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Foliar Application of Sakurab (*Allium Chinense* G. Don) Extract on Tomato (*Lycopersicon Esculentun*) Production

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ABSTRACT

The demand for tomatoes is constantly high all year round. They are one of the most popular crops among home gardeners and farmers worldwide. Not only are they delicious, but they are also easy to grow and could provide high returns for the space they occupy. However, tomatoes are highly sensitive to several biotic and abiotic stresses. This study aimed to evaluate two varieties of tomatoes and their interaction effects in response to the application of Sakurab leaf extract as organic foliar fertilizer and insect pest repellent. It utilized Split Plot Randomized Complete Block Design (RCBD) replicated three times with 30 plots comprising two main plots: Tomato variety (V1 – Braveheart and V2 – Diamante). Each main plot was divided into five equal sub-plots: Sakurab leaf extract concentration [F1 – control (no foliar application), F2 – 2% foliar fertilizer (20 ml/ L of water), F3 – 5% foliar fertilizer (50 ml/ L of water), F4 – 10% foliar fertilizer (100 ml/ L of water), and F5 – 15% (150 ml/ L of water) levels of concentrations. In terms of growth parameters, results revealed that the varying levels of Sakurab leaf extract foliar application did not significantly affect the plant height, days to first flowering, days to fruiting, and the days to harvest. However, the marketable fruits per tomato plot, marketable fruits per plant, and the marketable yield of tomato plants per hectare were significantly ($P < 0.05$) affected by varying levels of Sakurab foliar application. Based on the findings, the Diamante variety applied with a 15% (150 ml/L of water) level of Sakurab leaf extract concentration which produced the most marketable fruits per plot and the yield per ton/ha is recommended. Further experiment using a higher level of concentration of Sakurab leaf extract such as 30%, 60%, and 90% within a controlled environment, including the assessment of pest and disease incidence is proposed.

INTRODUCTION

Tomato production is a promising business venture. In most tomato-producing provinces and countries, the low tomato production can largely be attributed to a low understanding of this crop and insufficient knowledge of the correct production techniques. McDougall *et al.* (2017), reported that the tomato is known to be the most profitable crop in the Philippines and is widely cultivated throughout the world. However, its production is plagued by several pests and disease problems, especially bacterial wilt, which substantially reduced yield. That is why farmers resort to the application of fertilizers to keep diseases and weeds away.

Researchers found that tomato crops tend to perform better when fertilized. Be it liquid or dry fertilizers. In this study, the researcher applied foliar fertilizers extracted from Sakurab (*Allium Chinense* G. don) leaves to improve the uptake of nutrients from the soil and could benefit the plant suffering from deficiencies. To provide nutrients that are needed in battling multiple diseases and stresses like worms and tumors in the growth of two varieties of tomatoes such as diamante and braveheart tomatoes.

Historically, Sakurab was an important commercial plant both in Asia and elsewhere mainly as a vegetable and as a moth repellant to control various diseases and stresses. According to Bah *et al.* (2012), in a study done in China, its medicinal value was discovered from the bulb's phytochemical constituents.

Sakurab is one of the most popular plants in Lanao del Sur and is grown abundantly. It is used in almost all the Meranao delicacies, and it could be a good source of income for farmers since it is a major ingredient in the preparation of "Palapa". The Sakurab leaves are usually cut off when you buy them in the markets. Its bulbs produce steroid saponins and organosulfur compounds that have fascinating biological and pharmacological effects, such as antifungal, antibacterial, anti-inflammatory, and hypocholesteremia properties. Their bulbs are used in the palapa preparation. Making use of the leaves as extract as foliar fertilizers could be of great help to the growers of Sakurab if the study is found effective.

Apart from the abundant supply of Sakurab in Lanao del Sur, Riotte (1978) found that Sakurab is used to repel moths. It is said that the juice of the plant repels insects and moles.

Furthermore, there have been fewer experiments done on Sakurab. Therefore, in a bid to increase the production and demand for Sakurab in Lanao del Sur, this study is done to provide a low-cost alternative to the cost of chemical inputs in growing tomatoes through the

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application of Sakurab leaf extract as an organic foliar fertilizer and insect pest repellant.

MATERIALS AND METHODS

Site Description

The field experiment was conducted at the College of Agriculture, Mindanao State University-Main Campus, Marawi City, Lanao del Sur, Philippines (7°59'34.6" N 124°15'31.2" E). The experimental area falls under Type IV climate, portrayed by equitably disseminated precipitation over time. The soil type of the experimental site is the adtuyon soil.

Experimental Design and Treatments

The study was laid out in a 2 x 5 factorial experiment settled in a Split Plot Randomized Complete Block Design (RCBD) replicated three times (Figure 1) with 30 plots and consisting of 32 plants in every plot. There were three replications with a total area of 20 x 18.5 (370 sqm) which was split into three equal blocks of 11 sqm. Each block is represented as replication having a 0.5-meter distance in between. These were divided into two equal parts to denote the main plot: Tomato variety (V1 – Braveheart and V2 – Diamante). Each main plot was separated into five equal parts to represent sub-plot: Sakurab leaf extract concentration [F1 – control (no foliar application), F2 – 2% foliar fertilizer (20 ml/ L of water), F3 – 5% foliar fertilizer (50 ml/ L of water), F4 – 10% foliar fertilizer (100 ml/ L of water), and F5 – 15% (150 ml/ L of water) levels of concentrations, thus sub-plots were prepared and subjected to different treatment concentrations. Each sub-plot contained 32 plants based on a planting distance of 0.5 m between rows and hills respectively.

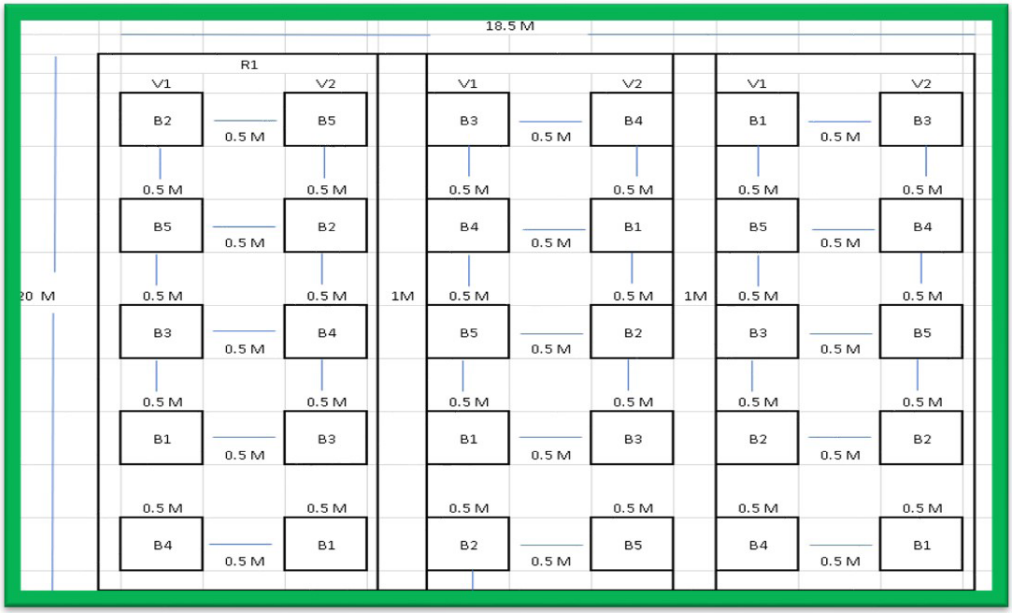

Figure 1: Experimental layout

Growing Plots Preparation

Alternate plowing and harrowing were used in the plot preparation until a good soil was obtained. With a spade and rake, the experimental plots were then set out.

Seedling Production

Seed of Braveheart and Diamante tomato varieties were used. The seeds were planted in sterilized plastic seedling trays containing sterilized mixture of one-part garden soil and one-part vermicast (1:1). A shallow hole was created in each cell of the seedling tray using a bamboo stick covered with fine soil. The seedling trays were then watered using an atomizer to moisten the growing medium and hasten seed germination. Irrigation was done daily until the seeds are fully germinated and regular watering as soon as the seedlings emerged.

Transplanting of Seedlings

To meet the population requirement in each variety of tomatoes, five plots were transplanted with Braveheart seedlings and another five plots with Diamante seedlings. Planting distances were 75 cm between rows and 50 cm between hills, with a 25-cm provision on both sides of the plot. Thus, eight plants were planted in a row, resulting in 32 plots per plot.

Nutrient Management

Chicken dung with a 2.4 kg weight per plot was applied to the topsoil layer during leveling of the experimental plots and applied to the various treatments. Complete fertilizer (14-14-14) was also applied based on the prescribed rate of 120-120-120 kg NPK/ha. A total of 940 grams of fertilizer was applied per plot (11 m^2).

Preparation of Sakurab Leaf Extract as Foliar Fertilizer

Foliar application using Sakurab (*Allium Chinense* G. don) leaf extract was used in this study following the preparation of Dacumos (2009). Matured and healthy

leaves of Sakurab were gathered, weighed, and chopped. For every 500 grams of Sakurab leaves, 500 ml of water was added and blended using a fruit blender. A fine cloth was used to separate the leaf extract decoction, which was then squeezed. The extract was placed in a firmly sealed bottle to avoid contamination. The produced stock solution was refrigerated before being used as a foliar spray fertilizer.

Weeding and Hilling-up
Hilling up was done days 14 days after transplanting by loosening the soil and providing aeration to the plants using a spade. This action also helps in reducing the growth of weeds.
On the other hand, a weed-free pathway between blocks was maintained for a clean experimental area. Hand-pulling of weeds in the plots was practiced at an early stage of development to keep away from contest for nutrients, water, carbon dioxide, space, and sunlight.

Trellising
Bamboo poles were used as posts to train the vines using plastic straws.

Water Management
The first watering was done after transplanting the seedlings using water sprinklers. 10 liters of water were applied to every plot. Succeeding irrigations were done at weekly intervals up to two weeks before the last harvest except during rainy days.

Pest Management
Tomatoes used in the study were grown organically, therefore, no pesticides were applied. Application of foliar spray using Sakurab (*Allium Chinense* G. don) leaf extract was done twice based on their prescribed treatments.

Harvesting and Sorting of Fruits
Tomatoes were harvested by handpicking them at the breaker stage when one-third of the fruit had turned yellow or orange.

Data Gathered
Plant Growth Parameters
Plant Height (cm)
The height of plant was measured by randomly selecting 10 sample plants at the inner portion of the experimental plot on a weekly basis. Starting from the soil base up to the tip of the leaves, measurements were continuously done until the first harvest.

Days to Flowering
This was determined by counting the days from transplanting up to the appearance of the first flower bud, that is 50% of the plants per plot produced flower buds.

Days to Fruiting
This was determined by counting the days from the appearance of the flower bud to the appearance of the first fruiting, or that is 50% of the plants per plot produced fruits

Days to Harvest
This was determined by counting the days from transplanting up to the first harvest per fruits per plot

Yield Parameters
Number of Clusters Per Plant
The number of clusters per plant was computed by counting 10 test plants randomly selected from each plot. The sum of clusters was divided by the quantity of test plants.

Total Marketable Fruits Per Plot (kg)
This was measured by weighing the total marketable fruits harvested per plot. Fruits that are marketable are those without damage, not deformed, and no damage by fruit borers.

Marketable Fruits Per Plant (kg)
This was determined by weighing all the fruits obtained from the 10 test plants chosen at random from each plot. The total weight of fruits was divided by the number of test plants.

Yield Per Hectare (ton)
Yield per hectare was computed using the formula:
= yield (kg/plot) x (10,000 /ha)/ plot area x (1 ton/1000 kg)

Statistical Analysis
The data acquired from the experiment was analyzed by one-way Analysis of Variance (ANOVA) in Split-Split Plot Design with three replications using the Statistical Tool for Agricultural Research (STAR), 2013 version. Least Significant Difference (LSD) was utilized to determine the significance of differences among treatments. Statistical significances were established at $P < 0.05$ level.

Chemical Analysis
A 400 ml/ L of water Sakurab leaf extract was analyzed through two accredited laboratories prior to the foliar application. The proximal analysis (Table 1) was done at Regional Standards and Testing Laboratories, Department of Science and Technology in Cagayan de Oro City, whereas the NPK test analysis (Table 2) was performed at The First Analytical Services and Technical Cooperative (F.A.S.T) Laboratories in Cagayan de Oro City.

Table 1: Proximal Analysis of the Sakurab Leaf Extract

Parameters	Unit	Methods Used	Result
Nitrogen	%	Kjeldahl	0.165

Phosphorus	%	By Computation	0.0616
Potassium	%	Flame AES	0.0283
Phosphorus as P2O5	Photometer	Colonmetric	0.141
Potassium as K2O	By Computation	By Computation	0.0341

Source: DOST Laboratories, Cagayan de Oro City

Table 2: Chemical Analysis of Sakurab Leaf Extract (NPK)

Sample Description	Parameters	Methods Used	Result
Extract, coded as Sakurab (*Allium Chinense* G. Don)	Ash	OMA AOAC	0.11
			g/100g
Date of Sampling: 18 February 2022 (Production date)	Moisture Content	OMA AOAC	99.39
			g/100g
Lab code:	Crude protein	OMA AOAC	0.18
	Fat, Total	OMA AOAC	0.09
	Total	Computation by difference	0.23
	Carbohydrates		g/100g

Source: F.A.S.T. Laboratories, Cagayan de Oro City

Soil Analysis

Prior to plot preparation, composite soil samples were taken from the experimental area and subjected to analysis at the Soil Science Laboratory, College of Agriculture, Mindanao State University, Marawi City, Lanao del Sur.

Table 3: Soil Analysis of the Experimental Area

Parameters	Methods Used	Result
pH Total N, %	Kjeldahl	5.2
Exchangeable K, ppm	Flame AES	48.08
Extractable P, ppm	Bray Method using	0.47
	Vis Spectometer	
	Photometer	
Organic matter	By Computation	2.92
CEC	By Computation	12.73

Source: College of Agriculture Soils Science Laboratory, Mindanao State University, Marawi City

RESULTS AND DISCUSSION

Plant Growth Parameters

Plant Height (cm)

Table 4 shows the average increase in tomato plant height 8 weeks after transplanting, from week 1 to 6, the tomato plant height under different levels of foliar application showed no significant difference ($P > 0.05$). Thus, levels of Sakurab foliar application did not affect the plant height of the tomato. This affirms the statement of Sakya (2019) on the growth phases of tomato. Accordingly, the vegetative growth phase starts from the first week until fourth week which is characterized by fast growth. Flowers will show up at generative phase and the plant height just increments marginally or no further increment.

Table 4: Plant height of tomato (cm) as affected by variety and Sakurab leaf extract foliar application

Sakurab Leaf Extract Concentration (%)	Variety	Week After Transplanting							
		1	2	3	4	5	6	7	8
0	BH	9.08	16.66	24.03	21.48	44.3	67.35	82.95	93.27[a]
	DM	9.47	14.49	23.88	20.78	41.84	61.58	72.3	78.13[b]
2	BH	10.69	16.5	25.48	23.05	40.43	63.96	79.62	90.91[a]
	DM	10.12	16.11	26.71	24.05	46.29	62.66	70.77	87.1[b]
5	BH	9.18	18.04	25.18	27.82	44.39	69.74	86.86	97.21[a]
	DM	9.99	17.02	26.13	21.93	40.43	62.13	70.14	82.23[b]

10	BH	10.53	17.15	24.56	23.51	40.57	65.74	82.44	94.33[a]
	DM	10.41	17.05	25.06	22.88	45.81	62.05	75.13	76.3[b]
15	BH	9.69	12.72	23.7	23.17	41.24	67.26	80.98	97.45[a]
	DM	10.95	17.02	24.95	22.39	44.7	61.83	72.48	78.5[b]
Average Plant Height	BH								94.56[a]
	DM								80.37[b]

BH = braveheart; DM = diamante
a-b values within a column having a common superscript letter are different (P < 0.05)

However, 8 weeks after transplanting, Figure 2 shows that the plant height of Braveheart tomato was higher (94.56 cm) compared to the Diamante variety (80.37 cm). Sakurab foliar application of Braveheart tomato with 5%, 10%, and 15% maximally improved these attributes while Diamante tomato reacted to a lesser extent to Sakurab foliar application concerning development of plant height. The result of the present study implies that the level of Sakurab foliar application affected the plant height of tomatoes.

As revealed by Afzal *et al.* (2015), the growth, yield, and quality attributes of the tomato crop was significantly affected by foliar application. The explanation may be due to the foliar application has expanded the foliage and implicitly expanded the photosynthesis which eventually boosted the plant height of tomato.

Figure 2: Plant height of tomato as affected by the Sakurab leaf extract foliar application
Bar with uncommon letters is significantly different at 5%, using LSD Test of Significance

Days to First Flowering

Table 5 depicts the days to first flowering of two varieties of tomatoes under different levels of Sakurab foliar application. No significant difference (P > 0.05) was observed in the two varieties of tomatoes. This means that the mentioned days to first flowering of tomato under different levels of Sakurab foliar application were not affected by their respective levels of Sakurab concentration. Furthermore, there were no interactions between the two varieties of tomatoes and the Sakurab application on the days to first flowering.

Table 5: Days to the first flowering of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	**Sakurab Leaf Extract Concentration (%)**					**Mean**
	0	**2**	**5**	**10**	**15**	
Braveheart	8.67	8	8.67	8.00	9.00	8
Diamante	9	9	10.00	9.67	10.00	9.5

a-b values within a column having a common superscript letter are different (P < 0.05)

Days to Fruiting

The number of days to fruiting for various Sakurab foliar treatment levels, are shown in Table 6. There was no significant difference (P > 0.05) between the two tomato varieties. This suggests that the days to fruiting of tomatoes grown under various levels of Sakurab foliar application were unaffected by the foliar concentration applied. The treatments applied regardless of level did not have a significant effect on the number of days to fruiting in both varieties. As shown in Table 6, the average number of days to fruiting for varieties Braveheart and Diamante was 34 days and 32 days, respectively.

Table 6: Number of days to fruiting of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	Sakurab Leaf Extract Concentration (%)					Mean
	0	2	5	10	15	
Braveheart	34	33	34	35	35	34
Diamante	32	32	31	32	32	32

a-b values within a column having a common superscript letter are different (P < 0.05)

Days to Harvest

Table 7 reveals the days to harvest for various foliar treatment levels. There was no significant difference between the variety, the varying levels of Sakurab leaf extract concentrations and their interactions on the days to harvest tomato fruits. This means that the days to harvest of tomatoes under different levels of foliar application were not affected by their respective levels of Sakurab foliar application. Table 7 shows that variety Braveheart produced fruits that are ready to harvest at 18 days from the days of fruiting while the variety Diamante produced fruits at 20 days from the days of fruiting.

Table 7: Number of days to harvest of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	Sakurab Leaf Extract Concentration (%)					Mean
	0	2	5	10	15	
Braveheart	20	19	17	18	17	18
Diamante	20	19	20	19	20	20

a-b values within a column having a common superscript letter are different (P < 0.05)

Yield Parameters

Number of Clusters Per Plant

The number of clusters per plant in two varieties of tomatoes was not significantly (P > 0.05) affected by the varying levels of foliar application as shown in Table 8. The results indicate that the Sakurab foliar application did not influence the number of clusters per plant of two varieties of tomatoes. The application of Sakurab leaf extract regardless of the level of concentration did not have a significant effect on the number of clusters per plant. Table 8 shows that the average number of clusters per plant in variety Braveheart was 3.93 while 4.0 in variety Diamante respectively. There was a slight difference between the means of the two varieties of tomatoes but the application of Sakurab leaf extract in general did not significantly affect the clusters.

Table 8: Number of clusters per plant of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	Sakurab Leaf Extract Concentration (%)					Mean
	0	2	5	10	15	
Braveheart	3.67	4.00	3.67	4.33	4.00	3.93
Diamante	3.67	4.33	4.00	4.00	4.00	4.00

a-b values within a column having a common superscript letter are different (P < 0.05)

Marketable Fruits Per Plot (kg)

The total marketable fruits of tomato produced per plot were significantly (P < 0.05) affected by two varieties of tomatoes and the varying levels of Sakurab foliar application as shown in Table 9 and Figure 3. Results revealed that 20.21 kg of Diamante tomato fruits were collected versus 16.55 kg of Braveheart tomato fruits. This is 4.06 kg more than the Braveheart variety's marketable tomato fruits. Furthermore, with a 15% (150 ml/L of water) Sakurab foliar concentration, a significant difference (P < 0.05) was seen in the two varieties of tomatoes. This demonstrates how Sakurab foliar concentration affects the kg of marketable fruits per tomato plot. As investigated by Thanaa *et al.* (2017), plants treated with the application of leaf aqueous extract exhibited significant and effective improvement in the fruit set, yield, fruit weight, firmness, color, soluble solids content, vitamin C, anthocyanin content, and antioxidant activity. This can be ascribed to the concentrate's substance of minerals and chemicals which might have directly or indirectly impacted the fruit growth and development process and thusly expanded the quantity of fruits.

Table 9: Marketable fruits per plot (kg0 of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	Sakurab Leaf Extract Concentration (%)					Mean
	0	2	5	10	15	
Braveheart	13.80^{d}	15.90^{cd}	16.74^{bc}	17.50^{ab}	18.80^{a}	16.55

Diamante	17.67^{d}	18.30^{cd}	21.23^{bc}	21.93^{ab}	23.93^{a}	20.61

a-b values within a column having a common superscript letter are different (P < 0.05)

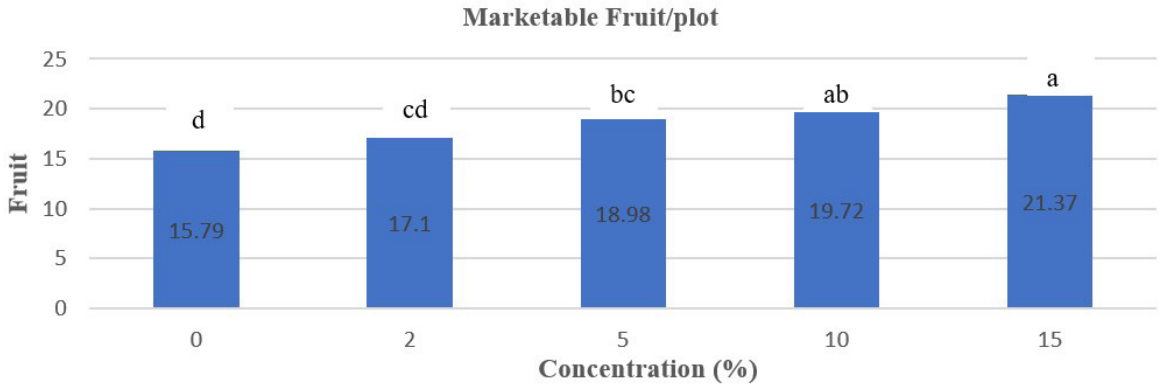

Figure 3: Marketable fruits per plot (kg) of tomato as affected by Sakurab leaf extract foliar application
Means with the same letter are not significantly different

Marketable Fruits Per Plant (kg)

Table 10 and Figure 4 present the number of marketable fruits per plant at various levels of Sakurab foliar concentration. Two tomato varieties with a 15% (150 ml/L of water) foliar concentration showed a significant difference (P < 0.05).

This reveals that foliar application of Sakurab to tomatoes affected the marketable fruits per plant. The 15% level of concentration surpassed all other treatments with the greatest marketable fruits (21.37 kg) while the treatments 5% with 19.72 kg and 10% with 18.98 kg did not differ significantly. The varieties applied with the 2% Sakurab leaf extract concentration weighed 17.1 kg while the varieties applied with 0% Sakurab foliar application gave the lowest marketable fruits (15.1 kg).

As investigated by Ahmad (2021), the utilization of allium extract in the techniques of foliar and ground application prompted significant differences in growth characteristics. The quality of tomato plants was improved possibly because of the vitamins, mineral salts, and various elements.

Table 10: Marketable fruits per plant (kg) of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	**Sakurab Leaf Extract Concentration (%)**					**Mean**
	0	**2**	**5**	**10**	**15**	
Braveheart	2.97^{c}	3.21^{bc}	3.4^{abc}	3.72	4.38	3.54
Diamante	3.83^{c}	3.94^{bc}	4.37	4.53	4.59	4.25
Mean	**3.83^{c}**	**3.94^{bc}**	**4.37**	**4.53**	**4.59**	

a-b values within a column having a common superscript letter are different (P < 0.05)

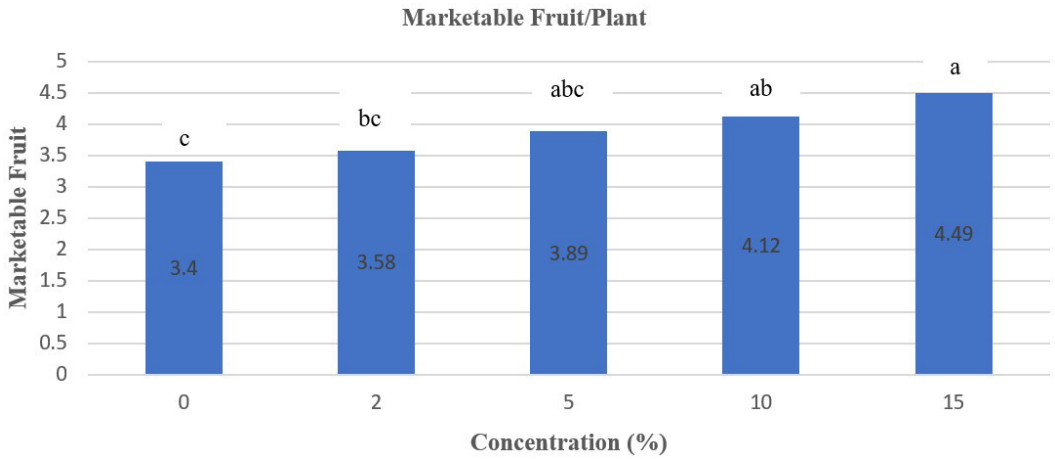

Figure 4: Marketable fruits per plant (kg) of tomato as affected by Sakurab leaf extract foliar application
Means with the same letter are not significantly different

Tomato Yield Per Hectare (ton/ha)

Table 11 and Figure 5 shows that varied amount of Sakurab foliar concentration had a substantial impact on tomato yield per hectare ($P < 0.05$). A higher marketable yield (19.5 tons/ha) was found in the varieties applied with a 15% (150 ml/L of water) Sakurab level of concentration as compared with other treatments. The differences in marketable yield between 10% (100 ml/L of water), 5% (50 ml/L of water), and 2% (20ml /L of water) Sakurab foliar application were small with 17.83, 17.17, and 16.17 tons/ha, respectively, while the 0% level of Sakurab foliar application gave the lowest marketable yield of 14.33 ton/ha. This suggests that varying levels of Sakurab foliar concentration have significantly impacted the marketable yield of tomato plants per hectare. Geroche *et al.* (2022) concluded that foliar application of fertilizer had positive effect on the growth and yield of rice.

Table 11: Yield per hectare (ton/ha) of tomato as affected by variety and Sakurab leaf extract foliar application

Variety	Sakurab Leaf Extract Concentration (%)					Mean
	0	2	5	10	15	
Braveheart	12.67^{c}	15.67^{bc}	15.33^{b}	16.00^{ab}	17.00^{a}	0.54
Diamante	16.00^{c}	16.67^{bc}	19.00^{b}	19.67^{ab}	22.00^{a}	4.25
Mean	**14.33**	**16.17**	**17.17**	**17.83**	**19.5**	

a-b values within a column having a common superscript letter are different ($P < 0.05$)

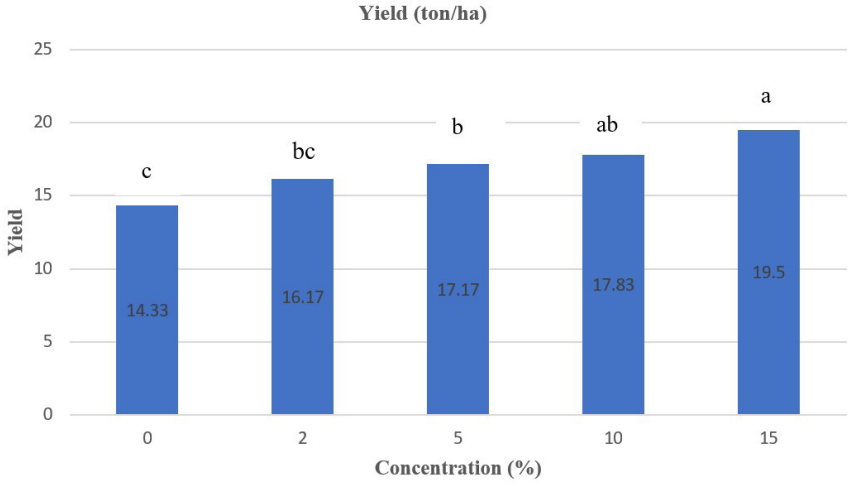

Figure 5: Yield (ton/ha) of tomato as affected by variety and Sakurab leaf extract foliar application
Means with the same letter are not significantly different

CONCLUSIONS

Based on the conditions of the experiment and the results, it is safe to conclude that the varying levels of Sakurab leaf extract concentrations of 15% (150 ml/L of water) and 10% (100 ml/L of water) were more effective for the two varieties of tomato plants. On the other hand, Diamante is superior to Braveheart variety in Lanao del Sur based on yield. In addition, the varying levels of Sakurab leaf extract foliar application did not have a significant effect on the plant height, days to first flowering, days to fruiting, and days to harvest regardless of the levels of concentration applied. Maximum production of tomatoes was achieved at 19.5 tons per hectare with a 15% (150 ml/L of water) level of Sakurab leaf extract concentration.

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