MARCH
2019

INTERNATIONAL JOURNAL OF AGRICULTURE, ENVIRONMENT AND FOOD SCIENCES

YEAR : 2019
VOLUME : 3
ISSUE : 1

www.jaefs.com
dergipark.gov.tr/jaefs
editor@jaefs.com

e-ISSN : 2618-5946

JAEFS

JAEFS

International Journal of Agriculture, Environment and Food Sciences

Int J Agric Environ Food Sci

e-ISSN : 2618-5946
DOI: 10.31015/jaefs

www.jaefs.com

March

Volume : 3 Issue : 1 Year : 2019

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

Production Information

Journal Name	International Journal of Agriculture, Environment and Food Sciences
Abbreviation	Int J Agric Environ Food Sci
Subjects	Agriculture, Environment and Food Sciences
e-ISSN	2618-5946
Publisher	Gultekin Ozdemir
Owner	Gultekin Ozdemir
Language	English
Frequency	Quarterly (March, June, September, December)
Type of Publication	International, Scientific, Open Access Double-blinded peer review Widely distributed periodical
Manuscript Submission and Tracking System	JAEFS uses the submission system of TUBITAK-ULAKBIM JournalPark Open Journal Systems - http://dergipark.gov.tr/jaefs
License	Journal is licensed under a Creative Commons Attribution 4.0 International License
Legal Responsibility	Authors are responsible for content of articles that were published in Journal.
Indexed and Abstracted in	Crossref, Directory of Open Access Journal (DOAJ), Google Scholar, Scilit, ROAD (Directory of Open Access Scholarly Resources), Neliti, International Citation Index, ROOT Indexing, ResearchBib, Index Copernicus International, ESJI, JournalTOCs, TEELS, ResearchGate, Microsoft Academic
Address	International Journal of Agriculture, Environment and Food Sciences Gultekin Ozdemir Dicle University Faculty of Agriculture Department of Horticulture, 21280 Diyarbakir / TURKEY
Contact	Phone: +90 532 545 07 20 E-mail: editor@jaefs.com jaefseditor@gmail.com Web : www.jaefs.com dergipark.gov.tr/jaefs

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

Aim and Scope

"International Journal of Agriculture, Environment and Food Sciences" (JAEFS) is an international journal, which publishes original research and review articles dealing with Agriculture, Environment and Food Sciences.
JAEFS Journal is an international, scientific, open access periodical published in accordance with independent, unbiased, and double-blinded peer-review principles.
Journal publishes Quarterly (March, June, September, December).
The publication language of the journal is English and continues publication since December 2017.
A Digital Object Identifier (DOI) number has been assigned for each article accepted to be published in JAEFS, starting from December 2017.
Journal of JAEFS welcomes article submissions and does not charge any article submission or processing charges.

International Journal of Agriculture, Environment and Food Sciences areas of interest include, but are not limited to: Agricultural Engineering and Technology, Environmental Engineering and Technology, Food Engineering and Technology, Agriculture, Environment, Food, Agriculture History, Agricultural Economics, Agronomy, Animal Sciences, Aquaculture, Biochemistry, Biotechnology, Bioinformatics and Data Science, Crop Science, Dairy Science, Extension Science and Education, Entomology, Environmental Science, Fish and Fisheries, Food Processing, Food Chemistry, Food Culture, Food Health and Nutrition, Food History, Food Industry Development, Food Marketing, Food Policy and Practices, Food Safety, Forestry, Horticulture, Information Technologies and Systems, Irrigation, Molecular Biology, Organic Agriculture, Plant Physiology, Plant Breeding, Plant Protection, Plant Sciences, Precision Agriculture, Rural Development and Policy, Sustainable Agriculture, Soil Science, Plant Nutrition, Energy Crops, Veterinary, Water Resources.

Open Access Statement

International Journal of Agriculture, Environment and Food Sciences (JAEFS) publishes fully open access journal, which means that all articles are available on the internet to all users immediately upon publication.
All the original articles and review papers published in JAEFS journal are free to access immediately from the date of publication.
International Journal of Agriculture, Environment and Food Sciences (JAEFS) don't charge any fees for any reader to download articles and reviews for their own scholarly use.
Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author. This is in accordance with the BOAI definition of open access.
Copyright of the layout and design of International Journal of Agriculture, Environment and Food Sciences articles remains with the journal and cannot be used in other publications.
International Journal of Agriculture, Environment and Food Sciences also operates under the Creative Commons Licence CC-BY-NC-ND.
All authors publishing with the JAEFS accept these as the terms of publication.
Benefits of open access for Authors include:
Free access for all users worldwide
Authors retain copyright to their work
Increased visibility and readership
Rapid publication
No spatial constraints

Copyright Policy

Authors who publish with International Journal of Agriculture, Environment and Food Sciences (JAEFS) agree to the following terms:

Authors transfer the copyright to International Journal of Agriculture, Environment and Food Sciences (JAEFS) . Authors, however, upon the publication of their work, can republish it in an another journal or book provided that they obtain the permission of the Journal. Moreover, they are to include the note indicating that their work has first been published in International Journal of Agriculture, Environment and Food Sciences (JAEFS) and the link to their work in the journal.
Authors, upon the publication of their work, can publish it in online environments and/or social networks (personal webpages, course content websites, Facebook, etc.). However, they also provide the link to the work as published in the journal.
"International Journal of Agriculture, Environment and Food Sciences" journal is licensed under a

Creative Commons Attribution 4.0 International License 

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946

www.jaefs.com

Int J Agric Environ Food Sci 3 (1) March 2019

DOI: 10.31015/jaefs

Contents

Research Articles

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.1 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):1-4 (2019)

Awareness of medical and aromatic plants in the western black sea region

Fatma Çiğdem Sakinoğlu Oruç[1,*] İlkay Ejder Erturan[2] Deniz Oruç[3] Sadık Hasan Oruç[4]

[1]Duzce University, Çilimli Vocational School, Plant and Animal Production Division, Duzce, Turkey
[2]Duzce University, Çilimli Vocational School, Accounting and Taxation Department, Duzce, Turkey
[3] Duzce University, Faculty of Health Sciences, Duzce, Turkey
[4]Guclu Huzelnut Company, Duzce, Turkey

[*]Corresponding Author: cigdemsakinoglu@duzce.edu.tr

Abstract

In our research, the level of awareness about medicinal and aromatic plants in different professions groups (farmers, civil servants, workers, retired, students and unemployed) and education levels were examined through direct interviews in Western Black Sea Region (Düzce, Sakarya, Zonguldak, Bartın). By using the Neyman method, 77 people were investigated, based on the Likert scale to measure awareness levels, and the results were evaluated by SPSS method.
As a result of our research, 24.7% of them prefer medicinal and aromatic plants when they are sick, while 81.8% think that medicinal and aromatic plants are organic. 66.2 %agree that organic certification is required for medicinal and aromatic plants. 63.6% of inadequate education is remarkable when the problems are expressed. At the rate of 5.2% is TV and 15.6% is for newspapers are used for information acquisition. According to the study, it was concluded that the level of awareness of the medicinal and aromatic plants in the Western Black Sea region is not sufficient, and starting from school programs, it is necessary to raise awareness of the public by means of non-formal education, magazines and courses besides TV and newspaper.

Keywords: Western Black Sea Region, Medicinal and aromatic plants, Awareness

Received: 16 May 2018 Accepted: 10 October 2018 Revised: 21 October 2018 Published: 10 January 2019

Introduction

All animals, plants and humans in nature are the product of a balance. In mythology, plants were treated as the most valuable gift given to humans by the Gods. All plants are in the service of human being and the relationship with plants has begun from the human existence. According to archaeological findings from the early ages, people were primarily benefited from plants to obtain nutrients and to address health problems (Koçyiğit, 2005.).

Throughout the history of humanity, many diseases (diabetes, hepatitis, shortness of breath, etc.) have been tried and tried to be treated using plants. The World Health Organization (WHO) reports that nearly 4 billion people around the world are trying to eliminate health problems with herbal drugs in the first place (80% of the world population). Furthermore, 25% of the prescriptions are plant originated (vimbilastin, reserpine, quinine, aspirin, etc.) in the developed countries (Farnsworth, et al, 1985). Especially after the 1990s, the presence of new areas of medicinal and aromatic plants, increase in demand for natural products; It increases the volume of use of these plants every day. Today, the medical plants market is estimated to have an annual figure of about 60 billion dollars (Kumar, 2009).

The interest and demand for organic production plants and drugs is increasing every day. According to the five-year data, which covers the 2003-2007 years in Turkey, the organic production area is 147,589 ha and the production area of the medicinal plants in this area is 1,977 ha. The share of medicinal plants in total area is 1.3%. The average organic product production quantity for the same period in terms of production quantities is 308,014 tons. In total production, the production of medicinal and aromatic plants is 12,928 tons and its share is 4.5% (Bayram, et al, 2010).

The western Black Sea region continues from the west of the Kızılırmak Delta to the Adapazarı Plains. Düzce, Sakarya, Zonguldak and Bartın are among the provinces of the Western Black Sea region. The first striking feature of the region is that it is a mountainous region. The mountains in this area are more or less parallel to the shore and are in a row separated from each other by pit areas. The second feature of the region is that it is open to sea effects. For this reason, the region is rainy in every season and the temperature difference between seasons is very low. A lush vegetation is observed in general (Genç, 2001). However, hazelnut, corn, wheat, bean cultivation stems from the structural characteristics of the region and family continuity, while hazelnut ranks first among these plants. The most prominent agricultural product is hazelnut in the provinces of Düzce and its neighboring provinces Sakarya, Kocaeli, Bolu, Zonguldak, Bartın and Kastamonu. Hazelnut farming is carried out in the land of around 300,000 decares in this

Cite this article as:
Oruc, F.C.S., Erturan, I.E., Oruc, D., Oruc, S.H. (2019). Awareness of medical and aromatic plants in the western black sea region. Int. J. Agric. Environ. Food Sci., 3(1): 1-4. DOI: https://doi.org/10.31015/jaefs.2019.1.1
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 1-4
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

 DOI: https://doi.org/10.31015/jaefs.2019.1.1

region and nearly 3 million farmers are living in hazelnut farming. With these figures, the region has a 40% share in Turkey hazelnut production area (Anonymous, 2011). Although the linden plant is not cultivated by being taken into the culture, it is consumed and traded by collecting from the plants in the garden of houses and forest areas.

At the point where the world is coming today, environmental awareness has ceased to be an ideal and has become a task for future generations. Mankind is mortgaging their next generation of lives at a great pace. For this reason, it is of great importance to educate people in order to gain correct behavior about the environment. Many problems are based on lack of education and insensitivity. Many problems related to the environment will be resolved, with the gain of environmental awareness to people (Kızılaslan, et al, 2005)

In addition to environmental awareness, the acquisition of farming awareness is of great importance. The acquisition of this awareness is intensified by the influence of visual and printed media. However, it was determined that the visual and printed media was rarely followed (40.2%) in the examined companies. 74.5% follow TV broadcasts, 14.9% follow brochures and 8.5% follow magazines among the Companies which are following visual and printed media.

We wanted to investigate the levels of awareness about the plants that the people of the region used or witnessed at different stages of their lives, except for the plants that they had traditionally cultivated. Considering the People's interest in medicinal and aromatic plants in developing Turkey, examining the potential in the region and measuring the interest and knowledge of the people of the region will shed light on us.

Material and Methods

In this study, we investigated the knowledge of the 77 people who live in the Western Black Sea Region (Düzce, Sakarya, Zonguldak and Bartın) on medicinal and aromatic plants by direct interview method. Using the Neyman method, 77 people were surveyed about whether medicinal and aromatic plants are recognized, their usage conditions, whether medicinal and aromatic plants are organic, whether organic certification is needed and where they receive the information about medicinal and aromatic plants, the Likert scale was based and the results were evaluated by SPSS method. In our study, 77 people from different professions (farmers, civil servants, workers, retired, students and unemployed), different education levels (literacy, primary education, secondary education, high school and university) and different income levels were included in the survey. The survey was conducted by experts and participants were provided with answers to all questions.

Results and Discussion

In our study, we tried to answer the question of whether medicinal and aromatic plants may be alternative to hazelnut with the survey conducted in 77 people on different age, profession, education and income levels living in the Western Black Sea region.

Table 1. Where you live?

	#	%
Düzce	28	36,4
Sakarya	24	31,2
Zonguldak	14	18,2
Bartın	11	14,3
Total	77	100

In our study, 36,4% of the 77 people live in Düzce, 31,2% in Sakarya, 18,2% in Zonguldak and 14,3% in Bartın (Table 1).

Table 2. Your age?

	#	%
26-35	3	3,9
36-45	9	11,7
46-55	20	26,0
56-65	32	41,6
66-75	13	16,9
Total	77	100

41,6% of respondents are 56-65 years, 26% of the age 46-56 years, 16,9% in 66-75 age group, 15,6% is under 45. The average age is 54 (Table 2).

Table 3. Your job/profession?

	#	%
Farmer	52	67,5
Civil Servant	3	3,9
Worker	1	1,3
Retired	21	27,3
Total	77	100

In our study, 67.5% of the respondents are farmers and 27.3% are retirees. In total, 5.2% of workers and civil servants were included in the survey. A large part of the pensioner retired from the agricultural sector. Civil servants and workers also help agricultural workers in their families (Table 3).

Table 4. Education?

	#	%
Literacy	3	3,9
Primary Education	57	74,0
Secondary Education	7	9,1
High School	8	10,4
University	2	2,6
Total	77	100

When we look at the educational status of the majority of the farmers who participated in our survey, we see that 74% of them are primary school graduates. Only 2.6% are university graduates. The level of Education remains relatively low (Table 4).

Table 5. Social Security?

	#	%
Social Security Authority (SSK)	24	31,2
Government Retirement Fund (Emekli Sandığı)	4	5,2
Social Security Authority for Self-Employed (Bağ-Kur)	38	49,4
Agricultural Insurance	10	13,0
Uninsured	1	1,3
Total	77	100

It was observed that 49.4% of the farm members were self-employed thru Bağ-Kur. Only 1 person out of 77 people is uninsured (Table 5).

Table 6. In Which Chamber Are You Registered?

	#	%
Chamber of Agriculture	73	94,8
Craftsman's Association	4	5,2
Total	77	100

94.8% of 77 people surveyed have registered in the agricultural chamber (Table 6).

Table 7. Which one do you use when you get sick?

	#	%
Medicinal Plants	5	6,5
Drugs	50	64,9
Both	20	26,0
None	2	2,6
Total	77	100

Although 81% of the people in the Western Black Sea region where we carry out our survey are primary and secondary school graduates, they still turn to the drugs recommended by the doctor when they get sick. 64.9% of respondents prefer to use drugs only when they are sick, while 6.5% prefer to use medicinal herbs only. 26 %of them use both drugs and medicinal plants. As an alternative to the use of drugs, they use medicinal plants which are consumed as tea (Table 7).

Table 8. Are Medicinal and Aromatic Plants Organic?

	#	%
Yes	63	81,8
No	14	18,2
Total	77	100

In our survey conducted on 77 people, when asked whether the medical and aromatic plants are organic or not, 81,8% of 77 people have been deemed to think that medical plants are organic without certification is questioned (Table 8).

Table 9. How Do You Get Information About Medicinal and Aromatic Plants?

	#	%
TV (Visual Media)	4	5,2
Farmers	8	10,4
Engineers	27	35,1
All	38	49,4
Total	77	100

The people who participated in the survey have a wide range of information. TV, farmers, engineers are very useful to the public in acquiring information. In our study, the level of utilization of visual and printed media was 5.2% while in other studies 75% still obtains information from the media (Table 9).

Coclusion

In our research conducted on 77 people with a 54-year-old average in Duzce, Sakarya, Zonguldak and Bartın from the Western Black Sea region, we tried to measure the awareness of the medicinal and aromatic plants that are used in Alternative Medicine and that have become a part of our lives. 96.1% are literate and 96.4% are farmers and retirees in group of 77 people. Only one person is insured. It seems that there is a high awareness of the future here. Almost all farmers are registered in the agricultural chamber. Their goal is to reach the right information from engineers and people who are interested in agriculture. Although the use of visual and printed media in accessing information across Turkey reaches 75%, only 5.2% of the participants in our survey prefer visual media. The rest of the people are trying to get information from engineers or farmers dealing with this issue.

Although traditional medicinal and aromatic plants are in our lives, only 6.5% are trying to benefit from medicinal plants when they get sick. 26% of them are using medicinal plants in addition to drugs. 64.9% of them use medication under doctor's control.

There is a group of 81.8% who believe that medicinal and aromatic plants are organic. However, information on whether or not there is organic document is unfortunately low enough to say no.

Those who participate in the survey in the Western Black Sea Region who have high literacy and want to secure their lives have a sympathy for medicinal and aromatic plants, but they do not have enough and accurate information. Apart from the visual and printed media, the efforts to obtain information from farmers working on this issue are causing inaccurate or incomplete information.

In our study in the western Black Sea region, awareness can be increased by organizing informative meetings on medicinal and aromatic plants and directing them to cultivation and production in the region. With more extensive studies, the level of awareness about medicinal and aromatic plants for the region, orientations, problems and solutions should be examined.

References

Anonymous, (2011). Turkey Statistical Institute Database. Access Date: 02.06.2011

Bayram, E., Kırıcı, S., Tansı, S., Yılmaz, G., Arabacı, O., Kızıl, S., Telci, Đ., (2010). Possibilities of Increasing Production of Medical and Aromatic Plants. Turkey Agricultural Engineering Technical Conference Proceedings Book-I, 437–456, 11– 15 Ocak, Ankara.

Farnsworth, N. R., Akerev, O. Bingel, A.S. (1985). The Bullettion of WHO., 63: 9865-9871.

Genç, Ö. (2001). Social and Economic Status of the Black Sea Region,. Development Bank of Turkey General Economic Research, January, Ankara.

Kızılaslan, H., Kızılaslan, N. (2005). Awareness Level and Behaviors of Rural People in Environmental Issues (Case of Artova District of Tokat Province), 1 (1): 67-69

Koçyiğit, M. (2005). An Ethnobotanical Research in Yalova, Graduate Thesis, Institute of Health Sciences, Istanbul University.

Kumar, S.A. (2009). Plants-based Medicines in India. http://pib.nic.in/feature/feyr2000/fmay2000/f240520006.html. Access Date: 06.06.2010.

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.2 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):5-8 (2019)

Determination of nutritive value and analysis of mineral elements for wild edible *Stachys lavandulifolia* vahl. var. *lavandulifolia* growing in eastern Anatolia

Murat Tuncturk[1] **Ruveyde Tuncturk**[1,*] **Unal Karik**[2] **Tamer Eryigit**[3]

[1]Van Yuzuncu Yıl University, Agricultural Faculty, Field Crops Department, Van, Turkey
[2]Aegean Agricultural Research Institute, İzmir, Turkey
[3]Van Yuzuncu Yıl University Gevas Vocational School, Department of Plant and Animal Production, Van, Turkey

[*]Corresponding Author: ruveydetuncturk@yyu.edu.tr

Abstract

The genus *Stachys* (Lamiaceae) is represented by about 300 species found in the world. Turkey is one of the richest countries in *Stachys* diversity being represented by 83 species with a level of 48% endemism. In this study, *Stachys lavandulifolia* Vahl. was collected from Alacabük mountain of Tatvan in Eastern Anatolia. *S. lavandulifolia* Vahl. subsp. *lavandulifolia*, known as "dağ çayı, tüylü çay", is widely consumed in Anatolia as herbal tea. *Stachys* species belong to one of the oldest medicinal plants that are used both for pharmaceutical purposes and in folk medicine; It is used for the treatment of gastrointestinal and respiratory disorders, and is known as an appetizer, carminative, stimulant, digestive, diuretic, and throat pain reliever. Wild plants gathered from nature are cheaper food and important for human health. Thus, in the present study, nutritional value and mineral composition of used parts of selected *S. lavandulifolia* Vahl. var. *lavandulifolia* was investigated.

In laboratory analysis, total ash, % N, crude protein, crude fiber and pH were examined as nutritional value. Useful minerals (Ca, Cu, Fe, K, Mg, Mn, Na, P, S and Zn) and some heavy metals (Cd, Co, Cr and Pb) that are hazardous elements for livings were also determined. The total ash, total nitrogen and crude protein, pH and crude fiber content of the plants were identified as 7.00%, 1.31%, 8.03%, 6.53% and 38.40%, and respectively. Mineral analysis showed that the wild plants samples contained considerably high amounts of potassium (17.46g/kg), phosphorus (4.70g/kg), calcium (17.25g/kg), magnesium (2.47g/kg), iron (241.37mg/kg), manganese (22.95mg/kg) and zinc (18.56mg/kg). This work contributed to the nutritional properties of some wild plants, and the results may be useful for the evaluation of dietary information.

Keywords: Nutrient content, Wild plant, *Stachys lavandulifolia,* Eastern Anatolia

Received: 22 May 2018 Accepted: 23 November 2018 Revised: 21 December 2018 Published: 10 January 2019

Introduction

The genus *Stachys* is one of the largest genera in the flowering plant family of Lamiaceae with about 300 species distributed in Europe, Asia, Africa, Australasia, and North America (Evans, 1989). This genus is mainly distributed in subtropical and tropical regions of both hemispheres. Stachys species have many pharmacological activities and they are known as "Deli adaçayı, dağ çayı or Tüylü çay" in Anatolia. *Stachys* species are widely used in folk medicine against skin infections, peptic ulcers, respiration and kidney disorders for their antibacterial, anticancer, anti-inflammatory, antipyretic, anti-anxiety, antioxidant and cytotoxic effects. Several studies have been reported that common secondary metabolites of the *Stachys* L. are iridoids, flovonoids, diterpenes and essential oils —(İşcan et al., 2015). Decoctions or infusions of *Stachys* are applied as tonics to treat skin or taken internally for stomach disorders. Many *Stachys* species are used in the preparation of food such as yoghurt or jelly to improve the taste and as flavours (Ferhat et al., 2017). *Stachys lavandulifolia* Vahl (Wood betony) is one of *stachys* genus members. Fresh and dried aerial parts of the plant, such as leaves and flowers are used as traditional medicine for humans (Moghanlou et al., 2018). *Stachys lavandulifolia* Vahl is an herbaceous wild plant native to Turkey which is traditionally used in Turkey folk medicine as tea for reducing anxiety and for treatment of stomach disease, against tumor, ulcer and anorexia (Sajjadi et al., 2017).

Various studies have been undertaken on the effects of micro and macronutrients in treatment human diseases. Some micronutrients, although required in minor quantities are essential for health of human. Zn, Fe, Cu, Cr, Mo, Se, Pb, Cd and Co are harmful only at high concentrations over than acceptable levels in the human body(Zeiner et al., 2015).

Until today, there are no reports about chemical composition of the *Stachys lavandulifolia* Vahl. var. *lavandulifolia* species. Therefore, the aim of this study was to determine the nutritional values and mineral compositions of *S. lavandulifolia* Vahl. var. *lavandulifolia* species which

Cite this article as:
Tuncturk, M., Tuncturk, R., Eryigit, T. (2019). Determination of nutritive value and analysis of mineral elements for wild edible *stachys lavandulifolia* vahl. var. *lavandulifolia* growing in eastern anatolia. Int. J. Agric. Environ. Food Sci., 3(1), 5-8. DOI: https://dx.doi.org/10.31015/jaefs.2019.1.2
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 5-8
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

 DOI: https://dx.doi.org/10.31015/jaefs.2019.1.2

grew as wild plants in the Van region of Eastern Anatolia, Turkey.

Material and Methods

Some chemical compositions of *Stachys lavandulifolia* Vahl. var. *lavandulifolia* which located in natural flora at around Van Lake in Eastern Anatolia Region, were determined. The plants were collected from natural flora in 2013 and botanical identifications were made by the Department of Biology, Science Faculty, Van Yuzuncu Yil University according to 'Flora of Turkey (Davis et al., 1988). Some information for *S. lavandulifolia* Vahl. var. *lavandulifolia* species are given in Table 1.

Plants were cleaned from foreign materials, separated to parts used and washed with deionized water, dried in room temperature, ground, packaged in plastic bags and kept in desiccators until analysis. Electric Muffle Furnace set at 550 ºC was used for determination of total ash content (inorganic matter). Kjeldahl apparatus and method were used to find the nitrogen content of the samples.

After total nitrogen content determination, crude protein contents were calculated by formulas

$$\%Nitrogen = \frac{(V1 - V2)xNx0.014}{m} x100 \rightarrow \%Protein = \%Nitrogen \times F$$

pH values were determined by pH-meter in the plant samples. Crude fiber analyses were accomplished by AOAC (Association of Analytical Chemists) method (AOAC, 2000). Mineral compositions of the samples were determined as follows; dried plant samples were ashed in a furnace by nitric (AR) and hydrochloric acid (AOAC). Afterwards, distilled water (50 ml) was added to samples in a volumetric flask. All the analyses were repeated three times and standard materials were used for chemical analyses. Atomic Absorption Spectrometry was used for determination of mineral contents. Phosphorus (P) was determined by molybdate-vanadate and sulphur (S) was observed according to the Mitchell (1992) method in conjugation with a UV-Visible spectrophotometer (Shimadzu UV-1201 V; Shimadzu, Kyoto, Japan). The average data obtained from chemical analyses have been shown in Table 2 with their standard deviations.

Tablo1. Some introductory information of *Stachys lavandulifolia* Vahl. var. *lavandulifolia* species

Plants' Scientific Name	Family	Local Name	Used Parts	Locality	Collection No
Stachys lavandulifolia Vahl. var. *lavandulifolia*	Lamiaceae	Hairy tea, mountain tea, crazy tea	Aerial parts (especially, leaves and flowers)	B9	F 12555

L: B9; Bitlis, Tatvan, the west slopes of Alacabük Mountain, Dağdibi village, 2004, 2250m

Results and Discussion

In this study, nutrient content of *Stachys lavandulifolia* Vahl. var. *lavandulifolia* species that are important for human health for the prevention and control of diseases, were investigated and some properties such as the values of total ash, total nitrogen, crude protein, pH and crude fiber contents are given in Table 2 and mineral compositions in Table 3. The values are given as mean ± SD.

The total ash, total nitrogen, crude protein, pH and crude fiber contents of *S. lavandulifolia* Vahl. var. *lavandulifolia* situated in Van flora were determined as 7.0%, 1.31%, 8.03%, 6.53 and 38.40%, respectively. In previous studies, total ash, total nitrogen, crude protein, pH and crude fiber content of some medicinal and edible plants were found in intervals of 6.43-8.54 % (Dias et al., 2013), 1.36-8.46 % (Maiti et al., 2016), 1.30-21.69 %, 5.41-7.44 % and 36.19-46.33 % (Tuncturk et al., 2017) respectively. We conclude from this study that obtained values are compatible with the previous scientific reports on medicinal and aromatic plants.

According to the results of the study; mineral elements such as Sodium (Na), magnesium (Mg), Potassium (K), Calcium (Ca), phosphorous (P) and sulphur (S) contents were determined as 0.34, 2.47, 17.46, 17.25, 4.70 and 0.45 g/kg from *S. lavandulifolia* Vahl. var. *lavandulifolia* species, respectively. Nutrition element concentration values of some medicinal plants obtained from previous studies were summarized for above minerals here: Na concentrations varied from 0.21 to 36.66 g/kg (Canbay and Zerrin, 2015); Mg values of medicinal and edible plants were found between 0.17 and 33.33 g/kg (Canbay and Zerrin, 2015; Maiti et al., 2016). K content changed between 5.47-163.35 g/kg (Maiti et al., 2016) in wild vegetables. Ca concentrations were found in a wide range from 3.37 to 21.89 g/kg (Canbay and Zerrin, 2015); P contents varied from 0.53 -5.79 g/kg (Maiti et al., 2016). Our findings are agreeing with the results of these researches. Mineral element rate of the plants is affected from a number of factors such as plant genetic structure, growing conditions, soil characteristics, water availability, growing seasons etc. Therefore, serious variability in mineral compositions of the plants and their different parts is expected. This status has been supported by scientific reports(Yildirim et al., 2001).

Table 2. The average chemical composition values of *Stachys lavandulifolia* Vahl. var. *lavandulifolia.*

Parameters	*Stachys lavandulifolia* Vahl. var. *lavandulifolia.*
Total ash (%)	7.00 ± 1.000
N (%)	1.31 ± 0.015
Crude protein (%)	8.03 ± 0.231
pH	6.53 ± 0.153
Crude Fiber (%)	38.40 ± 1.440

Table 3. Mean values of mineral compositions of *Stachys lavandulifolia* Vahl. var. *lavandulifolia.*

Minerals	*Stachys lavandulifolia* Vahl. var. *lavandulifolia.*
Na (g/kg)	0.34 ± 0.016
Mg (g/kg)	2.47 ± 0.369
K (g/kg)	17.46 ± 0.437
Ca (g/kg)	17.25 ± 0.990
P (g/kg)	4.70 ± 0.920
S (g/kg)	0.45 ± 0.080
Mn (mg/kg)	22.95 ± 2.190
Fe (mg/kg)	241.37 ± 2.720
Cu (mg/kg)	21.49 ± 0.840
Zn (mg/kg)	18.56 ± 0.240
Cr (mg/kg)	1.06 ± 0.072
Cd (mg/kg)	0.34 ± 0.040
Co (mg/kg)	0.73 ± 0.060

In the present study, we also determined some micronutrients and heavy metal contents. As seen in Table 3, the concentrations of Mn, Fe, Cu and Zn in studied samples were determined as 22.95, 241.37, 21.49 and 18.56 mg/kg, respectively. Different micronutrients, although required in minor quantities are essential for good health of mankind and animals. The deficiency of these elements causes abnormalities leading to infection of diseases (Maiti et al., 2016). Maiti et al. (2016) reported that Fe, Cu and Zn concentrations are between 98.28-3973.55 mg/kg, 4.17-33.88 mg/kg and 9.49-216.31 mg/kg, respectively in the result of analysis of micronutrients of 44 medicinal plants species utilized traditionally.

Analyzed plant samples had limited and trace levels of chromium (Cr), cadmium (Cd) and cobalt (Co) as 1.06, 0.34 and 0.73 mg/kg, respectively. These metals known as heavy metals and their hazardous effects on living organisms in certain quantities were reported. Cr, Cd and Co contents of medicinal plants and wild vegetables were determined between 0.10-425.0 mg/kg(Esetlili et al., 2014; Canbay and Zerrin, 2015), 0.007-0.47 mg/kg (Zeiner et al., 2015) and 0.05-1.35 mg/kg(Esetlili et al., 2014), respectively.

Conclusion

The genus *Stachys* is one of the largest genera in the flowering plant of *Lamiaceae* family. *Stachys* species are have many pharmacological activities. *S. lavandulifolia* Vahl that we were working on is an herbaceous wild plant native to Turkey which is used in Turkey folk medicine many of the plants used for medical purposes are collected from nature and marketed. It is concluded that it is important to analyze the chemical compositions of medicinal and aromatic in terms of safe consumption. In the current study, it was identified to be rich of minerals concentration of *S. lavandulifolia* Vahl. var. *Lavandulifolia species.* The accumulation of toxic elements in the human body will cause to adverse health effects. This study showed that are not pose any risk to human health of heavy metal concentrations of investigated plant.

References

AOAC (2000). (17. Edition) Official methods of analysis, 17 ed. Maryland, USA.: Association of Official Analytical Chemists, Inc.

Canbay, H.S., Zerrin, F.S. (2015). Determination of Heavy Metals and Nutrient Elements in Some Plants Medicinal Used in Eskişehir. Suleyman Demirel University Journal of Natural and Applied Science 19:83-90. [Google Scholar]

Davis, P.H., Mill, R.R., Tan, K. (1988). Flora of Turkey and East Aegean Islands (Suppl. 1), Vol. 10. Edinburgh: Edinburgh University Press.

Dias, M.I., Barros, L., Dueñas, M., Pereira, E., Carvalho, A.M., Alves, R.C., Oliveira, M.B.P., Santos-Buelga, C., Ferreira, I.C. (2013). Chemical composition of wild and commercial Achillea millefolium L. and bioactivity of the methanolic extract, infusion and decoction. Food chemistry, 141:4152-4160 [CrossRef] [PubMed]

Esetlili, B.Ç., Pekcan, T., Çobanoğlu, Ö., Aydoğdu, E., Turan, S., Anac, D. (2014). Essential Plant Nutrients and Heavy Metals of some Medicinal and Aromatic Plants. Tarım Bilimleri Dergisi, 20:239-247. [CrossRef]

Evans, W.C. (1989). Trease and Evans' Pharmacognosy : 13th Edition. Published by Bailliere Tindall., London.

Ferhat, M., Erol, E., Beladjila, K.A., Çetintaş, Y., Duru, M.E., Öztürk, M., Kabouche, A., Kabouche, Z. (2017). Antioxidant, anticholinesterase and antibacterial activities of Stachys guyoniana and Mentha aquatica. Pharmaceutical biology, 55:324-329. [CrossRef] [PubMed]

İşcan, G., Köse, Y.B., Demİrcİ, B. (2015). Chemical Composition and Antimicrobial Effects of Stachys Rupestris Essential Oil. Anadolu University Journal of Science and Technology–C Life Sciences and Biotechnology, 4:41-47. [CrossRef]

Maiti, R., Rodriguez, H.G., Degu, H.D., Kumari, C.A., Sarkar, N. (2016). Macro and Micronutrients of 44 Medicinal Plant Species Used Traditionally in Nuevo Leon, Mexico. International Journal of Bio-Resource & Stress Management, 7(5):1054-1062. [CrossRef]

Mitchell, C.C. (1992). Plant Analysis Reference Procedures for the Southern Region of the United States. Southern Cooperative Series Bulletin no: 368. Athens GA: The University of Georgia Crops and Soil Science Dept.

Moghanlou, K.S., Isfahani, E.N., Dorafshan, S., Tukmechi, A., Aramli, M.S. (2018). Effects of dietary supplementation with Stachys lavandulifolia Vahl extract on growth performance, hemato-biochemical and innate immunity parameters of rainbow trout (Oncorhynchus mykiss). Animal Feed Science and Technology, 237:98-105. [CrossRef]

Sajjadi, S.E., Ghanadian, M., Rabbani, M., Tahmasbi, F. (2017). Isolation and identification of secondary metabolites from the aerial parts of Stachys lavandulifolia Vahl. Iranian Journal of Pharmaceutical Research, 16:58-63. [PubMed]

Tuncturk, R., Tuncturk, M., Eryigit, T., Karik, U. (2017). Study on Chemical Composıtıons of Achillea Species In East Anatolia. Jatuspab-2 (The Second Japan-Turkey International Symposium on Pharmaceutical and Biomedical Sciences). Oral presentation, September 11th - 12th, 2017 / Trabzon- Turkey.P:98. . In.

Yildirim, E., Dursun, A., Turan, M. (2001). Determination of the nutrition contents of the wild plants used as vegetables in Upper Coruh Valley. Turkish Journal of Botany, 25:367-371. [Google Scholar]

Zeiner, M., Cindrić, I.J., Požgaj, M., Pirkl, R., Šilić, T., Stingeder, G. (2015). Influence of soil composition on the major, minor and trace metal content of Velebit biomedical plants. Journal of pharmaceutical and biomedical analysis, 106:153-158. [CrossRef] [PubMed]

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.3 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):9-11 (2019)

Fusarium graminearum growth and its fitness to the commonly used models

Edgar Cambaza[1,*] **Shigenobu Koseki**[1] **Shuso Kawamura**[1]

[1]Laboratory of Food Process Engineering, Graduate School of Agriculture, Hokkaido University, Sapporo, Japan

[*]Corresponding Author: edy@bpe.agr.hokudai.ac.jp

Abstract

Fusarium graminearum causes head blight in wheat and corn, and produces chemicals harmful for humans and other animals. It is important to know how it grows in order to prevent outbreaks. There are three well-known growth models for microorganisms and they seem applicable to molds: linear, Gompertz and Baranyi. This study aimed to see which could better represent *F. graminearum's* growth. Three replicates were grown in yeast extract agar (YEA) for 20 days, the Feret's radius was measured in ImageJ software, and then related to the models. Baranyi's model was only acceptable according to a Wilcoxon test ($p = 0.280$). Thus, this shall be the one used, even in routine analyses.tional properties of some wild plants, and the results may be useful for the evaluation of dietary information.

Keywords: *Fusarium graminearum,* Mold growth, Linear model, Gompertz, Baranyi

Received: 28 May 2018 Accepted: 06 January 2019 Revised: 08 January 2019 Published: 10 January 2019

Introduction

Fusarium graminearum is a fungal plant parasite responsible for the disease known as FHB (*Fusarium* head blight) in crops such as wheat and corn, and mycotoxin contamination in humans (Weidenbörner, 2001; Yoshizawa, 2013). The toxins include deoxynivalenol, nivalenol and zearalenone (Hussein & Brasel, 2001; Pestka, 2007; Y. Sugiura, 1996). The former two are emetic and the latter has estrogenic properties.

There is a body of studies on fungal growth (Berger, Le Meur, Dutykh, Nguyen, & Grillet, 2018; Garcia, Ramos, Sanchis, & Marin, 2009; Møller, Andersen, Rode, & Peuhkuri, 2017; Sadovský & Koronthályová, 2017). Most are done for practical purposes such as brewing or drug production rather than mere scientific curiosity. Thus, the knowledge is either focused on substrate or environmental settings, very superficial or speculative based on bacterial studies. Thus, there is a need to properly describe how in fact fungi grow, especially molds.

Three major models used to describe fungal growth: one linear and two sigmoidal (Gompertz and Baranyi) (Garcia et al., 2009). Authors have been arguing about which is the best for practical purposes. While some prefer the linear's simplicity, others claim the sigmoidal to be more accurate representing the irregular biological nature of the phenomenon(Buchanan, Whiting, & Damert, 1997).

The choice of an appropriate growth model for *F. graminearum* will allow scientists to more accurately predict the propagation of FHB and prevent outbreaks. This study aimed to find out which major model explains *F. growth* in a system with limited nutrient supply, in minimal medium and at room temperature.

Material and Methods

Isolate

This study used *F. graminearum* from the JCM Catalogue. It is registered as the teleomorph *Giberella zeae* (Schwabe) Petch isolated by Y. Sugiura (1996) from rice stubble in Hirosaki, Aomori Prefecture, Japan. It is a known producer of deoxynivalenol, 15-acetyldeoxinivalenol and zearalenone (Yoshitsugu Sugiura, Watanabe, Tanaka, Yamamoto, & Ueno, 1990).

Incubation and Growth Analysis

Three *F. graminearum* replicates were grown in yeast extract agar (YEA) inside a black box inside a chamber, at room temperature during 20 days. Daily photos were taken using Nikon D3200. The shots were performed vertically at 25 cm above the specimens after opening the Petri dishes.

The radii were measured in ImageJ software. After setting the scale, taking the 90 mm of the plate's diameter as reference, the fungal area was isolated through RGB color threshold. Then, the Feret's diameter was determined and converted in radius. The growth models were determined using reference values such as the duration of lag phase (λ), end of the exponential growth (t_{max}), maximum growth rate (μ_{max}) and the maximum radius (y_{max}). The models were compared to the actual growth using Wilcoxon's paired test at $\alpha = 0.05$.

Cite this article as:
Cambaza, E., Koseki, S., Kawamura, S. (2019). Fusarium graminearum growth and its fitness to the commonly used models. Int. J. Agric. Environ. Food Sci., 3(1), 9-11. DOI: https://doi.org/10.31015/jaefs.2019.1.3
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 9-11
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

Results and Discussion

Observed growth

The mold grew in a logistic pattern with its typical sigmoidal curve (Figure 1**).**

The lag phase took 1 day, followed by 10 days of exponential growth. The maximum growth rate was 33 mm/d and the maximum radius was 45 mm. The Figure 2 shows the mold's growth rate during the exponential phase. It seems consistent with a 4th degree polynomial.

The growth was at its peak in the 2nd day, between the 4th and 5th, and also around the 9th and 10th days. There is a notable valley between the 6th and 7th days.

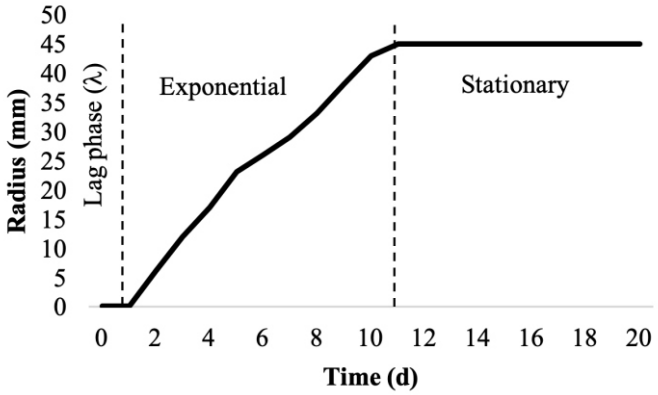


Figure1. *F.graminearum*'s growth during 20 days.

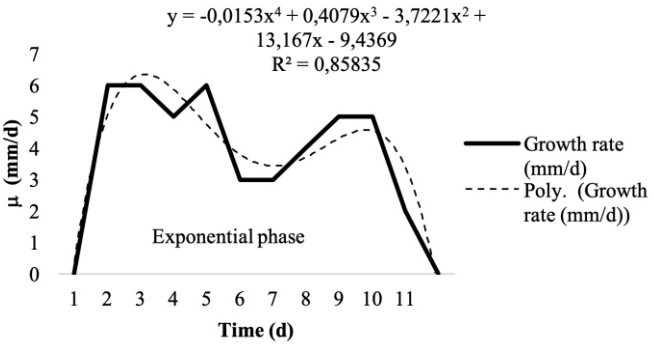


Figure 2. *F. graminearum*'s growth from the first day up to the end of the exponential phase.

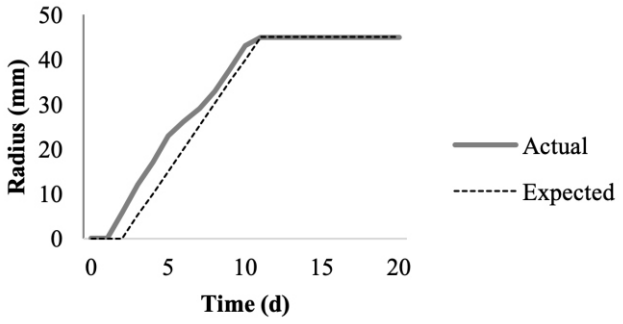


Figure 3. Comparison between the linear growth model and the actual growth.

Comparison with the models

First, the linear model was compared to the actual growth. A paired test suggests significant differences between them (p = 0.002). The Figure 3 below shows how the linear model would represent *F. graminearum*'s growth for 20 days.

The differences were noticeable, especially during the log phase. The lag phase also showed some discrepancy, as the actual growth started at least one day before what the linear model shows. On the other hand, the curves seemed to get closer as the time passes and finally connected in the beginning of the stationary phase. According to these observations, the linear model was not fit to represent *F. graminearum*'s growth.

Then, the Gompertz model was analyzed (Figure 4). A paired test also showed considerable differences between it and the actual growth ($p < 0.001$).

It seemedless representative if compared with the linear model. The Gompertz model seemed very smooth, almost without a lag phase and showing very harmonious transitions between the phases. The stationary phase's onset also took days longer than expected. Thus, this model was not the most adequate to represent *F. graminearum*'s growth.

The last model compared was Baranyi's (Figure 5).

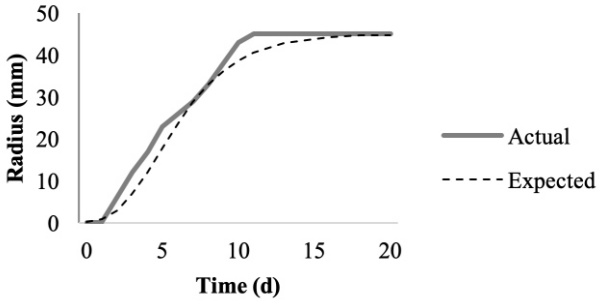


Figure 4. Comparison between the Gompertz model and the actual growth.

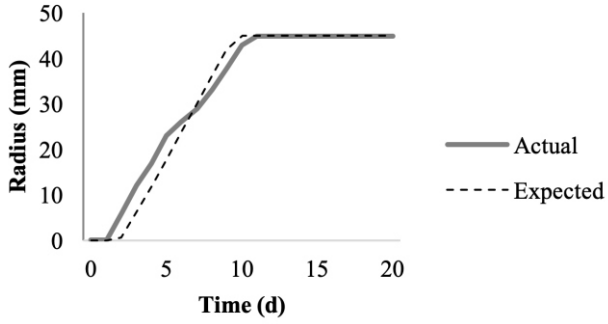


Figure 5. Comparison between the Baranyi's model and the actual growth.

This model did not show enough statistical differences to be regarded as substantially distinct from the observed values (p = 0.28), according to a paired test. They had noticeable discrepancies, especially in the slope variations in the log phase. Baranyi's model also seemed smooth but not as much as Gompertz. Its shapewas somewhere between the two previously analyzed. Yet, besides the considerably irregular shape of the actual growth curve during the log phase, Baranyi's model seemed fit enough to represent *F. graminearum*'s growth.

Discussion

The logistic pattern was expected, as it is common for biological systems, especially if subjected to confined spaces rich in nutrients (Deacon, 2006). In this case, the mold stopped growing in size due to the surface area available, rather than nutrient shortage. Once it happens, a color change is noticeable and it is probably a result of nutrient shortage (Cambaza, Koseki, & Kawamura, 2018).

Neagu and Borda (2013) also studied *F. graminearum*'s growth. Their maximum growth rate was higher (13.5 mm/d) and the fungus attained its full size at the 8th day. The difference might have been due to their media, enriched with barley and wheat extract, while here the medium is minimal, with yeast extract. Even between different yeast extracts the same molds present different behaviors (Sorensen & Sondergaard, 2014). The strain might have been another reason for the differences in growth rates, particularly for the case of *F. graminearum* comprises a polyphyletic group with the distinction between the strains and species still under scrutiny (Goswami & Kistler, 2004). Unfortunately, Neagu and Borda (2013) did not use the current models and ignored details such as phase distinction, probably because they just wanted to find out how long the mold takes to occupy the entire plate's surface.

The growth rate might be explained by some biological interactions (Deacon, 2006; Madigan, Martinko, & Parker, 2017). The lag phase consists of adaptation, followed by rapid growth. The following reduction is probably due to signals sent by the first hyphae reaching the plate's borders and facing the first signs of nutrient exhaustion. But it is not a major problem because there are more nutrients underneath the surface. After a re-adaptation to the new situation, they grew some millimeters and finally stopped growing as most reached the borders.

The linear model is certainly the easiest to work with and it is the most widely used (Garcia et al., 2009), but it should not be applied for *F. graminearum*, even for screening purposes. Gompertz should not also be used for the same purpose. Baranyi seems to be the only representative model for *F. graminearum*'s growth among the analyzed. This result agrees with Garcia's opinion on fungal growth (Garcia et al., 2009) based on Buchanan's meta-analysis on bacterial growth (Buchanan et al., 1997).

Conclusion

F. graminearum grows exhibiting a sigmoidal shape. A 4th degree polynomial regression is fit to predict its growth rate. Further studies may provide more insight at the current observations but as far as this experiment was carried, one shall regard, among size-based models originally developed for bacteria, the Baranyi as the best to represent the growth of *F. graminearum* and certainly many related fungi.

References

Berger, J., Le Meur, H., Dutykh, D., Nguyen, D. M., & Grillet, A.-C. (2018). Analysis and improvement of the VTT mold growth model: Application to bamboo fiberboard. Building and Environment. [CrossRef]

Buchanan, R. L., Whiting, R. C., & Damert, W. C. (1997). When is simple good enough: A comparison of the Gompertz, Baranyi, and three-phase linear models for fitting bacterial growth curves. Food Microbiol, 14(4), 313-326. [CrossRef]

Cambaza, E., Koseki, S., & Kawamura, S. (2018). The Use of Colors as an Alternative to Size in Fusarium graminearum Growth Studies. Foods, 7(7). [CrossRef]

Deacon, J. W. (2006). Fungal biology (4th ed.). Malden, MA: Blackwell Pub.

Garcia, D., Ramos, A. J., Sanchis, V., & Marin, S. (2009). Predicting mycotoxins in foods: a review. Food Microbiol, 26(8), 757-769. [CrossRef]

Goswami, R. S., & Kistler, H. C. (2004). Heading for disaster: Fusarium graminearum on cereal crops. Molecular plant pathology, 5(6), 515-525.

Hussein, H. S., & Brasel, J. M. (2001). Toxicity, metabolism, and impact of mycotoxins on humans and animals. Toxicology, 167(2), 101-134.

Madigan, M. T., Martinko, J. M., & Parker, J. (2017). Brock biology of microorganisms (Vol. 13): Pearson.

Møller, E. B., Andersen, B., Rode, C., & Peuhkuri, R. (2017). Conditions for mould growth on typical interior surfaces. Energy Procedia, 132, 171-176. [CrossRef]

Neagu, C., & Borda, D. (2013). Modelling the growth of Fusarium graminearum on barley and wheat media extract. Romanian Biotechnological Letters, 18(4), 8489.

Pestka, J. J. (2007). Deoxynivalenol: Toxicity, mechanisms and animal health risks. Animal Feed Science and Technology, 137(3–4), 283-298. doi: http://dx.doi.org/10.1016/j.anifeedsci.2007.06.006

Sadovský, Z., & Koronthályová, O. (2017). Exploration of probabilistic mould growth assessment. Applied Mathematical Modelling, 42, 566-575. [CrossRef]

Sorensen, J. L., & Sondergaard, T. E. (2014). The effects of different yeast extracts on secondary metabolite production in Fusarium. Int J Food Microbiol, 170, 55-60.[CrossRef]

Sugiura, Y. (1996). Gibberella zeae (Schwabe) Petch. In Japan Collection of Microorganisms (Ed.), JCM Catalogue. Tsukuba: Microbe Division (JCM).

Sugiura, Y., Watanabe, Y., Tanaka, T., Yamamoto, S., & Ueno, Y. (1990). Occurrence of Gibberella zeae strains that produce both nivalenol and deoxynivalenol. Appl Environ Microbiol, 56(10), 3047-3051.

Weidenbörner, M. (2001). Encyclopedia of Food Mycotoxins (1 ed.): Springer-Verlag Berlin Heidelberg.

Yoshizawa, T. (2013). Thirty-five Years of Research on Deoxynivalenol, a Trichothecene Mycotoxin: with Special Reference to Its Discovery and Co-occurrence with Nivalenol in Japan. Food Safety, 1(1), 2013002-2013002.[CrossRef]

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.4 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):12-15 (2019)

A survey of tomato blossom and flower drop to the influence of environmental phenomena (*solanum lycopersicum* L.)

Mohan Arthanari[1,*] **Senthilkumar Dhanapalan**[1]

[1]Department of Zoology, Kandaswami Kandar's College, Periyar University, Tamil Nadu, India

[*]Corresponding Author: elur.mohan@gmail.com

Abstract

In India, the production of Tomato (*Solanum lycopersicum* L.) varies every season and their market price also fluctuated. *S. lycopersicum* plants are self-pollinated. Pollination is an important ecological interaction and the first step for the sexual reproduction. Tomatoes Blossom and flower drop is a serious effect of the environmental factors. The present study was carried out during the monsoon season (October – December 2017) to the evaluate influence of abiotic factors on the production of tomato in Namakkal district, Tamil Nadu, India. During monsoon season the production of tomato was severely affected by various abiotic factors. The influence of maximum temperature has a positive correlation with tomato flower blossom and flower drop. Rainfall, Relative Humidity, and Wind have negative correlation the flower blossom and flower drop.

Keywords: Flower blossom/drop, Temperature, Relative Humidity, Wind, Rainfall

Received: 04 June 2018 Accepted: 22 October 2018 Revised: 08 December 2018 Published: 10 January 2019

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop. At present, about 160 million tons of fresh tomatoes are the production from 4.7 million hectares in India (FAOSTAT, 2011). *S. lycopersicum* are native to South America but were brought to Europe sometime in the 15th century, where they soon became popular and were exported around the world. Pollination is an important ecological interaction and the first step for the sexual reproduction of most plant species (Murcia, 1996). The ecosystem service for sustainable crop production is the mutualistic interaction between plant pollination. Tomatoes Blossom drop and reduced fruit set in a tomato can seriously impact yields. *S. lycopersicum* plants are self-pollinated at the rate of 98% or more. Pollination occurs primarily between 10 am to 4 pm (Levy *et al.,* 1978). Insect pollinators are not important for pollination of tomatoes grown in open field production (Levy *et al.,* 1978). The primary causes of blossom drop tomatoes are environmental factors (e.g., Temperature and Relative Humidity), secondary causes can include lack of water, reduced or extended light exposure, excessive wind, and heavy fruit set. The Intergovernmental Panel on Climate Change (IPCC, 2007) reports an approximate temperature increase ranging from 1.1 to 6.4 ° C during the 21st century. The Fourth Assessment Report (AR4) developed by the Intergovernmental Panel on Climate Change (IPCC, 2007) lists many observed changes in the global climate. The biological impacts of rising temperatures depend upon the physiological sensitivity of organisms to temperature change (Hegland *et al.,* 2009). Discussed the consequences of temperature-induced changes in plant-pollinator interaction. They found that the timing of both plants flowering and pollinator activity seems to be strongly affected by temperature. Without pollination, which stimulates fruit set, the flowers die or drop. This condition can affect tomatoes, peppers, snap beans and another fruiting vegetable. In tomatoes, blossom drop is usually preceded by the yellowing of the pedicle. Tomato flowers must be pollinated within approximately 50 hours or they will abort and drop off. This is about the time it takes for the pollen to germinate and travel up the style to fertilize the ovary at temperatures above 12.78°C (Monica Ozores-Hamrton and Gene McAvoy, 2012). A recent review has emphasized that plant-pollinator interactions can be affected by changes in climatic conditions in subtle ways. The aim of present study is to investigate the data on the impacts of climatic changes on tomato crop pollination.

Material and Methods

A study of the incidence areas of open field *S. lycopersicum* cultivation was carried out at the Kandaswami Kandar's college of Namakkal District (11.1202° N, 78.0040° E), North-western district of Tamil Nadu, India. The study area receives North East monsoon during the months of October – December. The normal level rainfall of the Namakkal District is about 291.4 mm in October to December (RMC, 2017). The observations were made at weekly intervals for tomato plants October to November - 2017. Eight *S. lycopersicum* plants cultured in pots separate

Cite this article as:
Mohan, A. and Senthilkumar, D. (2019). A survey of tomato blossom and flower drop to the influence of environmental phenomena *(Solanum lycopersicum* L.). Int. J. Agric. Environ. Food Sci., 3(1), 12-15. DOI: https://doi.org/10.31015/jaefs.2019.1.4
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 12-15
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

tubs and placed in an open field and weekly observation made individually on each plant regarding flower blossom, flower drops out. Meteorological data such as temperature, relative humidity, wind speed and rainfall during the study period were also recorded to assess the influence of these factors on the flowers losing incidences. The correlation coefficients between abiotic factors with flower blossom/drop was worked out by using the PSPP Statistical software Linux Mint 18.3, and various multivariate statistical methods, including Canonical Correspondence Analysis (CCA) Legendre and Legendre, (1998) and Bray - Curtis Similarity (Clarke, 1993) Analyzed using PAST Statistical Software Version 3.17.

Results

The data shows on the Abiotic factors (Table 1) such as Temperature, Relative Humidity, Wind Speed and Rainfall in Namakkal district (Tamil Nadu) during the study period (October – November 2017). The abiotic factors influence for tomato blossom/drop on open field culture. The highest temperature (35.14°C) and lowest (23.86°C) was recorded on I and IX week respectively. Maximum relative humidity (RH) was recorded on the IX week (95.43 %) and < 50% in I week (48.86 %). In III and IV weeks of our study period, maximum wind speed (18.57 Km/h) and minimum speed (4.57 Km/h) were recorded. During the tomato culture 1.28mm rainfall was recorded (II week) in the study area. Highest flower blossom (9) and flower drop (6.38) was registered in VII week (Figure 1).

Table 2 indicated the correlation between abiotic factors on the tomato flower blossom and drop. Among the abiotic factors, maximum temperature has a positive correlation with flower blossom (0.01) and flower drop (0.01) at the 0.01 percent level. A negative correlation has existed between minimum temperature (-0.27), maximum and minimum relative humidity (-0.05; -0.25); wind (-0.57; -0.31) and rainfall (-0.65) with flower drop respectively. Maximum wind and rainfall exhibit a negative correlation for the flower blossom (-0.61, -0.65) at the 0.05 level.

Table 1. The Meteorological data and the tomato flower blossom/drop Namakkal district of Tamil Nadu (Weekly Data)

Weeks	Min Temp	Max Temp	Min RH	Max RH	Min Wind	Max Wind	Rainfall	Flower Blossom	Flower Drop
I	26.14±1.21	35.14±1.35	48.86±5.49	85.86±6.54	4.86±1.07	15.29±3.35	1.04±1.00	1.88±0.99	0.63±0.74
II	25.86±1.21	33.86±2.19	55.00±8.23	91.14±1.35	5.57±1.13	14.14±4.60	1.28±0.88	5.25±3.54	4.50±2.93
III	26.29±0.95	33.29±2.43	56.86±16.71	86.00±4.28	6.29±0.49	18.57±2.15	0.33±0.65	3.88±1.36	2.74±1.91
IV	26.14±0.90	33.86±2.34	50.71±9.62	88.00±4.28	5.86±1.35	16.00±4.20	0.18±0.20	4.00±2.83	3.25±2.25
V	24.00±0.82	29.00±2.38	67.57±12.01	83.71±17.37	4.57±1.51	17.86±6.41	0.50±0.43	6.50±4.96	4.75±4.17
VI	24.14±0.69	30.14±1.95	62.00±12.30	92.57±3.41	6.00±1.00	15.43±3.99	0.24±0.36	7.63±2.92	5.38±2.50
VII	24.43±0.53	32.43±1.51	53.00±9.73	90.14±5.15	5.43±0.98	10.71±3.35	0.24±0.34	9.00±1.85	6.38±2.20
VIII	25.00±0.82	31.86±0.90	54.14±6.23	93.29±1.80	5.43±0.98	17.00±3.42	0.06±0.09	4.25±5.34	3.63±5.10
IX	23.86±0.38	27.29±1.70	79.71±9.39	95.43±3.69	6.86±2.79	18.29±3.99	3.11±3.32	0.57±0.98	0.29±0.76

Table 2. Pearson Correlation Coefficients for the influence of abiotic factors on the *S. lycopersicum* flower blossom/drop

	Min Temp	Max Temp	Min RH	Max RH	Min Wind	Max Wind	Rainfall	Blossom	Blossom Drop
Min Temp	1	0.90	-0.73	-0.41	-0.07	0.00	-0.27	-0.31	-0.27
Max Temp		1	-0.94	-0.40	-0.32	-0.40	-0.46	0.01	0.01
Min RH			1	0.36	0.45	0.51	0.69	-0.24	-0.25
Max RH				1	0.62	-0.10	0.43	-0.12	-0.05
Min Wind					1	0.28	0.47	-0.35	-0.31
Max Wind						1	0.26	-0.61	-0.57
Rainfall							1	-0.65	-0.65
Blossom								1	0.98
Blossom Drop									1

Multivariate Analysis

Canonical Correspondence Analysis, and Bray-Curtis Similarity were calculated with the environmental factor and tomato flower blossom and drop during the culture period. Figure 2, based on which 2 distinct groupings could be distinguished that apparently reflected differences in abiotic factor stress in tomato flower blossom/drop in the study area. Group I (Flower blossom/drop, Maximum Temperature, and Minimum Temperature); Group II included (Maximum Wind, Minimum Wind, Rainfall, Maximum RH and Minimum RH). Correspond to relatively Maximum and Minimum temperature, very highly influenced by a tomato flower drop and flower bloom. In Figure 3, a relationship has existed between the abiotic factors with flower blossom and a drop in the study place. However, from the CCA results, it is evident that abiotic factors such as Rainfall, Minimum Wind Speed, and Maximum Temperature have directly affected the tomato flower blossom and drop. Convincingly be presumed that in their place, the pollination is mainly stopped from maximum temperature and minimum wind, the rainfall also effected for the tomato flower bloom and drop because it highly increases relative humidity.

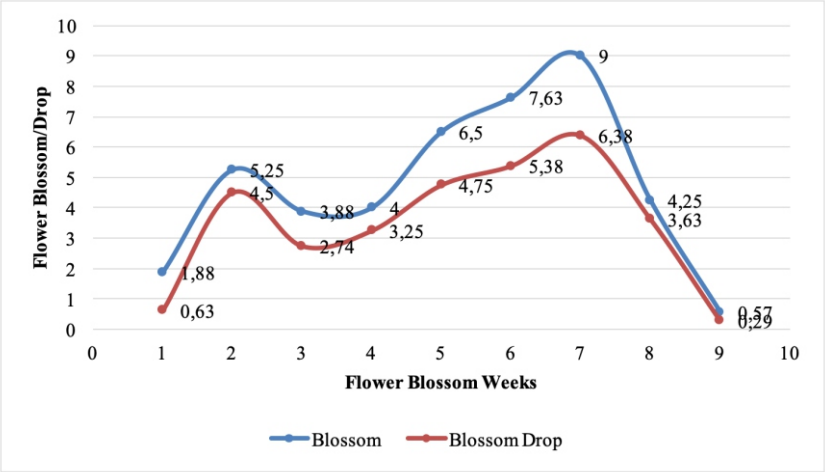


Figure 1. The Influence of abiotic factors on *S. lycopersicum* flower Blossom / Drop

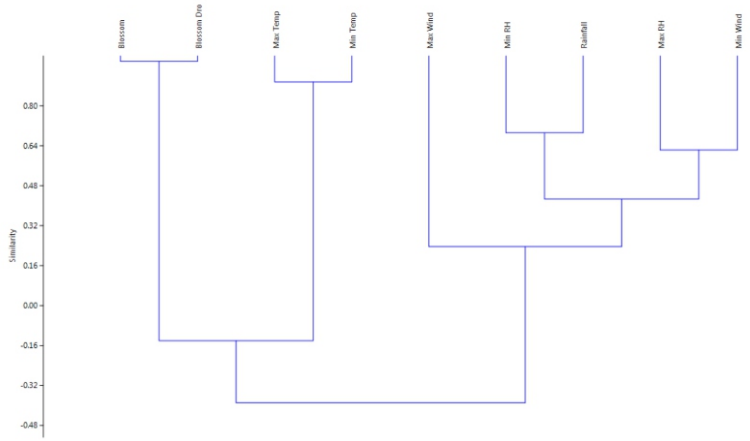


Figure 2. Bray - Curtis similarities Analyzed

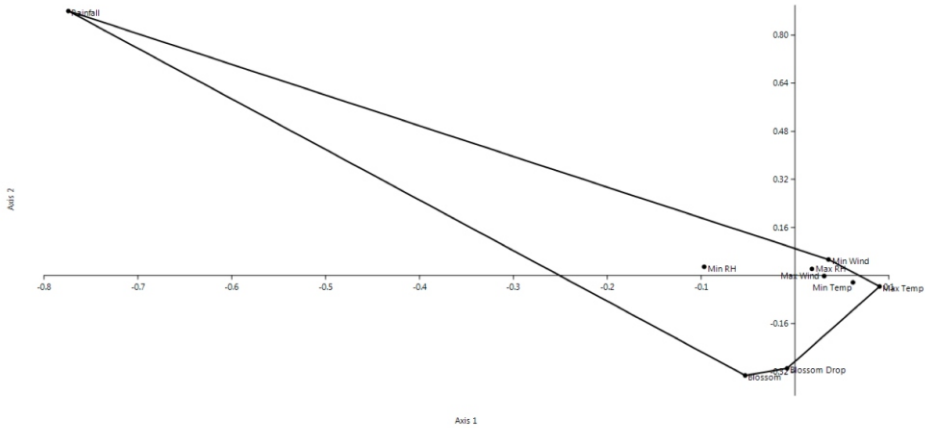


Figure 3. Canonical Correspondence Analysis (CCA)

Multivariate Analysis

Canonical Correspondence Analysis, and Bray-Curtis Similarity were calculated with the environmental factor and tomato flower blossom and drop during the culture period. Figure 2, based on which 2 distinct groupings could be distinguished that apparently reflected differences in abiotic factor stress in tomato flower blossom/drop in the study area. Group I (Flower blossom/drop, Maximum Temperature, and Minimum Temperature); Group II included (Maximum Wind, Minimum Wind, Rainfall, Maximum RH and Minimum RH). Correspond to relatively Maximum and Minimum temperature, very highly influenced by a tomato flower drop and flower bloom. In Figure 3, a relationship has existed between the abiotic factors with flower blossom and a drop in the study place. However, from the CCA results, it is evident that abiotic factors such as Rainfall, Minimum Wind Speed, and Maximum Temperature have directly affected the tomato flower blossom and drop. Convincingly be presumed that in their place, the pollination is mainly stopped from maximum temperature and minimum wind, the rainfall also effected for the tomato flower bloom and drop because it highly increases relative humidity.

Discussion

Extreme temperature, such as high daytime temperatures (above 29 °C), low night-time temperatures (below 13 °C) will cause serious flower drop from tomato plants. Tomatoes grow best if daytime temperatures range between 21°C and 29°C. Tomato plants can tolerate more extreme temperatures for short periods, several days or nights with temperatures outside the ideal range will cause the plant to abort fruit set and focus on survival (Mills, 1988). Temperatures over 40° C for only four hours can cause the flowers to abort. If the night temperatures fall below 12° C or if the day temperatures are above 29° C, the pollen becomes tacky and nonaviable, pollination can't occur. If the flowers weren't pollinated, the flowers will die and fall off. Chemicals growth regulators can sometimes help overcome low-temperature effects, but the resulting fruit is usually seedless and of poor quality.

The ideal relative humidity for tomato growth and development ranges between 40% and 70%. Relative humidity plays a major role in pollen transfer. If relative humidity is lower than the optimal range, it interferes with pollen release because the pollen is dry and unable to stick to the stigma. If relative humidity is higher than the optimal range, the pollen will not shed properly (Mills, 1988; Ozores-Hampton and McAvoy, 2010). Maximum Relative Humidity (RH) was higher throughout the study period and thus cause a fall in tomato production in the culture period. Excessive wind can drop flowers and or physically stopped them off, reducing fruit set. Excess wind can reduce the amount of energy the plant produces and thus can reduce flower production and fruit set (Monica Ozores-Hamrton and Gene McAvoy, 2012). Some areas will likely experience decreased rainfall, leading to more extensive drought periods. Thus water stress may decrease flower numbers. Snow cover might also be responding more to snow cover than to temperature (Inouye, 2008).

Conclusion

The production of tomato in the study area was seriously reduced by abiotic factors during the North-East monsoon season, because of fluctuation in temperature, wind speed, rainfall and relative humidity. Thus abiotic factors will play a major role in the production of tomatoes and also affects the economic growth of India.

References

Clarke, K. R. (1993). Non-parametric multivariate analysis of changes in community structure. Australian Journal of Ecology., 18: 117-143.[CrossRef]

FAOSTAT (2011). Food and Agriculture Organization of the United Nations. Top producers of tomatoes in world.

Hegland, S. J., Nielsen, A., Lázaro, A., Bjerknes, A. I., Totland, Ø. (2009). How does climate warming affect plant-pollinator interactions? Ecol Letters., 12: 184-195. [CrossRef]

Inouye. D.W. (2008). Effects of climate change on phenology, frost damage, and floral abundance of montane wildflowers. Ecology., 89: 353-362. [CrossRef]

IPCC (2007). Climate Change: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland. 104.

Legendre. P., Legendre. L. (1998). Numerical Ecology, 2nd English Ed. Elsevier, 853.

Levy. A., Rabinowitch. H. D., Kedar. N. (1978). Morphological and Physiological Characters Affecting Flower Drop and Fruit Set of Tomatoes at High Temperatures. Euphytica., 27(1): 211-218. [CrossRef]

Mills. L. (1988). Common Tomato Disorders under Desert Conditions. University of Nevada. Cooperative Extension., FS8860.

Monica Ozores-Hamrton., Gene McAvoy. (2012). Blossom Drop, Reduced Fruit Set, and Post-Pollination Disorders in Tomato. HS1195. Gainesville: University of Florida Institute of Food and Agricultural Sciences., https://edis.ifas.ufl.edu/pdffiles/HS/HS119500.pdf

Murcia. C. (1996). Forest Fragmentation and the Pollination of Neotropical Plants. In: Schelhas, Greenberg R (Eds). Forest patches in tropical landscapes. Island Press, Washington, D.C., USA.

Ozores-Hampton. M., McAvoy. G. (2010). What Causes Blossom Drop in Tomatoes?. The Tomato Magazine., 14(4): 4–5.

RMC. (2017). Regional Meteorological Center, Indian Meteorological Department of Earth Sciences, Government of India.

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.5 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):16-21 (2019)

Observation of plant development with compost, lime and chemical fertilizer support in acidic soil with high metal content

Emine Elmaslar Özbaş[1,*] **Atakan Öngen**[1] **H. Kurtuluş Özcan**[1] **Selda Yiğit Hunce**[1]

[1]Istanbul University-Cerrahpaşa, Engineering Faculty, Environmental Engineering Department, 34320, Avcılar/Istanbul/Turkey

[*]Corresponding Author: elmaslar@istanbul.edu.tr

Abstract

In this study, the growth of parsley plants (Petroselinum crispum) was observed in an acidic (pH 2) soil having high heavy metal concentrations with the addition of compost, lime and chemical fertilizer as soil amendments. The soil sample was obtained from the Kastel Village of the Çamburnu district in Trabzon. The compost used as soil conditioner was attained from the Kemerburgaz Recycling and Composting Facility located in Istanbul. Calcium ammonium nitrate was used as chemical fertilizer. Soil samples were prepared to contain i. 10% (v/v) compost (K1), ii. 10% (v/v) compost and 1.5% (v/v) chemical fertilizer (K2), iii. 10% (v/v) compost and 1.5% (v/v) lime (K3) iv. 1.5% (v/v) lime and 1.5% (v/v) chemical fertilizer (K4), v. 10% (v/v) compost, 1.5% (v/v) lime and 1.5% (v/v) chemical fertilizer (K5) and vi. 10% (v/v) compost and 1.5% (v/v) chemical fertilizer. The addition of chemical fertilizer was performed simultaneously with the plantation of parsley seeds. Also, plant seeds were planted in the both of the soil samples with no additives as a control samples. The prepared plant pots were placed in an artificially lighted environment with timer control obtaining 16 hours daylight, 8 hours night. Lengths and weights of root and aerial parts of parsley plants were measured at the end of the growth period. The pH of the soil mixtures in the plant pots were measured at the beginning and end of the experiment. At the end of the study, plant growth was not observed in the acidic soil sample in the absence of soil amendments. The best plant growth (aerial part length 18.6 cm, root length 4 cm, weight 0.2 g) was achieved in commercial plant soil containing ammonium nitrate. The appropriate plant growth (aerial part length 11 cm, root length 4 cm, weight 0.053 g) for the acidic and heavy metal containing soil were reached with the sample containing 10% (v/v) compost, 1.5% (v/v) lime and 1.5% (v/v) chemical fertilizer.

Keywords: MSW compost, Soil, Heavy metals, Soil remediation

Received: 28 June 2018 Accepted: 06 January 2019 Revised: 08 January 2019 Published: 14 January 2019

Introduction

It is known that the amount of harmful compounds in the environment is increasing along with the rapid rise of technology and industrial agriculture (Neilson and Rajakaruna, 2015). Factors such as industrial wastes, leachate, sewage sludge, mining and use of excessive fertilizer and pesticides are the main sources of harmful pollutants in soil and water environment (Memon et al., 2001; Järup, 2003). Organic and inorganic pollutants containing heavy metals are known as the most important pollutants causing environmental pollution. Unlike other types of pollution, heavy metals are in the high risk group for ecosystems due to their bioaccumulation and their resistance to chemical and biological degradation. Mercury (Hg), Cadmium (Cd), Copper (Cu), Manganese (Mn), Zinc (Zn) and Aluminum (Al) are the most commonly found heavy metals in the environment (Ullah et al., 2015). The presence of heavy metals in soil, especially in agricultural soils, poses a great danger to human health and the ecosystem (Zhuang et al., 2009; ; Luo et al., 2011; Sayara et al., 2011; Colin et al., 2012; Sultana et al., 2014; Aryal et al., 2016; ; Nirola et al., 2016; Zhou et al., 2017). Stabilization of heavy metals in the soil is regarded as a remarkable alternative to heavy metal removal due to its efficiency, short duration of action, more economical compared to other remediation methods, and the low efficacy on ecosystem (Kumpiene et al., 2008; Lee et al., 2009; Zhou et al., 2017). For this reason, stabilization studies carried out by application of soil amendments such as compost, lime and biochar to the soil system containing high amounts of heavy metals are frequently encountered in the literature (White et al., 1995; Gray et al., 2006; Shi et al., 2009; Du et al., 2010; Ruyters et al.,2011; Bolan et al., 2014; Ding et al., 2016; Huang et al., 2016; Li et al., 2016; Wang et al., 2016;; Xu et al., 2016).

Approximately 50% reduction in volume and in weight of domestic solid wastes is maintained by composting. Therefore, it is known as an effective and environmental friendly waste treatment method. The use of the obtained compost as a soil remediation material in agricultural areas is also an important environmental advantage (Zhang, 2013).

Cite this article as:
Ozbas, E.E., Ongen, A., Ozcan, H.K., Hunce, S.Y. (2019). Observation of plant development with compost, lime and chemical fertilizer support in acidic soil with high metal content. Int. J. Agric. Environ. Food Sci., 3(1), 16-21. DOI: https://doi.org/10.31015/jaefs.2019.1.5
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 16-21
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

DOI: https://doi.org/10.31015/jaefs.2019.1.5

Composting process is defined as a biochemical breakdown of organic parts of agricultural and urban solid wastes by bacteria and other microorganisms into humus. Compost is a soil conditioner and not a fertilizer. In contrast to chemical fertilizers, dissolution of compost materials can occur in a long time and its transportation to receiving organisms also takes time (Uygun, 2012). Composting is a significant part of modern integrated solid waste management. A valuable product with high humus content for various usage is obtained by composting method. The amount of solid wastes for landfilling is being reduced and organic wastes can be recovered in this way. The compost is mainly used for agricultural activities. In addition, it is frequently used in plantation, horticulture, public parks, golf areas and landscaping. The addition of lime to the soil increases the pH of soil and the conversion of heavy metals in soil to stationary forms by the effects of this pH increase have been asserted in many studies in the literature (Zhu et al., 2010; Mahar et al., 2015; Yan-bing et al., 2017).

In this study, it is aimed to observe the growth of the parsley plants in soils having highly acidic character and high heavy metal concentration by addition of soil amendments such as compost, lime and chemical fertilizer. For this purpose, experiments were carried out in plant pots in laboratory environment.

Materials and Methods

The first soil sample (T1) was obtained from the Kastel Village on the border of Çamburnu District of Trabzon. Also, a commercial plant soil (T2) (Tropical brand, soil for ornamental plants) was used and the growth of plants was examined on two soil samples. The compost sample used as soil conditioner was obtained from the Kemerburgaz Recycling and Composting Facility located in Istanbul Metropolitan Municipality. Calcium ammonium nitrate (Total nitrogen 26%, Ammonium nitrogen 13%, Nitrate nitrogen 13%) was employed as an chemical fertilizer. The addition of lime was carried out with slaked lime ($Ca(OH)_2$).

For the pH measurement of compost, distilled water was added to the compost sample in a ratio of 1/5 (e.g.: 2 g sample/10 mL distilled water), and the pH was measuredwith the pH meter after mixing for 10 minutes by magnetic stirrer (Methodenbuch zur Analyse von Kompost, 1994). In order to determine the pH value of the soil sample, 0.1 N KCl was added on the soil sample in a ratio of 1/2.5 and the pH value was read with the pH meter after mixing for 1 hour on the magnetic stirrer (Paradelo at al., 2011). The pH measurements were done by using Jenway 3040 Ion Analyzer. The C, H, N values of the soil and compost samples were determined using Thermo Scientific Flash 2000 CHN-S elemental analyzer.

Samples were prepared for analysis by the microwave digestion method (U.S. EPA, 2007) for identification of metal quantities in soil and compost samples. After the microwave digestion, the samples were filtered (with MN 640, 125 mm, Macherey-Nagel filter paper) and poured into HDPE balloons and volumes were fulfilled with ultrapure water to 50 mL. Analyses of the samples were performed with an ICP optical emission spectrometer (Perkin Elmer Optima 7000 DV) combined with an automatic sampler (Perkin Elmer S10 Autosampler).

Inorder to observe the plant growth , the mixtures to be placed in the plant pots were prepared as follows. T1 soil samples were prepared to contain (i) 10% (v/v) compost (K1), (ii) 10% (v/v) compost and 1.5% (v/v) chemical fertilizer (K2), (iii) 10% (v/v) compost and 1.5% (v/v) lime (K3) (iv) 1.5% (v/v) lime and 1.5% (v/v) chemical fertilizer (K4), (v) 10% (v/v) compost, 1.5% (v/v) lime and 1.5% (v/v) chemical fertilizer (K5) and (vi) 10% (v/v) compost and 1.5% (v/v) chemical fertilizer (K6).

Two weeks waiting period was applied prior to the addition of chemical fertilizer, to obtain reaction between compost, T1 sample and lime. Only irrigation was done at this stage. Moreover, the mixture prepared by 1.5 % (v/v) chemical fertilizer addition to T2 soil without any other conditioner addition were placed in the plant pots. Then, when parsley seeds were planted, the chemical fertilizer was added simultaneously. Seeds also were planted into the plant pots having no soil additives as control samples. The prepared pots were placed in an artificially lighted environment with timer control obtaining 16 hours daylight, 8 hours night. The temperature was kept constant during experimental period. The plants were harvested after 40 days. All experiments were replicated and mean values and standard deviations were presented.

Results and Discussion

The characterization of the compost and soil samples used in the experiments is presented in Table 1. According to Table 1, it is seen that T1 soil is acidic (pH 2) and the pH value of T2 soil is about 7. When C, H, N values are examined, it is seen that T1 soil has very low amount of C as 0.1% and N content is not detected in the samples. The C and N contents of T2 soil were determined as 3.42 % and 5.45 %, respectively. The pH of compost was determined as 7.9.

When the values in Table 2 are compared with the values in Table 1, it is seen that the pH value of T1 sample is defined as "toxic for all products". The pH value of the T2 sample is defined as "all products grow". When the values in Table 1 are compared with the values in Table 3, it can be seen that the compost used in the study provides the quality parameters in the "Compost Regulation". When the values in Table 1 are compared with those in Table 4, it is seen that the amounts of metals in T1 were found much higher than the limit values given in Table 4.

Root and aerial part lengths of growing parsley plants were measured after a period of 40 days. Their weights were recorded. The pH values of the mixture in the plant pots were measured at the beginning and at the end of the experiment. The short nomenclature of the samples and the pH values at the beginning and at the end of the study are presented in Table 5. According to results given in Table 5, the pH increases from 2 to 5 with the addition of 10% compost to T1 soil, and when 1.5% lime is added, the pH increases from 2 to 7. It is known that the proper pH value for parsley plants changes between 5-8. With the addition of compost and lime, the pH value of T1 soil is reached to a proper pH value for the development of parsley plant.

Root and stem lengths of harvested plants at the end of the 40-day growth period are displayed in Table 6. According to the Table 6, plant growth was not observed in plant pots containing only T1 soil, K1 and K2 mixtures. Although the pH values of the mixtures K1 and K2 were initially at the appropriate pH for the development of the parsley plant, it was considered that the reason of the observation of no plant growth can be the decrease in pH up to 4 (pH 4 in Table 1 is defined as toxic to most crops) at the end of the experiment. The plant growth (9.5 cm stem length, 2.5 cm root length,

0.00328 g weight) was observed even with only the addition of lime to the T1 soil (K3 mixture). The pH of K3 mixture was recorded as 6 at the end of the study. This pH value is defined as appropriate for the growth of all products in Table 1. Besides the lime, the addition of chemical fertilizer (K4 mixture) and, compost and chemical fertilizer (K5 mixture) to T1 soil improved the growth of parsley plants, especially it was resulted in an increase in their weights (Table 6).

Based on the K4 and K5 mixtures, it is considered that the addition of compost improves the porosity of the soil as well as the adjusting the pH for the plant growth, and the elimination of nutrient deficiency by using chemical fertilizer affect plant growth positively. Table 6 shows that the best plant growth was achieved in the mixture (K6) with fertilizer added to the T2 soil. However, it can be said that the results obtained from the experiments of K4 and K5 mixtures were lead to better plant growth than the results of experiments performed with only T2 soil (Table 6).

Conclusion

In this study, the growth of parsley plant was achieved in an acidic soil having high metal content by adding lime, compost and chemical fertilizer to the soil. Addition of only compost as a soil conditioner was not found sufficient and the addition of both lime and compost was suggested to buffer the acidity of the soil. Also, the addition of chemical fertilizer was promoted elimination of nutrient deficiency of the soil. Thus, the best conditions for the parsley plant growth in acidic soil have been determined as use of a combination of compost, lime and chemical fertilizer. As well as monitoring the plant growth in this type acidic and heavy metal containing soils, the accumulation of the heavy metals in roots and aerial parts of the grown plants was thought to be investigated as a future work with a longer study period.

Table1. Characterization of compost and soil samples

Parameters	Units	Compost	T1	T2
pH		7.9±0.01	2±0.02	7.00±0.01
C	%	11±2.11	0.1±0.001	3.42±0.002
N	%	0.4 ±0.001	-	0.545±0.001
C/N		28±1.03	-	6±0.03
H	%	-	0.75±0.002	0.95±1.03
Ni	mg/kg	36±1.05	20.14±0.09	2±0.001
Fe	mg/kg	11000±2.44	4165±1.12	5200±1.04
Cu	mg/kg	200±0.2	3515±1.44	48.89±0.05
Cd	mg/kg	1±0.001	134±0.005	ND
Zn	mg/kg	380±0.02	25901±0.22	125±0.01
Pb	mg/kg	80±0.1	3553±0.12	ND
Mn	mg/kg	320±0.015	140±0.01	110±0.02

±SD (Standard deviation), ND: Not detected

Table2. Relation between pH values and plant growth

pH	Soil reaction	Effects to products
3	Very high acidity	Toxic to all products
4	Strong acidity	Too toxic to most products
5	Moderate acidity	Toxic to some products
6	Light acidity	All products grow
7	Neutral	All products grow
8	Light alkaline	Most products grow
9	Medium alkaline	Toxic for many products
10	Strong alkaline	Toxic for all products

Table3. Compost quality parameters (Compost Notification, 2015)

Parameters	Values
pH	5.5-8.5
C/N	10-30
Copper (mg/kg)	450
Zinc (mg/kg)	1100
Cadmium (mg/kg)	3
Lead (mg/kg)	150
Nickel (mg/kg)	120

 DOI: https://doi.org/10.31015/jaefs.2019.1.5

Table 4. Generic Pollutant Limit Values (TKKNY , 2010)

Pollutant	Absorption by ingestion of soil and skin contact (mg/kg oven dry soil)	Inhalation of volatile substances (mg/kg oven dry soil)	Inhalation of fugitive dusts in the external environment (mg/kg oven dry soil)	Transport of pollutants to groundwater and drinking of that groundwater[1] (mg/kg oven dry soil)	
				SF = 10	SF = 1
Copper	3129	-	-	514	51
Zinc	23464	-	-	6811	681
Cadmium	70	-	1124	27	3
Lead	400	-	-	135	14
Nickel	1564	-	-	13	1

Table5. pH values of the soil mixtures in the pots at the beginning and end of the study

Sample name	Sample code	Initial pH	Final pH
Soil in acidic form	T1	2±0.01	2±0.01
Commercial plant soil	T2	7±0.015	6±0.02
T1+10 % compost	K1	5±0.01	4±0.01
T1+10 % compost+%1.5 chemical fertilizer	K2	5±0.012	4±0.014
T1+1.5 % lime	K3	7±0.021	6±0.01
T1+1.5 % lime+1.5 % chemical fertilizer	K4	7±0.01	7±0.011
T1+10 % compost+1.5 % lime + %1.5 chemical fertilizer	K5	7±0.013	7±0.001
T2+1.5 % chemical fertilizer	K6	7±0.002	6±0.01

±SD (Standard deviation)

Table6. Growth of plants at the end of the study

Sample code	Stem length (cm)	Root length (cm)	Stem weight (g)
T1	-*	-	-
T2	8±0.001	4±0.001	0.0345±0.0002
K1	-	-	-
K2	-	-	-
K3	9.5±0.002	2.5±0.0001	0.00328±0.00001
K4	10±0.0011	4±0.001	0.04335±0.000012
K5	11±0.001	4±0.0013	0.0532±0.00001
K6	18.6±0.01	4±0.0012	0.2011±0.00001

* Plant growth was not observed, ±SD (Standard deviation)

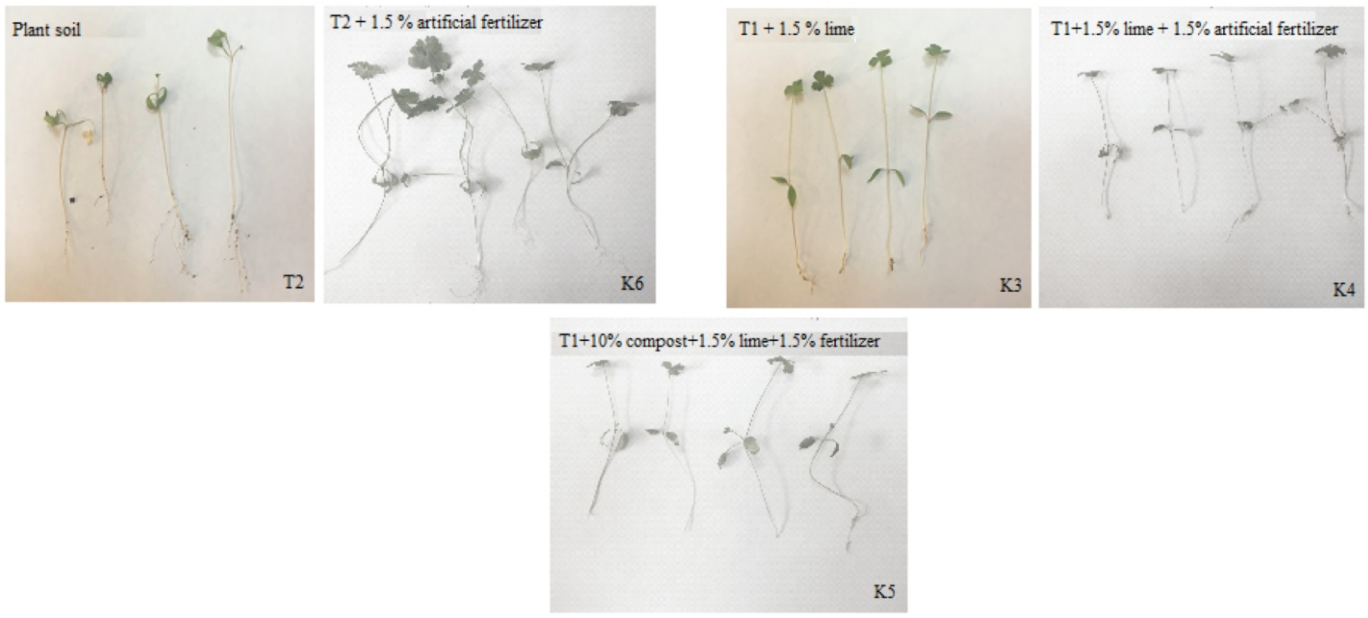


Figure1. Photos of plants developed at the end of the study

References

Aryal, R., Nirola, R., Beecham, S., Sarkar, B. (2016). Influence of heavy metals in root chemistry of Cyperus vaginatus R.Br: a study through optical spectroscopy. Int. Biodeterior and Biodegr, 113, 201-207. [CrossRef]

Bolan, N., Kunhikrishnan, A., Thangarajan, R., Kumpiene, J., Park, J., Makino, T., Kirkham, M.B., Scheckel, K. (2014). Remediation of heavy metal (loid) s contaminated soil to mobilize or to immobilize?. J. Hazard. Mater., 266, 141-166. [CrossRef] [PubMed]

Colin, V.L., Villegas, L.B., Abate, C.M. (2012). Indigenous microorganisms as potential bioremediators for environments contaminated with heavy metals. Int. Biodeterior. Biodegr., 69, 28-37. [CrossRef]

Compost Notification (Kompost Tebliği), (2015). Çevre ve Şehircilik Bakanlığı, Ankara.

Ding, Y., Liu, Y., Liu, S., Li, Z., Tan, X., Huang, X., Zeng, G., Zhou, L., Zheng, B. (2016). Biochar to improve soil fertility. A review. Agron. Sustain. Dev., 36, 36. [CrossRef]

Du, L.N., Yang, Y.Y., Li, G., Wang, S., Jia, X.M., Zhao, Y.H. (2010). Optimization of heavy metal-containing dye Acid Black 172 decolorization by Pseudomonas sp. DY1 using statistical designs. Int. Biodeterior. Biodegr., 64, 566-573. [CrossRef]

U.S. EPA. (2007). "Method 3051A (SW-846): Microwave Assisted Acid Digestion of Sediments, Sludges, and Oils," Revision 1. Washington, DC.

Gray, C., Dunham, S., Dennis, P., Zhao, F., McGrath, S. (2006). Field evaluation of in situ remediation of a heavy metal contaminated soil using lime and red-mud. Environ. Pollut., 142, 530-539. [CrossRef]

Huang, X., Liu, Y., Liu, S., Tan, X., Ding, Y., Zeng, G., Zhou, Y., Zhang, M., Wang, S., Zheng, B. (2016). Effective removal of Cr (vi) using b-cyclodextrinechitosan modified biochars with adsorption/reduction bifuctional roles. RSC Adv., 6, 94-104. [Google Scholar]

Järup, L. (2003). Hazards of heavy metal contamination. British Medical Bulletin, 68, 167–182. [CrossRef] [PubMed]

Kumpiene, J., Lagerkvist, A., Maurice, C. (2008). Stabilization of As, Cr, Cu, Pb and Zn in soil using amendment sea review. Waste Manag., 28, 215-225. [CrossRef] [PubMed]

Lee, S.-H., Lee, J.-S., Choi, Y.J., Kim, J.G. (2009). In situ stabilization of cadmium-, lead-, and zinc-contaminated soil using various amendments. Chemosphere, 77, 1069-1075. [CrossRef]

Li, X., Shunwen, D., Yuan, Y., Wenjin, S., Wu, M., Xu, H. (2016). Inoculation of bacteria for the bioremediation of heavy metals contaminated soil by agrocybe aegerita. RSC Adv., 6 (70), 65816-65824. [Google Scholar]

Luo, C., Liu, C, Wang, Y., Liu, X., Li, F., Zhang,, G., Li, X. (2011). Heavy metal contamination in soils and vegetables near an e-waste processing site, south China. Journal of Hazardous Materials, 186 (1), 481–490. [CrossRef]

Mahar, A., Wang, P., Li, R., Zhang, Z. (2015). Immobilization of lead and cadmium in contaminated soil using amendments: a review. Pedosphere, 25, 555–568. [CrossRef]

Memon, A.R., Aktoprakligil, D., Ozdemir, A., Vertii, A. (2001). Heavy metalaccumulation and detoxification mechanisms in plants. Turk. J. Bot., 25, 111-121. [Google Scholar]

Methodenbuch zur Analyse von Kompost (1994). Bundesgütegemeinschaft Kompost e. V. (Murat Kubatoğlu tarafından tercüme, İSTAÇ A.Ş.).

Neilson, S., Rajakaruna, N. (2015). Phytoremediation of Agricultural Soils: Using Plants to Clean Metal-Contaminated Arable Land. In: Ansari A., Gill S., Gill R., Lanza G., Newman L. (eds) Phytoremediation. Springer, Cham. [CrossRef]

Nirola, R., Megharaj, M., Saint, C., Aryal, R., Thavamani, P., Venkateswarlu, K., Naidu, R., Beecham, S. (2016). Metal bioavailability to Eisenia fetida through copper mine dwelling animal and plant litter, a new challenge on contaminated environment remediation. Int. Biodeterior. Biodegr., 113, 208-216. [CrossRef]

Paradelo R., Villada A., Barral M.T. (2011). Reduction of the short-term availability of copper, lead and zinc in a contaminated soil amended with municipal solid waste compost. J Hazard Mater., 188, 98–104. [CrossRef]

Ruyters, S., Mertens, J., Vassilieva, E., Dehandschutter, B., Poffijn, A., Smolders, E. (2011). The red mud accident in Ajka (Hungary): plant toxicity and trace metal bioavailability in red mud contaminated soil. Environ. Sci. Technol., 45, 1616-1622. [CrossRef] [PubMed]

Sayara, T., Borras, E., Caminal, G., Sarr a, M., S anchez, A. (2011). Bioremediation of PAHs-contaminated soil through composting: influence of bioaugmentation and biostimulation on contaminant biodegradation. Int. Biodeterior. Biodegr., 65, 859-865. [CrossRef]

Shi, W., Shao, H.., Li, H., Shao, M.., Du, S. (2009). Progress in the remediation of hazardous heavy metal-polluted soils by natural zeolite. J. Hazard. Mater., 170, 1-6. [CrossRef]

Sultana, M.Y., Akratos, C.S., Pavlou, S., Vayenas, D.V. (2014). Chromium removal in constructed wetlands: a review. Int. Biodeterior. Biodegr., 96, 181-190. [CrossRef]

TKKNK, (2010). Toprak Kirliliğinin Kontrolü ve Noktasal Kaynaklı Kirlenmiş Sahalara Dair Yönetmelik. Çevre ve Şehircilik Bakanlığı, Ankara.

Ullah, A., Heng, S., Munis, M.F.H., Fahad, S., Yang, X. (2015). Phytoremediation of heavy metals assisted by plant growth promoting (PGP) bacteria: A review. Environmental and Experimental Botany, 117, 28-40. [CrossRef]

Uygun S. (2012). Ülkemizde Kompost Üretimi Yapan Bazı Tesislerdeki Mekanizasyon Uygulamalarının Değerlendirilmesi, Ankara Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi.

Wang, H., Wang, X., Chen, J., Xia, P., Zhao, J. (2016). Recovery of nutrients from wastewater by a MgCl 2 modified zeolite and their reuse as an amendment for Cu and Pb immobilization in soil. RSC Adv, 6, 55809-55818. [Google Scholar]

White, C., Wilkinson, S.C., Gadd, G.M. (1995). The role of microorganisms in biosorption of toxic metals and radionuclides. Int. Biodeterior. Biodegr., 35, 17-40. [CrossRef]

Xu, Y., Yan, X., Fan, L., Fang, Z. (2016). Remediation of Cd (ii)-contaminated soil by three kinds of ferrous phosphate nanoparticles. RSC Adv., 6, 17390-17395. [Google Scholar]

Yan-bing, H., Dao-You, H., Qi-Hong, Z., Shuai, W., Shou-Long, L., Hai-Bo, H., Han-Hua, Z., Chao, X.(2017). A three-season field study on the in-situ remediation of Cd-contaminated paddy soil using lime, two industrial by-products, and a low-Cdaccumulation rice cultivar. Ecotoxicology and Environmental Safety, 136, 135–141. [CrossRef]

Zhang, H., Schuchardt, F., Li, G., Yang, J., Yang, Q. (2013). Emission of volatile sulfur compounds during composting of municipal solid waste (MSW), Waste. Manage., 33, 957–963. [CrossRef]

Zhou, R., Liu, X., Luo, L., Zhou, Y., Wei, J., Chen, A., Tang, L., Wu, H., Deng, Y., Zhang, F., Wang, Y. (2017). Remediation of Cu, Pb, Zn and Cd-contaminated agricultural soil using a combined red mud and compost amendment. International Biodeterioration & Biodegradation, 118, 73-81. [CrossRef]

Zhu, Q.H., Huang, D.Y., Zhu, G.X., Ge, T.D., Liu, G.S., Zhu, H.H., Liu, S.L., Zhang, X.N. (2010). Sepiolite is recommended for the remediation of Cd-contaminated paddy soil. Acta Agric Scand. Sect. B, 60, 110–116. [CrossRef]

Zhuang, P., Zou, B., Li, N., Li, Z. (2009). Heavy metal contamination in soils and food crops around Dabaoshan mine in Guangdong, China: implication for human health. Environ. Geochem. Health, 31, 707-715. [CrossRef]

International Journal of Agriculture, Environment and Food Sciences
JAEFS
e-ISSN : 2618-5946
DOI: 10.31015/jaefs.2019.1.6
www.jaefs.com
Research Article
Int J Agric Environ Food Sci 3(1):22-28 (2019)

Phosphatase enzyme activity in different soils formed on bazaltic parent material under semi humid climate conditions

Aylin Erkoçak[1] **Orhan Dengiz**[2,*]

[1]Black Sea Agricultural Research Institute, Samsun, Turkey
[2]Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Ondokuz Mayis University, Samsun, Turkey

[*]Corresponding Author: odengiz@omu.edu.tr

Abstract

Soil enzymes have an important role in determining the function of microorganism in soil ecosystem. In addition, the enzyme activities give much knowledge on the biochemical processes occurring in soil. Therefore, soil enzymes such as dehydrogenase, phosphatase and urease are indicators of soil biological productivity and activity. This study was carried out to determine phosphatase activity in different land use of Bafra-Engiz Basin, Samsun and to investigate the relations between soil pedogenetic processes, land use, elevation and phosphatase activities. For this purpose, soil samples taken from the four soil profiles classified as Typic Haplustert and Lithic Ustorthent. The analysis results related to phosphatase activity of soils in the study area changed between 8.1-177.3 µg p-nitrophenol. Moreover, according to statistical analysis results different profiles and different elevation were found to be important at 1% level of effect on phosphatase enzyme activity in the soils. Finally, it was also determined that the effect of different land use type on the activity of phosphatase enzyme activity in the soil was insignificant as statistically.

Keywords: Phosphatase enzyme activity, Soil development, Soil classification

Received: 01 September 2018 Accepted: 28 November 2018 Revised: 08 December 2018 Published: 10 January 2019

Introduction

Soil is a dynamic environment that differs in both time and space and contains many living species. These living species in the soil play an important role in bringing the vitamins and hormones that promote plant growth by storing plant nutrients dissolved in water. Soil microorganisms and some other macroscopic organisms increase soil fertility so they provide vegetation enhancement especially in natural ecosystems. These living species which help to form the soil by separating rocks and minerals are influential in the formation and development processes of the soils with the parent material, topography, climate and time factors. For this reason, microorganisms have significant functions on soil fertility and quality.

Microbial activity is also important in bio-chemical soil processes as well as it is also associated with the presence of soil enzymes (Kiss et al., 1975; Nakas et al., 1987; Martens et al., 1992; Elliott et al., 1993). Soil enzymes are related with other biological properties of soil and play a vital role in mineralization processes (Frankberger and Dick, 1983; Tate, 1987). In addition to that, enzymes such as urease, phosphatase and β-glycosidase are involved in the mineralization of organic matter in the soil and have also more effect for soil fertility (Burns, 1978). Some researcher indicated that many factors such as organic matter and agricultural practices influence the present populations of microorganisms in the soil (Coxson and Parkinson, 1987; Kowalenko et al., 1978). Thus, determination for amounts of these existing microorganisms in the soil can also reflect the activity of microorganisms with enzymes such as CO_2 production and dehydrogenase activity, together with different counting techniques (Nannipieri et al., 1990).

One of the most important indicators for soil development is structural growing (strong granular or block structure in surface and in subsurface horizons) stem from aggregate formation and aggregate size fractions. Dengiz et al. (2013) carried out an investigation to determine changes in microbial response in natural soil aggregates for soil characterization in different fluvial land shapes. The majority soils of in their study area were classified as Typic Ustifluvent and Typic Haplustept in Soil Taxonomy. Results of this study showed that the aggregate size distribution and some microbial properties and activities in aggregates varied significantly in different developed soil types formed on different fluvial landscape positions. Especially macroaggregates (diameter >250 μm) found high content in Typic Haplustept are important for soil porosity, microbial habitats and their activities and soil development. The main effects of the macroaggregates on the microbial response may be increasing by the accumulation and decomposition of organic matter. Consequently, researches indicated that this study evidenced contrasting microbial habitats in different soil aggregate sizes formed in various developed soils.

Cite this article as:
Erkocak, A., Dengiz, O. (2019). Phosphatase Enzyme Activity in Different Soils Formed on Bazaltic Parent Material under Semi Humid Climate Conditions. Int. J. Agric. Environ. Food Sci., 3(1), 22-28. DOI: https://doi.org/10.31015/jaefs.2019.1.6
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 22-28
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

DOI: https://doi.org/10.31015/jaefs.2019.1.6

In this present study, it was aimed to determine some physical and chemical properties with phosphatase enzyme activity of the soils developed on the bazaltic parent material in semi-humid temperate climatic conditions and to determine the relationships between phosphatase enzyme activity and different elevations and different land uses in the Engiz Basin located at Bafra district of Samsun province. Thus, it was planned that the effects of these parameters discussed on the formation and development processes of the soil in the study area.

Materials and Methods

General Description of Study Area

This study was carried out in Samsun-Bafra delta plain and its near district. The Bafra Plain found in the Kızılırmak Delta and located in the Central Black Sea Region of Turkey (Figure 1). The study area is far 30 km from west of the Samsun province and coordinated as 4554000-4558000 N and 751000-758000E UTM (37 Zone m). It covers about 1762 ha and its lies at an elevation from sea level between 10 and 300 m.

According to Soil Taxonomy (1999), the study site has mesic soil temperature regime and ustic moisture regime. Major physiographic units of the study area are four landscape features (foot slope, back slope, lowland plateau and shoulder) representing changes in geomorphology, topographic gradient, parent material and soil characteristics. The underlying bedrock consists primarily of Quaternary-age basaltic, colluvial deposits on the foot slope, lowland plateau, and Mesozoic-age basalt and marl-limestone on the back slope and highland plateau. The study area is covered mostly by forest and pasture land. A minority of the study area consists of a slightly sloped (0.0 to 2.0%) low plateau, while other sections are hilly and moderately to severely slope (3 to 20%). Only a small part of the foot slope and lowland plateau is agricultural land.

The Engiz Stream plays a major role in the formation and development of the study area's landscape. In the soils formed on the basalt material considered, there are pasture and dry farming areas, and although there are very few forest areas formed of oaks. The main herbaceous families that are common in pasture areas are; *Cruciferae, Gramineae, Umbelliferae, Compositae, Fabaceae and Rosaceae'*dır. In addition, in areas where dry agriculture is carried out, generally wheat agriculture has been cultivated.

The current climate in the region is semi-humid. The summers are warmer than winters (the average temperature in July is 22.2 and in January is 6.9 °C). The coldest month of the year is February in the study area (5.6 ºC). Average temperatures in four months of the year (December, January, February, and March) are below 10 °C but after April average temperatures raise. The mean annual temperature, rainfall and evaporation are 13.6◦C, 764.3 mm and 726.7 mm, respectively. When the distribution of rainfall according to the season is examined, it is seen that the most rainfall is in the autumn season and the least rainfall is in the summer season. According to this, it is possible to say that the rainfall is distributed all the year though it is not very regular.

Method

In this study based on the hypothesis that topography, parent material and vegetation cover might be the main controlling factors for biological activity in soil development, soils have been studied along a transverse section (diagonally in the southwestern to northwestern direction) using four representative profiles (Figure 2). The morphological features of these four profiles from the field were identified and sampled by genetic horizons and classified in accordance with Soil Survey Staff (1993, 1999). Twelve disturbed and undisturbed the samples of soil were taken to the laboratory to search for their physical, chemical features. The soil samples were first air-dried and then passed through a 2 mm sieve to be ready for laboratory analysis.

Four profiles were opened on the Southwest-Northeast transect section and from the horizons of each profile disturbed and undisturbed soil samples were made according to the horizon basis (Figure 2).

Physical and Chemical Analyses

Texture by hydrometer method (Bouyoucos 1951), pH and electrical conductivity (EC) in 1:1 (w/v) in soil: water suspension by pH-meter and EC-meter (Soil Survey Staff 1992), $CaCO_3$ by Scheibler calcimetric method (Soil Survey Staff 1992), total nitrogen by Kjeldahl method (Bremner and Mulvaney 1982), available P by 0.5 M $NaHCO_3$ extraction method (Olsen 1954), exchangeable cations (Na, K, Ca and Mg) by 1 N NH_4OAc extraction method, cation exchange capacity (CEC) by Soil Survey Staff (1992), soil organic matter by a modified Walkley-Black method (Jackson, 1958).

Phosphatase Enzyme Activity

Alkaline phosphatase activity (APA) was determined according to Tabatabai and Bremner (1969). 4 ml phosphate buffer (pH 11.0) and 1 ml of 0.025 M p-nitrophenyl phosphate (disodium salt hexahydrate) solution were added to the 1 g sample and the samples were incubated for 1 h at 37 ºC. The formation of p-nitrophenol was determined spectrophotometrically at 410 nm and results were expressed as µg p-nitrophenol g^{-1} dry soil h^{-1}. The results of alkaline phosphatase enzyme activity reported with the mean value of three replicates determinations calculated on an oven-dry basis; moisture was determined from loss in weight after drying the soil at 105 ºC for 24 h.

Statistical Analyses

SPSS 17.0 package program was used to determine the relationships between phosphatase enzyme activity and different profiles, land use and height in the soil samples of the study area.

Results and Discussions

Physical, Chemical Properties and Classification of Soils

Four profiles opened on southwest-northeast (SW-NE) section and soil samples were taken from the horizons belonging to each profile according to the horizon basis. Some physico-chemical analyses results of the profiles located on SW-NE transect are given in Table 1 and Table 2. In addition the majority soils of the study area were classified as Typic Ustifluvent and Typic Haplustept in Soil Taxonomy (1999).

The profile coded as PIV and classified as Typic Haplusert formed on the footslope position and has deep soil. All profile has clay texture and clay content of the profile varies between %56.2 and %78.4. This case directly affects the saturation of soils so, especially the increase in the amount of clay along with soil depth it also increases the saturation conditions of the soil. The cation exchange capacity (CEC) is 42.8 cmol(c). kg^{-1} due to the amount

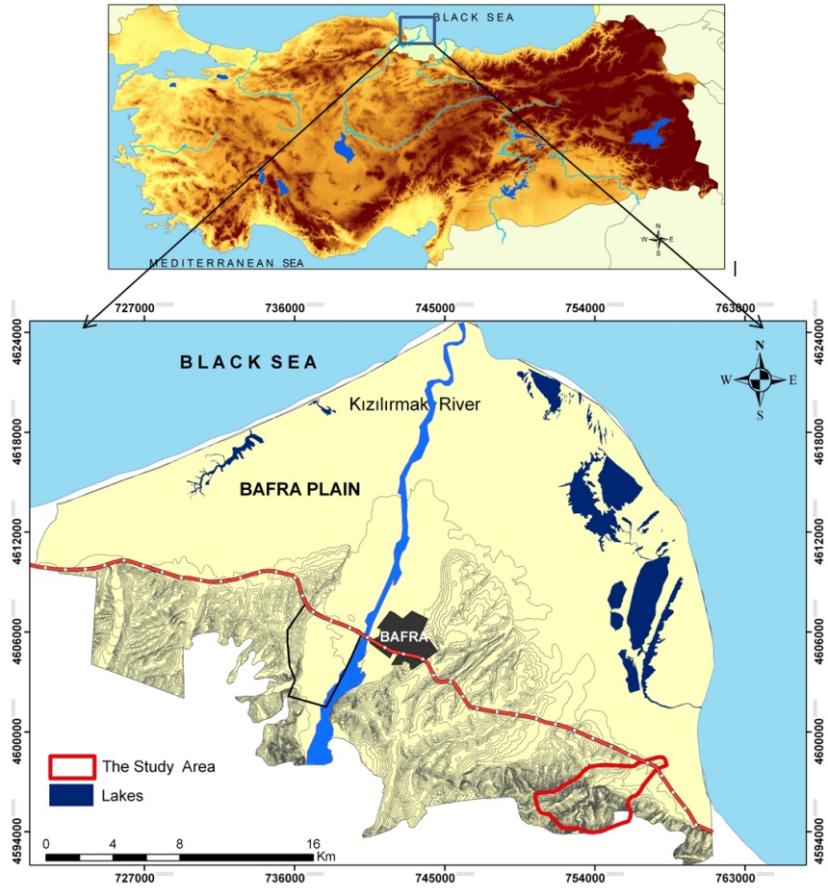


Figure 1. Location of the study area

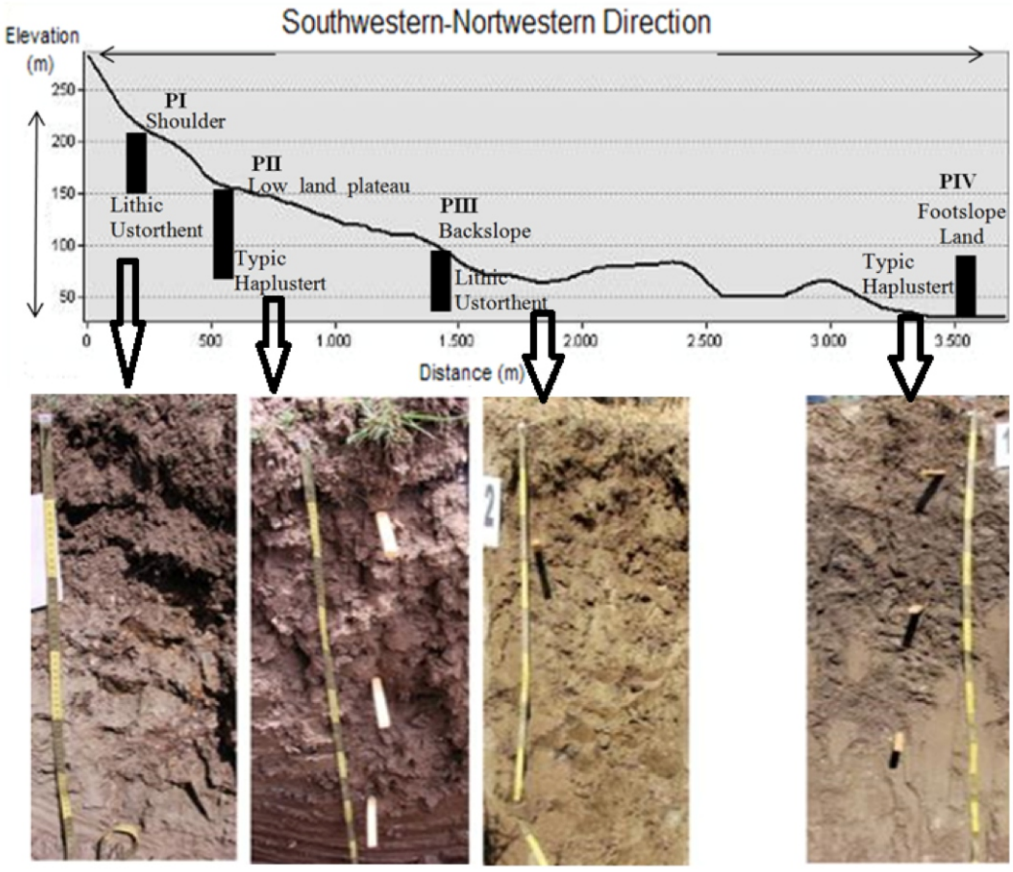


Figure 2. Transect of the four different soil profiles on basalt parent material but different topographical positions

DOI: https://doi.org/10.31015/jaefs.2019.1.6

of clay content and organic matter on the surface whereas, this amount shows reducing with the soil depth due to decreasing of organic matter content. In addition, organic matter content is 1.65% on the surface on the other hand, it falls dramaticly to 0.14% after 65 cm depth. The soil reaction of profile PIV has slightly alkaline and pH values range between 7.50 and 8.25. The amount of lime ($CaCO_3$) content was found low level in all the profile and changes between 0.20% and 2.67% from surface to depth because of leaching process. The dominant exchangeable cations of profile PIV are Ca and Mg ions in soils. Also, there is no salinity and alkalinity problem for this profile.

Lithic Ustortent showen as PIII symbols located on back slope position and slightly steep slope (12-20%). This profile has shallow depth. Generally the around fields of this profile have been used as degradated forest land due to deforestation activity. This situation leads to the transport of the soil from upland to low land due to unsuitable tillage practices. Profile PIII has low pedogenic process so, this soil can be defined as young soil and has Ap/Cr horizon order. While the surface horizon includes clay loam texture, subsurface layer (Cr) which is the parent material and mostly affected under parent rock alteration has sandy loam. It can also be said that although the CEC is 42.9 cmol(c). kg^{-1} due to the amount of clay content and organic matter on the surface it falls to 15.4 cmol(c). kg^{-1} after 24 cm depth. This situation shows parallel with the amount of organic matter and it was found 2.35% on the surface but it falls to 0.55% in the subsurface layer. The amount of lime was detected too low in the profile. On the other hand, due to dominant basic cations resulted from alteration and weathering of basaltic rock, soil reaction is also slightly alkaline and pH values range between 7.87 and 8.04. The dominant exchangeable cations are Ca and Mg ions in soils. Moreover, there is also no salinity and alkalinity problem for this profile.

The profile number PII classified as Typic Hapustert formed on lowland platue and has slightly slope (2-6%). The soils in these fields, which usually contain pasture covers, are depth and this profile showed similarity with PIV has heavy texture in all depth. Clay content varies between 40.3% and 68.5% in the profile. As in the profil coded as PIV, this case directly influences also the saturation increasing with clay content in soil depth. The bulk density values were the lowest in the surface or close to the surface horizons, and they increased progressively with depth. Similar results were reported by Göl and Dengiz (2008). Lower bulk density values were related to organic matter and clay content, especially at the surface horizon. The CEC values varied and could be correlated to clay and organic matter content, with maximum values of 42.80 cmol(c). kg^{-1}, in the surface soils of all profiles, and minimum values of 11.09 cmol(c). kg^{-1} in the subsurface horizons (C or Cr).Organic matter content was detected 1.71% in the surface soil but it deceresed to 0.59% after 48 cm depth. The soil reaction slightly alkaline and pH values range between 7.05 and 7.96. The amount of lime is too low in the profile. Besides, while the lime content is 0.79% in the surface layer, this ratio became 1.37% with increasing depth due to leaching and calcification processes. As the other all profiles, the dominant exchangeable cations are Ca and Mg ions in for PII. It can be also said that there is no salinity and alkalinity problem in the soils.

Profile located on the highest posion (at 185 m from sea level) of southwest-northeast section, was coded as PI. In this profile the soils have steep slope and the surface covered by very weak intensity vegetation so, soil has been excessively exposed to erosion process caused very shallow depth. Sommer et al. (2008) reported that in general, some parts of the landscape will erode faster than others depending on the local geomorphic situation and spatially varying soil erodibility. Other parts, which are not affected by soil erosion/sedimentation, e.g., flat plateaus, are characterized by further progressive soil development. Therefore, slope has been regarded as one of the most important factor that controls the pedogenic process on PI, and PIII. Depth of the PI and PIII' soils decreases with increasing slope degree. The clay content (34.4%) was higher in the A horizon whereas, sand content was found about 75% in subsurface layer in this profile. Ovalles and Collins (1986) reported that physical soil properties such as the distribution of clay content with depth, sand content and pH were highly correlated to landscape position. This profile has lower pH values, being located on the upper slope positions that promote basic cation leaching, whereas other profiles were neutral to basic soil reaction pH values. In addition, $CaCO_3$ contents ranged from 0.20% to 2.67% even the development of all these profiles on basaltic parent material which doesn't produce carbonate. It can be said that this case resulted from carbonate contamination. Similar to our findings, Aksoy (1991) found a lime content of 2% to 26% in soils on the Kayacik plains in Gaziantep, although the primary material in the area of their study was basalt.

The profile PIII and PI have shallow soil depth that can not have enough pedogenetic process. Because, these soils are located on high slope position and they are not covered with enough vegetation. It is well known that Slope brings greater runoff, as well as to greater translocation of surface materials down-slope through surface erosion and soil movement. Therefore, they have been exposed to erosion due to unsuitable tillage practices. These soils do not usually have endopedon except for an ochric epipedone on the surface. There is no horizon except for lithic contact in the depth of 50 cm subsurface. The horizon orders of the PI and PIII profiles were defined as A-Cr horizons. The soils are classified in the orthent sub ordo due to their location on the slope land and also these soils are classified under the ustorthent and Lithic Ustorthent sub ordo due to the humidity regime. According to the FAO/WRB (2014) classification system, these profiles were classified as Eutric Regosol.

As for PIV and PII profiles have very large amounts of swelling clays (50% and more along with the profile), as indicated by surface cracks ranging from 1 to 5 cm in width, as well as intersecting slickensides and shiny pressure faces in the subsurface horizon (Bss) This also reflects a shrinking and swelling of the soil. Accordingly, profiles PII and PIV were classified as Typic Haplustert. These profiles were also classified as Haplic Vertisol by taking the FAO/WRB (2014) classification system into consideration.

Phosphatase Enzyme Activity of Soils

Surface and subsurface soil samples were taken from four profiles to determine the phosphatase enzyme activity of the soils. For this purpose, the phosphatase enzyme activity has been carried out 3 repeatedly and the results of this analysis are given in Table 3.

Most of the chemical events that take place in the soil are the result of activities of microorganisms living in the soil. Microorganisms decompose high polymer compounds such as cellulose, lignin, phosphate esters, protein, carbohydrate,

Table 1. Some soil chemical analysis results of profiles classified according to Soil Taxonomy (1999) and FAO-WRB (2014)

Horizon	Depth (cm)	pH	EC ($dS.m^{-1}$)	$CaCO_3$ (%)	O.M (%)	Exchangeable Cations ($cmol.kg^{-1}$)			CEC ($cmol.kg^{-1}$)
						Na^+	K^+	$Ca^{++}+Mg^{++}$	
PIV / Typic Haplustert- Haplic Vertisol / Foot slope / Dry Farming / 25 m									
Ap	0-23	7.50	0.17	0.20	1.65	0.22	1.67	40.91	42.8
Bss1	23-65	7.30	0.44	0.98	1.26	0.25	1.47	39.64	41.4
Bss2	65-106	8.25	0.17	1.10	1.09	1.33	1.41	37.59	40.3
C	106 +	8.14	0.11	2.67	0.14	1.35	1.40	36.04	39.9
PIII/ Lithic Ustorthent- Eutric Regosol / Back slope / Degradated Forest / 42 m									
Ap	0-24	7.87	0.55	0.49	2.35	0.41	0.28	42.24	42.9
Cr	24+	8.04	0.10	0.29	0.55	1.03	0.15	14.20	15.4
PII / Typic Haplustert- Haplic Vertisol / Lowland platue / Pasture /132 m									
A	0-12	7,05	0.16	0.79	1.71	0.35	0.24	40.17	40.8
Bss1	12-48	7.72	0.19	0.29	1.69	0.74	0.31	48.07	49.1
Bss2	48-89	7.79	0.34	1.37	0.59	1.31	0.41	47.25	48.9
C	89+	7.96	0.30	1.18	0.17	1.26	0.24	32.84	34.4
PI / Lithic Ustorthent- Eutric Regosol / Shoulder / Pasture / 185 m									
A	0-16	7.03	0.19	0.50	2.25	0.28	1.02	33.16	34.5
Cr	16+	6.93	0.25	0.20	0.42	0.45	1.24	9.39	11.1

pH: Soil Reaction EC: Electrical Conductivity, OM: Organic matter, C: Clay, Si: Silt, S: Sand

Table 2. Some soil physical analysis results of profiles classified according to Soil Taxonomy (1999)

Horizon	Depth (cm)	Texture (%)				BD ($g\ cm^{-3}$)	Saturation (%)
		Clay	Silt	Sand	Class		
PIV / Typic Haplustert- Haplic Vertisol / Foot slope / Dry Farming / 25 m							
Ap	0-23	56.2	23.1	20.7	C	1.45	74.1
Bss1	23-65	62.6	12.8	24.5	C	1.57	82.3
Bss2	65-106	68.4	15.8	15.8	C	1.45	85.0
C	106 +	78.4	2.8	18.8	C	-	93.6
PIII/ Lithic Ustorthent- Eutric Regosol / Back slope / Degradated Forest / 42 m							
Ap	0-24	32.1	27.9	40.1	CL	1.41	48.8
Cr	24+	17.2	17.1	65.7	SL	-	25.4
PII / Typic Haplustert- Haplic Vertisol / Lowland platue / Pasture /132 m							
A	0-12	41.5	24.2	34.3	C	1.48	82.5
Bss1	12-48	68.5	18.3	13.2	C	1.50	106.1
Bss2	48-89	49.8	26.4	23.9	C	1.53	89.3
C	89+	40.3	34.2	25.5	C	-	79.0
PI / Lithic Ustorthent- Eutric Regosol / Shoulder / Pasture / 185 m							
A	0-16	34.4	25.5	40.1	CL	1.53	50.4
Cr	16+	17.1	8.4	74.5	SL	-	28.1

Table 3. Concentrations of the phosphatase enzyme activity in surface and subsurface horizons of profile

Horizon	Depth (cm)	Phosphatase Activity ((p-NF) g^{-1})
PIV / Typic Haplustert- Haplic Vertisol / Foot slope / Dry Farming / 25 m		
Ap	0-23	144.6
Bss1	23-65	177.3
PIII/ Lithic Ustorthent- Eutric Regosol / Back slope / Degradated Forest / 42 m		
Ap	0-24	67.7
Cr	24-74	81
PII / Typic Haplustert- Haplic Vertisol / Lowland platue / Pasture /132 m		
A	0-12	154.9
Bss1	12-48	134.4
PI / Lithic Ustorthent- Eutric Regosol / Shoulder / Pasture / 185 m		
A	0-16	145.2
Cr	16+	5.2

DOI: https://doi.org/10.31015/jaefs.2019.1.6

starch in organic wastes by releasing ecto-enzymes at the end of the series of biochemical reactions. In addition to microorganisms, higher plants also benefit from nutrient ions that come from high polymer compounds due to the effects of enzymatic reactions in the soil. In addition, microbial population and its activity have not only a essential role on bio-geo-chemical cycles of element in a soil profile but also have a significant task for the weathering processes or soil aggregation by providing organic ligands and acids, and by supplying increased CO_2 concentrations in the soil (Drever and Vance 1994). In this study, it has been determined that the phosphatase enzyme activity of the soil samples taken from the profiles found on (SW-NE) transect was changed between 8.1-177.3 µg p-nitrophenol. When the results of the analysis were evaluated, the activity of phosphatase enzyme in soil samples was determined generally higher level in the surface soils than subsurface soils (except for Bss of PIV). Dengiz et al (2013) reported that one of the most effective factors is organic carbon on microbial population and their activities to get their energy and nutrient elements. This case was also supported by Nyamadzawo et al. (2009) and Christensen and Sorensen (1985). They indicated that various soil textural fractions influence microbial growth and substrate utilization in soils. In this case, particularly clay types and their specific surface area' size have a fundamental role because sand fractions have smaller surface area, thus they can only support a smaller microbial population. Clay fractions have a larger surface area and are among the most important constituents influencing microbial population and their activities. In this study, when compared Typic Haplustert and Lithic Ustorthent, it can be detected that Lithic Ustorthent has lower phosphatase enzyme activity than Lithic Ustorthent due to its low organic matter, insufficient nutrient element concentration, low clay and high sand content.

Relationship of Phosphatase Enzyme Activity with Land Use Types and Elevation of Soils

The results of phosphatase enzyme activity were evaluated statistically in three different ways which are i-) relationship between the profiles and phosphatase enzyme activity, ii-) relationship between the land use and phosphatase enzyme activity and iii-) relationship between the elevation and position of profile and phosphatase enzyme activity.

In first case (relation between phosphatase enzyme activity and profiles), the statistical results for the changes in phosphatase enzyme activities of soils on the southwest-northeast section are presented in Table 4. According to the results of ANOVA test, it was found that different profiles along the Southwest-Northeast line are important at 1% level of the effect on phosphatase enzyme activity ($P=0.000<0.01$). According to the DUNCAN test, it was determined that the highest phosphatase enzyme activity along the Southwest-Northeast line was in the PIV, PI and PII profiles, respectively. Also, the lowest phosphatase enzyme activity was found in the PIII profile.

Statistical results for the relationship between land use types and phosphatase enzyme activity in the Southwest-Northeast section are also given in Table 4. It was found the different values of phosphatase enzyme activity in soils under various land use types after analysis. On the other hand, it was deceted that there was statistically insignificant difference between the land use pattern and the phosphatase enzyme activity in the soil.

As for relation the phosphatase enzyme activit and elevation and land position of profiles, according statistical results for changes in between phosphatase enzyme activity and different altitude of profiles were found to be important at 1% level of the effect on the phosphatase enzyme activity in the soil ($P=0.000<0.01$). It was determined that the maximum phosphatase enzyme activity was 25 m, 185 m and 132 m altitude, and the lowest phosphatase enzyme activity was found at 42 m altitude and back slope position. Accordingly, it can be said that the enzyme activity decreases as the height increases. In this case, it can be said that phosphatase enzyme activity is decreasing with increasing altitude but this case is not lineer relation between them.

Conclusion

In this current study the properties of various developed four soils profiles formed on topographically different positions of SE-NE direction were investigated. The investigation considered the phosphatase enzyme activity in Typic Haplustert and Lthic Ustorthent soils represented by four profiles formed on basaltic parent material in order to understand its relationship with these soils, landscape, land use, land position and elevation

As a result of this research, some physical and chemical properties and phosphatase enzyme activity of the soils formed on the basaltic parent material in semi humid temperate climatic conditions were determined in the Engiz Basin in Bafra district of Samsun province. In addition to that, the relationships between different altitude-slope positions and different land use types with phosphatase enzyme activity were investigated.

Table 4. Relationship between phosphatase enzyme activity and profiles, land use types and elevation-land positions

Profiles	**Mean + Standard Error**
PIV / Typic Haplustert- Haplic Vertisol	160.9±8.8a
PIII/ Lithic Ustorthent- Eutric Regosol	37.9±13.3b
PII / Typic Haplustert- Haplic Vertisol	144.6±5.4a
PI / Lithic Ustorthent- Eutric Regosol	145.2±2.8a
Land Use Types	**Mean + Standard Error**
Acricultural land	144.8+3.6
Pasture	99.4±20.1
Degradated Forest	110.0±15.8
Elevation (m) and Land Positions	**Mean + Standard Error**
25 m and Foot slope	160.9±8.8a
42 m and Back slope	37.9±13.3b
132 m and Lowland platue	144.6.6±5.4a
185 m and Shoulder	145.2±2.8a

Acknowledgement

This research was supported by TUBITAK project which has 213O073 number. We wish to thank TUBITAK for their support.

References

Aksoy, E.(1991). Güney doğu Anadolu bölgesindeki petrocalcik horizonlu toprakların önemli özellikleri oluşu ve sınıflandırılması. Toprak İlmi Derneği 12. bilimsel toplantısı (in Turkish)

Bouyoucos, G. J. (1951). A Recalibration of Hydrometer for Making Mechanical Analysis of Soils. Agronomy Journal, 43(9), 434-443. [Google Scholar]

Bremner, J.M. and Mulvaney, C.S. (1982). Nitrogen-Total. In: Page, AL, Miller, RH, editors. Methods of Soil Analysis. Part 2. 2nd edition. Agronomy Monographs, 9, Madison, WI: ASA and SSSA, p595–624.

Burns, R.G. (1978). Soil Enzymes. Academic Press. 149-190. London.

Coxson, D.S., and Parkinson, D. (1987). Winter respiratory activity in aspen woodland forest floor litter and soils. Soil Biol. Biochem. 19: 49-59. [CrossRef]

Christensen, B.T, Sorensen, L.H. (1985). The distribution of native and labelled carbon between soil particle size fractions isolated from longterm incubation experiments. J Soil Sci 36:219–229. [CrossRef]

Dengiz, O., Kızılkaya, R., Erkoçak, A., Durmuş, M. (2013). Variables of microbial response in natural soil aggregates for soil characterization in different fluvial land shapes. Geomikrobyology Journal, 30; 100-107. [CrossRef]

Drever, J.L, Vance, G.F. (1994). Role of soil organic acids in mineral weathering processes. In: Lewan MD, Pittman ED, editors. Role of Soil Organic Acids in Geological Processes. New York: Springer. p138–161.

Elliott, E.T., Cambardella, C.A., and Cole, C.V. (1993). Modification of ecosystem processes by management and the mediation of soil organic matter dynamics. Plant Soil, 22:129-138. [Google Scholar]

FAO-WRB. (2014). World References Base for Soil Resources. International soil classification system for naming soils and creating legends for soil maps. World Soil Rep., 106. FAO. Rome.

Frankberger W. T., Dick W. A. (1983). Relationships with enzyme activities and microbial growth and activity indices in soil. Soil Sci. Soc. of American J. 47: 945-951. [CrossRef]

Jackson, M. L. 1958. Soil Chemical Analysis. Englewood Cliffs, New Jersey: Prentice Hall Inc.

Göl, C. and Dengiz, O. (2008). Effect of Modifying Land Cover and Long-Term Agricultural Practices on the Soil Characteristics in Native Forest-Land. Journal of Environmental Biology, 29; 667-682. [Google Scholar]

Kiss, S., Dragan-Bularda, M., and Radulescu, D. (1975). Biological significance of enzymes accumulated in soil. Adv. Agron., 27:25-87. [CrossRef]

Kowalenko, G.C., L.V Arson, K.C., and Cameron, D.R. (1978). Effects of moisture content, temperature and nitrogen fertilization on carbon dioxide evoluuion from field soils. Soil Biol. Biochem. 10: 417- 423. [CrossRef]

Martens, D.A., Johanson, J.B., and Frankenberger JR, W.T. (1992). Production and persistence of soil enzyme with repeated addition of organic residues. Soil Sci., 153:53-61. [Google Scholar]

Nakas, J.P., Gould, W.D., and Klein, D.A. (1987). Origin and expression of phosphatase activity in semiarid grassland. Soil Biol. Biochem., 19:13-18. [CrossRef]

Nannipieri, P., Grego, S., and Ceccantl, B. (1990). Ecological Significance of the biological activity in soil. (in). Bollag. J.M. Stotzky. G. Soil Biochemistry. Volume 6. Mareel Dekker Inc. N.Y. [Google Scholar]

Nyamadzawo, G., Nyamangara, J., Nyamungafata, P., Muzulu, A. (2009). Soil microbial biomass and mineralization of aggregate protected carbon in fallow-maize systems under conventional no tillage in Central Zimbabwe. Soil Tillage Res 102:151–157. [CrossRef]

Olsen, S.R. (1954). Estimation of Available Phosphorous is Soil by Extraction with Sodium Bicarbonate. Circular No. 939.Washington, DC:U.S. Department of Agriculture.

Ovalles, F.A., Collins, M.E. (1986). Soil-landscape relationships and soil variability in north central Florida. Soil Sci. Soc. of American J. 50: 401-408. [CrossRef]

Soil Survey Staff. (1992). Procedures for Collecting Soil Samples and Methods of Analysis for Soil Survey. Soil Surv. Invest. Report, Washington D.C., USA: I. U.S. Gov. Print. Office.

Soil Survey Staff. (1993). Soil Survey Manual, USDA Handbook, Washington D.C., No: 18.

Soil Survey Staff. (1999). Soil Taxonomy. A Basic of Soil Classification for Making and Interpreting Soil Survey. USDA Handbook, Washington D.C., No: 436.

Sommer, M., Gerke, H.H. and Deumlich, D. (2008). Modelling soil landscape genesis-A time split approach for hummocky agricultural landscapes. Geoderma 145: 480–493. [CrossRef]

Tabatabai, M.A. and Bremmer, J.M. (1969). Use of p-nitrophely phosphate for assay of soil phosphatase activity. Soil Biol. Biochem.1: 301-307. [CrossRef]

Tate R. L. (1987). Soil enzymes and organic matter transformations. In soil organic matter, biological and ecological effects. Wiley-Interscience Publications, 69-94, New York.

International Journal of
Agriculture, Environment and Food Sciences

JAEFS e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.7 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):29-33 (2019)

Effects of tillage systems on second crop sesame *(sesamum indicum L.)* yield and weed density

Ferhat Ozturk[1,*]

[1]Department of Field crop, Faculty of Agriculture, Sirnak University, 73300, Sirnak, Turkey

[*]Corresponding Author: fozturk@sirnak.edu.tr

Abstract

The aim of this research was to define conventional (CT) and conservation tillage systems in sesame (Sesamum indicum L.) farming as a second crop after harvesting lentil in southeastern region in Turkey. Toward this aim, four different soil tillage methods namely, moldboard plough + disc harrow + float +seeding (CT), disc harrow plus+ float + seeding (RT1), cultivator +float+ seeding (RT2) and no-tillage (NT) (seeding by direct drill) were examined on yield of sesame and some of plan properties at southeastern part of Turkey.The experiment was carried out in research area of faculty of agriculture, Diyarbakir, Turkey in 2014 crop season. The study was designed in accordance with the randomized block design and carried out in three replications. The Results showed that seed yield and weeds density were positively affected by the tillage methods. The increase in the seed yield observed at Conservation tillage while decrease in the weeds population. The highest yield value was found from CT methods (1623.3 kg ha^{-1}). The tillage methods were not found statistically effect on protein and oil rate.

Keywords: Second crop, Sesame, Tillage, Yield, Emergence rate, Weed density

Received: 08 January 2019 Accepted: 24 February 2019 Revised: 03 March 2019 Published: 10 March 2019

Introduction

Sesame (Sesamum indicum L.) is among so major arable the second crop in conventional farming in Southeastern region of Turkey. It is very resistant to drought crop and is therefore mainly grown as dry land crop in Turkey. The average production amounts of sesame are 18410 tons and seed yield 656.8 kg ha^{-1} in Turkey (FAO, 2017). However, in our country, Entry of farm irrigation after GAP has led to increase in irrigation farming and therefore second crop sesame so important for grower. However, the most important problems in sesame is planting operations. The sesame seeds are minor and sowing must be made as close to the ground surface for seed emergence. Seed cannot be deep that the germination does not occur. Conventional tillage method is intensive in this region. Tillage is power-required work of agricultural manufacture. Because, the extreme cost of energy that is why the farmers need to economical tillage methods. The application of energy-saving systems can perform efficient supports to economical (Bayhan et al., 2006; Sessiz et al., 2009). Agriculture is considered as an energy conversion (Baran and Gokdogan, 2017). Farmers prefer conservation tillage in sesame farming. Conservation tillage methods offer considerable advantages compared to the conventional tillage. Therefore, reduce or no-tillage systems are becoming widespread. Other advantages of no-tillage include reducing soil moisture loss, reduced soil erosion, increased water protection and soil accumulation increasing soil organic matter; reduce time, and reducing greenhouse gas emission (Cakır et al., 2006; Sessiz et al., 2008) as compared to CT. NT has not been widely adopted in Turkey, especially in southeastern region. To increase production and reduce production cost in soil tillage operations, reduced tillage and direct seeding system is of great importance. Appropriate tillage and sowing technique can reduce factors that impede seedling emergence reduce energy and labor cost, and control weeds. How ewer, the success of tillage methods is depending soil, climate and local practices (Bayhan et al., 2006; Ozpinar and Cay, 2006; Sessiz et al., 2009; Sessiz et al., 2010). Especially weed control in agricultural cultural practices is so expensive among applications.

Weeds have an adverse effect on crop yields because of competition with cultivated plants (Sessiz et al., 2009; Öztürk et al., 2018). Mostly hand and cultivator do the weed control in sesame farming. Because the manual weed struggle is a tedious, time consuming and expensive process. Therefore, mechanicals struggle is so importance in weed control processes. The mechanically weed struggle does not only destroy weeds but also increases the aeration of the soil. The germination of weed seeds or the application of the vegetative propagation organs varies depending on the soil temperature, light, light soil handling patterns and processing depth. As the chemical struggle leads to environmental pollution that is why the mechanical struggle is important as alternative method of struggle.

Cite this article as:
Ozturk, F. (2019). Effects of tillage systems on second crop sesame (sesamum indicum L.) yield and weed density. Int. J. Agric. Environ. Food Sci., 3(1), 29-33. DOI: https://doi.org/10.31015/jaefs.2019.1.7
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 29-33
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

DOI: https://doi.org/10.31015/jaefs.2019.1.7

Agricultural irrigation has occurred an increase in the southeastern Anatolian region after project of The GAP. Therefore, the second product sesame cultivation has gained importance.

The soil structure deterioration, soil erosion occurred due to the conventional tillage method of the farmers in the region. Because of the farmers in the region, using of conventional tillage methods were occurred physical deterioration of soil and increased soil erosion etc. (Sessiz et al., 2009; Öztürk et al., 2018; Elicin et al., 2018).

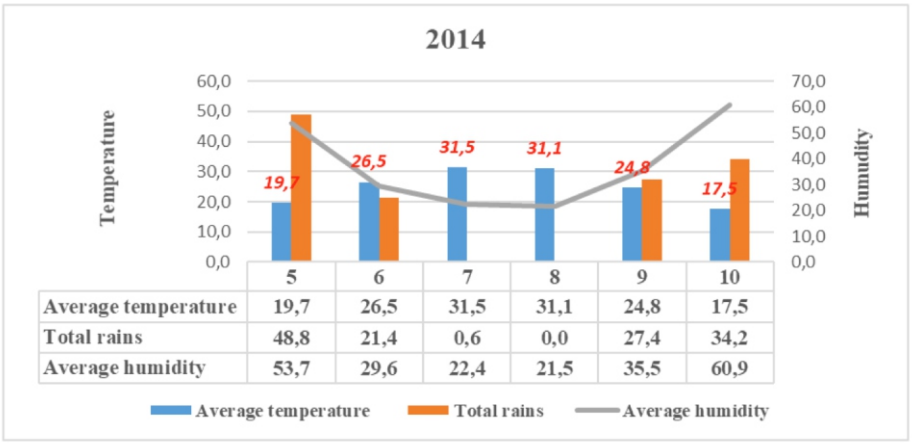
The goal of this research was to determine the effects of soil tillage systems on yield and weed density in second crop sesame in Southeastern part of Turkey.

Materials and Methods

This research was established in experimental area of the University of Dicle, Faculty of Agriculture, in Diyarbakir conditions, during the summer season in 2014 after lentil harvesting. The mean annual average precipitation is change between 476-600 mm for along years during summer growing season, and the mean annual air temperature is change between 31.5-17.5 °C. The analysis of soil in experimental area were determined as 71.1% (clayey), 1.25% (organic matter), 1.63 kg da^{-1} (phosphorus), 13.02 % (calcareous), saltless and midalcali (pH 7.73) in laboratory of GAPUTAEM (GAP International Agricultural Research and Training Center, Diyarbakır).

Soil Tillage Systems

Tillage systems (four systems), conventional, reduced (two reduced tillage system), and direct sowing (no tillage) were administered after lentil harvesting in June 2014. The specifications of the used devices in research are given table 1. The tillage systems are given in Table 2. The same tolls and machines were used for this experiment.



	5	6	7	8	9	10
Average temperature	19,7	26,5	31,5	31,1	24,8	17,5
Total rains	48,8	21,4	0,6	0,0	27,4	34,2
Average humidity	53,7	29,6	22,4	21,5	35,5	60,9

Figure 1. Monthly average air temperatures C, totally rains (mm) and humidity (percentage), Respectively during growing season.

Table 1. The specification of the devices used in research

Tool	Type	Working depth (cm)	Working width (m)
Moldboard plough	4 bottom	25-30	1.42
Heavy disk harrow	24 disc	15	2.5
Cultivator	11 sweeps	15	3.10
Float	Rectangle shape	shallow	3.00
Seed machine	4 row	4-6	2.8

Table 2. Tillage systems are used in research

Conventional tillage methods (CT)	Moldboard plough+ disk harrow+ float + direct seeding machine
Reduced Tillage methods (RT1)	Disc harrow+ float + direct seeding machine
Reduced Tillage methods (RT2)	Cultivator + float + direct seeding machine
Direct sowing (NT)	Direct seeding machine

Figure 2. Experimental area

(CT) was conducted with four bottom (1.42 m working with) moldboard plow to 25 cm depth. After plowing, the research area three times harrowed with disk (24 disk–tandem, working width, 2.5 m) at 20 cm depth, and leveled by float. RT consisted of two tillage methods (Table 2). RT1 is Disc harrow+ float + direct seeding machine, RT2 is Cultivator (11 sweeps, 3.10 m working with) + float + direct seeding machine. No-tillage (direct sowing treatment), sowing was made without tillage. The working with (four row) of direct seeding machine is 2.8 m. Working speed was constant as 1 m/s for all machines during the experiments. Massey Ferguson tractor was used in the experiments.

Experimental field were design after lentil harvesting as 12 plots with each measuring 12 m x 6 m. Before sowing, the experiment area was irrigated eight hours with sprinkler irrigation system. After seedbed preparation and irrigation, local variety sesame seed was sowing as second crop after harvest of lentil crop by pneumatic planting machine on June 23 in 2014. The planter has flat double discs + 8-wave colter (Table 1). Additionally extra weights were loaded on the top of seed drill for a better effect of colter into the soil (Sessiz et al., 2008; Sessiz et al.,2010). The sesame seeds were seeded nearly 1.0 cm deep at 0 kg ha^{-1}. No herbicide was applied to the field.

Examined properties

In this study, especially, weed density, seed yield and quality properties (protein and oil content) were examined. Harvesting area is (5 m x 0.7 m x 2 m) 7 m^2. Seame seeds were dried in oven at 65 ºC for 18 h. Protein rate was determined by means of the Kjeldahl method (AOAC, 2000). The oil content of the grain from each tillage system was determined using a Soxhlet extraction method.

Weed Measurement

The weeds were counted two times after emergence of sesame seeds; the first weed count was made 30 days after sowing. Just the first count of weeds, all of the weeds in plots was manually removed by worker. The second count of plants was made after 30 days of the first count. Plants count each plot of 3 replication 1 m^2 frame randomly discarded and the according to plants species have been counted in the remaining frame. Herbicide was not used before and after tillage.

Statistical analaysis

This experiment was arranged by randomized block with three replications.Data for each experiment were analysed by JMP 5.0 software program for comparison of Data was analyzed by JMP package program Mean tested by Tukey at the 1% level

Results and Discussion

The effect of tillage methods on sesame seed yield are shown in Table 3. Analysis of variance indicated that The applications were found significantly on yield while insignificant in protein content and oil content.

It has the effect of irrigation on the yield. The experiment area was irrigated after sowing. The highest value of yield was achieved as 1623.3 kg ha^{-1} by CT tillage method, while the lowest value was produced from RT2 and NT methods (respectively, 1320 and 1333.3 kg ha^{-1}). Several factors affect the seed yield and yield attributes in crop, including cultivar, seasonal variation, location, planting date, soil nutrient, moisture availability, growing conditions in different crops (Abdelaal et al., 2017; Barutçular et al., 2017; Gormus et al.,2017a, b). Seed yield is the most important target in sesame farming, but occurs as a result of the interaction of many components. The sowing time has an effect on yield and yield components. In the literature, it has been reported that the yield decreased as a result of late sowing (yield last planting date) Alamsarkar et al., (2007). Similarly our Seed yield results were found other researches (Yalcın and Cakır, (2006); Furat and Uzun, (2009); Silme and Çağırgan, (2009); Vita et al. (2007) studied no-tillage and conventional tillage effects on wheat seed yield. They were determineted high seed yield with no-tillage than conventional tillage.

In inirrigated condations, this values were found lower than irrigated condation by Polat et al. (2006) in southestern region in Turkey. Similar results were found by Sessiz and Söğüt, (2008) for sesame yield. The effect of soil tillage methods on content of sesame protein and oil are shown in Table 3. Protein and oil rate of sesame were found insignificantly ($p>0.05$) by tillage systems. There were not found siginificant differenes among the tillage systems. Parallel results were found in all tillage systems. The content values of protein were obtained as average % 51. However, oil content values were obtaines as average % 20. According to Vita et al. (2007), tillage methods was found insignificant on protein rate. Lopez et al. (1998) found high protein rate for conventional tillage than no-tillage. Same results were found by Sessiz and Söğüt (2008) for sesame protein content and oil content.

Weed density was found between 18.12-39.33 plant m^{-2} at the first count. The highest values of weed density was observed in NT tillage methods as 39.33 plant m^{-2} otherhand the lowest values was found in CT tillage methods as 18.12 plant m^{-2} at first count (Table 6). Weed density of the second count was found highest values in NT Tillage methods (32.66 plant m^{-2}). Similar result were reported by Çoruh and Boydaş, (2007). Özaslan and Gürsoy, (2015) reported that the effects of the tillage methods on weed population differed between the weed types. Sorghum halepense had the highest density under the reduced tillage method, while the Sinapis arvensis density increased under the conventional tillage treatment. The lowest weed density values were found in second count than the first count in this study. However, both the first count and the second count, the highest values were observed in NT treatment. The lowest values were obtained CT tillage methods (Table 6). According to second count of weed density was obtained lowest values in conventional tillage methods (16.33 plant m^{-2}).

Conclusions

Finally, the current research work was aimed to evaluate the tillage methods for seedy yield and weeds densities on sesame production. The weeds population are so problems for seed yield and yield component on sesame production. According to our research, the lowest weed population were observed in conventional tillage methods (CT). The conventional tillage methods used are high yield and weeds control successfully in sesame in Southestern Anatolia of Turkey.

DOI: https://doi.org/10.31015/jaefs.2019.1.7

Table 3. Analysis of variance of some quality

Source of variation	DF	Yield	Protein rate	Oil rate
Applications	3	*	ns	ns
Replies	2			
CV		8.41	2.32	1.01

ns: not significant *Significant at P < 0.05

Table 4. Sesame seed yield, oil and protein rate

Applications	Seed yield (kg ha^{-1})	Oil rate (%)	Protein rate (%)
CT	1623.3 a	51.13	19.60
RT1	1476.6 ab	51.46	20.30
RT2	1320.0 b	51.20	19.70
NT	1333.3 b	51.40	20.07
LSD	243.0	1.04	0.92

In each column, means followed by the same letter within columns are not significantly different (P < 0.01) according to Tukey test.

Table 5. Analysis of variance (mean square) for weeds population

Source of variation	DF	First Count	Second Count
Practies	3	*	*
Replication	2		
CV		19.2	8.86

ns: not significant *Significant at P < 0.05

Table 6. Tillage treatment and weeds density

Applications	Weed Density	
	First Count	Second Count
CT	18.12 b	16.33 b
RT1	29.33 a	27.58 a
RT4	38.33 a	32.00 a
NT	39.33 a	32.66 a
LSD	11.12	5.21

References

Abdelaal, A. A. Kh., Hafez, Y. M., EL Sabagh, A. (2017). Ameliorative effects of abscisic acid and yeast on morpho-physiological and yield characters of maize (Zea mays L.) plants under water deficit conditions. Fresenius Environmental Bulletin. 26 (12), 7372-7383. [Google Scholar]

Alamsarkar, M.N., Salim, M., Islam, N., and Rahman, M.M. (2007). Effect of sowing date and time of harvesting on the yield and yield contributing characters of sesame (Sesamum indicum L.). Int. J. Sustainable Crop. Prod., vol. 6, pp. 31–35. [Google Scholar]

AOAC. (2000). Association of Official Agricultural Chemists, Official and Tentative Methods of Analysis, 2nd Ed. Washington, DC, USA.

Baran M,F., Gokdogan, O. (2017). Determination of Energy Use Efficiency of Sesame Production. Journal of Tekirdag Agricultural Faculty, 14(3). [Google Scholar]

Barutçular, C., EL Sabagh, A., Koç, M., Ratnasekera, D. (2017). Relationships between Grain Yield and Physiological Traits of Durum Wheat Varieties under Drought and High Temperature Stress in Mediterranean Conditions. Fresenius Environmental Bulletin. 26(6), 4282-4291.

Bayhan, Y., B. Kayisoglu, E. Gonulol, H. Yalcin and N. Sungu. (2006). Possibilities of Direct Drilling and Reduced Tillage in Second Crop Silage Corn. Soil & Tillage Research, 88: 1-7. [CrossRef]

Cakır, E., H. Yalcın., E.Aykas., E. Gülsoylu.; B. Okur., S. Delibacak, A.R. Ongun. (2006). The Effects of conservation Tillage and Direct Seeding Applications on the Yield of Second Crop Maize. Journal of Agricultural Mechinery Science. 2 (2)139-146.

Çoruh, İ., Boydaş M. G. (2007). Effect of Different Soil Tillage Implements and Study Speeds on Density of Weed in Wheat. J. Agric. Sci., 17(1), 29-43. [Google Scholar]

De Vita, P. E. Di Paolo, G. Fecondo, N Di Fonzo, M. Pisante (2007). No-tillage and conventional tillage effects on durum wheat yield, grain quality and soil moisture content in Southern Italy. Soil and Tillage Research 92 (2007) 69-78. [CrossRef]

Eliçin, A.K., Pekitkan G., Bayhan, Y., Sessiz, A. (2018). Effects Of Tillage Methods On Weeds Density In Corn (Zea Mays L.) Production VI. Internatıonal Scıentıfic Congress. Agrıcultural Machınery v(2), p: 126-128.

FAO. 2017. http://www.fao.org/faostat/en/#data/QC. [Acces Date: 12.11.2018]

Furat, Ş., Uzun, B. (2009). Bazı seçilmiş Türk susam genotiplerinin agronomik özellikler ve kalite bakımından değerlendirilmesi. Türkiye VIII. Tarla Bitkileri Kongresi, 19-22 Ekim, Hatay, 169-172.

Gormus, O., Harun, R., EL Sabagh, A. (2017a). Impact of Defoliation Timings and Leaf Pubescence on Yield and Fiber Quality of Cotton. Journal of Agricultural Science and Technology. 19(4), 903-915. [Google Scholar]

Gormus, O., EL Sabagh, A., Harun, R., Islam, MS. (2017b). Enhancement of productivity and fiber quality by defining ideal defoliation and harvesting timing in cotton. Romanian Agricultural Research. 34, 226-232. [Google Scholar]

Lopez –Bellido, L., Fuentesn M., Castello, J.E., Lopez-Garrido, F.J. (1998). Effect of tillage, crop rotation and nitrogen fertilization on wheatgrain quality grown under rainfed Mediterranean conditions. Field crop res. 57, 265-276. [CrossRef]

Özaslan C., Gürsoy, S. (2015). The Effect of Conventional And Reduced Tillage Systems on Grain Yield And Weed Species Density In Common Vetch (*Vicia Sativa* L.) Production. Agriculture & Forestry, Vol. 61, Issue 3: 53-59. [CrossRef]

Özpinar S., Çay A. (2006). Effect Of Different Tillage Systems On The Quality And Crop Productivity Of A Clay-Loam Soil In Semi-Arid North-Western Turkey", Soil Research, vol.88, pp.95-106. [CrossRef]

Öztürk, F., Eliçin, A.K., Pekitkan G., Sessiz, A. (2018). Effects Of Tillage Methods On Weeds Population In Second Crop Soybean (Glycine Max. Meril L.). VI. Internatıonal Scıentıfic Congress. Agrıcultural Machınery v(2), p: 154-156.

Sessiz, A., Söğüt, T., Temiz, M.G., Gürsoy, S. (2009). Yield and Quality of Soybean (Glycine Max.L.) Sown as Double Crop Under Conservation and Conventional Tillage System in Turkey. Res. On. Crops. 10(3): 558-565.

Sessiz, A., T. Sogut, A. Alp and R.Esgici. (2008). Tillage effects on sunflower (*Helianthus annuus,* l.) emergence, yield, quality, and fuel consumption in double cropping system. Journal of Central European Agriculture. 9 (4): 697-710. [Google Scholar]

Sessiz, A., A. Alp and S. Gursoy, 2010. Conservation and conventional tillage methods on selected soil physical properties and corn (Zea Mays L.) yield and quality under cropping system in Turkey. Bulg. J. Agric. Sci., Volume: 16 Issue: 5 Pages: 597-608. [Google Scholar]

Silme, S.R. ve Çağırgan, M.İ. (2009). Dünya kolleksiyonundan seçilmiş susam genotiplerinin Antalya ikinci ürün koşullarında verim özelliklerinin değerlendirilmesi. Türkiye VIII. Tarla Bitkileri Kongresi, 19-22 Ekim Hatay, 173-176.

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.8 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):34-40 (2019)

Evaluation of growth, yield, quality and physiological parameters of eleven Australian bread wheat (*Triticum aestivum* L.) cultivars grown under the ecological condition of Diyarbakir, Turkey

Ferhat Kizilgeci[1,*] **Mehmet Yildirim**[2] **Akbar Hossain**[3]

[1]Mardin Artuklu University, Kızıltepe Vocational School, Department of Seed Production, Mardin, Turkey.
[2]Dicle University, Faculty of Agriculture, Department of Field Crops, Diyarbakır, Turkey.
[3]Bangladesh Wheat and Maize Research Institute (BWMRI), Dinajpur-5200, Bangladesh

[*]Corresponding Author: ferhatkizilgeci@artuklu.edu.tr

Abstract

Wheat cultivars generally show significant differences for grain yield, quality and physiological parameters under different environmental conditions. Thus it is crucial to assess the performance of bread wheat genotypes collected from different origins for domestication for a specific ecologic conditions and also to develop high yield as well as stress tolerant cultivars. In the context, the study was carried out under the ecological condition of Diyarbakır in Turkey during 2014-2015 growing season. In the present research, three Turkish origin bread wheat cultivars such as 'Pehlivan', 'Ceyhan 99' and 'Seri 2013' and eleven bread wheat of Australian origin such as 'LPB 08-1799', 'Eagle Rock', 'Magenta', 'Emu Rock', 'Wyalkatchem', 'Young', 'Calingiri', 'Yitpi', 'Corack', 'Envoy' and 'Mace' were used as experimental plant material. Data on grain yield, grain hardness, plant height, test weight, thousand kernel weight, wet gluten, protein content, zeleny sedimentation, starch content, normalized differences vegetative index, SPAD, leaf area index and canopy temperature were investigated in the study. After evaluation, it was found that all recorded traits of fourteen wheat bread cultivars were changed according to cultivars under the ecological conditions of Diyarbakir-Turkey. However, genotypes which were Australian origin performed the best than Turkish origin. Among the genotypes, the maximum values for grain yield, quality and physiological parameters were recorded for cultivar, 'Mace' (for grain yield) and 'Young' (for quality traits). Therefore, cultivars which were Australian origin can be grown and also may be used in the breeding programs to develop wheat cultivars to cultivate under the Diyarbakir ecological conditions of Turkey.

Keywords: Canopy temperature, Leaf area index, NDVI, Protein content

Received: 06 January 2019 Accepted: 24 February 2019 Revised: 03 March 2019 Published: 10 March 2019

Introduction

Bread wheat (*Triticum aestivum* L.) plays a significant role in terms of human nutrition (Hossain et al., 2018). It serves as a staple food for 40 percent of the world's population (Bockus et al., 2010). Wheat is consumed in different forms which includes; leavened breads and rolls, flat breads, porridge, biscuits, cakes, pasta and noodles (Shewry, 2009). It serves as a source of more 20% of the food calories (Bockus et al., 2010), protein, essential amino acids, minerals, vitamins and dietary fiber to the world's diet than any other food crops (Wijngaard and Arendt 2006; Shewry, 2009; Šramková et al., 2009; Kumar et al., 2011; Yildirim et al., 2018) and also provides about 55 percent of the carbohydrates (Breiman and Graur, 1995) globally.

In Turkey, wheat contributes more than half of the calories and protein in the diet. Although, Turkey is the tenth biggest wheat producer in the world with annual production is around 21.5 million tons from a total wheat production area of 7.66 million ha in 2017. The average yield of wheat in Turkey is 2.8 tons ha^{-1} (FAOSTAT, 2017). While its demand is increasing day by day to meet the food demand of the rapidly growing population. Therefore, it should be a continuous process to develop wheat varieties which are suitable to grow under the diverse environmental condition of Turkey. Although wheat has ability to grow multiple environmental conditions across the globe according their species, types as well as adaptability. Wheat plant generally shows differences in growth, grain yield, and quality traits as a result of variation of physiological and biochemical process of the plants under different environmental conditions. Some genotypes adapt easily to changing environment, while others are insufficient to adapt to changing conditions. Therefore, it is important to examine the wheat genotypes developed in different regions in terms of grain yield, quality and physiological parameters under diverse ecological conditions. The purpose of this study was to evaluate of the grain yield, quality and physiological parameters of some bread wheat cultivars which were originated from Australia and Turkey.

Cite this article as:
Kizilgeci, F. Yildirim, M. Hossain, A. (2019). Evaluation of growth, yield, quality and physiological parameters of eleven Australian bread wheat (*Triticum aestivum* L.) cultivars grown under the ecological condition of Diyarbakir, Turkey. Int. J. Agric. Environ. Food Sci., 3(1), 34-40. DOI: https://doi.org/10.31015/jaefs.2019.1.8
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 34-40
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

 DOI: https://dx.doi.org/10.31015/jaefs.2019.1.8

Material and Methods

Plant material, growing conditions and design of field experiment

A field experiment was carried out during November to June, 2014-2015 at the Research Area of the Faculty of Agriculture, Dicle University, Turkey (latitude 37° 53' 21.50" N, longitude 40° 16' 34. 79" E and 670 m above sea level). In the study, three Turkish origin bread wheat cultivars (i.e. 'Pehlivan', Ceyhan 99, 'Seri 2013') and eleven Australian origin bread wheat (i.e. 'LPB 08-1799', 'Eagle Rock', 'Magenta', 'Emu Rock', 'Wyalkatchem', 'Young', 'Calingiri', Yitpi', 'Corack', 'Envoy' and 'Mace') were used as plant material. Monthly mean temperatures and precipitation are showed in Figure 1.

The study was established randomized complete block design with four replications. All the cultivars were grown in 4 m long 6 rows with a 20 cm row spacing. The plant was fertilized with 60 kg N and $P_2 0_5$ ha^{-1} (20:20:0 NPK) at sowing and 60 kg N ha^{-1} (33 % ammonium nitrate) at tillering stage. The plants were harvested at full maturity by Hege-125 trial harvester machine in June.

Data collection and their procedure

Grain yield: Plot weight was calculated in kg $plot^{-1}$ and then converted to kg ha^{-1}

1000-kernel weight (TKW): In order to determine TKW, four hundred grains was counted with seed counter, which were then weighed (g) and the result multiplied by 2.5.

Plant height: Plant height was measured on ten randomly selected from the base of plant to the tip of the spike, by using a measuring tape.

Test weight, grain hardness, starch content, protein content, zeleny sedimentation and wet gluten: Grain samples were measured without subjected to milling process with NIT System Infratec 1241 Grain Analyzer (Foss).

Chlorophyll reading (SPAD): At the heading stage of plant, the chlorophyll content of flag leaf was recorded using a handheld SPAD meter (SPAD 502 Plus, Minolta Sensing Inc. Japan). Ten random flag leaves were selected from each plot for measurement of SPAD and the data was then averaged. Only healthier, green and disease free leaves were selected by avoiding the mid-vein.

Canopy temperature (°C): Canopy temperature was determined using an infrared thermometer (Rothenbenger) at heading stage. Data was recorded on clear sunny and calm days between 11:30 AM and 12:30 PM on plots with fully closed canopies. The sensor was held 1 m above the canopy at an angle of 30° to the horizontal. Assessments were made three times and the readings were averaged.

Leaf area index (LAI): This parameter was measured at heading stage by using LAI-2000 (LI-COR, Lincoln, NE).

Normalized differences vegetative index (NDVI): NDVI was measured using the Trimble GreenSeeker handheld crop sensor. Measurements were taken on sunny and cloudless day by passing the sensor over the plots at a height of about 40–50 cm above the canopy.

Statistical analysis: The obtained data were computed for proper statistical analysis according to SAS Program (1998). The LSD at 5% level of significance was used to differentiate between means.

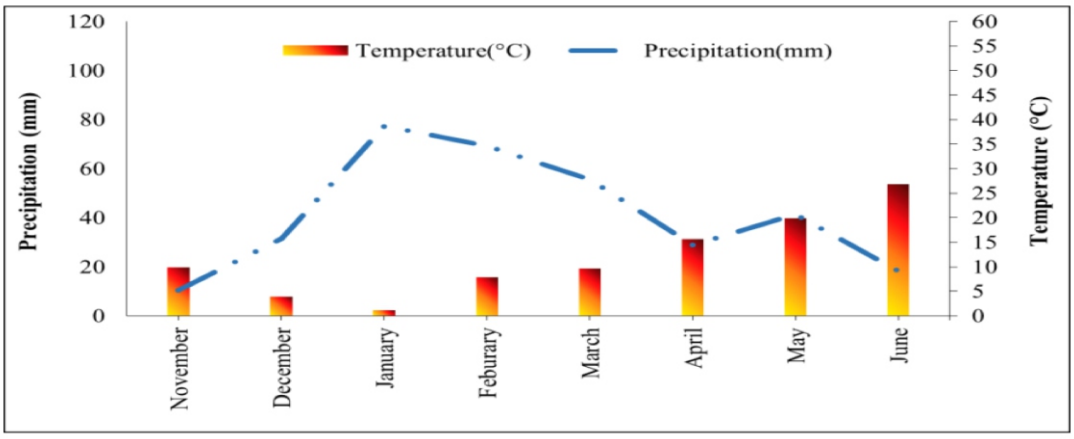


Figure 1. Monthly mean temperature and precipitation at Diyarbakir in the 2014-2015

Results and Discussion

Chlorophyll content (SPAD)

Chlorophyll content is an indication for stay green or leaf senescence in agricultural research projects (Kizilgeci, 2019). Statistically significant differences were shown among bread wheat genotypes for SPAD. The results of this study showed that the chlorophyll content in all genotypes were varied significantly. The highest SPAD value (47.38) was obtained from 'Envoy'. Meanwhile, the lowest (39.85) was recorded from 'Emu Rock' (Figure 2 & Table 1). Chlorophyll content could be use as indicator to determine the performance of photosynthetic rate and reflect photosynthetic potential and primary production (Anjum et al., 2011). Reynolds and Trethowan (2007) reported that chlorophyll content or stay-green was correlated with the transpiration efficiency, which affects to the enhancement of water use efficiency under drought stress conditions. Grain yield had a significant positive relationship with leaf area and leaf chlorophyll content, and the correlation between leaf area and leaf chlorophyll content was also positive. Furthermore, the chlorophyll content can simultaneously increase grain yield, and plants with large leaves and grate chlorophyll content can also produce higher grain yield (Yeganehpoor et al., 2016).

Canopy temperature (CT)

CT measurement is very simple by using an infrared thermometer, which in few seconds can determine the surface temperature of a field plot and it can be used as an indirect selection criterion for grain yield under certain environmental conditions. In the current study significant differences were observed among genotypes for canopy temperature.

The highest CT was recorded in 'Carack' (22.75 °C) and the lowest in 'Calingiri' (20.48 °C). The means of bread wheat varieties was found 21.87 °C (Figure 2 & Table 1). A lower canopy temperature has been linked to improved yield under heat stress (Reynolds et al., 2007; Bahar et al., 2011; Pinto and Reynolds, 2015; Deery et al., 2016; Öztürk and Aydın, 2017). Presumably genotypes with cooler canopies have the ability to extract more soil water (Reynolds et al., 2007). Lower canopy temperature has been previously linked to higher transpiration rates and therefore improved carbon capture and allocation efficiency and ultimately higher yields (Pinto et al., 2010; Cossani and Reynolds, 2015).

Normalized difference vegetation index (NDVI)

Spectral reflectance indices are important tools for evaluating photosynthetic traits. NDVI is one of the maximum broadly utilized vegetation indices as an indicator of canopy green area and it is associated with grain yield as well (Tanriverdi, 2003; Reynolds et al., 2007a; Kizilgeci et al., 2018). The differences among the bread wheat varieties were statistically significant for NDVI. The maximum NDVI value (0.772) was recorded in 'Pehlivan' and the minimum NDVI value (0.638) was recorded in 'Wyalkatchem' (Figure 2 & Table 1). The average NDVI of bread wheat varieties was 0.704. Crusiol et al., (2016) reported that NDVI estimates are affected by many factors, such as measuring stage, sensors and environment. Spectral reflectance NDVI is associated with yield and can be used to estimate stay-green (Lopes and Reynolds, 2012; Magney et al., 2016; Pinto et al., 2016; Rebetzke et al., 2016).

Plant height and leaf area index (LAI)

Plant height is a significant agronomic feature in bread wheat because of its closely associated with lodging. Plant height is also controlled by growing environment and also many genes. In the present study plant height was varied significantly for all genotypes under the ecological condition of Diyarbakir, Turkey. Among the genotypes, the maximum plant height was recorded in 'Pehlivan' (91.75 cm), while the minimum was recorded in 'LPB 08-1799' (55.00 cm). Turkish origin cultivars were taller than the Australian cultivars. Aykut et al., (2005) reported in a recent study that optimum plant height of wheat varieties have varied significantly from 70 to 100 cm, due to the genetic makeup of the specific varieties and also their interaction with growing environmental conditions.

Considering on the leaf area index of fourteen wheat genotypes, significant ($p \leq 0.01$) differences were found among cultivars. The highest LAI (3.83) was recorded from 'Magenta', while the minimum (2.78) was recorded from 'Seri 2013' (Figure 3 & Table 1).

Protein, starch and wet gluten content

The protein content is an inherent trait that can be influenced significantly by cultural practices, nitrogen practices and environmental factors. The differences among the bread wheat cultivars were statistically significant for protein content. The protein content varied between 14.36% ('Calingiri') and 16.48% ('Seri 2013') with an average of 15.41%. Previous bread wheat related researches reported the significant differences for protein content among genotypes which supports our results. Amanlıyev and İşankulıyev (2005) reported that the protein ratio of bread wheat at international standards is accepted as 12.5% (Figure 4 & Table 1).

Starch is also major constituent of the wheat grain. a significant difference was observed among cultivars. The maximum starch content (65.86%) was recorded in 'Calingiri' while, the minimum starch content (62.99 %) was recorded in 'Magenta' (Figure 4).

While wet gluten is the main factor in determining the quality of bread in bread wheat, it constitutes almost 80 percent of the total protein in grain. The data related to wet gluten content for all observed cultivars were given in Table 1. In the study, wet gluten of all genotypes was varied significantly. The value of wet gluten was the highest at 'Seri 2013' (29.37) and the lowest wet gluten was recorded in 'Calingiri' (24.82) (Figure 4 & Table 1).

Zeleny Sedimentation and grain hardness

Zeleny Sedimentation value is an important feature that gives information about gluten quality of wheat flour (Ozen and Akman 2015). In the present study, Zeleny Sedimentation value for all genotypes were varied significantly under the ecological condition of Diyarbakir, Turkey. The zeleny sedimantation value of cultivars ranged from 43.01 ml ('Ceyhan 99') to 50.92 ml (Seri 82 and 'Magenta') (Figure 5 & Table 1).

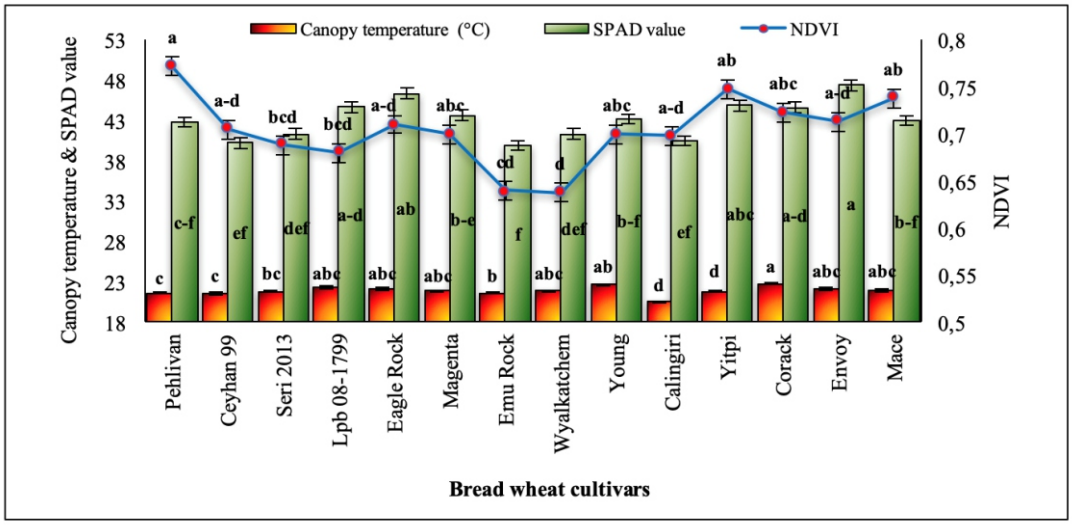


Figure 2. Chlorophyll content (SPAD), Canopy temperature (CT) and normalized difference vegetation index (NDVI) of bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

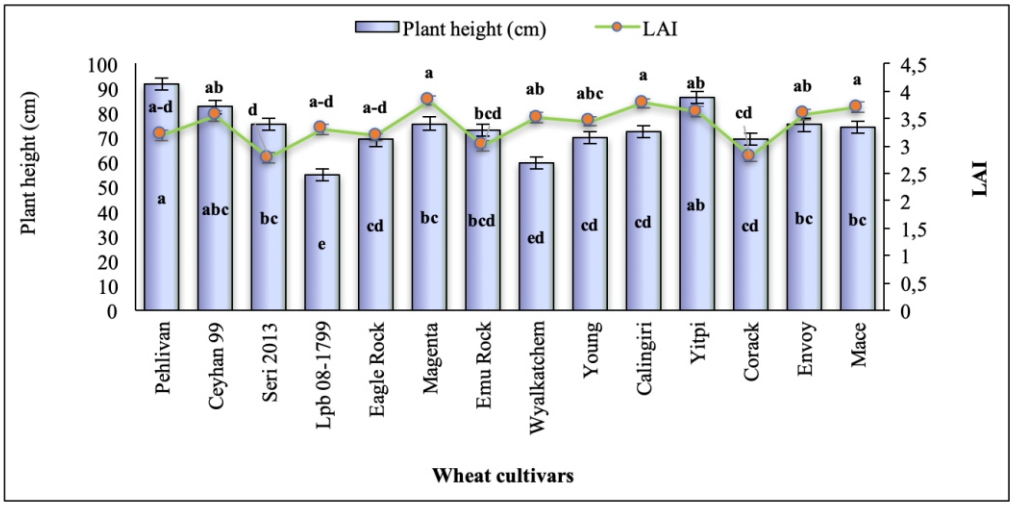


Figure 3. Plant height and leaf area index (LAI) of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

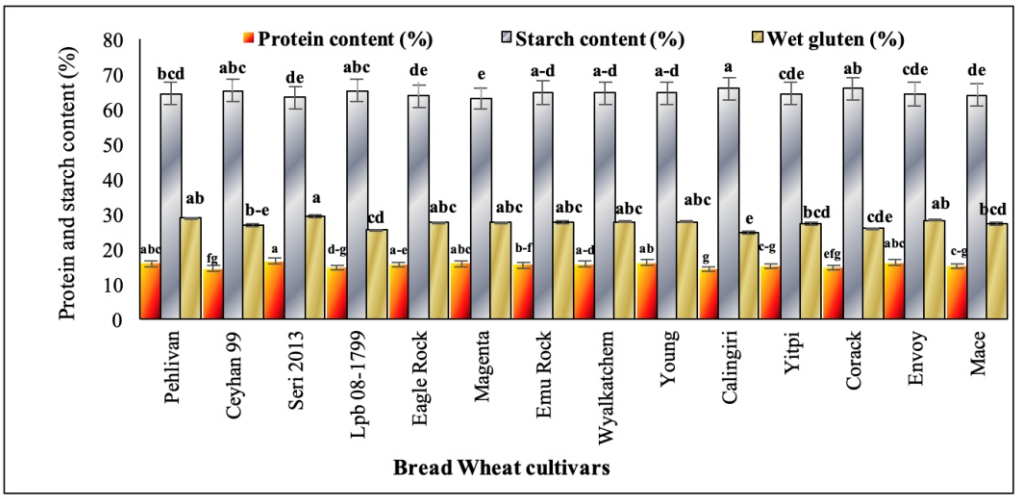


Figure 4. Protein, starch and wet gluten (%) content of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

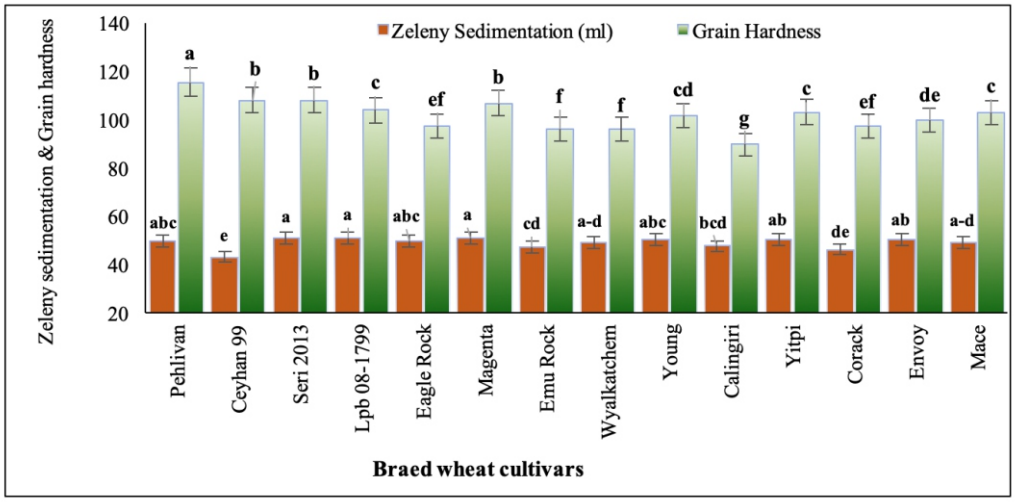


Figure 5. Zeleny sedimentation and grain hardness of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

Table 1. Mean data of investigated traits for bread wheat cultivars

	NDVI	CT (°C)	SPAD	LAI	PH (cm)	PC (%)	SC (%)	WG (%)	ZS (ml)	Grain Hardness	TW (kg hl^{-1})	TKW (g)	Grain Yield (kg ha^{-1})
Pehlivan	0.772a	21.60c	42.75c-f	3.20a-d	91.75a	15.85abc	64.42bcd	28.78ab	49.67abc	115.23a	84.40abc	37.51a	4304.9b-e
Ceyhan 99	0.705a-d	21.55c	40.20ef	3.55ab	82.50abc	14.47fg	65.28abc	26.85b-e	43.01e	107.90b	83.89bc	31.18cde	4484.0a-d
Seri 2013	0.688bcd	21.80 bc	41.35def	2.78d	75.50bc	16.48a	63.36de	29.37a	50.92a	107.93b	84.78abc	33.60b	3859.0c-g
Lpb 08-1799	0.680bcd	22.27abc	44.65a-d	3.30a-d	55.00e	14.77d-g	65.34abc	25.35ed	50.81a	103.9c	86.33a	32.32bc	4097.9 c-f
Eagle Rock	0.710a-d	22.10abc	46.35ab	3.18a-d	69.25cd	15.63a-e	63.74de	27.50abc	49.84abc	97.27ef	84.13abc	28.08fg	3702.1efg
Magenta	0.700abc	21.83abc	43.65b-e	3.83a	75.75bc	15.85abc	62.99e	27.51abc	50.92a	106.60b	84.13abc	30.14ed	3854.9c-g
Emu Rock	0.648cd	21.60b	39.85f	3.00bcd	73.25bcd	15.36b-f	64.69a-d	27.65abc	47.01cd	95.97f	83.77bc	33.48b	3716.0 d-g
Wyalkatchem	0.638d	21.85abc	41.33def	3.53ab	59.75ed	15.68a-d	64.55a-d	27.87abc	49.08a-d	96.04f	83.75bc	25.49h	2793.8h
Young	0.700abc	22.60ab	43.13b-f	3.45abc	70.00cd	16.19ab	64.62a-d	27.85abc	50.02abc	101.62cd	84.50abc	29.46ef	3511.1 fgh
Calingiri	0.698a-d	20.48d	40.43ef	3.78a	72.50cd	14.36g	65.86a	24.82e	47.49bcd	89.58g	80.01d	27.16gh	3238.9 gh
Yitpi	0.748ab	21.78bc	44.85abc	3.63ab	86.50ab	15.22c-g	64.36cde	27.26bcd	50.24ab	102.9c	83.66bc	33.03bc	4554.9abc
Corack	0.723abc	22.75a	44.63a-d	2.80cd	69.50cd	14.71efg	65.80ab	25.80cde	46.08de	97.13ef	83.99abc	30.10de	4146.5c-f
Envoy	0.713a-d	22.07abc	47.38a	3.58ab	75.25bc	16.06abc	64.28cde	28.32ab	50.41ab	99.39de	85.09ab	32.39bc	5038.9ab
Mace	0.738ab	21.90abc	42.98b-f	3.70a	74.25bc	15.15c-g	63.96de	27.16bcd	49.25a-d	102.76c	82.52c	31.99bcd	5204.2a
Mean	0.704	21.87	43.11	3.38	73.62	15.41	64.52	27.29	48.91	101.73	83.93	31.14	4036.2
LSD (5%)	0.079*	0.94**	3.45**	0.65*	13.82**	0.95***	1.39***	2.10**	3.21**	2.43**	2.35**	1.99***	773.8**
CV (%)	7.87	3.04	5.60	13.6	13.12	13.41	4.48	4.35	1.51	5.38	4.59	1.67	1.96

*,**,*** significant at %5, %1, %0.1 respectively. NDVI: Normalized differences vegetative index, CT: Canopy temperature; LAI: Leaf area index, PH: Plant height, PC: Protein content, SC: Starch content, WG: Wet gluten, ZS: Zeleny Sedimentation, TW. Test weight TKW: Thousand kernel weight

Grain hardness is one the most important traits that determine the end-use quality of wheat and its technological utilization. Usually wheats called soft and hard bread wheat. Flour yields of hard wheat are higher than soft wheat. Significant differences were showed among the cultivars for grain hardness. The highest grain hardness was obtained from 'Pehlivan' (115.23), while the lowest grain hardness obtained from 'Calingiri' (89.58). The grain hardness values indicate the softness as close to 100. Aydoğan and Soylu (2016) stated that grain hardness is a genetic factor and is not affected by environmental conditions.

Test weight and 1000-kernel weight

Test weight is one of the factors the most important effect on the quality of wheat. Test weight was statistically significantly differed between cultivars. The highest test weight value in this study was found in genotype 'LPB 08-1799' (86.33 kg hl^{-1}). While, the lowest test weight value was determined in 'Calingiri' (80.01 kg hl^{-1}) (Figure 6 & Table 1). Test weight is affected by several factors, such as genotype, environment, disease, cultural applications (Şener et al., 1997; Taghouti ve ark., 2010; Kızılgeçi, 2018).

Significant differences ($p \leq 0.01$) in the mean of 1000-kernel weight were found among bread wheat cultivars (Figure 6). Thousand kernel weight ranged from 25.49g ('Wyalkatchem') to 37.51g ('Pehlivan'). In terms of this trait, it was showed that varieties of Turkish origin have above average values.

Grain yield

The grain yield is considered a major parameter for screening wheat genotypes in breeding programs (Forgone, 2009). Grain yield in bread wheat is a complex character with several components, including genetic and environmental conditions. In terms of grain yield, differences among cultivars were found significant. The maximum grain yield was obtained from genotype 'Wyalkatchem', with 5204.2 kg ha^{-1}, whereas the minimum grain yield was obtained from 'Mace' with 2793.8 kg ha^{-1} (Figure 7 & Table 1).

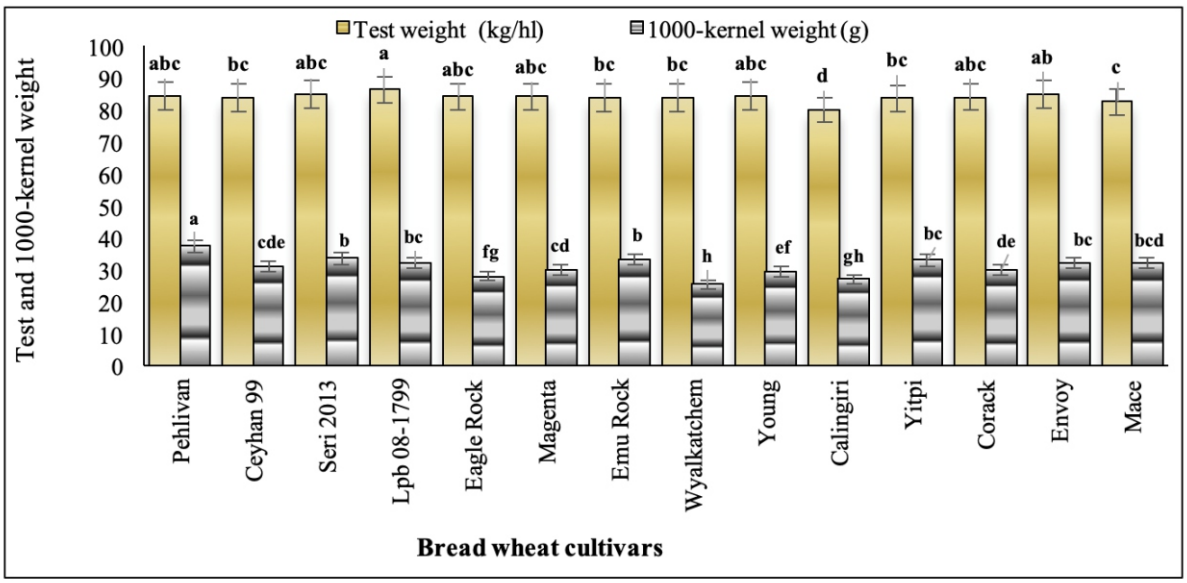


Figure 6. Test weight and 1000-kernel weight of fourteen bread wheat cultivars under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

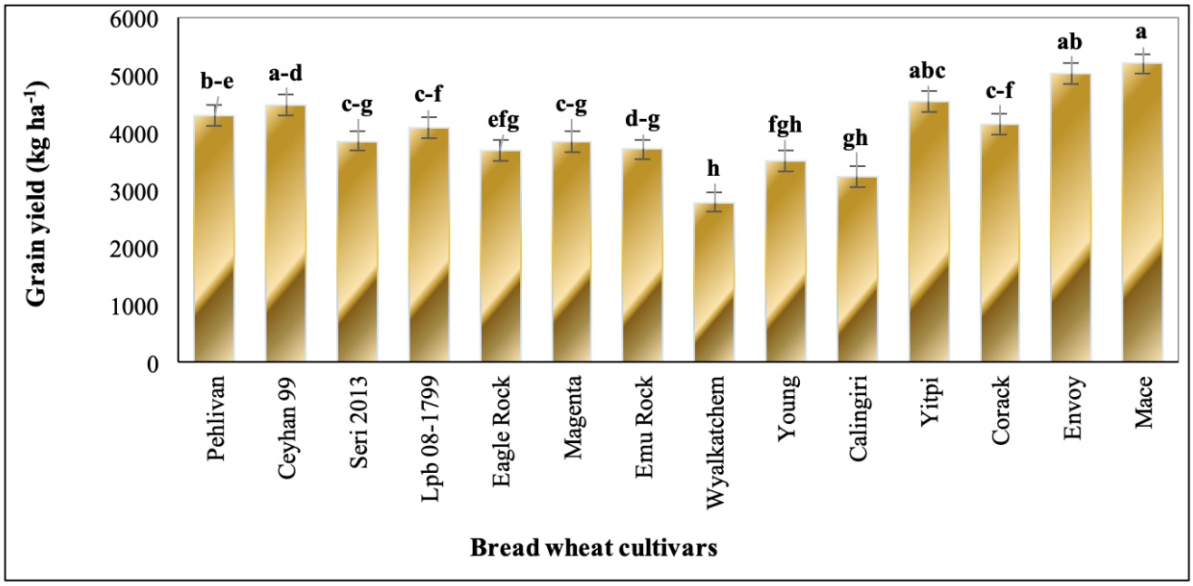


Figure 7. Grain yield (kg ha^{-1}) of fourteen bread wheat cultivar under the ecological condition of Diyarbakir in Turkey during the wheat growing season of 2014-15.

Conclusion

From the results and discussion of the study, it was found that grain yield, grain hardness, test weight, thousand kernel weight, plant height, wet gluten, protein content, zeleny sedimentation, starch content, NDVI, SPAD, LAI and canopy temperature of fourteen wheat bread genotypes were changed according to cultivars under the ecological conditions of Diyarbakir-Turkey. However, genotypes which were from Australian origin performed the best than Turkish origin. Among the genotypes, the maximum values for grain yield, quality and physiological parameters was recorded for genotype, 'Mace' (for grain yield) and 'Young' (for quality traits). Therefore, cultivars which were Australian origin can be grown and also may be used in the breeding programs for these valuable traits, under the Diyarbakir ecological conditions of Turkey.

Conflict of interest

Authors declared no conflict of interest

References

Amanlıyev, A. İşankulıyev, H., (2005), Tahıllar, okul kitabı (gollanma), S.A. Niyazov Tarım Üniversitesi, Aşgabat-2005, 35-38 (in Turkish).

Anjum, S.A., Xie, X.Y., Wang, L.C., Saleem, M.F., Man, C., Lei, W. (2011). Morphological, physiological and biochemical responses of plants to drought stress. Afr. J. Agr. Res., 6(9), 2026-2032. [Google Scholar]

Aykut, F., Yüce, S., Demir, İ., Akçalı Can, R.R., Furan, M.A., (2005). Ekmeklik Buğday Çeşit ve Hatlarının Bornova Koşullarında Performansları. Türkiye VI. Tarla Bitkileri Kongresi, 5-9 Eylül, Antalya, 89-93 (in Turkish).

Aydoğan, S., Soylu, S. (2016). Yetiştirme koşullarının bazı ekmeklik buğday çeşitlerinin kalite özelliklerine etkisi. Selçuk Tarım Bilimleri Dergisi, 2(2), 123-127. [Google Scholar]

Bahar, B., Yildirim, M., Yucel, C. (2011). Heat and drought resistance criteria in spring bread wheat (Triticum aestivum L.): Morpho-physiological parameters for heat tolerance. Scientific Research and Essays, 6(10), 2212-2220. [CrossRef]

Bockus, W.W., Bowden, R.L., Hunger, R.M., Murray, T.D., Smiley, R.W. (2010). Compendium of wheat diseases and pests (No. Ed. 3). American Phytopathological Society (APS Press).

Breiman, A., Graur, D. (1995). Wheat evolution. Israel Journal of Plant Sciences, 43(2), 85-98. [CrossRef]

Cossani, C.M., Reynolds, M.P. (2015). Heat stress adaptation in elite lines derived from synthetic hexaploid wheat. Crop Science, 55(6), 2719-2735. [CrossRef]

Crusiol, L.G.T., Carvalho, J. de F.C., Sibaldelli, R.N.R., Neiverth, W., Rio, A. do, Ferreira, L.C., Procópio, S. de O., Mertz-Henning, L.M., Nepomuceno, A.L., Neumaier, N., Farias, J.R.B. (2017). NDVI variation according to the time of measurement, sampling size, positioning of sensor and water regime in different soybean cultivars. Precis. Agric., 18:470. [CrossRef]

Deery, D.M., Rebetzke, G.J., Jimenez-Berni, J.A., James, R.A., Condon, A.G., Bovill, W.D., Hutchinson,P., Scarrow, J., Davy, R., Furbank, R.T. (2016). Methodology for high-throughput field phenotyping of canopy temperature using airborne thermography. Frontiers in plant science, 7, 1808. [CrossRef]

FAOSTAT, 2017. FAO Database. http://www.fao.org/faostat/en/ [Access Date: 01 January 2019]

Forgone, A.G. (2009). Physiological indicators of drought tolerance of wheat. Biology PhD Program. University of Szeged Faculty of Science and Informatics Department of plant Biology, Szeged.

Hossain, M.M., Hossain, A., Alam, M.A., EL Sabagh, A., Khandakar Faisal Ibn Murad, Haque, M.M., Muriruzzaman, M., Islam, M.Z. Das, S. Barutcular, C., Kizilgeci, F. (2018) Evaluation of fifty spring wheat genotypes grown under heat stress condition in multiple environments of Bangladesh. Fresen. Environ. Bull., 27, 5993-6004.

Kizilgeci, F., Yildirim, M., Akinci, C., Albayrak, O., Sesiz, U., Tazebay, N. (2018). Evaluation of relationships between yield and yield components with physiological parameters in barley (Hordeum vulgare L.) genotypes. Dicle University Journal of Institute of Natural and Applied Science, 7(2), 61-66

Kizilgeci, F. (2019). Post-anthesis changes in chlorophyll and agronomic traits of bread wheat genotypes. Applied Ecology And Environmental Research, 17(2),1913-1922.

Kumar, P., Yadava, R.K., Gollen, B., Kumar, S., Verma, R.K., Yadav, S. (2011). Nutritional contents and medicinal properties of wheat: a review. Life Sciences and Medicine Research, 22, 1-10. [Google Scholar]

Lopes, M.S., Reynolds, M.P. (2012). Stay-green in spring wheat can be determined by spectral reflectance measurements (normalized difference vegetation index) independently from phenology. Journal of experimental botany, 63(10), 3789-3798. [CrossRef]

Magney, T.S., Eitel, J.U.H., Huggins, D.R., Vierling, L.A. (2016). Proximal NDVI derived phenology improves in-season predictions of wheat quantity and quality. Agric. For. Meteorol., 217, 46–60. [CrossRef]

Ozen, S., Akman, Z. (2014). Determination of Yield and Quality Characteristics of Some Bread Wheat Cultivars in Yozgat Ecologial Conditions. SDÜ Ziraat Fakültesi Dergisi, 2(1), 35-43. [CABI] [Google Scholar]

Öztürk, A., Aydın, M. (2017). Physiological characterization of Turkish bread wheat genotypes for resistance to late drought stress. Turkish Journal of Agriculture and Forestry, 41(6), 414-440. [Google Scholar]

Pinto, R.S., Reynolds, M.P., Mathews, K.L., McIntyre, C.L., Olivares-Villegas, J.-J., Chapman, S.C. (2010). Heat and drought adaptive QTL in a wheat population designed to minimize confounding agronomic effects. Theor. Appl. Genet., 121, 1001–1021. [CrossRef]

Pinto, R.S., Reynolds, M.P. (2015). Common genetic basis for canopy temperature depression under heat and drought stress associated with optimized root distribution in bread wheat. Theoretical and Applied Genetics, 128(4), 575-585. [CrossRef]

Pinto, R.S., Lopes, M.S., Collins, N.C., Reynolds, M.P. (2016). Modelling and genetic dissection of staygreen under heat stress. Theor. Appl. Genet., 129:2055. [CrossRef]

Rebetzke, G.J., Jimenez-Berni, J.A., Bovill, W.D., Deery, D.M., James, R.A. (2016). High-throughput phenotyping technologies allow accurate selection of stay-green. Journal of experimental botany, 67(17), 4919-4924. [CrossRef]

Reynolds, J.F., Smith, D.M.S., Lambin, E.F., Turner, B.L., Mortimore, M., Batterbury, S. P.J., Walker, B. (2007). Global desertification: Building a science for dryland development. Science, 316, 847–851. [CrossRef]

Reynolds M.P., Trethowan R.M. (2007). Physiological interventions in breeding for adaptation to abiotic stress, In J. H. J. Spiertz et al. (ed) Scale and complexity in plant systems research, gene-plant-crop relations. Springer, Dordrecht, the Netherlands. [Google Scholar]

Shewry, P. R. (2009). Wheat. Journal of Experimental Botany, 60(6), 1537-1553. [CrossRef]

Šramková, Z., Gregová, E., Šturdík, E. (2009). Chemical composition and nutritional quality of wheat grain. Acta Chimica Slovaca, *2*(1), 115-138. [Google Scholar]

Şener, O., Kılınç M., Yağbasanlar T., Gözübenli, H., Karadavut, U., (1997). Hatay koşullarında bazı ekmeklik (Triticum aestivum L. Em Thell) ve makarnalık buğday (Triticum durum Desf) çeşit ve hatlarının saptanması. Türkiye II. Tarla Bitkileri Kongresi, 22 – 25 Eylül 1997, Samsun, 1-5. (in Turkish).

Taghouti, M., Gaboun, F., Nsarellah, N., Rhrib, R., El- Haila, M., Kamar, M., Abbad -Andaloussi F. and Udupa S. M. (2010). Genotype x Environment interaction for quality traits in durum wheat cultivars adapted to different environments. African Journal of Biotechnology, 9(21), 3054-3062. [Google Scholar]

Tanrıverdi, C. 2003. Available water effects on water stress indices for irrigated corn grown in sandy soils. Ph. D. Thesis, Department of Chemical and Bioresource Engineering, Colorado State University,

Wijngaard, H.H., Arendt, E.K., (2006). Buckwheat. Cereal Chemistry 83 (4), 391-401. [CrossRef]

Yildirim , M., Barutcular, C., Koc, M., Dizlek, H., EL Sabagh, A., Hossain, A., Islam, M.S, Toptas I., Basdemir F., Albayrak O., Akinci, C. (2018). Assessment of the grain quality of wheat genotypes grown under multiple environments using GGE biplot analysis. Fresenius Environmental Bulletin, 27(7), 4830-4837. [Google Scholar]

Yeganehpoor, F., Salmasi, S.Z. Kolvanagh, J. S., Golezani, K.G., Dastborhan, S. (2016). Changes in growth, chlorophyll content and grain yield of Coriander (*Coriandrum sativum* L.) in response to water stress, chemical and biological fertilizers and salicylic acid. Intl. J. Adv. Biol. Biomed. Res., 5(1), 228-236. [CrossRef]

JAEFS

International Journal of Agriculture, Environment and Food Sciences

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.9 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):41-45 (2019)

Assessment of GA_3 and BA application on gerbera cultivation in soilless culture

Ayşe Serpil Kaya[1,*] **Köksal Aydinşakir**[1] **Ümmü Özgül Karagüzel**[1]

[1]Batı Akdeniz Agricultural Research Institute, Antalya, Turkey

[*]Corresponding Author: ayserka07@hotmail.com

Abstract

This research was carried out to determine the effect of gibberellic acid (GA_3) and benzyladenine (BA) application on yield and quality components (multiplication ratio, flower stem length, flower diameter, vase life, flower stem diameter,) of gerbera. Three different levels of GA_3 (125, 250, 500 ppm) and BA (100, 200, 400 ppm) were applied by foliar spray. Compared to BA application, GA_3 applications gave good results on yield and quality parameters. The maximum yield was obtained by 125 ppm of GA_3 application. It was found that 500 ppm of GA_3 application most effective on stem length and flower diameter. On the other hand, it's determined that 400 ppm BA application significantly increased stem diameter and multiplication ratio. Its concluded that, the GA_3 and BA demonstration interference in growth characteristics of gerbera plant.

Keywords: Gerbera, Soilless culture, Growth regulators, Giberellic acid, Flower quality

Received: 10 August 2018 Accepted: 25 February 2019 Revised: 03 March 2019 Published: 10 March 2019

Introduction

Although there are several problems like production and marketing in cut flower industry in Turkey, cut flower sector is important agricultural sector which is still developing. In 2015, the area of cut flower production was 11 046 da in Turkey and 4 333 da in Antalya. The cut flower varieties mostly grown in Antalya are standard and spray carnation, gerbera, rose, gypsophila and solidago. Gerbera production area has reached 1131 da in 2015 (Kazaz et al., 2015).

The main problem in gerbera production is obtaining production materials of good quality in Turkey. The growers depend on foreign materials. To increase the yield and quality in gerbera production, plant growth regulators are used although is not very common (Kaya et al. 2004). To meet the demand of high value cut flower crop of gerbera, it is necessary to enhance the production both in quantitative and qualitative aspects. To overcome the factors limiting the growth and yield to harness maximum profit, growth regulators are used in plant cultivation. Patra et al. (2015) reported that using plant growth regulators in cultivation encourage flowering to get maximum yield. There are several research on the plant growth regulators on cut flower in Turkey.

Sogut and Kucuk (1998) reported that GA_3 applications consisted of *Rosa* sp. (5 mg L^{-1}), *Dianthus caryophylus* (1000 ppm), *Anthurium* (125-500 ppm) and *Chrysanthemum* (3000+2000+500 ppm)-(500+500+2000 ppm) enhanced shoot development whereas GA_3 applications consisted of *Rosa* sp. (100 mg L^{-1}) and *Gypsophila* (250 mg L^{-1}) encouraged flowering.

Kewte and Sable (1997) investigated the effects of GA_3 (100, 200, 300 ppm), and different nutrient elements (N, P, K, Mg, Mn, Fe, B), Na (100 ppm) and % 0.5 triacontanol applications on quality parameters and vase life on Paradise rose variety. The best result was obtained 300 ppm of GA_3 application.

Seker and Sujata (2001) investigated the coir media (coir pith + garden soil + farmyard manure), sawdust media (sawdust + garden soil + farmyard manure), commercial mixture (sand + red soil + farmyard manure), sand media (sand + farmyard manure) and red soil media (red soil + farmyard manure), and sprayed with GA at the dose of 100, 150 and 200 ppm and water (control) on *Gerbera jamesonii* cv. Mammut. GA was applied twice at monthly intervals starting after 90 days planting. The peak number of flower per plant was achieved 200 ppm of GA treatment. The treatment combination consisted of GA at 200 ppm and coir pith media were given the highest yield and quality whereas coir pith media was given the longest vase life.

El-Shafie et al. (1980), applied four spray applications of GA at 50, 100, 150 or 200 ppm and two applications of chlormequat at 500 and 700 ppm at monthly intervals to *Gerbera jamesonii*. Early flowering, number of flowers, flower diameter and flower stem length was promoted by low concentrations of GA, whereas chlormequat delayed flowering. The number of flowers was increased by GA at 100 ppm during the first season and at 100, 150 and 200 ppm in the second one.

Farina et al. (1989) studied GA_3 applications on three gerbera variety cultivated in a low temperature of 12ºC for winter season. They concluded that application at 100 ppm

Cite this article as:
Kaya, A.S., Aydinsakir, K., Karaguzel, U.O. (2019). Assessment of GA_3 and BA application on gerbera cultivation in soilless culture. Int. J. Agric. Environ. Food Sci., 3(1), 41-45. DOI: https://doi.org/10.31015/jaefs.2019.1.9
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 41-45
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

 DOI: https://dx.doi.org/10.31015/jaefs.2019.1.9

of GA_3 from November to February in monthly increase of yield in winter season and give lower yield in the following production season. Different GA_3 levels did not effect on peduncle length but plant regulators levels increased the inflorescence diameter. However, they stated that more research is required to determine the effect of plant variety and growth regulator levels.

Nair et al. (2002) investigated the effect three different levels of gibberellic acid, chlorocholine chloride, malichydrazide and ethepton (50, 100, 150 ppm of GA_3; 400, 600, 800 ppm of CCC; 250, 500, 750 ppm of MH; and 4, 6, 8 ppm of ethepton) on *Gerbera jamesonii* cv. Versace. All treatments were sprayed monthly from January to May (1998-2001) starting from two months after planting. Using 100 ppm of gibberellic acid gave the maximum plant spread and the highest leaf number and suckers and leaf area. While the GA at 100 ppm produced the highest flower number per pot (20.73) in first year, the highest flower number was obtained 100, 150 and 50 ppm GA in second year respectively. The largest flower diameter and vase life were obtained 800 ppm CCC treatments in both years whereas the largest flower stalks were obtained 150 ppm of GA treatments. The highest benefit cost ratio in both years was attributed to 100 ppm GA. In another study, plants of the gerbera cultivars Amber and Quenn Rebecca, raised in vitro, were potted in May and grown under glass in natural photoperiods. Half were sprayed with GA_3 at 50, 100, 200 or 500 mg L^{-1} at seven, fourteen or twenty-one days' intervals. Control plants were sprayed with tap water. Application of 200-500 gL^{-1} GA_3 in variety of *Gerbera jamesonii* cv. Amber raised in flower stem length but had no such effect on *Gerbera jamesonii* cv. Quenn Rebecca. Gibberallic acid application increased inflorescence size, but treatments were reduced vase life in both varieties. The cut flower yield was unaffected by any GA_3 treatment (Pobudkiewicz and Nowak 1992). There is limited literature on the application of BA which is used in this study. Sogut and Kucuk (1998) reported that 250 mgL^{-1} of BA and 500-1000 ppm of BA increased shoot developing on *rosa* spp. and *anthurium* respectively. The applications increased vase life of *dianthus* spp. BA is used in vitro culture nowadays.

This study was carried out to assessment the effects of GA_3 and BA application on yield, quality and multiplication ratio on *Gerbera jamesonii* cv. Sangria planted at glasshouse under Mediterranean conditions.

Materials and Methods

This study was carried out a glass greenhouse located at the Batı Akdeniz Agricultural Research Institute of Antalya, Turkey between 2003-2005. The plant of the Gerbera cultivar Sangria, raised in vitro, was obtained from Florist Firm. This variety has a red color, stem diameter is 11-13 cm, stem length is 65 cm and vase life is 10-12 days according to the catalog data. Yield is about 120-140 per square meter.

The research was designed according to randomized blocks; each treatment had 10 plants and was replicated three times. Rigid plastic black tubes which have 11 m length and 25 cm width 30 cm depth were used in the study. Turf and volcanic tuff (1:1) were used as growing media pH was determined as 7.31 and EC was 510 micromhos respectively.

After the seedlings sunk the funguses, gerbera seedlings were planted on 18 June 2003 in 30x30 cm intervals and each tube have 72 seedlings. To facilitate adaptation of the plants sprinkler irrigation was used in the first month of the study. After that drip irrigation system was located as one dripper for each plant. The nutritional program was made after two weeks planting date. Nutrient solution and their amounts which were used in the researc are given in Table 1.

Table 1. Nutrient elements and quantity used in research

Nutrient	Concentration
NO_3	11.25 mmol L^{-1}
H_2PO_4	1.25 mmol L^{-1}
SO_4	1.25 mmol L^{-1}
NH_4	1.50 mmol L^{-1}
K	5.50 mmol L^{-1}
Ca	3.00 mmol L^{-1}
Mg	1.00 mmol L^{-1}
Fe	35.00 µmol L^{-1}
Mn	5.00 µmol L^{-1}
Zn	4.00 µmol L^{-1}
B	30.0 µmol L^{-1}
Cu	0.75 µmol L^{-1}
Mo	0.50 µmol L^{-1}

The plants were treated against fungal diseases and insects periodically; old and diseased leaves were picked during the study. Greenhouse temperature and humidity were measured via thermo hygrograph.

Three different GA_3 (125, 250, 500 ppm) and BA levels (100, 200, 400 ppm) were applied by foliar spray once a month between October, 2003 and March, 2005. Application doses and dates were determined depending on literature like Farina et al. (1989); Pobudkiewicz and Nowak (1992) and taking production period in Antalya into consideration.

At the end of the study, multiplication ratio (number), flower stem diameter (mm), flower stem length (cm), flower diameter (cm), yield (number $plot^{-1}$), and vase life (day) were determined. Data were subjected to variance analysis and the significance of the differences across means were defined using Duncan's multiple range tests at significance level of p=0.05 (Gomez and Gomez, 1984).

Results and Discussion

The first flowers harvested in 20 September 2003. Because the GA_3 and BA application were started in 01 October 2003, first flowers were not evaluated. Data which is related to study were obtained between 20 October 2003-30 April 2004 in the first year and 20 October 2004-30 April 2005 in the second year of the experiment. Multiplication ratio (number) was determined only second year of the experiment.

The main goal of the gerbera production is to get best export quality flowers in winter months. In these months, the low air and soilless culture temperature, the negatively affect yield and quality in gerbera production (Rogers and Tjia, 1990; Korkut, 1998; Gürsan, 2000; Mercurio, 2002). These negative effects are more pronounced as the plant is getting older (Özzambak, 2004).

The variance analyzes results are presented in Table 2. The effects of different growth regulators levels were statistically significant on the gerbera yield and quality parameters such as flower stem length (cm), flower stem diameter (mm), flower diameter (cm), vase life (day) and multiplication ratio (number). Each plant growth regulators application formed a group in Duncan test (P0.05). Yield an quality parameters values of gerbera are given Figure 1, 2, 3, 4, 5.

Table 2. Variance analyzes results of study

Source of variation	d.f.	Characteristics (variable)					
		Yield (number plot^{-1})	Flower stem length (cm)	Flower stem diameter (mm)	Flower diameter (cm)	Vase life (day)	Multiplication rate (number)
Replication	2						
Treatments (T)	6	**	**	**	**	*	**
Error (T)	5						
Total	17						

*, **, significant at $P< 0.05$, and 0.01, respectively.

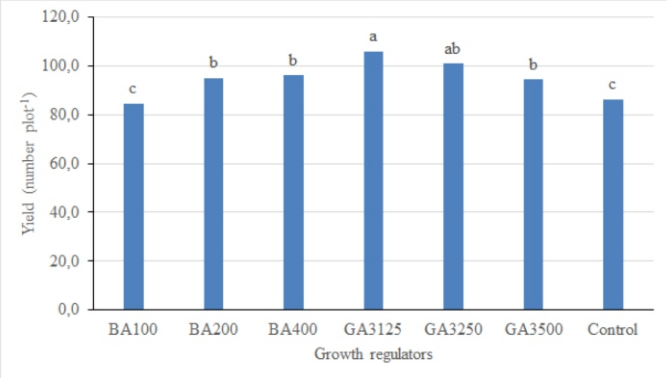


Figure 1. The effects of different GA_3 and BA treatments on yield

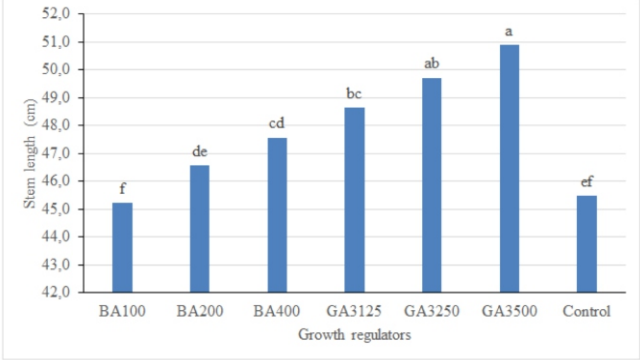


Figure 2. The effects of different GA_3 and BA treatments on stem length

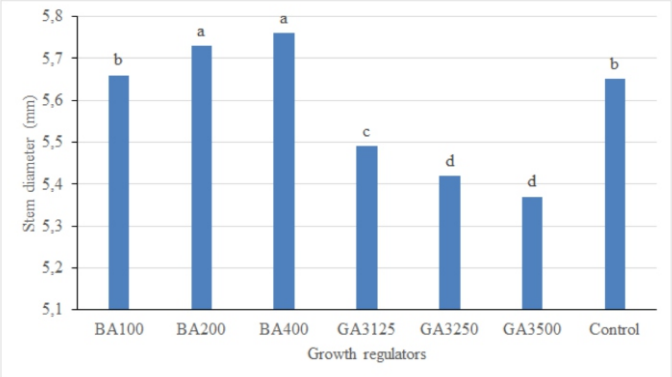


Figure 3. The effects of different GA_3 and BA treatments on stem diameter

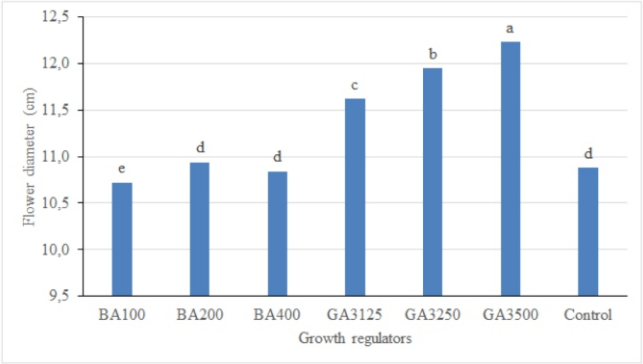


Figure 4. The effects of different GA_3 and BA treatments on flower diameter

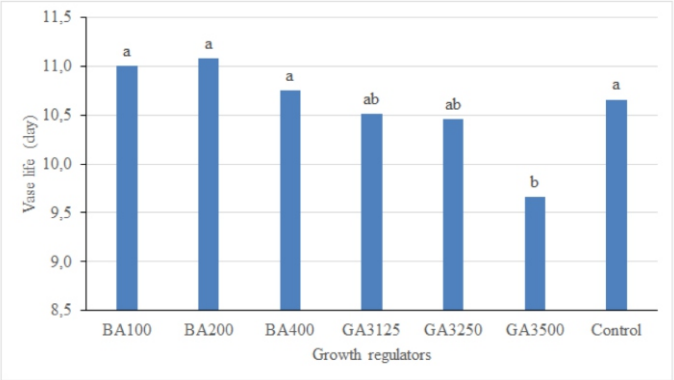


Figure 5. The effects of different GA_3 and BA treatments on vase life

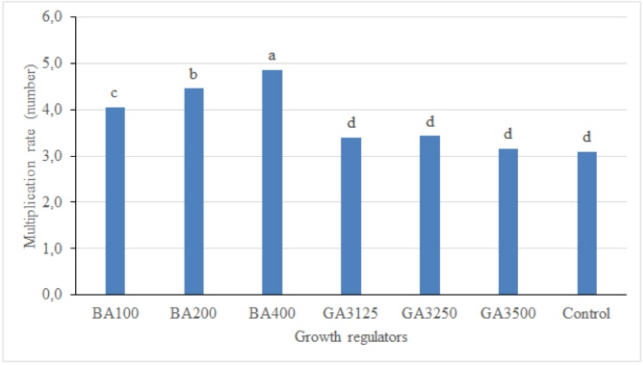


Figure 6. The effects of different GA_3 and BA treatments on multiplication rate

 DOI: https://dx.doi.org/10.31015/jaefs.2019.1.9

Application of gibberellin and benzyl adenine growth regulators as two effective and important chemical factors in gaining of more yield in flower production. The highest yield (106 number plot^{-1}) was obtained in 125 ppm of GA_3 and this was followed by 250 ppm of GA_3. No differences were detected between 100 ppm of BA application and control application while 200 ppm and 400 ppm applications increased yield (Figure 1). GA_3 encouraged promotion of flowering which due to increased synthesis as well as translocation of growth and flowering hormone. Chauhan et al. (2014) and Patra et al. (2015) stated that yield, flower stem length, flower stem thickness and vase life increased when level of 100 ppm GA_3 were applied in gerbera production.

These results are in accord with Hertogh and Nard (1993) in zantedeschia, Bhattacharya (1993) in lilium and Nair et al. (2002) in *Gerbera jamessonii* cv. Versace.

The longest flower stem length was obtained 500 ppm of GA_3 treatments which is followed by 250 and 125 ppm of GA_3, BA treatments and control (Figure 2). The highest flower stem diameter was obtained in 400 ppm and 200 ppm of BA treatments. GA_3 treatments were reduced vase life (Figure 3). Patra et al. (2014) concluded that application of GA_3 may possibly successfully impact the growth and flowering performance of the gerbera and rise in the concentration of GA_3 from 25 to 100 ppm increase the stem length and stem diameter. Pobudkiewicz and Nowak (1992), stated that application of GA_3 (500 ppm) and application of BA (400 ppm) increased the flower stem length in the 'Amber' gerbera variety. Salem et al. (2016) concluded that application of 150 ppm GA_3 increased the per plant yield, flower diameter, flower stem thickness and flower stem diameter in gerbera production.

Flower diameter that is one of the most vital quality criteria was affected by plant growth regulators statistically. It has been determined that all GA_3 applications gave best results compared to the BA applications and control in terms of flower diameter in the study. As shown in Figure 4, all GA_3 treatments affected flower diameter compared to BA and control treatments. These results obtained from 125, 250 and 500 ppm of GA_3 treatments are in harmony with Farina et al. (1989). While GA_3 treatments were reduced the flower stem diameter, BA treatments were increased flower stem diameter.

The largest vase life was obtained 200 ppm of BA (11.08 day) (Figure 5). Pobudkiewicz and Nowak (1992) stated that the peduncles of *Gerbera jamesonii* cv. Amber was influenced the GA_3 application, while did not effect on cv. Queen Rebecca. In this study, GA_3 increased the inflorescences diameter, while shortened vase life.

Compared to control plants, the finding of larger flower diameters in GA_3 applications at 500, 250 and 125 ppm doses were obtained. Farina et al. (1989) found that GA_3 application increased flower size. When the effects of the applications on the flower stem thickness were examined, it was determined that GA_3 doses decreased flower stem thickness according to the control and BA applications had an impressive effect. The thickest flower stalk was obtained with an application of 400 ppm of BA with 5.76 mm. Sujatha et al. (2002) reported that GA_3 treatments (100 ppm) from January to May showed best results in terms of flower size in gerbera at monthly interval

The application of BA at 400 ppm showed the best results for the promotion of multiplication ratio of this gerbera variety in this study. The highest multiplication ratio was obtained 400 ppm of BA and this was followed by 200 and 100 ppm of BA. GA_3 treatments did not affect multiplication ratio (Figure 6). The use of concentrations higher than 125 ppm of GA_3 did not increase the multiplication ratio. Chauhan et al. (2014) stated that application of 100 ppm GA_3 at performed better for flower stalk thickness, flowering span, stem length, number of ray florets per flower, yield, regeneration ratio and fresh and dry weight.

Conclusion

According to the results obtained in this study, it was determined that the plant growth regulators applied had effects on all parameters of yield and quality. The maximum yield was found in 125 ppm of GA_3. The highest quality characteristics like stem length and flower diameter were obtained from 500 ppm of GA_3 and this was followed by 250 and 125 ppm of GA_3 whereas the highest multiplication ratio was obtained 400 ppm of BA. GA_3 treatments were reduced vase life. According to the result obtained from the research, it is recommended that *Gerbera jamesonii* cv. Sangria should be treated 125 ppm of GA_3 to get the highest yield. On the contrary, it can be treated as much as 500 and 250 ppm of GA_3 respectively, to get the highest flower diameter and flower stem length. Additionally, it is reported that the GA_3 should be used when the gerbera growth in winter in the glasshouse.

References

Bhattacharjee, S.K. (1993). Studies on the effect of gibberellic acid on growth, flowering, flower quality and postharvest life of Rosa hybrid cv. Raktagandha. Indian Rose Annual, 11:77-83

Chauhan, R.V., Kava, K.P., Babariya, V.J., Pansuria, P.B., Savaliya, A.B. (2014). Effect of gibberellic acid on flowering and cut flower yield in gerbera under protected condition. Asian Journal of Horticulture 9(2): 404-407. [CrossRef] [Google Scholar] [CABI]

El-Shafie, S.A., Hassan, H.A. (1980). Effect of gibberellic acid and clormequat on the growth and flowering of gerbera. Horticultural Abstracts 50(1):43.

Farina, E., Paterniani, T., Volpi, L. (1989). Effect of GA_3 treatments on flowering of gerbera grown for winter production. Acta Horticulturae 246:159-166. [CrossRef] [Google Scholar]

Gomez, K.A., Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. An Int. Rice Res. Inst. Book. John Wiley and Sons, Inc. New York, 680 p. [Google Scholar]

Gürsan, K. (2002). Gerbera Yetiştirme Tekniği. Atatürk Bahçe Kültürleri Merkez Araştırma Enstitüsü, Yalova, 11 s. (in Turkish).

Hertogh, D., Nard, L.M. (1993). Physiology of Flowering Bulbs, Elsevier, Amsterdam, The Netherlands.

Kaya, A., Karagüzel, Ö., Aydinşakir, K., Arı, E., Özçelik, A. (2004). Pink elegance gerbera (*Gerbera jamessonii*) çeşidinde GA_3 ve BA uygulamalarının kış verimi ve kalitesi üzerine etkileri. Derim 21(2):35-39. (in Turkish). [Google Scholar]

Kazaz, S., Erken, K., Karagüzel, Ö., Alp, Ş., Öztürk, M., Kaya, A.S., Gülbağ, F., Temel, M., Erken, S., Saraç, Y.İ., Elinç, Z., Salman, A., Hocagil, M. (2015). Süs Bitkileri Üretiminde Değişimler ve Yeni Arayışlar. TMMOB Ziraat Mühendisleri Odası Türkiye Ziraat Mühendisliği

VIII. Teknik Kongresi, Bildiriler Kitabı-1, s: 645-672. 12-16 Ocak, Ankara. (in Turkish).

Kewte, M., Sable, A.S. (1997). Influence of growth regulators and foliar nutrients on vase life, grading and economics of rose cv. paradise. Journal of Soils of Crops 7(1):96-98.

Korkut, A.B. (1998). Çiçek Yetiştiriciliği. Hasad Yayıncılık Ltd. Şti. İstanbul, 222 s. (in Turkish).

Mercurio, G. (2002). Gerbera Cultivation in Greenhouse. First Ed. October 2002, Italy, 201 p.

Nair, S.A., Sharma, T.V.R.S., Singh, V. (2002). Effect of plant growth regulators on yield and quality of gerbera under bay island condition. Indian Journal of Horticulture 59(1):100-105. [Google Scholar]

Özzambak, E. (2004). Serada Topraksız Gerbara Yetiştiriciliği. İzmir Ticaret Odası. Yayın No:140, İzmir, 65 s. (in Turkish).

Patra, S.K., Beura, S., Shasani, T. (2015). Efficacy of GA3 on growth and flowering regulation of in vitro raised hybrid gerbera under shade net. Agricultural Science Digest 35(3): 173-177. [Google Scholar]

Pobudkiewicz, A., Nowak, J. (1992). The effects of giberellic acid on growth and flowering of *gerbera jamesonii* bolus. Folia-Horticulturae. 4(2):35-42. [Google Scholar]

Rogers ,M.N., Tjia, B.O. (1990). Gerbera Production. Timber Press, Inc. ISBN 0-88192-172-6, Hong Kong, 109 p. [Google Scholar]

Salem, R.A.A., Saravanan, S., Prasad, V.M. (2016). Effect of benzyl adenine on growth, yield and flowers of gerbera (*Gerbera jamesonii*). International Journal of Engineering Sciences & Research Technology, 5(3), 108–114. [CrossRef]

Sekar, K., Sujata, A. (2001). Effects of growing media and ga_3 on growth and flowering of gerbera (*gerbera jamesonii* h. bolus.) under naturally ventilated greenhouse. Proceedings of a National Seminar, South-Indian-Horticulture 49: 338-341.

Sogut, Z., Kucuk, R. (1998). Süs bitkileri yetiştiriciliğinde büyüme düzenleyicilerinin kullanımı. Türkiye 1. Ulusal Süs Bitkileri Kongresi, Ekim 1998, 6-9 Ekim, Yalova, s:369-375. (in Turkish).

Sujatha, A., Nair, I., Singh, V., Sharma, T.V.R.S. (2002). Effect of plant growth regulators on yield and quality of gerbera under Bay Island conditions. Indian Journal of Horticulture 59 (1): 100-105. [Google Scholar]

International Journal of Agriculture, Environment and Food Sciences

JAEFS

e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.10 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):46-49 (2019)

Sensitivity of oilseed rape (*Brassica napus* L.) to soil residues of imazethapyr herbicide

Mohammad Mehdizadeh[1,*]

[1]Faculty of Agricultural and Natural Resources, Department of Agronomy and Plant Breeding, University of Mohaghegh Ardabili, Ardabil, Iran

[*]Corresponding Author: mehdizade.mohammad@gmail.com

Abstract

Imazethapyr is one of imidazolinone herbicides that may leave residual activity in the soil for extended periods causing injury and yield reduction of susceptible crops in rotation. An experiment was conducted in order to study the sensitivity of oilseed rape (*Brassica napus* L.) to imazethapyr soil residues. Experimental type was completely randomized design with three replications. Treatments included Imazethapyr simulated concentrations residuals in soil (0.002, 0.004, 0.008, 0.012, 0.02 and 0.04 mg. kg^{-1}soil). Shoot and root biomass production was measured 30 days after emergence. Oilseed rape responses to imazethapyr residues was fitted with sigmoidal 3 and 4 parametric equations to the root and shoot biomass data as a function of the herbicide residue concentrations and was used to calculate the doses for 50% inhibition of root and shoot growth (ED_{50}). Results showed that the oilseed rape shoot and root dry matter were significantly affected by increasing imazethapyr soil residue ($p<0.01$). This reduction in root dry matter was severe than shoot dry matter, where root ED_{50} (0.0019 mg.kg^{-1}soil) was less than shoot dry matter (0.0025 mg.kg^{-1}soil). Considering the high sensitivity of oilseed rape to imazatepara residues, attention is needed to provide oilseed rape cultivation in fields with a history of imazateaper application.

Keywords: Dry matter, Herbicide, Imidazolinone, Pesticide, Sensitivity

Received: 21 November 2018 Accepted: 20 January 2019 Revised: 13 February 2019 Published: 15 March 2019

Introduction

Weed interference with agricultural plants is considered as one of the most important factors affecting crop yields and therefore weed control in agricultural land is of great importance. Persistence of herbicides in soil could be useful due to increasing the effectiveness control of weeds which alternately grow in fields but damage to sensitive crops in rotations (Mehdizadeh et al., 2016; Melo et al., 2016) and also their inhibitory effects on soil microorganisms is a negative consequence of this phenomenon (Sebiomo et al., 2011; Sathiyavani et al., 2015). Hence, understanding the factors and mechanisms that determine the persistence and degradation of herbicides, by providing management strategies, could be used to ensure the health of agro ecosystems. Herbicides with active residues in the soil are compounds that, due to their toxic residues, affect the growth of the plant in the next seasons (Mehdizadeh and Gholami-Abadan, 2018). Imidazolinone are one of the groups of herbicides that are easily absorbed by the root and foliage of the plants and accumulate in the meristem tissues and reduce the growth, the formation of necrosis and chlorosis, and finally the death of plant. Imazethapyr is one of the imidazolinone herbicides that are widely used for control of broad-leaved weeds in many crops (Webster et al., 2018). This herbicide inhibits the acetylacetate synthase enzyme, which plays an important role in the biosynthesis of branched-chain amino acids, valine, leucine and isoleucine (Zabalza et al., 2007). Imazethapyr is a relatively high persistant herbicide in the soil and its half-life has been reported for about 60 to 90 days in agricultural soils (Vencill, 2002). The persistence of these herbicides in the environment may increase the duration of weed control period, but it can cause damage to non-target organisms and sensitive crops in the rotation and also endangers human and environment health. Gaston et al. (2002) reported that with increasing imazethapyr concentration in soil, growth of root meristems, dry weight and fresh weight, and chickpea yield significantly decreased. Wiatrak et al. (2009) evaluate the performance of imazapic simulated residues on cotton plant and observed that growth, yield quantity and quality of cotton were significantly affected by the herbicide residues. Moyer and Esau (1996) found that sugar beet was affected by imazethapyr herbicide even one year after application. Alister and Kogan (2005) reported that the residues of imazapyr herbicides with imazaquin and imazethapyr reduced the yield of barley, oats, chickpeas, sugar beet and tomatoes one year after application.

Residues of herbicides in the soil could be measured by analytical or bioassays methods. Analytical methods are very specific and sensitive and just quantifying the total amount of herbicide residues in the soil (Grimalt and

Cite this article as:
Mehdizadeh, M. (2019). Sensitivity of oilseed rape (*Brassica napus* L.) to soil residues of imazethapyr herbicide. Int. J. Agric. Environ. Food Sci., 3(1), 46-49. DOI: https://doi.org/10.31015/jaefs.2019.1.10
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 46-49
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

Dehouck, 2016; Janaki et al., 2018). However, these methods are costly, time-consuming, requiring complex equipment and organic solvents for the extraction process (Sondhia and Singh, 2018). Bioassay is a relatively simple and inexpensive method that can measure toxic portions of the herbicides residues in the soil. Therefore, it seems that the use of analytical methods such as high performance liquid chromatography (HPLC) and plant bioassay method complement each other and can greatly help researchers to identify and quantify herbicide residues in the soil (Mehdizadeh et al., 2017). In this regard, Szmigielska and Schoenau (1999) reported that the use of plant bioassay method was more sensitive than ion exchange extraction method in evaluating the imazethapyr residues in soils. They detected very low concentrations of herbicide by bioassay method. Since the oilseed rape has been used as a reference plant to evaluate herbicides residues, this experiment was conducted to evaluate its sensitivity to simulated concentrations of imazethapyr herbicide in soil using bioassay method.

Materials and Methods

A greenhouse experiment was conducted during 2016 in a completely randomized design with 3 replications. The treatments consisted of different concentrations of imazethapyr in soil (0, 0.002, 0.004, 0.008, 0.012, 0.02 and 0.04 mg. kg^{-1}soil), which the effects of these concentrations on root and shoot biomass of oilseed rape were evaluated. For this purpose, after preparation of a soil with equal ratio of sand, soil and leaf mould, the aqueous stoke solution of 1000 ppm of imazethapyr was prepared and the remaining concentrations were prepared by dilution of stoke solution. Then, by using the syringe pipette, the calculated amount of herbicide solution was mixed up with the soil and poured onto the soil surface of the pots and after evaporation of the solvent (water) was completely mixed with the upper layer of the soil. Then 10 seeds of oilseed rape (Hyola cultivar) were planted at appropriate depth in every pot. During the experiment, the pots were irrigated uniformly. One week after the emergence of plants, five plants were thinned in each pot. After 30 days the plants were harvested and separately dried in an oven at 60 °C for 48 hours. Then, the root and shoot dry weight was measured. The data was subjected to analysis of variance using the MSTAT-C software. Mean comparisons were performed using Duncan Multiple Range Test (DMRT) set at 0.05. Oilseed rape response of dry weight of roots and shoot per pot (Y) were described by a three parameter log-logistic regression model as a function of imazethapyr doses, x:

$$Y = \frac{d}{1+\exp\{b(\log(x)-\log(e))\}}$$

Where *d* is the upper asymptote (maximum biomass per pot), which is close to the untreated control, *b* denotes the slope of the curve around the *e*, which denotes the dose that inflicts a 50% biomass reduction relative to *d*.

Results and Discussion

Based on the findings of experiment, the response of plant roots and shoot biomass to the simulated imazethapyr residues follows the logistic model which is accordance with results from other studies (Halloway et al., 2006; Santin-Montanya et al., 2006). The results showed that the imazethapyr residues in concentrations of 0.002-0.04 mg. kg^{-1} soil significantly reduced the oilseed rape root and shoot biomass ($P<0.01$) (Table 1).

According to the results, damage amount of root and shoot dry weight increased significantly with increasing imazethapyr concentration in soil, so that at the concentration of 0.002 mg.kg^{-1} soil, approximately 54% of root biomass and 45% of shoot biomass were reduced, while, at 0.122 mg. kg^{-1} soil, the root and shoot losses of oilseed rape were 100%.

Table 1. Analysis of variance of oilseed rape root and shoot dry matter to imazethapyr residues in soil.

Variation Resources	Df	Shoot Dry Matter	Root Dry Matter
Herbicide doses	6	4181.71**	4040.24**
Error	14	5.887	3.716

** Significant difference at P<0.01

Table 2. Mean comparison of rapeseed root and shoot dry matter in different levels of imazethapyr residues.

Herbicide doses (mg. kg^{-1} soil)	Shoot Dry Matter (% to control)	Root Dry Matter (% to control)
0	100[a]	100[a]
0.002	54.6[b]	46.3[b]
0.004	39.2[c]	31.2[c]
0.008	18.4[d]	12.5[d]
0.012	0[e]	0[e]
0.02	0[e]	0[e]
0.04	0[e]	0[e]

*Significant differences are denoted by different letters within each column at P<0.05 according to Duncan's Multiple Ranges Test.

Table 3. Parameters estimated by 3-parameter sigmoidal logistic equation to rapeseed root and shoot dry matter to imazethapyr residues in soil.

Traits	B	D	ED_{10}	ED_{50}	ED_{90}
Shoot Dry Matter	1.256(0.033)*	99.577(6.12)	0.000608(0.0002)	0.0025(0.0004)	0.0106(0024)
Root Dry Matter	1.216(0.028)	99.808(4.50)	0.000446(0.0002)	0.0019(0.0003)	0.0086(0.0016)

* Standard error

In biodegradation studies of herbicide residues in soil, ED_{10}, ED_{90} and especially ED_{50} are used to determine the sensitivity of plants to herbicide residues in soil. According to the results, the ED_{50} parameter for root biomass (0.0019 mg. kg^{-1} soil) was lower than the shoot biomass (0.0025 mg kg^{-1} soil), which indicates greater sensitivity of the root to residues of this herbicide in the soil (Table 3).

Bresnahan et al. (2000) Found that the residue of imazethapyr herbicide in very low concentrations (0.5 to 3 µg. kg^{-1} soil) also resulted in damage to different crops. Other studies also highlighted the high sensitivity of oilseed rape to herbicides residues in the soil. Mehdizadeh (2016) reported that oilseed rape is very suitable for use in bioassays for evaluating the side-effects of triasulfuron at low concentration rates. Mansoori et al. (2008) observed that residues of sulfosulfuron herbicides in the soil resulted in toxicity and reduced oilseed rape yield in rotation with wheat. They reported that increasing sulfosulfuron application rate from 42 to 52 g a.i. h^{-1} increased oilseed rape yield losses from 13.5 to 17.5 percent. It seems that in evaluating the imazethapyr herbicide residues, the use of root biomass parameters of sensitive plants such as oilseed rape, can be very accurate and effective due to the inhibitory effects of herbicide on cell division of root meristemic areas in susceptible plants. Therefore, Szmigielska et al. (2008) have used the mustard root bioassay as an appropriate biological indicator in evaluating the flucarbazone herbicide residues. Since roots are directly exposed to the herbicide residues, it seems to be more sensitive than shoots in response to herbicide residues. So that in this study, the sensitivity of oilseed rape root biomass was greater than that of the shoot biomass (Tables 2, 3 and Figure 1).

In bioassay studies of herbicides residues in soil, root growth of plants is one of the most important indicators in assessing the sensitivity of plant species to herbicide residues and determining the probable amounts of their residues. In this regard, Halloway et al. (2006) reported that the sensitivity of lentil root growth to metsulfuron methyl residues was an appropriate index for determining the possible residues of this herbicide in agricultural soils. They reported that, despite the inability of analytical methods to detect device the herbicide residues, lentil root bioassay test was a suitable measure for the detection of metsulfuron methyl residues. Szmigielska et al. (2008) found that mustard root bioassay was more effective than analytical methods in determining the flucarbazone herbicide residue in soil. They reported that mustard root bioassay had more than 88% of the acceptable results in determining the potential flucarbazone residues. The results of this study indicate that there is a difference in the sensitivity of oilseed rape root and shoot biomass to imazethapyr residues in the soil, suggesting that the evaluation of imazethapyr bioassay using oilseed rape root biomass could be used as an appropriate indicator for determining the residues of this herbicide.

Conclusion

In general, based on the findings of this study, application of imazethapyr even in very low concentrations (0.002 mg. kg^{-1} soil), it has a high potential for damage to oilseed rape plant, and it is possible to use oilseed rape, and especially the root biomass of this plant as a suitable parameter for determining the residues of this herbicide in agricultural soils. Hence, limitation in crop rotations could be one of the most important problems associated with the application of imazethapyr in soil. Although other factors can influence the persistence of herbicides in the soil, but according to the results of this study, it seems very important to consider the non-sensitive crops in rotation in fields that previously treated with imazethapyr. In this regard, it is recommended to perform analytical methods for determining the concentration of imazethapyr residues after harvest and comparing results with bioassay methods.

Conflict of interest

The author confirms that there are no known conflicts of interest associated with this study.

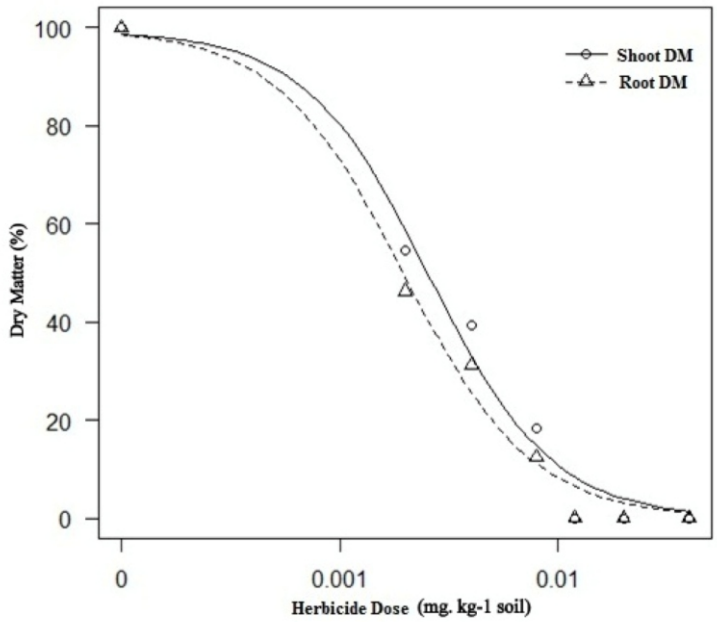


Figure 1. Rapeseed root and shoot dry matter response to imazethapyr residues in soil.

References

Alister, C., Kogan, M. (2005). Efficacy of Imidazolinone Herbicides Applied to Imidazolinone-Resistant Maize and Their Carryover Effect on Rotational Crops. Crop Protection, 24, 375-379. [CrossRef] [Google Scholar]

Bresnahan, G.A., Koskinen, W.C., Dexter, A.G., Lueschen, W.E. (2000). Influence of soil pHsorption interactions on imazethapyr carry-over. Journal of Agricultural Food Chemistry, 48, 1929-1934. [CrossRef] [Google Scholar]

Gaston, S., Zabalza, A., Gonzalez, E.M., Arrese-Igor, C., Aparicio-Tejo, P.M. Royuela, M. (2002). Imazethapyr, an inhibitor of the branched-chain amino acid biosynthesis, induces aerobic fermentation in pea plants. Physiologia Plantarum, 114, 524–532. [CrossRef] [Google Scholar]

Grimalt, S., Dehouck, P. (2016). Review of analytical methods for the determination of pesticide residues in grapes. Journal of Chromatography A, 1433, 1-23. [CrossRef] [Google Scholar]

Halloway, K.L., Kookana, R.S., Noy, D.M., Smith, J.G., Wilhelm, N. (2006). Persistence and leaching of imazethapyr and flumetsulam herbicides over a 4-year period in the highly alkaline soils of south-eastern Australia. Australian. Journal of Experimental Agriculture, 46, 669-674.

Helling, C.S. (2005). The Science of soil residual herbicides. Science and management, 3-22. [CrossRef] [Google Scholar]

Janaki, P., Bhuvanadevi, S., Dhananivetha, M., Murali A.P., Chinnusamy, C. (2018). Persistence of Quizalofop Ethyl in Soil and Safety to Ground Nut by Ultrasonic Bath Extraction and HPLCDAD Detection. Journal of Research in Weed Science, 1, 63-74. [CrossRef] [Google Scholar]

Mansoori, S., Zand, E., Baghestani-Meybodi, M.A., Tavakoli, M. (2008). Effect of sulfonylurea herbicides on yield and component of yield of canola. Weed Science, 4, 83-85. [Google Scholar]

Mehdizadeh, M. (2016). Effect of Pesticide Residues on Agricultural Food Production; A Case Study: Sensitivity of Oilseed Rape to Triasulfuron Herbicide Soil Residue. MOJ Food Processing & Technology, 2, 53-54. [Google Scholar]

Mehdizadeh, M., Alebrahim, M.T., Roushani, M., Streibig, J.C. (2016). Evaluation of four different crops' sensitivity to sulfosulfuron and tribenuron methyl soil residues. Acta Agriculturae Scandinavica, Section B-Soil & Plant Science, 66, 706-713. [CrossRef] [Google Scholar]

Mehdizadeh, M., Alebrahim, M.T., Roushani, M. (2017). Determination of Two Sulfonylurea Herbicides Residues in Soil Environment Using HPLC and Phytotoxicity of These Herbicides by Lentil Bioassay. Bulletin of Environmental Contamination and Toxicology, 99, 93-99. [CrossRef] [Google Scholar]

Mehdizadeh, M., Gholami-Abadan, F. (2018). Negative Effects of Residual Herbicides on Sensitive Crops: Impact of Rimsulfuron Herbicide Soil Residue on Sugar beet. Journal of Research in Weed Science, 1, 1-6. [CrossRef] [Google Scholar]

Melo, C.A.D., Dias, R.C., Mendes, K.F., Assis, C.L.P., Reis M.R. (2016). Herbicides carryover in systems cultivated with vegetable crops. Revista Brasileira de Herbicidas, 15, 67-78. [CrossRef] [Google Scholar]

Moyer, J.R., Esau, R. (1996). Imidazolinone herbicide effects on following rotational crops in Southern Alberta. Weed Technology, 10, 100–106. [CrossRef] [Google Scholar]

Santin-Montanya, I., Alonso-Prados, J.L., Villarroya, M., Garci-Baudin, J.M. (2006). Bioassay for determining sensitivity to sulfosulfuron on seven plant species. Journal of Environmental Science and Health B, 41, 781-793. [CrossRef] [Google Scholar]

Sathiyavani, E., Prabhakaran, N.K., Chinnusamy, C., Shanmugasundram, R., Soorianathsundaram, K. (2015). Effect of Herbicide residues on Soil Microorganisms in Turmeric. International Journal of Horticulture, 5, 1-12. [Google Scholar]

Sebiomo, A., Ogunder, V.W., Bankole, S.A. (2011). Effect of four herbicides on microbial population, soil organic matter and dehydrogenase activity. African Journal of Biotechnology, 10, 770-778. [Google Scholar]

Sondhia, S., Singh, P.K. (2018). Bioefficacy and Fate of Pendimethalin Residues in Soil and Mature Plants in Chickpea Field. Journal of Research in Weed Science, 1, 28-39. [CrossRef] [Google Scholar]

Szmigielski, A.M., Schoenau, J.J. (1999). Analysis of imazethapyr in agricultural soils by ion exchange membranes and a canola bioassay. communication in soil science and plant analysis, 30, 1831-1846. [CrossRef] [Google Scholar]

Szmigielski, A.M., Schoenau, J.J., Lervine, A., Schilling, B. (2008). Evaluation a mustard root bioassay for predicting crop injury from soil residual flucarbazone. Communications in soil science and plant analysis, 39, 413-420. [CrossRef] [Google Scholar]

Vencill, W.K. (2002). Herbicide handbook. 8th ed. Lawrence, K.S: Weed Science Society of America. 493p.

Webster, E., Teló, G., Blouin, D., McKnight, B. (2018). Imazethapyr plus Propanil Mixtures in Imidazolinone-Resistant Rice. Weed Technology, 32, 45-51. [CrossRef] [Google Scholar]

Wiatrak, P.J., Wright, D.L., Marois, J.J. (2009). Influence of Imazapic Herbicide Simulated Carryover on Cotton Growth, Yields, and Lint Quality. Crop Management, doi:10.1094/CM-2009-0720-01-RS.[CrossRef] [Google Scholar]

Zabalza, A., Gaston, S., Sandalio, L.M., Rio, L.A. Royuela, M. (2007). Oxidative stress is not related to the mode of action of herbicides that inhibit acetolactate synthase. Environmental and Experimental Botany, 59, 150–159. [CrossRef] [Google Scholar]

International Journal of
Agriculture, Environment and Food Sciences

JAEFS e-ISSN : 2618-5946 DOI: 10.31015/jaefs.2019.1.11 www.jaefs.com

Research Article Int J Agric Environ Food Sci 3(1):50-53 (2019)

Fruit consumption, its determinants and attitudes among undergraduates

Umali Sathsarani Herath[1,*]

[1]Sabaragamuwa University of Sri Lanka, Faculty of Agricultural Sciences, Department of Export Agriculture, Belihul Oya, Sri Lanka

[*]Corresponding Author: umaliherath21@gmail.com

Abstract

Fruits, being a good source of nutrients, can be used to fulfil the daily requirement of nutrients. However, the statistics of Food and Agriculture Organization and World Health Organization state that the worldwide per capita consumption of fruits and vegetables is estimated to be less than 20 to 50 percent of the minimum daily recommended intake. The health and well-being of the future generation of a country are critical in preventing malnutrition and chronic diseases. A study was carried out to find out the daily intake of fruits, barriers for consumption and other patterns in consumption among undergraduates. Moreover, the study focused on identifying knowledge on nutrition and opinions of undergraduates on fruit production. 50 students from the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka were randomly selected and given a self- administered questionnaire. The daily intake of a majority of students existed between 50-100g and most consumed fruits in fresh form. Unavailability in the market or the limited access was the major barrier for the intake of sufficient amount of fruits. The study concluded that the daily intake of fruits of undergraduates is less than the recommended level. Extension services and constant market prices can overcome the problems in fruit production.

Keywords: Fruits, Undergraduates, Fruit consumption, Barriers to fruit intake

Received: 12 November 2018 Accepted: 24 February 2019 Revised: 03 March 2019 Published: 15 March 2019

Introduction

Fruits contain numerous nutrients including vitamins, carbohydrates, and minerals that are essential for the well-being of humans. Consumption of fruits permits the intake of rich sources of ascorbic acid, thiamine, niacin, vitamin B6 as well as minerals such as potassium, magnesium, and calcium. Both glycaemic and non-glycaemic carbohydrates are found in fruits, however, they do not contain cholesterol, a point that can be used to classify fruits as a healthy source of food. Presence of dietary fibers that are vital for the maintenance of a healthy circulatory and digestive system enhances the importance of fruits as a non-nutritive food constituent. Studies regarding the link between the consumption of vegetables and fruits and chronic diseases show that prevention of these diseases while promotion of health can be a result of an increase in consumption of vegetables and fruits (Boirng et al, 2012). World Health Organization (WHO) and Food and Agriculture Organization (FAO) recommend a minimum daily intake of 400g or five portions of 80-grams of vegetables and fruits a day, excluding starchy tubers. This helps to prevent chronic diseases including heart diseases, cancer, diabetes, obesity and deficiencies in micronutrients. The low consumption of fruits and vegetables is responsible for approximately 1% of disability-adjusted life years, 14% of gastrointestinal cancer deaths, 11% of ischaemic heart diseases and 9% of stroke deaths worldwide (WHO/FAO, 2005). Even though consumption of fruits and vegetables is promoted, the world per capita consumption is less than 20 to 50 percent of the minimum daily recommended intake (Food and Agriculture Organization, 2015).

The future generation of any country are the adolescents and their nutritional needs are critical for the well-being of society and to break the intergenerational cycle of malnutrition, chronic diseases, and poverty (World Health Organization, 2016). In a study carried out among university students in Saudi Arabia, it was found that the fruit and vegetable consumption is far less than the WHO recommended level (Alsunni and Badar, 2015).

Taste preferences, costs, availability and knowledge of nutrition influence the fruit and vegetable intake of adolescents (Liming, 2004; Corwin et al., 1999). Contrary to this, during an investigation, Schroeter et al. (2007), discovered that self-rated health knowledge had little impact on the consumption of fruits and the green salad of college students. When compared between male and female students, females were more likely to eat fruit and vegetables (Unusan, 2004). Perera and Madhujith (2012), used a Food Frequency Questionnaire to study the fruit and vegetable consumption pattern of university students and concluded that the mean fruit and vegetable consumption per day is far

Cite this article as:
Herath. U.S. (2019). Fruit consumption, its determinants and attitudes among undergraduates. Int. J. Agric. Environ. Food Sci., 3(1), 50-53.
DOI: https://doi.org/10.31015/jaefs.2019.1.11
Year: 2019 **Volume:** 3 **Issue:** 1 (March) **Pages:** 50-53
Available online at : http://www.jaefs.com - http://dergipark.gov.tr/jaefs

less than the WHO recommendations and gender, income and taboos had a significant effect on this. They also state that most of the students have a fair knowledge on some of the basic aspects of nutrition such as health benefits of fruits and vegetable. This study found banana and papaya to be the most frequently consumed fruits by undergraduates.

Crops with an unrealized potential to contribute to the human welfare through ensuring food security and nutrition and reducing hidden hunger caused micronutrient deficiencies are considered as underutilized crops. In Sri Lanka, a number of underutilized fruits that can be effectively developed into promising crops to fulfil the nutritional requirements are present. The perspective of undergraduates on the use of underutilized fruits as healthy food to promote access to better nutrition for communities is helpful in determining future crops.

It is clear that fulfilling the nutritional needs of undergraduates is critical as adolescents are the future of a country. However, previous studies have identified that there is a considerable gap between the daily recommended intake and the actual consumption of fruits and vegetables by students. This has given rise to a need to inquire the daily intake of fruits of undergraduates and to identify the barriers and limitations for consumption that are faced by them. Therefore, this study was carried out in order to determine the patterns of consumption of fruits by undergraduates of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. Moreover, it is expected to identify the barriers to fruit consumption, solutions to overcome the barriers, perspective of undergraduates on underutilized fruit crops and fruit cultivation in Sri Lanka.

Materials and Methods

Collection of Data

A self-administered questionnaire was distributed among 50 randomly selected students of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka. This questionnaire collected information on the consumption, preferences and barriers to consumptions, probable solutions to overcome the barriers. Moreover, respondents self-rated themselves according to the knowledge in nutritional aspects. The questionnaire contained questions regarding the opinion of respondents regarding the underutilized fruits in Sri Lanka and fruit cultivation. Respondents ranked the method of intake, factors considered when selecting fruits, type of fruits consumed, barriers and remedies to increase production and consumption in order of preference. Rank 1 was given to the most common choice, barrier or the best solution according to their opinion while the value the rank increased with the decreasing importance.

Data Analysis

Descriptive statistical analysis to calculate frequencies was carried out using IBM SPSS software version 24. Data were graphically illustrated using MS EXCEL (2013). Bar charts were used in order to clearly compare the percentages of different ranks allocated by the respondents.

Results and Discussion

Age and gender distribution and spending on food

Among the respondents, 36% were between the ages of 20-23 years while the remaining 64% belonged to the age group 23-26 years. Female respondents exceeded the percentage of males with a value of 68%. Only 14% spend less than Rs.2000 per month on food. Expenses for food of 40% stood between Rs.2000-5000 and 46% it exceeded Rs.5000.

Intake of fruits

Grams of fruits consumed per day by a respondent varied as follows. 40% of respondents consumed between 50-100g of fruits daily and the intake of 36% was less than 50g. Only 2% consumed above 200g of per day. Therefore, the daily intake of a majority of respondents was less than the daily recommended level.

Table 1. Daily intake of fruits.

Grams	Percentage
Less than 50g	36%
Between 50-100g	40%
Between 100-150g	16%
Between 150-200g	6%
Above 200g	2%

Among the fruits that were mentioned as commonly consumed, 92% of respondents mentioned that they consumed banana at least once during a week and it was determined as the most commonly consumed fruit. Papaya was the next common fruit with a percentage of 50%. These results are similar to those discovered by Perera and Madhujith (2012).

Table 2. Commonly consumed fruits.

Fruit	Percentage (%)
Banana	92%
Papaya	50%

Consumption of fresh fruits was the common mean of intake of fruits as it was ranked as 1 by a majority of respondents. Fruit salads and juices were less popular than fresh fruits. The least common mean of intake of a large number of respondents was the consumption of value added products with 68% ranking it 4.

Table 3. Common mean of intake of fruits.

		Percentage (%)			
		Rank 1	Rank 2	Rank 3	Rank 4
Common method of intake	Fresh fruits	46	20	18	16
	Salads	30	48	18	04
	Juices	22	28	40	10
	Value added products	04	04	24	68

Factors affecting the selection specific fruits for consumption by respondents are given in Figure 1.

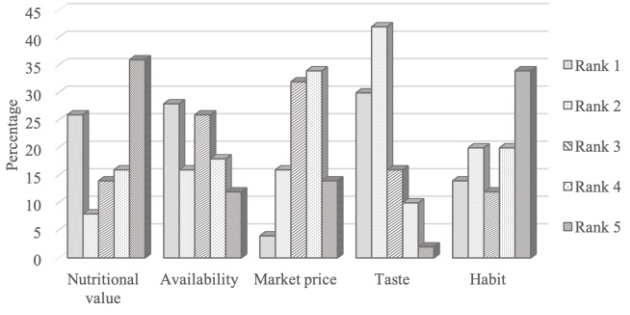


Figure 1. Factors that affect the selection of fruits.

30% of respondents ranked taste as the common factor that affects the selection of fruits for consumption. This result is similar to the findings by Perera and Madhujith (2012). Market price was considered as the most important factor by only 4%. Even though 26% considered the nutritional value as the most common factor considered when selecting a fruit, it was also ranked 5 by 36% of respondents making it the least considered factor by a majority.

Table 4. Types of fruits preferred.

Preference	Percentage (%)		
	Rank 1	Rank 2	Rank 3
Any fruits that were grown locally	68	26	06
Any fruits that were imported	22	26	52
Underutilized fruits	10	42	48

Fruits in the can be divided as fruits that are grown locally and fruits that are imported. There are underutilized fruits as well. 68% of the respondents preferred they would like to consume any type of fruit that is grown locally.

Table 5. Respondent's attitude on consumption of sufficient amount of fruits.

Consume sufficient amount of fruits	Percentage (%)
Yes	28%
No	72%

72% of respondents do not believe that they intake the sufficient amount of fruits daily. They identified the barriers for consumption of a sufficient amount as below. Some respondents pointed out more than one reason.

Table 6. Barriers for fruit consumption.

Barrier	Percentage (%)
High prices of fruits	54
Unavailability in the market	84
Pesticide residues on fruits	46
Health issues	22
Personal factors	46

Unavailability of fruits in the market or limited access to the marketed fruits is the major barrier for the respondents. Similar findings were revealed by Perera and Madhujith (2012). Moreover, 46% of respondents do not wish to consume fruits due to the fear of pesticide residues on them.

Knowledge on nutrition and suggestions to enhance the consumption

A majority of respondents had a fair knowledge of nutrients presence in fruit, fulfilment of the daily nutrient requirement by fruits and the recommended daily intake of fruits.

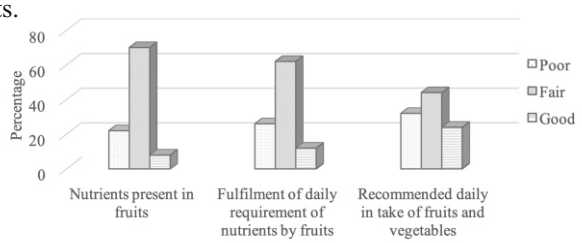


Figure 2. Knowledge on nutritional aspects.

Respondents marked more than one suggestions to improve fruit consumption. 82% of respondents cited the increase in convenience of obtaining fruits or availability as one of the remedies to overcome the barriers to fruit consumption. Also, a considerable percentage of respondents suggested value addition to produce new products as an option.

Table 7. Suggestions to increase the fruit consumption.

Suggestion	Percentage (%)
Decreasing prices	60
Convenience / Increasing availability	82
Growing fruits organically	44
Value addition to produce new products	72

Barriers to fruit production

26% of respondents identified the inconsistency of market prices in the major barrier for fruit production in Sri Lanka. Overcoming this barrier in production can have an effect on increasing the availability of fruits in the market.

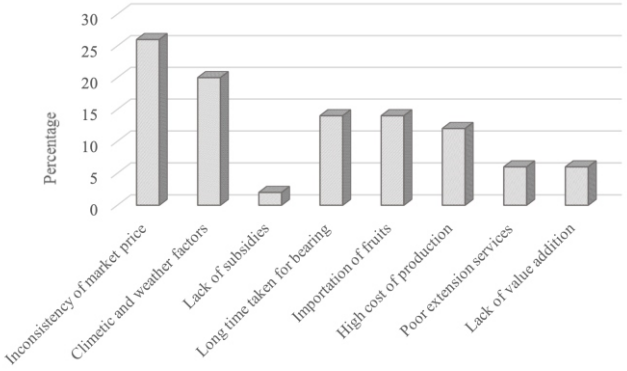


Figure 3. Barriers to the fruit production.

Cultivation of underutilized fruits

Other than fruits that are commonly available in the market, underutilized fruits can be used as a promising source of nutrients. Respondents stated their opinion on promotion of cultivation and consumption of underutilized fruits.

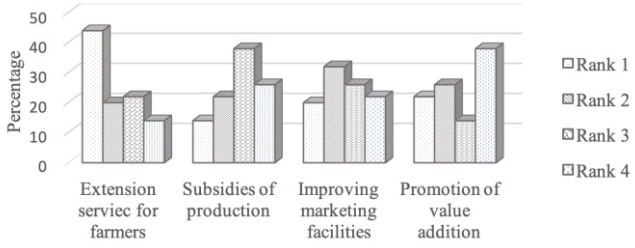


Figure 4. Remedies to overcome barriers in underutilized fruit production.

Improvement in extension services for farmers was ranked 1 as the most important remedy to overcome constraints in production of underutilized fruits by respondents with a percentage of 44%.

Consumption of underutilized fruits

Increasing awareness on nutrition among people was identified as the best option to promote the consumption of underutilized fruits.

DOI: https://dx.doi.org/10.31015/jaefs.2019.1.11

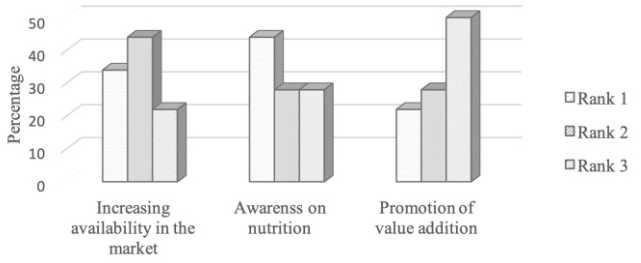


Figure 5. Suggestions to promote the consumption of underutilized fruits.

Among the respondents, Indian Plum (*Flacourtia indica*) (Uguressa in Sinhala) was the most popular underutilized fruit and the fruit with the higher potential to be produced and marketed. This was selected by 42% of the respondents. Therefore, there is a good potential to use underutilized fruit crops to fulfill the nutrient requirements through improvement of extension services to farmers and increasing awareness among the consumers.

Fruit cultivation in the home garden

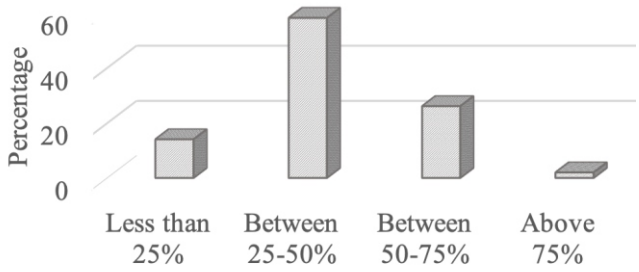


Figure 6. Fulfilment of fruit requirement from the home garden.

Cultivation of fruit crops in the home garden allows consumers to readily access to fruits. Fruit crops grown organically in own home garden is a good solution to overcome the barrier of not consuming fruits due to chemical residues on them. All the respondents had fruit crops cultivated in their home gardens. 58% of respondents fulfilled between 50-75% of their fruit requirement from their home gardens.

Respondents were asked their opinion on cultivation of fruit crops in the home garden organically.

Table 8. Cultivation of fruit crops in home garden.

	Organically managed (%)	Synthetic agrochemicals (%)
Present cultivation in the home garden	84	16
How respondents prefer to grow in the future	94	6

84% of respondents had their home gardens managed organically. Despite their present cultivation 94% prefer to grow fruits organically in the future.

Banana was identified as the common fruit crop grown in home gardens with 62% and the next was papaya with a percentage of 52%.

Table 9. Commonly grown fruit crops in home garden.

Fruit	Percentage (%)
Banana	62%
Papaya	52%

Conclusion

Despite having a fair knowledge on nutritional aspects, the daily fruit consumption of a majority of undergraduates of the Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka lies at a very lower value. Banana claims to be the commonly consumed and grown fruit. Overcoming the barriers of unavailability in the market and price fluctuations while promoting extension services and creating awareness can be used to increase the fruit consumption and production. Underutilized fruits have a good potential to be used to fulfill nutrient requirement and home gardens can play a crucial role in determining the fruit consumption.

References

Alsunni, A.A., Badar, A. (2015). Fruit and Vegetable Consumption and its Determinants among Saudi University Students. Journal of Taibah University Medical Sciences, 10(2), 155-162. [CrossRef] [Google Scholar]

Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., Leschik-Bonnet, E., Müller, M. J., Oberritter, H., Schulze, M., Stehle, P., Watzl, B. (2012). Critical review: Vegetables and Fruit in the Prevention of Chronic Diseases. European journal of Nutrition, 51(6), 637-63. [CrossRef] [Google Scholar]

Corwin, S.J., R.G. Sargent, C.E. Rheaume, R.P. Saunders. 1999. Dietary Behavior among Fourth Graders: A Social Cognitive Theory Study Approach. American Journal of Health Behavior, 23,182-197. [CrossRef] [Google Scholar]

Food and Agriculture Organization of the United Nations. (2015). Promotion of Fruits and Vegetables for Health: Report of the Pacific Regional Workshop (Online). Available at: http://www.fao.org/3/a-i4935e.pdf (Accessed: 30 October 2018).

Liming, L. (2004). Fruit and Vegetable Intake and Factors Influencing Intake of Adolescents: Developing the Questionnaires. Faculty of Graduate Studies, University of British Columbia. 9-10. [Google Scholar]

Perera, T., Madhujith, T. (2012). The Pattern of Consumption of Fruits and Vegetables by Undergraduate Students: A Case Study. Tropical Agricultural Research, 23 (3),261 – 271. [Google Scholar]

Schroeter, C., House, L., Lorence, A. (2007). Fruit and Vegetable Consumption among College Students in Arkansas and Florida: Food Culture vs. Health Knowledge. International Food and Agribusiness Management Review, 10 (3),63-89. [Google Scholar]

Unusan, N. (2004). Fruit and Vegetable Consumption among Turkish Students. International Journal of Vitamin Nutrition, 74(5), 341-348. [CrossRef] [Google Scholar]

World Health Organization and Food and Agriculture Organization. (2005). Fruit and Vegetables for Health (Online). Available at: https://www.who.int/dietphysicalactivity/fruit/en/ (Accessed: 30 October 2018).

World Health Organization. (2006). Adolescent nutrition: a review of the situation in selected South-East Asian Countries (Online). Available at: http://apps.searo.who.int/PDS_DOCS/B0239.pdf?ua=1 (Accessed: 30 October 2018).