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Sprouting, yield and economics of elephant foot yam (*Amorphophallus paeoniifolius* Dennst.) under the influence of different pre-planting treatments with organic and inorganic substances

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ABSTRACT : The aim of this study was to evaluate the sprouting, yield and economics of elephant foot yam under the influence of different pre-planting treatments using organic and inorganic substances. The pre-planting treatment of minisetts with thiourea at 400 ppm resulted in maximum sprouting percentage (97.22%). This treatment also recorded highest corm yield (12.57 t ha^{-1}) and showed maximum increase in corm yield (31.07%) over the control treatment. The economics over two years showed that among the different pre-planting treatments, the thiourea at 400 ppm stood as the best treatment which gave maximum net return of Rs. 91851 with a B: C ratio of 2.71 followed by thiourea at 300 ppm (net return Rs. 90651 and B: C ratio 2.69), thiourea at 200 ppm (net return Rs. 88951 and B: C ratio 2.66) and KNO_3 at 250 ppm (net return Rs. 88021 and B: C ratio 2.66).

KEY WORDS : Corm, Minisetts, KNO_3, Thiourea, GA_3

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Elephant foot yam (*Amorphophallus paeoniifolius* Dennst.) is one of the important tuber crops widely cultivated in the sub-tropical regions for its underground food reserves. The tubers serve as a cheap source of energy especially for the weaker sections of the society. Due to its high photosynthetic efficiency and high dry matter production capability per unit area, substantial yields may be obtained under poor and marginal soils under harsh climatic conditions. Traditionally, elephant foot yam is propagated through corms and cormels. Whole corm or cut corm pieces weighing about 500 to 750 g with a part of apical meristem is mainly used as planting material. A great portion (about 25%) of the harvested produce is lost as source of planting material. Gajendra variety of elephant foot yam is high yielding, free from acridity and it is popularly grown all over India as well as Chhattisgarh. Elephant foot yam tubers remain dormant for 2 to 3 months (Kay, 1987 and Anonymous, 1993). As a result of this, planting and harvesting are done at a particular time of the year. Hence, it necessitates breaking the dormancy by the use of organic and inorganic substances so that the planting materials could be made ready for planting early in the season to ensure early yields and lucrative market prices. This study aims to find out the sprouting, yield and economics of the different pre-planting treatments with organic and inorganic substances.

RESEARCH METHODS

The experiment was conducted at the Research and Instructional Farm of the Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during *Kharif* season of the years 2010 to 2011 and 2011 to 2012.The experiments were laid out in Randomized Block Design (RBD) with fifteen treatments and three replications. The treatment consisted of different concentrations of organic and inorganic substances which were applied as pre-planting soaking of corms for 1 h. Minisetts of weight 100 g were planted vertically in the month of July at a spacing of 60 × 60 cm in pits of size 30 × 30 × 30 cm at a depth of 10 to 15 cm, after treating these minisetts with fungicide (Dithane M-45 @ 2.5 g L^{-1}) followed by pre-planting soaking for 1 h in different organic and inorganic substances as per treatments. The farm yard manure (FYM) was incorporated in the soil at 200 q ha^{-1} before planting the minisetts. Recommended dose of nitrogen, phosphorus and potassium were applied at 100:60:100 kg ha^{-1} in the form of urea, single super phosphate and murate of potash, respectively. The entire quantity of phosphorus and one third dose of nitrogen and potassium were incorporated as basal applications. However, for the remaining two, one-third doses of each nitrogen and potassium were applied in two equal splits at 60 and 90 days after planting (DAP). The crop was harvested in the month of February when the leaves turned yellow and started drying. The sprouting percentage was recorded after the crop emergence was completed. The sprouting percentage or the plant emergence percentage was calculated with the help of following formula :

$$\text{Sprouting \%} = \frac{\text{Total number of emerged plants}}{\text{Total number of planted corms}} \times 100$$

The corm yield per plot was recorded at the time of harvesting in kilograms and the average yield per hectare was computed and expressed in tonnes. The first year (2010 to 2011), second year (2011 to 2012) and pooled data were analysed for economics. The total cost of cultivation and gross returns were calculated from the average input cost and average market price of the produce during the period of investigation. Based on these, the net income and benefit: cost (B: C) ratio was computed as follows:

Net return (Rs. ha^{-1}) = Gross return (Rs. ha^{-1}) – cost of cultivation (Rs. ha^{-1})

$$\text{B : C ratio} = \frac{\text{Net return (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

RESEARCH FINDINGS AND DISCUSSION

Appraisal of data presented in Table 1 revealed that the maximum sprouting percentage was recorded under T_8 *i.e.*, thiourea at 400 ppm (97.22%, pooled data)

Table 1 : Sprouting of elephant foot yam cv. GAJENDRA as influenced by different pre-planting treatments of minisett corms (2010-11, 2011-12 and average of the two years)

Treatments			Sprouting (%)		
			2010-11	2011-12	Pooled
T_1	:	Cow dung slurry (50%) + Water (50%)	92.59	90.74	91.67
T_2	:	Cow urine (50%) + Water (50%)	90.74	91.67	91.20
T_3	:	Cow dung (25%) + Cow urine (25%) + Water (50%)	93.52	92.59	93.06
T_4	:	Cow dung (37.5%) + Cow urine (37.5%) + Water (25%)	90.74	90.74	90.74
T_5	:	Cow dung (50%) + Cow urine (50%)	93.52	92.59	93.06
T_6	:	Thiourea at 200 ppm	94.44	96.30	95.37
T_7	:	Thiourea at 300 ppm	97.22	96.30	96.76
T_8	:	Thiourea at 400 ppm	96.30	98.15	97.22
T_9	:	KNO_3 @ 250 ppm	95.37	95.37	95.37
T_{10}	:	KNO_3 @ 500 ppm	94.44	93.52	93.98
T_{11}	:	KNO_3 @ 750 ppm	93.52	91.67	92.59
T_{12}	:	GA_3 @ 100 ppm	80.56	79.63	80.09
T_{13}	:	GA_3 @ 200 ppm	79.63	78.70	79.17
T_{14}	:	GA_3 @ 300 ppm	79.63	79.63	79.63
T_{15}	:	Water (Control)	78.70	77.78	78.24
C.D. (P=0.05)			4.60	3.92	3.24
S.E. ±			1.59	1.35	1.12

followed by T_7 *i.e.*, thiourea at 300 ppm (96.76%, pooled data), T_6 *i.e.*, thiourea at 200 ppm and T_9 *i.e.*, KNO_3 at 250 ppm (95.37%, pooled data). The minimum sprouting per cent at this stage was obtained under T_{15} *i.e.*, the control treatment (78.24%, pooled data) followed by T_{13} *i.e.*, GA_3 at 200 ppm (79.17%, pooled data), T_{14} *i.e.*, GA_3 at 300 ppm (79.63%, pooled data) and T_{12} *i.e.*, GA_3 at 100 ppm (80.09%, pooled data).

Dhua *et al.* (1988) reported that the different growth substances were found to increase the sprouting percentage in elephant foot yam. The findings are in accordance with Das *et al.* (1995) who reported that soaking of corm setts with thiourea and KNO_3 increased the sprouting percentage in elephant foot yam. Effect of

Table 2 : Yield and economics of elephant foot yam cv. GAJENDRA as influenced by different pre-planting treatments of minisett corms in one hectare area (2010-11, 2011-12 and average of two years)

Treatments	Yield (t)			Gross return (Rs.)			Cost of cultivation (Rs.)		
	2010-11	2011-12	Average	2010-11	2011-12	Average	2010-11	2011-12	Average
Cow dung slurry (50%) + water (50%)	11.21	11.03	11.12	112100	110300	111200	32328	34170	33249
Cow urine (50%) + Water (50%)	11.43	11.77	11.60	114300	117700	116000	32628	34470	33549
Cow dung (25%) + Cow urine (25%) + Water (50%)	11.70	11.80	11.75	117000	118000	117500	32478	34320	33399
Cow dung (37.5%) + Cow urine (37.5%) + Water (25%)	11.17	10.68	10.92	111700	106800	109200	32653	34495	33574
Cow dung (50%) + Cow urine (50%)	11.69	11.65	11.67	116900	116500	116700	32828	34670	33749
Thiourea @ 200 ppm	12.43	12.04	12.24	124300	120400	122400	32528	34370	33449
Thiourea @ 300 ppm	12.49	12.37	12.43	124900	123700	124300	32728	34570	33649
Thiourea @ 400 ppm	12.75	12.39	12.57	127500	123900	125700	32928	34770	33849
KNO_3 @ 250 ppm	12.31	11.92	12.11	123100	119200	121100	32158	34000	33079
KNO_3 @ 500 ppm	12.01	11.86	11.93	120100	118600	119300	32188	34030	33109
KNO_3 @ 750 ppm	11.71	11.78	11.74	117100	117800	117400	32218	34060	33139
GA_3 @ 100 ppm	10.54	10.60	10.57	105400	106000	105700	36128	37970	37049
GA_3 @ 200 ppm	10.61	10.47	10.54	106100	104700	105400	40128	41970	41049
GA_3 @ 300 ppm	10.53	10.46	10.49	105300	104600	104900	44128	45970	45049
Water (Control)	9.61	9.57	9.59	96100	95700	95900	32128	33970	33049

Market rate of elephant foot yam @ 10 kg^{-1}

Contd... Table 2

Treatments	Net return (Rs.)			B:C ratio		
	2010-11	2011-12	Average	2010-11	2011-12	Average
Cow dung slurry (50%) + water (50%)	79772	76130	77951	2.47	2.23	2.34
Cow urine (50%) + Water (50%)	81672	83230	82451	2.50	2.41	2.46
Cow dung (25%) + Cow urine (25%) + Water (50%)	84522	83680	84101	2.60	2.44	2.52
Cow dung (37.5%) + Cow urine (37.5%) + Water (25%)	79047	72305	75626	2.42	2.10	2.25
Cow dung (50%) + Cow urine (50%)	84072	81830	82951	2.56	2.36	2.46
Thiourea @ 200 ppm	91772	86030	88951	2.82	2.50	2.66
Thiourea @ 300 ppm	92172	89130	90651	2.82	2.58	2.69
Thiourea @ 400 ppm	94572	89130	91851	2.87	2.56	2.71
KNO_3 @ 250 ppm	90942	85200	88021	2.83	2.51	2.66
KNO_3 @ 500 ppm	87912	84570	86191	2.73	2.49	2.60
KNO_3 @ 750 ppm	84882	83740	84261	2.63	2.46	2.54
GA_3 @ 100 ppm	69272	68030	68651	1.92	1.79	1.85
GA_3 @ 200 ppm	65972	62730	64351	1.64	1.49	1.57
GA_3 @ 300 ppm	61172	58630	59851	1.39	1.28	1.33
Water (Control)	63972	61730	62851	1.99	1.82	1.90

Market rate of elephant foot yam @ 10 kg^{-1}

Appendix (a): Cost of cultivation of elephant foot yam cv. GAJENDRA in one hectare area during year 2010-11

Sr. No.	Operations	Rate (Rs.)	Quantity	Cost (Rs.)														
				T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}
Fixed cost																		
1	Field preparation tractor																	
	Ploughing	350 hr^{-1}	2 hr	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700
	Harrowing	350 hr^{-1}	3 hr	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
2	Seed Treatment	210 kg^{-1}	2.5 kg per	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525
	DithaneM-45		1000 litre															
3	Manure and fertilizer																	
	FYM	30 q^{-1}	200 q	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
	Urea	5.05 kg^{-1}	217.39 kg	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098	1098
	SSP	3.36 kg^{-1}	375 kg	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260
	MOP	6.30 kg^{-1}	166.67 kg	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
4	Manure and fertilizer application	125 man^{-1}	5	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
5	Planting Material	800 q^{-1}	15.50 q	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400
6	Planting Cost	125 man^{-1}	15	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875
7	Intercultural practices including Earthing up and weeding	125 man^{-1}	5	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
8	Irrigation	125 man^{-1}	5	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
9	Plant protection																	
	Rogor	190 lit^{-1}	2 lit	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380
	Dithane M-45	210 kg^{-1}	2 kg	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
10	Harvesting	125 man^{-1}	15	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875
11	Grading	125 man^{-1}	5	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
12	Miscellaneous			1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Total fixed cost			32128	32128	32128	32128	32128	32128	32128	32128	32128	32128	32128	32128	32128	32128	32128
Variable cost																		
01	Pre-planting treatments			200	500	350	525	700	400	600	800	30	60	90	4000	8000	12000	-
	Total cost (A+B)			32328	32628	32478	32653	32828	32528	32728	32928	32158	32188	32218	36128	40128	44128	32128

Note: cost of thiourea Rs. 2 g^{-1}, KNO_3 Rs. 120 kg^{-1} and GA_3 Rs. 40 g^{-1}

T_1 : Cow dung slurry (50%) + Water (50%)
T_2 : Cow urine (50%) + Water (50%)
T_3 : Cow dung (25%) + Cow urine (25%) + Water (50%)
T_4 : Cow dung (37.5%) + Cow urine (37.5%) + Water (25%)
T_5 : Cow dung (50%) + Cow urine (50%)
T_6 : Thiourea at 200 ppm
T_7 : Thiourea at 300 ppm
T_8 : Thiourea at 400 ppm
T_9 : KNO_3 at 250 ppm
T_{10} : KNO_3 at 500 ppm
T_{11} : KNO_3 at 750 ppm
T_{12} : GA_3 at 100 ppm
T_{13} : GA_3 at 200 ppm
T_{14} : GA_3 at 300 ppm
T_{15} : Water (Control)

Appendix (b): Cost of cultivation of elephant foot yam cv. GAJENDRA in one hectare area during year 2011-12

Sr. No.	Operations	Rate (Rs.)	Quantity	Cost (Rs.)														
				T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}	T_{15}
Fixed cost																		
1	Field preparation tractor																	
	Ploughing	350 hr^{-1}	2 hr	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700
	Harrowing	350 hr^{-1}	3 hr	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050	1050
2	Seed Treatment DithaneM-45	210 kg^{-1}	2.5 kg per 1000 litre	525	525	525	525	525	525	525	525	525	525	525	525	525	525	525
3	Manure and fertilizer																	
	FYM	30 q^{-1}	200 q	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
	Urea	5.63 kg^{-1}	217.39 kg	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224	1224
	SSP	5.45 kg^{-1}	375 kg	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044	2044
	MOP	11.87 kg^{-1}	166.67 kg	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977
4	Manure and fertilizer application	125 man^{-1}	5	625	625	625	625	625	625	625	525	625	625	625	625	625	625	625
5	Planting Material	800 q^{-1}	15.50 q	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400	12400
6	Planting Cost	125 man^{-1}	15	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875
7	Intercultural practices including Earthing up and weeding	125 man^{-1}	5	625	625	625	625	625	625	625	525	625	625	625	625	625	625	625
8	Irrigation	125 man^{-1}	5	625	625	625	625	625	625	625	525	625	625	625	625	625	625	625
9	Plant protection																	
	Rogor	190 lit^{-1}	2 lit.	380	380	380	380	380	380	380	380	380	380	380	380	380	380	380
	Dithane M-45	210 kg^{-1}	2 kg	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
10	Harvesting	125 man^{-1}	15	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875	1875
11	Grading	125 man^{-1}	5	625	625	625	625	625	625	625	525	625	625	625	625	625	625	625
12	Miscellaneous			1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
	Total fixed cost			33970	33970	33970	33970	33970	33970	33970	33970	33970	33970	33970	33970	33970	33970	33970
Variable cost																		
01	Pre-planting treatments			200	500	350	525	700	400	600	800	30	60	90	4000	8000	12000	-
	Total cost (A+B)			34170	34470	34320	34495	34670	34370	34570	34770	34000	34030	34060	37970	41970	45970	33970

Note: cost of thiourea Rs. 2 g^{-1}, KNO_3 Rs. 120 kg^{-1} and GA_3 Rs. 40 g^{-1}

T_1 : Cow dung slurry (50%) + Water (50%)
T_2 : Cow urine (50%) + Water (50%)
T_3 : Cow dung (25%) + Cow urine (25%) + Water (50%)
T_4 : Cow dung (37.5%) + Cow urine (37.5%) + Water (25%)
T_5 : Cow dung (50%) + Cow urine (50%)
T_6 : Thiourea at 200 ppm
T_7 : Thiourea at 300 ppm
T_8 : Thiourea at 400 ppm
T_9 : KNO_3 at 250 ppm
T_{10} : KNO_3 at 500 ppm
T_{11} : KNO_3 at 750 ppm
T_{12} : GA_3 at 100 ppm
T_{13} : GA_3 at 200 ppm
T_{14} : GA_3 at 300 ppm
T_{15} : Water (Control)

thiourea in increasing the alternate respiration might have resulted in breaking of dormancy and increasing sprouting percentage as reported by Kumar *et al*. (2011). Similar results have been reported by Bhagavan (2005); Kumar *et al*. (1998) and Basiouny (1983).

The data on corm yield (t ha^{-1}) presented in Table 2 revealed that the pre-planting treatments of corm setts of elephant foot yam with different organic and inorganic substances increased the average corm yield from 9.41 to 31.07 per cent over the control treatment (soaking of minisetts in water) and the highest corm yield (12.24 to 12.57 t ha^{-1}, pooled data) was obtained with thiourea at all the concentrations (200, 300 and 400 ppm) which were found to be statistically equal in increasing the corm yield. These were closely followed by KNO_3 at 250 ppm (12.11 t ha^{-1}, pooled data). In general, all the cow dung based pre-planting treatments (T_1 to T_5) gave better responses to productivity due to enhanced sprouting but were found to be comparatively less superior to the rest of the treatments except GA_3.

Mondal *et al*. (2005) obtained the highest corm yield of elephant foot yam with cow dung slurry treatment because of improvement in sprouting and vegetative growth of the crop plant. In this study, the corm yield did not show much improvement under cow dung based treatment in comparison to the rest of the treatments which might probably be due to a comparatively low percentage of sprouting.

The results in relation to thiourea and KNO_3 in increasing the corm yield are in conformity with Das *et al*. (1995) who reported an outstanding performance of these substances in increasing the corm yield.

The economics of the crop under experimentations were worked out as per the treatment of the experiment during both years (2010 to 2011 and 2011 to 2012) as well as in the pooled data which is presented in Table 2. The economics over the two years showed that among the different pre-planting treatments, the T_8 (thiourea at 400 ppm) stood as the best treatment which gave a maximum net return of Rs. 91851 with a B: C ratio of 2.71 followed by T_7 *i.e.*, thiourea at 300 ppm (net return Rs. 90651 and B:C ratio 2.69), T_6 *i.e.*, thiourea at 200 ppm (net return Rs. 88951 and B:C ratio 2.66) and T_9 *i.e.*, KNO_3 at 250 ppm (net return Rs. 88021 and B:C ratio 2.66). However, the minimum net return of Rs. 59851 with a B: C ratio of 1.33 was obtained under the T_{14} (GA_3 at 300 ppm) followed by T_{15} *i.e.*, control (net return Rs. 62851 and B: C ratio 1.90), T_{13} *i.e.*, GA_3 at 200 ppm (net return Rs. 64351 and B: C ratio 1.57) and T_{12} *i.e.*, GA_3 at 100 ppm (net return Rs. 68651 and B: C ratio 1.85) in the case of pooled data. [Appendix (a) and (b)]

Conclusion :

Among the different pre-planting treatments, thiourea at 400 ppm recorded a maximum sprouting percentage (97.22%) and corm yield (t ha^{-1}) and these treatment (thiourea at 400 ppm) stood as the best treatment in crop economy which gave a maximum net return of Rs. 91851 with a B: C ratio of 2.71.

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