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Effect of plant growth regulators on physico-chemical parameters of taro [*Colocasia esculenta* var. *antiquorum* (L.) Schott.]

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Abstract
Colocasia [*Colocasia esculenta* var. *antiquorum* (L.) Schott.], which is also known as Taro, Arvi, Katchu and eddode belongs to the family Aracea is an important edible aroid. Africa ranks first in area and production of colocasia and in India colocasia is favourite among Gujarat, Konkan region of Maharashtra and several other parts of south India. The cormels, corms, leaves and petioles are used as a vegetable and considered as rich source of carbohydrates, proteins, minerals and vitamins. Due to increasing demand of taro, there is a need to increase its yield. Foliar application of plant growth regulators is reported to improve growth and cormel yield. Hence, the present investigation has been carried out in the Horticulture Research unit, Department of Horticulture, Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi during Kharif season of 2017. There were eleven treatments used namely T_1- Naphthalene acetic acid (25 ppm), T_2- Naphthalene acetic acid (50 ppm), T_3- Indole Acetic Acid (25 ppm), T_4- Indole Acetic Acid (50 ppm), T_5- Maleic hydrazide (50 ppm), T_6- Maleic hydrazide (100 ppm), T_7- Gibberellic acid (100 ppm), T_8- Gibberellic acid (200 ppm), T_9- Ethrel (75 ppm), T_{10}- Ethrel (150 ppm) and T_{11}- Control (water spray only). To find out feasibility of increment in growth of taro by means of application of plant growth regulators on the till date most accepted variety of taro, Muktakeshi by the growers in the state of Jharkhand. Among the eleven treatments used GA_3 at 200 ppm was found to record maximum growth, yield and physico-chemical parameters except content of non-reducing sugar in cultivation of taro.

Keywords: Taro [*Colocasia esculenta* var. *antiquorum* (L.) Schott.], PGR, physico-chemical parameters

Introduction
Among the tuber crop produced, colocasia [*Colocasia esculenta* var. *antiquorum* (L.) Schott.], a member of family Araceae which is native to south central Asia is one of the important tuber crop particularly grown in Africa and Asia and occupies a very selective and special position. Some species are widely cultivated and naturalized in other tropical and subtropical regions. It is grown throughout the humid tropics and in the warmer regions of the temperate zones. Colocasia is the most important vegetable crop among the arum family due to its delicious taste, nutritive and medicinal value (Mishra and Roy Chowdhury, 1996) [8]. It is mainly cultivated for the edible cormels but the leaves and its young petioles are also cooked and used like spinach. The cormels, corms, leaves and petioles are used as a vegetable and considered as rich source of carbohydrates, proteins, minerals and vitamins. The corm is rich in starch and contains 17- 25% amylase. Planting of *Colocasia esculenta* is normally done during the rainy season but it can be done any time if irrigation facilities are available. The crop is harvested after 6 to 8 months of planting. It grows on all kinds of soil but thrives best in deep, well-drained, well manured, friable loam. Where rainfall is insufficient, the fields are frequently irrigated.

Moreover, the climate of Jharkhand is very favourable for the growth, development and expansion of this crop. Muktakeshi variety of taro has performed well in eastern and southern part of our country including Jharkhand. It is light brown skin coloured high yielding and itching free choicest variety of farmers of state of Jharkhand.

Taro is a promising tuber crop for the state of Jharkhand. It can be found in most of the Farmers field of Jharkhand on small holding for domestic consumption or as commercial crop.
Growth and yield of plants are greatly influenced by a wide range of factors, among which plant growth regulators are one. Plant growth regulators usually are defined as organic compounds, other than nutrients which in small concentration influence the physiological processes of plants.
Foliar application of plant growth regulators is reported to improve growth and tuber yield.
Plant growth regulators are also reported to improve yield of many horticultural crops those in which the underground part is economically important. Though, agronomical practices for taro has been standardized and there is always demand for enhancing its growth and yield from the growers. Hence, the present investigation has been formulated to find out feasibility of increment in growth, yield and physico-chemical parameters of taro by means of applications of growth regulators in the date most accepted variety of taro, Muktakeshi by the growers in the state of Jharkhand.
Hence, present study was undertaken with the objectives to evaluate growth, yield and physico-chemical parameters of taro with application of different plant growth regulators in the context of growth, yield and yield attributes.

Materials and Methods

The present investigation entitled "Effect of plant growth regulators on growth and yield of Taro [*Colocasia esculenta* var. *antiquorum* (L.) Schott.]," was conducted in the experimental field of the Department of Horticulture, Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi during the *Kharif* season of 2017. There were eleven treatments used namely T_1- Naphthalene acetic acid (25 ppm), T_2- Naphthalene acetic acid (50 ppm), T_3- Indole Acetic Acid (25 ppm), T_4- Indole Acetic Acid (50 ppm), T_5- Maleic hydrazide (50 ppm), T_6- Maleic hydrazide (100 ppm), T_7- Gibberellic acid (100 ppm), T_8- Gibberellic acid (200 ppm), T_9- Ethrel (75 ppm), T_{10}- Ethrel (150 ppm) and T_{11}- Control (water spray only) which was carried out in randomised block design with three replications.
These observations of physico-chemical parameters were recorded as per A.O.A.C. (1995) [1] protocols in the PG laboratory of the department of Horticulture, RAC, BAU, Ranchi. Reducing sugars and total sugars were estimated by Lane and Eynon method.
Total sugar comprised of reducing sugars and non reducing sugars, which can be hydrolyzed into reducing sugars under the experimental conditions.
Ascorbic acid content was determined by 2, 6-Dichlorophenol-indophenol visual titration method. The total soluble solids (TSS) of cormels (°Brix) were recorded by the help of hand refractometer and the value was recorded.

Results and Discussion

Table 1: Effect of Plant growth regulators on Reducing sugar, Non-reducing sugar and Total sugar of taro

Treatments	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T_1- Naphthalene Acetic Acid (25 ppm)	2.75	0.11	2.86
T_2- Naphthalene Acetic Acid (50 ppm)	2.58	0.12	2.70
T_3– Indole Acetic Acid (25 ppm)	2.77	0.11	2.88
T_4 - Indole Acetic Acid (50 ppm)	2.64	0.11	2.75
T_5- Maleic hydrazide (50 ppm)	2.25	0.14	2.39
T_6- Maleic hydrazide (100 ppm)	2.21	0.13	2.34
T_7- Gibberellic Acid (100 ppm)	2.94	0.11	3.05
T_8 - Gibberellic Acid (200 ppm)	3.03	0.10	3.13
T_9 - Ethrel (75 ppm)	2.45	0.12	2.57
T_{10} - Ethrel (150 ppm)	2.35	0.14	2.49
T_{11}- Control (Only water spray)	2.11	0.13	2.24
SEm ±	0.20	0.01	0.19
CD (p=0.05)	0.60	0.03	0.57
CV (%)	13.72	15.08	12.53

A close examination of mean value revealed that the application of plant growth regulators at different treatments had a marked effect with respect to sugar content in general. The maximum reducing sugar percent (3.03%) was recorded in treatment T_8 [GA_3 (200 ppm)] which was statistically at par with the treatments T_7[GA_3 (100 ppm)] (2.94%), T_3[IAA (25 ppm)] (2.77%) and T_1[NAA (25 ppm)] (2.75%). However minimum content of reducing sugar percent (2.11%) was recorded in T_{11}(control). The increase in the content of reducing sugar percentage was might be because of the phenomenon that during cormel formation the reducing sugar reserves get utilized in the biosynthesis of ascorbic acid. The results are in line with Rahbarian *et al.* (2014) [9].
A close examination of mean value revealed that the application of plant growth regulators at different treatments had a marked effect with respect to non-reducing sugar content in general. The maximum content of non-reducing sugar percentage (0.14%) was recorded under T_5[MH (50 ppm)] & T_{10}[Ethrel (150 ppm)](0.14%)followed by T_6[MH (100 ppm)] [0.13%] & T_{11}Control (water spray only) in comparison to other treatments. Exogenous application of plant growth regulators probably stimulated the activity of *amylase* enzyme which caused hydrolysis of starch. Then the starch readily converted into sucrose and thus the amount of non-reducing sugar (sucrose) increased. The results pertaining to non-reducing sugar were similar as that of Shivakumar *et al.* (2002) [10], Kumar *et al.* (2011) [7], Thapa *et al.* (2013) [11], Barani *et al.* (2013) [3] and Desai *et al.* (2014) [5].
It is evident from the Table 1. that all treatments had promising effect over control. The maximum total sugar (3.13%) was observed in T_8 [GA_3 (100 ppm)] which was statistically at par with 3.05% in treatments T_7 [GA_3 (100 ppm)],(2.88%) in T_3 [IAA (25 ppm)], (2.86%) inT_1 [NAA (25 ppm)], (2.75%) inT_4 [IAA (50 ppm)], (2.70%) in T_2 [NAA (50 ppm)] and (2.57%) in T_9 [Ethrel (75 ppm)]. The minimum content of total sugar percent (2.24%) was recorded in T_{11}(control). Total sugar percent again might be increased due to the hydrolysis of starch by *amylase* enzyme. As a result of

this starch converted into sugar and hence total sugar contents of tuber was increased. The results pertaining to total sugar were similar as that of Shivakumar *et al.* (2002) [10], Kumar *et al*. (2011) [7], Thapa *et al.* (2013) [11], Barani *et al.* (2013) [3].

Table 2: Effect of Plant growth regulators on Ascorbic acid content of taro

Treatments	Ascorbic acid content (mg per 100 g)
T_1- Naphthalene Acetic Acid (25 ppm)	14.11
T_2- Naphthalene Acetic Acid (50 ppm)	13.85
T_3- Indole Acetic Acid (25 ppm)	14.89
T_4 - Indole Acetic Acid (50 ppm)	13.56
T_5- Maleic hydrazide (50 ppm)	12.21
T_6- Maleic hydrazide (100 ppm)	11.86
T_7- Gibberellic Acid (100 ppm)	16.05
T_8 - Gibberellic Acid (200 ppm)	16.44
T_9 - Ethrel (75 ppm)	12.82
T_{10} - Ethrel (150 ppm)	12.80
T_{11}- Control (Only water spray)	11.57
S.Em ±	1.06
CD (p=0.05)	3.13
CV (%)	13.48

All treatment enhanced ascorbic acid content (mg 100 $g^{-1}$of cormel) over the control. Maximum ascorbic acid content (16.44mg 100 g^{-1} of tuber) was observed in treatment T_8 [GA_3 (200 ppm)] which was statistically at par with 16.05 mg 100 g^{-1} in T_7 [GA_3 (100 ppm)], 14.89 mg 100 g^{-1}in T_3 [IAA (25 ppm)],14.11 mg 100 g^{-1}inT_1 [NAA (25 ppm)], 13.85 mg 100 g^{-1}inT_2 [NAA (50 ppm)] and 13.56 mg 100 g^{-1}inT_4 [IAA (50 ppm)]while minimum content of ascorbic acid (11.57mg 100 g^{-1} of cormel) observed under T_{11} [control (water spray only)]. The increase in ascorbic acid content might be due to the continued synthesis of glucose-6 phosphate through the growth and development of cormel which is thought to be precursor of ascorbic acid. One more probable reason for increased ascorbic acid contents is catalytic influence of growth regulator on biosynthesis of ascorbic acid from sugar.
It was also possible that growth substances could have inhibit oxidation of synthesized ascorbic acid by reducing activity of the enzyme *ascorbic acid oxidase*. Similar results in respect of ascorbic acid in accordance with the findings by Kadiri *et al.* (1996) [6], Belakbir *et al.* (1998) [4], Abou El-Yazied and Mady (2011) [2], Thapa *et al.* (2013) [11] and Kumar *et al.* (2014).

Table 3: Effect of Plant growth regulators on Total Soluble Solid (°Brix) content

Treatments	TSS
T_1- Naphthalene Acetic Acid (25 ppm)	5.30
T_2- Naphthalene Acetic Acid (50 ppm)	5.10
T_3- Indole Acetic Acid (25 ppm)	5.35
T_4 - Indole Acetic Acid (50 ppm)	5.20
T_5- Maleic hydrazide (50 ppm)	4.70
T_6- Maleic hydrazide (100 ppm)	4.60
T_7- Gibberellic Acid (100 ppm)	5.55
T_8 - Gibberellic Acid (200 ppm)	5.60
T_9 - Ethrel (75 ppm)	4.95
T_{10} - Ethrel (150 ppm)	4.80
T_{11}- Control (Only water spray)	4.40
SEm ±	0.39
CD (p=0.05)	1.15
CV (%)	13.35

The maximum TSS (5.60°Brix) was observed in T_8 [GA_3 (100 ppm)] followed by 5.55°Brix in T_7 [GA_3 (100 ppm)], 5.35°Brix in T_3[IAA (25 ppm)], 5.30 °Brix in T_1 [NAA (25 ppm)], 5.20°Brix in T_4 [IAA (50 ppm)], 5.10°Brix in T_2[NAA (50 ppm)], 4.95°Brix in T_9 Ethrel (75ppm)], 4.80°Brix in T_{10} [Ethrel (150 ppm)],4.70°Brix in T_5 [MH (50 ppm)], 4.60°Brix in T_6 [MH (100 ppm)]. The minimum content TSS percent (4.40°Brix) was recorded with T_{11} [control (water spray only)].

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