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Influence of organic manures and bio-stimulants on growth and herbage yield of Colocasia (*Colocasia esculenta var antiquorum* L. Schott)

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Abstract
The current investigation entitled effect of organic manures and bio-stimulants on growth attributes of colocasia (*Colocasia esculenta var antiquorum* L. Schott), was conducted at Dr. BSKKV, Dapoli during the *kharif* season in the year 2024. In the experiment there were eight treatments and three replications in Randomized Block Design (RBD). The experimental results depicted that the treatment T_6 [FYM (30 t ha^{-1}) + Seaweed Extract (3 ml L^{-1}) + Humic Acid (1 ml L^{-1})] revealed significant superiority over other treatments in respect to the growth parameters *viz.*, plant height (34.14 cm), leaf area (38896.57 mm^2), number of leaves (10.27), leaf length (30.66 cm), leaf breadth (27.30 cm), petiole length (14.68 cm), leaf to petiole ratio (2.37), number of suckers per plant (5.57), herbage yield per plant (29.07 g $plant^{-1}$), herbage yield per plot (0.93 kg $plot^{-1}$), herbage yield per hectare (10.77 q ha^{-1}). However, the treatment combination of FYM @ 30 t ha^{-1} along with Seaweed Extract @ 3 ml L^{-1} noted significantly at par results.

Keywords: Colocasia, farm yard manure, seaweed extract, vermicompost, humic acid

Introduction

Taro (*Colocasia esculenta var. antiquorum* L. Schott), also referred as 'Arvi' or 'Colocasia', is a plant belonging to the Araceae family, specifically the subfamily Colocasioidae and the order Arales. It is an important tuber crop native to South Central Asia particularly grown in Africa and Asia. Colocasia is mainly cultivated for its fleshy corms and cormels, though all plant parts are consumed i.e., the leaves, petioles, corms and cormels.

The demand for organic food is steadily increasing both in developed and developing countries. There is scope for increasing the export of organically produced cocoyams (taro and tannia) fetching higher price in the market. Taro is highly responsive to organic manures and have fewer pest and disease problems as compared to other vegetables (Limisha *et al.*, 2021) [2]. Taro production which largely affects the soil fertility and also have enormous impacts on human health (Rengasamy *et al.*, 2015) [11]. Over the past decades there is wide focus on the scope of research and development on organic farming of tuber crops (Suja *et al.*, 2009; Suja *et al.*, 2010) [13, 14]. Manoeuvre of chemical fertilizer along with growth enhancing organic manures promotes the crop productivity and thereby enhances the soil fertility. Being an economically important crop, there is a greater need for augmenting the scope for its yield potential. The agronomical practices for taro have been standardized but still there has been a demand for enhancing its growth and yield. Therefore, the present investigation has been formulated to find out feasibility of increment in growth parameters of taro using applications of different organic sources.

Materials and Methods

The experiment was conducted under agro-climatic conditions in the Konkan region in the Maharashtra region. It was carried out during the Kharif of 2024 at the Department of Vegetable Science, College of Horticulture, Dapoli. The geological position on the world map is 17º46'0" northern latitude and 73º11'0'' eastern longitude. The variety was Konkan Manohar.

The experimental plot was laid out in Randomized Block Design (RBD) with three replications and eight treatments *viz*., T_1 [RDF (80:60:80 NPK kg ha^{-1}) + FYM (15 t ha^{-1})], T_2 [FYM (30 t ha^{-1})], T_3 [Vermicompost (5 t ha^{-1})], T_4 [FYM (30 t ha-1) + Seaweed Extract (3 ml L^{-1})], T_5 [Vermicompost (5 t ha^{-1}) + Humic Acid (1 ml L^{-1})], T_6 [FYM (30 t ha^{-1}) + Seaweed Extract (3 ml L^{-1}) + Humic Acid (1 ml L^{-1})], T_7 [Vermicompost (5 t ha^{-1}) + Humic Acid (1 ml L^{-1}) + Seaweed Extract (3 ml L^{-1})] and T_8 (Absolute control). The presence of growth hormones in seaweed extract may synergize with nitrogen to enhance chlorophyll production and shoot elongation. On the other hand, humic acid plays a vital role in determining its effectiveness as a plant growth promoter and soil conditioner. The observations were recorded at an interval of 30, 60, 90, 120 and 150 DAP.

Results and Discussion

- **Plant height (cm):** Plant height plays a very crucial role in determining the plant growth, vitality and form of the plant. The effect of organic manures and bio-stimulants on plant height showed significant differences in plant height at 30, 60, 90, 120 and 150 days after planting (DAP). The maximum plant height recorded (34.14 cm) in treatment T_6 [FYM (30 t ha^{-1}) + Seaweed Extract (3 ml L^{-1}) + Humic Acid (1 ml L^{-1})], which was statistically at par with T_2 [FYM (30 t ha^{-1})] (29.61 cm), T_4 [FYM (30 t ha-1) + Seaweed Extract (3 ml L^{-1})] (30.95 cm) and T_7 [Vermicompost (5 t ha^{-1}) + Humic Acid (1ml L^{-1}) + Seaweed Extract (3 ml L^{-1})] (29.52 cm). On the contrary, it was observed that the control treatment T_8 (25.10 cm) recorded the lowest plant height in Colocasia at 90 DAP. This revealed that farm yard manure plays significant role solely and when combined with liquid fertilisers. Vermicompost shows high organic carbon content, generally ranging from 12% to 18%, indicating good organic matter status. Similar results were seen by Suja *et al.* (2009) [13] while experimenting with tannia, Mazhar *et al.* (2020) [5] in onion cultivars and Prativa and Bhattarai (2011) [8] in tomato.
- **Number of leaves:** Treatment T_6 [FYM (30 t ha^{-1}) + Seaweed Extract (3 ml L^{-1}) + Humic Acid (1 ml L^{-1})] recorded the maximum number of leaves (10.27) which was found to be superior over other treatments, which was at par with T_2 [FYM (30 t ha^{-1})] (9.73), T_4 [FYM (30 t ha-1) + Seaweed Extract (3 ml L^{-1})] (10.10) and T_7 [Vermicompost (5 t ha^{-1}) + Humic Acid (1 ml L^{-1}) + Seaweed Extract (3 ml L^{-1})] (9.63). Whereas, the treatment T_8 (Absolute control) recorded the minimum number of leaves recorded the minimum number of leaves (7.93). It was due to increased cell division and enhanced supply of nutrients when applied in treatment combinations. Prabhakar *et al.* (2015) [10], Pawar *et al.* (2017) [9] in cauliflower and Mama *et al.* (2016) [4] in potato also reported similar results with respect to the number of leaves.
- **Leaf area (cm^2):** The results revealed that among different treatments significant difference was noticed for leaf area. The maximum leaf area at 60 DAP was observed in T_6 (388.97 cm^2) which was at par with T_4 (348.52 cm^2). Conversely, the area showed the lowest value in treatment T_8 (175.96 cm^2). The role of seaweed is its mildly acidic nature which enhances the solubility of certain micronutrients, improving their uptake by plants, ultimately expanding the leaf size. Similar findings were recorded by Nedunchezhiyan *et al.* (2017) [7]. At 150 DAP, the leaf area was found to be highest in T_2 (351.48 cm^2) which was comparable to treatment T_4 (313.19 cm^2). In contrast, T_8 showed the smallest leaf area (139.07 cm^2). Also, Mama *et al.* (2016) [4] presented the statistical analysis of the data which showed that leaf area of Potato crop was significantly affected by farmyard manure.

Table 1: Effect of organic manures and bio stimulants on plant height, number of leaves, leaf area, leaf length and leaf breadth of Colocasia

Treatments	Plant height (cm)					Number of leaves					Leaf area (cm^2)		Leaf length (cm)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	60 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	18.60	25.25	26.97	24.47	20.03	6.33	7.53	8.20	7.30	5.93	180.52	149.21	22.89	25.01	24.07	23.17	22.43
T_2	24.11	29.44	29.61	29.34	26.21	8.00	9.53	9.73	8.33	7.17	265.84	234.55	26.59	26.25	28.37	27.30	26.40
T_3	19.67	26.13	27.83	25.83	21.75	7.03	7.87	8.40	7.50	6.03	203.45	173.27	23.88	25.32	25.97	24.92	24.83
T_4	25.73	30.75	30.95	30.20	27.19	8.07	9.63	10.10	9.13	7.30	348.52	313.19	26.86	26.80	29.50	29.27	27.57
T_5	21.37	26.23	29.15	28.57	23.70	7.43	8.00	8.60	7.60	6.80	225.89	175.36	25.54	25.48	26.87	25.30	25.10
T_6	26.89	33.84	34.14	33.85	32.20	8.77	9.93	10.27	9.23	7.67	388.97	351.48	28.01	30.66	30.10	30.43	30.13
T_7	23.19	28.56	29.52	29.07	23.98	7.67	8.20	9.63	8.17	7.10	228.70	189.28	25.58	25.93	28.23	27.30	26.40
T_8	17.90	24.97	25.10	23.33	18.67	6.20	7.30	7.93	7.17	5.90	175.96	139.07	22.60	22.94	23.33	21.13	22.17
S.E.M ±	1.06	1.53	1.59	1.33	1.01	0.25	0.46	0.35	0.39	0.41	24.59	23.33	1.49	1.30	1.14	1.20	1.30
CD at 5%	3.20	4.63	4.83	4.04	3.07	0.77	1.38	1.08	1.20	1.23	74.57	70.76	4.52	3.96	3.47	3.63	3.95

Table 2: Effect of organic manures and bio stimulants on leaf breadth, petiole length, leaf to petiole ratio and number of suckers of Colocasia

Treatments	Leaf breadth (cm)					Petiole length (cm)					Leaf to petiole ratio					Number of suckers				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	19.21	19.13	20.10	19.83	20.60	9.87	11.54	11.79	12.12	11.37	2.32	2.17	2.04	1.91	1.97	0.00	0.63	1.13	1.40	1.83
T_2	22.13	23.70	24.03	24.43	22.77	11.20	12.50	13.01	13.89	13.10	2.37	2.10	2.18	1.97	2.02	0.00	0.80	1.37	2.50	4.17
T_3	19.63	19.77	21.60	22.23	20.90	10.10	11.62	12.14	12.50	11.47	2.36	2.18	2.14	1.99	2.16	0.00	0.70	1.17	1.67	2.33
T_4	22.63	23.75	26.40	25.00	23.90	11.53	12.58	13.78	14.23	13.27	2.33	2.13	2.14	2.06	2.08	0.00	0.93	1.73	3.00	4.23
T_5	21.03	20.37	22.53	22.73	22.17	10.90	12.00	12.61	13.25	12.29	2.34	2.12	2.13	1.91	2.04	0.00	0.73	1.23	1.77	2.67
T_6	23.37	27.30	26.60	25.80	24.73	12.40	13.43	14.47	14.68	13.55	2.26	2.28	2.08	2.07	2.22	0.00	1.30	1.93	3.63	5.57
T_7	21.15	23.44	23.40	24.40	22.53	11.10	12.05	13.00	13.60	12.97	2.30	2.15	2.17	2.01	2.04	0.00	0.77	1.27	2.10	3.00
T_8	17.86	18.20	18.59	18.43	18.40	9.70	11.03	11.55	11.48	10.53	2.33	2.08	2.02	1.84	2.11	0.00	0.50	1.07	1.30	1.60
S.E.M ±	1.07	1.53	1.69	1.55	0.92	0.46	0.42	0.59	0.49	0.46	0.031	0.042	0.042	0.063	0.049	0.00	0.150	0.185	0.187	0.252
CD at 5%	3.24	4.64	5.13	4.69	2.78	1.40	1.27	1.79	1.50	1.39	0.093	0.126	0.127	0.191	0.148	0.00	0.455	0.560	0.568	0.766

- **Leaf length (cm):** The highest leaf length was shown by treatment T_6 (30.66 cm) which was at par with T_4 (26.80 cm). This reveals that the effect of FYM in combination with seaweed extract and humic acid gives significantly superior results. On the contrary, treatment T_8 (22.94 cm) gave the lowest observed leaf length. The increase in leaf length increased the photosynthesis activity, thus increasing the food storage in the plant. Similar results were recorded by Mohanta *et al*. (2018) [6] in broccoli.
- **Leaf breadth (cm):** The leaf breadth was seen maximum in treatment T_6 (27.30 cm) which was at par with T_2 (23.70 cm), T_4 (23.75 cm), and T_7 (23.44 cm). The superiority of T_6 over other treatments was due to the combined role of three organic sources that led to increased width of the leaf. However, the lowest recorded leaf breadth was found in treatment T_8, i.e., Absolute control (18.20 cm). The results were similar to Tiwari *et al.* (2025) [15].
- **Petiole length (cm):** It was observed that amongst different treatments and treatment combinations, the highest petiole length was recorded in treatment T_6 (14.68 cm). This was statistically at par with treatments T_2 (13.89 cm), T_4 (14.23 cm), T_5 (13.25 cm) and T_7 (13.60 cm). On the other hand, the lowest petiole length was shown by treatment T_8 (11.48 cm). Verma *et al.* (2012) [16] showed similar results in taro and revealed that farm yard manure and vermicompost to be the best integrated nutrient management module for petiole length.

Leaf to petiole ratio

The application of different organic manures and bio-stimulants showed a non-significant trend in the leaf to petiole ratio. However, the highest ratio was observed in T_2 (2.37). The treatment T_6 (2.26) showed the lowest observed ratio in Colocasia. The effect of farmyard manure along with seaweed extract showed that the leaf and petiole length showed variation during the growth stages of Colocasia.

Number of suckers

The maximum number of suckers was observed in treatment T_6 (5.57) at 150 days after planting. The treatment T_8 (1.60) showed the lowest number of suckers. The number of suckers were influenced by factors including cultivar, spacing and nutrient management, especially with the organic manures. The combined application of FYM, vermicompost and inorganic fertilizers enhanced the absorption of nutrients especially nitrogen which increased the cell division, cell elongation and the plant growth. These findings are in line with Mahmoud *et al*., (2009), Vishwakarma *et al*., (2007) [17] and Kumar and Karuppaih (2008) [1].

Herbage yield per plant: The results regarding herbage yield per plant revealed that the highest yield was observed in treatment T_6 (25.40 g) at 30 DAP, while it was at par with T_2 (24.85 g) and T_4 (24.50 g). The lowest herbage yield was observed in T_8 (17.60 g). At 60 DAP, the maximum herbage yield was exhibited by T_6 (26.33 g) and it was significantly at par with T_2 (26.22 g) and T_4 (25.93 g), whereas T_8 (19.00 g) showed the similar trend. The yield was again found to be highest in T_6 (29.07 g), which was significantly at par with T_4 (28.36 g) at 90 DAP. The lowest herbage yield was observed in T_8 (21.00 g) per plant. The herbage yield was further reduced, at 120 DAP, its production pattern wherein the highest yield was shown by treatment T_6 (27.73 g). This treatment was at par with T_4 (27.93 g), while T_8 (17.33 g) showed the lowest yield. At 150 DAP, the trend was seen decreasing and it revealed that T_6 (25.20 g) observed highest herbage yield and the treatment at par to it was T_4 (24.23 g), whereas the lowest results were given by treatment T_8 (16.33 g). Similar findings were also observed by Shellikeri (2017) [12] in Colocasia which showed similar results in herbage yield per plant.

Table 3: Effect of organic manures and bio stimulants on herbage yield of Colocasia

Treatments	Herbage Yield															
	Per plant (g)						Per plot (kg)					Per hectare (q)				
	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	Cumulative	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP	30 DAP	60 DAP	90 DAP	120 DAP	150 DAP
T_1	7.22	7.73	8.35	6.96	6.67	36.93	0.62	0.67	0.72	0.60	0.57	19.50	20.87	22.53	18.80	18.00
T_2	9.21	9.71	10.04	8.89	8.37	46.22	0.79	0.84	0.87	0.77	0.72	24.85	26.22	27.12	24.00	22.60
T_3	7.56	8.27	8.89	7.10	6.82	38.64	0.65	0.71	0.77	0.61	0.59	20.42	22.33	24.00	19.17	18.41
T_4	9.07	9.60	10.50	10.35	8.97	48.50	0.78	0.83	0.91	0.89	0.78	24.50	25.93	28.36	27.93	24.23
T_5	8.07	8.65	9.26	7.64	7.15	40.78	0.70	0.75	0.80	0.66	0.61	21.80	23.37	25.00	20.63	19.30
T_6	9.41	9.75	10.77	10.27	9.34	49.53	0.81	0.84	0.93	0.89	0.81	25.40	26.33	29.07	27.73	25.20
T_7	8.41	8.99	9.77	7.91	7.36	42.43	0.73	0.78	0.84	0.68	0.63	22.70	24.27	26.37	21.37	19.87
T_8	6.52	7.04	7.78	6.42	6.05	33.80	0.56	0.61	0.67	0.55	0.52	17.60	19.00	21.00	17.33	16.33
S.E m ±	0.157	0.185	0.182	0.191	0.136	0.176	0.014	0.016	0.016	0.016	0.012	0.425	0.497	0.491	0.515	0.370
CD at 5%	0.478	0.561	0.552	0.580	0.413	0.535	0.042	0.049	0.049	0.048	0.035	1.288	1.509	1.489	1.562	1.122

Herbage yield per plot

The treatment T_6 (0.81 kg) showed the highest herbage yield per plot in Colocasia, which was at par with T_2 (0.79 kg) and T_4 (0.78 kg). The lowest herbage yield was achieved in T_8 (0.56 kg). At 60 DAP, the maximum herbage yield per plot was observed in T_6 (0.84 kg) and it was at par with T_2 (0.84 kg) and T_4 (0.83 kg). The treatment which showed minimum herbage yield was T_8 (0.61 kg). The highest herbage yield was recorded in T_6 (0.93 kg) at 90 DAP, which was significantly at par with T_4 (0.91 kg), whereas T_8 (0.67 kg) showed the lowest recorded yield per plot. At 120 DAP, the herbage yield per plot reduced and showed highest and lowest herbage yield per plot in T_6 (0.89 kg) and T_8 (0.55 kg), respectively. The highest yield was at par with treatment T_4 (0.89 kg). At 150 DAP, the maximum herbage yield per plot was observed in T_6 (0.81 kg). This was at par with T_4 (0.78 kg). The lowest herbage yield was obtained in treatment T_8 (0.52 kg). The result were in accordance with Shellikeri (2017) [12] in Colocasia which showed similar results in herbage yield per plot.

Herbage yield per hectare

The highest herbage yield per hectare at 30 DAP was observed in T_6 (9.41 qtl) which was at par with the treatments T_2 (9.21 qtl) and T_4 (9.07 qtl). The lowest herbage yield was seen in T_8 (6.52 qtl). At 60 DAP, the maximum herbage yield was observed in T_6 (9.75 qtl). This was significantly at par with T_2 (9.71 qtl) and T_4 (9.60 qtl), and the minimum herbage yield was observed in the case of T_8 (7.04 qtl). The treatment T_6 (10.77 qtl) showed the highest herbage yield, which was at par with the treatment T_4 (10.50 qtl) at 90 DAP. The lowest herbage yield per hectare was achieved in treatment T_8 (7.78 qtl). At 120 DAP, similar trend was observed in herbage yield, only the yield was seen to be decreasing. The average herbage yield was recorded to be highest in T_4 (10.35 qtl), that was at par with T_6 (10.27 qtl) and lowest in T_8 (6.42 qtl). Similarly, at 150 DAP, the highest and lowest herbage yield per hectare was seen in T_6 (9.34 qtl) and T_8 (6.05 qtl), respectively. The treatment that observed highest yield was at par with the treatment T_4 (8.97 qtl).

The above results are in close conformity with the findings of Suja *et al*. (2009) [13] reported that among the various nutrient management practices, application of ash 3 t ha^{-1} along with FYM increased the plant height and leaf production in tannia.

Conclusion

Based on the results recorded from the present investigation, the results can be concluded as follows. The effect of organic manures and bio-stimulants on growth parameters *viz.*, plant height, number of leaves, leaf length, leaf breadth, petiole length, leaf to petiole ratio, leaf area and number of suckers revealed significant results in treatment T_6 receiving 30 t ha^{-1} FYM, 3 ml L^{-1} Seaweed extract along with 1 ml L^{-1} Humic acid. Amidst all the treatment and treatment combinations, T_6 significantly affected the yield parameters of Colocasia such as herbage yield (per plant, per plot and per hectare). It can be concluded that treatment T_6 [FYM (30 t ha^{-1}) + Seaweed extract (3 ml L^{-1}) + Humic acid (1 ml L^{-1})] found to be significantly superior with respect to growth, yield and yield attributing characters in comparison with the other treatment and treatment combinations.

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