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GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus*) AS AFFECTED BY FOLIAR APPLICATION OF FISH TONIC

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ABSTRACT

Continuous application of inorganic fertilizer has been creating a variety of issues to the ecosystem hence it has made a trend to more devotion on organic applications in crop cultivation. Fish tonic is one of the organic applications which is used for improving crop growth and development. Therefore, the present study was mainly concentrated to find out the effect of fish tonic on vegetable cultivation as a foliar application and find out the effect on growth and yield parameters on Abelmoschus esculentus. Experiment was designed as complete randomized design with six replicates. Each replicate consisted with eighteen plants of Okra; variety Vimukthi. There were seven treatments such as T1 – No any applications, only water (control), T2 – Albert's Solution at 80g per 16 L of water, T3 to T7 - Fish tonic applied at 50, 100, 200, 400 and 600 ml of Fish tonic per 16 L of water respectively. The growth parameters such as plant height, number of leaves per plant, number of branches per plant, volume of the root fresh and dry root weight were taken weekly until 15 weeks. Meantime, time taken for flowering, number of flowers per plant and pods weight were taken as yield parameters. Data were analyzed using Analysis of Variance (ANOVA) from SAS 9.1.3 version. Subsequently, differences between treatment means were compared by Tukey's pairwise comparison Test at the 5% level of probability. According to the results, significantly higher plant height, number of leaves and more branchers were recorded from T2 to T7 compared to control treatment. There was no significant effect of treatments on the volume of the root, fresh root weight, dry root weight and number of flowers. A significantly more days were taken to flowering by T2 to T7 treatments. Further, weight of the pods were significantly higher in T3, T4, T5 and T6. The results revealed that compared to the control treatment, Albert's solution and fish tonic treatments were shown significant improvement on growth and yield parameters. Therefore, the study suggests that good quality yield can be achieved with fish tonic to reduce the high cost and harmful conditions by replacing Albert's solution like synthetic chemical liquid fertilizers.

Keywords: Albert solution, Fish tonic, Okra, Organic foliar application

INTRODUCTION

Okra (*Abelmoschus esculentus* (L) Moench), a vegetable of the Malvaceae family, is valued for its nutritional and medicinal properties (Gemede et al., 2014). With rising demand of Okra, fertilizer application is essential to boost the production. Chemical fertilizers, especially nitrogen-based, effectively enhance yield while excessive use causes environmental pollution and health risks. Organic fertilizers, derived from decomposed plant and animal waste, offer an environmentally friendly alternative (Chen, 2008).

Fish tonic, prepared by fermenting fish waste with brown sugar for at least three months, is rich in nutrients and amino acids (Ramesh et al., 2020). It serves as a natural nitrogen source during the vegetative stage, promoting growth and chlorophyll synthesis (Weinert et al., 2014). Foliar or soil application enhances nutrient uptake while minimizing leaching (Priyanka et al., 2019).

Sri Lanka's recent economic crisis severely impacted agriculture due to fertilizer shortages and high costs, increasing interest in organic alternatives like fish tonic. Organic fertilizers generally require larger quantities and microbial decomposition before nutrient availability, influencing application practices. Farmers also face a trade-off between traditional local varieties, which are resilient but lower yielding, and improved hybrids, which offer higher yields and disease resistance. Fish tonic has become a popular organic input, though application rates are vary. Therefore, this study aims to identify the most effective application for okra cultivation to enhance their growth and yield.

Historically, fish-based fertilizers have ancient origins. Egyptians used fish byproducts to enrich

soils, and Native Americans buried whole fish beneath crops, as exemplified by Squanto's advice to the Pilgrims to "fertilize the soil by burying fish alongside the maize seed," a technique that contributed to abundant harvests (historical record). Modern organic farming continues this tradition through fish tonic, providing nitrogen and amino acids essential for plant growth (Weinert et al., 2014; Ramesh et al., 2020).

Fish fertilizers release nutrients gradually via microbial activity, enhancing soil health and aeration by stimulating bacterial and fungal populations (Ahuja et al., 2020). Unlike synthetic fertilizers that provide quick nutrient availability, fish fertilizers promote long-term fertility and stronger roots. Fish Amino Acid (FAA), applied as foliar spray or soil drench, improves nitrogen uptake, chlorophyll production, and disease resistance through its high calcium content (Johari et al., 2020). The present study evaluates the effect of fish tonic on growth and yield of Okra to support sustainable, biologically active soil management amid rising agrochemical costs.

MATERIALS AND METHODS

The present study was conducted at the Research Unit of SOS Agriculture Training School, Bandarawela, to evaluate the effect of different concentrations of fish tonic on the growth and yield of Okra, variety Vimukthi (HVOK 023 – F1 hybrid). This hybrid was selected for its high yield potential and adaptability to both open-field and protected house cultivation.

Experimental design

The experimental design followed a Completely Randomized Design (CRD) with seven treatments and replicated six times. Each replicate contained three plants, totaling 126 plants (7 treatments × 6 replicates × 3 plants). UV-treated polythene grow bags (25 cm diameter × 30 cm height) were filled with well-pulverized, weed-free topsoil, and single seedling was planted per bag. Drainage holes were prepared to improve drainage.

The seven treatments consisted of T1; Control (no application), T2; 80g Albert's solution/16 L water, T3; 50 ml Fish Tonic/16 L water, T4; 100 ml Fish Tonic/16 L water, T5; 200 ml Fish Tonic/16 L water, T6; 400 ml Fish Tonic/16 L water, and T7; 600 ml Fish Tonic/16 L water.

After filling the UV-treated polythene grow bags with prepared topsoil, each pot was clearly labeled according to the assigned treatment (T1–T7) and corresponding replication number to ensure accurate data collection. The labeled pots were then arranged in the experimental area following a Complete Randomized Design with the spacing of 90 cm between rows and 60 cm within rows (90cm × 60cm), allowing adequate space for growth and maintenance. To distinguish between replications, a small drainage system was constructed to separate each replication block. This helped to prevent cross-contamination of treatments.

Treatment application was initiated one week after seedling establishment and continued weekly for 15 weeks. All applications were carried out in the morning before 10:00 a.m. Fish tonic and Albert solution were administered as foliar sprays using small hand sprayers, following the prescribed concentrations for each treatment group.

Fish tonic preparation

Fish tonic preparation was involved by fermenting fish waste with brown sugar in a 1:1 ratio under anaerobic conditions. Initially, 1 kg of fish waste was mixed with 500 g of brown sugar and allowed to ferment for two weeks, after which the remaining 500 g of brown sugar was added. After one month of anaerobic fermentation, the mixture was filtered, and the extract was used for treatment applications.

Growth parameters measured

Plant height (cm), cumulative number of leaves, and cumulative number of branches were recorded weekly for 15 weeks. Root volume, fresh and dry root weight were measured at the end of the trial (15th week).

Yield parameters measured

Days to first flowering were recorded for all plants. Flower counts were taken in the mornings from the start of flowering until the end of cultivation. Harvesting was started in the 7th week and pod weight (g) was collected two days interval until the 15th week.

All collected data were statistically analyzed using one-way ANOVA to determine the significance of differences among treatments. Tukey's pairwise comparison test was used to compare means at a 95% confidence level. Statistical analysis was performed using SAS 9.1.3 version.

RESULTS AND DISCUSSION

The study demonstrated that all the treatments with fish tonic and Albert solution significantly increased okra plant height at 1st, 4th and 7th WAP compared to the control ($P < 0.05$). This growth enhancement is attributed to the higher nitrogen content in these treatments, promoting early vegetative development.

Narmhikaa (2021) has been observed similar result for the soy bean that foliar application of fermented fish tonic significantly increased plant height versus control in that crop and Ekanayake et al. (2020) clearly reveled that fish tonic, being rich in amino

acids and minerals derived from fish waste fermentation, may improve leaf chlorophyll content, photosynthetic rate, and vascular development, resulting in taller plants. According to their study on Centella asiatica and green chili showed improved xylem function and enhanced plant height with fish tonic application. However, at 12 WAP and 15 WAP, no significant differences (P > 0.05) were observed among treatments, with average heights converging around 60 cm across all groups (Table 01). These results suggest that fish tonic and Albert's solution positively influence early growth but have limited effect on final plant height.

Table 01 : Effects of treatments on plant height at 1, 4, 7, 12, and 15 weeks

Treatment	Height (cm)				
	1WAP	4 WAP	7 WAP	12 WAP	15 WAP
T1 - No any applications (control)	2.14^{b}	7.89^{b}	26.497^{b}	62.4^{a}	69.43^{b}
T2 - Albert Solution (80g for 16 L)	3.244^{a}	14.972^{a}	46.28^{a}	76.44^{a}	85.44^{ab}
T3 - Fish Tonic - 50ml for 16 L	3.489^{a}	15.389^{a}	45.61^{a}	87.3^{a}	101.94^{a}
T4 - Fish Tonic - 100ml for 16 L	3.572^{a}	14.444^{a}	46.89^{a}	83.39^{a}	96.06^{ab}
T5 - Fish Tonic - 200ml for 16 L	3.517^{a}	15.306^{a}	45.5^{a}	79.22^{a}	92.6^{ab}
T6 - Fish Tonic - 400ml for 16 L	3.522^{a}	15.139^{a}	44.17^{a}	73.33^{a}	94.4^{ab}
T7 - Fish Tonic - 600ml for 16 L	3.333^{a}	14.972^{a}	43.83^{a}	73.11^{a}	78.89^{ab}
P-Value	0.000	0.000	0.000	0.225	0.059

Means followed by the same superscripts in a same column are not significantly different at 0.05 probability level.

The similar trend was observed for cumulative number of leaves also as in plant height. The application of fish tonic significantly enhanced the number of leaves, compared to the control at 2nd, 5th, 9th, and 12th weeks after planting. Treatments with 50, 100, 200, and 400 ml fish tonic per 16 L of water were produced a significantly higher number of leaves per plant at 9th WAP with compared to the control and the Albert solution applied treatment no significant differences were observed among the fish tonic applied treatments. This suggests that fish tonic, being rich in essential nutrients and bioactive compounds, promoted better vegetative growth than the chemical fertilizer (Albert's solution) and control.

With the application of fish tonic could be increase the number of leaves due to the availability of nitrogen and other micronutrients in fish-based formulation which attributed to boost chlorophyll synthesis and photosynthetic activity. Based on this mechanism, it was eventually contributing to higher biomass accumulation. This suggests that nutrient availability in treated plants supported more vigorous leaf development. However, by 15th WAP, no significant difference (P > 0.05) was observed among treatments. This plateau likely reflects the cessation of main stem growth and reduced leaf production at maturity, with new growth occurring mainly on lower branches producing smaller leaves.

A significant increase (P < 0.05) in the cumulative number of branches was observed at 4th, 10th, and 13th weeks after planting in treatments with Albert's solution and fish tonic compared to the control, while no significant differences were found at 1st and 7th WAP (Table 03). These results align with other reports such as Gnolizadeh et al. (2009) revealed that as adequate primary nutrients are essential for branch development. Furthermore, enhanced branching contributes to greater leaf area, which may improve photosynthetic capacity and overall plant growth. Furthermore, a study of Johari et al. (2020) on okra found that foliar sprays of fish amino acid significantly increased variables such as plant height and branch number, compared to control and other organic treatments.

There was no significant difference (P >0.05) among the treatments on root volume (27.22 – 50.5ml/plant) fresh root weight (27.22 – 48.11g/plant) and dry root weight (4.01 – 8.62g/plant) of this experiment. According to the studies of Khandaker et al., 2017; Ellyzatul et al., 2018, roots play a critical role in nutrient absorption, directly influencing plant growth, development, and fruit weight by ensuring adequate nutrition uptake and providing firm anchorage in the soil. Healthy roots also support soil ecosystems by sustaining other organisms. The present study's findings align with previous reports emphasizing that biofertilizers and biocontrol agents enhance root growth and volume, thereby improving overall plant health and yield.

Table 02: Effects of treatments on Cumulative Number of Leaves

Treatment	No of Leaves				
	2 WAP	5 WAP	9 WAP	12 WAP	15 WAP
T1 - No any applications (control)	2.5^{b}	4^{b}	5.833^{b}	10.167^{b}	13^{a}
T2 - Albert Solution (80g for 16 L)	3.722^{a}	6.389^{a}	9.056^{ab}	14.5^{a}	14.78^{a}
T3 - Fish Tonic - 50ml for 16 L	3.833^{a}	6.89^{a}	10.72^{a}	16.278^{a}	14.89^{a}
T4 - Fish Tonic - 100ml for 16 L	3.722^{a}	6.556^{a}	10.556^{a}	15.556^{a}	13.778^{a}
T5 - Fish Tonic - 200ml for 16 L	3.667^{a}	6.389^{a}	10.72^{a}	16.11^{a}	13.611^{a}
T6 - Fish Tonic - 400ml for 16 L	3.889^{a}	6.444056^{a}	12.06^{a}	16.278^{a}	13.222^{a}
T7 - Fish Tonic - 600ml for 16 L	3.722^{a}	6.056^{a}	9.556^{ab}	15.78^{a}	13.17^{a}
P-Value	0.000	0.001	0.002	0.000	0.469

Means followed by the same superscripts in a same column are not significantly different at 0.05 probability level.

Table 03: Effects of treatments on Cumulative Number of Branches

Treatment	No of Branches				
	1 WAP	4 WAP	7 WAP	10 WAP	13 WAP
T1 - No any applications (control)	0.722^{a}	1.001^{b}	1.722^{a}	2.667^{b}	2.944^{b}
T2 - Albert Solution (80g for 16 L)	1.167^{a}	2.0556^{a}	2.444^{a}	3.278^{ab}	4.056^{a}
T3 - Fish Tonic - 50ml for 16 L	1.5^{a}	2.278^{a}	2.667^{a}	3.667^{a}	4.667^{a}
T4 - Fish Tonic - 100ml for 16 L	0.889^{a}	2.167^{a}	2.722^{a}	3.278^{ab}	4.056^{a}
T5 - Fish Tonic - 200ml for 16 L	1.167^{a}	2.389^{a}	2.611^{a}	3.389^{a}	4.278^{a}
T6 - Fish Tonic - 400ml for 16 L	0.167^{a}	2.156^{a}	2.689^{a}	3.5^{a}	4.278^{a}
T7 - Fish Tonic - 600ml for 16 L	1^{a}	2.0667^{a}	2.367^{a}	3.333^{ab}	3.889^{a}
P-Value	0.372	0.002	0.068	0.005	0.000

Means followed by the same superscripts in a same column are not significantly different at 0.05 probability level.

A significant difference ($P < 0.05$) was observed in the number of days to flowering among treatments (Figure 01). Plants treated with Albert solution and fish tonic took significantly longer time to flowering compared to the control. This delay suggests that these treatments extended the vegetative growth phase, promoting stronger and more vigorous plant development. Consequently, healthier plants were able to transition to the reproductive stage more robustly, potentially leading to improved pod quality and yield.

When consider the number of flowers, there was no significant difference ($P>0.05$) among the treatments (1.167 - 2.111/ plant). It seems that those both fish tonic and albert solution are mainly enhancing the growth characters by providing more nitrogen to the plants during the growth stage. Meantime, those applications are not much influence to induce flowering.

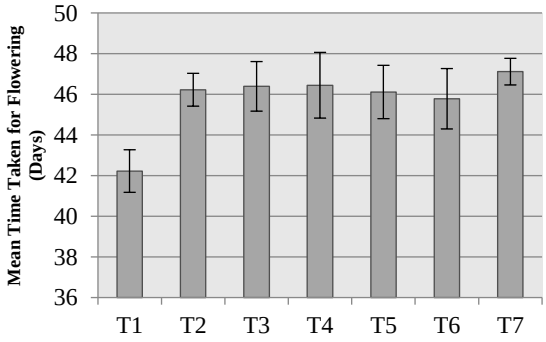

Figure 01: Effects of treatments on time taken for flowering (Days)

Although no significant differences (P > 0.05) in pod weight were observed among treatments at early and later stages (i.e. 7th, 13th, and 15th weeks after planting), a significant enhancement was recorded at 9th WAP in plants treated with fish tonic and albert solution compared to the control. Additionally, it was significantly increased the pod weight in fish tonic applications treatments compared to the albert solution and control at 11th WAP (Table 04). These results suggest that fish tonic may provide beneficial nutrients or growth-promoting compounds that support reproductive development and fruit formation during critical growth stages. These treatments appeared to delay the reproductive phase, allowing more time for photosynthesis and food accumulation, which directly contributed to increased pod yield by increasing the growth during the vegetative phase (Johari et al., 2020).

Table 04 : Effects of treatments on pods yield

Treatment	Yield (g)				
	7 WAP	9 WAP	11 WAP	13 WAP	15 WAP
T1 - No any applications (control)	50.83^{a}	63.5^{b}	38.3^{b}	36.33^{b}	42^{a}
T2 - Albert Solution (80g for 16 L)	94.67^{a}	112.3^{ab}	44^{b}	42^{ab}	63.83^{a}
T3 - Fish Tonic - 50ml for 16 L	90.3^{a}	162.3^{a}	114.7^{a}	66.67^{a}	61.17^{a}
T4 - Fish Tonic - 100ml for 16 L	75.5^{a}	116.7^{ab}	86.3^{a}	42.33^{ab}	56.17^{a}
T5 - Fish Tonic - 200ml for 16 L	81.8^{a}	169.7^{a}	73^{a}	48.5^{ab}	55.5^{a}
T6 - Fish Tonic - 400ml for 16 L	90.7^{a}	128.2^{ab}	104.9^{a}	49.7^{ab}	76.17^{a}
T7 - Fish Tonic - 600ml for 16 L	80^{a}	128.8^{ab}	48.83^{ab}	50.33^{ab}	51.33^{a}
P-Value	0.126	0.017	0.030	0.090	0.187

Means followed by the same superscripts in a same column are not significantly different at 0.05 probability level

CONCLUSION

In this study, the results reported that fish tonic and Albert's solution treatments demonstrated positive effects on growth and yield parameters. Proving that fish tonic offers a cost-effective, eco-friendly alternative to chemical fertilizers and functions as an effective organic growth regulator. It is recommended to apply fish tonic at moderate rates (200 and 400ml/16L water), as no additional benefits were observed with higher dosages. The use of fish tonic can reduce reliance on inorganic fertilizers and support sustainable agriculture. To obtain full benefits of organic farming including improved soil health, lower external input costs, efficient use of local resources, enhanced soil water-holding capacity, environmental conservation, and potential premium market prices, it is necessary for farmer education and training to promote sustainable farming practices in horticulture.

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REFERENCES

Ahuja, A., Dauksas, E.D., Fremme, J., Richardsen, R., and Loes, A.K. (2020): Fish and fish waste fertilizers in organic farming –with status in Norway: A review. Waste Management, 115: 95–112.

Chen, J. H.(2008). The Combined Use of Chemical and Organic Fertilizers and/or Bio Fertilizers for Crop Growth and Soil Fertility. Taichung, Taiwan.

Ekanayake E.M.U.I, Eranga G.A.S and Fernando K.M.C (2020). Effect of organic and inorganic liquid fertilizers on growth and yield of *Centella asiatica* (l.) and *Capsicum annuum* (l.) Var. Annuum. Tropical Agricultural Research & Extension. 23: 3 – 4.

Ellyzatul, A.B., Yusoff, N., Mat, N. and Khandaker, M.M. (2018): Effects of fish waste extract on the growth, yield and quality of *Cucumis sativus* L. Journal of Agrobiotech, 9 (1S): 250–259.

Gemede, H. F., Ratta, N., Haki, G. D., Woldegiorgis, A. Z. & Beyene, F. (2014). Nutritional quality and health benefits of okra (*Abelmoschus esculentus*): A review. Global Journal of Medical Research.

Gholizadeh, A., Amin, M.S.M, Anuar, A. R., and Aimrun, W. (2009). Evalution of Spad chlorophyll meter in two different stages and its temporal variability. European Journal of Science Research. 37(4): 65-69.

Johari, N.S.1, Asilah, A. M.1, Zalina, I.1, Fazhana, I.1, Ab-Latif, Z.,Shaibatul' Islamiah, C. M.1, and Tang, J. R.1, (2020), Effects Of Fish Amino Acid (Faa) Application on Growth and Development of Okra (*Abelmoschus Esculentus*) at Different Sampling Times, 3(2): 128-135.

Khandaker, M. M., Jusoh, N., Hafiza, Ralmi, N. H. A. A. and Ismail, S. Z. (2017). The effect of different types of organic fertilizers on growth and yield of *Abelmoschus esculentus* L. Moench (Okra). Bulgarian Journal of Agricultural Sciemce, 23: 119-125.

Narmhikaa K (2021). Effect of fermented fish tonic on the growth and yield of Glycine max. (L). World Journal of Advanced Research and Reviews. 12(03): 545–549.

Priyanka, B., Anoob, D., Gowsika, M., Kavin, A., Sri, S. K., Kumar, R. V. K, Gomathi, R. S., Sivamonica, B., Devi, G. V., and Theradimani, M. (2019). Effect of fish amino acid and egg amino acid as foliar application to increase the growth and yield of green gram. The Pharma Innovation Journal, 8: 684-686.

Ramesh, T., Rathika, S., Murugan, A., Soniya, R.R., Mohanta, K.K., and Prabharani, B. (2020). Foliar spray of fish amino acid as liquid organic manure on the growth and yield of Amaranthus. Chemical Science Review and Letters, 9: 511-515.

Weinert, E. J., Miller, S. A., Ikeda, D. M., Chang, K. S., McGinn, J. M., and DuPonte, M. W. (2014). Natural Farming: Fish Amino Acid. Sustainable Agriculture, SA-12. University of Hawai'i, College of Tropical Agriculture and Human Resources.