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**CONTENTS**

**Article**



**Review**

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# ANALYSIS OF CLIMATIC TRENDS IN EVAPORATION FOR ÇANAKKALE (TURKEY)

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***ABSTRACT:****In this study, temporal changes and trends in the series of annual, seasonal, and monthly evaporation of Çanakkale station of Turkish State Meteorological Service were analyzed. Time series of evaporation data set has been organized as climatological seasons that spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February). Non-parametric tests and Box-Jenkins method were used to determine climatic trends. Pettitt change-point analysis was applied to determine the change point of evaporation. Trend analysis results showed that a statistically significant increasing trend occurred in evaporation. Mean annual evaporation is estimated to increase 1.4498 mm per year and it is anticipated to reach 215.3356 mm in 2022. Furthermore, mean seasonal evaporation are estimated to increase 1.2251 mm, 1.6485 mm, and 0.4117 mm per year for spring, summer, and autumn, respectively. Therefore, Çanakkale is thought to be affected by global warming and climate change and this effect will continue. Evaporation should be continuously measured and monitoring program should be established to allow sustainable use and management of water resources. Global or regional climate change scenarios and projections must be considered in order to moderate the possible effects of climate change and global warming on Çanakkale.*

Key words*: Climate change, Evaporation, Trend analysis, Çanakkale*

## 1. Introduction

Evaporation is an important climatic factor affecting life of animal and plant. Changes in evaporation have big effect on management and planning of water resources, agricultural production, and irrigation control [1]. Climate change resulting from global warming has a significant impact on evaporation. Therefore, availability of water resources are affected by these changes [2]. Although changing climatic conditions, determination of evaporation trends will contribute to revealing the possible effects of climate change on evaporation.

Several authors analyzed climatic trends in evaporation that lead to different results for many regions around the world. Increasing trends in evaporation were reported in Israel [3], Brazil [4], eastern Asia including Tibetan Plateau, China and Japan [5], western Africa [6] and Iran [7]. On the other hand, decreasing trends were also reported in the USA [8], the USA and former Soviet Union [9], Italy [10], Australia [11], Japan [12], China [13-14], Thailand [15-16], Canada [2], and India [1, 17]. In Turkey, although many researchers [18-33] have investigated climatic changes in temperature and precipitation, the same interest has not been shown for evaporation. However, studies conducted on temporal trends in evaporation have been reported to be slightly different results in different regions. [34] found a declining trend in the evaporation in the south east of Turkey. Nevertheless, [35] reported that evaporation in 5 of the 9 stations evaluated in the study conducted in the west of Turkey showed a tendency to decrease while it showed an increasing tendency at 4 stations. In other studies carried out in the west of Turkey, increasing trend in evaporation have been reported [36-41].

Çanakkale plays a key role and makes a huge contribution for national agriculture production. Any major change in water structures can have serious consequences for hydrological processes. Therefore, studies on the monitoring of evaporation levels in Çanakkale are important for the sustainable use and management of water resources and agricultural activities. In this context, this study has been carried out to investigate the temporal changes of evaporation in Çanakkale by annual, seasonal and monthly analyses and to determine climatic trends of evaporation.

## 2. Material and Method

### *2.1.* Study Area and Climatic Data

Climatic data used in this study were obtained from Çanakkale meteorological observation station (**Figure 1**) of Turkish State Meteorological Service (TSMS). These climatic data consists of measured evaporation data between 1971 and 2011. Time series were arranged as climatic seasons that spring (March, April, May), summer (June, July, August), autumn (September, October, November) and winter (December, January, February).

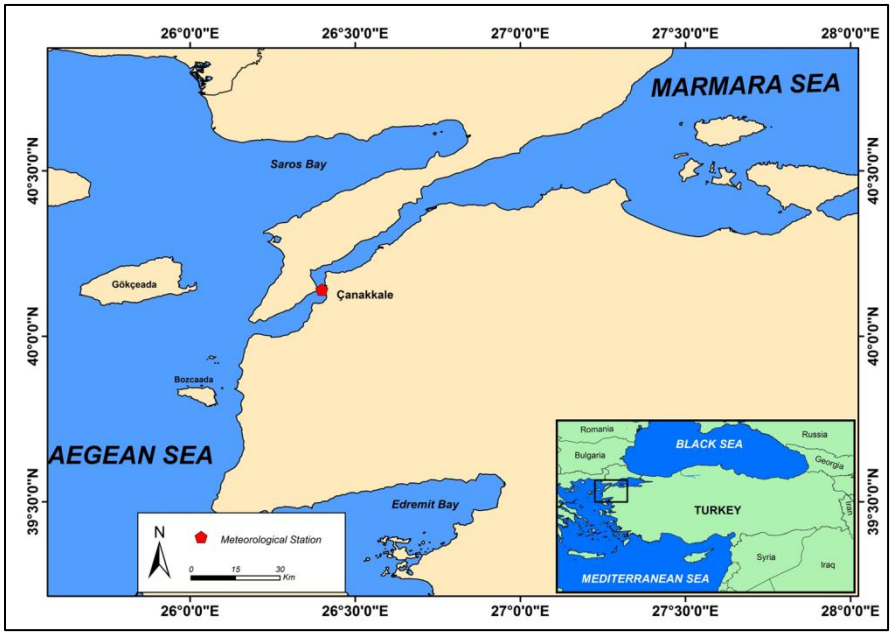


**Figure 1. The location of the meteorological observation station**

Çanakkale is located in the west of Turkey. It is surrounded by Aegean Sea, Marmara Sea and Çanakkale Strait. It has a transition climate type and summer is hot and dry while winter is cold and rainy. Mean monthly temperatures show that July is the warmest month while January is the coldest month with the long term averages of 6.4°C and 25°C [42].

### *2.2.* Change Point Analysis

A non-parametric approach developed by Pettitt [43] was used to determine the change point of evaporation data. This approach determines a significant change in the time series which is time of change is exactly unknown. This non-parametric test is described below:

$$K_T = \max\left|U_{t,T}\right| \text{ and for } t = 2, \ldots\ldots, T,$$

$$U_{t,T} = \sum_{i=1}^{t} \sum_{j=t+1}^{T} sgn(x_i - x_j)$$

$U_{t,T}$ confirms that whether both samples are in the same population or not. The null hypothesis of Pettitt test is that there is no change point in the dataset. Test statistic ($K_T$) and related probability ($p$) are used for significance calculating. The probability of significance for the test statistic is estimated with

$$p \cong 2 \exp\left(\frac{-6\ K_T^2}{T^3+T^2}\right)$$

Pettitt change point analysis was executed with the usage of "trend" package [45] in R statistical software [44].

### *2.3.* Trend Analysis

Trend analysis is the widely used method for detecting changes in the time series of climatic data [46]. Box-Jenkins method was applied for determining trends in mean annual, seasonal, and monthly evaporation. This method is based on linear, discontinuous and stochastic processes, and used for forecast and analysis of a time series. Autoregressive (AR), moving average (MA), and Autoregressive-moving average (ARMA) models are used for stationary processes while autoregressive integrated moving average (ARIMA) is used for non- stationary processes. These models aimed to decide that which model fits best and includes least parameter [47]. ARIMA model used in this study is explained as follow:

$$X_t = c + \Phi_1 X_{t-1} + \cdots + \Phi_p X_{t-p} + \theta_1 e_{t-1} + \theta_q e_{t-q} + e_t$$

$X_t$ is a variable that will be explain at $t$ time, $\Phi$ is the coefficient of per $p$ parameter, $\theta$ is the coefficient of per $q$ parameter, $c$ is the constant, and $e_t$ is error at $t$ time.

### *2.4.* Mann-Kendall Test

Non-parametric Mann-Kendall test [48-49] is a commonly used test for determining trends in the time series. Average is affected by extreme values in the dataset. [36] pointed out that Mann-Kendall test is an effective test to determine the trends in the time series contain extreme values. Kendall's tau and Spearman's rho tests were applied to investigate possible trends in evaporation. These non-parametric tests provide more fitting and trustworthy results than parametric tests. Mann-Kendall test is explained below.

$$S = \sum_{i=1}^{n-1} \sum_{k=i+1}^{n} sgn(x_k - x_i)$$

$$Z_c = \begin{cases} \dfrac{S-1}{\sqrt{var(S)}}, & S > 0 \\ \dfrac{S+1}{\sqrt{var(S)}}, & S = 0 \\ & S < 0 \end{cases}$$

$Z_c$ is the test statistic, $H_0$ will be rejected if $|Z_c| > Z_{1-\alpha/2}$ when $Z_{1-\alpha/2}$ is standard normal variable and $\alpha$ is the degree of significance. Trend magnitude can be determined as follow:

$$\beta = Median\left(\frac{x_i - x_j}{i-j}\right), \forall_j < i$$

where $1 < j < i < n$. A negative value of $\beta$ indicates a decreasing trend while a positive value of $\beta$ indicates an increasing trend.

## 3. Results and Discussion

Time series were identified and change points of evaporation were determined annually, seasonally and monthly. There are no records of evaporation measurements for winter period including December, January, February and March.

Pettitt's change point analysis results indicated that change point for mean annual evaporation was 1992 (**Table 1**). Trend analysis results pointed out that mean annual evaporation has increasing trend (**Figure 2**). This increase was found statistically significant ($p<0.01$). Mean annual evaporation is forecasted to increase 1.4498 mm/yr and to reach 215.3356 mm in 2022 (**Table 2**).

**Table 1. Results of non-parametric statistic tests and change years of evaporation**

| | Mean Evaporation (mm) | Pettitt Change Points | Mann-Kendall | | Spearman | |
|---|---|---|---|---|---|---|
| | | | *tau* | *p* | *rho* | *p* |
| | *Annual* | 1992 | 0.524** | 0.000 | 0.693** | 0.000 |
| *Seasonal* | *Spring* | 1992 | 0.490** | 0.000 | 0.683** | 0.000 |
| | *Summer* | 1992 | 0.359** | 0.001 | 0.505** | 0.001 |
| | *Autumn* | 1984 | 0.206 | 0.058 | 0.292 | 0.064 |
| | *Winter* | NA[a] | NA[a] | NA[a] | NA[a] | NA[a] |
| *Monthly* | *January* | NA[a] | NA[a] | NA[a] | NA[a] | NA[a] |
| | *February* | NA[a] | NA[a] | NA[a] | NA[a] | NA[a] |
| | *March* | NA[a] | NA[a] | NA[a] | NA[a] | NA[a] |
| | *April* | 1996 | 0.238* | 0.028 | 0.344* | 0.028 |
| | *May* | 1993 | 0.315** | 0.004 | 0.519** | 0.001 |
| | *June* | 1992 | 0.272* | 0.012 | 0.394* | 0.011 |
| | *July* | 1992 | 0.379** | 0.000 | 0.530** | 0.000 |
| | *August* | 1995 | 0.315** | 0.004 | 0.441** | 0.004 |
| | *September* | 1995 | 0.244* | 0.025 | 0.360* | 0.021 |
| | *October* | 1992 | 0.158 | 0.147 | 0.202 | 0.204 |
| | *November* | 1984 | 0.020 | 0.889 | -0.008 | 0.971 |
| | *December* | NA[a] | NA[a] | NA[a] | NA[a] | NA[a] |

* *Correlation is found significant at 0.05 level.*

** *Correlation is found significant at 0.01 level.*

[a] *NA indicates that evaporation could not measure due to freezing of the water in evaporation pans.*

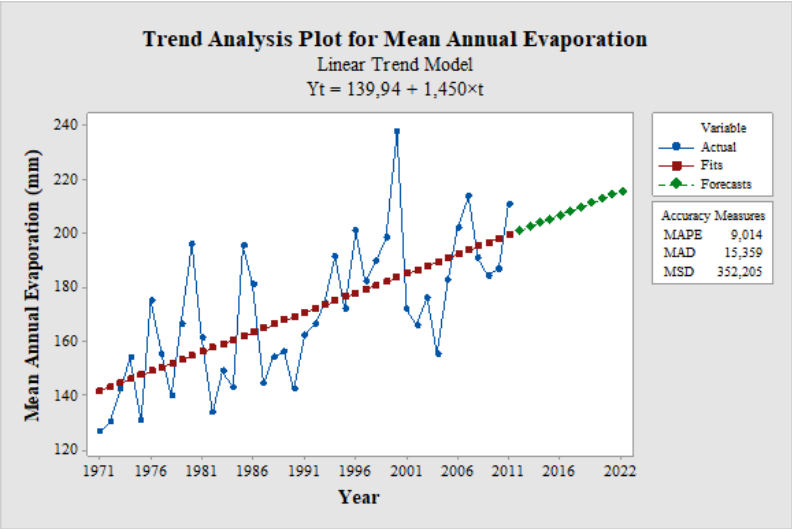


**Figure 2. Trend analysis results of mean annual evaporation**

Change points of mean seasonal evaporation for spring, summer, and autumn were determined as 1992, 1992, and 1984, respectively (**Table 1**). Results of trend analysis showed that evaporation tends to increase for all seasons (**Figure 3**). This trend was found statistically insignificant for autumn while significant ($p<0.01$) for spring and summer. Mean seasonal evaporation is predicted to increase 1.2251 mm, 1.6485 mm, and 0.4117 mm per season and to reach 174.2956 mm, 295.7466 mm, and 134.2265 mm in 2022 for spring, summer, and autumn, respectively (**Table 2**).

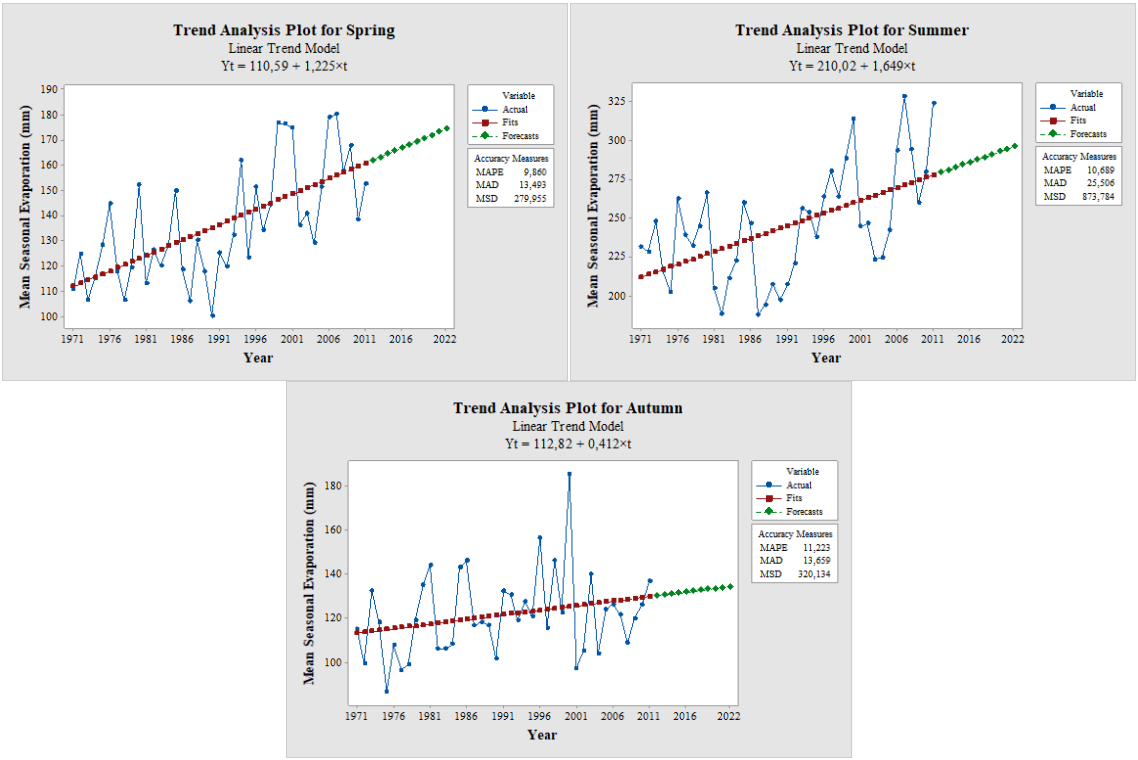


**Figure 3. Trend analysis results for mean seasonal evaporation**

Change points for mean monthly evaporation were given in **Table 1**. Unfortunately, change point analysis and trend analysis could not be carried out for January, February, March and December because of the evaporation values were not measured due to freezing of the water in evaporation pans. For the other months, trend analysis results pointed out that there were increasing trends for all months (**Figure 4**). These increasing trends were also found statistically significant for all months excepting October and November. Moreover, a significance level was determined at the 0.01 level for May, July, and August while at the 0.05 level for April, June, and September. Mean monthly evaporation is predicted to increase 0.6036 mm/yr, 1.3912 mm/yr, 1.3958 mm/yr, 1.9744 mm/yr, 1.5753 mm/yr, 0.7964 mm/yr, 0.2804 mm/yr and 0.0166 mm/yr from April to November. Furthermore, it is expected that mean monthly evaporation will reach 128.5132 mm, 209.2809 mm, 260.7406 mm, 327.7129 mm, 298.7870 mm, 195.5405 mm, 112.6295 mm, and 61.9774 mm in 2022, respectively (**Table 2**).

**Table 2. Forecasted values of evaporation for 2018-2022**

| ***Evaporation (mm)*** | | ***Years*** | | | | |
|---|---|---|---|---|---|---|
| | | **2018** | **2019** | **2020** | **2021** | **2022** |
| ***Mean Annual*** | | 209.5363 | 210.9861 | 212.4359 | 213.8858 | 215.3356 |
| ***Mean Seasonal*** | *Spring* | 169.3951 | 170.6202 | 171.8453 | 173.0704 | 174.2956 |
| | *Summer* | 289.1526 | 290.8011 | 292.4496 | 294.0981 | 295.7466 |
| | *Autumn* | 132.5799 | 132.9916 | 133.4032 | 133.8149 | 134.2265 |
| | *Winter* | NA* | NA* | NA* | NA* | NA* |
| ***Mean Monthly*** | *January* | NA* | NA* | NA* | NA* | NA* |
| | *February* | NA* | NA* | NA* | NA* | NA* |
| | *March* | NA* | NA* | NA* | NA* | NA* |
| | *April* | 126.0989 | 126.7024 | 127.3060 | 127.9096 | 128.5132 |
| | *May* | 203.7161 | 205.1073 | 206.4985 | 207.8897 | 209.2809 |
| | *June* | 255.1574 | 256.5532 | 257.9490 | 259.3448 | 260.7406 |
| | *July* | 319.8154 | 321.7898 | 323.7641 | 325.7385 | 327.7129 |
| | *August* | 292.4856 | 294.0610 | 295.6363 | 297.2117 | 298.7870 |
| | *September* | 192.3548 | 193.1512 | 193.9476 | 194.7441 | 195.5405 |
| | *October* | 111.5079 | 111.7883 | 112.0687 | 112.3491 | 112.6295 |
| | *November* | 61.9112 | 61.9277 | 61.9443 | 61.9609 | 61.9774 |
| | *December* | NA* | NA* | NA* | NA* | NA* |

* *NA indicates that evaporation could not measure due to freezing of the water in evaporation pans.*

In this study, maximum evaporation value was recorded in July 2011 by 366.6 mm while minimum value was recorded in November 1975 by 41.6 mm (**Table 3**). The highest mean annual evaporation was calculated in 1971 while the lowest was measured in 2000. For seasonal evaporation values, the highest evaporation was observed in 2007, 2007, and 2000; and the lowest was observed in 1990, 1987, and 1975 for spring, summer, and autumn, respectively. On the other hand, maximum evaporation values for mean

monthly evaporation were measured in 2006, 1999, 2000, 2011, 2007, 2000, 2000, 1998; and minimum values were measured in 1990, 1987, 1988, 1982, 1975, 1977, 1975, 1975 from April to November, respectively (**Table 3**).

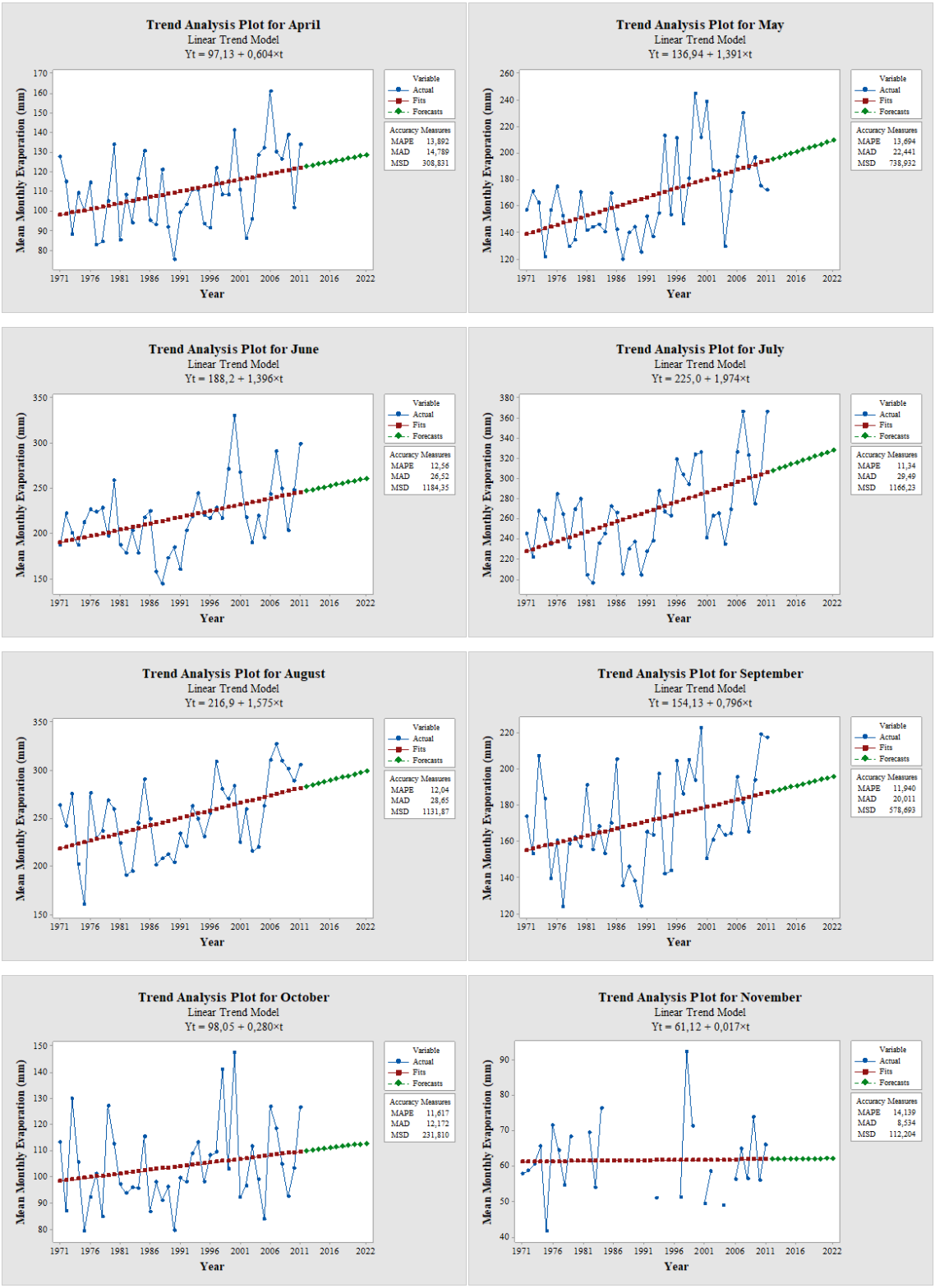

**Figure 4. Trend analysis results for mean monthly evaporation**

**Table 3. Maximum and minimum values of mean evaporation for annual, seasonal and monthly**

| | Period | Mean Evaporation (mm) | |
|---|---|---|---|
| | | ***Maximum*** | ***Minimum*** |
| | *Annual* | 126.33 | 237.53 |
| *Seasonal* | *Spring* | 100.30 | 180.10 |
| | *Summer* | 187.67 | 328.07 |
| | *Autumn* | 86.70 | 185.00 |
| *Monthly* | *April* | 75.40 | 161.20 |
| | *May* | 119.60 | 245.00 |
| | *June* | 144.20 | 330.70 |
| | *July* | 195.50 | 366.60 |
| | *August* | 159.80 | 327.10 |
| | *September* | 123.70 | 222.60 |
| | *October* | 79.20 | 147.40 |
| | *November* | 41.60 | 92.10 |

Evaporation measurements are requiring both more time and high-costly equipment [50]. Moreover, measurements could not be carried out due to the freezing of the water in evaporation pans when the air temperature is low. On the other hand, it is widely known that evaporation occurs during periods even the temperature is low. Evaporation occurs at high level in hot periods while at low level in cold periods.

A better understanding of future trends in evaporation due to climate change is of a great importance. This requires to revealing the structure of local or regional changes and the response given to the observed changes in a better way [51]. There are many studies worldwide that found both increasing and decreasing trend for evaporation. [8] reported a significant decreasing trend in the USA, Europe, Middle Asian and Siberian regions of the former Soviet Union for the period of 1945-1990. Decreasing trends were also reported in India [1, 17, 52], Canada [2], Italy [10], Japan [12], China [13-14], Australia [11], and Thailand [15-16]. [53] pointed out that evaporation for New Zealand was decreasing 2 mm annually since 1970. [54] stated that evaporation was statistically significantly decreased with average 3.3 mm/yr in Mexico for 1961-2010. On the other hand, statistically significant increasing trends were also reported in the south of Europe [55] and Middle East [56]. The largest change was reported by 97 mm increase for the western USA in a warm season during past 45 years [57]. Likewise, increasing trends were reported in Israel [3], Brazil [4], eastern Asia [5], western Africa [6], and Iran [7]. In Turkey, [34] reported a decreasing trend while [35] reported both decreasing and increasing trends in different regions. [38-41] reported increasing trend and

forecasted to increase in the future projections. Similarly, in this study, evaporation is predicted to increase by annual, seasonal and monthly analyses.

Although there are contradictions in the results of studies on climatic trends of evaporation, there are different ideas to explain this paradox. Worldwide studies have shown that evaporation is affected by climatic factors such as wind speed [58-60] and air temperature [38-41, 61]. [57] reported that the decrease in evaporation is also related to the decrease in temperature and the increase in low cloud cover. Therewithal, [62] reported that increased evaporation may be associated with global warming. Therefore, it is known that evaporation will increase with the temperature increases. Similarly, the results of this study also show that the evaporation tends to increase with the effect of the increase in temperature due to global warming.

## 4. Conclusion

In conclusion, it has been determined that there is a statistically significant upward trend in mean annual, seasonal and monthly evaporation for Çanakkale. It is predicted that evaporation will increase in future projections. Therefore, Çanakkale is thought to be affected by global warming and climate change and this effect will continue. Monitoring the changes in the amount of evaporation contributes to the prediction of changes in the volumes of available water resources. Evaporation should be continuously measured and monitoring program should be established to allow sustainable use and management of water resources and to continue of agricultural activities in an efficient manner. Global or regional climate change scenarios and projections must be considered in order to moderate the possible effects of climate change and global warming on Çanakkale.

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# EVALUATION OF DIYARBAKIR GAZI STREET SOUND ENVIRONMENT PERCEPTION BY SOUNDSCAPE APPROACH

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**Abstract:** *In this study, it was aimed to measure the perception of sound environment of users in urban spaces with sound quality metrics (loudness, sharpness, roughness, and fluctuation strength). For this purpose, a questionnaire was applied to participants in Gazi Street, Suriçi district of Diyarbakir, which was selected as a field study. In the questionnaire study, participants were asked about the demographic / personal characteristics, questions about the purpose and duration of use of the space, and 35 adjective pairs with 5 bipolar scales in order to determine the perception of the sound environment. Binaural sound recordings were also performed simultaneously when the survey was conducted. The quantitative data of the loudness, sharpness, roughness, and fluctuation strength metrics of these sound records are calculated. By analyzing the results obtained from the questionnaire and the quantitative data of the sound recordings, correlations between the sound environment perception of the users and the sound quality metrics were determined. Apart from the quantitative data of sound recordings, the effect of the parameters (demographic / personal / social) which can affect the perception of the sound environment in urban spaces has been tried to be determined. In addition, the relationship between quantitative data of sound recordings and meteorological data has also been analyzed.*

**Key words***: Soundscape, Sound environment, Sound quality, Diyarbakir*

## 5. Introduction

In recent times, when studies about acoustic comfort were examined, the term “soundscape” has been often encountered and this term has been used in many disciplines [1]. Within etymology, the term “-scape” is defined as “area, place, field of vision” [2]. In ISO 12913-1 (2014), soundscape is described “acoustic environment perceived or experienced and/or understood by a person or persons” [3].

At first, the primary soundscape concept was confronted in music and acoustic ecology studies. In a quick process, the integrated approach of sound environment and perception stimulated more interests in other disciplines (acoustics, architecture, environmental health, psychology, sociology and urban studies, etc.) [4-6]. In evaluation of acoustic comfort through soundscape, both annoyance from noise and effects of different sounds peculiar to the analyzed field can be considered. Sound

environments of urban places are objectively measured, and also, users' subjective data about their perception can be assessed. The importance of soundscape in urban planning, designing and managing has been increasing in improving and/or increasing users' life quality day by day. Soundscape has not been only considered under noise control, it has dealt with sound concept as a source, one of the components of spatial planning and designing process. Soundscape studies have been done about the effective usage, design and management of sound resources [7-12].

In soundscape studies, various acoustic parameters and subjective data of users have been evaluated. In addition to standard acoustic quantities, researchers emphasize that psychoacoustic parameters (sound quality metrics), which are related to human perception, should be assessed in sound environment evaluations. In this study, acoustic and psychoacoustic parameters obtained by physical measurements and questionnaires made by subjective evaluators of users were used to investigate the region where the study was performed in terms of acoustic comfort.

The Suriçi region, the historical region surrounded by the walls of Diyarbakır was chosen as a study area. The region is one of the places where lots of sound sources are available to be heard in urban areas. This region involves various sound sources including not only traffic or human sounds but also soundmarks which belong to the region. Different sound sources exist together, which makes us have a great variety of quantitative information. In this study carried out in Gazi Street of the Suriçi Region, quantitative data of equivalent continuous sound pressure level, loudness, sharpness, roughness, fluctuation strength metrics were calculated and the subjective data of users were evaluated.

**Equivalent continuous sound pressure level** represents a fixed level which shows changes at levels in a certain period, is generally measured as A weighted sound level and is the equivalent one of noise in terms of energy [13]. $L_{Aeq,T}$ is used to determine sound pressure level in a certain T period. Its unit is desibel (dB). It is estimated using the Equation 1 [14].

$$L_{Aeq,T} = 10\lg\frac{\frac{1}{T}\int_{t_1}^{t_2} p_A^2(t)\,dt}{p_0^2}\ \text{dB} \qquad (1)$$

$T$: during a stated time interval of duration (starting at $t_1$ and ending $t_2$)

$p_A(t)$ : the A-weighted instantaneous sound pressure at running time $t$

$p_{(0)}$ : the reference sound pressure 20 μPa

The term "**sound quality**" described as "the original feasibility of sound in accordance with technics, objectives and/or tasks" started to be used in 1980s [15]. Psychoacoustic metrics were introduced for the evaluation of sound quality. [16]. Psychoacoustic metrics were defined as the mathematical model of sound perception. In this paper, loudness, roughness, sharpness and fluctuation strength metrics of the sound quality (psychoacoustic) metrics were examined.

**Loudness** is a type of subjective feeling in sound volume. Its unit is phon (P), its values are equal to SPL values in 1kHz [16]. Sound quality metrics are estimated based on time series of values regarding loudness metrics [17]. Zwicker and Fastl (1999) emphasised that the sense-stimulant relation of loudness metrics could be measured when the question of how a sound was high or soft was answered. They suggested that sensual satisfaction depended on loudness metrics [16].

**Sharpness** is an indicator of spectral balance between low and high frequencies [15]. Its unit is 'acum'. Taking only one of them into account, sharpness of one sound may be confused with sharpness of the other sound. Zwicker and Fastl (1999) stated that a sense of sharpness could be related with density, furthermore, it was closely associated with sensual pleasantness. When the sharpness value became high, the users' pleasantness level became lower [16].

Time-wise change of sound has two types of effects. One of them is **roughness**, the other one is **fluctuation strength**. **Roughness** represents temporary, slow changes of nearly 70 Hz in sound volume. Its unit is "asper". The values of roughness metrics is estimated from the intervals of 500 ms in time series of loudness metrics [17]. Roughness is a modulation based metric described as creak, grate, peep. Examples involving wuthering sounds such as a shaver or a sewing machine can be given as examples to roughness sounds. This type of sound generally creates unpleasant effects [15].

**Fluctuation strength** is estimated based on nonstable loudness and represents temporary, slow changes of nearly 4 Hz in sound volume [17-18]. Its unit is "vacil". When the Kang modulation frequency is between 13 Hz and 300 Hz, fluctuation strength turns into roughness effect [15]. The values of fluctuation strength are estimated from the intervals of 1000ms in time series of loudness [17].

In this study, the users' soundscape perceptions in urban places and the quantitative information about A-weighted equivalent continuous sound pressure level ($L_{Aeq}$) and loudness, roughness, sharpness and fluctuation strength from the sound quality metrics were statistically analyzed.

## 6. Methodology

In this paper, a field study was carried out in the Gazi Street of Diyarbakır Suriçi Region. Noise level measurements and sound records were done in the study area, the questionnaire was applied to the users. Binaural sound records were done at the relevant 5 points (Figure 1) in the Gazi Street. The questionnaire application was done in concurrence with these measurements. The questionnaire questions consisted of two sections. In the first section, the users' gender, age, education level (illiterate, primary school, secondary school, high school, university), income level (not working, less than minimum wage, minimum wage-3000TL, 3001-5000TL, 5001TL and over), reasons for coming to the area (for work, tour and shopping, passing on the way) and frequencies of coming (for the first time, a few times in a year, a few times in a month, a few times in a week) were asked. In the second section of the questionnaire study, the users were required to respond to 35 adjective pairs in the 5 point bipolar scale to determine how the soundscape in the Diyarbakır Suriçi Region was perceived by the users (Table 1).

The questionnaire study was done by 25 (female:16, male:9) participants. A-weighted equivalent sound pressure level ($L_{Aeq}$) and sound quality metrics (loudness, roughness, sharpness, fluctuation strength) were calculated from the sound recordings performed concurrently with the participants' survey applications. In addition, meteorological data (temperature, humidity, wind speed) were obtained from the Diyarbakır Meteorology Regional Directorate on the day and time of the recording (Table 2).

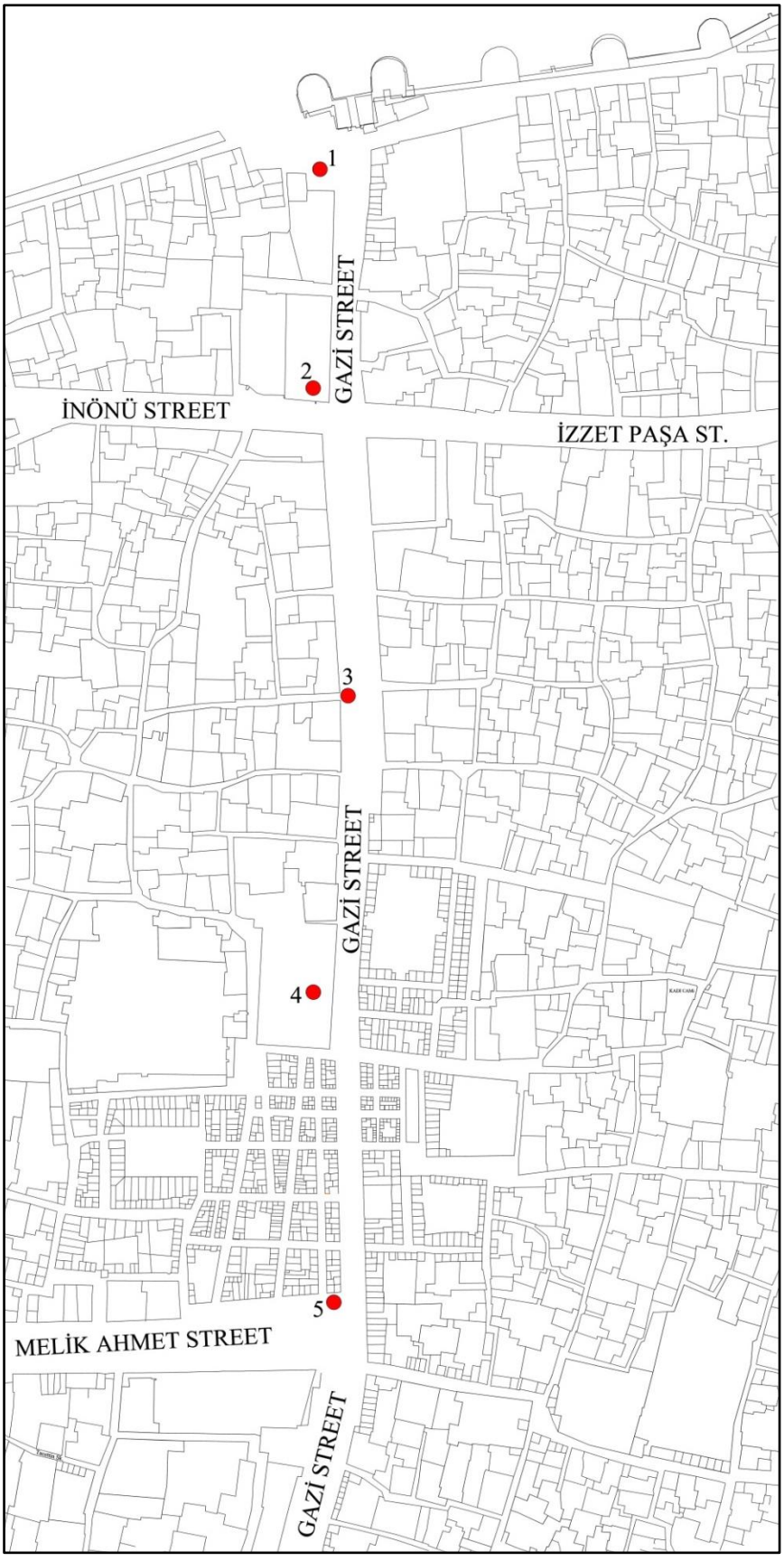


**Figure 1. Points of questionnaires and sound recordings**

**Table 1. Adjectives used in differential analysis**

| Adjectives | 1 | 2 | 3 | 4 | 5 | Adjectives |
|---|---|---|---|---|---|---|
| Unpleasant | | | | | | Pleasant |
| Calming | | | | | | Agitating |
| Ordinary | | | | | | Effective |
| Not Preferred | | | | | | Preferred |
| Unsocial | | | | | | Social |
| Meaningless | | | | | | Meaningful |
| Melancholic | | | | | | Cheerful |
| Disturbing | | | | | | Comfortable |
| Distracting | | | | | | Motivating |
| Oppressive | | | | | | Liberating |
| Strange | | | | | | Familiar |
| Not Reassuring | | | | | | Reassuring |
| Stressing | | | | | | Relaxing |
| Ugly | | | | | | Nice |
| Eerie | | | | | | Not Eerie |
| Stifling | | | | | | Roomy |
| Suprising | | | | | | Not Suprising |
| Boring | | | | | | Interesting |
| Noisy | | | | | | Quiet |
| Artificial | | | | | | Natural |
| Deserted | | | | | | Lively |
| Not Distinct | | | | | | Distinct |
| Discordant | | | | | | Harmonic |
| Far Away | | | | | | Nearby |
| Sonorous | | | | | | Not Sonorous |
| Rough | | | | | | Smooth |
| Grating | | | | | | Not Grating |
| Sharp | | | | | | Not Sharp |
| Hard | | | | | | Soft |
| Strong | | | | | | Weak |
| Unclear | | | | | | Clear |
| Irregular | | | | | | Regular |
| Unbalanced | | | | | | Balanced |
| Unsteady | | | | | | Steady |
| Varied | | | | | | Simple |

**Table 2. Quantitative data from field study**

| Survey number | App. point | Temp. (C) | Hum. (%) | Wind speed (m/sn) | $L_{Aeq}$ (dB) | Loudness (sone) | Roughness (asper) | Sharpness (acum) | Fluct. str. (vacil) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 13,20 | 68 | 0,80 | 70,0 | 28,8 | 1,63 | 1,768 | 1,14 |
| 2 | 1 | 13,20 | 68 | 1,80 | 69,6 | 27,3 | 1,54 | 1,729 | 1,11 |
| 3 | 1 | 13,30 | 69 | 0,10 | 67,9 | 26,1 | 1,84 | 1,712 | 1,16 |
| 4 | 1 | 13,10 | 68 | 1,20 | 67,5 | 26,2 | 1,56 | 1,675 | 1,10 |
| 5 | 1 | 13,00 | 66 | 0,70 | 69,0 | 27,2 | 1,51 | 1,714 | 1,09 |
| 6 | 2 | 12,80 | 67 | 0,70 | 70,7 | 30,7 | 1,52 | 1,806 | 1,14 |
| 7 | 2 | 12,70 | 68 | 0,30 | 79,8 | 39,2 | 1,96 | 1,974 | 1,15 |
| 8 | 2 | 12,70 | 68 | 0,00 | 69,6 | 27,9 | 1,49 | 1,732 | 1,14 |
| 9 | 2 | 12,60 | 70 | 0,60 | 70,0 | 28,8 | 1,45 | 1,699 | 1,12 |
| 10 | 2 | 12,40 | 69 | 0,60 | 72,9 | 32,0 | 1,68 | 1,855 | 1,19 |
| 11 | 3 | 12,20 | 70 | 0,70 | 73,5 | 35,2 | 1,56 | 1,935 | 1,23 |
| 12 | 3 | 12,20 | 71 | 0,60 | 71,4 | 30,1 | 1,51 | 1,662 | 1,04 |
| 13 | 3 | 12,20 | 72 | 0,60 | 72,9 | 32,5 | 1,58 | 1,631 | 1,19 |
| 14 | 3 | 12,10 | 74 | 1,00 | 71,6 | 31,3 | 1,60 | 1,766 | 1,01 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 15 | 3 | 12,00 | 74 | 1,60 | 72,0 | 34,8 | 1,70 | 1,509 | 1,20 |
| 16 | 4 | 11,90 | 75 | 0,60 | 78,5 | 38,3 | 1,36 | 1,586 | 1,14 |
| 17 | 4 | 11,70 | 76 | 0,60 | 67,9 | 25,2 | 1,37 | 1,740 | 0,97 |
| 18 | 4 | 11,70 | 78 | 0,70 | 67,9 | 25,4 | 1,41 | 1,782 | 0,97 |
| 19 | 4 | 11,50 | 78 | 0,50 | 68,3 | 26,3 | 1,35 | 1,746 | 1,00 |
| 20 | 4 | 11,30 | 79 | 0,40 | 67,9 | 25,3 | 1,47 | 1,804 | 1,07 |
| 21 | 5 | 11,20 | 80 | 0,00 | 71,1 | 29,9 | 1,57 | 1,682 | 1,13 |
| 22 | 5 | 11,10 | 81 | 0,00 | 72,9 | 35,6 | 1,44 | 1,741 | 1,22 |
| 23 | 5 | 11,10 | 81 | 0,50 | 73,0 | 34,3 | 1,61 | 2,022 | 1,23 |
| 24 | 5 | 11,20 | 81 | 1,30 | 78,2 | 45,0 | 1,73 | 2,793 | 1,18 |
| 25 | 5 | 11,20 | 82 | 1,70 | 73,1 | 34,8 | 1,55 | 1,802 | 1,23 |

## 7. Findings

In this study, quantitative data from the sound records, meteorological data and the users' subjective perception were statistically analyzed. The correlation between the $L_{Aeq}$ and the sound quality metrics (loudness, roughness, sharpness, fluctuation strength) obtained from sound recordings with meteorological data (temperature, humidity, wind speed) was not statistically significant ($p > 0,05$) (Table 3).

**Table 3. Relation between meteorological data with acoustic and sound quality data**

| | | $L_{Aeq}$ (dB) | Loudness (sone) | Roughness (asper) | Sharpness (acum) | Fluctuation strength (vacil) |
|---|---|---|---|---|---|---|
| **temperature** | Pearson Correlation | -0,248 | -0,347 | 0,303 | -0,292 | -0,051 |
| | **p** | **0,233** | **0,089** | **0,142** | **0,157** | **0,808** |
| **humidity** | Pearson Correlation | 0,162 | 0,281 | -0,262 | 0,292 | 0,029 |
| | **p** | **0,440** | **0,173** | **0,206** | **0,156** | **0,892** |
| **wind speed** | Pearson Correlation | 0,057 | 0,170 | 0,066 | 0,129 | 0,066 |
| | **p** | **0,788** | **0,416** | **0,756** | **0,538** | **0,755** |

The participants' gender, age, education level, income level, reasons and frequency for coming to the area were compared with their responses to 35 adjective pairs about sound environments. When the analyzes made by $X^2$ test are evaluated;

- Gender affected the frequencies of responses to the adjective pair of reassuring-not reassuring in statistically significant ways ($X^2$=3,472; p=0,034). Females considered sound environment reassuring rather than males. In addition, it was affective on the adjective pair of stifling- roomy ($X^2$=10,159; p=0,038). Most of the females stated that they were neutral in sound environment, the males considered more stifling.
- The age of the participants did not become statistically significant in the adjective pairs.
- Education level affected the frequencies of responses to the adjective pair of ordinary-effective in statistically significant ways ($X^2$=20,833; p=0,045). Most of the high school graduates regarded sound environment to be very effective, the primary school students regarded them to be ordinary, the university graduates as very ordinary. It affected the frequencies of responses to the adjective pair of sharp-not sharp in statistically significant ways ($X^2$=21,326; p=0,046). The university, high school and primary school graduates regarded them to be neutral.
- Income level affected the frequencies of responses to the adjective pair of disturbing- comfortable in statistically significant ways ($X^2$=26,183; p=0,045). While the ones with high income (3000

TL and over) considered disturbance of sound environment to be neutral, the ones with low income and not working found it to be more comfortable. In addition, income level was affective on the adjective pair of stifling- roomy ($X^2$=26,411; p=0,049). While the ones with high income regarded stifling- roomy situation of sound environment to be neutral, the ones not working suggested it to be some roomy and the ones with low income suggested it to be very stifling, respectively. The frequencies of responses to the adjective pair of varied-simple were statistically affected in significant ways ($X^2$=29,146; p=0,023). Most of the participants considered sound environment to be very varied.

- When their reasons for coming to the field and their responses to the adjective pairs were studied, it affected the frequencies of responses to the adjective pair of unpleasant - pleasant in statistically significant ways ($X^2$=26,190; p=0,045). The ones coming to shopping thought to be more pleasant rather than the others. The reasons for coming affected the frequencies of responses to the adjective pair of strange-familiar in statistically significant ways ($X^2$=27,619; p=0,035). Employees, shoppers and the passersby considered sound environment to be familiar, the ones coming for tour expressed to be strange.
- When their frequencies for coming were assessed, the frequencies of responses to the adjective pair of noisy-quiet were affected in statistically significant ways ($X^2$=18.173; p=0,033). As the ones coming every day considered to be highly noisy, the ones coming a few times in a week or a few times in a month regarded to be less noisy, the ones coming in shorter times (a few times in a year) assessed to be quiet. The frequency for coming affected the frequencies of responses to the adjective pair of regular-irregular in statistically significant ways ($X^2$=27,783; p=0,012). The ones coming a few times in a year considered to be regular, the others stated that there was an irregular sound environment.

When statistically comparing the participants' responses to 35 adjective pairs about soundscape perception regarding sound environment of Gazi Street with $L_{Aeq}$, loudness, roughness, sharpness and fluctuation strength (Table 4);

**Table 4. Relation between adjective pairs and acoustic-sound quality metrics**

| **Adjective pairs** | | **$L_{Aeq}$ (dB)** | **Loudness (sone)** | **Roughness (asper)** | **Sharpness (acum)** | **Fluc. Strg. (vacil)** |
|---|---|---|---|---|---|---|
| Unpleasant-Pleasant | Pearson Correlation | -0,154 | -0,124 | -0,250 | 0,169 | -0,379 |
| | p | 0,463 | 0,556 | 0,229 | 0,418 | 0,062 |
| Calming-Agitating | Pearson Correlation | -0,407 | -0,364 | -0,465 | 0,020 | -0,330 |
| | p | **0,044** | 0,074 | **0,019** | 0,923 | 0,107 |
| Ordinary-Effective | Pearson Correlation | -0,161 | -0,078 | -0,191 | -0,111 | -0,114 |
| | p | 0,442 | 0,712 | 0,360 | 0,599 | 0,588 |
| Not Preferred-Preferred | Pearson Correlation | -0,197 | -0,198 | -0,284 | 0,156 | -0,257 |
| | p | 0,344 | 0,343 | 0,169 | 0,456 | 0,214 |
| Unsocial-Social | Pearson Correlation | -0,346 | -0,249 | -0,108 | 0,027 | -0,201 |
| | p | 0,090 | 0,231 | 0,608 | 0,900 | 0,335 |
| Meaningless-Meaningful | Pearson Correlation | -0,356 | -0,338 | -0,449 | 0,109 | -0,415 |
| | p | 0,081 | 0,099 | **0,025** | 0,604 | **0,039** |
| Melancholic-Cheerful | Pearson Correlation | -0,333 | -0,325 | -0,219 | 0,098 | -0,331 |
| | p | 0,104 | 0,112 | 0,294 | 0,642 | 0,106 |
| Disturbing-Comfortable | Pearson Correlation | -0,051 | -0,041 | -0,105 | 0,184 | -0,311 |
| | p | 0,808 | 0,846 | 0,617 | 0,380 | 0,130 |
| Distracting-Motivating | Pearson Correlation | -0,228 | -0,276 | -0,205 | 0,280 | -0,490 |
| | p | 0,274 | 0,182 | 0,326 | 0,175 | **0,013** |
| Oppressive-Liberating | Pearson Correlation | 0,115 | 0,128 | 0,114 | 0,326 | -0,050 |
| | p | 0,584 | 0,544 | 0,587 | 0,111 | 0,812 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Strange-Familiar | Pearson Correlation | 0,284 | 0,308 | -0,233 | 0,082 | -0,098 |
| | p | 0,168 | 0,135 | 0,262 | 0,697 | 0,642 |
| Not Reassuring-Reassuring | Pearson Correlation | -0,049 | -0,021 | -0,043 | -0,051 | -0,217 |
| | p | 0,815 | 0,922 | 0,839 | 0,808 | 0,298 |
| Stressing-Relaxing | Pearson Correlation | -0,108 | -0,110 | -0,224 | 0,016 | -0,374 |
| | p | 0,608 | 0,601 | 0,283 | 0,939 | 0,066 |
| Ugly-Nice | Pearson Correlation | -0,256 | -0,238 | -0,360 | -0,069 | -0,429 |
| | p | 0,218 | 0,253 | 0,077 | 0,742 | **0,033** |
| Eerie-Not Eerie | Pearson Correlation | 0,067 | 0,066 | -0,225 | -0,009 | -0,401 |
| | p | 0,751 | 0,755 | 0,280 | 0,964 | **0,047** |
| Stifling-Roomy | Pearson Correlation | -0,202 | -0,167 | -0,298 | 0,196 | -0,386 |
| | p | 0,332 | 0,424 | 0,148 | 0,349 | 0,057 |
| Suprising-Not Suprising | Pearson Correlation | -0,202 | -0,115 | 0,014 | -0,200 | -0,187 |
| | p | 0,334 | 0,583 | 0,948 | 0,337 | 0,372 |
| Boring-Interesting | Pearson Correlation | -0,172 | -0,114 | -0,307 | -0,090 | -0,367 |
| | p | 0,412 | 0,586 | 0,136 | 0,667 | 0,071 |
| Noisy-Quiet | Pearson Correlation | -0,120 | -0,177 | -0,317 | -0,251 | -0,314 |
| | p | 0,568 | 0,398 | 0,123 | 0,227 | 0,126 |
| Artificial-Natural | Pearson Correlation | 0,086 | 0,103 | -0,296 | -0,210 | -0,164 |
| | p | 0,682 | 0,626 | 0,151 | 0,315 | 0,433 |
| Deserted-Lively | Pearson Correlation | -0,091 | -0,028 | -0,157 | -0,120 | -0,220 |
| | p | 0,666 | 0,895 | 0,454 | 0,568 | 0,290 |
| Not Distinct-Distinct | Pearson Correlation | -0,052 | -0,034 | -0,396 | 0,179 | -0,270 |
| | p | 0,805 | 0,873 | 0,050 | 0,392 | 0,191 |
| Discordant-Harmonic | Pearson Correlation | -0,047 | -0,110 | -0,211 | 0,085 | -0,367 |
| | p | 0,822 | 0,600 | 0,310 | 0,688 | 0,071 |
| Far Away-Nearby | Pearson Correlation | 0,059 | 0,002 | 0,090 | 0,281 | -0,061 |
| | p | 0,780 | 0,991 | 0,669 | 0,174 | 0,773 |
| Sonorous-Not Sonorous | Pearson Correlation | 0,239 | 0,233 | -0,104 | 0,137 | -0,135 |
| | p | 0,249 | 0,262 | 0,622 | 0,514 | 0,521 |
| Rough-Smooth | Pearson Correlation | -0,082 | -0,073 | -0,409 | -0,015 | -0,226 |
| | p | 0,698 | 0,727 | **0,042** | 0,942 | 0,277 |
| Grating-Not Grating | Pearson Correlation | 0,000 | -0,034 | -0,221 | -0,104 | -0,243 |
| | p | 0,999 | 0,872 | 0,288 | 0,621 | 0,241 |
| Sharp-Not Sharp | Pearson Correlation | -0,234 | -0,176 | -0,444 | -0,230 | -0,343 |
| | p | 0,261 | 0,399 | **0,026** | 0,269 | 0,094 |
| Hard-Soft | Pearson Correlation | -0,280 | -0,227 | -0,428 | -0,306 | -0,426 |
| | p | 0,175 | 0,275 | **0,033** | 0,137 | **0,034** |
| Strong-Weak | Pearson Correlation | 0,170 | 0,248 | -0,084 | 0,013 | 0,004 |
| | p | 0,417 | 0,232 | 0,690 | 0,952 | 0,983 |
| Unclear-Clear | Pearson Correlation | 0,048 | 0,012 | -0,173 | 0,403 | -0,172 |
| | p | 0,819 | 0,953 | 0,407 | **0,046** | 0,411 |
| Irregular-Regular | Pearson Correlation | -0,179 | -0,123 | -0,443 | 0,101 | -0,184 |
| | p | 0,391 | 0,557 | **0,027** | 0,631 | 0,378 |
| Unbalanced-Balanced | Pearson Correlation | -0,277 | -0,235 | -0,381 | 0,062 | -0,257 |
| | p | 0,180 | 0,258 | 0,060 | 0,768 | 0,214 |
| Unsteady-Steady | Pearson Correlation | -0,124 | -0,110 | -0,402 | 0,056 | -0,032 |
| | p | 0,555 | 0,600 | **0,046** | 0,792 | 0,881 |
| Varied-Simple | Pearson Correlation | -0,032 | -0,107 | -0,288 | 0,297 | -0,212 |
| | p | 0,879 | 0,611 | 0,163 | 0,150 | 0,308 |

- As the correlation between the participants' responses to the adjective pair of calming-agitating and $L_{Aeq}$ was statistically significant ($p<0,05$), the correlation between the other adjective pairs and $L_{Aeq}$ was not significant ($p>0,05$).
- There was no significant correlation between any adjective pairs and loudness.
- As there were statistically significant correlations between the responses to the adjective pairs calming-agitating, meaningful-meaningless, rough-smooth, sharp-not sharp, hard-soft, irregular-

regular, unsteady-steady and roughness from sound quality metrics ($p<0,05$), there was not a significant correlation in other adjective pairs ($p>0,05$).

- While there was only a significant correlation between the adjective pair of unclear-clear and sharpness ($p<0,05$), there was not a significant correlation in other adjective pairs ($p>0,05$).
- A significant correlation was found between the adjective pairs of meaningful-meaningless, distracting-motivating, ugly-nice, eerie-not eerie, hard-soft and fluctuation strength ($p<0,05$). But there was not a significant correlation in other adjective pairs ($p>0,05$).

## 8. Conclusion

By focusing on the soundscape approach, this paper measured the users' perception about sound environment with objective and subjective data in the Gazi Street of Diyarbakır Suriçi. Meteorological data and quantitative data about sound environment were analyzed. The relations between 35 adjective pairs and the users' personal/social characteristics and quantitative data of sound environment were researched. As a result of this study;

• There was not a significant relation between meteorological data (temperature, humidity, wind speed and $L_{Aeq}$ and sound quality (loudness, roughness, sharpness, fluctuation strength) metrics.

• There was not a significant relation between the quantitative data about loudness and the adjective pairs.

• The females considered sound environment more reassuring rather than the males. The males thought sound environment to be more stifling than the females.

• As most of the high school graduates thought sound environment to be very effective, the primary school graduates thought to be ordinary, very ordinary for the university graduates.

• As the ones with high income dealt with the disturbance of sound environment as neither disturbing nor comfortable, the ones with low income and the ones not working thought it to be some comfortable.

• The participants coming to the area for shopping considered sound environment pleasant rather than the others.

• Employees, shoppers, and passers-by considered sound environment to be familiar, participants who traveled for a while stated that the sound environment was strange.

• As the ones coming to the area every day considered sound environment to be highly noisy, for the ones coming a few times in a week or a few times in a month as less noisy, for the ones coming in shorter times (a few times in a year) as quiet.

• As the users coming to the area a few times in a year thought sound environment to be regular, the others stated to be irregular.

This study showed that the users' perceptions about sound environment could change in accordance with the parameters such as gender, age, social and cultural characteristics. When examining the sound environment of a region, not only quantitative information but also subjective information must be taken.

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# THE EFFECT OF DIFFERENT HORMONE CONCENTRATIONS AND SQUARE LENGTH ON CALLUS FORMATION IN COTTON ANTHERS

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**Abstract:** *Cotton is a hot climatic industrial plant commonly planted in both tropical and subtropical regions of the world. Four different genotypes of cotton, Aşkabat-100 (G. barbadense L.), Coker-312 and Stoneville-468 (G. hirsutum L.), were studied for callus induction. The cotton anthers extracted from immature floral buds (square) were used as explants. Cotton anthers taken from different length immature cotton square were used as explants. After samples taken from cotton, square of different lengths (2, 3, 4, 5 mm) were subjected to sterilization with different NaoCl concentrations (10, 20 and 30%) prepared in sterilized glass containers for surface sterilization, the immature anthers were extracted and placed in MS feeding media with various amounts of different hormones to induce callus formation. After the seeding done, lids of the petri dishes closed, to prevent the air inflow and outflow were covered with parafilms, then the petri dishes were left for dark in the climate room for about 30-60 days. The experiments were performed with three repetitions. Seeding was done every three days and callus size and regeneration rates that resulted from 5-week dark environment incubation were determined. Once the anthers were transferred to the induction media, one-hour cold (4°C) shock and one-hour hot shock (40°C) were applied to them, they were kept in dark for a while and were left for collagenase in climate room at 16/24 light regime. As the result of the experiments, the highest rate of callus formation was observed in Cooker 312 supplemented with 2mg $mL^{-1}$ of NAA and 2 mg $L^{-1}$ of BA hormones. Callus formation was also higher in the treatment where NAA was used than the media supplemented with 2,4-D. Additionally, callus formation showed better results in cold and hot shock applied anthers compared to the ones that were not shocked.*

**Key Words:** *Cotton, Floral buds, square, anther, callus*

## 1. Introduction

Cotton, with its various areas of use, is one of the crops that have a significant place in the sectors of agriculture, trade and industry all around the world. Cotton fiber accepted as the ideal textile

product for its structural properties [2]. Besides its fiber, seeds and residues that contain oil and protein are considered as an important animal food [9].

Among the various tissue culture methods used in cotton studies, anther culture is one of the important culturing method. However, anther culturing studies have not reached the desired level yet [4]. It is quite difficult to generate callus from cotton anthers. In a study carried out by [7], three different genotypes of cotton were used to generate callus from the immature ovules and anthers. In the study, they used MS feeding media, some auxins derivatives such as 2,4-D, IAA, IBA and Kinetin. However, they were not able to induce the callus formation from anthers while they obtained 88% success for ovules. At the end of the study, they reported that the amount of callus dropped when the concentration of 2,4-D was brought over 3mg $l^{-1}$ and 4 mg $l^{-1}$ [7].

In this study, we aimed at culturing the anthers extracted from immature buds in an appropriate feeding media by using different concentrations of a variety of hormones and at inducing callus formation in them [5].

## 2. Material and Methods

Three genotypes belonging to two cultivated species i.e *G. barbadense* (Aşkabat-100) and *G. hirsutum* (Coker 312, Stoneville-453 and Stoneville-468) are the biological materials of this study.

A total of 120 pots; each genotype of 40 pots containing 4 seeds were prepared and were grown in Green House. All other required work, such as watering carried for seeds to germinate and for plants to grow, was performed whenever necessary. After germination, a thinning was made so that each pot had only one plant.

After initial square, each square was labeled with a sticker that indicated its squaring time. Later, an average of 100 squares was calculated from each genotype every day until there were no buds on the plants. The extracted floral buds were measured by compass and were categorized as 2, 3, 4 and 5 mm [3-4].

For the surface sterilization of the collected buds, first 80% autoclaved with distilled water and 20% hyposolution was prepared, 3 drops of tween 20 was dropped then shaked for 15 minutes and finally they were rinsed with sterile pure water. In this study, pre-prepared MS feeding media and concentrations of auxins deriatives; NAA, IBA and 2,4-D with kinetin, to different feeding media of BA and TDZ 5. Three replicates of sterilized anthers from each category ((2 mm, 3mm, 4mm ve 5 mm) of each genotype in a pethri dish were cultured with the help of bisturi and pens [8].

Following the culture, the lids of the petri dishes were closed, and they were stretch-filmed to avoid any contamination. After anthers were transferred to the induction media, one-hour cold shock (+ 4°C) and one-hour hot shock (40 °C) were applied, they were kept in for a while and were taken to the growth room with 16/24 photoperiod conditions.

## 3. Discussions

The callus production rates of cotton genotypes investigated in 7 different feeding media given in Table 1. Callus production rates (%), depending on the genotype, varied between 0.0 and 4.8 (Table 1). The callus production rate of Coker-312 genotype in 3 mg/L NAA + 2 mg/L BA+0,5 mg/L TDZ ve 2 mg/l 2,4-D + 2 mg/l NAA + 2mg/l Kinetin+2 mg/l BA supplemented feeding media varied between

1.1 and 4.8, whereas the lowest callus production rate was observed in Askabat-100 genotype in 1 mg/L NAA + 1mg/l BA, 2 mg/L NAA + 1mg/l BA and 2 mg/l 2,4-D + 2 mg/l NAA + 2mg/l Kinetin+2 mg/l BA supplemented feeding media with range 0.0-1.1. Within the range of this study, Coker-312 genotype used as a material formed the group that had the highest rate of callus production, whereas Askabat-100 formed the group that had the lowest callus production [6].

**Table 1**. Average number of the callus formation in MS feeding media with various concentrations of tested hormones.

| Media Component | Number of Callus Formed by Each Genotype | | | |
|---|---|---|---|---|
| | Coker 312 | Aşkabat 100 | Stoneville 453 | Stoneville 468 |
| 1 mg/L NAA + 1mg/l BA | 3.5 | 2.6 | 0 | 0.1 |
| 2 mg/L NAA + 1 mg/L BA | 2 | 3 | 0 | 0.1 |
| 2 mg/l 2,4-D + 2 mg/l NAA +1 mg/l Kinetin 1mg/l BA | 4 | 2.87 | 0.2 | 0.5 |
| 2 mg/l 2,4-D + 2 mg/l NAA + 2mg/l Kinetin +2 mg/l BA | 4.8 | 2.85 | 1.1 | 1.4 |
| 1 mg/l 2,4-D + 2 mg/L NAA + 1 mg/l Kinetin | 2.55 | 0.8 | 0.21 | 0.66 |
| 3 mg/L NAA + 2 mg/L BA+0,5 mg/L TDZ | 1.1 | 0.5 | 1 | 1.4 |
| 1 mg/l NAA + 1 mg/ BA+ 0,5 mg/L TDZ | 2.7 | 1 | 0.2 | 0.6 |

Among the screened genotypes the highest callus average was determined in Coker-312 with 5.77 (5 mm square length) and the lowest callus average was determined in Askabat-100 with 0.0 (2 mm square length) (Table 2). Coker-312 genotype yielded higher callus formation averages (%) than Stoneville-453, Stoneville-468 and Ashkabat-100 genotypes. Callus formation rates varied with anther length (mm) and types [1].

**Table 2.** MS Media, viability percent and callus formation versus square

| Genotype | Square Length (mm) | Anther Viability % | Number of the Callus Formed |
|---|---|---|---|
| Coker 312 | 2 | 100 | 1.77 |
| | 3 | 100 | 1.88 |
| | 4 | 100 | 3.33 |
| | 5 | 100 | 5.77 |
| Stonville-453 | 2 | 100 | 1.00 |
| | 3 | 100 | 0.72 |
| | 4 | 100 | 0.43 |
| | 5 | 100 | 1.10 |
| Askabat-100 | 2 | 100 | 0.00 |
| | 3 | 100 | 2.62 |
| | 4 | 100 | 3.00 |
| | 5 | 100 | 3.25 |
| Stoneville 468 | 2 | 100 | 1.66 |
| | 3 | 100 | 0.88 |
| | 4 | 100 | 0.66 |
| | 5 | 100 | 3.25 |

## 4. Results

As the result of this study, it was observed that the highest numbers of callus were formed in the media supplemented with 2 mg/l 2,4-D + 2 mg/l NAA + 2mg/l Kinetin+2 mg/l BA for 3mm of each genotype. Among all the genotypes studied, Coker 312 (3 mm) formed the highest amount of callus while Stoneville 468 (2 mm) genotype showed the lowest one. Besides, the callus formation in the media with 2,4-D was found to be higher than the media supplemented with NAA.

According to obtained findings and results, positive results were obtained in 2 mg/l 2,4-D + 2 mg/l NAA + 2mg/l Kinetin+2 mg/l BA ve 2 mg/l 2,4-D + 2 mg/l NAA +1 mg/l Kinetin 1mg/l BA supplemented feeding media. This situation puts forth the need for the investigation of low doses of different plant growth regulators. As the best results have been obtained in terms of callus production rates from the Coker-312 genotype belonging to *G. hirsutum* L. species puts forth the idea that better results may be obtained from the types in these species. This situation shows that apart from Coker-312, types such as Coker-310, Stoneville-453 and Stonevile-468 may as well can be used as material in future studies.

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# AGROMYZID (DIPTERA) SPECIES AND THEIR PARASITOIDS IN BATMAN PROVINCE, TURKEY

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**Abstract:** *This study was carried out during 2010 and 2012 in province of Batman, Turkey, for surveying the agromyzid fauna. The specimens were collected by rearing of the mine-infested leaves of different cultivated and non-cultivated host plants. Seven species belonging to three genera of the subfamily of Agromyzinae and two species belonging to one genera of subfamily of Phytomyzinae were collected. These species were Agromyza albitarsis, Chromatomyia horticola, Liriomyza bryoniae, Liriomyza cicerina, Liriomyza huidobrensis, Liriomyza strigata, Liriomyza trifolii, Phytomyza affinis and Phytomyza orobanchia. In this study, among all determined parasitoids, 3 species were belonging to family of Braconidae and 1 species were belonging to the family of Eulophidae and Aphidiidae each. Among them, Diglyphus isaea Walker was the most widespreading species.*

**Key Words:** Agromyzidae, Parasitoid, Cultivated and Non-Cultivated Areas, Batman

## 1.Introduction

Leaf miners species belonging to Agromyzidae (Diptera) family damage by feeding on different plants. However adult females of the species belonging to this family cause the degradation of chlorophyll by inserting their ovipositor into leaf tissue during egg laying. This results whitish pinhead-size dots on the leaf surface. With a life span of 7-10 days, an adult female can cause as many as 120-140 white dots. This type of damage halts photosynthesis function and reduces the marketing values of crops significantly, especially in ornamental plants. By feeding and opening galleries in the tissue between two layers of leaves epidermis, pest larvae feed on mesophyll and cause the disappearance of mesophyll and resultlng the formation of whitish spots. Such leaves cannot photosynthesis and therefore yield and quality

losses occur. Many Agromyzidae species are monofag. Oligofag types are also available. Very few of Agromyzidae species are polifag and have a wide host range. Ferns, important group of flowering plants, monocotyledons and Dicotyledons are species of this family [26].

In a very rich flora of our country, so far, comprehensive studies on the species of this family have been done in recent years. The presence of 175 species of Agromyzidae are revealed in our country [13, 30, 34, 2, 28, 8, 11, 17, 20]. The research done on Agromyzidae in the anatolia Region Application area and vegetables production of Diyarbakır, Mardin and Şanlıurfa province revealed 28 species, and of these species, L. trifolii, and L. L. *Chicherina strigata* species were determined to be important [6, 8, 9].

This study was conducted to detect harmful and parasites species of family Agromyzidae in the agricultural and non-agricultural areas of Batman.

## 2. Material and Methods

The main material of the research was Agromyzinae and Phytomyzinae subfamilies belong to the Agromyzidae family, which were collected in cultivated and wild plants in 2010-2012 in Batman Center, Beşiri, Gercüş, Hasankeyf, Kozluk and Sason of Turkey. The samples collected from the research areas were labelled with the name, place and date of the host, and brought to the laboratory in polyethylene bags. In the laboratory, they were transferred to transparent plastic jars and to moist soil containing pots.

The abdomen of the obtained male subjects was individually placed in glass tubes containing 10% KOH to soften and clear the body with a fine-tipped needle under a stereoscopic binocular microscope. Then, these tubes were placed in a 15 cm metal container filled with water on the electric cooker and the abdomen in the tubes held in this environment was taken with the help of a fine pipette for 15-20 minutes after the water was boiled and transferred to the pit plate containing glacial acetic acid. It was left in this environment for 5 minutes. Then, another pit with 96 % alcohol was transferred into the slide, where it was left for 5 minutes, and then removed from the abdominal genital organs with the help of a fine-tipped needle. Diagnosis was made according to Spencer [23, 24, 25, 26, 27].

## 3. Results and Discussion

In this study, 9 agromyzid species were determined belonging to 2 subfamily and 5 genera.

**Subfamily: Agromyzinae**

**Species: *Agromyza albitarsis* Meigen, 1830**

**Synonym:** *Agromyza lygophora* Hering, 1937

The wing length was 2.2-2.6 mm with matte gray colour. Frons, all antenna segments and mesonotum are black colored, 3rd antenna segment is round.

**Distribution:** Canada, Western and Northern European countries [25].

this species was detected first in İzmir of our country [13].

**Material examined:** Gercüş, Hasankeyf, Beşiri, Kozluk and Sason from *Populus* sp. This species was found heavily.

**Parasitoid**: *Opius basalis, Cirrospilus lyncus, C. vittatus, Diglyphus isaea, Pnigalio soemius* [8,10].

In this study, parasitoid was not detected.

**Subfamily: Phytomyzinae**

**Species: *Chromatomyia horticola* (Goureau, 1851)**

**Synonym:** *Phytomyza atricornis* Meigen, 1935; *Phytomyza bidensivora* Séguy, 1951; *Phytomyza cucumis* Macquart, 1854; *Phytomyza fediae* Kaltenbach, 1860; *Phytomyza* Vimmer, 1928; *Phytomyza linariae* Kaltenbach, 1862; *Phytomyza meliloti* Brischke, 1882;

The wing length was 2.2-2.7 mm and black. Frons were dark yellow and orange in color with 2 upper and 1 bottom orbital bristles. 1st and 2nd antenna segments are yellow and 3rd segment is black colored, small and round.

**Distribution:** It is a cosmopolitan species in the world [25]. Turkey [3, 4, 19,13].

[1] In this study, Gercüş, Hasankeyf, Beşiri, Kozluk and Sason from *Sinapis arvensis* L., *Turgenia latifolia* (L.), *Sonchus* sp., *Xanthium* sp., *Papaver* spp., *L. esculentum* ve *Vicia* sp. It was found dense and widespread on the plants.

**Parasitoid:** *Pediobius acantha*, *Chrysocharis liriomyzae* Delucchi, *Cirrospilus vittatus*, *Diglyphus isaea* Walker, *D. minoeus* Walker, *Neochrysocharis formosa* Walker (Hymenoptera: Eulophidae); *Opius ambiguus* Wesmeal, *O. exiguus* Wesmeal, *O. osogovensis* Fischer and *O. pallipes* Wesmeal (Hymenoptera: Braconidae) [1, 21, 30, 8].

*O. pallipes* from *Sinapis arvensis* and *Sonchus* sp.; *D. isaea* from *L. esculentum* and *Vicia sp.*

**Species: *Liriomyza bryoniae* (Kaltenbach 1858)**

**Synonym:** A*gromyza bryoniae* (Kaltenbach 1858), *Liriomyza solani (*Hering 1927), *Liriomyza hydrocotylae* (Hering 1930), *Liriomyza mercurialis* (Hering 1932), *Liriomyza triton* (Frey 1945), *Liriomyza citrulli* (Rohdendorf 1950), *Liriomyza nipponallia* (Sasakawa 1961).

Mesonotum is a small species in bright black color. The frons are bright yellow in color and the gena form a elongated circle under the eye. The third antenna segment is bright yellowish.

**Distribution:** Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Japan, Republic of Korea, Nepal, Taiwan, Turkmenistan, Vietnam, Albania, Morocco, Morocco, Latvia, Lithuania, Malta, Moldova, Netherlands, Norway, Poland,

Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Ukraine, United Kingdom [29, 22, 20]. This was also recorded in the Eastern Mediterranean region of our contry [30].

In this study *Lycopersicum esculentum* and *Heliothropium* were detected in Beşiri and Kozan; *Citrullus vulgaris* and *Cucumis melo* were found in Sason.

**Parasitoid:** O. *pallipes, O. gafsaensis and D. isaea* [31, 8].

*D. isaea* was found from *L. bryoniae.*

**Species: *Liriomyza cicerina* (Rondani, 1875)**

**Synonym:** *Liriomyza ononidis* de Meijere 1925
*Liriomyza trichophthalma* (Hendel 1931)

The wing length is 1.3-1.6 mm. Head, mesonotum and 3rd antenna segment are black, 1st and 2nd antenna segments are yellowish.

**Distribution:** Africa, Asia and all European countries [24, 18, 20]. It is also common in our country [19, 14, 30, 8].

In this study *L. cicerina*, in Besiri, Kozluk and *Lens* sp. and *Cicer arietinum* was recorded in Sason districts.

**Parasitoid:** *Diauliropsis arenomia, Neochrysocharis albipes* Kurdjumov, *N. Ambitiosa, N. sericae, D. isaea, O. pallipes, O. monilicornis* and *O. exiguus* were recorded parasitoids [32, 8].

In this study, *D. isaea* and *O. pallipes* were obtained from the harmful species.

**Species: *Liriomyza huidobrensis* (Blanchard, 1926)**

**Synonym:** *Agromyza huidobrensis* (Blanchard, 1926), *Liriomyza cucumifoliae* (Blanchard, 1938), *Liriomyza langei* (Frick, 1951), *Liriomyza decora* (Blanchard, 1954), *Liriomyza dianthi* (Frick, 1958)

The wing length is 1.7-2.25 mm and the shiny black color. Frons are yellowish in color and have 2 bottom and upper orbital bristle. Mesonotum is a bright black color; The 3rd antenna segment is orange in color and the 1st and 2nd antenna segments are orange or brownish in color.

**Distribution:** Central America, South America, North America, Argentina, Brazil, Chile, Colombia, Peru, Venezuela, Belgium, Netherlands and Israel are recorded [25, 33]. It has been reported in Turkey [33, 34, 28].

In this study, this species were identified on *Capsicum annuum* in the central and Beşiri; on *Cucumis sativus* from Sason districts of Batman

**Parasitoid**: Parasitoids of *L. huidobrensis* have been reported in *D. isaea*, *D. poppoea*, *D. crassinervis*, *D. minoeus*, *Hemiptarsenus varicornis* (Hym: Eulophidae) and *Dacnusa* spp. (Hym .: Braconidae) [15, 33, 5, 10].

In this study, *D. isaea* was collected from the *Capsicum annuum* in Beşiri.

**Species: *Liriomyza strigata* (Meigen, 1830)**

**Synonym:** *Agromyza pumila* Meige

*Agromyza violae Curtis, 1844*

*Agromyza galeopsios* Hardy, 1853

The wing length 1.8-2.1 mm. It is a black colored species in its length. Frons, orbital area and all antenna segments are yellowish. The 3rd antenna segment is round and covered with hair.

**Distribution:** It was reported in European countries, Russia, Uzbekistan and Kyrgyzstan [25]. It has been also reported in many places in Turkey [13, 30, 7, 8, 28, 10].

In this study the species were obtained from *Cucumis melo*, *Phaseolus vulgaris* in Central, Beşiri and Kozluk; *Capsicum annuum* and *Lycopersicon esculentum* in Gercüş; *Solanum melongena* in Sason.

**Parasitoid:** *Dacnusa discolor*, *D. maculipes*, *Chorebes daimenes*, *O. exiguous*, *O. levis*, *O. pallipes*, *O. propodealis*, *Halticoptera smaragdina*, *Chrysocharis albicans*, *C. pubicornis*

and *P. acantha* as parasitoids [25].

In this study, *D.isaea*, *O. lonicerae*, *O. exiguous ve Aphidius ervi* parasitoid species were detected.

**Species: *Liriomyza trifolii* (Burgess, 1880)**

**Synonym:** *Agromyza phaseolunata* Frost, 1943; *Liriomyza alliovora* Frick, 1955; *Oscinis trifolii* Burgess, 1880

Wing length is 1.3 - 2.3 mm and greyish-black. Females are slightly bigger than males. The 3rd antenna segment with head and eyes and femur is yellow in color.

**Distribution:** It has been reported in USA, France, Holland, Italy, Canada, Hungary, Asia and Africa countries [24]. This species is also common in our country [30, 2, 8].

In this study, *Phaseolus vulgaris* L., *Solanum melongena* L., *Capsicum annum*, *Citrullus vulgaris* collected from in Beşeri and Hasankeyf, *Dahlia* sp. ve *Tribulus terestris* in Sason, *Lycopersicum esculentum* in Gercüş, *Papaver* sp., *Lactuca sativa* ve *Sonchus* sp. in Kozluk. It was found to be widespread and intense in all the areas of Batman.

**Parasitoid:** *Epiclerus nomocerus* , *Dacnusa sibirica*, *D. isaea*, D. *minoeus*, *D. begini*, *D. pachyneurus*, *Closterocerus formosus*, *O. ambiguus; O. exiguus;O. gafsaensis; O. lonicerae*, O. *osogovoensis; O. pallipes; Chrysonotomyia smaragdula*, *N. ambitiosa;N. albipes; N.*

*formosa; N. sericae;P. acantha; Sympiesis gordius, Halticoptera patellana, Hemiptarsenus zilahisebessi* as parasitoids [12, 16, 30, 35, 8, 10].

In this study, *D. isaea,* O. *exiguus,* O. *pallipes* and *Aphidius ervi* (Aphidiidae) were detected parasitoids.

**Species: *Phytomyza affinis* Fallen, 1823**

The wing width is 1.7-2.2 mm. Mesonotum matt black lateral parts and notopleural depression yellow. Acrosticals in 2-4 rows, coxae 1 yellow basally, II-III blackish. **Distribution**: It occure in European countries [25]. It was also found in Şanlıurfa province of the country [8].

In this study, it was collected from *Senecio* sp. and *Mentha* sp. in Beşiri and Sason.

**Parasitoid:** There is no record as parasitoid of *P. affinis.*

In this study, no parasitoid species were found.

**Species: *Phytomyza orobanchia* Kaltenbach, 1864**

The wings are 2.3-2.5 mm long and grayish black. The frons, which are light yellow or orange, protrude above the eye and have 2 upper and 1 bottom orbital bristle. The side of mesonotum, scutellum and thorax is grayish black.

**Distrubition:** U.S., Afghanistan, Bulgaria, Ethiopia, Iraq, Spain, Italy, Canada, Malta, Egypt, Hungary [25].

Samsun, İzmir, Bursa, Balıkesir, Çanakkale, Diyarbakır, Şanlıurfa [14, 7, 13, 8].

In this study, it was found on *Orobanche* spp. in Hasankeyf and Beşiri.

**Parasitoid:** *Sphegigaster orobanchiae* (Hym.:Pteromalidae) and *Aprocetus* sp. (Hym.: Ichneumonidae) as parasitoids [24, 8].

In this study, none of parasitoid were found.

## 4. Conclusion

Seven species belonging to three genera of the subfamily of Agromyzinae and two species belonging to one genera of subfamily of Phytomyzinae were found.

In the survey studies, adults of Agromyzidae were started to come out in March and increased in May and the end of April. The population decreased with increasing of temperature. The higher populations were higher in especially areas with higher humidity and lower populations was observed in areas where gets much sunlight. Because of unirrigated farming for many years, less plant diversity, less soil and air humidity and the lack of high species diversity, fewer species were identified in the study area compared to the other regions, especially the Aegean region.

In the study, higher Agromyzidae populations have been identified on the cultivated plants including melons, beans, tomatoes, peppers and eggplant and chickpea. The most common species of Agromyzidae was determined to be L. trifolii.

Five parasitoids species were detected, of which, *D. isaea* (Hym.: Eulophidae) was the most common and numerous. Being widespread with a high density, this parasitoid species indicates that it is effective on the Agromyzidae. Especially in recent years, mainly biological control was included into the "integrated pest management" and in organic farming practices. Therefore, conducting new studies to demonstrate the relationships between this pest and beneficial species in the region will be very important for future biological control applications.

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# WATER ABSORPTION AND BIODEGRADATION PROPERTIES OF POTATO WASTE-BASED POLYURETHANE FOAMS

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**Abstract:** *Potato-based polyurethane foams(PUFs) were prepared from the liquefied potato waste-based polyols. Potato wastes liquefied in the presence of polyethylene glycol/glycerin-dominant liquefaction reagent by using sulphuric acid as catalyst in a microwave oven system under stirring. 350 watt/min as micro-wave energy, 300 rpm/min as mixing speed and mass ratio as Biomass/PEG400/Glycerol 5/12/3 w/w/w had been constanted. The liquefied potato waste-based polyols were characterized for the preparation of polyurethane foams. The potato-based polyol which was obtained from 9% sulfuric acid catalyst within 30 min liquefaction reaction period was chosen for the preparation of PU foams. Biodegradation and water absorption properties of PU foams were measured and contrasted with syntetic petroleum-based commercial foams. Biodegrability of PU foam-based on liquefied potato wastes-contained foams was determined according to service biodegradation test for three months. The mean amount of water absorption of potato wastes-based PU foams was measured within 1, 2, 4, 8, 12, 24 and 48 hour. The weight losses of the liquefied potato wastes-based foams along with commercial synthetic PU-type rigid foams had been found 17.84% and 0,107% respectively. The mean amount water intake at potato wastes-based PU foams were higher within seven different time period than synthetic foams. Biodegradation and water absorption properties were found to be higher than those of petroleum-based PU foams dependently biomass content.*

**Keywords**:*Potato waste, liquefaction, polyurethane foam, biodegradation, water-absorption*

## 1. Introduction

Polyurethane (PU) is one of the most useful three-dimensional polymers, since it can exist in various forms of sheets, adhesives and paints. Polyurethanes can be produced through the interaction between polyols and polyisocyanate in polyaddition-type polymerization reaction (Alma et. al, 2003).

Polyols (polyether and polyester) and isocyanate are the two main raw materials for PU foam (PUF) production and currently are obtained from the fossil resources (Pan et. al,2011). The major drawback of petroleum-based products is that they are non-renewable and not-biodegradable (Pan et. al, 2011).

The preparation of low-cost polyols from abundant and renewable biomass resources has long been an interesting subject in the polyurethane industry (Yao et. al,1996). Liquefying biomass to produce the industrial chemicals is a novel method to utilize biomass resource. Earlier researches on this area were started from the liquefaction of wood mill (Besteu et. al,1985; Maldas and Shiraishi,1997;Vuori and Niemela,1988;Yamada and Ono,1999). However, most of the reaction are rigor and consume lots of energy. Researches improved the reaction conditions and the liquefaction product was able to be used to produce the resin or foam (Wang and Chen, 2007; Alma et.al, 2003;Lin et. al,1994;Yao et. al,1993). The methods and principles of liquefying the wood mill gave some idea on the utilization of the agricultural straw which had the similar composition as the wood mill (Wang, 2013). In addition, some scientific studies were reported on the liquefaction of the agricultural wastes (Cineli et. al, 2013; Wang and Chen, 2007;Alma et. al,2003;Lin et. al, 1994;Yao et. al,1993;Wang,2013;Hakim et. al,2011).

According to the Turkish Statistical Institute report, 4,750 million tone potato in Turkey and 376,45 million tone in the world were cultured in 2016 (agricultural wastes based on potato (potato crust and potato vines)) almost are burned or (potato crust) were carried out in soil for decaying. This condition pollutes the environment and wastes the biomass resource.

Granola strain potato contain mainly 84,62% water and 15,37% solid substances. Solid substance components are 11,80% starch, 0,78% invert sugar, 0,77% saccharose, 0,80% cellulose and other parts about protein and phenolic matters (Didin et. al, 2000).

The research is based on the production of rigid PU foam derived from starch-contained potato waste, which is environmentally-friendly pathway and has good water-absorptive and biodegrability property to reduce the demand for non-renewable fossil fuels and to restrain production of carbon dioxide “greenhouse gas” to lower global warning.

## 2. Methods

Potato waste were cut and dried under atmospheric pressure. Potato meal (0-80 mesh) was dried in an oven at 103 ± 2$^{o}$C for 24 hours before re-use. The liquefaction reagent was a mixture of PEG#400 and glycerin. Sulfuric acid was used as catalyst. Liquefaction reaction of biomass was realized by microwave-assistant heating method. The normal heating program was used, which was at 350 watt/min with 300 rpm/min mixing speed. An equivalent amount of sodium hydroxide aqueous solution (40% w/w) was added to neutralize the acid catalyst, thus the liquefied potato waste-based polyols were obtained. The specific gravity, apparent viscosity and surface tension of the liquefied potato-based

polyols were measured according to ASTM 4669, ASTM D 4878 and Pendant Drop Method respectively. Measurements were conducted at 25 ± 2 °C. The acid and hydroxide number of the biomass-based polyol were also determined by the titration method according to ASTM D 4662-08 and ASTM D 4274-05 individually.

***Preparation of the Rigid Foams***

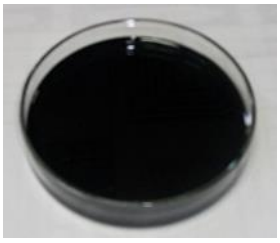
The pH of the potato crust-based polyol obtained above was adjusted by adding 40 wt % sodium hydroxide aqueous solution as blowing agent. Thus, the definite amounts of liquefied potato crust-based polyol, catalyst, surfactant (polymer editor) and water premixed thoroughly in a plastic cup in first step polymerization. Then, the prescript amount of MDI (at an isocyanate index of 90) was added and mixed quickly at a high stirring speed of 8.000 rpm for 15-20 seconds in second step polymerization. It was allowed to rise freely at room conditions. Foams were allowed to cure at room temperature for two days and then were removed from the plastic cup before cutting into test samples.

**Table 1.** Foam Formulations for the Liquefied Potato Wastes-Based Polyols.

| | Ingredients | Parts by Weight |
|---|---|---|
| 1. Liquid | Potato-based polyol | 100 |
| | Catalyst | 3 |
| | Surfactant | 2.5 |
| | Blowing agent (water, including water from neutralization with NaOH solution) | 6.25 |
| | PEG 400 (Polyethylene Glycol 400) | 20 |
| 2. Liquid | MDI (Diphenylmenthanediisocyanate) | 130 |


Potato


Potato miles


Liquefied potato

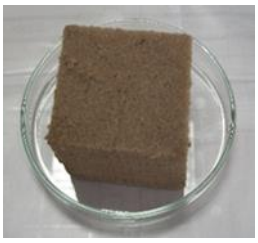

Potato-based foam

**Fig. 1.** Photographs of potato waste, potato miles, potato-based polyol and polyurethane foam derived from potato.

***Biodegradation of Potato-based PU Foams***

Biodegrability of potato waste-based PU foams and synthetic foams were evaluated according to service test. Oven-dried foam blocks (1cm x 1cm x 1cm) were buried in culture soil. ($CaCO_3$:20.35%, Salinity: 0.52 mhos/cm, pH: 7.96, organic matter: 49%, Total nitrogen: 0.13%, Phosphorous: 30.4 ppm, Exchangable $K^+$ ions: 1,56 m.e/100 g soil and Exchangable $Mg^{+2}$ ions: 6.96 m.e/100 g) then incubated

at 25ºC for 3 months. Water contents of soil was maintained at 60% by occasional addition of water. At the end of the incubation period, impurities on the samples were completely removed and oven dried. Eventually, the percent weight loss was calculated by the conventional method (Alma et al.2003).

***Water Intake Test of PU Foam Based on Liquefied Potato***

Prepared PU foam was cut into small pieces of equal volume (10 mm x 10 mm x 10 mm) before water intake test. The mean amount of water absorption of potato waste-based PU foams and petroleum-based foams were measured within 1, 2, 4, 8, 12, 24 and 48 hour according to following equation :

$$Water\ \ absorption = \frac{W_S - W_0}{W_0} X\ 100$$

where $W_0$ is the original weight of the PUF (g) and $W_s$ is the weight of the PU foam after water-absorption.

## 3. Results and Findings

**Table 2.** Effects of the reaction conditions on liquefaction reaction

| Biomass | Catalyst | acid catalyst concentration % | Reaction time (min) | *PIP (%) | Reaction Completion Temparature (ºC) |
|---|---|---|---|---|---|
| Potato | $H_2SO_4$ | 9 | 15 | 4.88 | 80.3 |
| Potato | $H_2SO_4$ | 4 | 15 | 6.04 | 78.2 |
| Potato | $H_2SO_4$ | 3 | 15 | 9.25 | 76.6 |
| Potato | $H_2SO_4$ | 9 | 30 | 0.60 | 97.0 |
| Potato | $H_2SO_4$ | 4 | 30 | 4.70 | 90.4 |
| Potato | $H_2SO_4$ | 3 | 30 | 5.74 | 84.2 |

Conditions: Potato waste/PEG400/Glycerin = 5/12/3, 350 watt/min microwave-heating energy, 300 rpm/min mixing speed

*PIP: Percent Insoluble Part

As can be seen from Table 2, by incremental acid catalyst concentrations, the PIP and reaction completion temperature had been decreased. In addition, the flash result was obtained from liquefaction reactions is as to liquefaction reactions of starch-main componently potato waste were not a balanced reaction and re-polymerizations were not occurred all the time.

**Table 3.** Properties of the Liquefied Potato-Based Polyols

| Catalyst | Organic acid concentration [%] | Reaction Time [min] | Apparent Density [g/cm$^3$][a] | Viscosity [Cp][a] | Surface Tension [dyn /cm][a] | Acid Value [ mg KOH/g] | Hydroxyl Value [mg KOH/g] |
|---|---|---|---|---|---|---|---|
| $H_2SO_4$ | 3 | 15 | 1.317 | 586 | 218.7 | 38.92 | 412.00 |
| $H_2SO_4$ | 4 | 15 | 1.337 | 589 | 223.7 | 40.03 | 388.03 |
| $H_2SO_4$ | 9 | 15 | 1.348 | 744 | 347.6 | 43.75 | 385.82 |
| $H_2SO_4$ | 3 | 30 | 1.158 | 877 | 193.9 | 33.41 | 407.90 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $H_2SO_4$ | 4 | 30 | 1.212 | 880 | 199.5 | 43.68 | 381.75 |
| $H_2SO_4$ | 9 | 30 | 1.257 | 893 | 334.2 | 50.31 | 372.49 |

[a] Polyols don't contain residue.

Potato waste polyols did not contain a residue component therefore values of specific gravity, viscosity and surface tension increased with increscent liquefaction ratio.

Generally, the viscosity of the liquefied mixtures obtained by microwave assistant liquefaction was slightly higher than the fossil-based polyol due to biomass components remaining in the liquefied mixture. These values listed in the Table 3 were somewhat larger but were still suitable for the preparation of polyurethane foam.

From the Table 3, the most significant change is the hydroxyl value (about three quarter of the mixture of PEG400 and glycerin). Table 3 showed that the hydroxyl value of the liquefied mixture had decreased and acidic substances had been produced with increasing liquefaction time (Pu and Shiraishi, 1994). These results suggested that dehydration and/or oxidation reactions occurred during the liquefaction of potato crust (Yao et al., 1996).

**Biodegradation of Potato-based PU Foams**

The weight losses (resulted from a 3-month service biodegradation test) of the liquefied potato-based foams along with commercial synthetic PU-type rigid foams are 17.84% and 0,107%, respectively. This can be explained by the fact that potato waste-based foams contain much more natural components as starch and cellulose (Alma et al., 2002;Ge and Sakai, 1993;Chen and Lu, 2009).

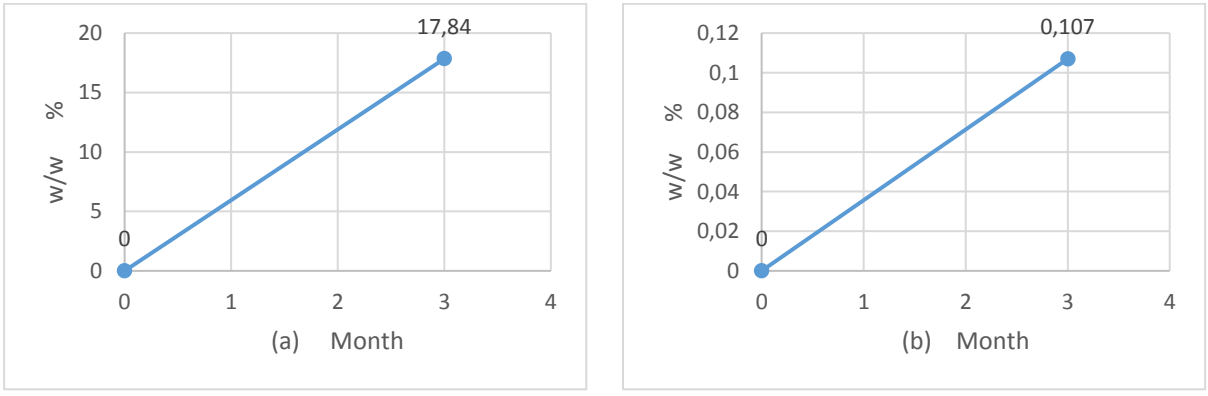



**Fig.2** Biodegradation Test Results of (a)Potato PU foam and (b)Synthetic PU foam

**Water Intake Test For Potato-based Foams**

The mean amount water intake at potato waste-based PU foams were 137%, 156%, 226%, 249%, 393%, 608%, 1,030% within 1, 2, 4, 8, 12, 24, and 48 hour respectively. The mean amount of water intake at petroleum-based foams were as to 35%, 42%, 52%, 65%, 76%, 84%, and 89% within 1, 2, 4, 8, 12, 24, 48 hour. This situation can be explained by the excellent hydrophilic characteristic properties of potato structure. Hydrophilic or water-absorbing foams are useful in manufacturing

absorbent products or in agricultural or horticultural purposes (Alfani et. al, 1998; Perkins, 1992;Hostettler, 1980).

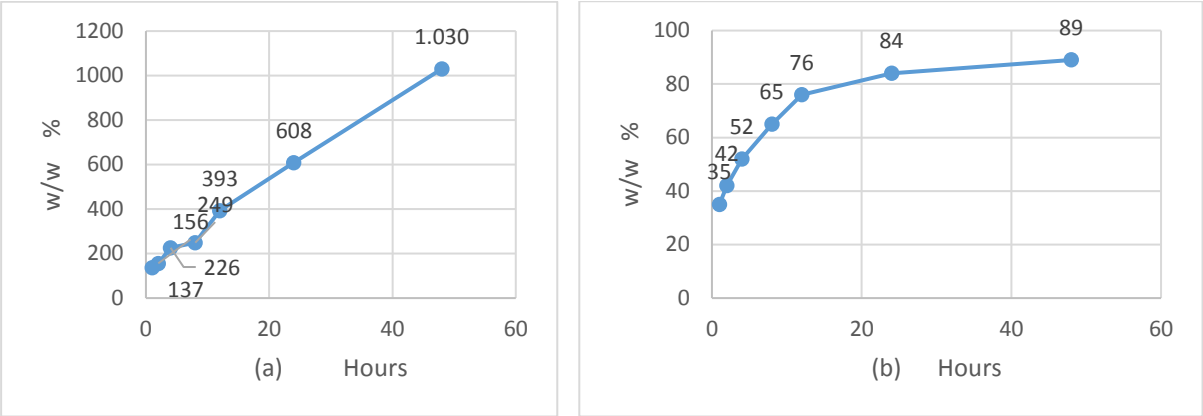



**Fig.3** Water Intake Results of (a)Potato PU foam and (b)Synthetic PU foam

## 4. Conclusion

In this study, potato meal was liquefied with PEG#400 main solvent and glycerin excipient solvent about 99.4% in mild conditions. This phenomenon was related to the high functionality of starches. During the liquefaction, starch and miserable cellulose degraded. Catalyst concentration, liquefaction time affected the liquefaction of potato meal-based polyols and their characteristics. Characteristic properties of biomass-based polyol were similar and slightly much over those of petroleum polyols.

**1.** Polyols showed to be good candidates for being used in PU foam synthesis.

**2.** Potato meal-based PU foams have greater biological degradability than synthetic fossils-based PU foams.

**3.** Water absorption of PU foams were found to be higher than synthetic foams.

Due to the concerns over the depletion of petroleum resources, there must been extensive interests to develop bio-based polyols and PUs (Luo et al., 2013; Gu et al., 2013; Zhang et al., 2014)

## Recommendations

As a novel technology, liquefaction of potato components has still many issues and further efforts are required for practical applications.

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# SOME SHRUB AND TREE TAXA IN THE GRASSLAND-PASTURE AND NATURAL VEGETATION OF TURKEY

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**Abstract***: Some shrub and tree taxa identified by different researchers in the meadow-pasture and natural vegetation of Turkey have been summarized in paper. Total 108 genus and 227 taxa were identified from 49 plant families. Although the vast majority of these taxa (165 taxa-72.7%) had shrub formation and the numbers of taxa in tree formation was only 27 taxa (11.9%). The other 35 plant taxa (15.4%) had a transitional formation between shrub and tree formations. When plants were ordered in terms of family, genus and taxa; Rosaceae was the first number family in 14 genus and 38 taxa (16.7%), Leguminosae in 12 genus and 35 taxa (15.9%), and Labiatae family in 11 genus and 25 taxa (11.0%) followed it. Even though the most taxa possessing families for shrub formation were Leguminosae (36 taxa), Labiatae (25 taxa) and Rosacea (21 taxa), for tree formation the ranking was as Fagaceae (5 taxa), Anacardiaceae (3 taxa), Ericaceae, Cupressaceae and Moraceae (2 taxa). Fagaceae (5 taxa), Anacardiaceae (3 taxa), Ericaceae, Cupressaceae ve Moraceae (2 taxa) families respectively had the most taxa belonging to transitional formation between shrub and tree formations. The results showed that the Kermes oak (Quercus coccifera) (in 11 studies), Black shrub (Paliurus spina-christi) (in 9 studies) and Murt shrub (Myrtus communis) (in 7 studies) were the most cited and frequently encountered shrub taxa by researchers in Turkey. Additionally, among the taxa were identified seven taxa as "endemic" and five taxa as "rare" plants.*

Key words: *Grassland, pasture, shrub, tree, taxa*

## 1. Introduction

In Turkey, the grassland-pasture area is 14.611.920 hectare (ha) and this accounts for 18.8% of the country's land [37]. Total size of pasture lands in-forests, side forests and top forests in Turkey are 3.450.736 ha, which accounts for 21% of total pasture size of the country [1]. There are about 8.3 million hectares of shrubs area in Turkey. Most of the shrubs consist of the maquis, which is natural vegetation of mediterranean climate. With a legal arrangement, these shrub areas were included in the forest area in 1969 [3]. Generally, due to over, untimely and non-uniform grazings, the amount of quality forage plant species are reduced and even disappeared in rangelands of Turkey [26]. Instead of the quality species, the rangelands are filled with other species, weeds and shrubs whose feed quality is low. Shrubs and trees are commonly seen in meadow and pasture lands that close to forests. Shrubs and trees in grassland-pasture areas are generally accepted as weed. This is due to the following reasons. They reduce the yield and quality of the forages, and they prevent comfortably animal grazing on rangelands [27]. Accordingly, the struggle with them is one of the important topics of pasture improvement programs. The pasture law numbered 4342 comes into force in 1998 in Turkey, pasture breeding studies started to gain speed in the Ministry of Food, Agriculture and Livestock, in Turkey [27]. In the control management with shrubs and tree taxa in the improvement of grassland-pasture, generally mechanical control, chemical control [11, 13, 15, 19, 22, 23 and 39] and biological control methods are used. Furthermore, usually goats are used in the method of biological control [40]. However, some shrubs and tree taxa in the grassland-pasture areas are the source of feed for domestic animals such as goats and sheep. They also contribute to the conservation of biodiversity by creating areas of nutrition and shelter for wild animals.

According to Gokkus *et al*. (2013), there are a great deal amount dry matter productions from herbaceous plants in the maquis areas. Especially they emphasized that amount of the forage varied depending on the frequency of the shrubs in the area [21]. The most of the sloping lands of in the Cukurova region are widely covered with maquis-shrub vegetation. The altitude of these lands extends up to 500-600 m higher than sea level. These shrubs generally are grazed with sheep and goat herds in winter period. The commonly found shrub species in these maqius are *Catycotome infesta, Cistus satviaefolius, Genista* sp., *Quercus coccifera* etc... [36]. Shrubs and small tree taxa are widely encountered in Mediterranean and Aegean Sea coasts up to 500 m height from sea level. Among the species the widely ones are wild olive (*Olea europea* L.), arbutas (*Arbutus unedo* L.), common myrtle (*Myrtus communis* L.), phllyrea, gum tree (*Pistacia lenticus* L.), Laden (*Cistus erectus* L.), Kermes oak (*Quercus coccifera* L.) and holy oak (*Quercus ilex* L.) [10]. In Kuredagi pasture land, a forest inside rangeland, rate of *Thymus sipyleus* species in botanical composition was 0.90% [1]. In Araplar village pastureland, Turkoglu district, Kahramanmaras the rate of *Paliurus spina-christi* was 1.15% [38].

Babalık and Fakir (2007) investigated the effects goats grazing on leaf morphology of some shrub species (*Quercus coccifera, Crataegus orientalis* var. *orientalis* and *Cotoneaster nummularia*) in Kozagacı plateau, Davraz Mountain, Isparta province. They were reported that the fragrant Juniper (*Juniperus foetidissima)* and the Greek Juniper (*Juniperus excelsa*) taxa converted their formation from tree formation into shrub formation due to intensive grazing [9]. In Kilis province, *Quercus coccifera,*

*Ziziphora clinopodioides* and *Thymus sipyleus* covered rate of 0.81-2.09%, 0.43-1.34% and 3.21%, respectively, in botanical composition of some pasture lands [31]. Weed species amount in rangelands of transitional zone of Cukurova region was % 58.7. Among the weed species, Murt shrubs (*Myrtus communis*) ratio was in 8.1% [13]. *Serbus eria* shrub taxa were covered 2.5% in Samsun province [41]. *Rubus sanctus* shrub species was covered 1.9% of flat rangelands in Kırıkhan district, Hatay province [14].

Gokkus *et al*. (2009) determined protein ratio of green biomass in *Phllyrea, Quercus coccifera* shrub taxa 5.56-7.61% to 5.63-7.25%, respectively in Canakkale province, Turkey [20]. In Isparta province, 1 hectare shrub area, covered with *Quercus coccifera,* is sufficient for 4 goats during a grazing period [35].

Alaturk et al. (2014) as result of their study conducted in Canakkale with 9 different shrub species, Phllyrea, Kermes oak, Cyprus oak, Gorse, Genista, Sea grape, Pseudoacacia, Goat bilberry and Prickly juniper, they reported that some important traits were ranged as followings; crude protein content 5.34-16.31%; crude oil content 4.46-7.57%; tannin content 0.11-2.18%; NDF ratio 35.22-53.87%; ADF ratio 23.77-44.15% and ADL ratio 8.54-16.98% [2].

Çetiner *et al*. (2015) reported that pre-improvement and management studies, 20-50% of the rangeland were covered with shrubs in Gerlengec village, Biga district, Canakkale province, Turkey [12].

*Astragalus microcephalus* and *Astragalus macrocephalus* species were found in high parts of Karacadag Mountains, located in the Southeast Anatolia. Moreover, these *Astragalus* species had shrub form and they were main feed sources for goat and sheep herds in the zone [27]. *Alhagi pseudalhagi*, shrub taxa, covers in 0.6-0.8% in the botanical composition of the pasture lands of Bismil district, Diyarbakır province [30]. The Kermes oak (*Quercus coccifera*), having a shrub or small tree form and predominant species, was used in feeding of goats due to its low input by people of Aegean and Mediterranean regions of Turkey [39]. The most economical control can be done against weed species in the pasture lands of Turkey with using goats in grazing. In this context, the most problematic species are *Centaurea, Cirsium* and *Rumex* having herbaceous formation, and *Rubus*, *Rosa* and *Genista* having shrub formation [40].

In this review study some shrub and tree taxa found in the grassland-pasture lands and natural vegetation of Turkey were examined.

## 2. Plant Growth Forms and Status of the Taxa

In this study, some species of shrub and tree taxa which have been determined by different researchers in the grassland-pasture areas and natural vegetation of Turkey have been sumarized. In the study, Latin, Turkish, English names, growth habitus and taxa for each family are given in the Table 1 cited by previous studies [1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 22, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 36, 37, 39, 40, 41 and 42]. Total 108 genus and 227 taxa belonging to 49 families in the grassland-pasture and natural vegetation of Turkey were determined (Table 1).

Detailed groupings were made by growth patterns of plant taxa (Table 1). The numbers of plant taxa in shrub forming were 107, and this indicated as the shrub (107). The other growth forms and taxa numbers were as followings; shrubby (17), half-shrubby (11), shrub or shrubby (6), half-shrub (4), scrub

shrub (2), shrub, half-shrub (2), shrub, dwarf-shrub (1), shrub, small shrub (1), shrub, aquatic shrub (1), shrub, half-shrubby (1), shrubby or half-shrubby (1), shrubby, shrub or woody-herb (1), small shrubby (1), small shrubby, herb or shrub (1), herb or half-shrub (1), herb or shrub (1), herb or shrubby (1), herbaceous-shrubby, half-shrub (1), wrapping shrub (1), creeping shrub (1), half-shrubby, shrubby (1), half-shrubby, herb or half-shrub (1) as "Shrub"; tree (17), shrub-tree (7), small tree (2), small shrub-tree (1) as “Trees” and shrub or tree (14), shrub or small tree-shrub (6), shrub or tree-shrub (3), shrub or tree (2), shrub or small tree (2), tree or shrub (1), tree or tall shrub (1), small shrub or shrub (1), shrub or scrub tree (1), shrub or small shrub-tree (1), shrub or rarely tree (1), shrub or rarely small tree (1), shrubby or woody (1).

The plant taxa were mainly grouped for three plant formations (Table 2). Plant taxa grouped; 165 taxa (72.7%) in shrub formation, 27 taxa (11.9%) in tree formation and 35 taxa (15.4%) in a transitional formation between shrub and tree formations.

*Leguminosae* (*Fabaceae*) family is the first number family with 36 taxa. It was followed by *Labiatae* (*Lamiaceae*) and *Rosacea* families with 25 and 21 shrub taxa, respectively. Even though 7 shurb taxa found in *Ericaceae* and *Rhamnaceae* families, 6 taxa found with shrub formation in *Chenopodiaceae* and *Cupressaceae* families. *Rosaceae* family (8 taxa) was the most numbers tree formation found taxa. It was followed by *Fagaceae*, *Salicaceae*, *Cannabaceae* families with 2 taxa, and *Cupressaceae*, *Anacardiaceae*, *Oleaceae*, *Cornaceae*, *Pinaceae* ve *Ulmaceae* with 1 taxa having tree formation and transitional formation between shrub and tree formations. The most taxa found in *Fagaceae* family with 5 taxa, it was followed by *Anacardiaceae* family with 3 taxa and *Ericaceae*, *Cupressaceae* and *Moraceae* faimilies with 2 taxa (Table 2). Furthermore, the status of the 10 families in terms of numbers of taxa belonging to 3 formations, shrub, tree and shrub-tree is indicated in Figure 1.

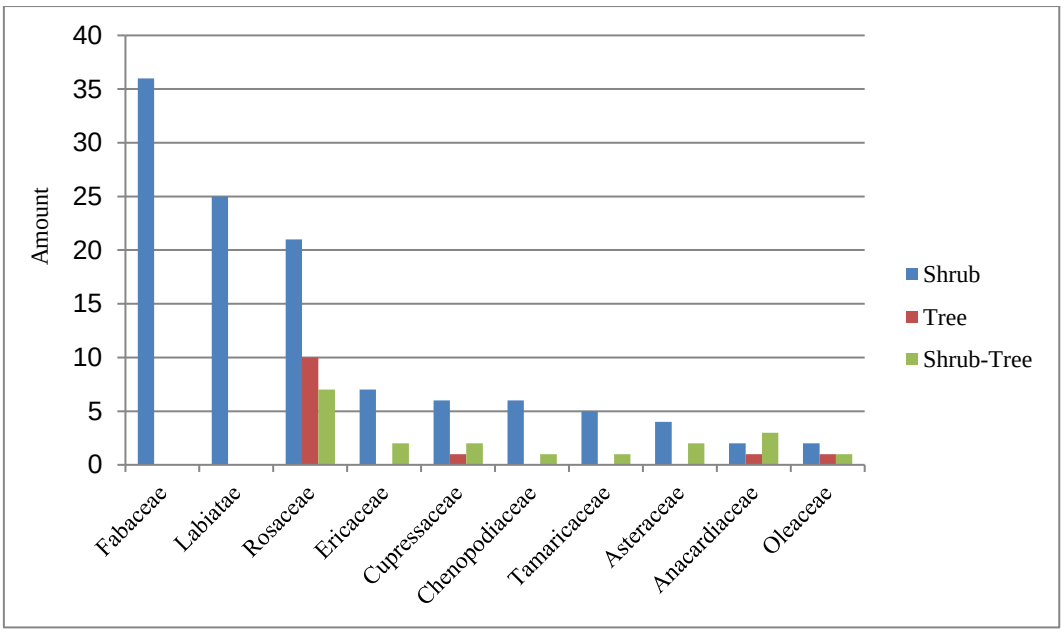


**Figure 1.** Numbers of plant taxa for shrub, tree and shrub-tree formations in the the most 10 common plant Families

### 3. Important Shrubs Taxa and Families in Turkey

Among 49 plant family, *Rosaceae* family was found as possessing the most numbers in 14 genus (13.0%.) and 38 taxa (16.7%). *Rosaceae* family was followed by *Leguminosae* (*Fabaceae*) in 12 genus (11.1%) and 36 taxa (15.6%), *Labiatae* (*Lamiaceae*) in 11 genus (10.2%) and 25 taxa (11.0%), *Chenopodiaceae* in 7 genus (6.48%) and 7 taxa (3.08%) and *Ericaceae* in 4 genus (3.70%) and 9 taxa (%3.96) (Table 2). In addition, the first 10 family, possessing the most number genus and taxa, were given in the Figure 2.

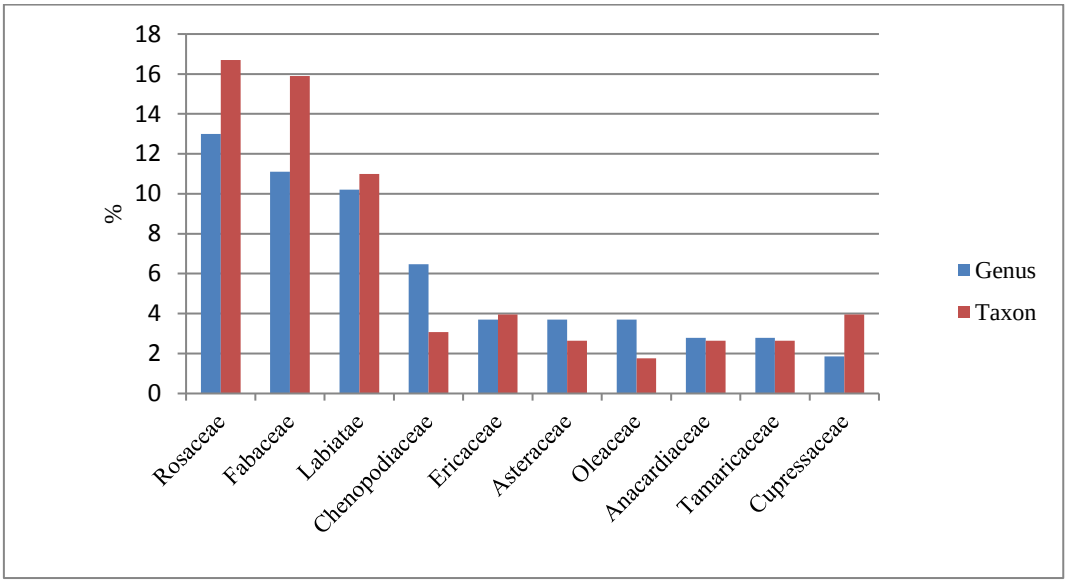


**Figure 2.** Numbers (%) of taxa and genus in the the most 10 common plant families, including shrub and tree forms plants

Among the taxa having shrub formation, the most found taxa is Kermes oak *(Quercus coccifera*) in Turkey. It was cited in 11 studies. It was followed by Black shrub (*Paliurus spina-christi)* (cited in 9 studies), Murt shrub (*Myrtus communis*) (cited in 7 studies), Thornburnet (*Sarcopoterium spinosum)*, Blackberry (*Rubus sanctus*), Small-headed astragalus (*Astragalus microcephalus*) (cited in 6 studies), Hairy germander (*Teucrium polium*), Chaste (*Vitex agnus-castus*) and Common camel thorn (*Alhagi pseudalhagi*) (cited in 5 studies).

Also, one of the most remarkable points of this work was that 7 shrub taxa were found as endemic (END LR lc). The endemic taxa were *Astragalus acicularis*, *Astragalus baibutensis*, *Astragalus condensatus*, *Astragalus cymbbostegius*, *Genista aucheri*, *Rhamnus hirtellus and Veronica multifida*. On the other hand, 5 shrub taxa were found as non-endemic rare plants (NB VU) [16]. These non-endemic rare plants taxa were *Alhagi mannifera*, *Galium incanum*, *Globularia cordifolia*, *Salvia fruticosa*, *Thymus transcaucasicus* (Table 1) [16].

## 4. Conclusions

Totally, 108 genus and 227 taxa were identified from 49 plant families in the scope of this study. It was also revealed that shrub, tree and transitional formation between shrub and tree formations had respectively 165 (72.7%) taxa, 27 taxa (11.9%) and 35 plant taxa (15.4%). Among all of the shrub taxa, the Kermes oak (*Quercus coccifera*), Black shrub (*Paliurus spina-christi*), Murt shrub (*Myrtus communis*), Thornburnet (*Sarcopoterium spinosum*), Blackberry (*Rubus sanctus*) and Small-headed astragalus (*Astragalus microcephalus*) have been the most reported taxa by the researchers in Turkey. In conclusion, long as uncontrolled and overgrazing continues in the grassland and pasture lands, quality forage crop species will disappear from these areas. The weeds and shrub taxa will continue to take the place of the quality forage plants.

***Table 1.*** *Some of the shrub and tree taxa found in the grassland-pasture and natural areas of Turkey* (1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 22, 23, 24, 25, 27, 28, 29, 30, 31, 33, 34, 36, 37, 39, 40, 41 and 42)

| ***Species Name*** | ***Life Forms*** | ***Turkish Name*** | ***English Name*** | ***Family*** |
|---|---|---|---|---|
| *Acantholimon acerosum* (Willd.) Boiss. | Shrubby | Sert kar dikeni, Çobanyastığı | | *Plumbaginaceae* |
| *Acantholimon acerosum* (Willd.) Boiss. var. *acerosum* | Shrubby | Pisik geveni | | *Plumbaginaceae* |
| *Acantholimon ulicinum* (Willd. Ex Schultes) Boiss. | Shrub, Small shrub | Pisik geveni, Çobanyastığı, Kurak kar dikeni | Prickly thrift | *Plumbaginaceae* |
| *Acantholimon venustum* Boiss. | Shrubby | Kar dikeni | Agrimony, Churchsteeples | *Plumbaginaceae* |
| *Acer monspessulanum* L. | Shrub or Scrub tree | Fransız akçaağacı | Montpellier maple | *Aceraceae* |
| *Alhagi mannifera* Desv. (NB VU) | Shrub or Shrubby | Deve dikeni | Camelthorn | *Leguminosae* (*Fabaceae*) |
| *Alhagi pseudalhagi* (M.Bieb.) Desv. | Shrub or Shrubby | Adi deve dikeni, Kara yandık | Camelthorn | *Leguminosae* |
| *Amygdalus communis* L. | Shrub or Tree | Acıbadem ağacı | Almon Tree | *Rosaceae* |
| *Amygdalus orientalis* Miller | Shrub | Keçi bademi | Goad almond | *Rosaceae* |
| *Arbutus andrachne* L. | Shrub | Sandal ağacı, Hartlap | Strawberry tree | *Ericaceae* |
| *Arbutus unedo* L. | Shrub | Dağ çileği, Kocayemiş | Strawberry tree | *Ericaceae* |
| *Artemisia absinthium* L. | Half shrubby | Pelin otu, Acı yavşan, Ak pelin, Büyük yavşan otu | Absinthium | *Compositae* (*Asteraceae*) |
| *Artemisia santonicum* L. | Half shrubby, Shrubby | Yavşan otu, Deniz yavşanı, Deniz pelini, Kokulu yavşan | Sagebrush | *Compositae* |
| *Asparagus acutifolius* L. | Shrubby | Çıtır, Tilkişen, Acı ot, Dikenli acı ot, Kırgın otu, Yabani kuşkonmaz, | | *Liliaceae* |
| *Astragalus acicularis* Bunge (END LR lc) | Shrub | | | *Leguminosae* |
| *Astragalus andrachneifolius* Fenzl | Shrub | Geven | Astragale | *Leguminosae* |
| *Astragalus aureus* Willd. | Shrub | Sarıçiçekli geven, Altın geveni | Astragale | *Leguminosae* |
| *Astragalus baibutensis* Bunge (END LR lc) | Shrub | Geven | Milk-vetch | *Leguminosae* |
| *Astragalus condensatus* Ledeb. (END LR lc) | Shrub | Yastıklı geven | | *Leguminosae* |
| *Astragalus cymbostegius* Bun. (END LR lc) | Shrub | Geven | Astragale | *Leguminosae* |
| *Astragalus gumnifer* Lab. | Shrub or Shrubby | Geven, Ak geven, Sakız geveni, Püs geveni, Zamk geveni | Gum tragacanth | *Leguminosae* |
| *Astragalus lagurus* Willd. | Shrub | Tüy başlı geven | Astragale | *Leguminosae* |
| *Astragalus macrocephalus* Willd. | Shrub or Shrubby | Küçükbaşlı geven, Boz geven, Kara geven | Astragale | *Leguminosae* |
| *Astragalus microcephalus* Willd. | Shrub or Shrubby | Küçükbaşlı geven, Boz geven, Kara geven | Astragale | *Leguminosae* |
| *Astragalus ponticus* Pallas | Half shrubby | Karadeniz geveni, Laz geveni | Pontic milk-vetch, Astragale | *Leguminosae* |
| *Astragalus prusianus* Boiss. | Shrub | | | *Leguminosae* |
| *Astragalus trojanus* Stev. | Shrub, Half shrubby | Truva geveni | | *Leguminosae* |
| *Astragalus wiedemannianus* Fischer | Shrub | | | *Leguminosae* |
| *Atriplex halimus* L. | Shrub | Yabani pazı, Parlak karapazı | Orache | *Chenopodiaceae* |
| *Berberis crataegina* DC. | Shrub | Adi hanımtuzluğu, Siyah meyveli hanımtuzluğu, Karamuk | Barberry, Cretan barberry | *Berberidaceae* |
| *Berberis cretica* L. | Shrub | Siyah meyveli hanımtuzluğu | Barberry | *Berberidaceae* |
| *Berberis integerrima* Bunge | Shrub | Hanımtuzluğu, Karamuk | Barberry | *Berberidaceae* |
| *Berberis vulgaris* L. | Shrub | Dağ kadıntuzluğu, Anberparis, Karamuk, Zibike | Common barberry, European barberry | *Berberidaceae* |
| *Buxus sempervirens* L. | Shrub | Şimşir | Common box, European box | *Buxaceae* |
| *Calicotome infesta* (C. Presl) Guss. | Shrub | | | *Leguminosae* |
| *Calicotome villosa* (Poiret) Link | Shrub | | | *Leguminosae* |
| *Camphorosma monspeliaca* L. | Shrub | | | *Chenopodiaceae* |
| *Capparis ovata* Desf. | Half shrub | Kapari, Kebere, Gebele | Caper bush, Common caper | *Capparaceae* |
| *Capparis ovata* Desf. var. *canescens* | Shrub, Half shrub | Kebere, Gebre otu, Kapari | Caper bush | *Capparaceae* |
| *Capparis ovata* Desf. var. *herbaceae* | Shrub, Half shrub | Kebere, Kapari | Caper bush | *Capparaceae* |

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| *Capparis spinosa* L. | Shrub | Kapari, Gebere, Kedi tırnağı | Caper | *Capparaceae* |
| *Capparis spinosa* L. var. *spinosa* | Half shrub | Kebere, Kapari | Caper | *Capparaceae* |
| *Caragana grandiflora* (Bieb.) DC. | Shrub | | | *Leguminosae* |
| *Carpinus betulus* L. | Tree | Karagürgen, Orsit | European hornbeam | *Betulaceae* |
| *Celtis glabrata* Steven ex Planchon | Tree | Çitlenbik, Dardağan | | *Cannabaceae* |
| *Celtis tournefortii* Lam. | Tree | Çitlenbik, Dardağan | | *Cannabaceae* |
| *Cerasus microcarpa* (C.A. Meyer) Boiss. subsp. *tortuosa* (Boiss. & Hausskn.) Browicz | Small tree | | | *Rosaceae* |
| *Chamaecytisus pygmaeus* (Willd.) Rothm. | Shrub | | | *Leguminosae* |
| *Cistus creticus* L. | Shrub | Karağan | Cretan rockrose | *Cistaceae* |
| *Cistus erectus* L. | Tree | Laden | | *Cistaceae* |
| *Cistus salviifolius* L. | Shrub | Adaçayı yapraklı laden | | *Cistaceae* |
| *Clematis orientalis* L. | Wrapping shrub | | Clematis | *Ranunculaceae* |
| *Colutea cilicica* Boiss. & Balansa | Shrub | Patlangaç | Blander senna | *Leguminosae* |
| *Coridothymus capitatus* (L.) Rchb. Fil. | Small shrubby | Bal kekiği | | *Labiatae* (*Lamiaceae*) |
| *Cornus sanguinea* L. | Small shrub-Tree | Kızılcık | Common dogwood | *Cornaceae* |
| *Cotinus coggyria* Scop. | Shrub | Boyacı sumağı, Duman ağacı | Red smoke bloom, Smoke brush | *Anacardiaceae* |
| *Cotoneaster integerrimus* Medik. | Shrub | Dağ muşmulası | Cotoneaster | *Rosaceae* |
| *Cotoneaster nummularia* Fisch. & C.A. Mey. | Shrub or Tree | Dağ muşmulası | | *Rosaceae* |
| *Crataegus aronia* (L.) Bosc. ex DC. var. *aronia* | Small tree | Alıç | Hawthorn | *Rosaceae* |
| *Crataegus curvisepala* Lindm. | Shrub or Tree | | | *Rosaceae* |
| *Crataegus microphylla* C. Koch | Shrub | | | *Rosaceae* |
| *Crataegus monogyna* Jacq. | Small tree | Alıç, Adi alıç, Akdiken, Adi akdiken, Yemişen | Oriental Thorn - large yellow/red haw, Hawthorn | *Rosaceae* |
| *Crataegus monogyna* Jacq. subsp. *monogyna* | Small tree | Alıç | Hawthorn | *Rosaceae* |
| *Crataegus orientalis* Pallas ex Bieb. var. *orientalis* | Small tree | Alıç | Hawthorn | *Rosaceae* |
| *Crataegus orientalis* Pallas ex M. Bieb. | Small tree | Alıç | Hawthorn | *Rosaceae* |
| *Crataegus pentagyna* Waldst. et Kit.ex Willd. | Shrub or Shrub-tree | | | *Rosaceae* |
| *Cytisopsis dorycniifolia* Jaub. et Spach | Shrub | | | *Leguminosae* |
| *Cytisus triflorus* L'Hérit. | Shrub | | | *Cistaceae* |
| *Daphne glomerata* Lam. | Shrub, Dwarf shrub | Kurtbağı, Sırımbağı | Daphne | *Thymelaeaceae* |
| *Daphne gnidioides* Jaub. et Spach. | Shrub | Defne, Develik, Havaza | Daphne | *Thymelaeaceae* |
| *Daphne oleoides* Shreber | Shrub | Zeytin defnesi, Havadana | Garland-flowered mezereon | *Thymelaeaceae* |
| *Daphne pontica* L. | Shrub | Karadeniz yabani defnesi, Kurtbağı | Twin-flowered daphne | *Thymelaeaceae* |
| *Daphne sericea* Vahl. | Shrub | İpeksi defne | | *Thymelaeaceae* |
| *Dittrichia viscosa* (L.) Greuter | Shrubby | Andız otu | | *Compositae* |
| *Dorycnium graecum* (L.) Ser. | Her or Half shrub | Tüylü yanık üçgülü, Kaplan otu | Canary clover, Trefoil | *Leguminosae* |
| *Dorycnium hirsutum* (L.) Ser. | Herb or Shrub | Ege yanık üçgülü | Gray brom, Hairy canary clover | *Leguminosae* |
| *Dorycnium pentaphyllum* Scop. | Small shrubby, Herb or Shrub | Zehirli yonca, Sarılık yonca | Dorycnium, Socarrillo | *Leguminosae* |
| *Elaeagnus angustifolia* L. | Shrub-Tree or Shrub | İğde | Russian olive | *Eleagnaceae* |
| *Ephedra campylopoda* C.A. Meyer | Creeping Shrub | Deniz üzümü | Ephedra | *Ephedraceae* |
| *Ephedra majör* Host. | Shrub, Aquatic shrub | Deniz üzümü, Hum | Ma huang | *Ephedraceae* |
| *Erica arborea* L. | Shrub | Süpürge ağ | | *Ericaceae* |
| *Erica manipuliflora* Salisb. | Shrub | Funda | Heather | *Ericaceae* |
| *Eriolobus trilobatus* (Poiret) Roemer | Small tree | At elması, Ateş dikeni, Ateş yaprağı | Wild apple tree | *Rosaceae* |
| *Ficus carica* L. | Shrub or Tree | İncir | Fig tree | *Moraceae* |
| *Ficus carica* L. subsp. *rupestris* (Hausskn.) Browicz | Shrub or Tree | İncir | Fig tree | *Moraceae* |
| *Frankenia hirsuta* L. | Herb or Shrubby | Tüylü deniz fundası | Sea heathweed | *Frankeniaceae* |
| *Fraxinus angustifolia* Vahl. subsp. *angustifolia* | Tree | Dışbudak | | *Oleaceae* |
| *Galium incanum* Sibth. & Sm. (NB VU) | Half shrubby, Herb or Half shrub | Yarı çalı yoğurtotu | Bedstraw | *Rubiaceae* |
| *Genista albida* Willd. | Shrub | Katırtırnağı | Soap wort | *Leguminosae* |
| *Genista anatolica* Boiss. | Shrub | Boyacı katırtırnağı | | *Leguminosae* |
| *Genista aucheri* Boiss. (END LR lc) | Shrub | Anadolu katırtırnağı, Anadolu boya çalısı | Petty whin, Anatolian needle furze | *Leguminosae* |
| *Genista carinalis* Gris. | Shrub | Katırtırnağı | | *Leguminosae* |
| *Genista lydia* Boiss. | Shrub | Lidya katırtırnağı | Lydian needle furze | *Leguminosae* |
| *Genista sessifolia* DC. | Shrub | Katırtırnağı, Boyacı katırtırnağı | Greenweed, Needl Furze | *Leguminosae* |
| *Genista tinctoria* L. | Shrub | Boyacı katırtırnağı | | *Leguminosae* |
| *Genista vuralii* A. Duran & H. Dural | Shrub | Katırtırnağı | Greenweed, Needl Furze | *Leguminosae* |
| *Globularia cordifolia* L. (NB VU) | Shrub | | | *Globulariaceae* |
| *Halimione portulacoides* (L.) Aellen | Shrub | Çorak otu, Tuzlu yalancı palı | See purslane | *Chenopodiaceae* |
| *Halocnemum strobilaceum* (Pall.) Bieb. | Scrub shrub | Çuvan, Acı ot | | *Chenopodiaceae* |
| *Halostachys belangeriana* (Moq.) Botsch. | Shrub or Small tree | | | *Chenopodiaceae* |
| *Hippophae rhamnoides* L. | Shrub | Yabani iğde | Seabuckthorn, Sanddorn | *Eleagnaceae* |
| *Hypericum scabrum* L. | Shrubby | Kaba kuzu kıran | St. Jonswort | *Guttiferae* (*Hypericaceae*) |
| *Ilex colchica* Poj. | Shrub or Tree | Çobanpüskülü | English holly | *Aquifoliaceae* |
| *Jasminum fruticans* L. | Shrub | Yabani yasemen, Boruk, Borumuk, Karaporuk | Wild jasmine | *Oleaceae* |
| *Juniperus communis* L. | Shrub | Adi ardıç, Bodur ardıç | Common juniper | *Cupressaceae* |
| *Juniperus communis* L. subsp. *nana* Syme | Shrub | Adi ardıç, Bodur ardıç | Common juniper | *Cupressaceae* |
| *Juniperus excelsa* M. Bieb. | Shrub | Boylu ardıç | | *Cupressaceae* |
| *Juniperus foetidissima* Willd. | Shrub | Kokulu ardıç | | *Cupressaceae* |
| *Juniperus irombinus* | Shrub | | | *Cupressaceae* |
| *Juniperus oxycedrus* L. | Shrub or Small tree | Katran ardıcı | Prickly juniper, Prickly cedar | *Cupressaceae* |

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| *Juniperus phoenicia* L. | Shrub-Tree | Finike ardıcı | Juniper | *Cupressaceae* |
| *Juniperus sabina* L. | Scrub shrub | İtalyan ardıcı, Sabin ardıcı | Savin, Savine | *Cupressaceae* |
| *Kochia prostrata* (L.) Schrad. | Shrubby or Half shrubby | Süpürge otu, Adi bozkır otu | Summer cypress, Mock cypres, fireweed | *Chenopodiaceae* |
| *Laurus nobilis* L. | Shrub or Tree | Defne, Har, Nehtel, Tahnal, Tefrün, Tehnel, Tenel | | *Lauraceae* |
| *Linum aroanium* Boiss. et Orph. | Half shrub | | | *Linaceae* |
| *Lonicera xylosteum* L. | Shrub | Hanımeli | Fly honeysuckle | *Caprifoliaceae* |
| *Malus communis* L. | Tree | Elma | Apple | *Rosaceae* |
| *Myricaria germanica* (L.) Desv. | Shrub | Alman ılgını, Yalancı ılgın | False tamarisk | *Tamaricaceae* |
| *Myrtus communis* L. | Shrub | Mersin, Murt, Murt çalısı | Myrtle | *Myrtaceae* |
| *Nerium oleander* L. | Shrub | Zakkum | Oleander | *Apocynaceae* |
| *Nitraria schoberi* L. | Shrub | | | *Zygophyllaceae* |
| *Noaea mucronata* (Forssk.) Aschers. et Sch. | Shrub | Dikenli ölmez otu | Goosefoots | *Chenopodiaceae* |
| *Oenanthe silaifolia* Bieb. | Shrub | Damla otu | Narrow-leaved water-dropwort, Sulpherwort | *Umbelliferae* |
| *Olea europaea* L. | Shrub | Yabani zeytin, Delice | Wild olive | *Oleaceae* |
| *Onobrychis cornuta* (L.) Desv. | Shrub or Shrubby | Boynuzlu korunga, Dağ çöveni | | *Leguminosae* |
| *Origanum onites* L. | Herbaceous-Shrubby, Half shrub | İzmir kekiği, Kaba tüylü mercanköşk | Cretan oregano, Rhigani, Pot marjoram | *Labiatae* |
| *Origanum sipyleum* L. | Half shrub | Bayır Çayı, Güvey otu | | *Labiatae* |
| *Origanum syriacum* L. | Shrubby | Dağ kekiği | Syrian oreganu | *Labiatae* |
| *Paliurus spina-christi* Miller | Shrub | Karaçalı, Çalı dikeni, Çaltı dikeni, Çeşmezen, İsa dikeni, Kara çaltı, Kara diken, Kışla dikeni, Kunar, | Jarusalem thorn, Garland thorn | *Rhamnaceae* |
| *Phillyrea latifolia* L. | Shrub or Small tree | Kesme, Akçakesme, Akçe kesme | | *Oleaceae* |
| *Phlomis kotschyana* Hub. -Mor. | Shrubby | Kudüs adaçayı | Jarusalem sage | *Labiatae* |
| *Pinus nigra* Arn. subsp. *pallasiana* (Lamb.) Holmboe | Tree | Anadolu karaçamı | | *Pinaceae* |
| *Pinus nigra* J. F. Arnold | Tree | Çam ağacı | | *Pinaceae* |
| *Pistacia atlantica* Desv. | Tree or Shrub | Atlas sakız ağacı | Atlas mastic tree | *Anacardiaceae* |
| *Pistacia khinjuk* Stocks | Tree | Melengiç | | *Anacardiaceae* |
| *Pistacia lentiscus* L. | Shrub or Shrub-Tree | Sakız ağacı, Akçakesme, Sakızağacı | Mastic tree | *Anacardiaceae* |
| *Pistacia terebinthus* L. | Shrub or Small tree | Çitlenbik, Melengiç | Terebinth, Terebinth Tree | *Anacardiaceae* |
| *Polygala comosa* Schkuhr | Shrubby | Sütotu | Tufted milkwort | *Polygalaceae* |
| *Polygala pruinosa* Boıss. | Half shrubby | Anadolu süt otu, Haç çiçeği, Yılan yoncası | Milkwort | *Polygalaceae* |
| *Populus tremula* L. | Tree | Titrek kavak | Trembling poplar | *Salicaceae* |
| *Potentilla fruticosa* L. | Shrub | Parmak otu | | *Rosaceae* |
| *Prasium majus* L. | Shrub | | | *Labiatae* |
| *Prosopis farcta* (Banks et Sol.) Macbride | Shrub | Çeti, Çedi | | *Leguminosae* |
| *Prunus amygdalus* Batsch | Shrub or Tree | Badem ağacı | | *Rosaceae* |
| *Prunus cerasus* L. | Shrub or Small tree | Vişne ağacı | Cherry | *Rosaceae* |
| *Prunus divaricata* Ledeb. | Shrub | Yunus eriği | | *Rosaceae* |
| *Prunus domestica* L. | Shrub or Tree | Erik ağacı | Plum tree | *Rosaceae* |
| *Prunus spinosa* L. | Shrub | Çakaleriği, Güvem | Blackthorn | *Rosaceae* |
| *Ptilostemon chamaepeuce* (L.) Less. | Shrub | Pembe tüyercik | | *Compositae* |
| *Pyrus elaeagnifolia* L. | Tree | Ahlat | Wild pear | *Rosaceae* |
| *Pyrus syriaca* Boiss. var. *syriaca* | Tree | Ahlat, Yabani armut | | *Rosaceae* |
| *Quercus brantii* Lindley | Tree | Meşe | | *Fagaceae* |
| *Quercus cerris* L. | Shrub or Small tree | Türk meşesi, Saçlı meşe | Turkey oak | *Fagaceae* |
| *Quercus coccifera* L. | Shrub or Small tree | Kermes meşesi | Kermes oak | *Fagaceae* |
| *Quercus ilex* L. | Tree or Tall shrub | Çalı meşesi, Karagan, Pırnal meşesi, Pırnar | | *Fagaceae* |
| *Quercus infectoria* Olivier subsp. *boissieri* (Reuter) O. Schwarz | Tree | Meşe | | *Fagaceae* |
| *Quercus macrolepis* Kotschy | Shrub or Tree | Palamut, Pullu meşe | Valonia oak | *Fagaceae* |
| *Quercus petraea* (Matt.) Lieb. | Shrub or Small tree | Sapsız meşe | Durmast oak, Sessile oak | *Fagaceae* |
| *Quercus pubescens* Willd. | Small tree | Tüylü Meşe | | *Fagaceae* |
| *Quercus robur* L. | Shrub or Tree | Saplı meşe, Adi meşe | Common oak, English oak | *Fagaceae* |
| *Quercus trojana* P.B. Webb | Tree | Makedonya Meşesi | | *Fagaceae* |
| *Reaumuria alternifolia* (Lab.) Britten | Shrub | Kör diken | | *Tamaricaceae* |
| *Rhamnus hirtellus* Boiss. (END LR lc) | Shrub | Cehri, Karaçalı | | *Rhamnaceae* |
| *Rhamnus oleoides* L. | Shrubby | Kör diken | | *Rhamnaceae* |
| *Rhamnus pallasii* Fisch. & C.A. Mey. | Shrub | Cehri | Buckthorn | *Rhamnaceae* |
| *Rhamnus rhodopeus* Velenovsky | Shrub | | | *Rhamnaceae* |
| *Rhamnus saxatilis* Jacq. | Shrub | | Rock buckthorn | *Rhamnaceae* |
| *Rhamnus tomentella* Benth. | Shrub | | | *Rhamnaceae* |
| *Rhododendron caucasium* Pallas | Shrub | Komar, Orman gülü | Rhododendron | *Ericaceae* |
| *Rhododendron luteum* Sweet | Shrub | Komar, Orman gülü | Rhododendron | *Ericaceae* |
| *Rhododendron ponticum* L. | Shrub or Tree | Ağu, Komar, Orman gülü, Kafil, Kaful, Kara ağu, Zelenika | Rhododendron | *Ericaceae* |
| *Rhododendron ungernii* Trautv. | Shrub or Small tree | Komar, Orman gülü | Rhododendron | *Ericaceae* |
| *Rhus coriaria* L. | Shrub | Adi sumak | Sicilian sumac | *Anacardiaceae* |
| *Ribes aureum* Prush | Shrub | Frenk üzümü, Sarı bektaşiüzümü | Golden currant | *Glossulariaceae* |
| *Rosa canina* L. | Shrub | Yabani gül, Kuşburnu, İtburnu, Köpekgülü | Dog rose, Wild rose, Heprose | *Rosaceae* |
| *Rosa dumalis* Bechst. | Shrub | Yabani gül, Kuşburnu, | Glaucous Dog rose | *Rosaceae* |
| *Rosa hemisphaerica* J. Herrm. | Shrub | Sarıçiçekli yaban gülü | Yellow flowers wild rose | *Rosaceae* |
| *Rosa micrantha* Sm. | Shrub | Kuşburnu | Smallflower sweetbrier | *Rosaceae* |
| *Rosa montana* Chaix | Shrub | Dağ gülü | | *Rosaceae* |

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| *Rosa pulverulenta* Bieb. | Shrub | Yabani gül | Wild rose | *Rosaceae* |
| *Rosa sempervirens* L. | Shrub | Deli gül, Yabani gül | | *Rosaceae* |
| *Rubus caesius* L. | Shrub | | | *Rosaceae* |
| *Rubus canescens* DC. | Shrub | Böğürtlen | Blackberry | *Rosaceae* |
| *Rubus discolor* Weihe et Nees. | Shrub | Himalaya böğürtleni | Himalayan blackberry, Himalayaberry | *Rosaceae* |
| *Rubus fruticosus* L. | Shrub | Böğürtlen | | *Rosaceae* |
| *Rubus sanctus* Schreber | Shrub | Böğürtlen, Kutsal böğürtlen, Mora dikeni | Blackberry | *Rosaceae* |
| *Ruscus aculeatus* L. | Shrub | Tavşan kirazı | Butcher's brome | *Rosaceae* |
| *Ruta chalepensis* L. | Half shrubby | Sedef otu, Kokarsedef | | *Rutaceae* |
| *Salix alba* L. | Tree | Aksöğüt | White willow | *Salicaceae* |
| *Salix triandra* L. | Shrubby or Shrub-Tree | Badem yapraklı söğüt | Almond willow | *Salicaceae* |
| *Salvia fruticosa* Miller (NB VU) | Shrubby | Adaçayı | Triloba sage | *Labiatae* |
| *Salvia pachystachys* Trautv. | Shrubby, Shrub or Woody-herb | Kalın başaklı adaçayı | Rough-spike sage | *Labiatae* |
| *Sarcopoterium spinosum* (L.) Spach | Shrub | Aptesbozan | | *Rosaceae* |
| *Satureja juliana* L. | Shrubby | Çalımsı geyik otu | Savory, Micromeria | *Labiatae* |
| *Satureja parnassica* Heldr.& Sart. ex Boiss. | Shrubby | Sipil geyik otu | | *Labiatae* |
| *Satureja spicigera* (C. Koch) Boiss. | Shrubby | Trabzon kekiği | Savory | *Labiatae* |
| *Satureja thymbra* L. | Shrubby | Pembe geyikotu | Pink savory, Barrel sweetener | *Labiatae* |
| *Sorbus aria* (L.) Crantz | Shrub | Kocakarı yemişi | Common whitebeam | *Rosaceae* |
| *Spartium junceum* L. | Shrub | Katırtırnağı, Saz kaytanotu Borcak, Borçoh, Boruk, Kuş çubuğu | Spanish brom, Weaver's broom | *Leguminosae* |
| *Stachys iberica* Bieb. | Half shrubby | Dağ çayı | Woundwort, Lamb's Ear | *Labiatae* |
| *Stachys iberica* Bieb. subsp. *stenostachya* (Boiss.) Rech. | Half shrubby | | | *Labiatae* |
| *Stachys lavandulifolia* Vahl. | Half shrubby | Mor çiçekli karabaş otu, Eşek otu, Tokalı çay, Tüylü çay | Woundwort, Lamb's Ear | *Labiatae* |
| *Styrax officinalis* L. | Shrub or Rarely tree | Ayı fındığı, Çakıldak, Tespih ağacı | Styrax tree | *Styracaceae* |
| *Tamarix articulata* Vahl. | Shrub or Tree | | Athel tamarisk | *Tamaricaceae* |
| *Tamarix parviflora* DC. | Shrub | Ilgın | Tamarisk | *Tamaricaceae* |
| *Tamarix smyrnensis* Bunge. | Shrub | Ilgın | Tamarisk | *Tamaricaceae* |
| *Tamarix tetrandra* Pallas ex M. Bieb. | Shrub | Ilgın | Tamarisk | *Tamaricaceae* |
| *Tanacetum abrotanifolium* (L.) Druce | Shrub or Tree | Ala renkli solucan otu | | *Compositae* |
| *Tanacetum armenum* (DC.) Schultz Bıp. | Shrub or Tree | Gümüşdüğme | Feverfew, Featherfew, Flirtwort | *Compositae* |
| *Teucrium chamaedrys* L. | Half shrubby | Yer meşesi, Bodur meşe | Germander, Wall germander | *Labiatae* |
| *Teucrium pollium* L. | Half shrubby | Mayasıl otu, Taş kekiği, Acı ot, Ak sedef otu, Anababa kekiği | Hairy germander | *Labiatae* |
| *Thuja orientalis* L. | Shrub or Tree | Doğu mazısı | Morpankhi, Thujone | *Cupressaceae* |
| *Thymbra spicata* L. | Shrub | Karabaş kekik | Spiked thyme | *Labiatae* |
| *Thymus fallax* Fisch. et C.A. Mey. | Shrub | | | *Labiatae* |
| *Thymus kotschyanus* Boiss. et Hohen. | Shrub | | | *Labiatae* |
| *Thymus leucotrichus* Hal. | Shrub | | | *Labiatae* |
| *Thymus sipyleus* Boiss. | Shrubby | Yastıklı kekik | | *Labiatae* |
| *Thymus transcaucasicus* Ronnıger (NB VU) | Shrub | | | *Labiatae* |
| *Thymus zygioides* Griseb. | Shrub | | | *Labiatae* |
| *Ulmus minör* Miller | Tree | Ova karaağacı, Gürgen yapraklı karaağaç | Smooth leaved elm, English elm | *Ulmaceae* |
| *Vaccinium arctostaphylos* L. | Shrub | Yaban mersini, Ayı üzümü | Caucasian whortleberry | *Ericaceae* |
| *Veronica multifida* L. (END LR lc) | Half shrubby | Yavşan otu, Venüs çiçeği | Speedwell | *Scrophulariaceae* |
| *Vibirnum lantana* L. | Shrub | Germişek, Germeşik, Germeşe | Wayfaring tree | *Caprifoliaceae* |
| *Vibirnum opulus* L. | Shrub or Small shrub-Tree | Kartopu, Geleboru, Girabolu | Wayfaring tree | *Caprifoliaceae* |
| *Vincetoxicum hirundinaria* Medicus | Shrubby | Panzehir otu, Kırlangıç otu | Swallow wort | *Asclepiadaceae* |
| *Vitex agnus-castus* L. | Shrub or Rarely small tree | Hayıt, İffet ağacı, Rahip biberi | Chaste tree | *Verbenaceae* |
| *Ziziphora clinopodioides* Lam. | Half shrubby | Dağ reyhanı, Kır nanesi, Nane ruhu | Persian wild thyme | *Labiatae* |

END LR lc: Endemic Plants, NB VU: Non-Endemic Rare Plants

***Table 2.*** *Numbers of families, genus and taxa with growth forms and ratios (%) of some shrub and Tree species found in the grassland-pasture and natural areas of Turkey*

| | Family | Genus | % | Taxa | % | Life Forms |
|---|---|---|---|---|---|---|
| 1 | *Rosaceae* | 14 | 13.0 | 38 | 16.7 | Shrub (21), Tree (10), Shrub or Tree (7) |
| 2 | *Leguminosae (Fabaceae)* | 12 | 11.1 | 36 | 15.9 | Shrub (36) |
| 3 | *Labiatae (Lamiaceae)* | 11 | 10.2 | 25 | 11.0 | Shrub (25) |
| 4 | *Chenopodiaceae* | 7 | 6.48 | 7 | 3.08 | Shrub (6), Shrub or Tree (1) |
| 5 | *Ericaceae* | 4 | 3.70 | 9 | 3.96 | Shrub (7), Shrub or Tree (2) |
| 6 | *Compositae (Asteraceae)* | 4 | 3.70 | 6 | 2.64 | Shrub (4), Shrub or Tree (2) |
| 7 | *Oleaceae* | 4 | 3.70 | 4 | 1.76 | Shrub (2), Tree (1), Shrub or Tree (1) |
| 8 | *Anacardiaceae* | 3 | 2.78 | 6 | 2.64 | Shrub (2), Tree (1), Shrub or Tree (3) |
| 9 | *Tamaricaceae* | 3 | 2.78 | 6 | 2.64 | Shrub (5), Shrub or Tree (1) |
| 10 | *Cupressaceae* | 2 | 1.85 | 9 | 3.96 | Shrub (6), Tree (1), Shrub or Tree (2) |
| 11 | *Rhamnaceae* | 2 | 1.85 | 7 | 3.08 | Shrub (7) |
| 12 | *Cistaceae* | 2 | 1.85 | 4 | 1.76 | Shrub (3), Tree (1) |
| 13 | *Caprifoliaceae* | 2 | 1.85 | 3 | 1.32 | Shrub (2), Shrub or Tree (1) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 | *Salicaceae* | 2 | 1.85 | 3 | 1.32 | Tree (2), Shrub or Tree (1) |
| 15 | *Eleagnaceae* | 2 | 1.85 | 2 | 0.88 | Shrub (1), Shrub or Tree (1) |
| 16 | *Fagaceae* | 1 | 0.93 | 10 | 4.41 | Tree (4), Shrub or Tree (6) |
| 17 | *Capparaceae* | 1 | 0.93 | 5 | 2.2 | Shrub (5) |
| 18 | *Thymelaeaceae* | 1 | 0.93 | 5 | 2.2 | Shrub (5) |
| 19 | *Berberidaceae* | 1 | 0.93 | 4 | 1.76 | Shrub (4) |
| 20 | *Plumbaginaceae* | 1 | 0.93 | 4 | 1.76 | Shrub (4) |
| 21 | *Cannabaceae* | 1 | 0.93 | 2 | 0.88 | Tree (2) |
| 22 | *Ephedraceae* | 1 | 0.93 | 2 | 0.88 | Shrub (2) |
| 23 | *Moraceae* | 1 | 0.93 | 2 | 0.88 | Shrub or Tree (2) |
| 24 | *Pinaceae* | 1 | 0.93 | 2 | 0.88 | Tree (2) |
| 25 | *Polygalaceae* | 1 | 0.93 | 2 | 0.88 | Shrub (2) |
| 26 | *Aceraceae* | 1 | 0.93 | 1 | 0.44 | Shrub or Tree (1) |
| 27 | *Apocynaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 28 | *Aquifoliaceae* | 1 | 0.93 | 1 | 0.44 | Shrub or Tree (1) |
| 29 | *Asclepiadaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 30 | *Betulaceae* | 1 | 0.93 | 1 | 0.44 | Tree (1) |
| 31 | *Buxaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 32 | *Cornaceae* | 1 | 0.93 | 1 | 0.44 | Tree (1) |
| 33 | *Frankeniaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 34 | *Globulariaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 35 | *Glossulariaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 36 | *Guttiferae* (*Hypericaceae*) | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 37 | *Lauraceae* | 1 | 0.93 | 1 | 0.44 | Shrub or Tree (1) |
| 38 | *Liliaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 39 | *Linaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 40 | *Myrtaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 41 | *Ranunculaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 42 | *Rubiaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 43 | *Rutaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 44 | *Scrophulariaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 45 | *Styracaceae* | 1 | 0.93 | 1 | 0.44 | Shrub or Tree (1) |
| 46 | *Ulmaceae* | 1 | 0.93 | 1 | 0.44 | Tree (1) |
| 47 | *Umbelliferae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| 48 | *Verbenaceae* | 1 | 0.93 | 1 | 0.44 | Shrub or Tree (1) |
| 49 | *Zygophyllaceae* | 1 | 0.93 | 1 | 0.44 | Shrub (1) |
| | **Total** | **108** | **100** | **227** | **100** | **227** |

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# EDUCATION CAN BE A RESEARCH SUBJECT TOO, THROUGH SCIENTIFIC TEACHING

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**Abstract**: *In the last few decades, many important discoveries have been made in the field of education research. Few have been more influential than Dr. Donald Bligh's discovery that lectures are an inefficient method for student retention of new information. In the years following Dr. Bligh's discovery, science education in the US has witnessed a significant change in focus away from lecture-styled approaches that emphasize memorization towards interactive approaches focusing more on the training of skill competence. A range of research has employed the principles of scientific teaching with great success to investigate a wide array of different learning methods, resulting in the development of powerful education platforms such as active learning and authentic research experiences (AREs). This article reviews some of the education literature behind scientific teaching, active learning, and AREs, ending with a short commentary about the immense potential for the application of these systems in higher education in the Middle East, both as a process of improving educational outcome as well as enhancing the efficacy of pedagogy as a research subject.*

**Keywords**: scientific teaching, active learning, STEM education, authentic research experiences, education research

## 1. Education as research.

In the last few decades, many important discoveries have been made in the field of education research. Few have been more influential than Dr. Donald Bligh's discovery that lectures are inefficient methods for students to retain new information [1, 2]. Not surprisingly, Dr. Bligh's results were greeted with some degree of skepticism [3, 4]. However, follow-up research conducted by a number of other authors has since confirmed that most students tend not to remember much when taught using a lecture-styled format [5-7]. This ineffectiveness has been demonstrated in knowledge learning [8-10] and found to be an even greater issue in skill learning [11-13]. In academic fields such as the sciences, which rely on the acquisition of laboratory expertise, skill learning is especially important, often considered a basic foundation for training good scientists [14-16].

In the years following Dr. Bligh's discovery, science education in the US has witnessed a significant change in focus away from lecture-styled approaches that focus on knowledge towards interactive approaches focused more on skill training [17, 18]. In 2004, Dr. Jo Handelsman and colleagues published their seminal paper in *Science* entitled "Scientific teaching". This paper described

the critical importance of using scientific methods to investigate the effectiveness of pedagogy [19, 20]. This process essentially involves designing and conducting experiments on various learning methods to produce statistically relevant data about educational outcomes, data that allows a determination about whether the methods were effective. As coined in the title of their paper, this process is known as *scientific teaching*.

Since this seminal work by Dr. Handelsman, a wide range of research has employed the principles of scientific teaching with great success to investigate many different learning methods [21, 22]. The use of technology in the classroom, for example, has been one of the areas studied extensively [23-25], as has the use of class activities employing group discussion strategies [26-28]. Both of these concepts, when employed in the right way, have been shown to be extremely successful in improving learning gains. The usefulness of inquiry-based learning systems [29, 30] and the development of new techniques for helping students understand and approach primary literature [31, 32] have been some of the many significant improvements in science education. In the US, many of these new learning techniques have been joined into different combinations to realize significant improvements in student outcomes, both in the classroom [33, 34] and on an institutional level [35].

**2. What is active learning?**

One of the combinations of new learning methods that has been particularly powerful and influential in the US is *active learning* [36, 37]. At its roots, the active learning system involves redesigning the activities occurring in-class to improve student interactions and feedback by implementing controlled problem-solving activities [38, 39]. These activities are specifically designed to focus student and instructor attention on the process of learning how to apply knowledge rather than simply memorize it, the latter of which is usually the goal in a lecture-based system. By emphasizing the majority of in-class time on problem-solving, active learning gives students the chance to receive more feedback and attention from instructors in developing their knowledge-use skills [40].

The strengths and advantages of active learning have been studied extensively in the last decade. Across the board, active learning has been shown to be very effective in improving learning gains [41, 35], yielding better student grades [42, 6], improving the retention of class material [43,44], and even improving student interest levels in various topics [45, 46]. A central principle of the active learning system is the idea of a "flipped classroom", a concept sometimes also referred to as "reverse design" [47-49]. A flipped classroom describes a situation in which the traditional in-class and out-of-class activities are reversed.

In traditional lecture classes, for example, new material is usually presented to students in class through lectures. In most science classes, out-of-class time is then used by students to work on assigned problems sets. These problems sets require the students to apply things they were shown in the lectures. There are two main shortcomings that arise through this traditional arrangement. The first is found in the simple fact that students do not tend to remember much of what they were told in lectures. We know this from Dr. Bligh's original work and in the wealth of follow-up research [1, 2, 5-7]. Since the problem sets require students to have this foundational knowledge, the lack of retention from lectures puts a lot of pressure on them to learn the bulk of the material by themselves. The second shortcoming is found in the fact that students receive very little feedback when they are working on the problem sets, making

the acquisition of problem-solving skills an independent endeavor with little instructor oversight [50, 51].

In the active learning system, this traditional arrangement of activities is flipped. In active learning, new material is introduced to students outside of the class, usually through online lectures or assigned readings [52, 53]. At the same time, the problem sets become in-class activities. Not only does this new arrangement allow for more feedback from instructors, the installation of a group problem-solving environment, another common element of active learning, allows for students to receive feedback from each other, allowing for much better retention of the material and faster learning [54, 6]. This allows the process of cooperative learning to enhance the pedagogical process while simultaneously bringing the more difficult of the two tasks--namely, learning new material and then applying it--under the direct supervision of instructors. Since most exams in science usually involve assessments of problem-solving ability, this rearrangement can also result in direct improvements of student grades [42, 6].

**3. Assessments for educational outcomes**

Because of the wide range of different learning approaches and the staggering breadth of things that students need to learn, a very active area of current education research has revolved around the design and implementation of new assessment tools which attempt to quantify student outcomes with statistical significance [55-57]. As described above, such tools have been used to quantify things such as student retention of new material [58-60] and problem-solving skill competence [61-63]. Both of these types of tools have been very important in establishing the usefulness of scientific teaching.

Another active area of research has been the design and implementation of tools that gauge student attitudes about classes, learning methods, instructors, and curricula [64-67]. These tools have been especially useful in uncovering the power of cooperative learning [68-70] while also allowing educational researchers to realize that there can exist a wide range of variability in the ways different students respond to the same teaching technique, even when this technique is applied in the same way to the same academic subject. These results have had significant implications in helping educators better understand the conditions that facilitate more inclusive learning [71-73].

Perhaps the rapid expansion of new assessment tool development is one of the most significant and important innovations driven by scientific teaching [74, 75]. Not only is the study and design of new tools currently a cutting-edge topic in education research, the deployment of existing tools in new situations or new cultural contexts is one of the concepts with wide reaching applicability, an untapped opportunity for education researchers in most countries, especially those with emerging education infrastructure. An especially interesting area of development is the construction and deployment of assessments for measuring skill competence [76, 77]. Recent developments in this area have clearly indicated that skill competence is something that needs to be measured with focused specificity. For example, an assessment that measures a student's ability to understand and apply genetics knowledge on paper does not necessarily predict that student's ability to use this knowledge in the lab, creating an important distinction about the relationships between discrete skills, creating the need for many different assessments.

In a general sense, perhaps the most important lesson to be learned from the abundance of education research hitherto generated through scientific teaching is the idea that just having the instructor explain something is not enough. Most teachers often subscribe to the misconception that explaining something once or twice should be sufficient for students to remember that information accurately and over long periods of time. Scientific teaching research clearly shows this is not true [78, 79]. Instead, a common thread that has emerged from the research is that the long-term retention of new material seems to require students to apply that information in some way, usually more than once, a goal that active learning is specifically designed to achieve [38, 39]. The distinctions between a student's recognition of a new word, his or her ability to define it, and the ability to apply it are things presented in self-evident fashion in Bloom's pyramid, a conceptual model found in psychology that organizes these and other modes of thinking into a structured hierarchy, showing that one must precede the other, something that has now been confirmed experimentally [80, 81].

**4. Authentic research experiences**

Active learning is not the only implement in science education that can be used to focus more time and attention on skill development. In traditional science education, classes are typically divided into two types: lecture and lab. Lectures are where new content knowledge is supposed to be delivered whereas labs are where students are expected to apply this new knowledge. The problem with traditional lab classes is that they are built like cookbooks, with everything explained beforehand and nothing new for students to discover [82, 83]. This is despite the fact that many science students actually join science because of their desire to discover, often leaving many disappointed about the lack of discovery-oriented intellectual stimulation in their course work [84, 85].

In the last few years, some universities such as Yale and Stanford, have started to implement new types of lab courses that specifically gives students the chance to make discoveries [86, 87]. One of these new types is something called the authentic research experience (ARE). An ARE is a lab course that is designed around a real research question that gives students the chance to discover. This inquiry-based approach is especially advantageous in lab classes because they allow students to practice critical research skills that would otherwise not be practiced in a traditional cookbook lab [88-90]. For example, in a cookbook lab, students are usually given a lab manual that explains everything that could possibly happen with their experiment, depriving them of the chance to make predictions about the experiment or troubleshoot problems, two critical skills that need to be practiced.

In an ARE, on the other hand, students do not possess this information. Instead, they are given an experimental question and some guidelines with which to make decisions about how they will conduct the experiment, resulting in a more realistic simulation of real research, a process that invariably requires the participants to deal with various levels of the unknown. At each step in the experiment, students are allowed to think about that step, sometimes by making hypotheses or designing experimental parameters while, at other times, implementing those parameters and troubleshooting the results. This process allows for a much more "authentic" experience in which students practice more of the actual research skills they will need as researchers. In addition to the improvement in the skills practiced, AREs also give students a strong sense of ownership over their experiments, heightening the level of satisfaction and enjoyment while stimulating the desire to discover and learn through discovery [88-90].

If designed well, an ARE can be used as a platform for generating real experimental data. Fudan University, for example, has recently implemented a large-scale ARE program called BIOS [91]. This program is a summer ARE with six topical tracks: biochemistry, cell biology, fly genetics, fish genetics, mouse genetics, and plant biology. Undergraduate participants receive training in two of these tracks over a period of eight weeks. Not only do the experiments in each track function as practice and lab training, some also yield real results of scientific significance, results that research labs are interested in. By training the students in the techniques that generate these results, the BIOS program functions as a focused system for training students in skills that are in demand by real research labs, labs that also participate in the training process by volunteering graduate students to work as teaching assistants.

**5. Opportunities outside the US**

Despite the significant amount of time during which scientific teaching has been developed and employed in the US, its use in other countries has been sluggish. In European countries, for example, a general awareness of flipped classrooms has only just begun to take hold. Nevertheless, it remains a fact that the vast majority of scientific teaching research is predominantly of US origin. One of the main reasons for this difference can be found in the lack of a centralized institution in Europe that active supports the dissemination of knowledge about scientific teaching. In the US, this role is taken up by the Howard Hughes Medical Institute (HHMI). Over the last few decades, HHMI has invested hundreds of millions of dollars into the development of various scientific teaching and active learning programs, a level of support that European countries simply have not yet enjoyed [92, 93].

The level of scientific teaching awareness in Asia has been very similar to that in Europe, characterized by some recognition of key concepts and the lack of a centralized authority actively pushing for reforms. Even in the sciences, an academic area that countries such as Japan, South Korea, and China have generally shared a favorable global reputation for, the implementation of class designs with scientific teaching or active learning principles remain almost totally non-existent. The concept of a flipped classroom has been implemented to various degrees in a few isolated academic settings, but these implementations have been met with mixed results usually leaning towards the negative. A main reason for these failures can be found in the fact that these class flipped designs have generally been implemented alone, without the simultaneous inclusion of other critical aspects of the active learning system such as statistically significant assessments or the installation of a cooperative learning environment that enhances feedback and interactivity.

Given the convincing nature and wealth of experimental support for the advantages of scientific teaching and active learning, it becomes difficult to say that the adoption of these two platforms outside of the US, especially in science classes, can be anything other than inevitable. For countries in the Middle East, the implementation and application of these new principles should be a significant step in improving the quality of education through enhancements of student outcome. From a policy and leadership perspective, there exists immense potential for a few diligent educators to take up the cause of scientific teaching and be the first to begin the implementation of these advanced forms of pedagogy. Not only will this courage be rewarded with the development of a new area of research in the region but the fruits of this labor will go to benefiting those who are the most important and most deserving: our students.

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# A RESEARCH ON FRUIT PRODUCTION POTANTIAL OF MARDIN PROVINCE

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***ABSTRACT:****Mardin province is one of the oldest and rarest settlements with a number of religious cultural heritage where agricultural production emerged first. According to 2016 year statistics, it has a share of 0.11% in Turkey's total fruit production which indicates that it is not a considerable fruit producer. Whereas, in this province, a number of fruit species can commercially be grown and cherry, pomegranate, pistachio, almond, olive and figs production is more prominent. Mardin has a terrestrial climate with considerably hot and dry summers, and cold winters. According to 2016 statistics total fruit production was realized to be 16.229 tons in Mardin. Considering the 2016 year total fruit production of Mardin districts, Kiziltepe, Omerli and Artuklu rank first, second and third with 3.424, 2.903 and 2.467 tons of fruit productions respectively as Mazidagi is the last with a production of 207 tons. Again, regarding the fruit production by species, 2.965 tons of pomegranate, 2.946 tons of cherry, 1.921 tons of pistachio, 1.888 tons of almond and 1.741 tons of olive were produced in Mardin in 2016. In this study, through presenting the existing status of the fruit production potential of the Mardin province, it was aimed to increase the awareness and set light to decision makers in future plans for making use of the existing fruit potential of Turkey.*

Key Words: Mardin, Fruit production potantial, Development opportunities

## 1. Introduction

In general, fruit production is of great importance because of human nutrition, raw material supply for industry and foreign trade [9].

Turkey has a quite large potential regarding both fruit species and production in the world [6]. and has favourable ecological conditions for growing many fruit species [9]. It is a gene centre for many fruit species such as apricots, figs, hazelnuts, almonds, walnuts, pomegranates, pistachio, apple and cherry. According to archaeological research, It has been known that many fruit species were grown in Anatolia a few thousand years ago [8, 5, 7]. In this context, Mardin is one of the oldest and rarest

settlements with a number of religious cultural heritage where agricultural production emerged first. According to 2016 year statistics, it has a share of 0.11% in Turkey's total fruit production which indicates that it is not a considerable fruit producer [1]. Whereas, a number of fruit species can commercially be grown and cherry, pomegranate, pistachio, almond, olive and figs production is more prominent [1]. Mardin has a terrestrial climate with considerably hot and dry summers, wet and cold winters and 730 mm of annual rainfall [3].

In this study, through presenting the existing status of fruit production potantial of Mardin province of Southeast Anatolia region in Turkey, it was aimed to increase the awareness and set light to decision makers.

**Mardin Provınce's Fruit Productıon Potantial**

Mardin province in Turkey map and the districts's map of Mardin were given Figure 1 and Figure 2, respectively. Turkey has 237.625.723 decares of area of agricultural land and 33.292.166 decares of the area for fruits and the beverage-spice crops [1]. Pear, quince, almond, walnut, pistachio, apple, plum, mulberry, fig, apricot, cherry, peach, nectarine, pomegranate, Persimmon, Loquat, wild apricot, cherry and olive are grown in Mardin province (Table 1). According to the year of 2016, Mardin province has 16.229 tons of fruit potantial production, 1.157.459 of number of fruitful trees, 563.966 of number of unfruitful trees and 1.721.425 of total number of trees (Table 1). Pear, Quince, almond, walnut, apple, plum, mulberry, pistachio, pomegranate, persimmon, figs, apricot, peach, nectarine, loquat, Jerusalem, Sour cherry, olive and cherry are grown in Mardin province. Pomegranate, cherry and olive production in Mardim province rank first, second and third with 2.965, 2.946 and 1.711 tons, respectively. Persimmon and Loquat's fruit production are the last place with 6 tons. In this context, Mardin Province is suitable for the cultivation of many fruit species and varieties.

Figure 1. Mardin province in Turkey map [4].


Figure 2. The Districts's Map of Mardin province [2].

**Table 1. Mardin province's fruit production according to 2016.**

| Name of Fruit Species | Area of Bulk Fruits (Decare) | Produc-tion (ton) | Average Yield per Tree (kg) | Number of Fruitless Trees | Number of Unfruitless Trees | Total Number of Fruit Trees |
|---|---|---|---|---|---|---|
| Pear | 244 | 405 | 18 | 22.065 | 7.605 | 29.670 |
| Quince | 67 | 30 | 21 | 1.415 | 1.107 | 2.522 |
| Almond | 4.130 | 1.898 | 12 | 159.947 | 93.461 | 253.408 |
| Walnut | 1.166 | 481 | 14 | 33.543 | 6.407 | 39.950 |
| Pistachio | 10.029 | 1.921 | 9 | 204.500 | 111.600 | 316.100 |
| Apple | 1.012 | 795 | 22 | 35.850 | 5.092 | 40.492 |
| Plum | 182 | 287 | 15 | 19.058 | 2.430 | 21.488 |
| Mulberry | 34 | 495 | 17 | 28.490 | 3.270 | 31.760 |
| Figs | 101 | 1.564 | 30 | 51.645 | 6.570 | 58.215 |
| Apricot | 203 | 399 | 14 | 29.300 | 2.635 | 31.935 |
| Cherry | 11.058 | 2.946 | 17 | 176.638 | 114.500 | 291.138 |
| Nectarine | 60 | 58 | 15 | 3.850 | 80 | 3.930 |
| Peach | 205 | 167 | 16 | 10.220 | 1.275 | 11.495 |
| Pomegranate | 1.803 | 2.965 | 42 | 70.705 | 40.062 | 110.767 |
| Persimmon | 5 | 6 | 9 | 650 | 40 | 690 |
| Loquat | 0 | 6 | 7 | 850 | 52 | 902 |
| Jerusalem | 0 | 13 | 8 | 1.660 | 12 | 1.672 |
| Sour cherry | 40 | 72 | 10 | 6.925 | 669 | 7.594 |
| Olive | 19.823 | 1.721 | 6 | 300.148 | 167.099 | 467.247 |
| TOPLAM | 50.162 | 16.229 | 14 | 1.157.459 | 563.966 | 1.721.425 |

**1.Artuklu district's fruit production potantial**

According to the year of 2016, Artuklu district has 2.467 tons of fruit potantial production, 243.008 of number of fruitful trees, 201.029 of number of unfruitful trees and 444.037 of total number of trees. Pear, almond, walnut, apple, plum, mulberry, pistachio, pomegranate, apricot olive and cherry are grown in Artuklu district. The highest fruit production was obtained from cherries with 671 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**2. Dargeçit district's fruit production potantial**

According to the year of Anonymus (2016), Dargeçit district has 424 tons of fruit potantial production, 32.562 of number of fruitful trees, 23.380 of number of unfruitful trees and 55.942 of total number of trees. Quince, almond, pistachio, walnut, apple, plum, mulberry, cherry, peach, pomegranate and apricot are grown in Dargeçit district. The highest fruit production was obtained from figs with 157 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties

**3. Derik district's fruit production potantial**

According to the year of ANONYMUS (2016), Derik district has 2.191 tons of fruit potantial production, 233.720 of number of fruitful trees, 23.238 of number of unfruitful trees and 256.958 of total number of trees. Pear, almond, pistachio, walnut, mulberry, pomegranate, cherry, fig and apricot are grown in Derik district. The highest fruit production was obtained from olive with 647 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**4. Kızıltepe district's fruit production potantial**

According to the year of ANONYMUS (2016), the districts where the most fruit production is done in the districts of Mardin are Kızıltepe with 3.424 tons. Kızıltepe district has 149.930 of number of fruitful trees, 91.770 of number of unfruitful trees and 241.700 of total number of trees. Pears, almonds, pistachios, walnuts, apples, plums, peaches, pomegranates, olives, figs and apricots are grown in Kızıltepe. The highest fruit production was obtained from pomegranate with 1.836 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**5. Mazıdağı District's Fruit Production Potantial**

According to the year of ANONYMUS (2016), with 207 tons.of production Mazıdağı districts ranks the lowest in fruit production among the all districts of Mardin province. It has 18.430 of number of fruitful trees, out of 26.450 total number of trees. Pear, quince, almond, pistachio, apple, plum, mulberry, sour cherry, fig and apricot are grown in Mazıdağı district. The highest fruit production was obtained from walnut with 95 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**6. Midyat District's Fruit Production**

According to the year of ANONYMUS (2016), Midyat is the last among the other districts of Mardin regarding number fruit species. Only seven fruit species, namely pears, pistachios, almond, walnuts, cherries, pomegranates and olives are grown in the Midyat district. Midyat district has 70.366 of number of fruitful trees out of 170.620 number of trees. The highest fruit production was obtained from almond with 508 tons. In this context, this district is suitable for the cultivation of some fruit species and varieties.

**7. Nusaybin District's Fruit Production Potantial**

According to the year of ANONYMUS (2016), the districts where the most fruit species is done in the districts of Mardin are Nusaybin with 20 numbers. Nusaybin district has 142.895 of number of fruitful trees, 22.615 of number of unfruitful trees and 165.510 of total number of trees. Pear, quince, pistachio, almond, walnut, apple, plum, mulberry, cherry, peach, nectarine, pomegranate, Persimmon, Loquat, cherry, wild apricot, olive, fig and apricot are grown in the Nusaybin district. The highest fruit production was obtained from almond with 508 tons. In this context, this district is suitable for the cultivation of some fruit species and varieties.

**8. Omerli district's fruit production**

According to the year of ANONYMUS (2016), Ömerli district has 2.903 tons of fruit potantial production, 106.490 of number of fruitful trees, 36.732 of number of unfruitful trees and 143.222 of total number of trees. Pear, almond, olive, pistachio, walnut, plum, mulberry, pomegranate, fig and apricot are grown in Ömerli district. The highest fruit production was obtained from olive with 960 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**9. Savur District's Fruit Production**

According to the year of ANONYMUS (2016), Savur district has 840 tons of fruit production, 83.565 of number of fruitful trees, 7.425 of number of unfruitful trees and 90.990 of total number of trees. Pear, quince, almond, pistachio, walnut, plum, mulberry, cherry, pomegranate, fig and apricot are processed in Savur district. The highest fruit production was obtained from apple with 322 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**10.Yeşilli District's Fruit Production**

According to the year of ANONYMUS (2016), Yeşilli district has 1.698 tons of fruit potantial production, 76.493 of number of fruitful trees, 49.503 of number of unfruitful trees and 125.996 of total number of trees. Pearl, quince, almond, walnut, apple, plum, mulberry, peach, pomegranate, persimmon, loquat, peach, pomegranate, wild apricot, olive, fig and apricot are grown in

Yeşilli district. The highest fruit production was obtained from cherry with 1.051 tons. In this context, this district is suitable for the cultivation of many fruit species and varieties.

**Development Opportunities of Fruit Production Potantial of Mardin Province**

Fruit producers need to make regular cultural processes to reduce profit inefficiency. In order to reduce production costs, more contribution of the technical and scientific research is needed to increase fruit yield and quality. It is necessary to accelerate the development of new fruit species and varieties suitable for Mardin ecological conditions and planting systems Necessary and timely measures should be be taken done to prevent diseases and harms of orcharding. In order to achieve good quality production, fruit producers need to grow fruit with certified seedlings. Hazelnut producers have to make agricultural insurance for the loss of natural disasters. Fruit producers should act in cooperation with other institutions and organizations, In facilitating this, provincial governor may provide coordination of relevant institutions such as faculties of agriculture, vocational schools and institutes of the universities, under the coordination of provincial governors.

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# CURRENT SITUATION OF DIYARBAKIR PROVINCE IN TERMS OF CROP PRODUCTION

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**Abstract**: *This study was carried out to determine current situation in terms of crop production in the province of Diyarbakir. This study, sowing-planting areas and production-yield values of field and horticultural crops were revealed. Total crop production of the province is 5 984 430 decares. Field crop production is practiced in 90.3% of the land used for crop production and horticultural production in 7.0% of it, while the remainder 2.7% is left to fallow. Diyarbakir is the granary of the region. Wheat from cereals, lentil from legumes, cotton from industrial plants, and corn silage from forage crops are grown the most in Diyarbakır. Watermelon and tomato are the most widely grown vegetable and plum and mulberry are the most widely grown fruit in the province. Diyarbakır also has a significant potential for viticulture.*

**Keywords:** *Crop production, Field crops, Horticulture, Diyarbakır*

## 1.Introduction

Diyarbakır province, which has a long history with its historical texture, is among the most important cities of Turkey. Diyarbakir, a very old settlement dating from Byzantine and Roman times, is a city that has been under Turkish domination for centuries after the Turks settled in Anatolia.

The province of Diyarbakır is located in the north-west of Mesopotamia, also known as Al-Jazeera, in the middle of the Southeastern Anatolia Region. Diyarbakir is surrounded by Batman and Muş in the east; Mardin in the south; Şanlıurfa, Adıyaman and Malatya in the west; Bingöl and Elazığ in the north.

50% of agricultural enterprises in Diyarbakır province are made have only crop production, 45% crop and animal production and 5% only animal production [1]. As is the case throughout Turkey,

agricultural enterprises in Diyarbakır province are becoming smaller as population growth increases and the growing population is employed in non-agricultural areas, due to the inadequate development of agriculture and the division of arable land through inheritance.

In the province of Diyarbakir, field farming is generally carried out and some of the land is fallow land because of the lack of irrigated farming areas. With irrigated agriculture to be carried out together with the start of the GAP Project including the province of Diyarbakır, it is planned that both the fallow fields will remove and the second crop production will be start and therefore the production will be increased. With the families in the villages, a large part of the population living in the provincial and district centers is directly or indirectly interested in agriculture and animal husbandry.

The purpose of this study is to reveal the current situation of Diyarbakır province, which deals with agriculture and animal husbandry, in terms of crop production.

## 2. General Characteristics of Diyarbakır Province

Diyarbakır Province is located between 37˚ 30 'and 38˚ 43' north latitudes, 40˚ 37 'and 41˚ 20' east longitudes in Southeastern Anatolia Region. The surface area is 15 355 km$^2$. The city center is 670 m above sea level. 45% of the lands belonging to the province of Diyarbakır are arable land. 95% of the lands are suitable for agriculture. It is known that 37% of the province of Diyarbakir is covered by mountains and the share of plains is around 31% [1].

The province of Diyarbakır has a hard terrestrial and subtropical highland climate. The summer months are generally arid because the climate is hard and rainfall is low. When we look at the climate data of Diyarbakir for long years (1970-2011); it is seen that the annual average temperature is 15.8 ºC. The highest temperature was 44.8 ºC in 28 August 1998 and the lowest temperature was -23.4 ºC in 30 December 2006. Looking at the long-term data, it is seen that the average annual precipitation amount is 474.9 mm. The rains are mostly seen in winter and spring, and the summer months are usually arid. Snow falls in December, January, February and very little in November and March. The falling snow stays in place 1-6 days [1].

The data for the last five years of Diyarbakır province crop production areas are given in Table 2.1.

Table 2.1. Crop production areas in Diyarbakır province [2]

| | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|
| TOTAL AREA | 5.991.103 | 5.708.380 | 6.015.174 | 6.147.045 | 6.060.447 | 5.984.430 | 100 |
| FIELD CROPS | 5.339.176 | 5.167.288 | 5.469.928 | 5.553.326 | 5.484.753 | 5.402.894 | 90.3 |
| FALLOW | 215.370 | 121.650 | 120.766 | 183.519 | 165.959 | 161.453 | 2.7 |
| VEGETABLES | 160.640 | 167.414 | 169.481 | 154.741 | 154.512 | 161.358 | 2.7 |
| FRUITS | 275.917 | 252.028 | 254.999 | 255.459 | 255.223 | 258.725 | 4.3 |

The Diyarbakır province has not seen much change in the agricultural areas of the last five years. The province has an agricultural area of 5 984 430 decares of a total surface area of 15 355 000 decares. It is seen that this corresponds to only 38.97% of the total area available. It is observed that the production areas, which were 39.01% in 2011, increased up to 39.47% in 2015 (Table 2.1).

According to the five-year average in Diyarbakır province, 90.3% of the total agricultural land is cultivated field crops and 7.0% is cultivating horticultures. The rest of the area is to have been fallow land. When we look at the total production area in our country; 89.8% of the cultivated areas are field crops, 10.2% are vineyard and horticultural agriculture [3] given that it is done it is seen that Diyarbakır province is behind in terms of horticulture, but it is far ahead in terms of field crops.

## 3. Field Crops

### 3.1. Cereals

The cultivated area (da), production amounts (ton) and yields (kg $da^{-1}$) for the last five years of cereals in Diyarbakır province are given in Table 3.1.

According to the average of the last five years of cereals growing in Diyarbakır province, it is seen that most wheat cultivation is done as in many cities in our country and this ratio is 83.2% in cereals. Wheat was followed by barley with 12.0% and grain corn with 4.2% (Table 3.1).

**Table 3.1.** Data related to cultivation of cereals in Diyarbakır province [2]

| | | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|---|
| WHEAT (DURUM) | Cultivated Area (da) | 1.454.763 | 1.486.226 | 1.595.995 | 1.118.580 | 906.958 | 1.312.504 | **29.4** |
| | Production (ton) | 428.749 | 433.436 | 548.863 | 316.051 | 277.504 | 400.921 | |
| | Yields (kg $da^{-1}$) | 295 | 292 | 344 | 283 | 308 | 304 | |
| WHEAT (OTHER) | Cultivated Area (da) | 2.173.079 | 1.993.324 | 2.134.461 | 2.757.567 | 2.960.183 | 2.403.723 | **53.8** |
| | Production (ton) | 685.240 | 608.746 | 699.823 | 760.558 | 915.292 | 733.932 | |
| | Yields (kg $da^{-1}$) | 315 | 305 | 328 | 276 | 309 | 307 | |
| BARLEY (OTHER) | Cultivated Area (da) | 566.255 | 554.045 | 514.000 | 520.103 | 533.309 | 537.542 | **12.0** |
| | Production (ton) | 172.198 | 197.959 | 182.115 | 162.342 | 174.388 | 177.800 | |
| | Yields (kg $da^{-1}$) | 304 | 357 | 354 | 312 | 327 | 331 | |
| CORN (GRAIN) | Cultivated Area (da) | 112.914 | 133.451 | 193.887 | 199.707 | 294.289 | 186.850 | **4.2** |
| | Production (ton) | 89.933 | 113.098 | 208.363 | 229.201 | 328.019 | 193.723 | |
| | Yields (kg $da^{-1}$) | 796 | 847 | 1.075 | 1.148 | 1.115 | 996 | |
| RICE | Cultivated Area (da) | 20.136 | 18.750 | 19.687 | 21.341 | 17.476 | 19.478 | **0.4** |
| | Production (ton) | 10.544 | 8.297 | 9.450 | 10.548 | 8.514 | 9.471 | |
| | Yields (kg $da^{-1}$) | 524 | 443 | 480 | 494 | 487 | 486 | |
| MILLET | Cultivated Area (da) | 10.850 | 12.372 | 10.940 | 9.980 | 9.925 | 10.813 | **0.2** |
| | Production (ton) | 1.820 | 1.653 | 1.630 | 1.491 | 1.488 | 1.616 | |
| | Yields (kg $da^{-1}$) | 168 | 135 | 149 | 149 | 150 | 150 | |
| RYE | Cultivated Area (da) | 140 | - | 47 | 20 | 20 | 45 | **0.001** |
| | Production (ton) | 14 | - | 8 | 4 | 4 | 6 | |
| | Yields (kg $da^{-1}$) | 100 | - | 170 | 200 | 200 | 134 | |
| **Total cultivated area (da)** | | | | | | | **4.470.956** | **100.0** |

According to the data of the last five years; it is seen that the production amount of wheat is 1 134 853 tons and yield 306.0 kg da$^{-1}$, the production amount of barley is 177 800 tons, the yield is 331.0 kg da$^{-1}$, the production amount of corn is 193 723 tons and the yield is 996.0 kg da$^{-1}$ from the most grown cereals.

### 3.2. Food Legumes

The cultivated area (da), production amounts (ton) and yields (kg da$^{-1}$) for the last five years of legumes in Diyarbakır province are given in Table 3.2.

When we look at the average of Diyarbakır province's past five years legumes cultivated, it is seen that the most lentil cultivation is done and this ratio is 87.8% in legumes. Lentil is followed by chickpea with 11.9% and haricot beans with 0.3% (Table 3.2).

According to the data of the last five years; it is seen that the production amount of lentil is 86 766 tons and the yield is 202.0 kg da$^{-1}$, the production amount of chickpea is 9 664 tons, the yield is 166.0 kg da$^{-1}$ and the production amount of haricot bean is 405 tons and the yield is 275.0 kg da$^{-1}$ from the most grown legumes.

**Table 3.2.** Data related to cultivation of food legumes in Diyarbakır province [2]

| | | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|---|
| CHICKPEA | Cultivated Area (da) | 61.940 | 57.675 | 60.431 | 54.701 | 57.001 | 58.350 | **11.9** |
| | Production (ton) | 10.092 | 9.227 | 9.832 | 9.057 | 10.110 | 9.664 | |
| | Yields (kg da$^{-1}$) | 163 | 160 | 163 | 166 | 177 | 166 | |
| BEAN (HARICOT) | Cultivated Area (da) | 2.000 | 1.450 | 1.512 | 1.380 | 1.130 | 1.494 | **0.3** |
| | Production (ton) | 466 | 406 | 428 | 395 | 331 | 405 | |
| | Yields (kg da$^{-1}$) | 233 | 280 | 283 | 286 | 293 | 275 | |
| LENTIL (RED) | Cultivated Area (da) | 424.650 | 432.955 | 465.749 | 435.651 | 390.593 | 429.920 | **87.8** |
| | Production (ton) | 77.296 | 92.952 | 82.762 | 98.076 | 82.742 | 86.766 | |
| | Yields (kg da$^{-1}$) | 182 | 215 | 178 | 225 | 212 | 202 | |
| **Total cultivated area (da)** | | | | | | | **489.764** | **100.0** |

### 3.3. Industrial Crops

The cultivated area (da), production amounts (ton) and yields (kg da$^{-1}$) for the last five years of industrial crops in Diyarbakır province are given in Table 3.3.

**Table 3.3.** Data related to cultivation of industrial crops in Diyarbakır province [2]

| | | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|---|
| COTTON (COTTON UNSEED) | Cultivated Area (da) | 451.228 | 405.940 | 418.240 | 396.869 | 308.999 | 396.255 | **32.6** |
| | Production (ton) | 195.413 | 175.091 | 197.835 | 191.729 | 141.289 | 180.271 | |
| | Yields (kg da$^{-1}$) | 433 | 431 | 473 | 483 | 457 | 455 | |
| COTTON (FIBER) | Cultivated Area (da) | 451.228 | 405.940 | 418.240 | 396.869 | 308.999 | 396.255 | **32.6** |
| | Production (ton) | 72.303 | 64.784 | 77.097 | 69.022 | 50.866 | 66.814 | |
| | Yields (kg da$^{-1}$) | 160 | 160 | 184 | 174 | 165 | 169 | |
| COTTON (COTTON SEED) | Cultivated Area (da) | 451.228 | 405.940 | 418.240 | 396.869 | 308.999 | 396.255 | **32.6** |
| | Production (ton) | 115.684 | 103.655 | 113.206 | 113.503 | 83.641 | 105.938 | |
| | Yields (kg da$^{-1}$) | 256 | 255 | 271 | 286 | 271 | 268 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SOYBEAN | Cultivated Area (da) | 300 | 825 | 1.233 | 1.348 | 1.148 | 971 | **0.1** |
| | Production (ton) | 90 | 269 | 324 | 477 | 385 | 309 | |
| | Yields (kg da$^{-1}$) | 300 | 326 | 263 | 354 | 335 | 316 | |
| SUNFLOWER (OIL) | Cultivated Area (da) | 28.173 | 28.411 | 30.765 | 13.592 | 12.102 | 22.609 | **1.9** |
| | Production (ton) | 2.405 | 3.737 | 4.592 | 1.539 | 1.289 | 2.712 | |
| | Yields (kg da$^{-1}$) | 85 | 132 | 149 | 113 | 110 | 118 | |
| UNPROCESSED TOBACCO | Cultivated Area (da) | 274 | 2.152 | 780 | 859 | 1.119 | 1.037 | **0.1** |
| | Production (ton) | 55 | 290 | 60 | 124 | 181 | 142 | |
| | Yields (kg da$^{-1}$) | 201 | 135 | 77 | 144 | 162 | 144 | |
| SUGAR BEET | Cultivated Area (da) | 55 | 600 | 300 | - | 340 | 324 | **0.03** |
| | Production (ton) | 356 | 2.880 | 1.513 | - | 2.310 | 1.765 | |
| | Yields (kg da$^{-1}$) | 6.473 | 4.800 | 5.043 | - | 6.794 | 5.778 | |
| **Total cultivated area (da)** | | | | | | | **1.213.706** | **100.0** |

When we look at the average of the industrial crops cultivation of the last five years of Diyarbakir province, it is seen that the most cotton (cotton unseed, cotton fiber and cotton seed) is produced and this ratio is 97.8% in industrial crops. The cotton is followed by sunflower with 1.9%, soybean and unprocessed tobacco with 0.1% and sugar beet with 0.03% (Table 3.3).

According to the data of the last five years; the production amount of cotton is 353 023 tons, the yield is 455.0 kg da$^{-1}$ in cotton unseed, 169 kg da$^{-1}$ in cotton fiber and 268 kg da$^{-1}$ in cotton seed, the production amount of sunflower is 2 712 tons and the yield is 118.0 kg da$^{-1}$, the production amount of soybeans is 309 tons, the yield 316 kg da$^{-1}$, the production amount of unprocessed tobacco 142 tons, the yield 44 kg da$^{-1}$ and the sugar beet production 1 765 tons and the yield of 5 778 kg da$^{-1}$ from the most grown industrial crops.

### 3.4. Forage Crops

The cultivated area (da), production amounts (ton) and yields (kg da$^{-1}$) for the last five years of forage crops in Diyarbakır province are given in Table 3.4.

**Table 3.4.** Data related to cultivation of forage crops in Diyarbakır province [2]

| | | **2011** | **2012** | **2013** | **2014** | **2015** | **ORT** | **%** |
|---|---|---|---|---|---|---|---|---|
| VETCH (COMMON, HUNGARIAN) (GRAIN) | Cultivated Area (da) | 15.471 | 18.308 | 11.030 | 6.330 | 6.950 | 11.618 | **16.7** |
| | Production (ton) | 1.425 | 1.400 | 1.026 | 656 | 670 | 1.035 | |
| | Yields (kg da$^{-1}$) | 92 | 77 | 93 | 182 | 191 | 127 | |
| BITTER VETCH (GRAIN) | Cultivated Area (da) | 8.000 | 8.872 | 6.755 | 6.940 | 7.050 | 7.523 | **10.8** |
| | Production (ton) | 875 | 805 | 664 | 683 | 709 | 747 | |
| | Yields (kg da$^{-1}$) | 109 | 92 | 99 | 98 | 101 | 100 | |
| GRASSPEA (GRAIN) | Cultivated Area (da) | 2.000 | 2.414 | 1.500 | 1.550 | 1.300 | 1.753 | **2.5** |
| | Production (ton) | 200 | 179 | 143 | 147 | 117 | 157 | |
| | Yields (kg da$^{-1}$) | 100 | 75 | 95 | 95 | 90 | 91 | |
| VETCH (GREEN HERBAGE) | Cultivated Area (da) | 18.191 | 21.878 | 17.230 | 14.475 | 14.085 | 17.172 | **24.7** |
| | Production (ton) | 12.956 | 16.284 | 12.798 | 7.698 | 8.224 | 11.592 | |
| | Yields (kg da$^{-1}$) | 730 | 751 | 746 | 688 | 593 | 702 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BITTER VETCH (GREEN HERBAGE) | Cultivated Area (da) | 1.320 | 1.395 | 1.120 | 1.070 | 995 | 1.180 | **1.7** |
| | Production (ton) | 1.056 | 937 | 760 | 805 | 741 | 860 | |
| | Yields (kg da$^{-1}$) | 800 | 678 | 679 | 752 | 745 | 731 | |
| ALFALFA (GREEN HERBAGE) | Cultivated Area (da) | 5.035 | 5.537 | 4.445 | 4.562 | 4.410 | 4.798 | **6.9** |
| | Production (ton) | 7.046 | 6.814 | 6.219 | 4.937 | 4.998 | 6.003 | |
| | Yields (kg da$^{-1}$) | 1.399 | 1.243 | 1.401 | 1.082 | 1.133 | 1.252 | |
| SAINFOIN (GREEN HERBAGE) | Cultivated Area (da) | 750 | 966 | 500 | 800 | 750 | 753 | **1.1** |
| | Production (ton) | 600 | 560 | 300 | 440 | 413 | 463 | |
| | Yields (kg da$^{-1}$) | 800 | 585 | 600 | 550 | 551 | 617 | |
| CORN (SILAGE) | Cultivated Area (da) | 22.977 | 25.177 | 24.696 | 29.099 | 21.325 | 24.655 | **35.5** |
| | Production (ton) | 60.800 | 74.196 | 72.852 | 115.304 | 85.823 | 81.795 | |
| | Yields (kg da$^{-1}$) | 2.720 | 2.947 | 2.950 | 3.962 | 4.025 | 3.321 | |
| **Total cultivated area (da)** | | | | | | | **69.452** | **100.0** |

It is seen that the most vetch (as herbage and grain) is produced in Diyarbakır province according to the averages of the last five years and this ratio is 41.4% in forage crops. Vetch is followed by silage corn with 35.5%, bitter vetch (with herbage and grain) with 12.5%, alfalfa with 6.9%, grasspea with 2.5% and sainfoin with 1.1% (Table 3.4).

According to the data of the last five years; the production amount of vetch is 1 035 tons for grain and 11 592 tons for herbage, the yield is 127.0 kg da$^{-1}$ for grain and 702.0 kg da$^{-1}$ for herbage, the production amount of silage corn is 81 795 tons and the yield is 3 321 kg da$^{-1}$, the production amount of bitter vetch is 747 tons for grain and 860 tons for herbage, the yield is 100 kg da$^{-1}$ for grain and 731 kg da$^{-1}$ for herbage, the production amount of alfalfa is 6 003 tons, yield is 1 252 kg da$^{-1}$, the production amount of grasspea for grain is 157 tons, the yield is 91 kg da$^{-1}$ and the production amount of the sainfoin is 463 tons and the yield is 617 kg da$^{-1}$ from the most grown forage crops.

## 4. Horticulture

### 4.1. Vegetables

The cultivated area (da) and production amounts (ton) for the last five years of vegetables in Diyarbakır province are given in Table 4.1.

**Table 4.1.** Data related to cultivation of vegetables in Diyarbakır province [2]

| | | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|---|
| CABBAGE (WHITE) | Cultivated Area (da) | 26 | 20 | 16 | 10 | 10 | 16 | **0.01** |
| | Production (ton) | 56 | 43 | 39 | 25 | 25 | 38 | |
| LETTUCE (CURLY) | Cultivated Area (da) | 11 | 11 | 11 | 11 | 11 | 11 | **0.01** |
| | Production (ton) | 7 | 7 | 7 | 7 | 7 | 7 | |
| LETTUCE (HEAD) | Cultivated Area (da) | 163 | 159 | 164 | 134 | 135 | 151 | **0.1** |
| | Production (ton) | 192 | 183 | 188 | 147 | 149 | 172 | |
| SPINACH | Cultivated Area (da) | 60 | 60 | 60 | 40 | 40 | 52 | **0.03** |
| | Production (ton) | 72 | 72 | 72 | 60 | 60 | 67 | |
| PURSLANE | Cultivated Area (da) | 160 | 150 | 150 | 120 | 120 | 140 | **0.1** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Production (ton) | 80 | 75 | 75 | 72 | 72 | 75 | |
| PARSLEY | Cultivated Area (da) | 307 | 315 | 317 | 222 | 222 | 277 | **0.2** |
| | Production (ton) | 248 | 317 | 308 | 213 | 226 | 262 | |
| ARUGULA | Cultivated Area (da) | 60 | 65 | 65 | 65 | 65 | 64 | **0.04** |
| | Production (ton) | 30 | 33 | 32 | 33 | 33 | 32 | |
| CRESS | Cultivated Area (da) | 110 | 115 | 110 | 95 | 95 | 105 | **0.1** |
| | Production (ton) | 27 | 29 | 28 | 29 | 29 | 28 | |
| PEPPERMINT | Cultivated Area (da) | 82 | 94 | 100 | 102 | 103 | 96 | **0.1** |
| | Production (ton) | 37 | 41 | 41 | 45 | 45 | 42 | |
| ONION (FRESH) | Cultivated Area (da) | 1.720 | 1.827 | 1.693 | 1.824 | 1.819 | 1.777 | **1.1** |
| | Production (ton) | 1.746 | 1.849 | 1.707 | 1.819 | 1.816 | 1.787 | |
| ONION (DRIED) | Cultivated Area (da) | 4.919 | 6.174 | 5.679 | 5.267 | 5.322 | 5.472 | **3.4** |
| | Production (ton) | 6.899 | 7.290 | 7.176 | 6.840 | 7.087 | 7.058 | |
| GARLIC (FRESH) | Cultivated Area (da) | 611 | 635 | 535 | 595 | 545 | 584 | **0.4** |
| | Production (ton) | 356 | 344 | 289 | 309 | 331 | 326 | |
| GARLIC (DRIED) | Cultivated Area (da) | 1.127 | 1.303 | 1.111 | 1.036 | 1.147 | 1.145 | **0.7** |
| | Production (ton) | 709 | 709 | 717 | 787 | 851 | 755 | |
| LEEK | Cultivated Area (da) | 30 | 20 | 20 | 15 | 15 | 20 | **0.0** |
| | Production (ton) | 45 | 30 | 30 | 23 | 23 | 30 | |
| RADISH (RED) | Cultivated Area (da) | 33 | 40 | 238 | 240 | 240 | 158 | **0.1** |
| | Production (ton) | 56 | 73 | 770 | 775 | 775 | 490 | |
| CARROT | Cultivated Area (da) | - | - | 200 | 200 | 200 | 120 | **0.1** |
| | Production (ton) | - | - | 1.100 | 1.100 | 1.100 | 660 | |
| TOMATO (TABLE) | Cultivated Area (da) | 21.870 | 22.383 | 22.465 | 22.840 | 22.508 | 22.413 | **13.8** |
| | Production (ton) | 68.307 | 67.670 | 69.678 | 71.802 | 69.070 | 69.305 | |
| TOMATO (SAUCEBOAT) | Cultivated Area (da) | 14.035 | 14.630 | 14.645 | 15.153 | 15.058 | 14.704 | **9.1** |
| | Production (ton) | 34.964 | 35.379 | 35.954 | 38.438 | 37.826 | 36.512 | |
| CUCUMBER (TABLE) | Cultivated Area (da) | 10.510 | 10.785 | 11.629 | 11.725 | 12.465 | 11.423 | **7.0** |
| | Production (ton) | 26.634 | 27.356 | 30.789 | 31.547 | 33.256 | 29.916 | |
| CUCUMBER (GHERKIN) | Cultivated Area (da) | 506 | 558 | 506 | 556 | 555 | 536 | **0.3** |
| | Production (ton) | 888 | 981 | 912 | 994 | 991 | 953 | |
| CUCUMBER (ACUR) | Cultivated Area (da) | 1.246 | 1.225 | 1.065 | 680 | 580 | 959 | **0.6** |
| | Production (ton) | 2.158 | 1.854 | 1.559 | 793 | 599 | 1.393 | |
| PEPPER (SAUCEBOAT) | Cultivated Area (da) | 4.065 | 4.100 | 3.840 | 3.150 | 3.150 | 3.661 | **2.3** |
| | Production (ton) | 5.982 | 5.940 | 5.621 | 4.682 | 4.749 | 5.395 | |
| PEPPER (GREEN) | Cultivated Area (da) | 6.108 | 6.211 | 6.848 | 7.078 | 6.767 | 6.602 | **4.1** |
| | Production (ton) | 8.917 | 8.915 | 10.303 | 10.923 | 10.596 | 9.931 | |
| PEPPER (POINTED) | Cultivated Area (da) | 6.618 | 6.698 | 6.999 | 7.370 | 7.346 | 7.006 | **4.3** |
| | Production (ton) | 8.844 | 8.631 | 9.076 | 10.036 | 10.084 | 9.334 | |
| OKRA | Cultivated Area (da) | 87 | 95 | 117 | 115 | 115 | 106 | **0.1** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Production (ton) | 40 | 43 | 50 | 52 | 52 | 47 | |
| EGGPLANT | Cultivated Area (da) | 7.701 | 7.763 | 8.024 | 8.640 | 8.630 | 8.152 | **5.0** |
| | Production (ton) | 18.637 | 18.390 | 18.959 | 20.104 | 20.256 | 19.269 | |
| PUMPKIN (MARROW) | Cultivated Area (da) | 199 | 202 | 230 | 222 | 220 | 215 | **0.1** |
| | Production (ton) | 313 | 305 | 318 | 324 | 326 | 317 | |
| PUMPKIN (SQUASH) | Cultivated Area (da) | 10 | 10 | 8 | - | - | 6 | **0.0** |
| | Production (ton) | 9 | 9 | 6 | - | - | 5 | |
| BEANS (FRESH) | Cultivated Area (da) | 2.217 | 2.222 | 2.301 | 1.983 | 1.983 | 2.141 | **1.3** |
| | Production (ton) | 1.518 | 1.505 | 1.554 | 1.424 | 1.425 | 1.485 | |
| KIDNEY BEANS (FRESH) | Cultivated Area (da) | 21 | 20 | 20 | 20 | 20 | 20 | **0.01** |
| | Production (ton) | 13 | 12 | 12 | 12 | 12 | 12 | |
| MELON | Cultivated Area (da) | 26.872 | 27.771 | 27.051 | 21.301 | 19.381 | 24.475 | **15.1** |
| | Production (ton) | 67.181 | 69.320 | 68.193 | 54.953 | 50.589 | 62.047 | |
| WATERMELON | Cultivated Area (da) | 51.356 | 52.349 | 53.580 | 45.495 | 45.695 | 49.695 | **30.6** |
| | Production (ton) | 187.139 | 191.098 | 196.190 | 172.893 | 174.462 | 184.356 | |
| **Total cultivated area (da)** | | | | | | | **162.303** | **100.0** |

It is seen that the most watermelon cultivation was done in Diyarbakır province according to the average of the last five years and this ratio is 30.6% in vegetables. The watermelon is followed by tomato with 22.9%, melon with 15.1%, pepper with 10.7%, cucumber with 7.3%, eggplant with 5.0%, fresh and dry onion with 4.5% and fresh bean with 1.3%. Vegetables cultivation such as cabbage, lettuce, spinach, purslane, parsley, arugula, cress, peppermint, pumpkin (marrow and squash), garlic, kidney bean, leek, radish, carrot, acur, okra is very low (Table 4.1).

According to the data of the last five years; the average cultivated area of watermelon is 49 495 da, the production amount is 184 356 tons, the cultivated area is 22 413 da for table tomato, 14 704 da for sauceboat tomato and the production amount is 69 305 tons and 36 512 tons respectively, the cultivated are is 24 475 da for melon and the average production amount is 62 047 tons, the cultivated areas of sauceboat, green and pointed pepper are 3 661, 6 602 and 7 006 da respectively and the production amounts are 5 395, 9 931 and 9 334 tons respectively, the cultivated area is 11 423 da for table cucumber and 536 da for cucumber (gherkin) and the production amount is 29 916 and 953 tons respectively, the cultivated area is 8 152 da for eggplant and the production area is 19 269 tons, the cultivated area is 1 777 da for fresh onion and 5 472 da for dry onion and the production areas of fresh and dry onion 1 787 and 7 058 tons respectively, the area of cultivation of fresh beans was 2 141 and the production area was 1 485 tons from the most grown vegetables.

### 4.2. Fruits

The fruits area (da), production amounts (ton) and yield per tree (kg) for the last five years of fruits in Diyarbakır province are given in Table 4.2.

**Table 4.2.** Data related to cultivation of vegetables in Diyarbakır province [2]

| | **2011** | **2012** | **2013** | **2014** | **2015** | **ORT** | **%** |
|---|---|---|---|---|---|---|---|
| Fruits area (da) | 966 | 1.042 | 1.058 | 1.084 | 1.082 | 1.046 | **1.83** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| APPLE (GOLDEN) | Production (ton) | 420 | 415 | 474 | 362 | 435 | 421 | |
| | Yield per tree (kg) | 19 | 19 | 21 | 16 | 20 | 19 | |
| APPLE (STARKING) | Fruits area (da) | 104 | 105 | 105 | 99 | 94 | 101 | **0.18** |
| | Production (ton) | 80 | 83 | 84 | 81 | 72 | 80 | |
| | Yield per tree (kg) | 23 | 23 | 23 | 22 | 21 | 22 | |
| APPLE (AMASYA) | Fruits area (da) | 95 | 127 | 141 | 136 | 145 | 129 | **0.23** |
| | Production (ton) | 56 | 64 | 66 | 52 | 46 | 57 | |
| | Yield per tree (kg) | 23 | 23 | 23 | 19 | 17 | 21 | |
| APPLE (OTHER) | Fruits area (da) | 3.185 | 3.329 | 3.311 | 3.103 | 3.096 | 3.205 | **5.61** |
| | Production (ton) | 1.213 | 1.212 | 1.091 | 1.014 | 1.076 | 1.121 | |
| | Yield per tree (kg) | 24 | 24 | 22 | 20 | 22 | 22 | |
| PEAR | Fruits area (da) | 4.988 | 5.106 | 4.966 | 4.750 | 4.759 | 4.914 | **8.60** |
| | Production (ton) | 2.111 | 2.176 | 2.134 | 1.798 | 1.817 | 2.007 | |
| | Yield per tree (kg) | 23 | 23 | 23 | 20 | 21 | 22 | |
| QUINCE | Fruits area (da) | 975 | 1.079 | 989 | 844 | 806 | 939 | **1.64** |
| | Production (ton) | 356 | 492 | 492 | 318 | 324 | 396 | |
| | Yield per tree (kg) | 25 | 27 | 26 | 20 | 21 | 24 | |
| PEACH (NECTARINE) | Fruits area (da) | 5 | 5 | 4 | 4 | 4 | 4 | **0.01** |
| | Production (ton) | 164 | 132 | 132 | 97 | 98 | 125 | |
| | Yield per tree (kg) | 25 | 20 | 20 | 15 | 15 | 19 | |
| PEACH (OTHER) | Fruits area (da) | 544 | 563 | 552 | 555 | 547 | 552 | **0.97** |
| | Production (ton) | 239 | 237 | 240 | 192 | 196 | 221 | |
| | Yield per tree (kg) | 19 | 18 | 18 | 16 | 17 | 18 | |
| PLUM | Fruits area (da) | 12.713 | 12.954 | 13.020 | 12.693 | 12.685 | 12.813 | **22.41** |
| | Production (ton) | 1.059 | 1.046 | 1.030 | 629 | 874 | 928 | |
| | Yield per tree (kg) | 18 | 17 | 17 | 11 | 16 | 16 | |
| APRICOT | Fruits area (da) | 2.196 | 2.521 | 2.501 | 2.267 | 2.157 | 2.328 | **4.07** |
| | Production (ton) | 999 | 848 | 831 | 620 | 665 | 793 | |
| | Yield per tree (kg) | 21 | 17 | 17 | 14 | 16 | 17 | |
| WILD APPRICOT (ZERDALI) | Fruits area (da) | 160 | 173 | 171 | 160 | 155 | 164 | **0.29** |
| | Production (ton) | 83 | 89 | 89 | 58 | 58 | 75 | |
| | Yield per tree (kg) | 18 | 18 | 18 | 13 | 12 | 16 | |
| CHERRY | Fruits area (da) | 1.113 | 1.188 | 1.350 | 1.359 | 1.355 | 1.273 | **2.23** |
| | Production (ton) | 298 | 291 | 317 | 225 | 235 | 273 | |
| | Yield per tree (kg) | 16 | 16 | 17 | 12 | 12 | 15 | |
| SOUR CHERRY | Fruits area (da) | 744 | 774 | 780 | 745 | 731 | 755 | **1.32** |
| | Production (ton) | 285 | 300 | 299 | 242 | 241 | 273 | |
| | Yield per tree (kg) | 14 | 15 | 14 | 13 | 13 | 14 | |
| ELEAGNUS | Fruits area (da) | - | - | - | - | - | - | - |
| | Production (ton) | 14 | 14 | 13 | 14 | 14 | 14 | |
| | Yield per tree (kg) | 47 | 47 | 43 | 47 | 47 | 46 | |
| STRAWBERRY | Fruits area (da) | 20 | 20 | 20 | 25 | 25 | 22 | **0.04** |
| | Production (ton) | 60 | 60 | 59 | 75 | 75 | 66 | |
| | Yield per tree (kg) | 3 | 3 | 3 | 3 | 3 | 3 | |
| MULBERRY | Fruits area (da) | 8.930 | 9.806 | 9.981 | 10.051 | 10.064 | 9.766 | **17.08** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Production (ton) | 8.698 | 9.114 | 9.854 | 6.007 | 8.881 | 8.511 | |
| | Yield per tree (kg) | 17 | 18 | 20 | 12 | 18 | 17 | |
| | Fruits area (da) | 2.016 | 2.074 | 2.154 | 1.904 | 1.908 | 2.011 | **3.52** |
| POMEGRANATE | Production (ton) | 999 | 1.020 | 1.034 | 896 | 842 | 958 | |
| | Yield per tree (kg) | 20 | 20 | 20 | 18 | 17 | 19 | |
| | Fruits area (da) | 1.615 | 1.922 | 1.959 | 1.886 | 1.884 | 1.853 | **3.24** |
| FIG | Production (ton) | 813 | 806 | 789 | 766 | 782 | 791 | |
| | Yield per tree (kg) | 18 | 17 | 17 | 17 | 17 | 17 | |
| | Fruits area (da) | 70 | 70 | 71 | 70 | 70 | 70 | **0.12** |
| OLIVE (OILY) | Production (ton) | - | - | - | - | - | - | |
| | Yield per tree (kg) | - | - | - | - | - | - | |
| | Fruits area (da) | 6.279 | 7.466 | 7.729 | 7.727 | 7.629 | 7.366 | **12.89** |
| ALMOND | Production (ton) | 2.924 | 3.213 | 3.370 | 2.170 | 2.793 | 2.894 | |
| | Yield per tree (kg) | 9 | 10 | 11 | 7 | 9 | 9 | |
| | Fruits area (da) | 3.205 | 3.573 | 3.825 | 3.760 | 3.848 | 3.642 | **6.37** |
| WALNUT | Production (ton) | 1.835 | 1.863 | 1.812 | 871 | 1.384 | 1.553 | |
| | Yield per tree (kg) | 27 | 27 | 26 | 12 | 19 | 22 | |
| | Fruits area (da) | 3.540 | 4.286 | 4.411 | 4.442 | 4.384 | 4.213 | **7.37** |
| PISTACHIO | Production (ton) | 702 | 1.999 | 1.978 | 1.511 | 1.408 | 1.520 | |
| | Yield per tree (kg) | 8 | 15 | 15 | 11 | 10 | 12 | |
| **Total area (da)** | | | | | | | **57.167** | **100.0** |

According to the average of the last five years of Diyarbakır province fruit cultivation, it is seen that the highest number of plum cultivation was done and this ratio was 22.41% in fruits. The plum is followed by mulberry with 17.08%, almond with 12.89%, pear with 8.60%, apple with 7.85% (Golden, Starking, Amasya and others), pistachio with %7.37, walnuts with 6.37%, apricots with 4.07%, pomegranate with 3.52%, fig with 3.24%, cherry with 2.23%, quince with 1.64% and sour cherry with 1.32%. It is observed that the cultivation of fruits such as peaches, eleagnus, olives and strawberries is very low (Table 4.2).

According to the data of the last five years; it is seen that the planting area of the plum is 12 813 da, the production amount is 928 tons and the yield per tree is 16 kg; planting area of the mulberry is 9 766 da, the production amount is 8 511 ton and the yield per tree is 17 kg; planting area of the almond is 7 366 da, the production amount is 2 894 ton and the yield per tree is 9 kg; planting area of the pear is 4 914 da, the production amount is 2 007 ton and the yield per tree is 22 kg; planting area of the apple is 4 481 da, the production amount is 1 679 ton and the yield per tree is 21 kg; planting area of the pistachio is 4 213 da, the production amount is 1 520 ton and the yield per tree is 12 kg; planting area of the walnut is 3 642 da, the production amount is 1 552 ton and the yield per tree is 22 kg; planting area of the apricot is 2 328 da, the production amount is 793 ton and the yield per tree is 17 kg; planting area of the pomegranate is 2 011 da, the production amount is 958 ton and the yield per tree is 19 kg; planting area of the fig is 1 853 da, the production amount is 791 ton and the yield per tree is 17 kg; planting area of the cherry is 1 273 da, the production amount is 273 ton and the yield per tree is 15 kg; planting area of the quince is 939 da, the production amount is 396 ton and the yield per tree is 24 kg and planting area of the sour cherry is 755 da, the production amount is 273 ton and the yield per tree is 14 kg from the most grown fruits.

### 4.3. Viticulture

The planting area (da), production amounts (ton) and yield per tree (kg) for the last five years of viticulture in Diyarbakır province are given in Table 4.3.

**Table 4.3.** Data related to cultivation of viticulture in Diyarbakır province [2]

| | | 2011 | 2012 | 2013 | 2014 | 2015 | ORT | % |
|---|---|---|---|---|---|---|---|---|
| GRAPE (TABLE-SEEDY) | Planting area (da) | 174.093 | 145.274 | 147.091 | 148.540 | 152.090 | 153.418 | **76.12** |
| | Production (ton) | 115.112 | 97.529 | 88.002 | 83.747 | 65.982 | 90.074 | |
| | Yield per tree (kg) | 661 | 671 | 598 | 564 | 434 | 586 | |
| GRAPE (TABLE-SEEDLESS) | Planting area (da) | 5.450 | 5.460 | 5.644 | 5.650 | 5.650 | 5.571 | **2.76** |
| | Production (ton) | 3.291 | 3.292 | 3.384 | 3.385 | 3.387 | 3.348 | |
| | Yield per tree (kg) | 604 | 603 | 600 | 599 | 599 | 601 | |
| GRAPE (DRYING-SEEDY) | Planting area (da) | 22.905 | 22.905 | 23.005 | 23.285 | 19.735 | 22.367 | **11.10** |
| | Production (ton) | 11.595 | 14.536 | 20.255 | 17.663 | 12.673 | 15.344 | |
| | Yield per tree (kg) | 506 | 635 | 880 | 759 | 642 | 684 | |
| GRAPE (DRYING-SEEDLESS) | Planting area (da) | 1.700 | 1.700 | 1.700 | 1.700 | 1.700 | 1.700 | **0.84** |
| | Production (ton) | 272 | 272 | 261 | 261 | 255 | 264 | |
| | Yield per tree (kg) | 160 | 160 | 154 | 154 | 150 | 156 | |
| GRAPE (WINEMAKING) | Planting area (da) | 18.306 | 18.506 | 18.461 | 18.620 | 18.620 | 18.503 | **9.18** |
| | Production (ton) | 10.733 | 10.688 | 11.311 | 13.052 | 13.436 | 11.844 | |
| | Yield per tree (kg) | 586 | 578 | 613 | 701 | 722 | 640 | |
| **Total area (da)** | | | | | | | **201.558** | **100.0** |

According to the average of the last five years of Diyarbakır province viticulture, it is seen that the highest number of table-seedy grape cultivation was done and this ratio was 76.12% in viticulture. The table-seedy grape is followed by drying-seedy grape with 11.10%, winemaking grape with 9.18%, table-seedless grape with 2.76% and drying-seedless grape with 0.84% (Table 4.3)

According to the data of the last five years; it is seen that the planting area of the table-seedy grape is 153 418 da, the production amount is 90 074 tons and the yield per tree is 586 kg; the planting area of the drying-seedy grape is 22 367 da, the production amount is 15 344 tons and the yield per tree is 684 kg; the planting area of the winemaking grape is 18 503 da, the production amount is 11 844 tons and the yield per tree is 640 kg; the planting area of the table-seedless grape is 5 571 da, the production amount is 3 348 tons and the yield per tree is 601 kg and the planting area of the drying-seedless grape is 1 700 da, the production amount is 264 tons and the yield per tree is 156 kg from the most grown viticulture.

## 5. Results

In Diyarbakır province, it is observed that wheat, barley and grain corn in the group of cereals; lentils and chickpeas in the group of food legumes; cotton and sunflower in the group of industrial plants; vetch, silage corn and bitter vetch in the group of forage crops; watermelon, tomato, pepper and melon in the group of vegetables; plum, mulberry and almond in the group of fruits; table-seedy grape, drying-

seedy grape and winemaking grape in group of viticulture are the most grown. When we look at crop production, it is seen that most of the wheat is cultivated in Diyarbakır province as it is in many other provinces, and it is seen that most barley, lentil and cotton cultivation is done after wheat.

As a result of this study, it has been concluded that we should focus on the determination of wheat, barley, lentil and cotton varieties suitable to the ecological conditions of Diyarbakir. For this purpose; It is foreseen that the works to be carried out by the institutions and organizations in Diyarbakır (mainly Dicle University Agricultural Faculty, GAP International Agricultural Research and Training Center Directorate, Food, Agriculture and Animal Husbandry Directorate and other institutions and organizations) will provide great contributions to the province and farmers of Diyarbakir in order to increase the yields, qualities and sowing areas of these plants already grown.

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