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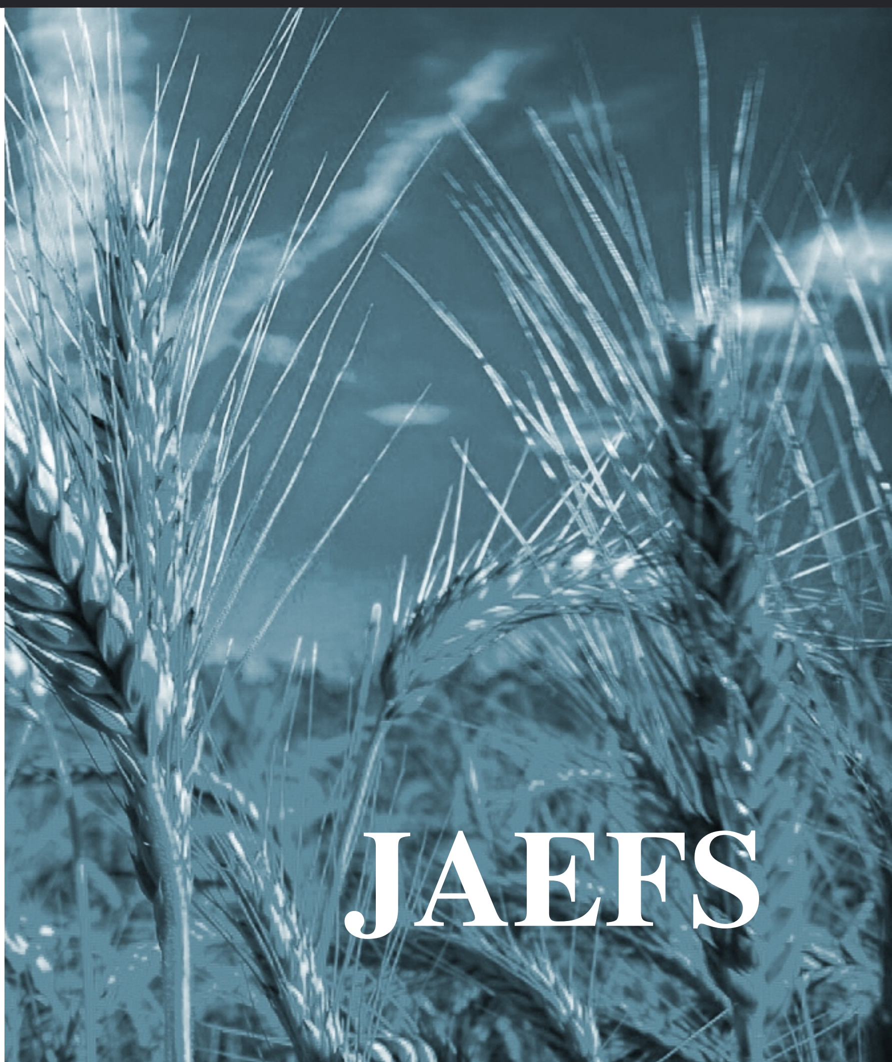


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Journal of JAEFS welcomes article submissions and does not charge any article submission or processing charges.

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## Contents

### Research Articles

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Research Article

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# EVALUATION OF THE MINERAL ELEMENT PROFILE OF WASTES OF SOME WINE GRAPE (*VITIS VINIFERA* L.) VARIETIES

**Serpil Tangolar[1*] Ayfer Alkan Torun[2] Semih Tangolar[1] M. Bülent Torun[2]**

[1]Department of Horticulture, Faculty of Agriculture, University of Çukurova, Adana/ Turkey
[2] Department of Soil Science and Nutrition, Faculty of Agriculture, Çukurova University, Adana, Turkey

[*]Corresponding Author: stangolar@cu.edu.tr

## ABSTRACT

In this study, the level of macro and micro elements of six wine grape cultivars were determined in seeds, bagasse (skin and pulp) and pomace (seed, skin and pulp) by inductively coupled plasma mass spectrometry and atomic absorption spectroscopy after microwave digestion (ICP-AES). The levels of macro and micro elements exhibited a genotype dependent alteration and affected by the part of the berry sampled. Potassium was the predominant macro element in bagasse and pomace, varying from 6.78 g/kg dry weight in pomace (Carignane) to 21.05 g/kg dry weight in bagasse (Cabernet Sauvignon). However, the level of calcium was higher than potassium in seeds and varied between 4.95 g/kg (Kalecik karası) and 6.73 g/kg (Carignane). Seeds were also richer than the bagasse and pomace related with phosphorus, magnesium, and sulfur. Among the micro elements, Fe had the highest amount in all parts of the berries. Its content ranged from 13.9 mg/kg dry weights in bagasse of Semillon to 24.8 mg/kg dry weight in seeds of Syrah. Iron, manganese, zinc and molybdenum in seeds; copper and boron in bagasse were higher amount than the other groups analyzed. The results of this study show that all parts of the grape berries are potentially rich sources of mineral elements. So, they could be used as a food supplement to improve the nutritive value of the human diet and for some engineering processes in food industry.

**Keywords:** Grapevine, Wine Grape, Mineral Elements, Grape Wastes, Bagasse, Pomace

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## INTRODUCTION

Wine grape production has an important amount in total grape production of the world. Annual world grape production is 73.5 million metric tons. Approximately, 70% of this total belongs to wine grape production [1]. Yearly world wine production is about 30 billion liters.

In Turkey, about 38% of the total grape production which is four million tons is used for raisins, 50% used as table, and 12% used for winemaking and the production of grape juice, jam, jelly and other traditional grape products (such as molasses, vinegar, etc.) [2, 3, 4, 5].

Besides Turkey, in the entire wine producing countries, wine and grape juice industries have been producing an important amount of grape waste and by products [6,7, 8, 9]. Some of these are grape seeds, stalks, skin and pulp. Totally, more than 20 percent of clusters of wine grapes are obtained as waste. Management of grape wastes is one of the important problems for wine and the other grape juice industries. Researches have been going on for obtaining high quality products such as compost, fertilizer, grapeseed oil etc. from grape wastes [6, 10, 11].

Recent studies have shown that grapes and their wastes have many benefits on human health, such as those coming from carbohydrates, sugar, organic acids, soluble and insoluble fiber, vitamins (A, B, C, and E), fatty acids, amino acids, polyphenols (flavonoids, phenolic acids, and resveratrol) and most of the macro and micro minerals (calcium, potassium, magnesium, boron, manganese and iron etc. [2, 12, 13, 14, 15, 5, 9, 11, 16, 17, 18, 19]. Daily consumption of grapes and grape products has been recommended in articles [20, 15].

However, there is a lack of knowledge on the utilization of wine and grape juice industry wastes for food industry, the utilization of these wastes in the food industry can create new food sources for human consumption, and create additional markets for grape producers [6, 8, 11, 19].

The objective of this study was to investigate the macro and micro element constituents of grape berries of eight wine grape cultivars.

## MATERIALS AND METHODS

### Materials

This experiment was carried at an experimental vineyard, established in approximately 1100 m elevation from sea level in Pozantı/Adana Research Station of Cukurova University on a clayey loam soil. Wine grape varieties used were Kalecik karası, Syrah, Carignane, Semillon, Chardonnay and Cabernet Sauvignon.

The own rooted grapevines were 18 years old and trained on bi-lateral cordon trellis system with three wires (one wire for the arms and two wires for the foliage) at 1.3 m canopy height and spur pruned. Planting distances were 2 m × 3 m (vine × row) in west-east row orientation. Vineyard was under non-irrigated and without manure conditions. Suckering was done before flowering and shoot trimming was achieved after fruit set. All other practices were applied according to the standard viticultural practices.

Thirty vines of each variety were arranged in three replications of 10 vines each. Total thirty clusters (10 clusters from each replication) were randomly sampled from vines at harvest time of each cultivar. Brix level was 22 for Carignane, 23 for Cabernet Sauvignon, 24.5 for Shiraz and Semillon, 25.5 for Kalecik karası and 26.5 for Chardonnay. Berries were separated from clusters without pedicels and these were squeezed by hand through cheesecloth. After removing the juice, the rest were separated into groups for analysis, as seeds and bagasse (skin and pulp). Samples were held at 65 °C to constant weight in a drying oven and dried samples were ground in a plant grinder. They were stored at -80 °C until analyzed.

### Methods

Elemental concentration for macro (P, K, Ca, Mg, S, Na) and micronutrients (Fe, Cu, Zn, Mn, Mo, B) were analyzed as follows. Ground berry samples were subjected to acid digestion in a closed microwave system (Milestone 1200 Mega) by using 1 ml of 30% $H_2O_2$ and 5 ml of 65% $HNO_3$. Elemental concentrations of the digested samples were measured by ICP–AES (Inductively Coupled Plasma-Atomic Emission Spectrometry, Jobin Yvon-Paris). Elements concentration was checked by using certified standard reference materials from the National Institute of Standards and Technology (NIST; Gaithersburg, MD).

### Statistical analyses

One-way analysis of variance using a completely randomized design was performed on the data using the MSTAT-C statistics program. The means presented in the tables with a standard error of the mean consist of three replications. Differences between the means were obtained by the LSD (Least Significant Difference) test at 1% level [21, 22].

## RESULTS

**Bagasse (skin and pulp):** Macro and micro element contents of bagasse are presented in Table 1. Among the macro elements, the level of potassium was found to be higher than the other elements. Potassium content of bagasse was between 7.87 g/kg for Carignane and 21.05 g/kg for Cabernet Sauvignon. In this part of berry, after potassium, calcium levels ranged from 1.00 to 1.70 g/kg, phosphorus from 0.83 to 1.19 g/kg, sulfur from 0.47 to 0.75 g/kg, magnesium from 0.39 to 0.61 g/kg, and sodium from 0.02 to 0.08 g/kg.

Among the micro elements iron was the predominant element in bagasse of grapes. This element was followed by copper, manganese, zinc, and the others, respectively. The micro elements level of bagasse ranged from 13.9 (Semillon) to 23.1 mg/kg (Chardonnay) for iron, from 5.2 (Semillon) to 18.4 mg/kg (Cabernet Sauvignon) for copper and from 3.6 (Semillon) to 10.9 mg/kg (Cabernet Sauvignon) for manganese, from 2.6 (Semillon) to 4.7 mg/kg (Cabernet Sauvignon) for zinc.

**Seeds:** Macro and micro element contents of seeds are presented in Table 2. Among the macro elements, the calcium contents of seeds were found to be higher than the other elements. The calcium level of seeds varied between 4.95 g/kg (Kalecik karası) and 6.73 g/kg (Carignane). This element was followed by potassium, phosphorus, magnesium, sulfur and sodium elements level, respectively. The highest levels of macro elements of seeds were found in Kalecik karası and Cabernet Sauvignon for potassium, in Cabernet Sauvignon for magnesium, in Syrah for phosphorus, in Carignane and Chardonnay for sulfur, and both of the Semillon and Chardonnay for sodium.

Among the micro elements iron had the highest amount in seeds of the berries, similar to bagasse levels. There were no significance differences among cultivars for lead levels of seeds. Iron, manganese, copper and zinc contents of seeds were higher than that of the other micros.

The micro element content of seeds ranged from 17.6 (Semillon) to 24.8 (Syrah and Chardonnay) mg/kg for iron, from 9.2 (Semillon) to 12.7 (Chardonnay) mg/kg for copper, from 12.0 (Kalecik karası) to 26.6 (Cabernet Sauvignon) mg/kg for manganese, from 9.9 (Kalecik karası) to 14.3 (Chardonnay) mg/kg for zinc, from 0.09 (Semillon) to 0.24 (Cabernet Sauvignon) mg/kg for boron, from 0.08 (Kalecik karası) to 0.50 (Syrah) mg/kg for Molybdenum.

**Pomace (seed, skin and pulp):** Macro and micro element contents of pomace are presented in Table 3. Among the macro elements, the level of potassium was found to be higher than the other elements. The highest levels were obtained from Cabernet Sauvignon for potassium (17.6 g/kg), from Syrah (3.46 g/kg) and Carignane for calcium (3.27 g/kg), from Syrah for phosphorus (1.91 g/kg), from Cabernet Sauvignon for sulfur (0.93 g/kg), from Carignane and Cabernet Sauvignon for magnesium (0.85 g/kg) and from Semillon for sodium (0.07 g/kg).

Among the micro elements iron had also the highest amount in pomace of the berries. This element was followed by copper, manganese, zinc, and the others, respectively. Except for iron, there were significant differences among the cultivars for all the micro elements level of pomace. Iron levels have varied between 14.1 (Semillon) and 23.9 mg/kg (Carignane). The highest and lowest values were obtained from Cabernet Sauvignon and Semillon (15.7 and 6.2 mg/kg, respectively) for copper, from Cabernet Sauvignon and Semillon (14.5 and 6.6 mg/kg, respectively) for manganese, from Syrah and Semillon (7.53 and 4.0 mg/kg, respectively) for zinc related with analysis of pomace.

## DISCUSSION

Macro and micro elements values found in our research for grape pomace and seeds and bagasse fractions were evaluated as considerable amounts for all varieties. Although there are many literature on the mineral contents of whole grapes [12, 13, 23, 14, 5, 24, 16], knowledge on comparing the mineral levels in different parts of the berries is lacking. So, this article has been discussed using limited reports.

Tangolar et al. [11] reported that macro and micro element values of grape seeds were changed between 2.9 and 4.4 g/kg for phosphorus; 3.3 and 5.0 g/kg for potassium; 1.3 and 1.7 g/kg for magnesium; 4.8 and 7.9 g/kg for calcium and 12.28 and 18.97 mg/kg for zinc; 17.30 and 27.0 mg/kg for iron; 11.13 and 23.86 mg/kg and 7.27 and 13.04 mg/kg for copper in their research. These results were in agreement with the results from in our study. Macro and micro elements values in berries from healthy, symptomatic and asymptomatic vines obtained by [25] were also very close to the bagasse and pomace values.

Similarly, the potassium values in this study were close to the values of [13, 23, 5, 24, 17] given for about 1 kg of grapes. Besides these grape values, according to the [26], potassium values were also about 8-12 g/kg for dry beans, 7-7.1 g/kg for nuts, 4-4.25 g/kg for potato, 2-2.1 g/kg for orange and 1.0-1.1 g/kg for apple. These results showed that, potassium level of berry parts apart from grape juice were found to be remarkably similar amounts. Similarly, the sodium values were found close to the values reported in the same literature, but calcium, magnesium, copper, iron and zinc values given in this report were lower than those in our study. This is because, berry parts other than fruit juice is thought to be a result of being more intense. Iron amounts were a little less than the amounts given by [26] for the legumes, but higher than that of potatoes, oranges and apples.

Macro and micro element level in different fruits and vegetables given [23] have also clearly shown the importance of nutrient capacity in different parts of the grapes. These, demonstrated that the seed, skin and pulp of the berries (in other words "wastes and by-products of grape juice or wine making industry) could be used as a rich mineral elements source.

Finally, it can be explained that wastes obtained from wine making and grape juice industry are good natural sources of macro and micro elements. If they can be used as a food supplement to improve the nutritive value of the human diet and industrial purposes, they will be very beneficial to human nutrition and the food industry.

**Table 1.** Macro and micro element contents of bagasse (skin and pulp)

| Cultivar | Macro elements (g/kg dry weight) | | | | | |
|---|---|---|---|---|---|---|
| | P | K | Mg | Ca | S | Na |
| Syrah | 1.08±0.05 b | 9.33±0.40 d | 0.40±0.01 de | 1.25±0.02 c | 0.64±0.01 b | 0.02±0.00 d |
| Kalecik karası | 0.90±0.01 c | 10.2±0.2 c | 0.41±0.00 d | 1.57±0.02 b | 0.58±0.00 c | 0.03±0.00 d |
| Carignane | 0.83±0.00 c | 7.87±0.04 e | 0.61±0.01 a | 1.70±0.04 a | 0.47±0.01 f | 0.04±0.01 cd |
| Semillon | 0.90±0.01 c | 8.92±0.10 d | 0.39±0.00 e | 1.00±0.02 e | 0.52±0.00 d | 0.08±0.00 a |
| Chardonnay | 0.89±0.00 c | 10.98±0.02 b | 0.49±0.00 c | 1.05±0.00 de | 0.50±0.00 e | 0.06±0.00 ab |
| Cabernet Sauvignon | 1.19±0.01 a | 21.05±0.10 a | 0.53±0.00 b | 1.10±0.01 d | 0.75±0.00 a | 0.05±0.00 bc |
| LSD 1% | 0.06 | 0.57 | 0.02 | 0.07 | 0.01 | 0.02 |
| **Cultivar** | **Micro elements (mg/kg dry weight)** | | | | | |
| | Fe | Cu | Mn | Zn | B | Mo |
| Syrah | 18.3±0.9 ab | 7.3±0.1 b | 4.2±0.1 d | 3.5±0.2 b | 0.31±0.02 d | 0.23±0.01 a |
| Kalecik karası | 19.6±0.02 ab | 6.7±0.06 b | 5.6±0.04 c | 3.1±0.27 b | 0.39±0.00 c | 0.13±0.02 b |
| Carignane | 15.2±0.6 b | 5.8±0.5 c | 6.4±0.1 b | 3.2±0.4 b | 0.37±0.0 c | 0.02±0.0 c |
| Semillon | 13.9±0.02 b | 5.2±0.02 c | 3.6±0.05 e | 2.6±0.04 b | 0.36±0.00 c | 0.12±0.01 b |
| Chardonnay | 23.1±3.3 a | 5.9±0.05 c | 4.1±0.00 d | 2.8±0.05 b | 0.47±0.00 b | 0.04±0.01 c |
| Cabernet Sauvignon | 18.9±0.44 ab | 18.4±0.2 a | 10.9±0.05 a | 4.7±0.08 a | 0.86±0.00 a | 0.11±0.03 b |
| LSD 1% | 4.4 | 0.7 | 0.2 | 0.7 | 0.03 | 0.06 |

Mean values (n: 3) followed with one or more of the same letters in the each column were not significantly different at $P < 0.01$, according to the LSD test; Elements are analyzed separately.

**Table 2.** Macro and micro element contents of grape seeds

| Cultivar | Macro elements (g/kg dry weight) | | | | | |
|---|---|---|---|---|---|---|
| | P | K | Mg | Ca | S | Na |
| Syrah | 3.22±0.03 a | 3.75±0.04 b | 1.30±0.02 d | 6.54±0.06 a | 1.25±0.01 b | 0.04±0.02 ab |
| Kalecik karası | 2.33±0.02 d | 4.73±0.03 a | 1.29±0.01 d | 4.95±0.02 c | 1.12±0.01 d | 0.01±0.00 b |
| Carignane | 3.05±0.03 b | 3.87±0.01 b | 1.42±0.01 c | 6.73±0.04 a | 1.32±0.01 a | 0.05±0.00 ab |
| Semillon | 2.35±0.02 d | 3.10±0.03 c | 1.30±0.01 d | 6.32±0.02 b | 1.17±0.01 c | 0.06±0.00 a |
| Chardonnay | 2.91±0.03 c | 3.83±0.04 b | 1.47±0.02 b | 6.27±0.08 b | 1.30±0.02 a | 0.06±0.00 a |
| Cabernet Sauvignon | 2.41±0.02 d | 4.74±0.06 a | 1.63±0.01 a | 6.26±0.02 b | 1.23±0.01 b | 0.04±0.01 ab |
| LSD 1% | 0.07 | 0.01 | 0.04 | 0.18 | 0.03 | 0.03 |
| **Cultivar** | **Micro elements (mg/kg dry weight)** | | | | | |
| | Fe | Cu | Mn | Zn | B | Mo |
| Syrah | 24.8±1.04 | 12.1±0.12 b | 19.2±0.3 b | 13.8±0.10 b | 0.11±0.00 d | 0.50±0.03 a |
| Kalecik karası | 23.2±3.6 | 9.8±0.07 d | 12.0±0.09 d | 9.9±0.03 e | 0.16±0.00 b | 0.08±0.00 d |
| Carignane | 23.6±0.1 | 10.9±0.01 c | 19.2±0.2 b | 13.2±0.4 c | 0.13±0.00 c | 0.11±0.01 d |
| Semillon | 17.6±0.2 | 9.2±0.01 e | 17.1±0.2 c | 10.4±0.03 e | 0.09±0.01 e | 0.35±0.00 b |
| Chardonnay | 24.8±0.3 | 12.7±0.2 a | 17.3±0.2 c | 14.3±0.2 a | 0.13±0.00 c | 0.19±0.02 c |
| Cabernet Sauvignon | 20.5±0.3 | 12.5±0.1 a | 26.6±0.1 a | 12.0±0.1 d | 0.24±0.00 a | 0.23±0.04 c |
| LSD 1% | NS | 0.30 | 0.52 | 0.52 | 0.01 | 0.07 |

Mean values (n: 3) followed with one or more of the same letters in the each column were not significantly different at $P < 0.01$, according to the LSD test; Elements are analyzed separately. NS. Non-Significant

**Table 3.** Macro and micro element contents of pomace (seed, skin and pulp)

| Cultivar | Macro elements (g/kg dry weight) | | | | | |
|---|---|---|---|---|---|---|
| | P | K | Mg | Ca | S | Na |
| Syrah | 1.91±0.08 **a** | 7.09±0.16 **de** | 0.75±0.03 **b** | 3.46±0.25 **a** | 0.88±0.03 **b** | 0.05±0.02 **ab** |
| Kalecik karası | 1.44±0.01 **bc** | 8.34±0.01 **c** | 0.73±0.00 **b** | 2.64±0.02 **b** | 0.78±0.00 **c** | 0.02±0.00 **b** |
| Carignane | 1.46±0.07 **bc** | 6.78±0.08 **e** | 0.85±0.01 **a** | 3.27±0.12 **a** | 0.72±0.02 **d** | 0.02±0.00 **b** |
| Semillon | 1.23±0.00 **d** | 7.29±0.09 **d** | 0.61±0.01 **c** | 2.35±0.03 **b** | 0.67±0.00 **d** | 0.07±0.00 **a** |
| Chardonnay | 1.32±0.01 **cd** | 8.87±0.04 **b** | 0.73±0.01 **b** | 2.48±0.03 **b** | 0.70±0.01 **d** | 0.05±0.01 **ab** |
| Cabernet Sauvignon | 1.59±0.01 **b** | 17.6±0.17 **a** | 0.85±0.00 **a** | 2.66±0.03 **b** | 0.93±0.00 a | 0.05±0.00 **ab** |
| LSD 1% | 0.14 | 0.33 | 0.05 | 0.36 | 0.05 | 0.02 |
| **Cultivar** | **Micro elements (mg/kg dry weight)** | | | | | |
| | **Fe** | **Cu** | **Mn** | **Zn** | **B** | **Mo** |
| Syrah | 20.5±1.0 | 9.7±0.3 **b** | 10.1±0.6 **b** | 7.53±0.4 **a** | 0.22±0.01 **e** | 0.32±0.03 **a** |
| Kalecik karası | 21.0±1.9 | 7.7±0.02 **c** | 7.3±0.1 **c** | 5.13±0.02 **c** | 0.31±0.0 **c** | 0.14±0.04 **bc** |
| Carignane | 23.9±7.7 | 7.0±0.2 **d** | 10.7±0.5 **b** | 6.07±0.6 **bc** | 0.30±0.00 **c** | 0.08±0.02 **c** |
| Semillon | 14.1±0.1 | 6.2±0.1 **e** | 6.6±0.1 **c** | 4.00±0.1 **d** | 0.27±0.01 **d** | 0.15±0.02 **bc** |
| Chardonnay | 16.6±0.2 | 7.4±0.02 **cd** | 7.4±0.1 **c** | 5.40±0.1 **c** | 0.38±0.0 0**b** | 0.08±0.03 **c** |
| Cabernet Sauvignon | 19.7±0.6 | 15.7±0.1 **a** | 14.5±0.2 **a** | 6.87±0.1 **ab** | 0.74±0.01 **a** | 0.23±0.04 **ab** |
| LSD 1% | NS | 0.5 | 1.0 | 0.9 | 0.02 | 0.09 |

Mean values (n: 3) followed with one or more of the same letters in the each column were not significantly different at $P < 0.01$, according to the LSD test; Elements are analyzed separately. NS. Non-Significant

## CONCLUSIONS

Wineries and other grape juice processing industry have been producing important amount of grape wastes every year and after the processing to different ways, it's by –products have especially been using as compost in grape growing and the other areas. Seeds are important part of grape pomace and from this very valuable grapeseed oil is produced. So in this experiment seeds were also evaluated separately. This work is aimed to show the amount of macro and micro nutrients to be gained using with/ or without seed of grape pomace. It was shown that seeds for phosphorus, magnesium, calcium, sulfur, iron, manganese, zinc and for molybdenum; bagasse for potassium, copper, and for boron was considerable rich sources. This source can also be evaluated to increase the food value.

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# DETERMINATION OF FLOWER CHARACTERISTICS OF SOME KIWIFRUIT GENOTYPES (*ACTINIDIA* SPP.) OBTAINED WITH BREEDING PROGRAM

**Arif Atak**[1,*] **Yeşim Doyğacı**[1] **Kemal A. Kahraman**[1]

**Gülhan Gülbasar Kandilli**[1] **Abdülbaki Şen**[1]

[1]Department of Viticulture, Ataturk Horticulture Central Research Institute, 77102 Yalova, TURKEY

[*]Corresponding Author: arif.atak@tarim.gov.tr

## ABSTRACT

All *Actinidia* species are dioecious, male and female flowers grow on separate kiwifruit plants. In breeding studies, it is generally desirable to obtain female individuals. However, male plants are also of great importance for pollination. Therefore, it is necessary to examine the flower characteristics of the genotypes obtained by breeding studies. This research was conducted in the kiwifruit breeding plot of Yalova Atatürk Horticultural Central Research Institute for two years. Genotypes obtained from cultivars belonging to *Actinidia deliciosa* and *Actinidia chinensis* were used in the research. At the time of flowering, phenological observations of male and female genotypes, which are prominent in the population, have been made and the developmental stages of the flowers have been determined. At least 10 flowers of each genotype were used to determine the morphological characteristics.

Number of leaves, number of petals, number of male organs, number of filaments, number of female organs, number of female organs and number of stylus were examined in order to determine flower characteristics. When the data obtained as a result of two years are evaluated; significant differences have been obtained particularly in terms of flowering time, flowering period, the number of stylus, the filament size, the number of female organs and the number of male organs. Female cultivars/genotypes tend to flowering later than male cultivars/genotypes, and female cultivars/genotypes have shorter filament length than male cultivars/genotypes. It has also been clearly observed that ovaries are not functional in male types.

**Keywords:** Kiwifruit, Flowering, Phenology, Flower structure, Selection

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## INTRODUCTION

Turkey is the gene centre of many plant species and at the same time have important plant species and diversity. Turkey is one of the countries with different ecologic due to its geographical position and different climate structures. It is also successfully cultivated in many foreign species. 75 of the 138 species known in the world are grown in Turkey. Kiwifruit is one of these plants [1]. Despite the fact that the kiwifruit homeland is China, the first breeding work started in 1904 with the introduction of kiwifruit seeds to New Zealand and spread over the world from New Zealand. A very large part of the kiwifruit grown in Turkey is *Actinidia deliciosa* cv. Hayward. However, in recent years new cultivars have been developed in countries such as Italy, New Zealand and China. These are cultivars of *A.chinensis* and *A.deliciosa* which have different fruit flesh, aroma and harvest time.

Kiwifruit was first introduced to Turkey in 1988 and from this date to daily (about 30 years) production has increased every year. With the increasing production, all over the world, the demands of the consumers began to change. Consumers started to demand different cultivars, and started to work on breeding to develop new kiwifruit cultivars to provide an alternative to single cultivar [2].

In this breeding program, it is a priority aim to develop cultivars of kiwifruit with a yellow and/or red fleshed to the grower of our country.

In addition, the expansion of kiwi production areas in terms of the suitability of new cultivars to different ecological areas, solving the problem of early harvest, it is also aimed to offer cultivars with different flavour and aroma to consumers. In addition to these, besides fresh consumption of kiwifruit, expansion of different consumption areas such as cake, fruit juice and drying, reduction of kiwifruit and nursery imports, and reaching the potential of our country to export kiwifruit are among the aims of breeding program.

All *Actinidia* taxa are probably functionally dioecious, although this has been unequivocally established in a few taxa such as in *A.chinensis* and *A.polygama*. In all *Actinidia* taxa in which pistillate and staminate flowers are known have been described, female plants carry pistillate flowers which can be described as morphologically "perfect" since they have both well-developed pistils and what appears at first sight to be non-functional stamens whereas the staminate flowers of male plants are clearly unisexual, they have stamens but only small, rudimentary ovaries which don't contain viable ovules. Male plants therefore don't normally carry fruit [3].

Male and female flowers grow on separate kiwifruit plants [4, 5]. Kiwi is a dioecious species, with pale, straw-coloured flowers, arranged singly or in groups, according to the cultivar. The flowers have five sepals and six petals and a diameter of about 3 - 5 cm when open. The female flowers have several functional stigmata in the central region, surrounded by anthers that produce sterile pollen. The male flowers consist of a rudimentary and non-functional pistil and a large number of stamens with anthers that produce viable pollen grains [6].

Due to the different flower structure of kiwifruit compared to other species, flower phenology and morphology must be well evaluated during the breeding program. In this study, the flower morphology and phenology of the Hort16A, Jintao, Hayward, Topstar and 17684 seedlings were evaluated for two years.

## MATERIALS AND METHODS

### Plant Materials

The research was carried out in Atatürk Horticultural Central Research Institute in kiwifruit breeding plot. The *A.deliciosa* cv. Hayward which is 15 years old was used as a rootstock. Hybrid genotypes were grafted on this cultivar. All hybrid genotypes were obtained with open pollination. Flower characteristics were evaluated in the 4th and 6th years after grafting. Genotypes used in the research;

Seedlings of Hort 16 A; HO-A-13, HO-143, HO-I-14, HO-120, HO-8, HO-D-18, HO-H-18, HO-39, HO-153, HO-151.

Seedlings of 17684; B-19, B-25, B-34, B-26, B-64, B-24, B-39, B-16

Seedlings of Jintao; J-188, J-141, J-191, J-172

Cross of Hayward and Topstar; TH-44, TH-64, TH-50, TH-21

Also Matua, Tomuri and Hayward used as control cultivars.

### Methods

Flowering dates were followed during April and May to identify phenology of kiwifruit genotypes during the two growing season. The flower samples used in the research were taken when 70% flowering in each genotype. It was brought together with the flower stalk and brought to the laboratory to be examined. Measurements were made with digital callipers.

Number of sepal, number of petal, number of stamen, filament length (mm) and width of ovary (mm) were determined in male genotypes. In addition to these flower characteristics, the number of stylus and stylus length (mm) in the female genotypes were also determined. At least 10 flowers from each genotype were analysed.

## RESULTS AND DISCUSSION

As the genotypes of the different species were examined, naturally flowering varied in the dates. Also the climate data for the years of the study are given in Figure 1. The beginning of flowering was determined respectively as Hort16A (HO) seedlings, 17684 (B) seedlings, Jintao (J) seedlings, and finally Topstar-Hayward (TH) seedlings. The flowering start dates are given in Table 1 for 2015 and 2017.

The dates of the start of flowering of Hort16A seedlings were determined as the first week of May and the last week of April.

The flowering dates of the Jintao seedlings were determined as the second and third week of May. The flowering dates of 17684 seedlings were determined as the first and second week of May. Seedlings of Hayward, Tomuri, Matua and Topstar-Hayward (TH) were determined as the third and fourth week of May to beginning of the flowering.

Female and male flowers were determined during two vegetation periods. The flower characteristics of female and male genotypes are given in Table 2 and 3 as average of two years. The number of male organs (number of stamen) in Tomuri, Matua, TH-50 and TH-44 cultivars/genotypes were higher than the other genotypes. The number of male organs was 169.3 in Tomuri, 62.3 in Matua, 59.6 in TH-50 and 41.0 in TH-44. In other male genotypes, the average number of male organs was 49,24

The number of sepal was found to be close to each other in all cultivars/genotypes, and it was 6.17 on average. The petals are the most beautiful and glamorous part of the kiwi flower. The number of petals was close to 6.87 in all cultivars/genotypes. The genotypes in the filament size (mm) and the female organ size (mm) were found close to each other (Figure 2).

The number of male organs was found to be higher than other genotypes in Hayward (182.7), TH-64 (189.7) and TH-21 (151.0) but they are not functional. Hayward 9.5 mm and TH-21 9.5 mm were found to be longer than other types in terms of length of stylus length (mm). Female flowers have an average of 34.46 the number of stylus, while male flowers are not functional. The number of stylus was found to be 42.9 in B-19 and 45.0 in B-25 and it was found that they had more stylus compared to other genotypes. Because of the flower structure of kiwifruit, male and female plants must bloom at the same time with each other. This is very important for better fruit set also quality. The importance of correct identification of flower characteristics has also been emphasized in breeding studies [7]. This is especially important for cultivars/genotypes belonging to the *A.chinensis*, which have more flowers. Generally, artificial pollination applications to *A.chinensis* genotypes increase yield and quality [3, 8]. Male cultivars/genotypes have single, triple, and five flowers, whereas female flowers usually have single and double flowers. In addition, male flowers make it easier to distinguish between female and male flowers due to small and non-functional structures of the ovaries. It was observed that male flowers bloomed earlier than female flowers and remained flowering for a longer time.

Male flowers also secrete an aromatic odour that attract insects [9]. This increases the pollination rate. A similar situation was observed in the cultivars/genotypes used in the study, diferent researchers are made similar comments in their study [10, 11]. In the Hayward variety, the female organ was found to be 8.2 mm wide, the stylus size 9.4 mm and the stylus number 37.8. Similar to this study, also it was reported that 30-40 number of stylus were carried by the Hayward cultivar [12].

As a result, female cultivars/genotypes tend to flowering later than male cultivars/genotypes, and female cultivars/genotypes have shorter filament length than male cultivars/genotypes. It has also been clearly observed that ovaries are not functional in male types.

## CONCLUSIONS

Kiwifruit breeding has gained momentum in recent years due to changing consumer demands. Due to the flower structure, the male and female genotypes of the kiwifruit must be well evaluated. Some important genotypes have been examined in this study conducted for this purpose. It is thought that this study will contribute to speed up the breeding studies and contribute to the quality of fruit. It should also be remembered that the quality of the fruit is absolutely important in the harmony of a good male and female plant.

**Table 1**. First flowering date of genotypes

| | Year | HO-A13 (M) | HO-143 (M) | HO-I-14 (F) | HO-120 (F) | HO-H-18 ( M) | HO-8 (F) | HO-D18 (F) | HO-39 (M) | HO-153 (M) | HO-151 (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| First Flowering | 2015 | 03.05 | 13.05 | 29.04 | 30.04 | 28.04 | 04.05 | 02.05 | 29.04 | 04.05 | 07.05 |
| | 2017 | 04.05 | 11.05 | 01.05 | 29.04 | 01.05 | 02.05 | 02.05 | 30.04 | 01.05 | 04.05 |

| | Year | B-34 ( M) | B-64 ( M) | B-19 (F) | B-25 ( F) | B-26 ( M) | B-24 (F) | B-16 ( M) |
|---|---|---|---|---|---|---|---|---|
| First Flowering | 2015 | 13.05 | 14.05 | 15.05 | 12.05 | 11.05 | 14.05 | 15.05 |
| | 2017 | 08.05 | 07.05 | 08.05 | 09.05 | 08.05 | 09.05 | 07.05 |

| | Year | HAYWARD (F) | TOMURİ ( M) | MATUA ( M) | TH-21 (F) | TH-44 ( M) | TH-50 ( M) | TH-64 (F) |
|---|---|---|---|---|---|---|---|---|
| First Flowering | 2015 | 21.05 | 19.05 | 17.05 | 24.05 | 26.05 | 26.05 | 27.05 |
| | 2017 | 21.05 | 16.05 | 14.05 | 23.05 | 20.05 | 20.05 | 26.05 |

| | Year | J-188 ( M) | J-191 (F) | J-172 ( M) | J-141 (F) |
|---|---|---|---|---|---|
| First Flowering | 2015 | 17.05 | 17.05 | 20.05 | 20.05 |
| | 2017 | 10.05 | 13.05 | 14.05 | 17.05 |

M: Male. F: Female. HO: Hort16 A seedlings. B: 17684 Seedlings. J: Jintao seedlings. TH: Hayward/Topstar X Tomuri Seedlings

**Table 2**. Some flower characteristics of female genotypes

| Characteristics of Flower | FEMALE GENOTYPES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J-191 | J-141 | HO-I-14 | HO-120 | HO-8 | HO-D-18 | HO-151 | Hayward | B-19 | B-24 | B-25 | TH-64 | TH-21 |
| Number of Sepal | 6.1 | 6.7 | 6.6 | 7.0 | 7.4 | 6.1 | 6.7 | 5.1 | 5.9 | 6.0 | 5.8 | 5.8 | 5.3 |
| Number of Petal | 6.4 | 6.8 | 8.1 | 9.0 | 8.3 | 6.0 | 6.7 | 6.6 | 6.4 | 8.3 | 6.6 | 6.1 | 6.7 |
| Number of Stamen | 57.3 | 62.7 | 55.3 | 49.6 | 52.0 | 41.6 | 43.9 | 182.7 | 59.2 | 60.3 | 57.4 | 189.7 | 151.0 |
| Number of Stylus | 29.9 | 35.0 | 32.7 | 34.0 | 33.8 | 24.2 | 29.2 | 37.8 | 42.9 | 34.1 | 45.0 | 32.0 | 37.4 |
| Filament length (mm) | 8.8 | 9.1 | 8.0 | 6.5 | 9.2 | 8.1 | 7.5 | 10.0 | 9.6 | 11.8 | 11.2 | 8.6 | 11.6 |
| Width of Ovary (mm) | 5.5 | 6.0 | 6.7 | 7.0 | 7.1 | 6.2 | 6.2 | 8.2 | 6.2 | 7.1 | 7.1 | 6.5 | 8.4 |
| Stilus Length (mm) | 8.0 | 7.9 | 5.9 | 6.7 | 6.3 | 6.3 | 6.0 | 9.5 | 8.0 | 8.4 | 8.5 | 7.4 | 9.5 |

**Table 3**. Some flower characteristics of male genotypes

| Characteristics of Flower | MALE GENOTYPES | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J-188 | J-172 | HO-A-13 | HO-143 | HO-H-18 | HO-39 | HO-153 | B-34 | B-26 | B-39 | B-16 | B-64 | Tomuri | Matua | TH-50 | TH-44 |
| Number of Sepal | 5.7 | 7.1 | 6.6 | 6.0 | 6.3 | 6.3 | 6.2 | 6.0 | 5.5 | 5.9 | 5.8 | 5.6 | 5.9 | 5.7 | 7.1 | 6.6 |
| Number of Petal | 6.2 | 7.9 | 7.8 | 6.8 | 7.2 | 6.7 | 6.9 | 5.7 | 5.5 | 6.4 | 6.4 | 5.7 | 6.2 | 6.2 | 7.9 | 7.8 |
| Number of Stamen | 62.3 | 59.6 | 41.0 | 92.7 | 49.2 | 40.4 | 42.3 | 53.7 | 53.9 | 52.0 | 49.2 | 62.8 | 169.3 | 62.3 | 59.6 | 41.0 |
| Width of Ovary (mm) | 13.2 | 10.4 | 6.2 | 11.9 | 7.8 | 8.8 | 7.3 | 12.8 | 11.1 | 11.8 | 10.8 | 10.0 | 12.6 | 13.2 | 10.4 | 6.2 |
| Filament length (mm) | 3.4 | 3.0 | 2.5 | 3.7 | 3.4 | 2.7 | 2.9 | 3.6 | 3.5 | 3.1 | 2.9 | 3.4 | 3.4 | 3.4 | 3.0 | 2.5 |

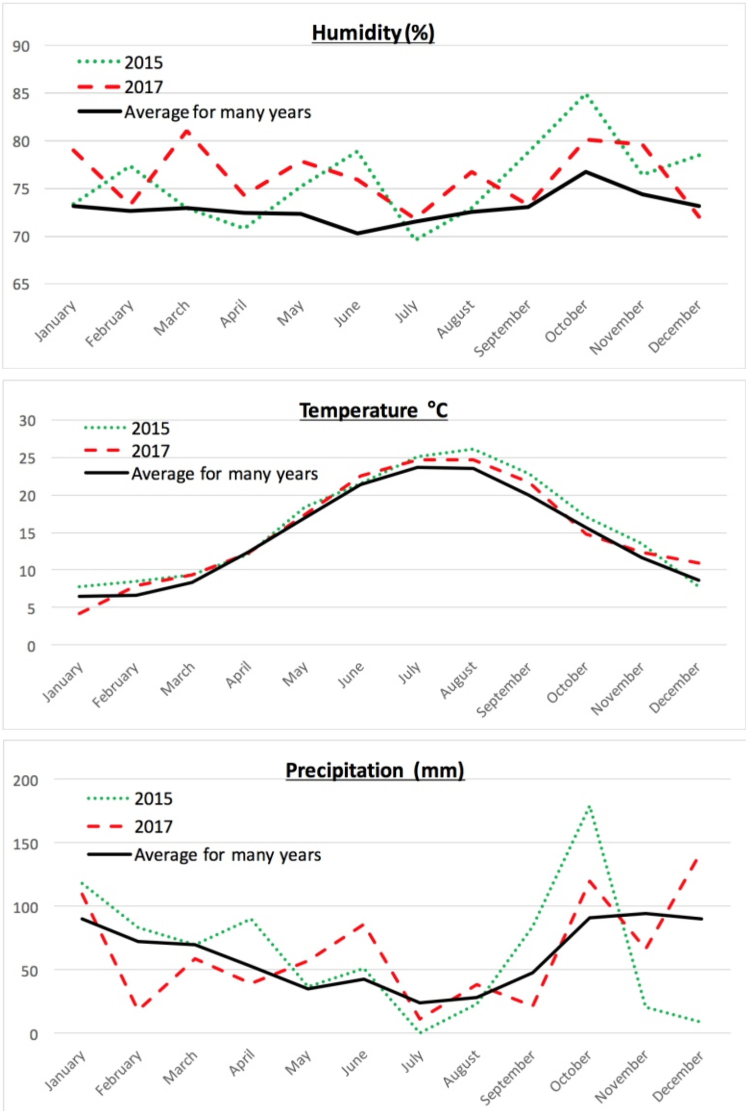


**Figure 1**. 2015 and 2017 climate data of experimental area

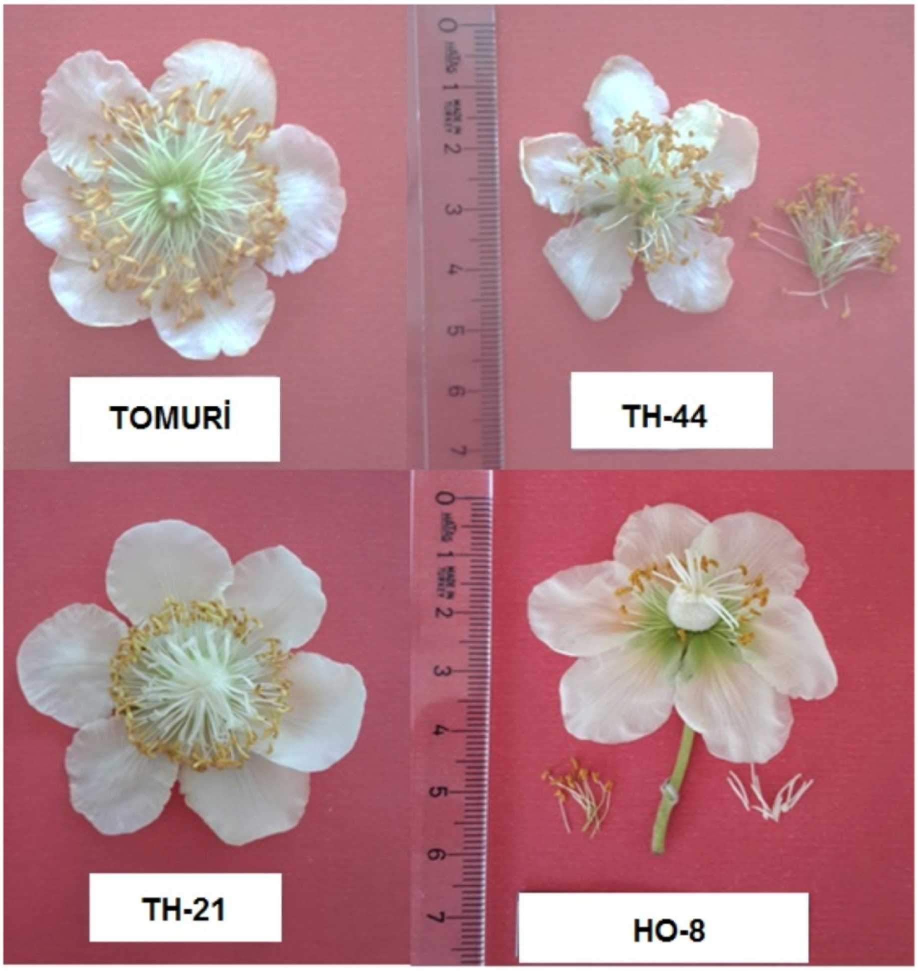


**Figure 2.** Full opened flowers of Tomuri, TH-44, TH-21, and HO-8

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# CHLOROPHYLL PIGMENT CONCENTRATION AND SEA SURFACE TEMPERATURE OF THE BLACK SEA

**Mehmet Tahir Kavak**[1,*]

[1]Dicle University, Faculty of Education, Department of Physics, Diyarbakır, Turkey

[*]Corresponding Author: mtkavak@gmail.com

## ABSTRACT

As an enclosed sea, the Black Sea has countless economic activities (mainly tanker traffic and fisheries) and recreational activities, with the consequence of being threatened by dramatic dangers and pollution. Optical remote sensing can provide a novel look at physical processes and then driving mechanisms. It is worthwhile to know how the temperature and other marine parameters change on seasonal and long-term scales.

In the paper CZCS (Coastal Zone Color Scanner) and AVHRR (Advanced Very High Resolution Radiometer) satellite were used to study the relationship between photosynthesis and SST since phytoplankton forms the very lowest clement in the marine ecosystem. Satellite derived data could provide information on the amount of sea life present in any given area throughout the world. The information could also be useful in connection with studies of global changes m temperature and what effect they could have on the total abundance of marine life.

Present work which used CD-ROM set from NASA did not found evidence of correlation between chlorophyll pigment concentration and SST of the Black Sea with 99.95% certainty, three channel algorithm or the use of fluorescence or chlorophyll absorption peak in the red suggested for future work.

**Keywords:** Phytoplankton, CZCS, AVHRR. Temperature, Black Sea

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## INTRODUCTION

Many studies have been made on the relationship between SST (sea surface temperature) and chlorophyll, for instance by [1,2,3,4].

The upwelling event, due to the interface between cold and warm water masses brings nutrients up from deep waters which is attractive to plankton and therefore it is possible to detect likely areas for plankton concentration by monitoring the sea temperature [5].

Normally the carbon dioxide in the atmosphere is in balance with the carbon dioxide in the ocean. During photosynthesis phytoplankton remove carbon dioxide from seawater and release oxygen as a by-product. This allows the oceans to absorb additional carbon dioxide from the atmosphere. If fewer phytoplankton existed, atmospheric carbon dioxide would increase. Phytoplankton also affect carbon dioxide levels when they die. Phytoplankton, like plants on land, are composed of substances that contain carbon. Dead phytoplankton can sink to the ocean floor. Other material sinking to ocean bottom soon covers the phytoplankton. In this way, the ocean act as a sink, a place to dispose of global carbon, which otherwise would accumulate in the atmosphere as carbon dioxide. Other global sinks include land vegetation and soil. However the carbon sinks are frequently returned to the atmosphere as carbon dioxide by burning or decomposition. Deforestation contributes to the accumulation of carbon dioxide in the atmosphere by reducing the removal of carbon dioxide. Carbon dioxide acts as a 'greenhouse' gas in the atmosphere, and therefore an increase in its concentration may contribute to global warming. The increase of carbon dioxide means less long-wavelength energy emitted from the Earth can escape to space. This would lead to a gradual warming of the Earth, but there are other factors that could counteract this warming effect. This would lead to a gradual warming of the Earth, but there are other factors that could counteract

For example, cloud cover reflects sunlight before it reaches the Earth; an increase in cloud cover would reduce the amount of sunlight that reaches the Earth's surface.

If we can set up a relationship between photosynthesis and temperatures, satellites could aid in determining the amount of sea life present in any given area throughout the world. The information could also be used to explain global changes in temperature and what effect they could have on the total abundance of marine life.

Hood et al. [1] led a two-day cruise in which he collected both satellite thermal data as well as biological data off the coast of northern California. His team found two distinct waters masses, one hot and one cold, which were divided by a front. On the landward side of the front, they found that there was a sharp decline in SST (sea surface temperature) as well as an abundance of phytoplankton biomass. On the seaward side of the front, they observed an increase in SST as well as a decrease in the amount of phytoplankton biomass. However Robinson and LeB. Williams [2] who performed another study in the mid-1980s in the British Antarctic did not support the hypothesis that SST (Sea Surface Temperature) directly affects the amount of chlorophyll concentration. Correlation between SST and chlorophyll pigment concentration has also been investigated by Nykjaer and Van Camp [3] on a Northwest African upwelling area. Nykjaer and Van Camp [3] used ten simultaneous pair of CZCS and NOAA GAC images and the images were analyzed with respect to;

a) Describing the relationship between SST and CHL (total pigment concentration) in terms of similarities, discrepancies and spatial variability

b) Identifying different water masses through the relationship between SST and CHL

c) Inferring concepts of upwelling events based on the SST/CHL relationship. They did not find a linear correlation between pigment concentration and temperature in the surface.

The pigment pattern of the Black Sea has been studied from space using the CZCS by Barale and Murray [7] and Barale and Schlittenhard [6]. Their findings, in all of the CZCS images (they considered composited images) available, showed that major rivers such as the Danube, Dnestr and Dnepr, the Don in the sea of Azov, as well as other minor rivers, mostly along the western and southern coast of the Black Sea, produce distinct plumes interacting with the marine environment. Within the range of plumes, as with coastal runoff in general, it is often impossible for the CZCS to distinguish the signature of biogenic pigments from that of the total load of dissolved and suspended materials present in the water

The main feature of the Black Sea appearing in the OCEAN time series of composite images is the high pigment concentration. This could possibly be related to the combined effect of coastal runoff, strong stratification and circulation in general, on the presence and abundance of suspended and dissolved matter in surface waters. The impact on the surface color field of river discharges along the western coast can readily be evaluated [7].

## THE DATA

18-km resolution scenes from the CZCS and the AVHRR CD-ROM (Compact Disc-Read Only Memory) set were used [8] containing chlorophyll pigment concentration and SST respectively. The CD-ROM set was obtained from NASA (National Aeronautics and Space Administration). Two satellite derived data sets presented on the CD·ROM were in co-registered format [8].

## DATA ANALYSIS

64 images of the Black Sea were extracted from the NASA CD-ROM set. Statistics were calculated by excluding flag values for the whole basin. 32 of the images were from the CZCS monthly averaged phytoplankton pigment concentration, the other 32 were from AVHRR monthly averaged SST for the same time. The cross-plot of 64 images is presented in Figure 1. Both monthly averaged chlorophyll pigment concentration and SST have been plotted against time in Figure 2.

The satellite data sets gave us the information for the SST and CHL values in the form of a digital number, DN. We then applied the following equations, as suggested by NOAA [8] to determine the SST and CHL.

CHL (in $mg/m^3$) is given by:

$$CHL\ 10^{(0.012\,DN\ 1.14)} \qquad (1)$$

where DN is an integer between 0-255 from the CD-ROM image data, SST (in ℃) is given by:

$$SST\ 0.15\mathrm{DN} \qquad (2)$$

where DN is an integer between 0-255 from the CD-ROM image data.

## RESULTS

Figure 1 shows the monthly average chlorophyll pigment concentration and SST of whole basin. Relationship between SST and chlorophyll pigment concentration were not significantly different ($p<0.05$) statistically.

Figure 2 shows the variability of average chlorophyll concentration and SST in a year. The figure were drawn by averaging SST and chlorophyll pigment concentration from 1981-1986. There were decrease in both chlorophyll and SST from November to March and increased from March to June.

Figure 3 shows monthly averaged CZCS data for the Black Sea from 1979-1986 in both the mean and individual year chlorophyll variability. The highest values of chlorophyll pigment concentration was occurred from September to January and there was a significant differences year by year. La Violette [9] used similar data for the North Adriatic region, have found that the highest values of chlorophyll pigment concentration occur in winter months. High chlorophyll pigment concentration in winter could be due to less-stratified (better-mixed by winter winds) water that is more likely to be rich in nutrients.

## CONCLUSIONS

As can be seen from the data were obtained on the CD-ROM set, there was no evidence of correlation between chlorophyll pigment concentration and SST of Black Sea. The zero correlation hypothesis was tested and passed with 99.95%, certainty.

As far as is known there are no clear indications as to whether temperature was the principal component in determining biomass growth. There are too many factors which must be taken in to account. Surface flow zones, substrate concentration, temperature gradients, oxygen abundance, and other factors are important [8].

There is no unique algorithm for case 1 waters (those waters for which phytoplankton and their by-products play the dominant role in determining the optical properties of the water body) and case 2 waters (sediment dominated waters) as it seems to be dependent on geographic locations. Thus different waters require different algorithms [10]. As Bowers, Harker and Stephan [11] indicated, inorganic sediment concentration has to be known in order to derive chlorophyll concentration from a blue-green ratio measured by satellite to obtain more accurate results. Bowers, Harker and Stephan [11] suggested using a three channel algorithm or the use of fluorescence or chlorophyll absorption peak in the red.

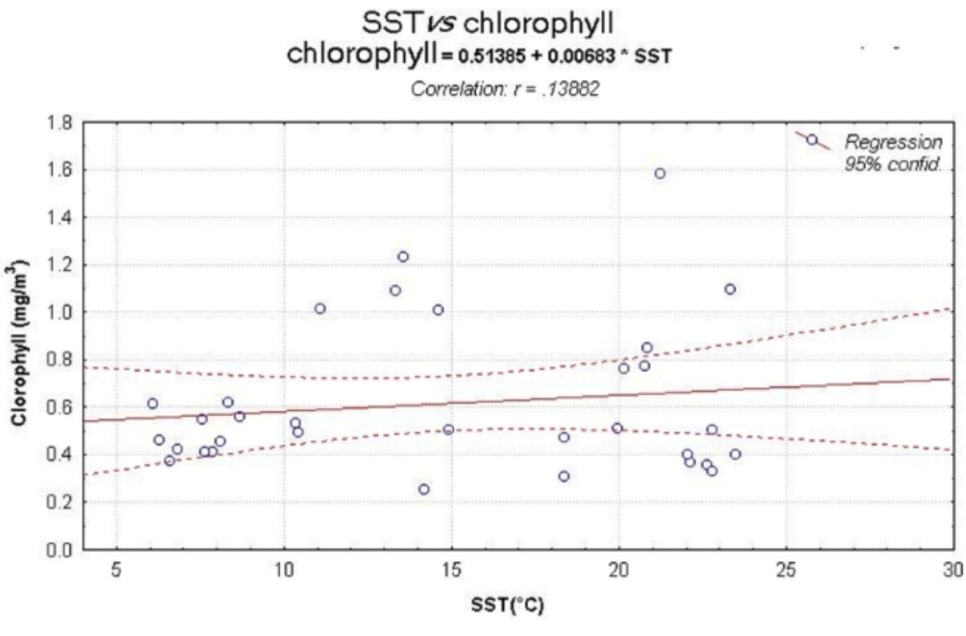


**Figure 1.** Monthly average chlorophyll pigment concentration and SST of whole basin.

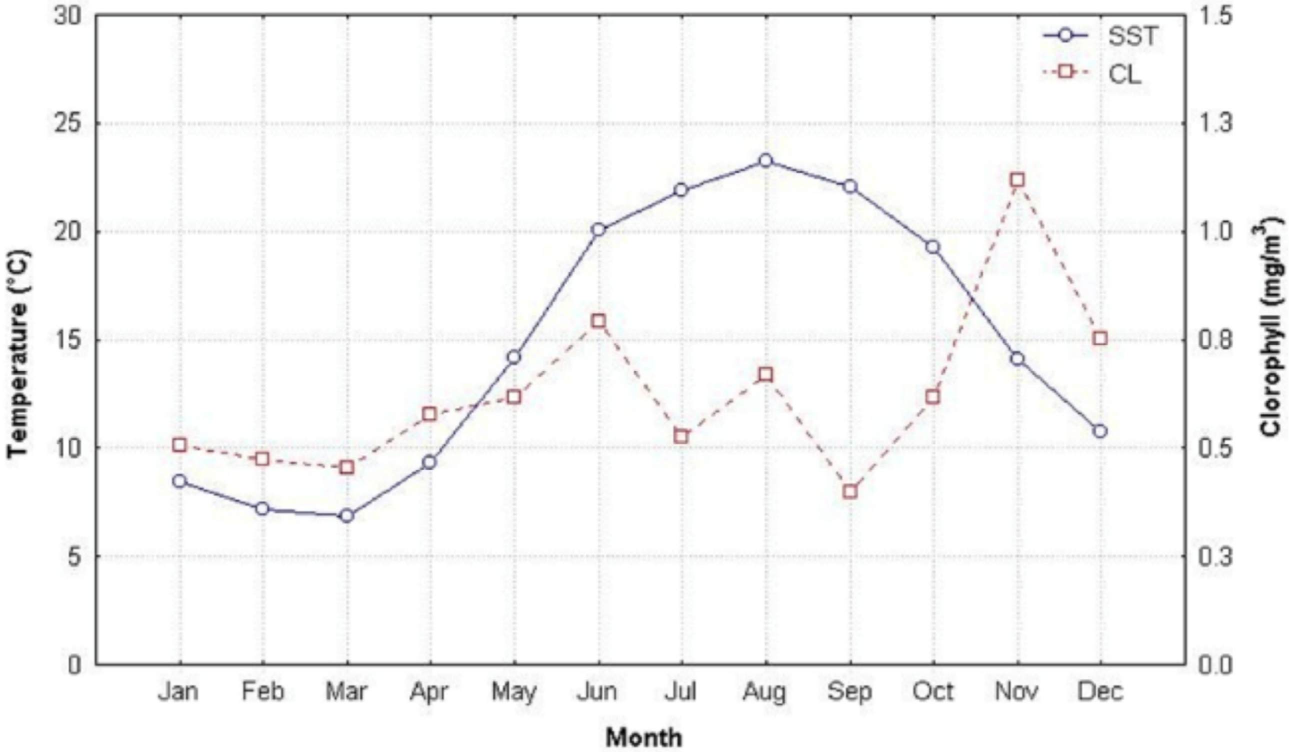


**Figure 2.** Monthly average variation of SST and chlorophyll pigment concentration on the Black Sea.

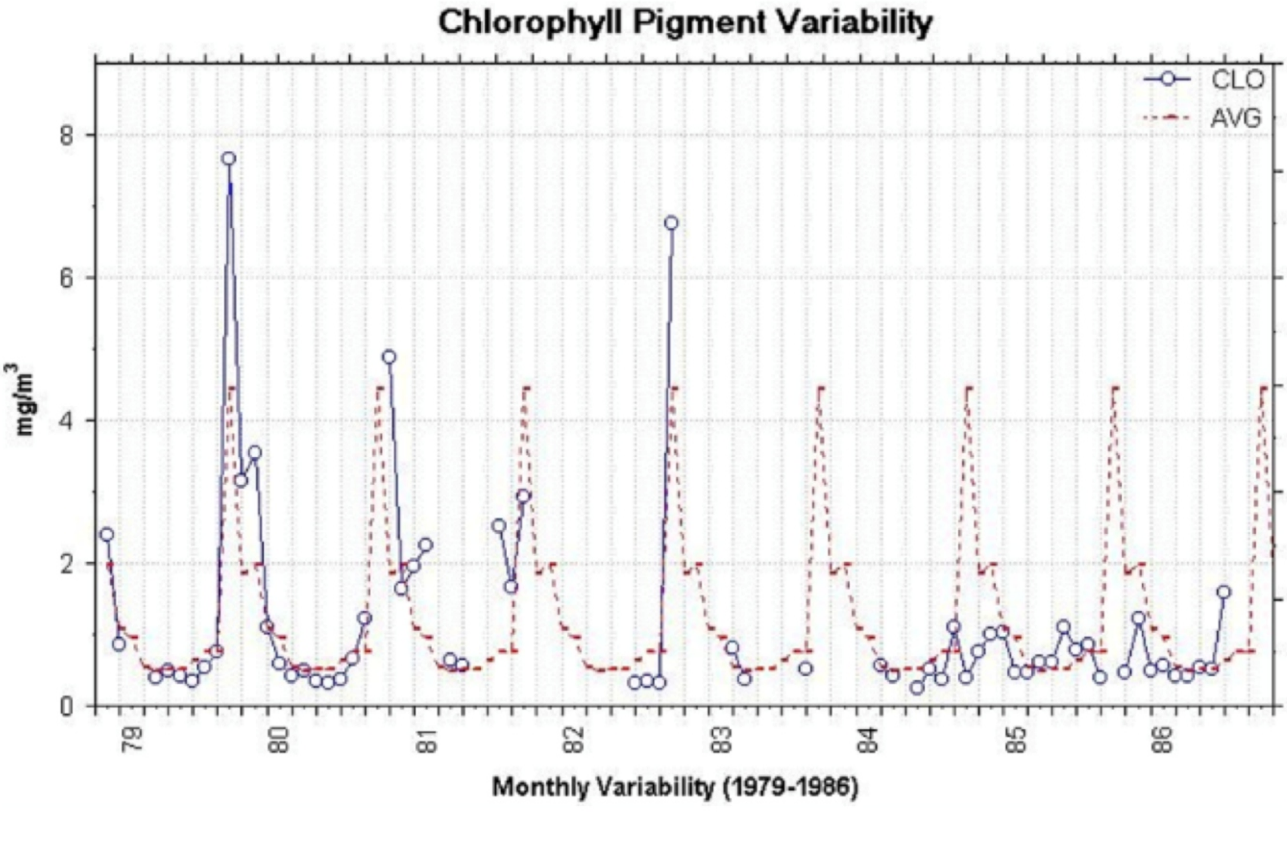


**Figure 3.** Monthly mean chlorophyll pigment variability from 1979 to 1986.

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# EVALUATION OF WATER QUALITY IN EUTROPHIC SHALLOW LAKES: CASE STUDY ON LAKE ULUABAT, TURKEY

**Saadet Hacısalihoğlu**[1,*] **Feza Karaer**[2]

[1]Bursa Technical University, Department of Environmental Engineering, Bursa, Turkey
[2]Uludag University, Department of Environmental Engineering, Bursa, Turkey

[*]Corresponding Author: saadet.hacisalihoglu@btu.edu.tr

## ABSTRACT

Lake Uluabat is one of the most important shallow lakes in Turkey. The lake is located 15 km south of the Marmara Sea and 30 km west of the city of Bursa. The lake is very important in terms of biodiversity, but knowledge of its water quality is somewhat limited. The objective of this study was to assess water quality in Lake Uluabat and provide information for future management decisions. The temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), alkalinity, chemical oxygen demand (COD), nitrogen species, phosphorus species, and chlorophyll-a (Chl-a) concentrations were monitored monthly at ten sampling points in the lake between August 2013 and July 2014. As a result, it was determined that the lake water has the characteristics of class 4 waters according to the Turkish Surface Water Quality Management Regulations (SWQMR). Also it was determined that Mustafakemalpaşa Brook carries significant amount of pollution loads into the lake. According to qualitative and quantitative observations, the effects of human impact and current status of the lake were determined. The physical and chemical characteristics of the lake water have changed according to human activities and nutrient loadings. According to the trophic level values and concentration values, the Lake exceeded the regulation limits.

**Keywords:** Lake Uluabat, Monitoring, Pollution, Trophic State, Water Quality

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## INTRODUCTION

Physical and chemical characteristics of lake waters and their variations govern the environmental, ecological, and biological status of the lakes. Lakes are also subjected to a high human impact. Many studies examined the physical and chemical status of the lake water and demonstrated which factors controlled the water quality, ecologic status and eutrophication patterns [1-6]. Lake Uluabat is one of the most important wetland area in Turkey and is increasingly threatened by pollution [1]. Organic and inorganic pollution has also affected the nutrient status of the lake, and in this respect, the greatest concern deals with eutrophication [7-8]. Intensive agricultural activities, industrial activities, and mining in the lake basin have adversely influenced the water quality in the lake. Water quality of the lake is somewhere limited. It is therefore essential to prevent and control water pollution and to implement regular monitoring programs for water quality management [9]. Lake Uluabat is one of the richest lakes in terms of aquatic plants besides fish and bird populations in Turkey. For this reason, the Lake was placed under protection by the RAMSAR agreement in 1998 and the living lakes partnership program of 2002. The aim of this study was to examine water quality variables in Lake Uluabat each month between August 2013 and July 2014, to classify the lake water quality according to the "SWQMR". Also, eutrophic level of the lake has also been identified. This study will provide baseline data for future water quality and management studies.

## MATERIALS AND METHODS

### Study Area

Lake Uluabat is located between 40°10' N and 28°36' E in northwestern Turkey (Figure 1), near the southern part of the Sea of Marmara, 30 km away from Bursa. The lake is the most important part of the Susurluk basin. It is a large but shallow lake with a mean depth of 1.5-2 m, and maximum depth 4.5 m in winter season [10]. The surface area of the lake was measured between 161 and 138 $km^2$ [1]. The lake is recharge principally by the Mustafakemalpaşa (MKP) Brook from the southwest and has its only outlet in the northwest, where it drains into the Kocasu Brook [11]. The location of Lake Uluabat and the sampling points are shown in Figure 1.

### Sampling Methods and Analysis

Water samples were collected from 10 different sampling points marked S1-S10 in Figure 1. The sampling points were selected according to their distances from the contaminant sources in the lake and their hydrodynamic characteristics. Samples were also taken from the MKP Brook. Water samples were taken monthly between August 2013 July 2014 and they were collected from 0.5 m below the surface using dark polyethylene bottles. During sampling in situ temperature (T), pH, electrical conductivity (EC), dissolved oxygen (DO), and chlorophyll-a (Chl-a) were measured using Hach brand OTT-Hydrolab DS5 device. The device was calibrated with appropriate solutions prior to every field work. Alkalinity, orthophosphate ($PO_4$-P), total phosphorus (TP), ammonium nitrogen ($NH_4$-N), nitrate nitrogen ($NO_3$-N), total nitrogen (TN), total kjeldahl nitrogen (TKN), and chemical oxygen demand (COD) parameters measured according to the American Public Health Association standard methods [12]. The results were evaluated in comparison with "SWQMR".

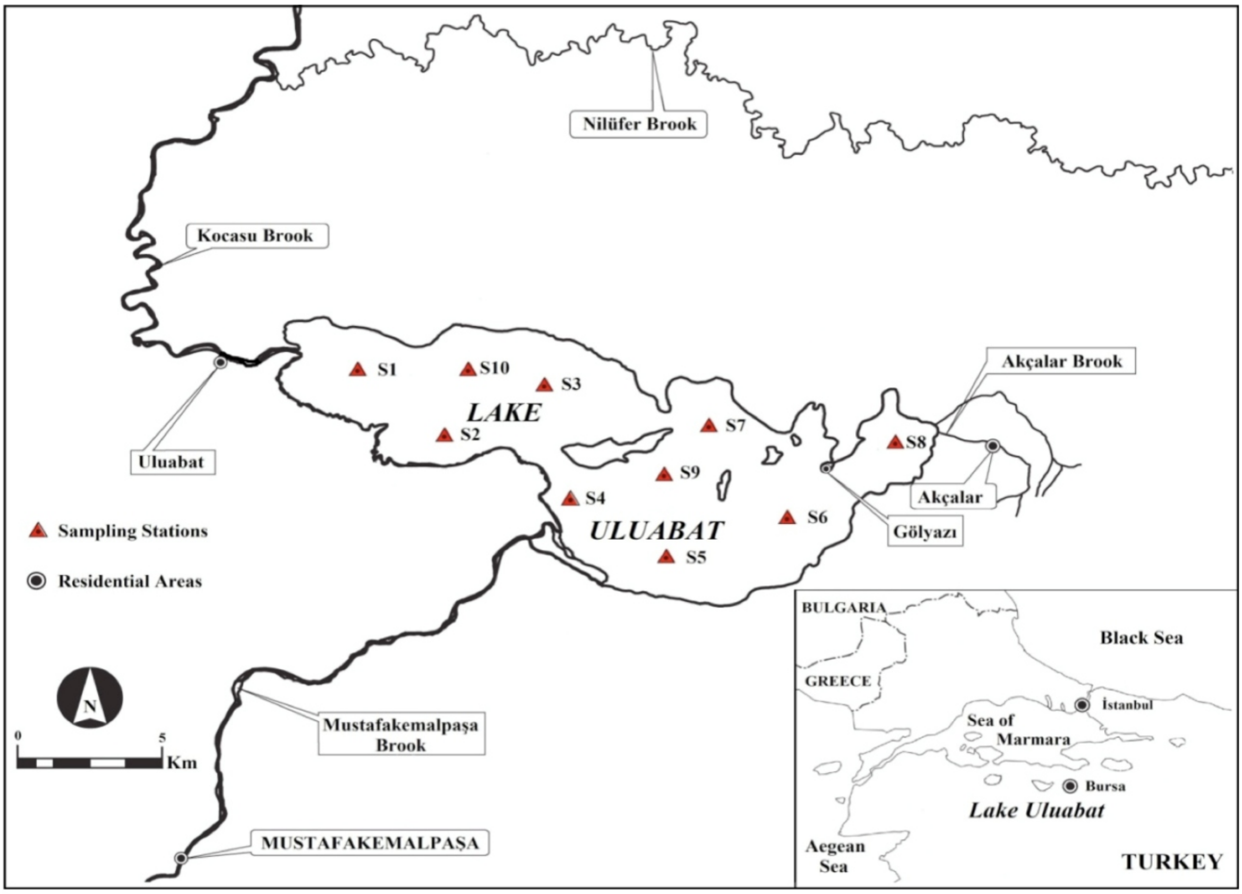



**Figure 1.** Location of Lake Uluabat and Sampling Points

The "Surface Water Quality Management Regulations" (SWQMR) divides inland waters into four classes; class 1. high quality water; class 2. slightly polluted water; class 3. polluted water; and class 4. highly polluted water [13]. Table 1 shows the SWQMR classifications [14]. Trophic state of the Lake Uluabat has been determined in accordance with Carlson (1977). Statistical tests were performed using the SPSS 22.0 program. ANOVA was performed to determine the variability of the water quality variables within and between both 10 sampling points and 12 months in Table 2. As shown in Table 2, spatial variations of water quality variables exception of pH, EC, TKN, and TP were not significant (ANOVA, $p>0.05$), but temporal variations of all parameters were significant (ANOVA, $p<0.05$).

Therefore, the mean values of all water quality variables of all sampling points were evaluated. Also, TSI values were calculated using mean values of all sampling points.

## RESULTS AND DISCUSSION

### Water Quality

After one year monitoring processes, the average values of water quality parameters were given in Figure 2, some statistic values of the water quality parameters are summarized in Table 3 and correlation matrix for these parameters are shown in Table 4.

The mean temperature in Lake Uluabat was found to be 16.31°C, with a maximum of 26.4°C in August and minimum of 5.8°C in December. In terms of temperature, Lake Uluabat can be classified as class 1, according to SWQMR. The temperature was found to have significant negative correlations with EC (r -0.475), and DO (r -0.796) and significant positive correlations with COD (r 0.429), $NO_3$-N (r 0.565), $NH_4$-N (r 0.259), TKN (r 0.466), TN (r 0.498), $PO_4$-P (r 0.419), TP (r 0.623), Chl-a (r 0.317). The pH is an important variable in water quality assessment as it influences many biological and chemical processes within a water body [15]. Also pH value is one important factor to control eutrophication in a lake [16]. The mean pH was 8.54, the lowest pH was 8.1 in June, the highest pH was 9.1 in July. In terms of pH, the Lake can be classified as class 3, according to the SWQMR. pH was significantly and negatively correlated with alkalinity (r -0.359). The lowest EC measured in Lake Uluabat was 530 µS/cm, in June; the highest EC was 766 µS/cm in January, and the mean EC was 624.41 µS/cm. In terms of EC, Lake Uluabat was in class 2, according to the SWQMR. EC was significantly and negatively correlated with T (r -0.475), $NO_3$-N (r -0.231), TKN (r -0.224), TN (r -0.226), $PO_4$-P (r -0.336), and TP (r -0.522), and significant positive correlations with DO (r 0.380), and Alkalinity (r 0.253). The lowest DO measured in Lake Uluabat was 7.3 mg/l, in August; the highest DO was 12.3 mg/l, in March, and the mean DO was 10.12 mg/l. Dissolved oxygen values dropped to low levels in summer with the increase in the temperature, also reached high levels during winter months. The reason for the measurement of low dissolved oxygen concentration in August, the algae population reached maximum values in this month. In terms of DO, Lake Uluabat is in class 1, according to the SWQMR. DO is significantly negatively correlated with T (r -0.796), COD (r -0.609), $NO_3$-N (r -0.560), $NH_4$-N (r -0.357), TKN (r -0.492), TN (r -0.516), $PO_4$-P (r -0.641), TP (r -0.763), Chl-a (r -0.454), and significantly positively correlated with EC (r 0.380). The mean alkalinity in Lake Uluabat was found to be 238.45 mg $CaCO_3$/l, with a maximum of 257 $CaCO_3$/l in May, and minimum of 193 $CaCO_3$/l in December. High alkalinity is observed in the water bodies with eutrophication particularly spring season [17]. Also high alkalinity of lake water might be due to the use of detergents and wash off from area having calcite and dolomite minerals could also partly contribute to alkalinity [17, 18]. There is no SWQMR classification for this parameter. Alkalinity is significantly negatively correlated with pH (r -0.359), $PO_4$-P (r -0.349), and TP (r -0.228), and significantly positively correlated with EC (r 0.253). The mean COD was 71.95 mg/l, the lowest COD was 16 mg/l in January, the highest COD was 192 mg/l in August. In terms of COD, the Lake is in class 4 (highly polluted water), according to the SWQMR. COD is significantly negatively correlated with DO (r -0.609), and significantly positively correlated with T (r 0.429), $NO_3$-N (r 0.400), $NH_4$-N (r 0.366), TKN (r 0.440), TN (r 0.451), $PO_4$-P (r 0.487), TP (r 0.465), and Chl-a (r 0.565). In summer, as the microbial activities increase, the degradation rate of the organic matters increases. Therefore, the DO level decreases where COD increase [2, 10].

**Table 1.** Water Quality Classifications based on SWQMR [14]

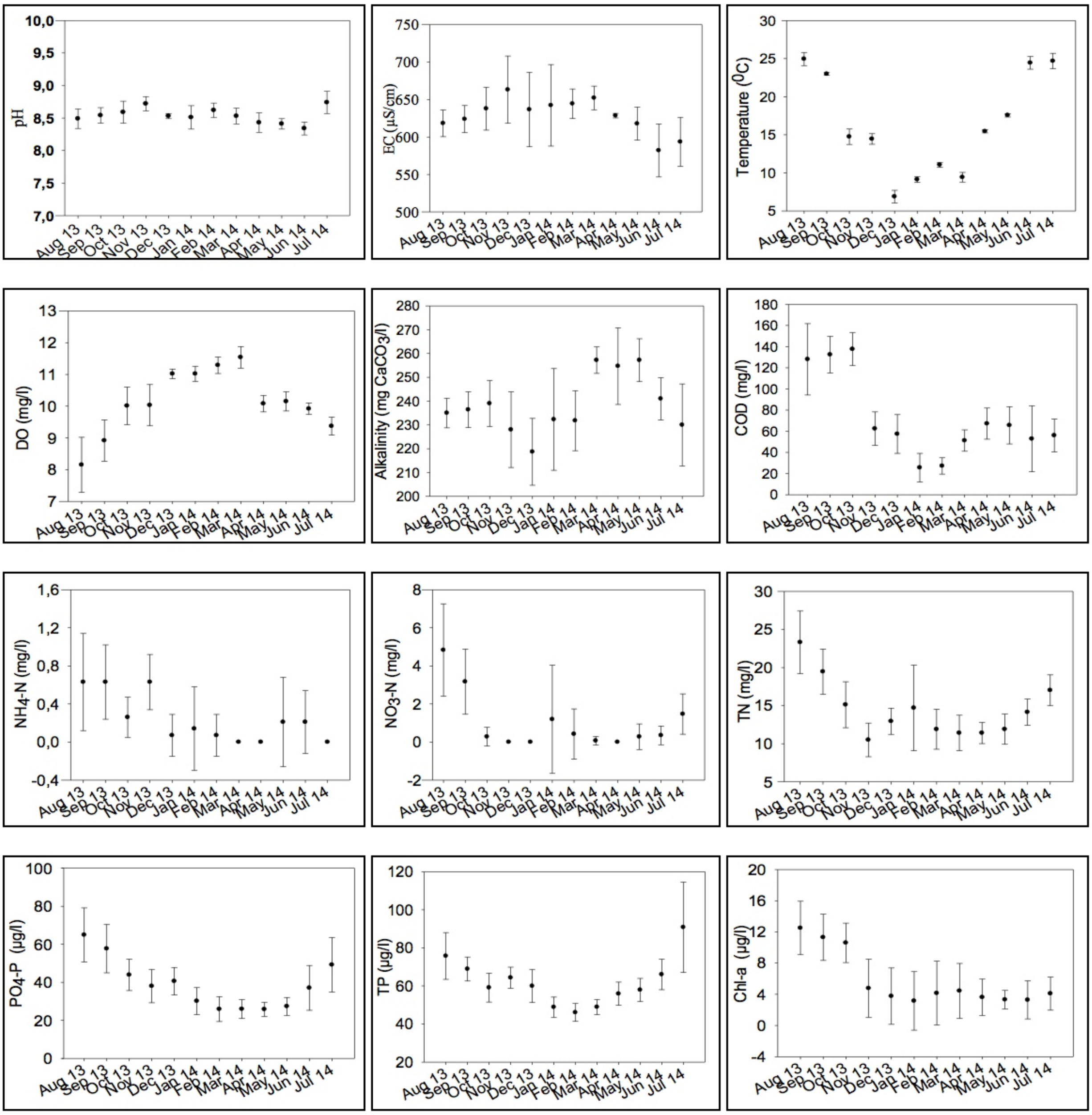
| | Water Quality Classes | | | |
|---|---|---|---|---|
| Parameters | 1 | 2 | 3 | 4 |
| T (ºC) | ≤25 | ≤25 | ≤30 | >30 |
| pH | 6.5-8.5 | 6.5-8.5 | 6.0-9.0 | <6.0 or >9.0 |
| EC (μs/cm) | <400 | 400-1000 | 1001-3000 | >3000 |
| DO (mg/l) | >8 | 6-8 | 3-6 | <3 |
| COD (mg/l) | <25 | 25-50 | 50-70 | >70 |
| $NO_3$-N (mg/l) | <5 | 5-10 | 10-20 | >20 |
| $NH_4$-N (mg/l) | <0.2 | 0.2-1 | 1-2 | >2 |
| TKN (mg/l) | 0.5 | 1.5 | 5 | >5 |
| TP (mg/l) | <0.03 | 0.03-0.16 | 0.16-0.65 | >0.65 |

**Table 2.** ANOVA (Between Groups) of water quality variables in Lake Uluabat

| ANOVA(The factor is sampling month) | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Temperature | 4787.7 | 11 | 435.25 | 957.44 | 0.000 |
| pH | 1.5 | 11 | 0.13 | 7.490 | 0.000 |
| EC | 59876.6 | 11 | 5443.33 | 5.283 | 0.000 |
| DO | 109.6 | 11 | 9.96 | 47.250 | 0.000 |
| Alkalinity | 16457.2 | 11 | 1496.11 | 8.984 | 0.000 |
| COD | 166740.9 | 11 | 15158.26 | 41.866 | 0.000 |
| $NO_3$-N | 252.9 | 11 | 22.99 | 13.261 | 0.000 |
| $NH_4$-N | 16.6 | 11 | 1.51 | 2.822 | 0.003 |
| TKN | 645.7 | 11 | 58.70 | 13.410 | 0.000 |
| TN | 1600.8 | 11 | 145.53 | 17.543 | 0.000 |
| $PO_4$-P | 18878.0 | 11 | 1716.18 | 19.581 | 0.000 |
| TP | 17507.0 | 11 | 1591.54 | 17.051 | 0.000 |
| Chl-a | 1358.3 | 11 | 123.49 | 12.939 | 0.000 |
| ANOVA(The factor is sampling point) | | | | | |
| Temperature | 7.6 | 9 | 0.84 | 0.019 | 1.000 |
| pH | 0.5 | 9 | 0.05 | 2.143 | 0.032 |
| EC | 31796.5 | 9 | 3532.95 | 2.789 | 0.006 |
| DO | 6.2 | 9 | 0.69 | 0.608 | 0.788 |
| Alkalinity | 3650.7 | 9 | 405.63 | 1.449 | 0.176 |
| COD | 3261.3 | 9 | 362.37 | 0.197 | 0.994 |
| $NO_3$-N | 21.0 | 9 | 2.33 | 0.613 | 0.784 |
| $NH_4$-N | 4.18 | 9 | 0.46 | 0.729 | 0.682 |
| TKN | 173.77 | 9 | 19.30 | 2.248 | 0.024 |
| TN | 290.0 | 9 | 32.22 | 1.606 | 0.122 |
| $PO_4$-P | 3873.6 | 9 | 430.41 | 1.935 | 0.054 |
| TP | 4385.7 | 9 | 487.30 | 2.310 | 0.020 |
| Chl-a | 179.3 | 9 | 19.93 | 0.992 | 0.451 |

df degree of freedom, F frequency, Sig. level of significance

**Figure 2.** Temporal variations in water quality parameters of Uluabat Lake (Mean±SD)




In spring and winter months, as the volume of the rains and winds increase, circulation occurs in the lake and the flow rates which recharge the lake increase, and as a result of these mixings the lake water gains oxygen again [1, 10, 17]. The mean $NO_3$-N concentration was 1 mg/l, the lowest $NO_3$-N was 0 mg/l, and the highest $NO_3$-N was 9.8 mg/l in August. When the results evaluated, it has been found nitrate levels are higher in summer than other seasons. In terms of $NO_3$-N concentration, the Lake is in class 1, according to SWQMR. $NO_3$-N concentration is significantly negatively correlated with EC (r -0.231), and DO (r -0.560), and significantly positively correlated with T (r 0.565), COD (r 0.400), $NH_4$-N (r 0.225), TKN (r 0.639), TN (r 0.753), $PO_4$-P (r 0.472), TP (r 0.461), and Chl-a (r 0.382). The mean $NH_4$-N concentration was 0.32 mg/l, the lowest $NH_4$-N was 0 mg/l, and the highest $NH_4$-N was 6.3 mg/l in October. In general, $NH_4$-N concentrations were higher in rainy months and summer. In terms of $NH_4$-N concentration, the Lake is in class 2, according to SWQMR. $NH_4$-N concentration is significantly negatively correlated with DO (r -0.357), and significantly positively correlated with T (r 0.259), COD (r 0.366), $NO_3$-N (r 0.225), TKN (r 0.359), TN (r 0.345), $PO_4$-P (r 0.343), TP (r 0.261), and Chl-a (r 0.304).

The mean TKN concentration was 13.48 mg/l, the lowest TKN was 8.4 mg/l in February and March, and the highest TKN was 23.1 mg/l in August. In terms of TKN concentration, the Lake is in class 4, according to SWQMR. TKN concentration is significantly negatively correlated with EC (r -0.224), DO (r -0.492), and significantly positively correlated with T (r 0.466), COD (r 0.440), $NO_3$-N (r 0.639), $NH_4$-N (r 0.359), TN (r 0.980), $PO_4$-P (r 0.520), TP (r 0.387), and Chl-a (r 0.463). The mean TN concentration was 14.48 mg/l, the lowest TN was 8.4 mg/l in February and March, and the highest TN was 32.9 mg/l in August. There is no SWQMR classification for TN. TN concentration is significantly negatively correlated with EC (r -0.226), DO (r -0.516), and significantly positively correlated with T (r 0.498), COD (r 0.451), $NO_3$-N (r 0.753), $NH_4$-N (r 0.345), TKN (r 0.980), $PO_4$-P (r 0.528), TP (r 0.407), and Chl-a (r 0.466). In this study it has been found all nitrogen forms were higher in summer and autumn. Nitrogen and phosphorus forms are assessed due to their limiting role in the primary production of the phytoplankton [19]. Primary production high in spring and summer, and agricultural activities in the region start same seasons, so the transport of nitrogen forms from agricultural areas into the lake increase at that time [1]. Also main sources of nitrogen forms in Uluabat Lake basin were domestic wastewater, agricultural activities and stockbreeding [20].

The mean $PO_4$-P concentration in Lake Uluabat was 38.88 µg/l, the lowest $PO_4$-P was 20.6 µg/l in February, and the highest $PO_4$-P was 74.4 µg/l in August. $PO_4$-P concentration is significantly negatively correlated with EC (r -0.336), DO (r -0.641), Alkalinity (r -0.349), and significantly positively correlated with T (r 0.419), COD (r 0.487), $NO_3$-N (r 0.472), $NH_4$-N (r 0.343), TKN (r 0.520), TN (r 0.528), TP (r 0.760), and Chl-a (r 0.360). The mean TP concentration in Lake Uluabat was 61.87 µg/l, the lowest TP was 38.7 µg/l in February, and the highest TP was 131.7 µg/l in August. In terms of TP concentration, the Lake is in class 2, according to SWQMR. TP concentration is significantly negatively correlated with EC (r -0.522), DO (r -0.763), Alkalinity (r -0.228), and significantly positively correlated with T (r 0.623), COD (r 0.465), $NO_3$-N (r 0.461), $NH_4$-N (r 0.261), TKN (r 0.387), TN (r 0.407), $PO_4$-P (r 0.760), and Chl-a (r 0.246). Phosphorus is the most significant factor limiting for the primary production [1]. The highest $PO_4$-P concentrations were generally measured in summer, and this could be related to the lower water level in the lake during this period. Levels of microbial activity rise at high temperatures, so the release of phosphorus from sediment is quite dependent on temperature. The activity of the macrophytes found over much of the bottom of the Lake increase in summer, which in turn increases the amount of phosphorus released from the sediment. Macrophytes do not actually release phosphorus, but they lead to an increase in the release of phosphorus from the sediment by decreasing the DO through respiration or by increasing the pH of the water by photosynthesis [21, 22]. The mean Chl-a concentration in Lake Uluabat was 5.75 µg/l, the lowest Chl-a was 0.14 µg/l in April, and the highest Chl-a was 16.07 µg/l in August. There is no SWQMR classification for this parameter. Chl-a concentration is significantly negatively correlated with DO (r -0.454), and significantly positively correlated with T (r 0.317), COD (r 0.565), $NO_3$-N (r 0.382), $NH_4$-N (r 0.304), TKN (r 0.463), TN (r 0.466), $PO_4$-P (r 0.360), and TP (r 0.246). Chl-a concentrations are useful for evaluating the concentrations of phytoplankton biomass [4]. In summer, temperature increase also photosynthesis increase, algae reproduce in the Lake and the concentration level of Chl-a increase [23]. In this study, results show that high levels of Chl-a concentrations in spring and summer, when the temperature is high. As shown in Table 3, the coefficients of variation (CVs) for the pH, EC, DO, Alkalinity, $NO_3$-N, $NH_4$-N were 1.92-10.37 %, and the CVs for T, TKN, TN, $PO_4$-P, TP were 22.7-39.68 %, while COD (57.8 %) and Chl-a (77.9 %) varied considerably.

**Water Quality of MKP Brook**

MKP Brook is the major flowing into Lake Uluabat. The Brook has got the drainage area of 10414 $km^2$ [1]. Water quality of this brook was determined during sampling period. Flow measurement of the Brook was obtained from the Regional Directorate of State Hydraulic Works (DSI). Annual average flow rate value of the Brook was determined to be 6.99 $m^3/s$ in sampling period. The highest flow was measured in October (11.1 $m^3/s$), the lowest in July (1.84 $m^3/s$).

MKP Brook carries significant amount of suspended solids to lake [1]. In a study of Aksoy and Özsoy in 1998, it is observed that surface area and volume of the lake decreased to a ratio of 12% between the years of 1984, 1993, and 1998. This was caused by the lignite plants and the sand pits around the lake [24]. In addition there are many residential areas around the Brook. Some of these areas are discharge wastewater to MKP Brook, and finally to Lake Uluabat [1,11]. Figure 3 has shown the daily average flow of MKP Brook, and Table 5 has shown water quality and loads of some water quality parameters of the Brook. The loads were calculated using data from analyses and flow data from DSI.

As shown in Table 5, the Brook was carried excessive amount of COD, TKN, and TN (tone/month) into the Lake. Also, it was carried phosphorus forms, and nitrogen forms into the Lake.

**Table 3.** Some statistic values of the water quality parameters in Lake Uluabat

| Parameters | N | Mean | Median | SD | CV (%) | Maximum | Minimum |
|---|---|---|---|---|---|---|---|
| T ($^0$C) | 12 | 16.31 | 15.3 | 6.37 | 39.05 | 26.4 | 5.8 |
| pH | 12 | 8.54 | 8.5 | 0.17 | 1.99 | 9.1 | 8.1 |
| EC (µs/cm) | 12 | 628.4 | 627.5 | 37.92 | 6.03 | 766 | 530 |
| DO (mg/l) | 12 | 10.12 | 10.1 | 1.05 | 10.37 | 12.3 | 7.3 |
| Alk. (mg /l) | 12 | 238.4 | 238 | 17.01 | 7.13 | 257 | 193 |
| COD (mg/l) | 12 | 71.95 | 64 | 41.59 | 57.80 | 192 | 16 |
| $NO_3$-N (mg/l) | 12 | 1.00 | 0 | 1.92 | 1.92 | 9.8 | 0 |
| $NH_4$-N (mg/l) | 12 | 0.32 | 0 | 0.79 | 2.46 | 6.3 | 0 |
| TKN (mg/l) | 12 | 13.48 | 12.6 | 3.06 | 22.70 | 23.1 | 8.4 |
| TN (mg/l) | 12 | 14.48 | 13.3 | 4.58 | 31.63 | 32.9 | 8.4 |
| $PO_4$-P (µg/l) | 12 | 38.88 | 34.5 | 15.43 | 39.68 | 74.4 | 20.6 |
| TP (µg/l) | 12 | 61.87 | 60.4 | 15.22 | 24.59 | 131.7 | 38.7 |
| Chl-a (µg/l) | 12 | 5.75 | 3.9 | 4.48 | 77.90 | 16.07 | 0.14 |

*N* number of samples, *SD* standard deviation, *CV* coefficient of variation

**Table 4.** Correlation matrix between water quality parameters

| Pearson's rho | T | pH | EC | DO | Alk. | COD | $NO_3$-N | $NH_4$-N | TKN | TN | $PO_4$-P | TP | Chl-a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T | 1.000 | | | | | | | | | | | | |
| pH | -0.140 | 1.000 | | | | | | | | | | | |
| EC | **-0.475** | 0.098 | 1.000 | | | | | | | | | | |
| DO | **-0.796** | 0.050 | **0.380** | 1.000 | | | | | | | | | |
| Alk. | 0.107 | **-0.359** | **0.253** | 0.094 | 1.000 | | | | | | | | |
| COD | **0.429** | -0.046 | -0.094 | **-0.609** | 0.054 | 1.000 | | | | | | | |
| $NO_3$-N | **0.565** | 0.030 | **-0.231** | **-0.560** | -0.045 | **0.400** | 1.000 | | | | | | |
| $NH_4$-N | **0.259** | 0.069 | 0.114 | **-0.357** | -0.127 | **0.366** | **0.225** | 1.000 | | | | | |
| TKN | **0.466** | 0.061 | **-0.224** | **-0.492** | -0.093 | **0.440** | **0.639** | **0.359** | 1.000 | | | | |
| TN | **0.498** | 0.047 | **-0.226** | **-0.516** | -0.081 | **0.451** | **0.753** | **0.345** | **0.980** | 1.000 | | | |
| $PO_4$-P | **0.419** | 0.026 | **-0.336** | **-0.641** | **-0.349** | **0.487** | **0.472** | **0.343** | **0.520** | **0.528** | 1.000 | | |
| TP | **0.623** | 0.010 | **-0.522** | **-0.763** | **-0.228** | **0.465** | **0.461** | **0.261** | **0.387** | **0.407** | **0.760** | 1.000 | |
| Chl-a | **0.317** | 0.071 | 0.179 | **-0.454** | 0.138 | **0.565** | **0.382** | **0.304** | **0.463** | **0.466** | **0.360** | **0.246** | 1.000 |

In bold, correlation significant at the $p<0.05$ level (two tailed), all cells show the correlation coefficient (r)

**Table 5.** Water quality and loads of some water quality parameters in MKP Brook

| Parameters | Mean±SD | Load (t/month) |
|---|---|---|
| Flow Rate ($m^3/s$) | 6.99±2.89 | |
| T ($^0C$) | 17.2±5.9 | |
| pH | 8.22±0.21 | |
| EC (µs/cm) | 729.5±94.6 | |
| DO(mg/l) | 10.3±1 | |
| Alkalinite (mg/l) | 292±21 | |
| COD (mg/l) | 90.3±73.6 | 1636.06 |
| $NO_3$-N (mg/l) | 1.17±1.94 | 21.19 |
| $NH_4$-N (mg/l) | 1.11±1.45 | 19.93 |
| TKN (mg/l) | 15.63±5.8 | 283.18 |
| TN (mg/l) | 16.8±6.95 | 304.38 |
| $PO_4$-P (µg/l) | 61.5±10.9 | 1.11 |
| TP (µg/l) | 81.86±12.91 | 1.48 |
| Chl-a (µg/$m^3$) | 3.39±2.28 | |

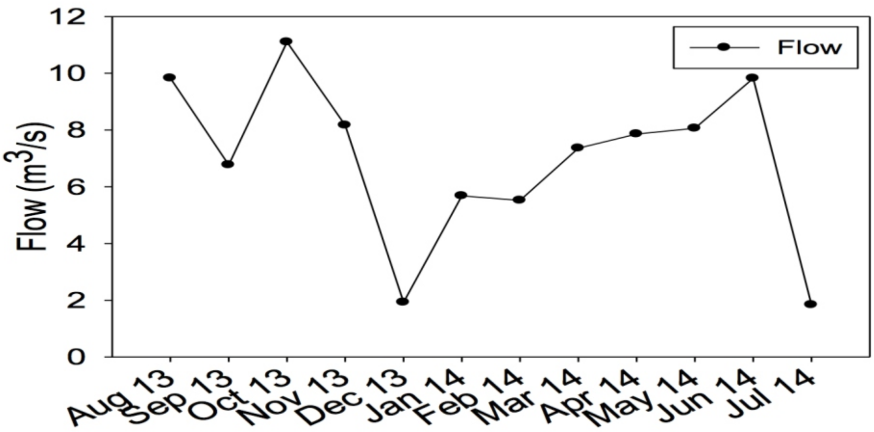



**Figure 3.** Daily average flow of MKP Brook

**Trophic State of Lake Uluabat**

The relationship between biotic and abiotic factors, the determination of the trophic level is important in lakes [25]. Point and non-point sources within the watershed area of lakes contribute to high nutrient concentrations. Algal growth in nearly all eutrophic lakes is limited by the concentration of phosphorus rather than nitrogen [26, 27]. Trophic state indices are effective methods in determining the trophic states of the lakes. Various classification criteria have been considered in order to assess the trophic condition and water quality of coastal ecosystems and freshwater lakes through the use of specific indices based on environmental factors [28]. Trophic state of the Lake Uluabat has been determined in accordance with Carlson (1977)[29]. TSI value is calculated by using the chlorophyll-a (µg/l), total phosphorus (µg/l) and total nitrogen (mg/l) concentrations. In the numeric scale which is created in accordance with the TSI formulas based on Carlson (1977), 0-40 is oligotrophic; 40-50 is mesotrophic, 50 and above is eutrophic. The oligomesotrophic level (30<TSI<40), passage from the mesotrophic level to the eutrophic level (40<TSI<60), passage from the eutrophic to the hypereutrophic level (60<TSI<70) and the hypereutrophic levels (TSI>70) have been determined in order to determine the interim passages [31]. Monthly trophic state indices for TN, TP, Chl-a were presented in Figure 4.

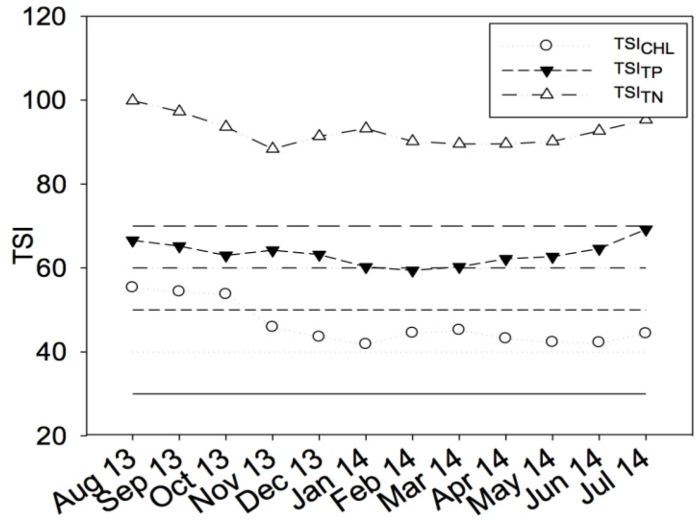



**Figure 4**. Monthly trophic state indices (TSIs) for Lake Uluabat (the threshold values for the oligomesotrophic (30), mesotrophic (40), eutrophic (50), eutrophic to hypereutrophic (60), and hypereutrophic (70) states)

As shown in Figure 4, the $TSI_{TN}$ values show hypereutrophic levels, $TSI_{TP}$ values lay between eutrophic to hypereutrophic, and hypereutrophic levels. $TSI_{Chl-a}$ values lay between eutrophic and eutrophic to hypereutrophic levels. The trophic levels of lakes determine their intended use. The excessive nutrient increases, which stem from the canalization of waste waters where animal and human excrements are discharged, not only causes the increase in algae, but also the bacteria that are hazardous for health. When this is taken into consideration, Lake Uluabat has exceeded the limit values for drinking water and recreation oriented use [8]. Nitrogen could be very effective to algae growth as the consequence of discharging the domestic waste water to fresh water. Untreated domestic waste waters and chemical fertilizers from agricultural lands in the Lake Uluabat basin precipitate into the Lake. Therefore, there is a large amount of nitrogen input to the lake [30]. It was determined that Lake Uluabat has become useless for drinking water and other recreational uses since all of Lake Uluabat has reached the hypereutrophic level and that the increase in phosphorus and nitrogen caused the eutrophication in the lake.

## CONCLUSIONS

Lake Uluabat was designated by the Ministry of Environment as a RAMSAR site in 1998 and also it was chosen as a partner of International Living Lakes Network in 2000. The Lake, which is a member of this network, has worldwide significance. It provides a habitat for a wide variety of fauna and flora, making it a very important part of the ecosystem. The results of the study clearly demonstrate that the concentrations of water quality parameters undergo temporal changes. This situation was also tested by ANOVA test. According to the SWQMR, the lake should be classified as highly polluted water, and in general, at the eutrophic to hypereutrophic level according to its TSI values. There should be more effort to protect the lake from pollution. In order to prevent pollution problem in the lake, we must keep waste water loads under control. The temporal variation in the concentration of nitrogen and phosphorus was largely due to changes in land and water management practices within the lake basin as well as changes in the treatment of wastewater discharges. According to all findings we emphasize that the trophic status of Lake Uluabat is endangering the lake balance, which is going to be disturbed, and some measures must be taken to prevent these circumstances. As a result, the long term monitoring and control of domestic and industrial wastewaters, restricted uses of agricultural pesticides and fertilizers are the important factors have to be taken into consideration in lake management.

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# THE USE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN AGRICULTURAL RISK MANAGEMENT BY THE AGRICULTURAL EXTENSION SERVICES IN MALAYSIA

**Muhammad Ali**[1,*] **Norsida Man**[1] **Ismail Abd Latif**[2]

**Farrah Melissa Muharam**[1] **Siti Zobidah Omar**[3]

[1]Universiti Putra Malaysia, Faculty of Agriculture, Department of Agriculture Technology, Serdang, Malaysia
[2]Universiti Putra Malaysia, Faculty of Agriculture, Department of Agribusiness and Bioresource Economics, Serdang, Malaysia
[3]Universiti Putra Malaysia, Faculty of Modern Languages and Communication, Department of Communication, Serdang, Malaysia

[*]Corresponding Author: aliupm115@gmail.com

## ABSTRACT

The study was aimed to determine the existing status of extension services provided for agricultural risk management in making use of Information and Communication Technologies (ICTs). There were 360 farmers selected through multistage cluster sampling technique and data were collected from four areas of Malaysia. The results reveal that farmers could get limited information from extension staff on the use of ICTs for disaster information. Moreover, most of the farmers still could not get support from extension staff to integrate ICTs for agricultural risk management. Farmers highlighted that extension staff need training to improve their capacity. Therefore, public and private sector should initiate various training programs firstly for the extension field staff and then diffuse various management skills and techniques into farmer fields for better agricultural risk management using ICTs.

**Keywords:** Agricultural extension, Agricultural risk management, ICTs, Malaysia

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## INTRODUCTION

Climate change is one of the serious challenges to agricultural extension services that affect farms and farmers in various dimensions. According to Mulder [1], impacts of climate changes should not be ignored for sustainable development. However, the extension service providers are not yet fully sensitized and equipped with techniques to help farmers in managing agricultural risks through immediate and low cost solutions. In Malaysia, extension services are offered by public (Department of Agriculture) and private sector. The extension wing of public and private sectors is responsible to disseminate useful information and agricultural technologies among farmers through field level staff. However, extension services are mostly focused on just traditional style of agricultural technology transfer but less attention has been paid on using ICTs for agricultural risk management. As day by day farmers have to face different problems dissimilar to the past so, there is a need to opt digital options for quick solutions and making this sector sustainable. Extension service providers can motivate the farming community to use available digital options for minimizing the risks associated with agricultural sector. These risks can be related with production, price, market, technology, legal, health, and personal [2]. Risk in agricultural sector is related to various factors which leave negative impacts originated from different variables like natural, biological, climatic and input and output prices [3, 4, 5].

Similarly, Wossen et al. [6] highlighted that adoption of technologies were not only alleviating poverty but also increasing income and productivity of farmers. That is why, adoption of technologies would ultimately trigger economic growth along with wide marketing opportunities, reducing poverty at large [6] and making agriculture more sustainable [7].

According to Baharuddin [8], apart from blessed natural landscape with numerous resources in Malaysia, natural disasters such as floods, droughts and land sliding are causing adverse effects on the agricultural sector. In Malaysia, the flood prone area is nearly 9% of the total land area (2.97 million ha). In fact, agricultural sector needs more attention of public, private, NGOs and development sector as more problems are emerging with the passage of time. In this regard, extension as a central player has to accelerate the pace for addressing issues for the farmers and with the farmers. Baig and Aldosari [9] also mentioned that in Asian countries, there is a need to reconsider extension system in the present scenario as there are many challenges emerging.

In this era of digital technologies, not only extension personnel but also farmers are naturally getting interest and attention to use ICTs in the agricultural sector. It is due to the fact that they are already using ICTs for social interaction in various forms. However, farmers are not well informed and equipped with the benefits hidden in the ICTs which can be harnessed for keeping them informed about weather forecasts, agricultural best practices, innovations in agricultural sector and many more. Indeed, various ICTs are getting attention of various development sectors in various states of Malaysia as these are convenient, speedy and resourceful. However, digital based agricultural sector is less focused due to lack of awareness and knowledge about its potential role in the management of agricultural risks. Baig and Aldosari [9] along with other authors [10, 11, 12] have pointed out that existing extension methods (traditional) like individual, group and mass contact methods need to be grafted with ICTs for making the information available to all players in an efficient, quick and effective manner [11]. Ultimately, it would give boost to the traditional extension system. Tata and McNamara [13] conducted study in Kenya and emphasized that there is a need to incorporate ICTs in agricultural extension system through government level investments. Importantly, failure to graft ICTs in agricultural extension could lead to underperformance of digital technologies for better extension service delivery particularly in agricultural risk management and generally in agriculture.

More importantly, it is not just attitude, motivation, behavioural intention and behaviour of farmers and extension staff but also their capacity and competency in both agricultural risk management and ICT usage and well equipped institutions to support ICTs for timely risk management from the perspective of present and future. Indeed, agricultural sector has become more risky due to climate changes and extension agents are supposed to help farming community to use ICTs for agricultural risk management. That is why this study was planned to assess the existing situation of extension services at different states of Malaysia. The study would be helpful in understanding the role being played by extension service providers in the study area. The result would also be useful for policy makers, extension professionals and farmers to realize the importance of extension services and ICTs in agricultural risk management.

## METHODOLOGY

The research was conducted in four areas of Malaysia affected by disasters or perceived to be prone to natural catastrophes. Multi stage cluster sampling method was used. In this regard, three clusters namely East, South and North zones were chosen on account of geographical locations which were reflecting the three states. Then, areas such as Pahang, Terengganu (East), Johor (South), Kedah (North) were randomly selected from the three states. Lastly, the lists of farmers were obtained to randomly select sample size from each area. Thus, 90 farmers were chosen by using simple random technique that was representing areas of four state districts as mentioned in the Map of Malaysia (Figure 1). The selection criteria of respondents' selection were natural disaster experience. So, the total sample size was 360 farmers. Study data were collected using structured questionnaire forms completed by local enumerators during face to face farmer interviews. Descriptive method of Statistics was used to analyze the data. The results were generated by using Statistical Package for Social Sciences (SPSS version 21).

## RESULTS AND DISCUSSION

### Sources of Information on Weather Forecast

Information acts like power and also empowers the farmers which can ultimately help in action and reaction (decision).


**Figure 1.** Study area location.

According to Demiryurek [14], one of the important factors in agriculture is information which helps the farmer in better management of agriculture and facilitate in better decision making when provided by extension service, research, academia and other agricultural organizations. It makes the farmer more knowledgeable that inhibits making wrong decisions. Mittal and Mehar [15] conducted a survey in Indo-Gangetic plains of India to assess the agricultural information networks and needs of farmers along with risk management strategies and found that farmers had multiple sources of information and did not rely on single source, on the basis of information accessibility, precision and trustworthiness.

Farmers use single or various sources regarding weather forecasts for appropriate management of agricultural risks. In this regard, farmers were asked about different sources of information (more than one) and the results of empirical research in Table 1 depict that television and fellow farmers were the main sources of information as revealed by 79.4% and 61% of the farmers. The results are consistent with Ngathou et al. [16] who conducted research in North Alabama to explore sources of information by limited resource farmers and found that information received by face to face contact and through television programs are most useful methods. Almost 40% of farmers said opinion leaders are their main source of information. Similarly, radio and newspapers were also sources of information as reported by 37.2% and 35.3% of the farmers. Almost similar percentage of farmers highlighted Department of Meteorology and Department of Agriculture as their information pool pertaining to weather updates. Regardless to these sources, self-judgment was perceived effective by more than slightly half of the research population. Moreover, state authority was least significant as a source of weather information as only 2.2% farmers were able to obtain relevant information. There were only five farmers who said that they did not have any information at all. Whereas, only 1.9% of the farmers disclosed that they had other sources of information like trade dealers and relatives etc.

It is clear from Table 1 that television, fellow farmers and self-judgment were better sources of weather information for the management of agricultural risks in the eyes of farming community in the research area. The links with fellow farmers in terms of agricultural sector development can never be ignored as these links facilitate farmer to farmer interaction and mirror the snowball effect. This effect ensures that most of the farmers access each other and get informed about any update because inter communication is supposed to be good and cheap solution for majority of the farmers.

It was observed from the research area that most of the farmers waste their precious time to gather the information, judging the credibility, reliability and matching with own needs which some time lead to delay in the decision and final action. Moreover, type and nature of risk, time, technology, information source (s) and decision making ability could be important factors for the farmers. So, rapid digital technologies (ICTs) and extension service providers either public or private might help the farmers in taking the decision. Similarly, farmers can also confirm the consequences of their decision through discussion with extension experts and also results of other farmers through ICTs.

**Frequency of Visits by Agriculture Extension Staff**

Extension workers in their mandate areas play a vital role in the agricultural development. They contact farmers face to face or indirectly help them select the best fit actions to address their challenges. In this regard, their frequency of contact may differ from country to country and even area to area within the same country. FAO [17] highlighted that extension officers are important frontline workers as they visit the farmers for the establishment of extension-farmer tie-ups, motivation, and detections of problems. Extension programs organized by extension field staff also transform rural areas for ultimate development. Aonngernthayakorn and Pongquan [18] pointed out that extension programs were one of the agricultural information sources of the paddy farmers in central Thailand.

Table 2 displays, the frequencies of extension staff's farmer visits. It is obvious from the table that most of the farmers were visited on annual and biannual basis. Again, one of the most striking results is that an important proportion of the farmers have never been visited (23.9%). This finding is in harmony with Phetsamone [19] who reported that 26% of the surveyed farmers did not have access to extension services in Laos.

**Contributions by Extension Workers**

Farming community needs help by the extension experts most of the time in agricultural sector. They not only inform farmers to adopt new technologies but also contribute to convey new ideas into their existing agricultural practices. Davis et al. [20] pointed that there was a need to change the existing traditional role of extension into new dimensions of support services which must help in variety of emerging challenges like malnutrition, risk and disaster preparation, adaptation to climate variations and resilience of farmers. In this regard, farmers were asked the supports or contributions given by extension staff in integrating ICTs into the agricultural risk management. The results were presented in Table 3.

The results disclosed that farmers had mixed feelings on the supports by extension workers. It may be due to the fact that extension staff is not well equipped and trained in drawing the attention of farmers. So, if extension staff is already trained then these digital innovations in the agricultural risk management would be easy. Lastly, Extension officers have to be fully supportive particularly in the areas where farmers are more prone to natural catastrophes.

**Information about Use of ICTs from Officers**

Farmers try to receive as much as information especially in the risk management field and their areas. Indeed, it is a common perception that extension staff is well trained and better informed in the variety of issues in agricultural sector. Farmers were asked about information they have received (more than one answer) from agriculture extension staff about various uses of ICTs in the management of agricultural risks. The empirical results given in Table 4, demonstrate that 33.3% of the farmers responded that they received information about use of ICTs for disaster prevention. While, 27.2% of the farmers said that extension officers informed them about use of ICTs for well preparation in case of any disaster occurrence. Moreover, 22.2% of farmers acknowledged that extension specialists facilitated the farmers in the ICT usage for pre and post recovery. In addition, there were 23.1% farmers who replied that extension workers brought into their notice about use of digital means for knowing about market price condition during disasters. There were 38.6% of the farmers who highlighted any other as information given by extension personnel like pest and diseases, health related issues, destruction of physical infrastructure, food shortage, shifting to secure places, public and private services for disaster victims, relocation of livestock, volunteers, emergency medical services and government polices etc.

Therefore, it can be gathered that farmers receive variety of information from extension field staff before, during and post disasters for agricultural risk management by the use of ICTs. However, still there are many farmers who remained uninformed about sudden natural disasters which might lead them towards losing interest in the agricultural sector. Thus, if all the farmers are well informed and prepared in advance to tackle any natural disaster by the help of ICTs then risk management in agriculture can also be ensured to some extent. Efforts of extension field staff are being desperately needed in this regard.

**Extension Staff Knowledge**

The intensity of risk may be even higher when service providers either do not help farmers at

In this regard, farmers were asked to assess extension staffs' knowledge capacity on agricultural risk management by using ICTs. So, the results demonstrate that (as displayed in Table 5) more than 62% of farmers believed that extension staff's knowledge capacity on the use of ICTs is low and needs improvement. As a matter of fact, when extension staff is experienced, well equipped with up-to-date knowledge, they can be beneficial to farmers and satisfying their needs. Another point to remember is the possibility that extension staff with a continuous or frequent contact might be ranked as good or very good by the respondents.

**Table 1.** Sources of information on weather forecast.

| Sources | Frequency (*) | Percentage |
|---|---|---|
| Television | 286 | 79.4 |
| Fellow farmers | 220 | 61.1 |
| Self-judgment | 187 | 51.9 |
| Opinion leaders | 146 | 40.6 |
| Radio | 134 | 37.2 |
| Newspapers | 127 | 35.3 |
| Department of Meteorology | 39 | 10.8 |
| Department of Agriculture | 38 | 10.6 |
| Department of Veterinary Sciences | 15 | 4.2 |
| State authority | 08 | 2.2 |
| Telecommunication Company | 07 | 1.9 |
| Department of Fisheries | 05 | 1.4 |
| No information | 05 | 1.4 |
| Any other | 07 | 1.9 |

(*) Respondents gave more than one answer

**Table 2.** Frequency of agriculture extension staff visits.

| Frequency of visits | Frequency | Percentage |
|---|---|---|
| Weekly | 14 | 3.9 |
| Fortnightly | 11 | 3.1 |
| Monthly | 38 | 10.6 |
| Bi annually | 103 | 28.6 |
| Annually | 108 | 30.9 |
| Never | 86 | 23.9 |
| **Total** | **360** | **100.0** |

**Table 3.** Contributions by extension workers.

| Support | Frequency | Percentage |
|---|---|---|
| No support | 81 | 22.5 |
| Minimal support | 68 | 18.9 |
| Some support | 43 | 11.9 |
| Adequate support | 130 | 36.1 |
| Very supportive | 38 | 10.6 |
| **Total** | **360** | **100.0** |

**Table 4.** Information about use of ICTs from officers.

| Purpose of using ICTs | Frequency (*) | Percentage |
|---|---|---|
| Market prices | 83 | 23.1 |
| Disasters information | 120 | 33.3 |
| Relocation in case of emergency | 55 | 15.3 |
| Well preparedness for any possible disaster | 98 | 27.2 |
| Pre and post recovery | 80 | 22.2 |
| Others | 139 | 38.6 |

(*) Respondents gave more than one answer

**Table 5.** Extension staff knowledge.

| Extension Staff Knowledge | Frequency | Percentage |
|---|---|---|
| Very Poor | 139 | 38.6 |
| Poor | 41 | 11.4 |
| Fair | 44 | 12.2 |
| Good | 97 | 26.9 |
| Very Good | 39 | 10.8 |
| **Total** | **360** | **100.0** |

## CONCLUSION AND RECOMMENDATIONS

It can be concluded that the primary sources of weather forecast were T V and fellow farmers as agricultural extension services in the research area were not satisfying. It was due to less frequent farmer and the inadequate supports by extension field. Although, farmers have been receiving information on the use of ICTs from extension agents exclusively for disasters through ICTs, extension agents need building their knowledge capacities on agricultural risk management. Frequent visits, skills and knowledge up-gradation through training programs on regular basis, farmer friendly support and policy measures and decisions particularly at the time of disasters and help for resource-poor small farmers are required in general but especially in disaster prone areas in Malaysia.

In order to reach majority of disaster prone farmers, extension service providers need to be fully aware, equipped and empowered themselves in all aspects so that they can easily help the farmers required. Additionally, there is a need to allocate more funds, develop methods to integrate ICTs and involve all stakeholders for proper agricultural risk management. Lastly, extension service providers' role and duties should be redefined.

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