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Effect of foliar spray of Amirthakaraisal on okra (*Abelmoschus esculentus*) cultivation

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Abstract

An experiment was carried out to study the performance of different concentrations of Amirthakaraisal, a foliar spray, on okra (Abelmoschus esculentus) development and yield. The conducted experiment followed a Completely Randomized Design (CRD) with the following treatments; T1 - Full recommended fertilizer, T2 - Compost 10 ton/ha, T3 - 5 ton/ha compost as basal and 5 ton/ha compost as topdressing, and 5 ton/ha compost as basal and 5 ton/ha compost as topdressing with 1% (T4), 3% (T5), 5% (T6) Amirthakaraisal as a foliar spray at 1st, 3rd and 5th week after planting. The results showed that there were significant differences ($P<0.05$) in plant height, number of leaves per plant, number of pods per plant, and dry weights of leaf, stem, and root. However, there were no significant differences ($P>0.05$) in the fresh weight and dry weight of pods among the tested treatments. The study suggests that foliar application of Amirthakaraisal at a 5% level compared to 1% and 3% application is effective in improving okra plant growth.

Keywords: Amirthakaraisal; Compost; Growth; Okra; Fertilizer; Yield

1. Introduction

Okra (*Abelmoschus esculentus* L) is a major vegetable crop in tropical and subtropical regions of the world and belongs to the *Malvaceae f*amily [1]. Okra contains high fiber, essential vitamins such as A, C, and K, and some essential minerals [2, 3]. Okra has several health benefits for a variety of human ailments, including cardiovascular diseases, gastrointestinal issues, type 2 diabetes, and cancer [4].

It is cultivated in the Wet, Intermediate, and Dry zones of Sri Lanka. Okra is a resilient crop that can grow in a variety of climates [5]. Due to the excellent meteorological and soil conditions, as well as the simplicity with which crop management may be accomplished, okra is a very common vegetable among dry-zone farmers. Okra growth and yield, on the other hand, are influenced by factors such as soil nutrition, seed quality, climate, and cultural practices, as well as the plant growth regulator application [6]. One of the key reasons restricting okra production has been discovered as low yield due to inadequate soil nitrogen conditions [1].

Fertilizers are compounds that improve the nutrient status of soil to improve soil fertility and plant development and productivity. Fertilizer has become an important aspect of contemporary agriculture, and to achieve high yields, large amounts of nitrogen and other inorganic fertilizers are frequently applied to vegetable gardens and fields [7]. This has a dramatic effect on the enhancement of production and productivity. Excessive inorganic fertilizers, on the other hand, reduced fertility, hardened the soil, intensified pesticides, polluted air, and water, and emitted greenhouse gases, posing health and environmental risks. The use of chemical fertilizers regularly depletes vital soil nutrients and minerals that occur naturally in rich soil. Inorganic fertilizers are unattractive to individuals concerned about environmental

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sustainability because of their significant economic and ecological costs. As a result, replacing chemical fertilizers with low-cost organic manures is critical for the long-term viability of agriculture output and the preservation of soil fertility for a better future.

Foliar application of organic liquid fertilizers directly to the leaves is the greatest success than the conventional application methods like surface, banded, or beneath the soil surface application methods [8]. Introducing low-cost materials such as organic fertilizer is vital to increasing crop production in developing countries. Amirthakaraisal is one of the cheapest organic fertilizers that can be applied as a foliar spray, which is prepared by mixing cow dung, cow urine, jaggery, and water. Cow urine supplies nitrogen, which is necessary for plant growth, while cow manure serves as a breeding ground for microbes [9]. Irrigation with Amirthakaraisal reduced root-borne diseases and improved soil enzymatic activity; it also worked as a nutrient and effective growth booster [10]. Amirthakaraisal contains key macronutrients (N, P, and K), as well as micronutrients (Zn, Fe, Mn, and Cu) and reducing sugars [11]. Beneficial microorganisms of Amirthkaraisal enhanced soil quality, crop development, and yield [12]. Though Amirthakaraisal has several nutrients, research findings on its effects on crops are scanty. Based on the above facts, the present investigation was undertaken to study the effect of foliar spray of different concentrations of Amirthakaraisal on the growth and yield of okra (*Abelmoschus esculentus).*

2. Material and methods

An experiment was carried out at the Faculty of Technology, Eastern University, Sri Lanka, which is located in the low country dry zone. The okra variety *Haritha* seeds were sown in the sandy regosol. The experiment follows a Completely Randomized Design (CRD) with six treatments. T1 - Full recommended fertilizer, T2 - Compost 10 ton/ha, T3 - 5 ton/ha compost as basal and 5 ton/ha compost as topdressing and 5 ton/ha compost as basal and 5 ton/ha compost as topdressing with 1% (T4), 3% (T5), 5% (T6) Amirthakaraisal as a foliar spray at 1st, 3rd and 5th weeks after planting.

Amirthakaraisal was prepared at the Laboratory of Faculty of Technology, EUSL. 1000 g of cow dung and 1000 ml of cow urine were taken in a wide-mouthed pot for the preparation of the solution and 10-liter water was poured into the pot and the ingredients were mixed well. Then, 250 g of jaggery was added and stirred well until it got dissolved. The mixture was allowed for 24 hours to ferment and stored in the shade by covering it with a lid to avoid the breeding of insects. Different concentrations of Amirthakaraisal such as 1%, 3%, and 5% were prepared separately in beakers by adding the proper amount of water.

45 cm height and 30 cm diameter pots were employed in this experiment. Scarified okra seeds were sown at the rate of two seeds per pot with 1-2 cm depth. Amirthakaraisal was sprayed at the rate of 25 ml for each plant in T4, T5, and T6 at two weeks intervals. Foliar applications were done early in the morning for better absorption. All pots were watered once daily in the evening. Except for fertilizer application, all agronomic operations were carried out according to the recommendations of the Department of Agriculture. The destructive sampling method was used to measure the growth and yield parameters. Parametric and non-parametric statistics were used to analyze the collected data.

3. Results and discussion

3.1. Plant height

As shown in Figure 1, significant difference in plant heights were observed ($P<0.05$) among the treatments at 2, 4, 6, and 7 weeks after planting (WAP). However, plant heights were not significantly varied at 2 WAP. Among the tested treatments the tallest plant was observed in T6 while the lowest in T4 from 2WAP to 7WAP. [13] found similar results in chili plants that were treated with the highest percentage (5%) of Amirthakaraisal. This may be due to the increased absorption of nutrients and minerals by the plants and the presence of phenols in Amirthakaraisal.

[14], found that phenolic compounds aid in the plants' height. They further stated that maximum phenolic compound concentration in wild oat plants was observed at the stem elongation stage. [15] Found similar results in an experiment performed with *Capsicum annum*, that the macronutrients such as N, P, K, Ca and micronutrients present in abundance in the Amirthakaraisal can improve the growth characteristics of the crops.

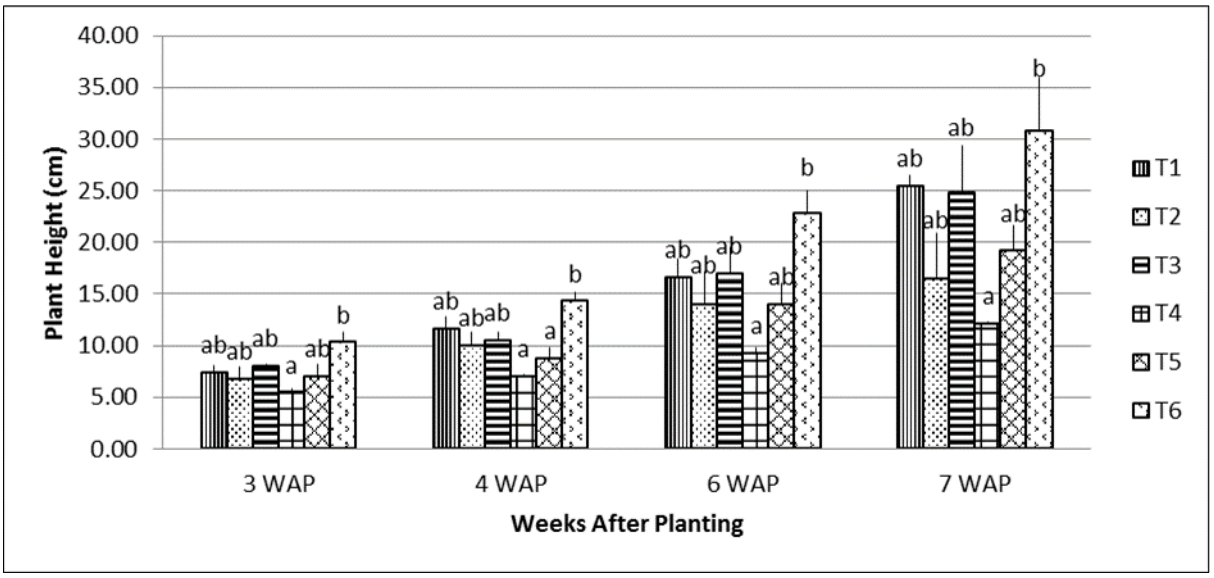

Figure 1 Effect of Amirthakaraisal foliar spray on the plant height at different growth stages

3.2. The number of leaves per plant

The effect of Amirthakaraisal foliar spray on the number of leaves is given in Table 1. Foliar application of Amirthakaraisal significantly influenced the number of leaves ($P < 0.05$) at 7 WAP.

Table 1 Effect of Amirthakaraisal foliar spray on the number of leaves at different stages of crop

Treatments	Number of leaves		
	4th WAP	6th WAP	7th WAP
T1	6	7	8
T2	4	4	6
T3	5	6	9
T4	5	4	5
T5	5	6	8
T6	6	7	7
Chi square	6.429	4.708	10.000
P value	0.160	0.079	0.017

No any significant difference (P>0.05) was observed the number of leaves per plant with the application of Amirthakaraisal as confirmed with *P*-values of 0.160 and 0.079 and chi-square values of 6.429 and 4.708 at 4th and 6th WAP respectively (Table 1). However, there was a significant difference (P<0.05) at the 7th WAP was confirmed with a *P*-value of 0.017 and chi-square value of 10.00. At 7 WAP, the significantly highest number of leaves (9) was observed in T3 while the lowest number of leaves (5) was observed in T4 (Table 1). However, a significant increase in the number of leaves was observed in the 3% and 5% application of Amirthakaraisal compared to the 1% application. No significant differences were observed at 4 and 6 WAP. Therefore, the effect of foliar application of Amirthakaraisal at the rate of 3% and 5% produced a high number of leaves as the same in T1 and T3 and this may be due to the increased nitrogen content of Amirthakaraisal with increasing concentration. This scenario was supported by [16], who found that Nitrogen deficiency can cause oxidative stress to leaf and lead to leaf abscission.

3.3. The dry weight of okra

Foliar application of Amirthakaraisal significantly influenced the dry weight of the leaf, stem, and root ($P < 0.05$) as shown in Table II at 7WAP. T1 recorded the maximum dry weights of leaf, stem, and root (2.79g, 6.67g, and 2.337g) while T4 recorded the minimum dry weights. However, no significant differences were observed among the rest of the treatments (T2, T3, T5, and T6) in terms of leaf and root dry weight. In stem dry weight, no significant differences were observed among T2, T3, and T6. Therefore, 3% and 5% foliar applications of Amirthakaraisal resulted in significantly the same dry weights as T1, T2, and T3.

Table 2 Effect of Amirthakaraisal foliar spray on the dry weight of leaf, stem, and root of okra at harvest

Treatments	Leaf dry weight(g)	Stem dry weight(g)	Root dry weight(g)
T1	$2.790^{a} \pm 0.7736$	$6.67^{a} \pm 1.3224$	$2.337^{a} \pm 0.5659$
T2	$1.133^{ab} \pm 0.2161$	$2.360^{ab} \pm 0.5002$	$0.650^{ab} \pm 0.1247$
T3	$1.310^{ab} \pm 0.4886$	$3.41^{ab} \pm 1.1232$	$1.197^{ab} \pm 0.3422$
T4	$0.317^{b} \pm 0.1259$	$0.753^{b} \pm 0.2938$	$0.2167^{b} \pm 0.0723$
T5	$1.230^{ab} \pm 0.1686$	$1.917^{b} \pm 0.7936$	$0.820^{ab} \pm 0.2273$
T6	$1.430^{ab} \pm 0.5273$	$4.68^{ab} \pm 1.2242$	$1.760^{ab} \pm 0.5110$
P value	0.0046	0.011	0.013

The value represents the mean ± standard error of four replicates. P<0.01; Means with the same letter are not significantly different according to Duncan's Multiple Range Test at the 5% level.

However, a significant increase in dry weights of leaf, stem, and root was observed in the 3% and 5% application of Amirthakaraisal compared to the 1% application and T3. Therefore, the effect of foliar application of Amirthakaraisal at the rate of 3% and 5% increased the dry weights and they are on par with T2 and T4. The increase in the dry weight of leaves was mainly due to the high number of leaves on the plant (Table 2). Amirthakaraisal is enriched with indole acetic acid [11] and enhances the plant growth and development that leading to the increment of the dry weight of the leaf, root, and stem with increasing concentration.

3.4. The number of pods per plant

The effect of Amirthakaraisal foliar spray on the number of pods per plant is given in Table III. There was no significant difference (P>0.05) at the 6th WAP confirmed with a *P*-value of 0.229 and a chi-square value of 5.323 is shown in table III. However, foliar application of Amirthakaraisal significantly influenced the number of pods ($P < 0.05$) at 7 WAP.

Table 3 Effect of Amirthakaraisal foliar spray on the number of pods per plant at different stages of crop

Treatments	Number of pods per plant	
	6th WAP	7th WAP
T1	2	2
T2	1	1
T3	1	2
T4	1	1
T5	1	1
T6	1	3
Chi square	5.323	11.648
P value	0.229	0.034

The highest number of pods per plant was observed in T6 (3) followed by T1 and T3 (2). The findings of [17] showed the same, that organic practices have increased the yield in Chili plants and, [18] reported that a 1% increased concentration of Amirthakaraisal leads to a 1.24% increase in the yield per acre. This might be due to the presence of indole acetic acid (IAA) and gibberellic acid in Amirthakaraisal, which increased the number of pods. This was supported by [19], that the exogenous application of indole acetic acid (IAA) and gibberellic acid has increased the number of pods in okra.

3.5. The fresh and dry weight of pods per plant

The effect of foliar spray of Amirthakaraisal on the fresh and dry weight of pods per plant is given in Tables 4 and 5.

Table 4 Effect of Amirthakaraisal foliar spray on the fresh weight of pods at different harvests

Treatments	Fresh Weight (g)	
	6WAP	7WAP
T1	14.18 ± 0.66	12.17 ± 3.91
T2	3.36 ± 3.36	8.55 ± 9.74
T3	2.69 ± 2.69	12.52 ± 10.33
T4	0.00 ± 0.00	3.04 ± 5.27
T5	5.53 ± 5.53	8.40 ± 7.28
T6	7.53 ± 4.14	15.33 ± 8.50
P value	0.122	0.512

Values represent the mean ± standard error of four replicates.

Application of Amirthakaraisal did not influence (P>0.05) the fresh and dry weight of pods as definite with *P*-values of 0.122 and 0.512 for fresh weight and *P*-values of 0.067 and 0.428 for dry weight at 6WAP and 7WAP respectively (Table 4 and 5).

Table 5 Effect of Amirthakaraisal foliar spray on the dry weight of pods at different harvests

Treatments	Dry Weight (g)	
	6WAP	7WAP
T1	1.47 ± 0.06	1.63 ± 0.35
T2	0.28 ± 0.28	1.12 ± 0.79
T3	0.28 ± 0.28	1.50 ± 0.71
T4	0.00 ± 0.00	0.29 ± 0.29
T5	0.50 ± 0.50	1.12 ± 0.56
T6	0.76 ± 0.41	2.17 ± 0.78
P value	0.067	0.428

Values represent the mean ± standard error of four replicates.

The highest fresh weight and dry weight of pods were observed in T1 followed by T6 at 6WAP. However, at 7WAP highest fresh and dry weights were observed in T6. The lowest fresh weight and dry weight of pods were observed in T4 at both 6 and 7 WAP. However, increasing the concentration of Amirthakaraisal increased the pod's fresh and dry weight. This may be due to the high potassium content of Amirthakaraisal [17]. Potassium increases the transmission of photoassimilates from leaves to pods [20]. This was supported by [21], who found that the maximum dose of potassium (80 kg K_2O ha^{-1}) increased the pod yield in okra. Amirthakaraisal has a good effect on chlorophyll synthesis, and it could have enhanced the photosynthesis of okra plants [15].

4. Conclusion

The results reveal that the application of Amirthakaraisal had significant influences ($P<0.05$) in plant height, the number of leaves per plant, dry weights of leaf, stem and root, and the number of pods per plant. Further at harvesting, the highest value was observed in T6 and the lowest value in T4. From the findings of the current study, among the all treatments, foliar application of Amirthakaraisal at the rate of 5% effectively improved the plant growth parameters of okra. Amirthakaraisal is an inexpensive natural fertilizer that can be used to increase crop growth in an environmentally friendly manner.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have no conflict of interest to declare.

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