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ZİRAAT FAKÜLTESİ DERGİSİ

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Tokat Gaziosmanpasa University, Faculty of Agriculture
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Tokat Gaziosmanpaşa Üniversitesi, Ziraat Fakültesi, 60240 Taşlıçiftlik Yerleşkesi – TOKAT Telefon: (356) 252 16
16 / 2141 Faks: (356) 252 14 88

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e-mail:gamze.bayram@gop.edu.tr

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e-mail: sedat.karaman@gop.edu.tr

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e-mail: tkarakoy@sivas.edu.tr

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e-mail: umran.ensoy@gop.edu.tr

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e-mail: yakut.gevrekci@ege.edu.tr

Yalçın Tahtalı, Tokat Gaziosmanpaşa Üniversitesi, Ziraat Fakültesi, Zootekni Bölümü, Tokat, Türkiye /*Tokat Gaziosmanpasa University, Agricultural Faculty, Animal Science, Tokat, Turkey*

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ARASTIRMAX

AMAÇ VE KAPSAM

Gaziosmanpaşa Üniversitesi Ziraat Fakültesinin 1985 yılından beri hakemli v bilimse süreli yayınıdır.Tokat Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi, Tarım bilimleri (tarım ekonomisi, zootečni, biyosistem mühendisliđi, tarla bitkileri, su ürünleri mühendisliđi, bahçe bitkileri, bitki koruma, toprak bilimi ve bitki besleme) alanındaki uluslararası bilimsel makaleleri Türkçe ve İngilizce olarak yayınlamayı amaçlamaktadır. Dergi yılda en az iki kez basılır. 2014 yılı itibariyle senede 3 baskı yapmıştır.

YAYIN POLİTİKASI

Dergide yayınlanacak makaleler İngilizce yayınlanır. Makaleler incelenmek üzere dergiye sorumlu yazar tarafından sunulur. Sunulan makalelerin başka bir yerde yayınlanmamış olması gerekir. Telif Hakkı Devir Sözleşmesi Formu tüm yazarlar tarafından imzalanmış olmalıdır.

Dergimizde yayınlanacak makaleler araştırma ve yayın etiđine uygun olmak zorundadır. Etik kurul kararı gerektiren klinik ve deneysel hayvan çalışmaları için ayrı etik kurul onayı alınmış olmalı ve belgelendirilmelidir. Dergimize gönderilecek bilimsel yazılarda, ICMJE (International Committee of Medical Journal Editors) tavsiyeleri ile COPE (Committee on Publication Ethics)'un "Editör ve Yazarlar için Uluslararası Standartlar"ı dikkate alınmaktadır.

Dergiye sunulan makale, Dergi Sekreteryası tarafından yazım kuralları ve içerik açısından ön değerlendirmeye alınır. Dergide basılacak nitelikte bulunmayan makale yazara iade edilebilir. Uygun bulunanlar ise bilimsel açıdan değerlendirilmek üzere konusunda uzman hakemlere (maksimum 15 gün süre için) gönderilir. Hakem incelenmesinden sonra basıma uygun olmayan makaleler yazara bildirilir, makaleler iade edilmez. Hakem onayından geçenler içinde düzeltme yapılması istenen makaleler gerekli dokümanlarla yazara iletilir. Yazar gerekli düzeltmeleri en kısa sürede (maksimum 15 gün) tamamlayarak dergi e-posta adresine gönderir. Editörler kurulu nihai kararını vererek makaleyi uygun bulursa basım ünitesine gönderir. Basımına karar verilen ve düzeltme için yazara gönderilen eserde, ekleme veya çıkartma yapılamaz.

Bir yazarın derginin aynı sayısında ilk isim olarak, en fazla iki eseri basılabilir.

Yayınlanan makalelerin tüm sorumluluđu yazar(lar)ına aittir

AIMS AND SCOPE

Journal of Agricultural Faculty is scientific, peer reviewed journal and belonged to the Tokat Gaziosmanpaşa University Faculty of Agriculture since 1985. Journal of Agricultural Faculty of Tokat Gaziosmanpaşa University aims to publish the international scientific paper on agriculture sciences (agricultural economics, animal science, biosystems engineering, field crops, fisheries engineering, horticulture, plant protection, soil science and plant nutrition). The journal is published at least twice in a year. The journal was published three issues in a year at 2014 year.

PUBLISHING POLICY

Manuscripts are published in English. The manuscripts are submitted to the journal from Turkey and the other countries for review by corresponding author. The manuscript submitted should not have been submitted and published in another journal

Manuscripts published in our journal must be appropriate to the research and publication ethics. Separate ethical board resolutions are needed for each clinical and experimental study on animals which requires ethical board decision. International Committee on Publication Ethics' (ICMJE) recommendations and Committee on Publication Ethics' (COPE) "International Standards for Editors and Auditors" should be taken into consideration for the scientific manuscripts sent to our Journal.

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Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi, yayın politikasında akademik ilke ve etik değerlere bağlıdır. Etik ilke ve değerlere ilişkin ulusal ve uluslararası standartlara uygun olarak yayın hayatını sürdürmektedir. Bu kapsamda, COPE (Committee on Publication Ethics) tarafından belirlenen standartlar ve YÖK "Bilimsel Araştırma ve Yayın Etiği Yönergesi"nde belirlenen esaslar dikkate alınmaktadır (<https://publicationethics.org/>, <https://www.yok.gov.tr/Sayfalar/Kurumsal/mevzuat/bilimsel-arastirma-ve-...>). Makale değerlendirme sürecinde kabul edilen araştırma ve yayın etiği standartlarına aykırılığı tespit edilen eserlerin yayın talebi reddedilir. Eserin yayınlanmasından sonra söz konusu aykırılığın tespit edilmesi halinde eser yayından kaldırılır. Hakemli dergide yayın ilkeleri ile ilgili tüm taraflardan (yazar, dergi editörü, hakem ve yayımcı kuruluşlar) beklenen genel etik davranışlar ve sorumluluklara ilişkin tanımlamalar aşağıda belirtilmektedir.

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- Tüm yazarların araştırmaya katkısı bulunmalıdır.
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- Tüm yazarlar hatalı makalenin geri çekilmesini ve hataların düzeltilmesini sağlamak zorundadır.

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ETHICAL PRINCIPLES AND PUBLICATION POLICY

PRINCIPLES OF PUBLICATION ETHICS

Journal of Agricultural Faculty of Gaziosmanpaşa University is committed to academic principles and ethical values in its editorial policy. It continues its publication life in accordance with national and international standards regarding ethical principles and values. In this context, the standards set by COPE (Committee on Publication Ethics) and the principles set in the Council of Higher Education "Scientific Research and Publication Ethics Directive" are taken into account (<https://publicationethics.org/>, <https://www.yok.gov.tr/Sayfalar/Kurumsal/mevzuat/bilimsel-arastirma-ve-...>). The publication request of the works that are found to be in violation of the research and publication ethics standards accepted in the manuscript evaluation process is rejected. If the said contradiction is detected after the publication of the work, the work is removed from the publication.

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1. The Journal of Gaziosmanpaşa University Faculty of Agriculture is published three issues in a year as in April, August and December.
 2. The journal publishes original research articles in the field of Agricultural Sciences that have not been published previously and including original research articles published as an abstract in proceeding books.
 3. If the authors are the same in the manuscripts, only two of them are accepted for the publication in the same issue.
 4. There is no royalty payment to the authors. Also there is no publication fee for the accepted manuscript.
 5. Authors are responsible for the scientific content of the manuscripts to be published.
 6. The research articles should be prepared in English under the main headings; Title, Abstract, Öz, Keywords in Turkish and in English, Introduction, Material and Methods, Findings and Discussion, Results and References.
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Sonuç: Elde edilen sonuçların bilime ve uygulamaya katkısı önerilerle birlikte vurgulanmalıdır

Teşekkür: Bu bölümde çalışmanın yapılmasına katkı veren kişi, kuruluş ve projelere yer verilebilir.

8. Makalede yer alan türlerin bilimsel isimleri italik karakterde olmalı ve ondalık sayılar nokta işareti ile ayrılmalıdır.

9. Grafik, harita, fotoğraf, resim ve benzeri sunuşlar "Şekil", sayısal değerlerin verilışı "Çizelge" olarak isimlendirilmelidir. Şekil ve Çizelgelere ait İngilizce isimlendirmelerin altında Türkçe isimlendirmeler de yer almalıdır. Verilen tüm çizelge ve şekillere metin içerisinde atıf yapılmalı ve makale içinde atıf yapılan yere en yakın yerde atıftan sonra verilmelidir.

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Preparation of a Computer Software Program for the Feasibility Study of Livestock Enterprises

Durhasan MUNDAN^{1*}  İbrahim Talha MUNDAN² 

¹Harran University, Faculty of Veterinary Medicine, Department of Animal Science, Şanlıurfa

²Gaziosmanpaşa University, Faculty of Engineering, Department of Computer Engineering, Tokat

*Corresponding author's email: durhasanmundan@gmail.com

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Abstract: This study was carried out with the aim of developing a software program that will enable the breeder to decide easily during the preparation of the feasibility for livestock enterprises. For this purpose, 63 enterprises in Gaziantep and Şanlıurfa provinces/Turkey were visited between the years 2021-2022 and all the data obtained were evaluated. The "C#" programming language was used in the development of the software program. "Microsoft SQL Server" database was used to store the obtained data. This feasibility program is a software program where productivity checks are performed for enterprises and their personnel. It is a program that can be used easily from a small-capacity enterprises to a large-capacity enterprises. The cost calculations are not included in the program due to the economic conditions of the market. As a result, this program, which was prepared by taking into account software engineering techniques, will provide great advantages and conveniences for enterprises. Risk factors will be determined and alternatives will be presented with this software program that performs enterprises efficiency testing. It has been concluded that this software will be a program that can be preferred by the breeder since it can be used on all computers and offers different alternatives in enterprises establishments.

Keywords: Database, Enterprises, Feasibility, Livestock, Software.

Hayvancılık İşletmelerinin Fizibilite Etüdü için Bilgisayar Yazılım Programının Hazırlanması

Öz: Bu çalışma, hayvancılık işletmeleri için fizibilitenin hazırlanması sırasında yetiştiricinin kolaylıkla karar vermesini sağlayacak bir yazılım programı geliştirmek amacıyla yapılmıştır. Bu amaçla 2021-2022 yılları arasında Gaziantep ve Şanlıurfa illerinde 63 işletme ziyaret edilmiş ve elde edilen tüm veriler değerlendirilmiştir. Yazılım programının geliştirilmesinde "C#" programlama dili kullanılmıştır. Elde edilen verilerin saklanması için "Microsoft SQL Server" veritabanı kullanılmıştır. Bu fizibilite programı, işletmeler ve çalışanları için verimlilik kontrollerinin yapıldığı bir yazılım programıdır. Küçük kapasiteli işletmelerden büyük kapasiteli işletmelere kadar rahatlıkla kullanılabilen bir programdır. Maliyet hesaplamaları piyasanın ekonomik koşulları nedeniyle programa dahil edilmemiştir. Sonuç olarak yazılım mühendisliği teknikleri dikkate alınarak hazırlanan bu program işletmeler için büyük avantajlar ve kolaylıklar sağlayacaktır. İşletmelerin verimlilik testleri gerçekleştiren bu yazılım programı ile risk faktörleri belirlenecek ve alternatifler sunulacaktır. Bu yazılımın tüm bilgisayarlarda kullanılabilmesi ve işletme kuruluşlarında farklı alternatifler sunması nedeniyle yetiştiricinin tercih edebileceği bir program olacağı kanaatine varılmıştır.

Anahtar Kelimeler: Fizibilite, Hayvancılık, İşletmeler, Veritabanı, Yazılım.

1. Introduction

Today, with the widespread use of information and communication technologies (ICT) in all areas of life, there have been radical changes in the structure and understanding of societies. As in most sectors, it is very difficult for the enterprise to continue its activities in the livestock sector without using technology and automation systems, without computers and databases. The main advanced technology components used in livestock are collected under the concept of "computer-aided herd management systems" (Goncu et al., 2015).

There is an increase in the number of medium and large-capacity enterprises engaged in intensive, integrated, organic and industrial livestock. This increase has some advantages and disadvantages. There are 4 main components that make up livestock enterprises. These are structure and facilities, machinery and equipments, live animals, worker and administrative personnel. There is a need for reliable data so that the components of the enterprise can be used in enough numbers and in the correct location. It is

important to establish a healthy database in order to provide reliable data (Anonymous, 2022).

A database is a collection of organized data. As a result of developments and advances in computer technology, databases are created at every stage of production. All data recorded by application software is transferred to the database. The available information kept in the databases includes the land area, the number and area of the sections related to the structure, the number of animals in the enterprise, the facilities, machinery and equipment, the number of working personnel, etc information. A database management system is a software system consisting of more than one program in which studies such as creating a new database, editing, developing and maintaining the created database are performed. This software system enables them to develop interfaces suitable for data input-output and shapes data types on behalf of users. Today, database software such as Microsoft Access, Microsoft SQL and MySQL are used to store the data obtained. The use of these database software and database management systems is important for the breeders. Database software has positive aspects such as data independence, data reliability, data integrity, minimum data repetition, data consistency, data sharing (Ozkan, 2015).

The first software for dairy cow breeding management was introduced in the middle of the 1980's. In livestock, new requirements and trends in data management have begun, which are related to the application of new technologies. In this context, software programmes represent a new and efficient apparatus. In the coming years, the demands of breeders will increase and the existing software will be developed and updated continuously and will be presented with more developed new software (Maciuc et al., 2015).

Software is the name given to all the programs that allow electronic apparatus to do a certain working. In other words, it is a set of expressions created by using computer language to solve an existing problem. In the software to be developed, software engineering techniques are observed. At this stage, it should have features such as correct working, ease of use, easily upgradeable, robustness, reusability, productivity, portability, testability, excellent performance, up to date and documentability. The software is used in livestock enterprises to develop the capacity and improve productivity and transparency in working processes. It is absolutely necessary to plan the usage of the software programmes, in other words to establish with

departments of a farm will be automated (Maciuc et al., 2015; Nizam, 2015).

Feasibility is a comprehensive study that analyzes enterprises from technical, financial, economic, marketing, risk assessment, social and institutional perspectives. The feasibility is prepared before the final investment decision is made. This is an opportunity to foresee risks. A good feasibility study is necessary in order to correctly evaluate the general conditions and production results of the enterprises (Anonymous, 2016; Widayati, 2018).

A breeder who wants to invest will be able to learn which animal species and breed, how many decares of land, and how much budget is required in a very short time with this software program before establishing a enterprises. The breeder will have decided from the beginning whether or not to make the investment. This software program will be a more original product of the feasibility study. In addition, it is important that the programmer who prepares the feasibility program has knowledge about livestock and can produce the correct alternatives for the breeder.

With this study, it was aimed to develop a software program that can be used in the preparation process of feasibility for livestock enterprises. For this purpose, a software program was developed in which technical, economic and financial studies of enterprises in the livestock sector can be kept together. There are various software programs related to livestock enterprises. But the absence of any study on feasibility is important in terms of being an original study.

2. Material and Methods

2.1. Material

In this study, 63 livestock enterprises were used as material. For this study, 63 enterprises operating in Gaziantep and Şanlıurfa provinces/Turkey were visited. 21 of these enterprises are dairy cattle enterprises, 15 beef cattle enterprises, 12 dairy sheep enterprises, 7 fattening sheep enterprises, 5 laying hen enterprises and 3 broiler chicken enterprises. During the visit, photographs were taken and recorded on the computer to obtain the data. In addition, the technical information of the "Zootechnics and Livestock Enterprises Economics" subject was used in the preparation of the software program. The positive and negative sides of the visited enterprises were determined and compared with the existing technical information. All data collected between July-2021 and July-2022 were evaluated in Microsoft Excel program.

2.2. Method

In the development of this software, a Windows 11 operating system computer with Intel Core i5 processor, 16 GB memory (Ram) and 1 TB hard disk was used. "C#" programming language, Microsoft Visual Studio 2019, a programming software supported by .net technology, was used in order to develop a software program for keeping technical, economic and financial study data in livestock enterprises. "Microsoft SQL Server" database was used to record the data of the enterprise. The databases obtained by using the "Microsoft SQL Server" database consist of many tables. While preparing the data files, data fields suitable for the information to be recorded are created. The type of data to be entered in this section is defined and the upper values of the data to be included in this section are

determined. In this database format, the data field type "VarChar" is used for entering numeric data, "SmallDateTime" for entering date data, "Number" and "Float" for entering real numbers, and "Int" for entering integers that are not too large. Key fields are defined to establish connections between tables. Indexes are used to access records faster (Ozkan, 2015; Dasdemi, 2019).

3. Results and Discussion

The enterprises in Gaziantep and Sanliurfa were visited and evaluated in terms of feasibility studies. Before establishing a enterprises, the grower must submit 3 copies of the feasibility report to the state institutions (Agriculture provincial and district directorate). Some information about the livestock enterprises visited is given in Table 1.

Table 1. Number of enterprises visited in terms of using computer software programs

Cizelge 1. Bilgisayar yazılım programlarını kullanma açısından ziyaret edilen işletme sayıları

Enterprises	Gaziantep			Sanliurfa			The overall total
	Using the program	Not using programs	Total	Using the program	Not using programs	Total	
Dairy cattle	8	4	12	6	3	9	21
Beef cattle	3	1	4	8	3	11	15
Dairy sheep	4	2	6	3	3	6	12
Beef sheep	2	1	3	2	2	4	7
Laying hen	2	1	3	1	1	2	5
Broiler chicken	1	1	2	1	-	1	3
	20 (67%)	10 (33%)	30	21 (64%)	12 (36%)	33	63

A total of 63 enterprises were visited, of which 30 in Gaziantep and 33 in Sanliurfa. According to Table 1, 67% of the enterprises visited in Gaziantep use computer and software programs, while 64% of the enterprises in Sanliurfa use computer and software programs. In other words, 1/3 of the enterprises are breeding without computer and software programs. In total, 65% of enterprises monitor their animals with computers and software programs.

For the feasibility study, a needs analysis should be done and how necessary this software should be calculated. During the analysis a enterprises, process and data model suitable for the identified needs was created. In the software preparation stage, the current conditions were analyzed and the needs were determined. The time plan to be followed in the coding stage was created at this stage. The software was coded in accordance with the models created during the design stage. The developed software has been tested. At this stage, necessary corrections were made by returning to the coding development stage of the test results until the software reached a sufficient level. The software, which passed the test phase, was installed. It is the last maintenance-update and a maintenance and update plan

has been created to ensure the sustainability of the system. The calculation screen code is given in Figure 1.

```

1 bagvuru
private void button1_Click(object sender, EventArgs e)
{
    int sayi = Convert.ToInt32(textBox1.Text);

    donum.Text = Convert.ToString(sayi/10);
    personel.Text = Convert.ToString(sayi /50);
    su.Text = Convert.ToString(sayi /12);
    alan.Text = Convert.ToString(sayi * 5);
    saman.Text = Convert.ToString(sayi *2);
    yonca.Text = Convert.ToString(sayi *4);
    silaj.Text = Convert.ToString(sayi *22);
    yem.Text = Convert.ToString(sayi *10);
}

```

Figur 1. Calculator screen code

Şekil 1. Hesaplama ekran kodu

The software prepared at the end of this feasibility study has been developed according to the standards accepted in the livestock industry and has been prepared to comply with the standards of the livestock industry to which it will be applied. The studies of the researchers on this subject and the data collected from Gaziantep and Sanliurfa were evaluated together and a new software program was designed. Login to the program

is made with the user name and a password to be given to the breeder from the login screen interface shown in Figure 2.

When the program is run, an encrypted login screen



Figure 2. User input interface
Şekil 2. Kullanıcı girişi arayüzü

will be encountered. After the user name and password are entered correctly on this screen, the "Main Form" will appear on the screen (Figure 3).



Figure 3. Main menu screen
Şekil 3. Ana menü ekranı



Figure 4. Enterprises type selection screen
Şekil 4. İşletme tipi seçim ekranı



Figure 5. Calculation screen
Şekil 5. Hesaplama ekranı

A new window will appear according to the animal type selected in the main menu (Figure 3). In this study, enterprises with the Holstein breed were preferred. By selecting the animal type from this screen, it is possible to switch to another screen where the data is calculated. On this screen, there is a program that calculates according to the previously obtained data (Figure 4).

Dairy cattle is taken as an example in Figure 4. The necessary structures and facilities, machinery and equipment, number of animals, number of worker and administrative personnel required for the establishment of a dairy cattle business (550 heads) will be automatically reflected on the calculation screen. All values of minimum 100 heads and maximum 1000 animals will be calculated and presented as results. The components and quantities required for the enterprises will be displayed in detail on the calculation screen.

4. Conclusion

In many studies, it has been reported that most of the enterprises owners have a low level of education. In order to make maximum use of computer-aided software programs functionally, it should be prepared by considering the education levels of the breeders. It will be important to take some measures while expanding the application fields of these software in the livestock sector.

Software and automation systems in livestock enterprises are generally applied in large-capacity enterprises. However, it has been reported that software and automation systems can also be applied in small-capacity enterprises, and that it can have a positive effect on enterprises technically and economically. Widayati et al. (2018) investigated on the readiness of the development of beef cattle in Bintuni District, West Papua in terms of technical, social and economic. The same researchers worked on techniques related to land availability, targeted land for the enterprises area, determination of the technical feasibility of the land and feasibility assessment in 62 enterprises. Guilhermino & Esslemont (1993) reported in their study in England that 62% of dairy cattle enterprises use a computer program to produce. The results obtained by the researchers (62%) were similar to the results in this study (65%). Nadaroglu et al. (2014) the temperature-humidity index calculation program was designed as the first agricultural meteorological application for livestock activities in Turkey. The program prepared with the "Temperature-Humidity Index" application calculates the stress values of animals. Stress intensities and color columns are created according to the stress values. With

this program, breeders will be able to take the necessary precautions by seeing the time zones and stress intensities in which their animals can be stressed 72 hours in advance. Nadaroglu et al. (2014), the temperature-humidity index program PHP 5.3. prepared in software language. In the study of Goncu et al. (2015) examined software related to farm animals and studied the utilization rate and efficiency of existing functions. Viazzi et al. (2014) reported that there is a software that automatically detects the lameness problem, which is frequently seen in cattle. Celikyurek & Aygun (2015) prepared a computer program for recording information about sheep and goats in their study. This program is written in Visual Basic. The Microsoft Access files were used as database. Microsoft Excel program was used for reporting processes. The records kept in the prepared computer package program are generally breeding, maintenance, feeding, feed, pre- and post-slaughter data, disease, herd management, pedigree etc. are records. Today, the tendency to use computers in businesses is increasing. For this purpose, there are programs written in Turkish for scientific purposes. The program allows a limited number of technical records to be kept. Maciuc et al. (2015) presented original results on a software program for production and reproduction data management in dairy enterprises. They used a management system database- SGBD for this purpose. Slob & Hurst (2022) mentioned Digital Twins and Industry 4.0 Technologies in their review. Researcher, after applying the selection criteria and quality assessment, selected 22 articles and used them in the literature study. The same researchers conducted their work on five databases, including Scopus (SC), Web of Science (WoS), Springer Link (SL), ScienceDirect (SD), and IEEE Xplore (IEEE). In addition, the databases they used were selected according to their relevance to agriculture and informatics domain.

There are many benefits to using "livestock management software" in enterprises. Livestock management software helps to calculate profit, increase profit and use time positively. Livestock management software is essential for running a successful ranch. It is essential for breeders to make an investment in appropriate software that is designed to meet the demands of modern enterprises. The utilization of farm management software can boost productivity by up to 20%. This software can make the management of a farm incredibly smoother. People who use livestock management software have recorded 40% higher growths and productivity than those who still use traditional cattle management methods. It is expected

that there will be investments made in livestock sector which will aid the introduction of technological advancements both in logistics and farm management. Artificial intelligence is one such technology which needs immediate implementation in the livestock industry. The automated milking booth is a section of animal husbandry which has an increasing application of artificial intelligence system (Singh, 2022).

To increase the efficiency of the enterprise, temporal and spatial data should be used. This requires virtualization of all objects in an enterprise. A digital twin can be used for virtualization. Digital twins (DT) offer a new way to represent a physical object or system in a digital environment. A DT is a data-driven, digital copy of a real-world object or environment that can be used for decision support and systems analysis (Balafoutis et al., 2017; Pylianidis et al., 2021; Verdouw et al., 2021).

The Small and Medium Enterprise Development Authority (SMEDA) was established with the objective to provide fresh impetus to the economy through the launch of an aggressive SME support program. The pre-feasibility study of 100 head dairy cows by the "Small and Medium Enterprises Development Authority Ministry of Industry and Production Government of Pakistan" is based on the business analysis of establishing a dairy farm in the Environmentally Controlled Housing (ECH) system. In this pre-feasibility study, all the necessary information for the establishment of a business is given in detail. The objective of the pre-feasibility study is primarily to facilitate potential entrepreneurs in project identification for investment. The project pre-feasibility may form the basis of an important investment decision and in order to serve this objective, the document/study covers various aspects of project concept development, start-up, and production, marketing, finance and business management. The purpose of this document is to facilitate potential investors in setting up Dairy Farm with ECH system on commercial basis by providing them a general understanding of the business with the intention of supporting potential investors in crucial investment decisions (Anonymous, 2016).

As a result, it is necessary to increase the number of livestock enterprises using computer and software programs. In addition, the agenda proposes growth purposeful policies that support the formalization of micro, small and medium-capacity enterprises. Later, expanding the application areas of the software programs used in the feasibility preparation will be

important in terms of technical, economic and financial aspects.

With this software program, it will be possible to see the information that will be required for a enterprises that is in the setup stage, the deficiencies / surpluses and correct / wrongs for an operating enterprises. In this way, the use of some unnecessary structures, installations, machinery and equipment will be prevented. With this software program, the breeder will be able to receive consultancy services, and as a result, the service quality will increase in feasibility preparation.

The study areas of research (especially small, medium and large-capacity enterprises) should be expanded. Support should be given to the development of local software. This is very important for the economy of the country. Thus, a significant contribution to the economy of the country will be made by reducing software imports from abroad.

Computer package programs to be used in modern livestock enterprises should be prepared by taking into account the opinions and demands of all researchers and breeders and livestock structure. This software program will be prepared in a way that can be used on tablets and mobile phones in future studies. In addition, software studies that make economic analyzes and calculate costs in the future are also considered. It is expected that this study will shed light on other studies to be carried out.

Conflicts of Interest

The authors declare no conflict of interest.

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Comparison of Cold Storage Abilities of 'Ayvaniye' and 'Granny Smith' Apple Cultivars

Fatmanur ÇEZİK¹ Osman Nuri ÖCALAN¹ Emircan DİNÇER¹
Ala Asi Mohammed AL-SALIH¹ Muhammed Rahmetullah ÇİĞDEM¹
Mehmet Emin İŞBİLİR¹ Ebubekir PAŞAZADE²
Burhan ÖZTÜRK³ Onur SARAÇOĞLU¹

¹Tokat Gaziosmanpaşa University, Faculty of Agriculture, Department of Horticulture, Tokat

²Central Black Sea Transition Zone, Agricultural Research Institute, Tokat

³Ordu University, Faculty of Agriculture, Department of Horticulture, Ordu

*Corresponding author's email: osmannuri.ocalan@gop.edu.tr

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Abstract: The aim of this study is to compare the 'Granny Smith' apple cultivar, which is well-known to withstand storage, and the 'Ayvaniye' apple, a local cultivar, in terms of some quality characteristics, and to determine their suitability for storage. The apples included in the experiment were stored at 1 ± 0.5 °C and $90\pm 5\%$ relative humidity for 6 months. Measurements and analyses were done once a month from the beginning to the end of storage. The parameters examined in the trial are: Weight loss, fruit flesh firmness, pH, titratable acidity (TA), soluble solids content (SSC), total phenolic substance content (TPC), total antioxidant activity (TAA) and fruit outer colour (L^* , a^* , b^*). As a result; weight loss, pH, TAA, L^* and a^* parameters were found higher in 'Ayvaniye' cultivar. In terms of TA, SSC, TPC and b^* parameters, 'Granny Smith' cultivar was better. Additionally, the flesh firmness of 'Granny Smith' cultivar was higher at the beginning of storage. When all parameters were evaluated, 'Ayvaniye' cultivar is suitable for cold storage for 6 months, but weight loss may be a problem for storage longer than 6 months.

Keywords: Antioxidant, Firmness, *Malus communis* L., Phytochemical, Total phenolic

'Ayvaniye' ve 'Granny Smith' Elma Çeşitlerinin Soğukta Depolama Kabiliyetlerinin Karşılaştırılması

Öz: Bu çalışmanın amacı, depolamaya dayanımı iyi bilinen 'Granny Smith' elma çeşidiyle, yerel bir çeşit olan 'Ayvaniye' elmasının bazı kalite özellikleri bakımından karşılaştırılması yapılarak depolamaya uygunluğunun belirlenmesidir. Denemeye alınan elmalar 1 ± 0.5 °C ve 90 ± 5 nispi nemde 6 ay boyunca muhafaza edilmiştir. Depolamanın başlangıcından sonuna kadar ayda bir olmak kaydıyla ölçüm ve analizler yapılmıştır. Denemede incelenen parametreler şunlardır: Ağırlık kaybı, meyve eti sertliği, pH, titre edilebilir asitlik (TEA), suda çözünür kuru madde (SÇKM), toplam fenolik madde içeriği (TPC), toplam antioksidan aktivite (TAA) ve meyve dış rengi (L^* , a^* , b^*). Çalışma sonucunda, 'Ayvaniye' çeşidinde ağırlık kaybı, SÇKM, TAA, L^* ve a^* parametreleri daha yüksek bulunmuştur. pH, TEA, TPC ve b^* parametreleri açısından ise 'Granny Smith' çeşidi daha iyidir. Ek olarak depolama başlangıcında 'Granny Smith' elmalarının meyve eti sertliği daha yüksek olmuştur. Tüm parametreler değerlendirildiğinde 'Ayvaniye' çeşidinin 6 ay boyunca soğuk depolamaya uygun olduğu tespit edilmiştir ancak 6 aydan uzun depolamalar için ağırlık kaybı problem olabilir.

Anahtar Kelimeler: Antioksidan, Sıklık, *Malus communis* L., Toplam fenolik

1. Introduction

Apple (*Malus communis* L.); it is a temperate climate fruit species belonging to the *Malus* genus of the *Rosales* order, *Rosaceae* family, *Pomoideae* subfamily. Today, cultivated apple has spread to almost all temperate climate regions of the northern and southern hemispheres. In Türkiye, it is almost grown in every region. However, Northern Anatolia, grown wild

species is most suitable region. The transition areas between Northern Anatolia, the Black Sea coastal region, and the Central Anatolia and Eastern Anatolia plateaus constitute the apple culture areas. In the Aegean region, it is grown successfully in areas above 500 m altitude (Güleryüz, 1975; Özkan, 1998; Yanar and Ecevit, 2009).

According to 2021 data of FAO stats, Asia (65.8%) has the highest apple production in the world (Figure 1).

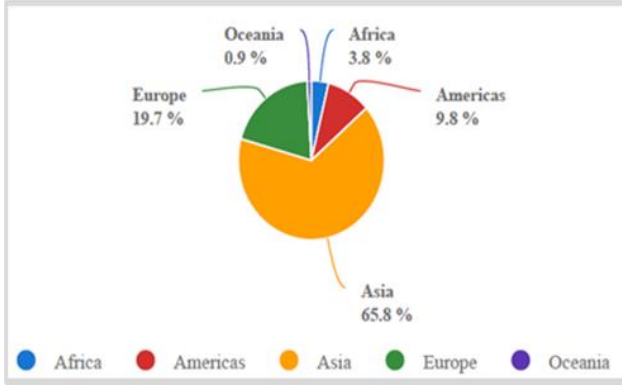


Figure 1. Percentage distribution of apple production among continents in 2021. (FAO)

Şekil 1. 2021 yılında Kıtalar arasında elma üretiminin yüzdesel dağılımı (FAO)

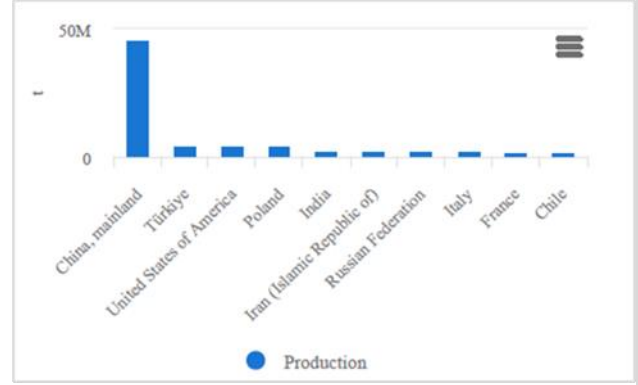


Figure 2. The top 10 countries with the most apple production in 2021. (FAO)

Şekil 2. 2021 yılında en fazla elma üretimi yapan ilk 10 ülke (FAO)

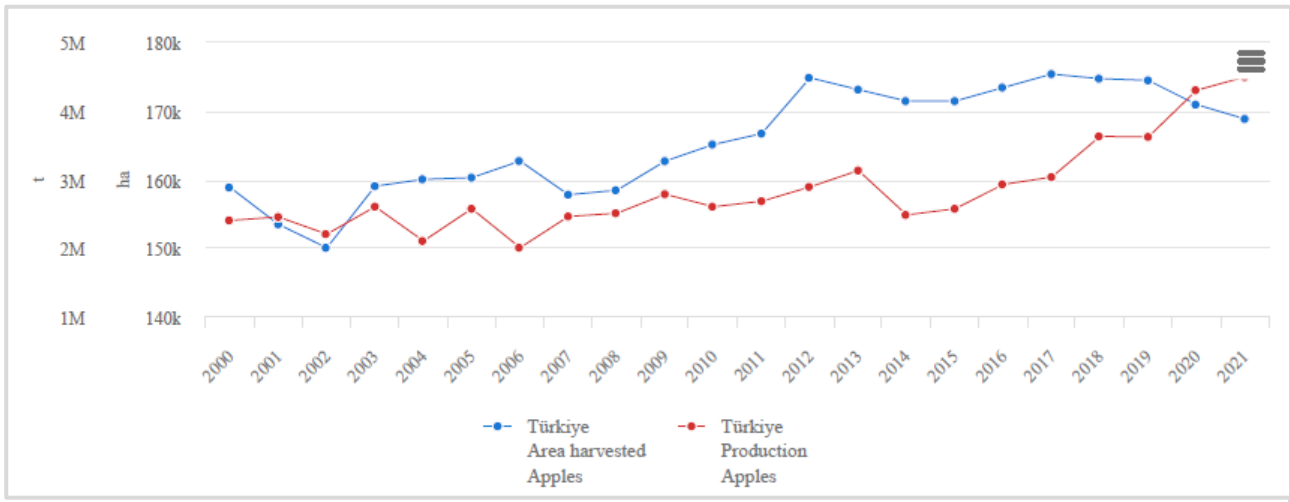


Figure 3. Apple production by years in Türkiye (FAO)

Şekil 3. 2021 yılında Türkiye’de yıllara göre elma üretimi (FAO)

In 2021, total apple production was 93 144 358.17 tons in the world (FAO). According to the countries, China ranked first with a production of 45 983 400 tonnes. Turkey followed with 4 493 264 tonnes. The USA ranked third with a production of 4 467 206 tonnes (FAO; Figure 2). Türkiye has shown a steady increase in apple production in recent years (FAO; Figure 3).

Apple generally loses its quality after harvest. In stored products, the loss of quality is very slow. Storage is the process of keeping the product in conditions that preserve its quality for later marketing (Karaman at al., 2009). The most appropriate way to preserve the products with the least loss of quality and quantity is cold storage (Kaynaş at al., 2009). Apples can be stored under appropriate storage conditions for 4-10 months, depending on the cultivar (Saraçoğlu at al., 2011). There is not enough information regarding cold storage of local apple cultivars in rural areas. Determining the

post-harvest storage capabilities and fruit quality characteristics of local cultivars will provide both a more profitable income for the people in that region producing them and benefit for future breeding studies.

'Ayvaniye' was evaluated as the local apple cultivar in this study. It is cultivated in Gürün district of Sivas province. This local cultivar has been grown for many years. There is no orchard consisting only of this cultivar in the district, and producers grow it for domestic consumption. In addition, the 'Ayvaniye' cultivar is marketed in small quantities to neighbouring provinces and districts outside the Gürün district and to Istanbul. 'Ayvaniye' cultivar apples ripen late and harvest time is mid-October. It has the ability to be preserved for a long time under ordinary storage conditions after harvest. Some pomological and chemical properties of the fruit are as follows: Fruit weight is 135.22, fruit width is 66.58 mm, fruit length is 71.24 mm, fruit skin colour is

slightly yellowish red, soluble solids content is 12.7%, pH is 3.30 and titratable acidity value is 9.68 g/L (Paşazade, 2015).

Another cultivar used in the study is 'Granny Smith'. The cultivar, originated from Australia, is widely grown in Türkiye. It produces abundant crops every year. It produces fruit early and ripens late. It is harvested after mid-October. The fruits are medium sized, sometimes large and high quality. Its skin colour is bright green. Red stain occurs in high areas. It can be stored up to 9 months (Gerçekçiöğlü et al., 2018).

In apples, late cultivars are more resistant than early varieties. Therefore, fruits of resistant varieties are used for long-term storage (Karaçalı, 2018). The aim of this study is to investigate the suitability of the late 'Ayvaniye' apple cultivar for storage, included in the genetic resources of Türkiye, in comparison with the 'Granny Smith' apple cultivar, known for its storage resistance.

2. Materials and Methods

2.1. Plant material

The study was planned according to one way ANOVA with three replications. For both varieties, 12 trees were determined, four trees in each replicate. In the experiment, 'Granny Smith' and 'Ayvaniye' apples were harvested from Gürün district of Sivas province on October 23, 2022. Starch content was taken into consideration when determining the harvest date. Harvesting was done when one third of the starch content in the apple had been converted into sugar. 'Granny Smith' apples were harvested from 6-year-old trees grafted onto MM106 rootstock. 'Ayvaniye' apples were harvested from 14-year-old trees grafted onto seedling rootstocks. Injured and rotten apples were separated, and care was taken to ensure that they were homogeneous in size and weight. The apples included in the experiment were placed in plastic crates. Then, they were stored for 6 months at 1 ± 0.5 °C and $90\pm 5\%$ relative humidity (Altuntaş et al., 2009; Saraçoğlu et al., 2011).

2.2. Measurements and analysis

2.2.1. Weight loss

At the beginning of cold storage, the initial weights of the fruits were determined with a digital scale (Radwag, Poland) with an accuracy of 0.01 g. Final weights were then determined on the 30th, 60th, 90th, 120th, 150th and 180th days of storage. The data were calculated as a percentage according to the Equation 1.

$$\text{Weight loss (WL)} = \frac{\text{WL}(\text{first}) - \text{WL}(\text{end})}{\text{WL}(\text{first})} \times 100 \quad (1)$$

2.2.2. Fruit flesh firmness

Flesh firmness was measured in kg with a hand penetrometer (model FT-327; McCormick Fruit Tech, Yakima, WA) by removing a thin skin from the fruit surface and then converted to Newton (N) (Ozturk et al., 2013).

2.2.3. pH, Titratable acidity (TA) and Soluble solids content (SSC)

After evaluating the fruit firmness, the fruits were blended in a blender and placed in 50 ml falcon tubes. For pH measurement, 5 g of fruit samples were weighed and 95 ml of pure water was added. Then, pH value was determined. Immediately afterwards, 0.1 N sodium hydroxide was added to the samples for titratable acidity determination and titrated to pH 8.1. Titratable acidity was calculated according to malic acid types with the following equations:

$$A = \frac{S \cdot N \cdot F \cdot E}{C} \times 100 \quad (2)$$

- A: Percentage of acidity (%)
- S: Amount of sodium hydroxide used (ml)
- N: Normality of sodium hydroxide used
- F: Factor of sodium hydroxide used
- E: equivalent value of the corresponding acid (0.067 for malic acid)
- C: Amount of sample taken (ml)

The water-soluble solid content of the juice samples obtained after centrifugation was measured with a digital refractometer (Atago PAL-1, Japan (Brix= 0-53%)) and expressed as percentage.

2.2.4. Total phenolic substance compounds (TPC) and Total antioxidant activity (TAA)

Total phenolics content was measured according to the procedure described by Singleton and Rossi (1965). Briefly, fruit pulp was extracted with a buffer containing acetone, water and acetic acid (70:29.5:0.5 v/v) for 24 h at dark. Samples were replicated three times. Extracts were combined with Folin-Ciocalteu's phenol reagent and water, and incubated at room for 8 min followed by the addition of 7% sodium carbonate. After 2 h, the absorbance at 750 nm was measured in an automated UV-vis spectrophotometer (Model T60U, PG Instruments). Gallic acid was used as the standard. The results were expressed as micrograms (μg) gallic acid equivalent (GAE) g^{-1} fresh weight (fw). Total

antioxidant capacity analysis was performed by Ozgen et al. (2006) was done according to the procedure described. Fruit juices were taken from the samples and replicated three times. The absorbance values of the samples were read at 593 nm. Results are expressed as $\mu\text{mol Trolox equivalent (TE) g}^{-1}$ fresh weight (fw).

2.2.5. Fruit colour (L^* , a^* , b^*)

The colour parameters L^* , a^* , and b^* were measured from the outer skin of the fruit (for all three cheeks) with a colorimeter (Minolta, model CR-400, Tokyo, Japan). L^* represents values from black (0) to white (100), a^* from green(-) to red(+), and b^* from blue(-) to yellow(+).

2.2.6. Statistical analysis

The experiment was designed according to way ANOVA. All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA), checking the significance ($p < 0.05$) of differences between means according to the Duncan multiple comparison test.

3. Results and Discussion

Harvested fruits continue their vital activities by using the energy released by their respiration in other metabolic events. This metabolic activity is closely related to the storage conditions of fruits. Under appropriate storage conditions, it is possible to minimize the rate of metabolic events in the fruit by slowing down respiration. The most suitable storage for apples is

provided under conditions of -1 to 0 °C temperature and 85-95% relative humidity (+4 °C for European cultivars) (Karaman et al., 2009). By keeping the ambient humidity high, water loss in fruits is limited and damages such as quality decrease, wilting, decrease in crispness and weight loss are delayed (Karaçalı, 2018).

3.1. Weight loss (%) and fruit flesh firmness (kg/cm^3)

The weight losses in 'Ayvaniye' and 'Granny Smith' apples are shown in Figure 4A. Accordingly, it was determined that the weight losses in the 'Ayvaniye' cultivar were higher during storage. At the end of the 6th month, weight loss was determined as 3.25% in 'Ayvaniye' apples and 2.69% in 'Granny Smith' apples. In a similar study in the literature, it was determined that the weight loss in 'Braeburn' apples (control group) stored in cold temperatures for 6 months was over 3% (Öztürk et al., 2014). Another success of the 'Granny Smith' apple is Erbaş and Koyuncu (2020), who reported that the weight loss in the control group apples at the end of 6 months of cold storage was 4.42%. In another study, the weight losses in the 6th month of 'Granny Smith' and 'Amasya' apples stored in cold storage for 10 months were reported as 4.55% and 5.75%, respectively (Saraçoğlu, 2007). When compared to our findings, it seems that the data in the literature is higher. These differences may be due to the 'Granny Smith' apple cultivar being grown on different rootstocks and in different ecological regions.

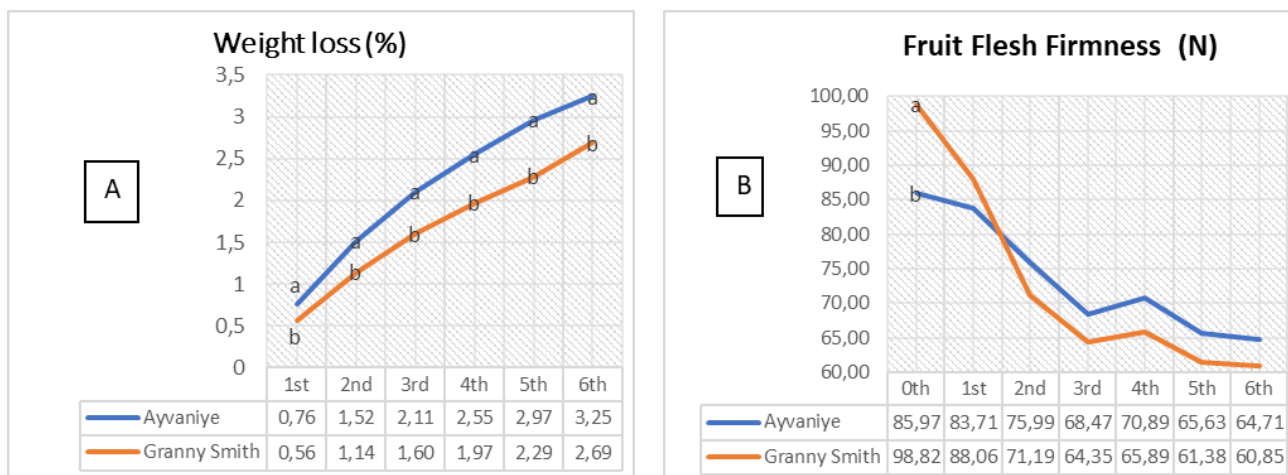


Figure 4. Weight (A) and firmness (B) losses in 'Ayvaniye' and 'Granny Smith' apples during storage (**Significant differences observed between cultivars each month are indicated with different letters**).

Şekil 4. 'Ayvaniye' ve 'Granny Smith' elmalarında depolama boyunca meydana gelen ağırlık (A) ve sertlik (B) kayıpları (**Çeşitler arasında her ay gözlenen önemli farklılıklar farklı harflerle belirtilmiştir**).

At the beginning of storage (0th month), it was determined that 'Granny Smith' cultivar apples had

harder fruit flesh compared to 'Ayvaniye' cultivar (Figure 4B). However, there was a significant decrease

in the 'Granny Smith' cultivar and at the end of the first month, the fruit flesh firmness reached the same level as the fruits of the other cultivar. In the following periods, the firmness of the fruit flesh of both cultivars were decreased to a similar level. When it came to the last period of storage, there was no significant difference between the cultivars. In a study conducted in previous years, the reactions of 'Granny Smith' apple and 'Yomra' apple, which is also a local cultivar, to cold storage were compared. As a result of the measurements made at 0, 3 and 4th months, it was reported that the 'Granny Smith' cultivar had harder structured fruits compared to the local cultivar (Saraçoğlu et al., 2011). These results contain similar and different findings when compared to this study. The difference can be explained by the fact that the local cultivar we used harder fruit flesh. In

another study, examining the pomological properties of local apple cultivars grown in Çatak and Tatvan regions, it was reported that the fruit flesh firmness of apples was varied between 60.82-38.26 N (Özrenk et al., 2010). The local apple cultivar (Ayvaniye) we used in this study has a value above these values (85.97 N).

3.2. pH, titratable acidity (TA) and soluble solids content (SSC)

It was determined that TA and SSC values were found higher in 'Granny Smith' cultivar apples while pH values were found higher in 'Ayvaniye' cultivar. pH values were increased during storage in both cultivars (Figure 5A). On the other hand, TA values were decreased throughout storage (Figure 5B).

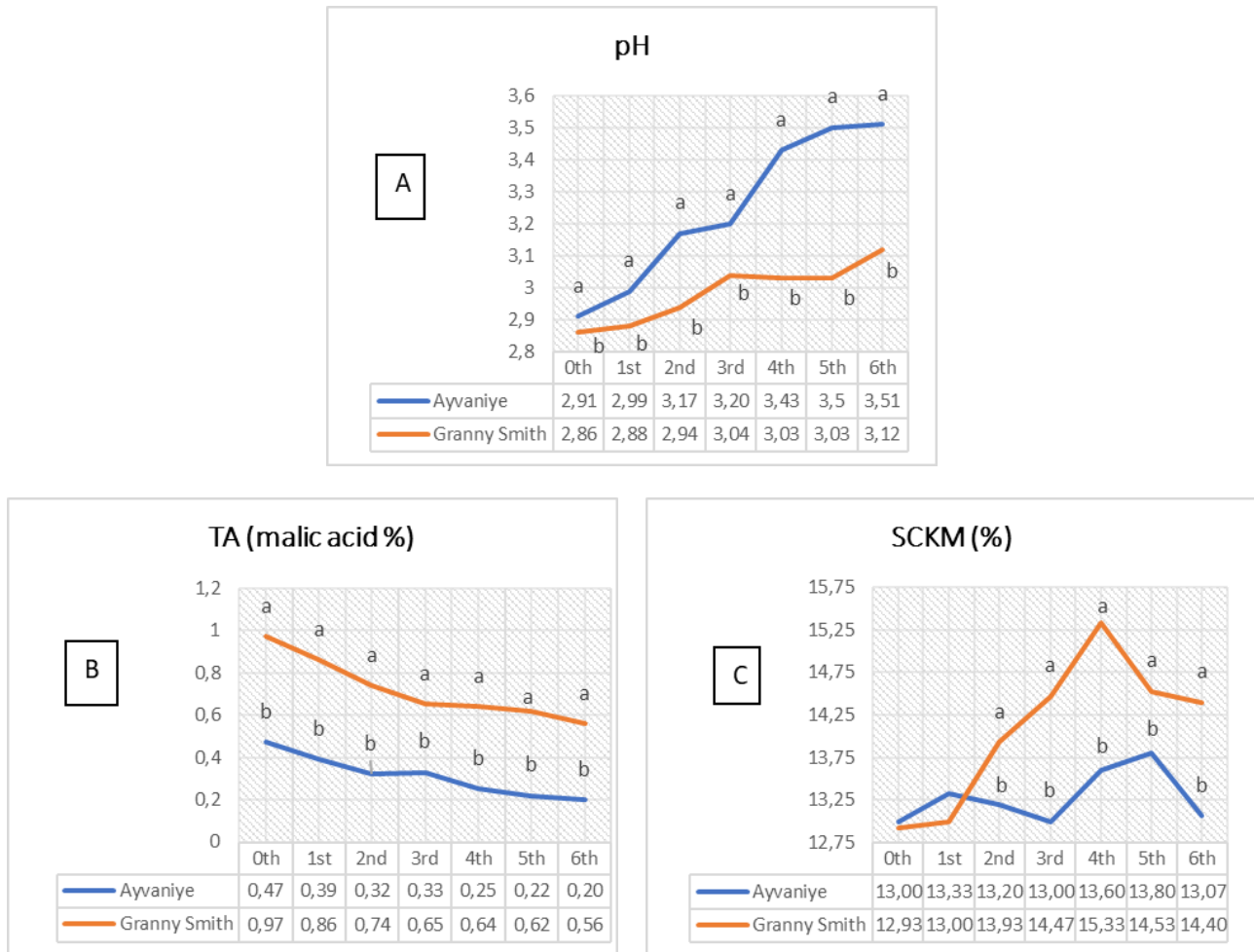


Figure 5. Changes in pH (A), TA (B) and SSC (C) values of 'Ayvaniye' and 'Granny Smith' apples during storage (Significant differences observed between cultivars each month are indicated with different letters).

Şekil 5. 'Ayvaniye' ve 'Granny Smith' elmalarının depolama boyunca pH (A), TA (B) ve SÇKM (C) değerlerinin değişimi (Çeşitler arasında her ay gözlenen önemli farklılıklar farklı harflerle belirtilmiştir).

SSC amounts were varied: In 'Ayvaniye' apples, it was increased until the 5th month and then decreased, and in 'Granny Smith' apples, it was increased until the

4th month and then decreased (Figure 5C). It is known that organic acids are consumed during the respiration process of fruits during the ripening process, causing TA

to decrease and SSC and pH values to increase (Hosseinifarahi et al., 2020). Organic acid contents of some products such as apples, pears and tomatoes; It continues to decrease after harvest because they take part in the neutralization of cations in respiration, sometimes in sugar synthesis, and crystallize in the form of salt in the cell (Türk et al., 2017). On the other hand, an increase in pH values occurs with the breakdown of organic acids carrying H⁺ ions (Polat et al., 2020). The reason for the increase in SSC was attributed to Khan et al. (2008) stated that it was caused by the loss of juice and the increase in solubility of cell wall components. It has been reported in different studies that in fruits belonging to species showing climacteric features, there is an increasing in the SSC value until the climacteric maximum point, and after this point, a decreasing in this feature is observed due to the effect of aging (Güner et al., 2022; Kurubaş & Erkan, 2018; Selçuk & Erkan, 2015). In this study, 'Ayvaniye' apples reached their climacteric maximum at the end of the 5th month, and 'Granny Smith' apples reached their climacteric maximum at the end of the 4th month. After this point, SSC amounts began to decline. In parallel with findings of this study, Güner et al. (2022) in the 'Fuji' apple and

Öztürk et al. (2013) in the local apple cultivar 'Ak Sakı', reached similar results in terms of pH, TA and SSC.

3.3. Total phenolic substance compounds (TPC) and Total antioxidant activity (TAA)

TPC values are given in Figure 6A. Accordingly, significant differences were found between the two cultivars. By the end of the 5th month, the TPC content of 'Granny Smith' apples was found to be higher than 'Ayvaniye' apples. When it came to the last month of storage, higher TPC was detected in 'Ayvaniye' apples. In addition, it was determined that the TPC values of both cultivars reached their lowest values at the end of the 3rd month and started to increase after this point. TAA values are given in Figure 6B. Here, significant differences emerged in other storage periods except the 3, 5 and 6th months. Contrary to TPC, TAA values were found to be higher in 'Ayvaniye' apples at 0, 1, 2 and 4th months. In general, while there was a decrease in 'Ayvaniye' apples in terms of TAA, there was an increase in 'Granny Smith' apples. There was no significant difference between the two cultivars in the last two periods of storage.

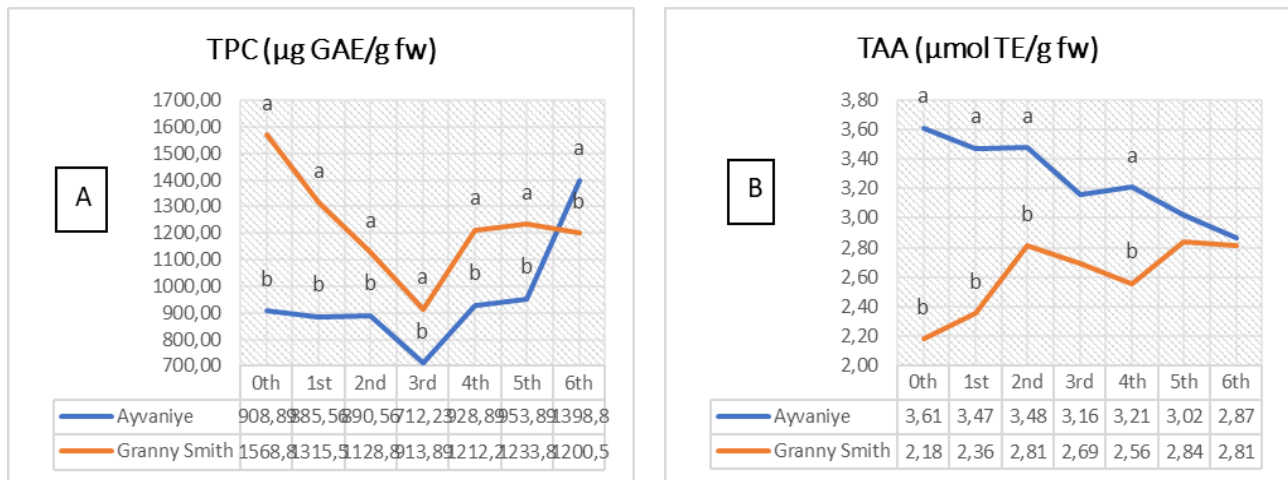


Figure 6. Total phenolic substance (TPC) (A) and total antioxidant activity (TAA) (B) values of 'Ayvaniye' and 'Granny Smith' apples throughout storage

*Significant differences observed between cultivars each month are indicated with different letters.

Şekil 6. 'Ayvaniye' ve 'Granny Smith' elmalarının depolama boyunca toplam fenolik madde (TPC) (A) ve toplam antioksidan aktivite (TAA) (B) değerleri

*Çeşitler arasında her ay gözlenen önemli farklılıklar farklı harflerle belirtilmiştir.

It is important to keep the phytochemical content of fruits at higher levels throughout storage. Some phenolic substances can protect cell components against oxidative damage because they have antioxidant activity (Sayyari et al., 2022). According to Ali et al. (2019), the main cause of the decrease in TPC may be oxidation. As a result of this study, it was determined that while the

phenolic substance content decreased in some periods, the antioxidant activity increased in that period (especially in the early periods of the 'Granny Smith' cultivar). Again, while the phenolic substance content increased in some periods, it was determined that the antioxidant activity decreased in that period (especially in the last periods of the 'Ayvaniye' cultivar). Contrary

to this study, some studies have reported a positive relationship between total phenolic substances and total antioxidant activity (Amiri et al., 2021; Haider et al., 2020; Sogvar et al., 2016). However, this positive relationship may not occur in different fruits and stress conditions. This may be due to the presence of substances such as anthocyanin, flavonoid and ascorbic acid, which have antioxidant properties, in addition to phenolic substances (Hassanpour, 2015; Heldt & Piechulla, 2015). Additionally, the increase in the activities of antioxidant enzymes (Ascorbate peroxidase (APX), glutathione reductase (GR) catalase (CAT) and superoxide dismutase (SOD)) under different stress conditions may have affected the positive relationship between total phenol and antioxidant activity (Yasar & Uzal, 2023; Yasar et al., 2008). In addition, changes in the total phenol content of fruits after harvest; may vary depending on cultivar, maturity stage at harvest, growing season and storage time (Özgan & Sabır, 2018). As a matter of fact, Güner et al. (2022) reported

that there was a decrease in the total phenolic substance and antioxidant activities of 'Fuji' apples throughout storage.

3.4. Fruit colour (L*,a*,b*)

In terms of L* values, significant differences were found between the two cultivars only in the 1st and 4th months of storage (Figure 7A). It was determined that the L* values of 'Ayvaniye' apples were higher in these months. Therefore, it was determined that 'Ayvaniye' apples had a lighter and brighter appearance compared to 'Granny Smith' apples. a* values are given in Figure 7B. Accordingly, significant differences were found between the two cultivars. During storage, it was determined that the skin colour of 'Ayvaniye' apples was red and its tones, while the skin colour of 'Granny Smith' apples was green and its tones. In addition, a more intense yellow colour and shades were detected in the skin colour of 'Granny Smith' apples compared to 'Ayvaniye' apples (Figure 7B).

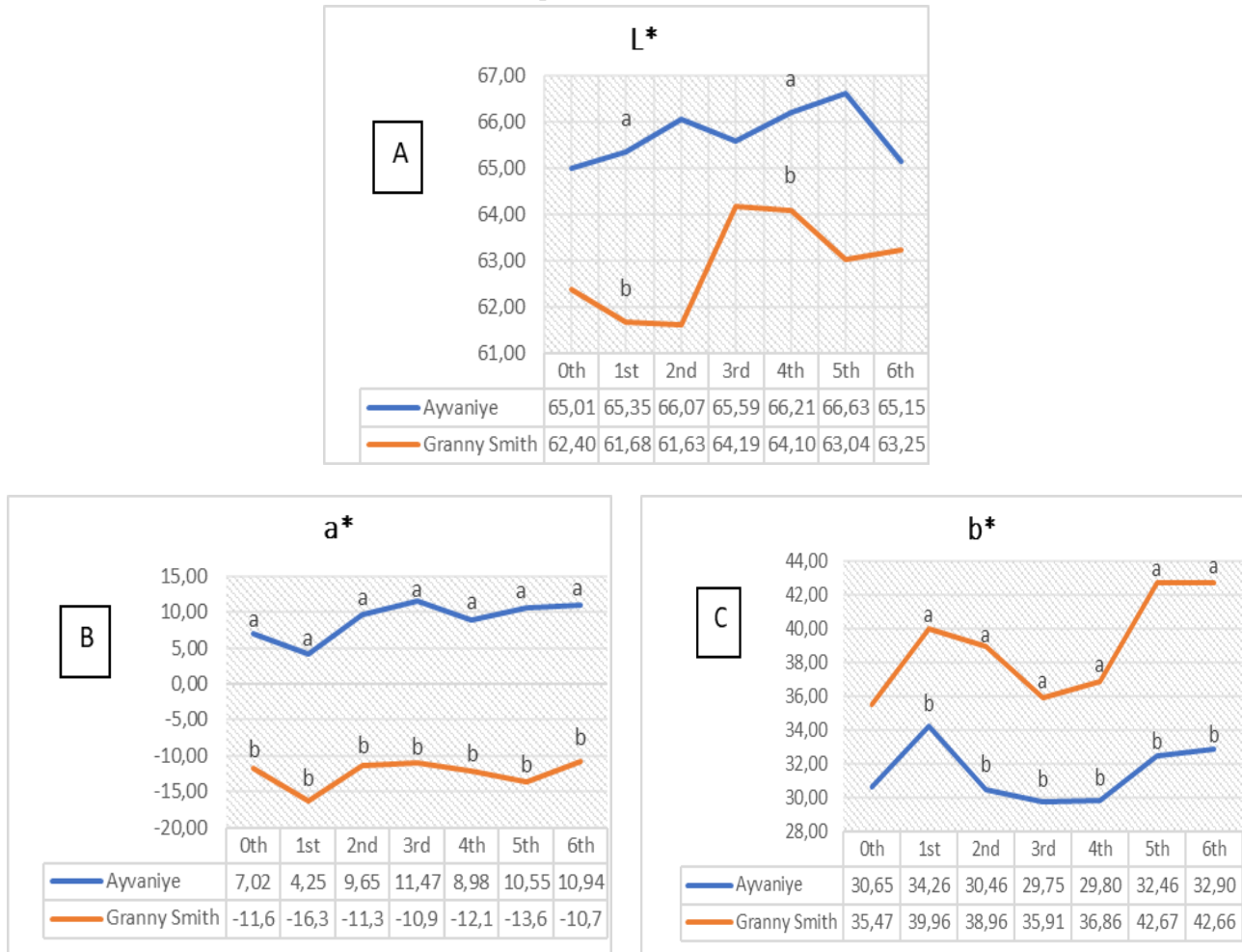


Figure 7. Changes in L* (A), a* (B) and b* (C) values of 'Ayvaniye' and 'Granny Smith' apples throughout storage
*Significant differences observed between cultivars each month are indicated with different letters.

Şekil 7. 'Ayvaniye' ve 'Granny Smith' elmalarının depolama boyunca L* (A), a* (B) ve b* (C) değerlerinin değişimi
*Çeşitler arasında her ay gözlenen önemli farklılıklar farklı harflerle belirtilmiştir.

4. Conclusion

In this study, the storage suitability of the 'Ayvaniye' apple cultivar was compared with the 'Granny Smith' apple cultivar in terms of some quality parameters. As a result of 6 months of cold storage, 'Ayvaniye' cultivar apples; weight loss, pH, TAA, L* and a* values were found to be higher compared to the 'Granny Smith' cultivar. In 'Granny Smith' cultivar apples, TA, SSC, TPC (excluding the last storage period) and b* values were higher. In addition, it was not determined that the flesh of 'Granny Smith' apples was harder at the beginning of storage, and that there was no significant difference between the two cultivars in later periods. As a result, it was determined that the 'Ayvaniye' cultivar is suitable for cold storage, but weight loss may be a problem for storage longer than 6 months.

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Production and Marketing Problems of Tomato Producers and Quit of Tomato Production: The Case of the Central District of Tokat Province

Rüveyda YÜZBAŞIOĞLU^{1*} Gülbahar TOSUN¹

Gaziosmanpaşa University, Faculty of Agriculture, Department of Agricultural Economics, Tokat,

*Corresponding author's email: ruveyda.kiziloglu@gop.edu.tr

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Abstract: The cultivation area and production amount of tomato, which is economically important and included in plant production, is decreasing every year. In this research, which examines the problems of producers in the production and marketing of labor-intensive and high-cost tomato production, the situation of quit tomato cultivation is also examined. A survey was conducted with 76 tomato producers in the villages of Tokat province. It has been observed that the producers among the active working population have 25 years of tomato growing experience and their education level is at primary school level. While the biggest problem of tomato producers in production is disease and product loss, the biggest problem in marketing is low prices and price instability. It was determined that 49% of producers gave up tomato cultivation. The reasons why producers give up tomato production are; Because it is not profitable, product disease is a product marketing problem and input costs are high. In line with the research results, it may be recommended that producers organize seminar courses on the disease. It is thought that both product and price stability can be achieved by developing policies for price instability and, most importantly, by establishing marketing cooperatives specific to this product in the region.

Keywords: Tomato, Marketing, Problem, Abandonment, Cultivation

Domates Üreticilerinin Üretim ve Pazarlama Sorunları ve Domates Üretiminden Vazgeçme Durumu: Tokat İli Merkez İlçe Örneği

Öz: Ekonomik boyutta önemli olan ve bitkisel üretim içerisinde yer alan domatesin ekim alanı ve üretim miktarı her geçen yıl azalmaktadır. Yoğun emek isteyen ve yüksek maliyetli domates üreticiliğindeki üretim ve pazarlamadaki üreticilerin sorunlarını inceleyen bu araştırmada domates yetiştiriciliğinden vazgeçme durumu da incelenmiştir. Tokat ilinde merkeze bağlı köylerde 76 domates üretimi gerçekleştiren üretici ile anket yolu ile görüşme yapılmıştır. Aktif çalışabilir nüfus içindeki üreticilerin 25 yıllık domates yetiştiriciliği tecrübesine sahip olduğu ve eğitim düzeylerinin ilkokul seviyesinde olduğu gözlemlenmiştir. Domates üreticilerin üretimdeki en büyük sorunu hastalık ve ürün kaybı iken pazarlamadaki en büyük sorunu ise fiyat düşüklüğü ve fiyat istikrarsızlığı olarak ortaya konulmuştur. Üreticilerin %49'unun domates yetiştiriciliğinden vazgeçtiği tespit edilmiştir. Üreticilerin domates üreticiliğinden vazgeçme nedenleri ise; karlı olmadığı için, ürün hastalığı, ürünün pazarlama sorunu olduğu ve girdi maliyetleri yüksek olmasıdır. Araştırma sonuçları doğrultusunda üreticilerin hastalık konusunda seminer kurs düzenlenmesi önerilebilir. Fiyat istikrarsızlığı için politika geliştirilmesi ve en önemlisi bölgede bu ürüne özgü pazarlama kooperatifleri kurularak hem ürün hem de fiyat istikrarı sağlanabileceği düşünülmektedir.

Anahtar Kelimeler: Domates, Pazarlama, Sorun, Vazgeçme, Yetiştiricilik

1. Introduction

According to FAO, 2021 data, the total tomato cultivation area in the world is 5,167.39 hectares. It was determined that 22.15% of the cultivation areas were in China and the most cultivation was made in this region. In terms of cultivation area, China is followed by India with 16.35%, Nigeria with 16.34%, Pakistan with 3.25% and Türkiye with 3.20%. In other words, it can be said that Türkiye has the fifth largest cultivation area in the world with 165.20 hectares of cultivation area.

According to TURKSTAT, 2022 data, tomato cultivation and production took place in 79 provinces in

Türkiye. In 2021, the tomato planting area of 1,652.04 decare decreased by 3.93% and in 2022, the planting area was 1,587.19 decare. Antalya province ranks first in terms of cultivation area, accounting for 11% of Türkiye's tomato cultivation area. Antalya is followed by Bursa (10.16%) and Manisa (7.30%). Tokat province, which was examined as the research region, is Türkiye's tomato growing area. It ranks twelfth with 1.89%. While the tomato cultivation area in Tokat province was 38,118 decare in 2021, production was made in 29.97 decare in 2022, decreasing by 21.37% compared to the previous year. In other words, it can be

said that almost a quarter of the cultivation area has been abandoned.

According to FAO, 2021 data, the amount of tomato production in the world is 189,133.96 tons. It was determined that 35.76% of the production amount was produced in China and tomato production was highest in this region. In terms of tomato production amount, China is followed by India with 11.20% and Türkiye with 6.92%. In other words, Türkiye can be said to be the third largest tomato producer in the world with a production amount of 13,000.00 tons.

According to TURKSTAT data for 2022, the amount of tomato production was 13,095.26 tons in 2021, decreasing by 0.73% and producing 13,000.00 tons in 2022. Antalya province, in terms of production amount, constitutes 19.60% of Türkiye's tomato production amount.

ranks first. The top five provinces in terms of production amount produce 51.34% of Türkiye's tomato production amount. These provinces are Antalya (19.60%), Bursa (11.01%), Manisa (7.58%), Izmir (6.58%) and Mersin (6.57%), respectively. Tokat province, which was examined as the research region, ranks twelfth by producing 1.73% of Türkiye's tomato production amount. While the amount of tomato production in Tokat province was 279.09 tons in 2021, it decreased by 19.39% in 2022 compared to the previous year, reaching 224.98 tons. In other words, it can be said that almost a quarter of the cultivation area has been abandoned.

According to TURKSTAT and FAO data, it has been observed that there is a significant decrease in tomato production in terms of cultivation area and therefore production amount. In the light of this information, it was aimed to examine the problems of tomato growers and their abandonment of production in Tokat, which is an important place for tomato cultivation. For this purpose, it was first wanted to examine the socio structures of the producers in the central villages where production is intense, and then the problems in production and marketing were wanted to be determined. In the last stage, manufacturers are forced to abandon the product. By examining the tendencies, factors that may affect quit were tried to be determined with the econometric model. Thus, it is aimed to find the reason for the serious decrease in income in tomato cultivation and to propose solutions to the problem.

When the studies on the research topic are examined, it can be said that they are grouped under four main headings. While calculating the cost of some plant products in agricultural production, there are studies

calculating the cost of tomato production (Kocaköse & Aktürk, 2019; Bayramoğlu et al., 2021). It is possible to come across studies examining tomato production and market structure in greenhouse cultivation (Daka et al., 2012; Engindeniz, 2015; Öruk & Engindeniz, 2019; Değer et al., 2020). Studies examining the economic structure and marketing of tomato production have been found in the literature (Oğuz & Arısoy, 2002; Güler, 2018; Kazak et al., 2018; Bozdemir et al., 2021; Karadaş and Güler, 2021; Çiftçi & Tapkı, 2023). Otto et al. (2007), in their research in South Tenerife, found that tomato producers switched to banana processing. When studies on a national basis are examined, it is possible to come across studies examining the effect of cover change on land degradation or climate change (Bajocco et al., 2012; Loffe et al., 2012; Cegielska et al., 2018; Zhang et al., 2019).

According to the literature, there is no research that examines in detail why tomato production, whose cultivation area has decreased in recent years, or the events that caused the abandonment, will provide richness in looking at the literature from a different perspective.

2. Materials and Methods

2.1. Material

The material of this research Tokat Gaziosmanpaşa University Social and Human Sciences Research Ethics Committee at the 16th session on 29.12.2022, according to the decision number 01-60 consisted of data obtained through a survey from tomato producers in the villages of the Central district of Tokat province in January 2023.

2.2. Method Followed During Data Collection

By using the sampling method, more detailed, cheaper and quicker data about a population is obtained (Çiçek & Erkan, 1996; Yamane, 2010).

According to the data of the Ministry of Agriculture and Forestry for 2021, there are 1697 tomato growers in the villages of Tokat province center, on a total area of 3,679.78 decares. Considering the variance of the total cultivated area (2.17%), it was determined to be less than 75% and the sample volume was determined with the help of the simple random sampling formula based on the average. Before determining the sample volume, it was determined that tomato cultivation was carried out in 113 villages of the center. Purposeful sampling Based on the method, it was decided to include 11 villages, which are the most intensive tomato growers and correspond to 10% of the total villages (113 villages), within the scope of the research.

The number of enterprises that will represent the population, taking into account the tomato cultivation area;

$$n = \frac{N * S^2 * t^2}{(N-1)d^2 + S^2 * t^2} \quad (1)$$

Calculated using Equation 1 (Çiçek & Erkan, 1996)

n: Number of businesses to represent the population (76),

N: Total tomato cultivation area in the central district (3,679.78),

S: Standard deviation of the population (2.17)

t: ruler value at 90% confidence limits (1.65)

d = acceptable margin of error (10% of the average of the total tomato cultivation area in the central district: 3.81)

After calculating the number of businesses to be surveyed, a random numbers table was used to determine the businesses to be surveyed.

2.3. Method Followed During Data Analysis Phase

In the study, the factors affecting tomato producers' abandonment of production were determined by binary

logit analysis. Dependent in logit the model variable is a dummy and the predicted probability values vary between 0 and 1.

Some variables in the logistic model were converted into categorical variables so that differences between categories could be obtained as odds ratios. For ease of interpretation, some of the independent variables were included in the model as dummy variables.

As an explanatory variable to the model; age of the producers (continuous variable), experience in tomato production (years, continuous variable), educational status (0 if literate, If a primary school graduate is coded as 1, if a secondary school graduate is coded as 2, if a high school graduate is coded as 3 and if a college graduate is coded as 4), tomato cultivation area (decare, continuously variable), factors that trigger producers to give up on tomato production (since it is not profitable, crop disease, marketing problem of the product). and input costs are high) was included in the model as a dummy variable (coded as 1 if it caused people to give up, 0 otherwise).

Table 1 gives the codes, explanations and some statistical properties of the dependent and independent variables in the model.

Table 1. Variables used in the binary logit model

Çizelge 1. Binary logit modelinde kullanılan değişkenler

Code	Variable
Dependent Variable (Y)	Case of abandoning tomato production: 1 Status of not quit tomato production: 0
Age	Manufacturer's age: (Continuously variable)
Experience	Tomato production experience: (Continuously variable)
Education	Educational status of the producer: Literate: 0 Primary school graduate: 1 Secondary school graduate: 2 High school graduate: 3 College graduate: 4 Bachelor's degree: 5 Master's degree: 6
Receiving The Supplement	Tomato production area: (decare, continuously variable)
Azkar	Consideration of quit tomato production because it is not profitable: if thinking: 1, if not thinking: 0
Illness	Consideration of quit tomato production because there are too many crop diseases: if thinking: 1, if not thinking: 0
Marketing Problems	Consideration of quit tomato production because of problems in marketing the product: if thinking: 1, if not thinking: 0
Cost	Consideration of quit tomato production because input costs are too high: if thinking: 1, if not thinking: 0

3. Result and Discussion

3.1. Demographic structures of producers

The average age of the producers is 48.20 and they have been producing tomatoes for an average of 25.22 years. When research on tomato cultivation in recent years is examined, it is possible to come across producers with similar active age groups and similar

years of experience in tomato cultivation. Daka et al. (2012) found the average age of greenhouse tomato producers in Muğla province to be 46, while Değer et al. (2020) stated that the producers of greenhouse tomato cultivation in Muğla Fethiye are on average 47 years old and have approximately 18 years of experience. While Karadaş & Güler (2021) determined that the producers

in Iğdır province have an average age of 52, Kazak et al. (2018) stated that the average age of the producers in İzmir Torbalı is 45 years old and that they have been producing tomatoes for 13 years, and Öruk & Engindeniz (2019) in their research calculated the average age of the producers as 45 years old and that they have 21 years of experience in tomato cultivation. When we look at the educational status of the producers, it is seen that the highest share is made up of primary school graduates with a rate of approximately 36%, followed by secondary school graduates with a maximum rate of 25%, and the least share is made up of illiterate people (1.32%) and bachelor's degree graduates (1.32%). It is seen that it forms (Table 2). Çiftçi and Tapkı (2023) determined that 50% of tomato producers in Hatay province were primary school graduates. Daka et al. (2012) found that 67% of greenhouse tomato producers in Muğla province and Karadaş and Güler (2021) found that 44% of tomato producers in Iğdır province were primary school graduates. When recent studies are examined, it can be said that the education level of the majority of producers is primary school or an average of 5 years of education.

Table 2. Educational status of the producer

Çizelge 2. Üreticilerin eğitim durumu

Educational Status	Frequency	Share (%)
Illiterate	1	1.32
Primary school	27	35.53
Middle school	19	25.00
High school	17	22.37
College	4	5.26
Licence	7	9.21
Degree	1	1.32
Total	76	100.00

When the producers' participation in seminars and courses on tomato cultivation was examined, it was determined that 67% of the producers did not attend the seminars and courses, while 33% did. When the production branch of the producers was considered, they were asked whether there was plant and animal production and it was determined that the highest rate of plant and animal production was approximately 57%. Following this, it was determined that only herbal production was made at the rate of approximately 42% and not at the rate of approximately 58%. There are an average of 5 individuals in the household. When we look at the presence of individuals who bring income to the producers' households, it is determined that there are fewer individuals in the household with agricultural income (10.53%), while there are more individuals without agricultural income (89.47%).

It was determined that 46.05% of the producers were members of the cooperative and producer union, while 53.95% were not members. Daka et al. (2012) found that 76% of the producers growing tomatoes in greenhouses in Muğla province were members of the cooperative.

3.2. Tomato production and producer problems

It was calculated that the producers produced tomatoes in an average area of 9.79 decares and the average yield was 7,171 kg/da. Considering that the general yield in Tokat province is 7,507 kg/da according to TURKSTAT's 2022 data, it can be said that the average yield of the producers interviewed within the scope of the research is slightly low. It was calculated in the research results that tomato producers harvest tomatoes on average 8 times a year and experience an average annual product loss of 16,504.61 kg per business.

The biggest part of the problems experienced by producers in production is crop disease, and This problem appears in 89% of cases. Following this, it is seen that 58% of producers experienced product loss during harvest and the most common problems with input are identified with a rate of approximately 55%. Collector, distributor, processor and marketer problems are among the problems they experience with a rate of approximately 53%. Labor (46.05%) and planting, maintenance and fertilization (40.79%) are also among the problems experienced. It is seen that the problems experienced with the accommodation and transportation of seasonal workers and the lack of modern equipment were determined to be the same rate, approximately 16%. It was observed that the least experienced problems were insufficient technical knowledge with a rate of approximately 9% and credit with a rate of approximately 11% (Table 3). It is possible to come across manufacturers experiencing similar problems because of research. Karadaş & Güler (2021) stated in their research that among the most common problems experienced by tomato producers in Iğdır province in production, the cost of growing the product is very high and the unit price of the product is very low. Kazak et al. (2018) mentioned product loss as the biggest problem in production of tomato producers in İzmir Torbalı, Öruk & Engindeniz (2019) found product loss among the biggest problems in production of greenhouse tomato producers in Muğla province.

Table 4 examines the problems experienced by producers in marketing tomato products. When we look at the problems experienced by manufacturers in marketing, the most common problem is price

instability, and it has been determined that this problem is experienced by approximately 86%, and then another of the most experienced problems is the lack of price determination and lack of control. It is another of the main problems experienced by approximately 82%. Failure to sell at the desired price (76.32%), market structure. The fact that it is irregular (75.00%) and that production and demand vary throughout the year (69.74%) are also among the problems experienced at high rates. When we look at the situations where the buyer cannot be found at the desired time (57.89%), the cooperatives are insufficient (57.89%), and the relevant institutions and organizations do not provide

information (51.32%), it has been determined that more than half of them have problems. Less than the information given here the problems experienced are the lack of storage facilities (48.68%), the buyer not paying in advance (44.74%), and the product prices not being received on time (30.26%). In the literature, price instability is the biggest problem in marketing tomato producers. Studies in the literature showing that there are studies are as follows: Kazak et al., who studied tomato producers in Torbalı, Izmir (2018) and Örük & Engindeniz (2019), who studied greenhouse tomato cultivation in Muğla province.

Table 3. Problems faced by producers in tomato production

Çizelge 3. Üreticilerin domates üretiminde karşılaştığı sorunlar

Main Problems Encountered by Manufacturers	Frequency	Share (%)
Crop Disease	68	89.47
Product Loss at Harvest	44	57.89
Input Supply	42	55.26
Picker. Distributor. Experiencing Processor and Marketer Problems	40	52.63
Labor Expense	35	46.05
Sowing, Planting, Maintenance, Fertilization Expense	31	40.79
Housing of Seasonal Workers. Transport	12	15.79
Harvest Problem Due to Lack of Modern Agricultural Machinery and Equipment	12	15.79
Loan Procurement	8	10.53
Lack of Technical Knowledge	7	9.21

Table 4. Problems experienced by producers in marketing tomato products

Çizelge 4. Üreticilerin domates pazarlamasında karşılaştığı sorunlar

Problems	Frequency	Share (%)
Price Instability	65	85.53
No Price Determination and No Control	62	81.58
I Can't Sell At The Price I Want	58	76.32
Market Structure Irregular	57	75.00
Production and Demand Varies During the Year	53	69.74
Not Finding a Buyer at the Desired Time	44	57.89
Cooperatives Are Insufficient	44	57.89
Relevant Institutions and Organizations Not Providing Information	39	51.32
Lack of Preservation Possibility (Storage)	37	48.68
Buyer Not Making Advance Payment	34	44.74
We Cannot Receive Product Prices on Time	23	30.26

3.3. The situation of producers quit tomato production and the factors affecting quit

When the situation of producers quit tomato production and switching to another product production is examined; It was determined that more than half of the producers (51.32%) will continue tomato production (Table 5). There are studies in the literature on producers who are considering quit other herbal products it is also possible to find studies conducted. Baş & Ateş (2010) found that 63% of tobacco producers in Muş province would give up production if the tobacco law came into effect. Can (2020) stated in his research that 67% of black cumin growers in Uşak province will give up

production

Considering the reasons why producers give up tomato production; switching to a more profitable branch of production (31.58%), low profitability (28.95%), diseases (26.32%) and market experiencing problems (23.68%) is one of the main reasons why they prefer to give up. It was determined that the reasons that least affected this situation were not wanting to do it (2.63%), lack of knowledge (1.32%) and returning to growing only seedlings (1.32%) (Table 6). Baş & Ateş (2010) found that the reason for tobacco producers in Muş province to abandon crop cultivation was that they did not find production profitable. Can (2020) It was

concluded that the reason why black cumin producers in Uşak province gave up production was that they planted it for trial purposes and that the expected profit was not achieved. Tasci et al. (2021) stated that the most important reasons that triggered the abandonment of wheat production in Çorum province were the high production cost of the product and the very low unit sales price of the product.

Table 5. Situation of producers quit tomato production and switching to other product production

Çizelge 5. Üreticilerin domates üretiminden vazgeçip başka ürün üretimine geçmek isteme durumu

Consideration of Quit Tomato Production	Frequency	Share (%)
Wanting to Give Up	37	48.68
Wanting to Continue	39	51.32

Table 6. Reasons for producers to give up tomato production

Çizelge 6. Üreticilerin domates üretiminden vazgeçme nedenleri

Reasons	Frequency	Share (%)
Desire to Switch to a More Profitable Branch of Production	24	31.58
Profitability is Low	22	28.95
Illness	20	26.32
Market Problem	18	23.68
Input Cost	15	19.74
Efficiency is Low	14	18.42
Irrigation Problem	8	10.53
Not Wanting to Do	2	2.63
Lack of Information	1	1.32
Don't Just Return to Seedling Growing	1	1.32

Table 7. Products that producers consider growing instead of tomatoes

Çizelge 7. Üreticilerin domates üretiminden vazgeçip yetiştirmeyi düşündükleri ürünler

Products	Frequency	Share (%)
Those who continue to grow tomatoes	39	51.32
Corn - Grain Corn	11	14.47
Sunflower	6	7.89
Beet	9	11.84
Pepper	2	2.63
Bean	2	2.63
Wheat	2	2.63
Garlic	1	1.32
Cucumber	1	1.32
Barley	1	1.32
Ornamental Plants	1	1.32
Vine Leaf Production	1	1.32

It has been determined that when producers want to give up tomato production and switch to a different production, the first products they consider growing are corn - grain corn (14.47%), followed by beet (11.84%)

and sunflower (7.89%). The products that were least produced were garlic, cucumber, pepper, barley, ornamental plants and vine leaves at the same rates (1.32%) (Table 7).

Due to the high input costs in tomato production, it was aimed to determine the factors affecting the thoughts of producers who plan to switch to a more profitable production branch with an econometric model. For this purpose, binary logit regression, which is easy to interpret from models where the dependent variable is used as a dummy variable, was chosen. Beta values, standard errors and marginal effects of the variables in the model are given in Table 8. In the resulting values, the likelihood (significance level) value is acceptable in every confidence interval, the model's independent variables explain the dependent variable (Mc Fadden corrected R^2) by 95%, and the Chi square value is acceptably low; It ensures that the model is meaningful and interpretable.

According to the model, it was determined that four factors that affect quit tomato production (because it is not profitable, product disease, marketing problems of the product and high input costs) affect the abandonment of tomato production positively at the 1% significance level and positively affect the cultivation area at the 5% significance level.

In other words, a one-unit increase in producers quit production because it is not profitable can cause an increase in overall abandonment by 56%. another expression Producers who do not think that production is profitable are 56% more likely to give up production than those who think that it is profitable.

It can be said that producers who experience crop disease in tomato cultivation are 58% more likely to give up crop cultivation than those who do not. Similarly, according to the marginal effects in Table 8, it can be said that producers who experience marketing problems in Tomato are 55% more likely to give up on crop cultivation than those who do not, and that producers who find the input costs in tomato crop cultivation are too high are more likely to give up on crop cultivation at a rate of 53% compared to those who do not.

A one-unit increase in the tomato cultivation area of tomato producers can increase the abandonment of tomato cultivation by 0.1%. In other words, it can be said that producers do not plan to plant more and it is easier to plan to give up production rather than expanding the planting area.

It has been observed that the fact that the producers are younger or have more years of experience in tomato cultivation has a positive effect on quit tomato cultivation, but there is no econometrically significant relationship. Because the increase in the level of education also increases tomato It was determined that it positively affected the abandonment of productivity,

but there was no econometrically significant relationship.

In short, the reasons why producers give up production are really positive reasons for quitting. It can be said that it affects both ways. It has been observed that the socio-characteristics of the producers affect it, but there is no statistical relationship.

Table 8. Binary logit analysis result of factors affecting producers' abandonment of tomato production

Çizelge 8. Üreticilerin domates üretiminden vazgeçmesini etkileyen faktörlerin binary logit analiz sonucu

	Coefficient	Standard error	z	P (importance level)	Marginal Effect
Constant	-10.605	8.340	-1.27	0.204	
Age	-0.037	0.152	-.24	0.810	-0.001
Experience	0.094	0.176	0.53	0.593	0.002
Educatio	0.842	1.001	0.84	0.400	0.016
Plant Area	0.162**	0.095	1.71	0.087	0.004**
Azkar	36.744	0.019	29.47	<0.001	0.561*
Illness	35.406	0.017	33.97	<0.001	0.578*
Marketing Problems	37.291	0.016	34.67	<0.001	0.553*
Cost	32.615	0.016	32.22	<0.001	0.526*

Representation at significance level *: 1%, **: 10%

Chi square [8 variable]: 95.086, Converted R²:52.653, McFadden R²: 0.903

Severity Level: 0.000

In Türkiye, which ranks among the top three in world tomato production, the amount of tomato production has decreased, especially in recent years. After examining the production and marketing problems of tomato producers in Tokat province, the main aim was to determine the reasons why tomato producers gave up production and the factors affecting the abandonment. It has been observed that tomato producers are in the active working age range and that they are growing tomatoes at a level that can be considered experienced compared to the average age. As is a reality in Türkiye, it has been determined that the education levels of tomato producers in Tokat province are low. It is obvious that in agricultural production, producers generate income from several production branches in order to reduce risk, rather than specializing in a single production branch, especially due to risk and uncertainty. In this study, more than half of the producers engage in plant production as well as animal production production is also available in the results of his research.

The biggest problem of tomato producers in production is crop disease and crop loss. In other words, it is concluded that producers experience economic losses due to product loss due to the disease occurring in the tomatoes they grow. The biggest reason to give up crop cultivation is It is an economic problem. Therefore, it is necessary to pay attention to this problem of producers. Seminar courses should be organized to

provide producers with detailed information about the diseases. In fact, relevant institutions and organizations can propose a project idea to organize seminar courses of this size.

The biggest problem in product marketing is price instability and low prices. Economic problems lie at the root of the marketing problems experienced by producers. It may be recommended to implement a price control policy in order to protect the producer's economy. The actual marketing cooperatives are Türkiye's biggest deficiency, and this deficiency can be emphasized once again because of this research. Producers may not have much influence in the market as small businesses, but if they enter the market as a cooperative, they can have a stronger say in the market both in selling products and in price stability.

As a result of the research, it was determined that since tomato cultivation requires intensive labor and is high cost, producers with fewer retirees have started to turn to more economical products. After determining the main purpose of the research, the factors affecting the abandonment of crop cultivation, were tried to be determined with an econometric model. As a result of the model, it was determined that the producers' reasons for abandoning production affected the abandonment positively rather than the effect of demographic factors. In other words, it can be said as a result of the research that the reasons for manufacturers' abandonment are actually directing them to another product.

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Comparison of Different Pruning Methods for Training Young Fernor Walnut Trees

Abadan NARBAYEVA¹ Yaşar AKÇA^{1*}

¹University of Tokat Gaziosmanpaşa, Faculty of Agriculture, Department of Horticulture, Tokat,

*Corresponding author's email: akcanut@gmail.com

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Abstract: The aim of the study is to determine the effects of minimal pruning (MP) and unpruned&unheaded (UP&UH) on young Fernor walnut cultivar trees concerning, tree growth, yield, nut quality and water use efficiency. The trees in the research orchard were planted in 2017. According to the data, a statistically significant difference was found between (MP) and (UP&UH) in terms of shoot length, canopy length, tree height, yield, kernel weight, kernel ratio and nut length. The two-year cumulative yield value was found to be 6036.28 g in (MP) and 9865.87 g in (UP&UH). The stem water potential values (GSP), (MPa) of (MP) and (UP&UH) were 7.65 and 7.50, respectively. Considering the significant difference in yield between two pruning methods, it has been observed that water use efficiency is higher in (UP&UH). If water deficiency and insufficient fertilization are combined with (UP&UH), significant losses in tree growth, yield and nut quality can occur. In this context, (UP&UH) should be considered along with other factors that will affect tree growth, yield and fruit quality.

Keywords: Pruning, Training, Yield, Fernor, Walnut.

Genç Fernor Ceviz Ağaçlarının Yetiştirilmesinde Farklı Budama Yöntemlerinin Karşılaştırılması

Öz: Çalışmanın amacı, minimum budama (MP) ve budamama&tepe vurmamanın (UP&UH) genç Fernor çeşidi ceviz ağaçlarında ağaç gelişimi, verim, meyve kalitesi ve su kullanım etkinliği üzerine etkilerini belirlemektir. Araştırma bahçesindeki ağaçlar 2017 yılında dikildi. Verilere göre (MP) ile (UP&UH) arasında sürgün uzunluğu, taç uzunluğu, ağaç yüksekliği, verim, iç ağırlığı, iç oranı ve meyve boyunda istatistiksel olarak önemli farklılıklar bulundu. İki yıllık kümülatif verim değeri (MP) ağaçlarında 6036,28 g, (UP&UH) ağaçlarında 9865,87 g olarak belirlendi. (MP) ve (UP&UH)'nin ortalama gün ortası gövde suyu potansiyeli değerleri (MPa) sırasıyla 7,65 ve 7,50'dir. İki budama yöntemi arasındaki verim farkı dikkate alındığında (MP) uygulamasında su kullanım etkinliğinin daha yüksek olduğu görüldü. Sulama suyu yetersizliği ve yetersiz bitki besleme&gübreleme yönetimi (MP&UH) ile birleştiğinde ağaç gelişiminde, verimde ve meyve kalitesinde önemli kayıplara neden olabilir. Bu bağlamda (MP&UH) uygulaması, ağaç gelişimi, verim ve meyve kalitesini etkileyecek diğer faktörlerle birlikte düşünülmelidir.

Anahtar Kelimeler: Budama, Şekil budaması, Verim, Fernor, Ceviz.

1. Introduction

Training and pruning of adult walnut trees serve purposes: controlling tree size balancing generative and vegetative development, enhancing nut size, promoting the formation of new fruit buds, ensuring proper light distribution within the tree, and eliminating old, dried, dead or overlapping branches. Additionally pruning aims to shape the tree suitably for harvesting and picking operations by machinery. Another objective of pruning in mature walnut trees is to stimulate strong spur development, encourage female flower formation, and facilitate the growth of large nuts. (Akça, 2014; Andersen, 1984).

In walnut varieties that bear fruit on terminal branches, pruning may delay yield. However, this effect

is not seen in varieties that produce high amounts of fruit on lateral branches. Significant differences exist between varieties regarding development type, fruiting location, vigor and many other characteristics. If young fruit-bearing trees are minimally pruned, it can encourage sufficient shoot development to form fruit areas. Conversely, heavy pruning of young trees may delay the onset of yielding.

Studies investigating the effects of different pruning methods on yield and fruit quality in walnut cultivation in Turkey are very limited (Argaç, 2021). According to our observations in walnut orchards where hard pruning is practiced in walnut cultivation, our initial results indicate that the shoots are susceptible to damage from the onset of yield is delayed, productivity is low and

increased susceptibility to *Xaj* disease.

Similar research has been conducted on Ashley, Howard and Chandler varieties (Hasey et al., 1998; DeBuse et al., 2010). However, there is no study on the Fernor variety. Fernor trees have different morphological and physiological characteristics compared to the Ashley, Howard and Chandler varieties, their responses to different pruning systems remain unknown.

Walnut growers in Türkiye prefer very hard pruning over minimal pruning. There is a common belief that minimal or no pruning is not appropriate in walnut cultivation. Growers hold belief that with hard pruning, the tree will have a more uniform shape and stronger growth. In fact, it is widely believed that if young walnut trees are not pruned, their development will stagnate, leading to decreased yield and fruit quality due to early fruit bearing. Consequently, very hard pruning is performed on young trees. When we realized that we could not change habits with rhetoric, we realized that we needed applied research results. The only way to overcome resistance to paradigm change should be persuasion with results based on research.

It has been reported that young trees of the Howard, Chandler, Tulare, Forde, Solano and Livermore varieties do not require pruning to maintain growth and achieve adequate yield. Heavy pruning is not recommended for these cultivars as it leads to reduced yields and smaller trees. Pruning may delay yield on varieties that bear fruit on terminal branches, such as Hartley and Franquette. However, this effect is not observed in cultivars that bear fruit on lateral branches (Hasey et al., 1998).

There is no research investigating the effects of different pruning methods on yield in young Fernor walnut trees. The use of hard pruning methods, especially in the Fernor variety, delays the age at which trees start yielding. In our research, we investigated the effects of pruning management on tree development, yield, nut quality and water stress in young Fernor trees. Additionally, our study aimed to provide new results against the hypothesis that pruning reduces tree growth in varieties that bear fruit on lateral branches.

2. Material and Method

2.1. Material

2.1.1. Plant Material

In 2017, an extensive walnut orchard was planted in the Northeast of Turkey, in Lüleburgaz (41°18'44.08"N & 27°17'42.64"E), with trees spaced at 8m x 4m grafted 'Fernor' trees onto *J. regia* L. rootstock. Fernor walnut

cultivar has the characteristics of late leafing and lateral bud fruitfulness. Fernor is the most used cultivar after the Chandler variety in walnut orchards established in Turkey in recent years.

2.1.2. Soil characteristics of the orchard where the research was conducted

Physical and chemical properties of the soils of the research orchard presented in Table 1.

Table 1. Physical and chemical properties of soils
Cizelge 1. Toprakların fiziksel ve kimyasal özellikleri

Parametre	Results	Unite	Metod
Soil pH	7.50	%	-
Electrical conductivity (EC)	0.04	%	Saturation
CaCO ₃	1.95	%	Calometric
Saturation	74.80	%	Saturation
Organic matter (OM)	1.49	%	Walkey-Black
(N)	0.07	ppm	Kjeldahl
P	7.07	ppm	Olsen
K	191.54	ppm	Amonium Asetat - ICP
Ca	8 014.23	ppm	Amonium Asetat- ICP
Mg	740.81	ppm	Amonium Asetat- ICP
Fe	21.11	ppm	DTPA-ICP
Cu	1.68	ppm	DTPA-ICP
Zn	0.37	ppm	DTPA-ICP
Mn	8.50	ppm	DTPA-ICP

2.1.3. Devices used to measure length and weight

Meters were used to measure trunk length, shoot length, tree height, and canopy and tree width. An electronic caliper with 0.01 mm precision was used to determine fruit sizes from pomological characteristics, and an electronic scale with 0.01 g precision was used to determine nut and kernel weight.

2.2. Method

2.2.1. Preparation practices for different pruning methods on saplings

Fernor saplings were initially over 2.00 meters high and were pruned to 50 cm upon planting. Drip irrigation was installed from the outset, and orchard management followed standard practices appropriate to the environment and the age of the plantation. Before onset of the second growing season trees were cut at 1.80 m and 5-6 scaffold branches were selected, including the leading branch. Subsequently main shoot leader and scaffold branches were pruned during in the winter training, removing either 1/3 or 2/3 of their length depending on their annual growth, typically around a meter. During the three first year's stakes were used. The objective was to achieve 5 to 6 limbs, growing the first at 1.50 m from the soil. A minimal pruning system was applied to trial trees in 2018 and 2019 to establish a main branch system that would allow adequate light penetration (Ryugo et al., 1980). Trials of two different pruning systems started in 2020.

2.2.1.1. Minimum pruning method (MP)

In 2020 and 2021, the branches of the trees that will undergo (MP) were cut below 150 cm from the soil level, and 25% to 30% of the shoots from the previous year were cut and headed (Figure 1).

2.2.1.2. Unpruned/Unheaded training method (UP&UH)

In 2020, in (UP&UH), only narrow-angle and forked branches and branches below 150 cm on the trunk were removed. All other branches were unpruned and unheaded. Trees that were not crowned and cut under management UP&UH in 2020-2021 were released.

However, during the summer pruning of these trees, only the forked branches, if any, were reduced to single branches (Figure 1).

2.2.2. Determination of the effects of pruning management on phenological, morphological, pomological and yield

In order to determine the effect of pruning management on phenological characteristics, data on bud burst time, leafing time, female flowering time, male flowering time, harvest time and leaf fall time were taken.



Figure 1. Crown shape of trees treated with (MP) (left) and (UP&UH) (right)

Resim 1. (MP) (solda) ve (UP&UH) (sağda) uygulama yapılan ağaçların taç şekli

In order to assess the act of pruning management on morphological characteristics, various parameters were examined, including tree trunk circumference, tree height, tree and canopy volume, canopy length and width.

In order to assess the act of pruning management on morphological characteristics, various parameters were examined, including tree trunk circumference, tree height, tree and canopy volume, canopy length and width.

Additionally, the yield per tree was determined to evaluate the effect of pruning methods on yield (g/tree). Tree volume (TV) and crown volume (CV) were calculated based on Equation 1 (Stehr, 2005) and Equation 2 (Arğaç, 2001).

$$TV(m^3) = [(L+W)/4]^2 \cdot \pi \cdot H / 2 \quad (1)$$

L: Crown height

W: Crown width

H: Tree height

$$CV(m^3) = \pi r^2 h / 2 \quad (2)$$

h: Crown height

r: Crown width

In order to determine the effect of pruning methods on pomological characteristics, nut weight, kernel weight, kernel percentage shell thickness, nut dimensions (length, height, width) and kernel color characteristics were examined. Pomological characteristics were examined in 20 nuts randomly taken from 12 trees selected for each application.

2.2.3. Effect of pruning managements on plant water stress

Irrigation time, irrigation interval and irrigation water amount were determined using climate data obtained

from the climate station in the research orchard. Soil moisture values obtained from digital soil moisture sensors.

To directly determine the effects of two different pruning treatments on plant water stress, stem water potential (GSP) values were measured with a pressure chamber device between in June and October. Measurements were conducted on Thursdays between 12.00 and 13.30 on three trees selected from each of the trial plots. Measurements were made on leaves selected from the south side of the tree. The leaf was wrapped with foil and the measurement was taken after waiting for 10 minutes. Leaf water potential was determined using a PMS 615 model device (Fulton et al., 2001).

2.2.4. Plant nutrition and leaf macro and micro element contents

Leaf and soil analyses were conducted to determine plant nutrition management, and yield served as a basis for adjustments. A total of 150 kg of nitrogen (N), 90 kg of potassium (K), and 40 kg of phosphorus (P) were applied per hectare. Additionally foliar fertilization with combined microelements was applied throughout the season. The effects of (MP) and (UP&UH) applications on leaf macro and micro element contents were examined.

2.2.5. Evaluation of data

The experiment was set up with 3 replications and 4 trees were included in each replication. The effects of two different pruning methods on morphology, pomology and yield were analyzed in the SAS statistical program and comparisons were made with the Duncan test.

3. Results and Discussion

The aim of the research is to determine the effects of (MP) and (UP&UH) on young trees of Fernor variety on the growth vigor, yield, nut quality and water use efficiency of the trees.

3.1. Effect of pruning methods on phenological characteristics

The leafing time, the time of receptive period in female flower and the time of pollen shedding of the trees that received (MP) were observed approximately 5 days earlier than the trees that (UP&UH). Harvest time and leaf fall dates were found to be similar for two pruning managements.

3.2. Effect of pruning methods on morphological characteristics

3.2.1. Tree trunk circumference

In (MP), the average tree trunk circumference values were measured between 37.70 cm and 43.50 cm, with and the average trunk circumference value calculated as 39.61 ± 1.69 cm. In (UP&UH), the trunk circumference ranged from 35.50 cm to 41.80 cm with the average trunk circumference recorded as 38.46 ± 1.89 cm (Table 2).

The effect of two pruning methods on the trunk circumference was found to be insignificant (Table 1). Similar results were reported in a study on Chandler walnut variety, where the effect of training systems on trunk circumference was also found to be insignificant. Moreover, investigations on four different pruning methods in Chandler cultivar revealed that trees without pruning exhibited the highest trunk circumference (126.90), while trees subjected to minimal pruning showed the lowest trunk diameter (Aletà et al., 2006). Like our research results, the effect of minimum pruning and non-pruning management on the tree trunk environment was found to be statistically insignificant (Argaç 2021). The effects of hard pruning, minimum-low level pruning, minimum pruning and unpruned/unheaded treatments on the trunk circumference were found to be insignificant in Gillet, Forde and Tulare varieties. However, in Chandler variety, a significant difference was found between severe pruning (27.9 cm) and other pruning methods (29.7-32.0 cm). Similar to our research results, the lowest trunk circumference value was found in the Tulare variety under unpruned/unheaded methods, and the highest value was found in the Gillet variety under minimum pruning (DeBuse et al., 2010).

Table 2. Effect of different pruning methods on morphological characteristics

Çizelge 2. Farklı budama yöntemlerinin morfolojik özellikler üzerine etkisi

Pruning Methods	Tree trunk circumference (cm)	Tree height (m)	Tree volume (m ³)	Canopy volume (m ³)	Canopy length (m)	Canopy width (m)	Shoot length (cm)
(MP)	39,61 ^a	5,50 ^b	36,32 ^a	18,28 ^a	4,00 ^b	4,17 ^a	90,28 ^a
(UP&UH)	38,46 ^a	5,71 ^a	41,12 ^a	20,91 ^a	4,23 ^a	4,29 ^a	33,32 ^b

*The difference between means shown with different letters in the same column is significant (P<0.05)

3.2.2. Tree height (m)

In (MP), tree height were measured between 4,90 and 5,76 m, and the average tree height was $5,50 \pm 0,27$ m. In (UP&UH), tree height varied from 5.48 m to 6.35 m, and the average tree height was $5,71 \pm 0,22$ m. A significant difference ($P < 0,05$) was found in the tree heights between (MP) and (UP&UH) (Table 2). DeBuse et al. (2010) reported that different pruning systems had no significant effect on tree height, but they noted that the highest tree height was observed in minimally pruned trees. Similarly, in our research, the height of (UP&UH) trees was found to be higher than (MP) trees, consistent with the results of Argaç (2021).

3.2.3. Tree and canopy volume (m³)

In (MP), tree volume (m³) varied between 24,93 and 42,66 and the average canopy volume was $36,32 \pm 6,35$. In (UP&UH), the tree volume (m³) ranged from 33,12 to 52,17 and the average tree volume was $41,12 \pm 5,12$ (Table 1). In (MP), canopy volume (m³) varied between 11.62 -23.99 and the average canopy volume $18,28 \pm 3,67$. In (UP&UH), the canopy volume ranged from $13,92 \text{ m}^3$ - $26,54 \text{ m}^3$ and the average canopy volume was $20,91 \pm 3,20 \text{ m}^3$ (Table 2).

There was no statistical difference between the tree volume and canopy volume of trees with (MP) and (UP&UH) (Table 1). Similar to our research results, Argaç (2021) stated that the effect of non-pruning and minimum pruning on the tree and canopy volume is insignificant, but the tree and canopy volume values of trees without pruning are higher than the values of trees with minimum pruning.

3.2.4. Canopy length and width (m)

In (MP), the canopy length varied between 3.40 and 4.29 m, and the average canopy length was $4,00 \pm 0,27$ m. In (UP&UH), the canopy length was found between 3.98 and 4.85 m, and the average canopy length was $4,23 \pm 0,23$ m. A statistically significant difference was found between the canopy length of trees with (MP) and (UP&UH) (Table 2).

In (MP), the canopy width varied between 3.45 and 4.80m, and the average canopy length was $4,17 \pm 0,35$ m. In (UP&UH), the canopy width was found between 3.58 and 4.95 m, and the average canopy width was $4,29 \pm 0,23$ m. A statistically insignificant difference was found between the canopy width of trees with (MP) and (UP&UH) (Table 2).

3.2.5. Shoot length (cm)

In (MP), the shoot length varied between 79,6.0 to

106.0 cm and the average shoot length was $90,28 \pm 7,38$ cm. In (UP&UH), the shoot length varied between 20,06 to 41,06 cm and the average shoot length was $33,32 \pm 6,38$ cm. A statistically significant difference was found between the shoot length of trees with (MP) and (UP&UH) (Table 2).

Dalkılıç et al., (2005) compared the effects of six different intensities of pruning on vegetative growth in eight-year-old trees of Yalova-4 and Bilecik walnut varieties. They found significant effects of different pruning severities on vegetative development. Specifically, significant effects of pruning intensities on the number of annual shoots, total shoot length, and total number of buds were observed in the Yalova variety. The effect of different pruning intensities on the number of annual shoots in the Bilecik variety was found to be insignificant.

3.2.6. Average yield (g/tree)

According to two years, average yield values per tree in (MP) varied between 1707.28g and 4329.4g. The average yield of (UP&UH) management was between 2829.62 and 7036.25. The two-year cumulative yield was found 6036.68 g in (MP) and 9865.87 g in (UP&UH). The cumulative yield of (UP&UH) was determined to be 61.18% higher than that of (MP) management (Table 3). A significant difference ($P < 0,05$) was observed between the yield values of (MP) and (UP&UH) (Table 3).

Table 3. Effect of different pruning methods on yield (g/tree)

Çizelge 3. Farklı budama yöntemlerinin verim üzerine etkisi (g/ağaç)

Pruning Methods	Average Yield (g/ tree)		Cumulative y ield (g/tree)
	2021	2r022	
(MP)	1707.28 b	4329.4 b	6036,28b
(UP&UH)	2829.62 a *	7036.25 a *	9865,87a

* The difference between means shown with different letters in the same column is significant ($P < 0,05$)

In the study comparing the yield values of Chandler trees with minimal pruning and no pruning in Bursa ecological conditions, it was reported that trees without pruning had a higher yield of 40.56% compared to trees with minimum pruning, which is consistent with our research results (Argaç 2021). Some studies have indicated that no significant difference in yield resulting from pruning walnut trees, but these results are from studies on mature trees. Observations conducted at UC Davis orchards and grower orchards in California have shown that walnut trees can grow without pruning even in the early years (Lampinen et al., 2015). The effects of

hard pruning, minimum-low level pruning, minimum pruning and no-topping-no-pruning management on yield were found to be insignificant in Tulare variety and significant in other varieties (Chandler, Gillet, Forde). The highest yield value was found in unpruned and unheaded management, consist with our research results (DeBuse et al., 2010). Olsen et al., (1990), reported that the yield value of annually pruned trees did not significantly differ from that of unpruned trees, in contrast to our research results. According to Lampinen et al., (2015), the yield of trees that are not pruned except for removing branches that get in the way of shakers or tractors has a cumulative yield similar to trees that are pruned every year for the first 7 years.

3.2.8. Effect of pruning methods on pomological characteristics

The kernel colors of the trees applied to two different pruning methods were found to be similar (Figure 2).

In (MP), average nut weight was found as 11.57 ± 0.59 (g), kernel weight was 5.09 ± 0.40 (g), shell thickness (mm) was 1.85 ± 0.15 , nut length (mm) was 37.12 ± 0.53 , nut height (mm) was 32.55 ± 0.51 , nut width

(mm) was 31.23 ± 0.88 in 2021 year. In (MP), average nut weight was found as 13.30 ± 0.42 (g), kernel weight was 6.37 ± 0.36 , shell thickness (mm) was 1.58 ± 0.09 , nut length (mm) was 40.75 ± 0.95 , nut height (mm) was 34.43 ± 0.61 , nut width (mm) was 32.56 ± 0.54 in 2022 year (Table 4).

In (UP&UH), average nut weight was 12.01 ± 0.48 (g), kernel weight was 5.32 ± 0.27 (g), shell thickness (mm) was 1.79 ± 0.16 , nut length (mm) was 38.11 ± 0.81 , nut height (mm) was 33.84 ± 1.15 , nut width (mm) was 32.13 ± 1.09 in 2021 year (Table 4).

In (UP&UH), average nut weight was found as 13.44 ± 0.43 (g), kernel weight was 6.69 ± 0.32 (g), shell thickness (mm) was 1.64 ± 0.1 , nut length 41.15 ± 1.02 (mm) nut height was 34.35 ± 0.45 , nut width (mm) was 32.81 ± 0.54 in 2022 year (Table 4). According to 2021 data, there was a significant difference ($P < 0.05$) between pruning methods in terms of nut length and nut height values. In the 2022 data, differences were found in terms of kernel weight and kernel percentage (Table 4). However, the effect of pruning methods on other pomological characteristics was found to be insignificant.

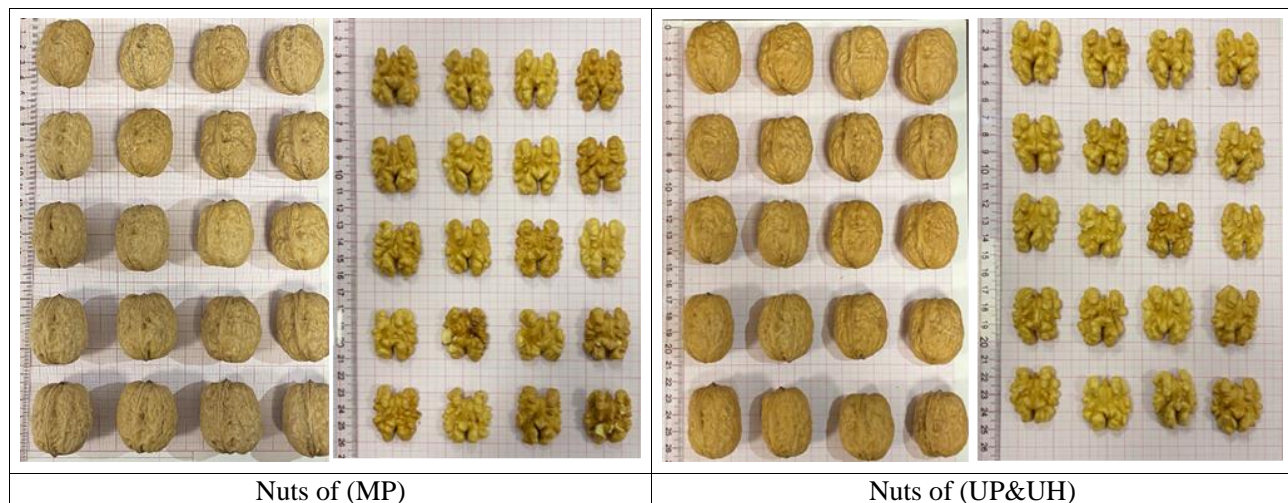


Figure 2. The nuts of (MP) and (UP&UH)

Resim 2. Minimum budama ve budamama & tepe vurmama uygulanan ağaçların meyveleri

Table 4. Effect of different pruning methods on pomological characteristics

Çizelge 4. Farklı budama yöntemlerinin pomolojik özellikler üzerine etkisi

Pruning Methods	Nut weight (g)	Kernel weight (g)	Kernel percentage (%)	Shell thickness (mm)	Nut length (mm)	Nut height (mm)	Nut width (mm)
2021							
(MP)	11.57 a	5.09 a	43.97 a	1.85 a	37.12 b	32.55 b	31.23 a
(UP&UH)	12.01 a	5.32 a	44.28 a	1.79 a	38.11 a*	33.84 a*	32.13 a
2022							
(MP)	13.30 a	6.37 b	47.70 b	1.58 a	40.75 a	34.43 a	32.56 a
(UP&UH)	13.44 a	6.69 a*	50.57 a*	1.64 a	41.15 a	34.35 a	32.81 a

*The difference between means shown with different letters in the same column is significant ($P < 0.05$)

Argaç (2021) reported no difference between nut width, shell thickness, kernel weight and kernel percentage of trees with minimal pruning and non-pruning trees. However there was a significant difference between management practices in terms of nut weight. Conversely, Olsen et al., (1990) stated that there were losses in nut size and nut quality in unpruned walnut orchards. The inconsistency of the results regarding the effects of pruning methods on nut quality may be attributed to variations in the walnut varieties used in the research, rootstock variety combinations, irrigation, plant nutrition, disease and pest management strategies.

3.2.9. Effect of pruning methods on midday stem water potential

In order to determine the effects of pruning management on plant water stress, leaf water potential values were measured and the results are presented in Table 5. Average stem water potential values were found as 7.65 in trees with (MP), and 7.5 in trees with (UP&UH). The difference between (MP) and (UP&UH) was found to be approximately 0.15 MPa (Table 5). There was no statistically significant difference between pruning management methods in terms of seasonal midday trunk water potential values (Table 5). Lampinen et al., (2015) reported that, similar to our research results, the effect of different pruning systems on water stress was minimal. They found no significant difference in average seasonal midday trunk water potential values between pruning treatments in 2005, 2006 and 2009. In 2007, 2008 and 2010, slight differences were detected (approximately 0.05 MPa). In our study, the irrigation management of the trees subjected to two different pruning methods was similar; thus, the amount of water provided to the trial trees and the irrigation timing were consistent.

Table 5. Midday trunk water potential values (MPa) of different pruning methods

Çizelge 5. Farklı budama yöntemlerinin gövde su potansiyeli üzerine etkisi

Date	(MP)	((UP&UH))
July 1, 2022	7.0	7.5
July 15, 2022	7.0	6.0
August 1, 2022	8.5	8.5
August 15, 2022	7.5	7.5
September 1, 2022	6.5	6.0
September 15, 2022	10.0	10.5
October 1, 2022	7.0	7.0
October 15, 2022	7.5	7.0
Average	7.65 ^a	7.5 ^{**}

*The difference between means shown with different letters in the same column is significant (P<0.05)

Although the yield values (gr/tree) of no-pruning management were higher, the water use efficiency values of these trees were also observed to be high. As a matter of fact, similar to our research results, Lampinen et al., (2008) reported that unpruned trees had higher yield than pruned trees with the same amount of water.

3.2.10. The content of macro and micro elements of leaf

The content of macro and micro elements of leaf in (MP) and (UP&UH) are presented in Table 6. The macro and micro element contents of the leaves of the trees to which two different pruning methods were applied were found to be similar. The nitrogen, potassium and zinc contents of the leaves were found to be insufficient, but the copper content was high (Table 6)

Table 6. The content of macro and micro elements of leaf in MP and (UP&UH)

Çizelge 6. MP and (UP&UH) budama yöntemlerinin yaprak makro ve mikro element içerikleri

	(MP)	(UP&UH)	Unite	Metod
N	2.19	2.3	%	Kjeldahl
P	0.16	0.15	%	Wet digestion-ICP
K	1.15	1.04	%	" "
Ca	2.2	1.76	%	" "
Mg	0.65	0.49	%	" "
Fe	95	78	ppm	" "
Cu	130	118	ppm	" "
Zn	8	9.22	ppm	" "
Mn	85	97	ppm	" "

4. Conclusion

With (UP&UH), the costs of pruning labor and collecting pruning pieces are eliminated. Moreover, the earlier and higher yield of trees in the initial years positively impacts orchard management costs. In our study, unlike others, pruning management was started after a balanced and regular main skeleton was achieved on the canopy. It is estimated that this practice will increase light penetration into the trees canopy. According to preliminary results, the results contradict the hypothesis that young walnut trees that are not pruned will experience growth stagnation, crown fruit branches dying, and tree size reduction.

For pruning management to be recommended despite its positive results, ecological conditions, plant nutrition and irrigation management must also be considered. If (UP&UH) management is combined with inadequate irrigation and suboptimal plant nutrition, significant setback in tree development, yield and nut quality may occur. Consequently, pruning management should be integrated with other factors influencing tree

development, yield and fruit quality. It should not be implemented in walnut orchards without considering integrated orchard management. Additionally, for more definitive and consistent results, the research should be continued for at least 5 more years. Final decisions should be based on the findings obtained in the subsequent years.

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