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Effect of GA_3 and Urea Treatments on Improvement of Microtuber Production and Productivity of Different Types of Planting Material in Greater Yam (*Dioscorea alata* L.)

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Abstract

An experiment was under taken to study the effect of different concentrations of urea and GA_3 treatments on the improvement of microtuber production in the vine cuttings of *Dioscorea alata* L. From the experimental finding it was observed that Urea 2% and $GA_3$1ppm treatment shows better response for days taken for rooting, root length, number of roots per cutting survival % in the field and nursery condition and mean number of micro tubers production per cuttings. Similarly for productivity study and observations on all other vegetative and tuber characters were highest in planting of whole tubers (200gm) followed by planting of whole tubers (150gm) and cut tubers of 50gm. The value for all the observations was lowest in planting of rooted vine cuttings.

Keywords: cut tubers, GA_3, microtuber, whole tuber, vine cutting, urea

Introduction

Among tropical tuber crops the greater yam (*Dioscorea alata* L.) occupies an important position because of their food, nutritional, medicinal and industrial significance. *Dioscorea alata* is an old monocot from the family *Dioscoreaceae* (Ayensu, 1972). In India *D. alata* tubers are consumed mainly in the southern and northern states. They are also cultivated as a cash crop in some area where they are more important than potato. These crops have wide adaptability and are less stringent in input needs like fertilizer application, irrigation and plant protection. They are efficient converters of solar energy to dry matter (Behera *et al*., 2009). Yams underground tubers are seriously affected by pathogen accumulation (Malauri *et al.,* 1998) which reduces the quality of planting material. Transportation of high volumes of planting material for field planting is difficult during planting seasons. About 2,500 to 3,000 kg of planting material is required to plant one hactare. Thus the cost of planting material increases the cost of production (Onwueme, 1978: Shiwachi *et al*., 2005).

Under conventional propagation the rate of multiplication of tubers is very slow as a piece of tuber has only one or two sprouts. To counter the scarcity of planting material an attempt was made to standardize and develop an *in vivo* rapid multiplication method through the use of vine cuttings treated with Urea and GA_3 to accelerate microtuber production, which could be used fully as seed tuber for yam planting. Similar attempts were made to study efficacy of productivity by using different types of planting material viz. whole tubers (200 gm), whole tubers (150 gm), cut tubers of 50 gm and rooted vine cuttings and the results were presented.

Materials and methods

The experiment was conducted during the year 2007-2008 at the Botanical garden of the Post Graduate Botany Department, Utkal University, Vanivihar, Bhubaneswar. The soil of the experimental field was sandy loam. After the layout of the experimental plots and prior to the application of manure or fertilizer, soil samples were collected from each plot from the top layer of 15 cm soil depth by using a soil agar. The result of the soil analysis are viz. total N_2 (0.068 %), Available P (0.00128%), Available K (0.00347%) followed by Organic carbon 0.6936% and Soil pH (5.8).

Vine cuttings from 45 days old plants of *D. alata* were taken as explants by trimming the leaf during the month of May-June. Before starting the experiment the nursery bed was prepared (90 cm X 90 cm) by mixing with sun dried sand and cow dung and was sterilized with *Tricoderma viridae* followed by *Steptocycline* at 0.015%. The nursery bed was wetted and the vine cuttings were planted, one by one in the nursery bed at close spacing by dipping with 0.02 % bavistin to prevent further fungal incidence. Beds were

watered twice daily depending on rainfall and the status of the environmental condition of the days. To arrest the senescence process of leaves of vine cuttings 1%, 2%, 3% Urea was spread in one nursery bed and concentration of GA_3 1ppm,10ppm and 100 ppm was spread to another nursery bed and an untreated control bed. Various parameter like days taken for rooting, length of root (cm), number of roots/cutting, survival (%) in nursery and field, axillary bud development (%), number of tubers/plant, weight of tuber (gm), length and width of tuber (cm) were observed and tabulated. Similarly for productivity trial different type of planting material viz. whole tubers (200 gm), whole tubers (150 gm), cut tubers of 50 gm and rooted cuttings were taken and planted in the field.

Field preparation and experiment design

Before planting, the field was ploughed, leveled and furrows were made at 30 cm distance from row to row. Sprouted sets were planted on ridges. The experiment was conducted following FRBD (Factorial Randomized Block Design). Considering the heterogeneous planting material a spacing of 60×60 cm was provided. The fertilizers dose was 100:100:100 Kg NPK/ha. Entire quantity of P_20_5 was applied as basal dose, 50 percent N and K was applied at 30 days and rest 50 percent N and K was applied at 60 days after planting. The crop was planted during end part of June and harvested during February. Observations on survival % length of the vine (cm), number of branches, number of leaves /plant, number of tuber per plant, tuber weight (gm) tuber length and width (cm) was recorded. The total yield was calculated per hectare.

Results and discussion

Production of microtuber from the vine cuttings came across several problems i.e.(i) leaves turn yellow(ii) root system cease to function (iii) immediately after planting tuber production starts from axillary position. Although the longevity of vine cutting is around 60 days but leaves turn yellow and start to wither even after planting. Therefore to arrest senescence process of leaves of vine cuttings, 1%, 2%, 3% Urea and GA_3 was spread to different nursery beds of the planted vine cuttings. In the vine cuttings days taken for rooting was earliest in 2% Urea (6.98 days) followed by 3% Urea (7.61days) and most delayed in control (12.36 days). Similarly length of root was highest in 2% Urea (7.68 cm) followed by 3% Urea (7.65 cm) and shortest in control (4.16 cm).Among the treatments number of roots per cutting was highest in 2% Urea (38.16) followed by 3% Urea(32.00) and least number of root was recorded in the control (12.84). Survival % in the nursery bed was highest in control (68.45%) followed by 1% Urea (58.48%) and least in 1% Urea (27.62%) treatment. Survival % in the field condition was highest in 2% (42.42%) followed by 3% Urea (41.26%) and least in the control (34.64%). Axillary bud development % was highest in 1% Urea (42.37%) and least in the control (26.76%). Mean number of micro tuber was highest in 2% Urea (1.84) followed by least number (0.78) in control. Average weight of the micro tubers was at par in 3% Urea (2.64 gm) followed by 1% Urea (2.54 gm) and least was in 2% Urea (1.98 gm). Average length of the tuber was highest in 1% Urea (1.64 cm) followed by control (1.28 cm). Similarly width of the micro tuber was highest in the control (0.98 cm) followed by 2% Urea (0.87 cm) (Tab. 1). From the observation it was found that spraying of Urea helps in rooting as well as increased the size of microtuber and increased the numbers of root per cutting but the survival rate was decreased with increase in Urea concentration.

Similarly a significant difference was found amongst different treatments of GA_3. Days taken for rooting were earliest in GA_3 1ppm (14.12 days) treatment followed by control (16.45days). Percentage of success in the nursery bed was highest (62.32%) in $GA_3$100 ppm treatment where as 1ppm GA_3 (47.82%) and 10ppm GA_3 (47.30) are at par and followed by control (42.38%).Survival % in the field condition was highest (60.02%) in $GA_3$10 ppm treatment followed by GA_3 100 ppm (57.48%) and lest percentage (37.13%) of survival in field condition was found in control. Axillary bud development was highest in GA_3 100 ppm (41.54%) treatment and least in control (9.34%) followed by GA_3 1ppm (9.89%).Length of shoot was highest (8.81 cm) in GA_3 100 ppm treatment and least was found in control (3.46 cm) followed by $GA_3$1ppm (4.02 cm). Number of roots per cuttings was highest (4.92) in 1ppm

Tab. 1. Effect of Urea spraying on micro tuber production in *D. alata* vine cuttings

Treatment	Days taken for rooting	Length of root (cm)	No. of roots / cutting	Survival rate in nursery (%)	Survival in field (%)	Axillary bud development (%)	No. of tubers	Weight of tuber (gm)	Length of tuber (cm)	Width of tuber (cm)
T_1 (Urea 1%)	8.67	5.48	23.28	58.48	38.42	42.37	0.54	2.54	1.64	0.84
T_2 (Urea 2%)	6.98	7.68	38.16	48.28	42.42	39.48	1.84	1.98	1.21	0.87
T_3 (Urea 3%)	7.16	7.65	32.00	27.62	41.26	32.45	1.16	2.64	1.22	0.83
T_4 (Control)	12.36	4.16	12.84	68.45	34.64	26.76	0.78	2.34	1.28	0.98
S.E.M.±	0.55	0.32	1.58	1.75	1.72	1.76	0.14	0.22	0.13	0.11
C.D. (0.05)	1.67	0.99	4.87	5.39	5.30	5.42	0.45	0.68	0.40	0.32

Tab. 2. Effect of GA_3 spraying on micro tuber production in *D. alata* vine cuttings

Sl. No.	Treatments	Days taken for rooting	Percentage of success	Percentage of axillary bud development	Length of shoot (cm)	No. of roots/ cutting	Length of roots (cm)	No. of tubers/ plant	Survival rate (%)	Weight of tuber (gm)
1.	GA_3 1 ppm	14.12	47.82	9.89	4.02	4.92	4.93	0.54	46.47	3.79
2.	GA_3 10 ppm	17.61	47.30	35.72	5.04	4.11	5.19	0.88	60.02	5.39
3.	$GA_3$100 ppm	18.01	62.32	41.54	8.81	3.58	4.30	1.74	57.48	7.28
4.	Control	16.45	42.38	9.34	3.46	4.83	5.32	0.34	37.13	3.85
	S.E.M. ±	0.45	2.11	1.31	0.29	0.24	0.27	0.09	1.88	0.37
	C.D. (0.05)	1.41	6.50	4.04	0.90	0.74	0.85	0.27	5.79	1.14

GA_3 followed by control (4.83).Length of root was highest in control (5.32 cm) followed by GA_3 10ppm (5.19). Number of microtubers per plant was highest in GA_3 100 ppm (1.74) and least in control (0.34).Weight of microtuber was highest in 100 ppm GA_3 (7.28 gm) followed by 10ppm GA_3 treatment (5.39 gm) and least in 1ppm GA_3 (3.79 gm) followed by control (3.85 gm)(Tab. 2).From the result it was concluded that GA_3 1ppm treatment were earliest to complete rooting as compared 10 and 100 ppm of GA_3. Senescence could not be arrested in GA_3 treatment but application of GA_3 10 ppm and 100 ppm delayed the rooting, percentage of axillary bud production and shoot length. Tuber weight was highest in GA_3 100 ppm treatment as against control (Tab. 2).

Shiwachi *et al*., (2005) reported that microtubers were produced from two varieties of *D. rotundata* using vine cuttings planted in carbonized rice husk or coco-peat in a screen house. The cuttings established better and produced more microtubers in carbonized rice husk than in coco-peat 100 days after planting. Vine cuttings of seven varieties planted in carbonized rice husk produced 1.7 ± 0.8 minitubers per cutting with mean weight of 3.0 ± 2.7 gm and 70.1% moisture content. About 63% of these sprouted after 77-105 days of storage under ambient air temperature. Vine cuttings of *D. rotundata* can be used to produce microtubers within 100-120 days that could be used in germplasm exchange and for production of seed yams. Vander and Escobar (1990) reported that expanded potato production in developing countries using cuttings as a source of good quality planting material is the simple low cost methods for root induction and establishment of the *in vivo* propagules for potato cultivation in warm tropical sites of Philippines.

Productivity study of different types of planting material of *D. alata* presented in Tab. 3. The survival percentage was highest (93.40%) in planting of whole tubers (200 gm) followed by whole tubers (150 gm) (86.60%) and 50 gm cut tubers (83.60%). The lowest survival percentage was noticed in planting of rooted cuttings (79.20%). The length of the vine was highest (386.00 cm) in planting of whole tuber of 200 gm followed by cut tuber 50 gm (324.00 cm) and least was found in rooted cuttings (141.00 cm). Observations on all other vegetative and tuber characters was highest in planting of whole tubers (200 gm) followed by planting of whole tubers (150 gm) and cut tubers of 50 gm. The value for all the observations was lowest in planting of rooted cuttings. The highest yield (61.10 t/ha) was obtained from planting of whole tubers (200 gm). The yield was 43.16 t/ha by using 150 gm whole tubers. Cut tubers weighing 50 gm produced 39.62 t/ha. Planting of vine cuttings yielded least i.e.,16.84 t/ha (Tab. 3).

From the experimental finding, it can be concluded that more storage from of carbohydrate in the planting material has direct influence on the vegetative character and the yield potential. From the study it was confirmed that over all vegetative and tuber characters were highest in planting of whole tubers of 200 gm followed by planting of whole tubers of 150 gm and cut tubers of 50 gm. The value for all the observations was lowest in planting of rooted cuttings among the four planting materials of *D.*

Tab. 3. Productivity of different types of planting material of *D. alata*

Treatments	Survival %	Length of vine (cm)	No. of branches	No. of leaves/plant	No. of tubers/plant	Tuber weight (gm)	Tuber Length (cm)	Tuber width (cm)	Yield (t/ha)
Rooted cuttings	79.20	141.00	2.20	94.00	1.60	772.00	23..40	9.40	16.84
Whole tuber (150 gm)	86.60	287.00	2.80	111.00	2.00	1796.00	28.80	12.00	43.16
Whole tubers (200gm)	93.40	386.00	4.80	183.00	2.40	2354.00	28.60	13.00	61.10
Cut tubers (50gm)	83.60	324.00	3.60	172.00	2.20	1710.00	30.80	11.80	39.62
S.E.M±	0.937	7.849	0.32	5.99	0.24	45.57	0.81	0.56	0.081
C.D (0.05)	2.88	24.18	0.99	18.48	0.77	140.43	2.50	1.74	0.25

alata. Whole tubers weighing 150 or 200 gm when used as planting material produced very good yield followed by 50 gm cut tubers. Kayode (1984) studied the effect of sett size and spacing on *D. rotundata* in three locations of Savanazone of Nigeria. Spacing had no significant effect on tuber yield but sett size less than 400 gm gave the highest yield while Nwoke *et al*., (1984) reported that larger setts gave higher tuber yield. Akoroda (1985) reported that setts of 200-250 gm were suitable for maximizing the present levels of available crop growth resources and for optimizing SMR under mono crop system on tractor made ridges using stakes of about 2 meters in yam cultivation.

Conclusions

From the experimental finding it is concluded that spraying of Urea helps in rooting and increased the numbers of root per cutting, but the survival rate was decreased with the increase in Urea concentration but there is an increase in the weight of the microtuber. Similarly, lower concentrations of GA_3 induce earliest to complete rooting as compared to higher concentration. Senescence could not be arrested in GA_3 treatment, whereas higher concentration of GA_3 10 ppm and 100 ppm delayed the rooting, percentage of axillary bud production and shoot length but tuber weight was doubled as against the control. Productivity study on different types of planting material in *D. alata* concludes that more storage from carbohydrate in the planting material has direct influence on the vegetative character and the yield potential, which for higher yield whole tubers weighing 150 or 200 gm were preferred in the commercial scale of yam faming.

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