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Effect of Growth Regulator and Chemical Treatment on Dormancy Breaking in Elephant Foot Yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson)

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Abstract

Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) is one of the most nutritious tropical tuber crop grown for its starchy corms. It is propagated through both corms and cormels. Availability of quality seed material is the major constraints in elephant foot yam cultivation.Field experiment was conducted at ICAR-Central Tuber Crops Research Institute, Sreekariyam,Thiruvananthapuram, Kerala during 2014 -2015 to find out the effect of growth regulators and chemical treatments on breaking corm dormancy to induce uniform sprouting and enhance yield in elephant foot yam. The results revealed that elephant foot yam corms treated with GA_3 (200 ppm) resulted in uniform sprouting with 88.69 % sprouting at 60 days after planting. The growth parameters indicated that maximum plant height (48 cm) and canopy spread (71.10 cm) were recorded in plants raised from corms treated with GA_3 (200) ppm at 90 days after planting. The corm yield data revealed that plants raised from corms treated with GA_3 (200 ppm) produced highest corms yield (10.21 t ha^{-1}) followed by plants raised from corms treated with IAA (100 ppm) which produced 7.31 t ha^{-1}. The corm yield of plants raised from untreated corm was very low (4.15 t ha^{-1}). Plants raised from corms treated with thiourea (0.5%) produced significantly maximum number of corms (10,059 ha^{-1}).

Key words: Sprouts, breaking dormancy, gibberellic acid, growth regulator, corms yield

Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) is a tuber crop belonging to Araceae family. It is widely cultivated cash crop due to its production potential and popularity as a tuberous vegetable in India. It is a perennial herb and commercially cultivated as annual, generally bearing one to few broad highly dissected leaf with long petiole and rhizomatous stem called corm (Nicolson, 1987) (Jos et al., 1977; Prakash and Nayar, 2000).The corms are rich in starch and are used as staple food. In India, it is commercially cultivated as a food crop in Andhra Pradesh, Bihar, Odisha, West Bengal, Gujarat, Kerala, Tamil Nadu, Maharastra, Uttar Pradesh, Jharkhand, Chhattisgarh, Punjab and North – Eastern states of India (Nedunchezhiyan and Byju, 2005; Nedunchezhiyan et al., 2006). The corm is consumed as a vegetable after boiling, baking and frying (Nedunchezhiyan et al., 2002; Nedunchezhiyan, 2008). However, in northern and eastern states, wild, local cultivars are generally grown for making pickles. It has several medicinal properties and found to be effective in the treatment of piles, dysentery, asthma, swelling of lungs, vomiting and gastrointestinal disorders (Raghu et al., 1999). In addition, it is used in pharmaceutical preparations, especially in ayurvedic medicines. It has high dry matter production capacity per unit area than most of the other vegetables. Several factors affect the growth and yield of elephant foot yam (Ravi et al., 2011; Suja et al., 2012).

Lack of sufficient planting material of uniform size, non availability of good quality planting material and corm dormancy are the major constraints limiting the production of elephant foot yam (Bhagavan et al., 2008) and (Misra et al., 2001). By adopting conventional method of propagation, multiplication rate of 1:4 and by the minisett technique, multiplication rate of 1:15 could be attained (James George and Nair, 1993).Whole corms or cut corm pieces (500-750g) having part of apical meristem is mainly used as planting material. A major portion (about 25%) of the harvested produce is lost as source of planting material. At times, it is very difficult to access large quantity of quality planting materials by resource poor farmers. The apical bud of the cormels sprouts simultaneously in the planted corms, irrespective of the size, once dormancy is broken or bud development is complete. Hence, farmers separate the cormels from the corms immediately after harvest and use as seed material. It requires 5.0 to 6.0 t of corms to plant one ha area and the bulkiness of the material makes the transportation and safe storage difficult. Corms are not suitable for immediate planting due to the dormancy and also slow development of bud which takes about 3-4 month after harvest. The new sprout emerges from the corm not only dormancy, bud differentiation and bud growth takes nearly two month after dormancy breaking then sprout growth is visible:

Studies reported that the corm dormancy depends mainly on intrinsic balance of abscisic acid (ABA) and GA_3 which indicates that GA_3 has pronounced effect in regulating dormancy. Growth regulators gibberellic acid, Indole acetic acid and other chemicals agents like potassium nitrate, thiourea are used to break seed dormancy and to improve seed germination in many plant species (Pallais et al., 1991; Karam and Al-Salem, 2001; Bahrani et al., 2008; Zeinalabedini et al, 2009; Deng et al., 2010; Zeng et al., 2010). Gibberellic acid, potassium nitrate and thiourea were found to hasten sprouting (Nedunchezhiyan and Mohankumar, 1997; Kumar et al., 1998; Bhagavan, 2005) and enhance sprouting percentage. (Dhua et al 1988; Das et al., 1995; Kumar et al., 1998; Bhagavan, 2005) in elephant foot yam. Mukherjee et al., (2009) reported that thiourea had greater influence in breaking dormancy in elephant foot yam. Soaking bottom corm setts for 6 h in thiourea, KNO_3, gibberellic acid and CCC (Chlormequat) increased sprouting percentage and growth (Das et al., 1995; Dhua et al., 1988; Kumar et al., 1998). Dhua et al., (1988) reported that 250g basal corm portion treated with 200 mg thiourea, 500mg KNO_3, 0.02 ml CCC per litre increased sprouting percentage of cut pieces. Ethrel or ethephon was reported to induce early sprouting in corm (Dhua et al., 1988; Bala and indira, 1992). Treating cut pieces of corms from lower half with chemicals significantly improved sprouting, growth and yield. Keeping in view of the above facts, the present investigation was undertaken to study the effect of growth regulators and chemical treatments on breaking dormancy, induce uniform sprouting and enhance yield.

Materials and Methods

The field experiment was conducted at ICAR-Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram, Kerala, India with elephant foot yam variety Gajendra during the crop season 2014 -15. The elephant foot yam corm size of 150-200g were subjected to eleven different treatment viz., T_1 - gibberellic acid (200 ppm), T_2- gibberellic acid (500 ppm), T_3- indole acetic acid (100 ppm), T_4- indole acetic acid (200 ppm), T_5- thiourea 0.5%, T_6- thiourea (1%), T_7- potassium nitrate (0.5%), T_8- potassium nitrate (1%) T_9- heat treatment of corms by exposing to 40^0 C for 30 days in the heat chamber, T_{10}- water treatment, T_{11}- control (without treatment). The experiment was conducted in Randomized block Design and the eleven treatments were replicated thrice and planted under rainfed conditions. The crop was planted with 75 x 75 cm spacing, FYM @10 t ha^{-1} and NPK @ 80:60:80 kg ha^{-1} were applied as per the package of practices recommended by ICAR-CTCRI. The crop was harvested treatment wise after 9 months and the corm yield were recorded.

Results and Discussion

GA_3 is one of the most important plant hormone involved in the promotion and maintenance of seed germination. GA_3 are known to obviate the requirement of seeds for various environmental cues, promotes germination and counteract with cytokinins (Bewley and Black, 1994). It is one of the major plant hormones involved in the control of mobilization of food reserves from the endosperm or cotyledons (Black, 1972). The physiological component of dormancy determines the dormancy level response to external gibberellic acid application (Geneve, 2003) and promotes seed germination (Baskin and Baskin,1971). Freshly harvested cassava seeds exhibit physiological

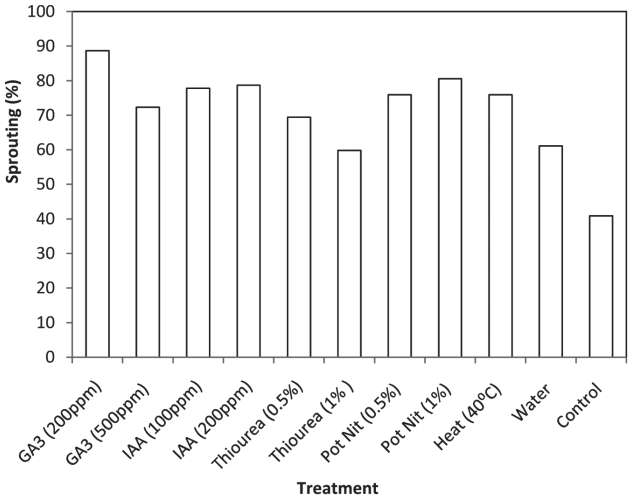

Fig 1. Effect of growth regulator treatments on sprouting

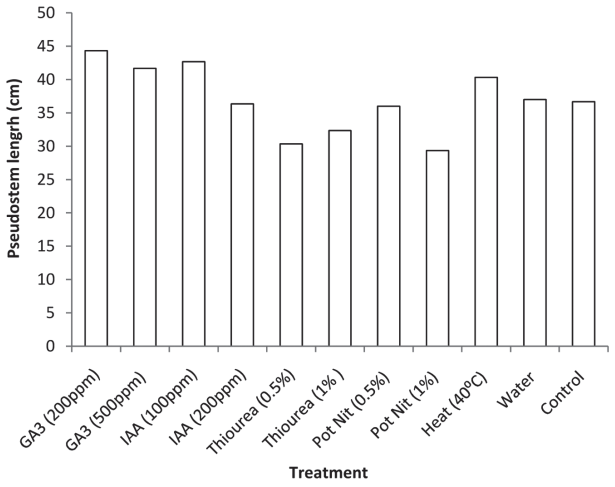

Fig 2. Effect of growth regulator treatments on pseudostem length

dormancy and require three months of storage at ambient temperature for germination (Jennings and Iilesias, 2002). The longevity of seeds to germination increased with reduced bound water (Roberts and Ellis, 1989). The seed dormancy can be broken through cold stratification (Carpital et al., 1983), temperature (Junttila, 1973) light (Scheibe and lang,1965) and darkness (Rajendren et al.,2000) as well as by GA_3 (Baskin and Basin,1971). Seeds permanently undergo deep physiological dormancy with longer seed storage at low temperature and pre-treatments become unsuccessful to break such dormancy. In the present study, growth regulator GA_3, IAA treatment were used to break dormancy and induce uniform sprouting of elephant foot yam. Growth regulators significantly influenced the sprouting, corm development, number of corm and corm yield in the variety Gajendra. (Table1). Among the growth regulators, gibberellic acid (200 ppm) treated corms produced significant difference was observed in number of 50 and 100% sprouting was observed in the growth regulator treatment. Thiourea (0.5%) treated corms significantly reduced the number of days for 50 and 100% sprouting than GA_3 (200 ppm, 500 ppm) and control.

GA_3 (200 ppm) treated corms reduced days for 50% sprouting by 8-10 days and days for 100% sprouting by 10-12 days. Among the different treatments, thiourea treated corms produced better effect on days to sprouting. Thiourea (0.5%) treated corms took significantely lesser number of days to 50% (35 days) and 100% sprouting (51days) in elephant foot yam. It was followed by GA_3 (200 ppm and 500 ppm) and indole acetic acid (100 ppm, 200 ppm). Kumar et al., (1998) reported that thiourea was the most effective in breaking dormancy of elephant foot yam corms with 92% sprouting in 75 days after harvesting compared to 18% sprouting in the control.The results revealed that elephant foot yam corms treated with potassium nitrate (1%) resulted in maximum uniform sprouting with 56.48% and 80.55% sprouting at 30 and 60 days after planting (DAP) respectively. Corms treated with IAA (200 ppm) had 45.37%, 78.70% sprouting at 30 and 60 days after planting (DAP) respectively (Fig. 1). The effect of GA_3 (200 ppm) treatment for 30 minutes was tested and recorded a maximum plant survival (88.69%) followed by potassium nitrate (1%) treatment with sprouting of 80.55%. The plant survival rate of heat treatment corm exposed 40^0C temp for 30 days had 75.92%.

Effect of growth regulator on pseudostem length

The effect of different growth regulators and chemical treatment of corm on pseudostem length of elephant foot yam plants was assessed. The corms soaked with IAA (100 ppm) for 30 minute corms produced plant with pseudostem length of 47.54 cm at 90 days after planting. Corms treated with GA_3 (500ppm) produced 46.56 cm, where as GA_3 (200 ppm) produced shoot length of 43.62cm, whereas minimum pseudostem length 33.62 cm was recorded with thiourea treatment (0.5%) followed by thiourea (1%) with pseudostem length of 35.53cm. (Table1). The corms treated with potassium nitrate (0.5%, 1%) treatment produced plant with pseudostem

Table 1 Effect of growth regulators and chemical treatments on sprouting, Pseudostem length, canopy spread, number of corms and corm yield in elephant foot yam.

Treatments	Days to 50% sprouting	Days to 100% sprouting	Plant survival (%)	Pseudostem length at 90 days (cm)	Canopy spread at 90 days(cm)	Number of corms ha^{-1}	Corms yield t ha^{-1}
$T_{1:}$ GA_3 200 ppm	44	56	88.69	43.62	75.33	9945	10.21
$T_{2:}$ GA_3 500 ppm	43	53	72.29	46.56	69.50	7659	6.54
$T_{3:}$ IAA100 ppm	42	54	77.77	47.54	71.00	9245	7.31
$T_{4:}$ IAA 200 ppm	43	55	78.69	44.43	71.83	9145	7.18
$T_{5:}$ Thiourea 0.5%	35	56	69.44	33.62	60.00	9059	7.00
$T_{6:}$ Thiourea 1%	36	51	59.80	35.53	43.66	6059	6.11
$T_{7:}$ KNO_3 0.5%	44	52	75.92	40.35	73.50	9717	5.63
$T_{8:}$ KNO_3 1%	45	54	80.55	37.65	62.33	7087	4.34
$T_{9:}$ Heat Treatment ($40^{O}C$)	45	53	75.92	41.30	69.66	6859	5.10
$T_{10:}$ Water Treatment	46	58	61.11	42.66	64.55	7430	4.73
$T_{11:}$ Control	48	68	40.92	38.66	62.30	7210	4.15
CD (0.05)	2.32	2.65	14.68	0.81	0.94	2170	2.19

length 40.35 cm and 37.65 cm respectively. Corms soaked with water for 30 minutes produced plant with pseudostem length 42.66 cm. However, control treatment resulted in minimum pseudostem length of 38.66 cm as compared to other treatments (Fig. 2).

Effect of growth regulator on canopy spread

The effect of different growth regulators and chemical treatment on canopy spread of elephant foot yam corm was assessed. It was found that the planting material soaked in GA_3 (200 ppm) for 30 minutes produced canopy of leaves spread to 75.33cm at 90 days after planting. Whereas corms treated with potassium nitrate (0.5%) plant produced canopy spread of 62.33 cm. Corms subjected to heat treatment produced plants with canopy spread of 69.66 cm diameter. Whereas the minimum canopy spread (43.66 cm) was recorded in the plants raised from the treatment with thiourea 1% (Table 1). The corms treated with potassium nitrate (0.5%, 1%) produced plants with canopy spread of 73.50 cm and 62.33 cm respectively. Whereas water soaked treatment for 30 minutes resulted in plants with canopy spread 64.55 cm. The minimum canopy spread 62.30 cm was recorded in control plants as compared to other treatments.

Effect of growth regulators on corm number and yield

The growth parameters indicated that maximum pseudostem length (47.54 cm) and canopy spread (71.10 cm) were recorded in plants raised from corms treated with GA_3 (200 ppm) at 90 days after planting. The corm yield data revealed that plants raised from corms treated with GA_3 (200 ppm) produced significantly maximum corm yield (10.21 t ha^{-1}) whereas plants raised from corms treated with IAA (100 ppm) produced (7.31 t ha^{-1}). The differences in corm yield of plants raised from corms treated with IAA (200ppm), Thiourea (0.5%), GA_3 (500ppm), Thiourea (0.1%) and potassium nitrate (0.5%) were statistically not significant. (Table1.). The corm yield of plants raised from untreated corm was very poor (2.72 t ha^{-1}). Plants raised from corms treated with thiourea (0.5%) produced significantly maximum number of corms (10,059 ha^{-1}) and with GA_3 (200ppm) produced 9,945 corms per hectare.

Conclusion

The present study result revealed that plant raised from GA_3 (200ppm) treated corms produced significantly maximum number of corms (9945 ha^{-1}) followed by potassium nitrate (0.5%) which resulted in corm number of (9717 ha^{-1}). Whereas with GA_3 (200 ppm) treatment resulted maximum corm yield (10.21 t ha^{-1}) followed by IAA (100 ppm) treatment produced (7.31 t ha^{-1}).

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