourea - 300 ppm) which was statistically remained at par with treatment T₁ (Thiourea - 200 ppm) which took only 0.67 less days for first senescence. The maximum number of days (200.67 days) required for 50 % senescence was also recorded in treatment T₂ (Thiourea - 300 ppm) and was statistically remained at par with treatment T₁ (Thiourea - 200 ppm) which took 199.67 days for 50 % senescence. Whereas, the longest period

required for complete senescence (205.00 days) was recorded with T₁ (Thiourea - 200 ppm) treatment but it was statistically remained at par with T₂ and T₃ treatments which required 204.33 days and 204.00 days, respectively for complete senescence. It might be due to the function of thiourea that concomitantly increase cell metabolic rate and retard senescence by protecting and preventing chloroplasts from senescing and retarding chlorophyll destruction and/or increase chlorophyll biosynthesis. This was supported by the findings of Jocelyn, 1972 who studied chemical properties of thiols.

The significant effect of all growth parameters also provided support for a possibility that thiourea might have resulted into creation of more photosynthetically active leaf for longer period, leading to more absorption and utilization of radiant energy which ultimately resulted in higher plant height, number of leaflets, canopy spread and culm girth. Similar, results were reported by Solanki (2002) in cluster bean and Balai (2005) in coriander.

Soaking treatment of corm setts gave significant differences on yield and yield attributing characters like corm diameter, number of cormels per corm, corm yield per plant, corm yield per plot and yield per hectare (Table 3). Significant influence was observed on corm diameter by different soaking treatments. The highest corm diameter (14.83 cm) was recorded in treatment T₁ (Thiourea - 200 ppm) which was statistically remained at par with T₂, T₃, T₅, T₄ and T₆ treatments having 14.73 cm, 13.80 cm, 13.69 cm, 13.50 cm and 13.17 cm corm diameter, respectively. This might be due to early sprouting of corm setts in these treatments which resulted into sufficient vegetative growth and canopy spread which in turn to higher photosynthesis, increased assimilates and translocation of these

assimilates to the resulting corms thereby increasing their diameter (Kumar *et al.*, 2009). Ample energy may be made available for the bulking of corms due to improvement in vegetative characters of plants. Similar results were reported by Mohankumar *et al.*, (1973) in elephant foot yam.

Treatment T₁ (Thiourea 200 ppm) resulted in maximum corm yield per plant (1.315 kg) which was statistically at par with T₂, T₃, T₅ and T₄ which produced corm weight of 1.237 kg, 1.208 kg, 1.151 kg and 1.130 kg per plant, respectively. Among different treatments, T₁ (Thiourea - 200 ppm) treatment produced highest corm yield (17.367 kg) per net plot which was statistically remained at par with T₂ (16.367 kg/net plot), T₃ (16.167 kg/net plot), T₅ (16.167 kg/net plot), T₄ (15.700 kg/net plot) and T₆ (15.600 kg/net plot) treatments. This corm yield was when converted on hectare basis, the highest corm yield of 30.15 t ha⁻¹ was produced in treatment T₁ which was statistically remained at par with T₂, T₃, T₅, T₄ and T₆ treatments, which produced 28.41 t ha⁻¹, 28.07 t ha⁻¹, 28.07 t ha⁻¹, 27.26 t ha⁻¹ and 27.08 t ha⁻¹, respectively. Increase in corm yield under this treatment might be ascribed to comparatively greater individual growth and development of plants due to early sprouting and vigour. The increase in yield attributes and yield obtained with thiourea treatment was most probably due to increased photosynthesis favoured by both improved photosynthesis effect and source to sink relationship (Anonymous, 2002). These results are in conformity with the findings of (Nedunchezhiyan and Mohankumar, 1994; Kumar *et al.*, 1998; Bhagavan, 2005). Dhua *et al.*, 1988 and Das *et al.*, 1995 also reported outstanding performance of these substances in increasing the corm yield. Shant and Singh, 1985 reported that when thiourea was applied as seed soaking, exhibited growth regulating effect. Vassilev and Mashev, 1974 also observed that thiourea exhibited the activities like cytokinin.

Analysis of dry matter content, starch content, calcium oxalate content and β -carotene content

from the corm of elephant foot yam was carried out as per the standard methods. The highest dry matter content (32.60 %) of corm was analysed in treatment T₂ (Thiourea 300 ppm) which was statistically remained at par with treatments T₁, T₃ and T₄ which had 32.43%, 31.40 % and 31.33 % dry matter content. Sahu and Singh (1995) observed that thiourea affects both carbohydrates and nitrogen metabolism which in turn enhances plant performance and increased dry matter production and yield. The minimum number of cormels per corm (0.67) was recorded on the corms produced in control (T₁₁) which was statistically remained at par with treatments T₉ (1.20), T₃ (1.33) and T₄ (1.47). The maximum starch content of 17.80 % was found in T₁ (Thiourea 200 ppm) treatment and was at par with T₂ (17.57 %) treatment. Thiourea also plays an important role in maximizing starch accumulation in the corms. Shanu *et al.*, (2013) observed that thiourea with its sulphydral group not only favoured larger green photosynthetic surface but it might have also favoured the activity of starch synthetase in coriander. It might be due to the fact that thiourea molecule is a good donor of sulphur atoms in biological reactions (Randle and Bussard, 1993). Balai and Keshwa (2011), observed that application of thiourea increases the total uptake of N, P and K and creates lighter microbial population in soil which is responsible for mobilizing essential nutrients which may increase starch content. The lowest calcium oxalate content (0.0200 %) was found in treatment T₁₀ (MH 500 ppm) which was statistically remained at par with T₁₁ (0.0205 %), T₇ (0.0205 %), T₄ (0.0207 %) and T₁ (0.0209 %) treatments. Higher β -carotene content (147.13 IU) was found in treatment T₂ (Thiourea- 300 ppm) which was statistically remained at par with T₁ (146.33 IU) treatment. It might be due to the fact that production of these quality parameters was possible only at the later stages of development of plant and tuber growth when compared to early stages of their harvest. In the present study early emergence and delayed maturity were noted under these treatments which may have enhanced opportunity for accumulation of beta

carotene over longer period. Similar results have been reported by Bhagavan (2005) and Ashokan *et al.*, (1984).

On the basis of present findings inferred that effect of chemicals had highly influenced on vegetative, yield and quality parameters. The pre-planting soaking of setts in thiourea @ 200 ppm was found better for boosting up the production of elephant foot yam cv. Gajendra.

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