

 <p>ISSN NO. 2320-5407</p>	<p>Journal Homepage: -www.journalijar.com</p> <p>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)</p> <p>Article DOI:10.21474/IJAR01/3420 DOI URL: http://dx.doi.org/10.21474/IJAR01/3420</p>	 <p>INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR) ISSN 2320-5407 Journal homepage: http://www.journalijar.com Journal DOI:10.21474/IJAR01</p>
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RESEARCH ARTICLE

CERTAIN ECOLOGICAL CHARACTERISTICS OF FIRE-RESISTANT FOREST PROJECTS (YARDOP) IN KEPSUT (BALIKESİR/TURKEY).

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Manuscript Info

Manuscript History

Received: 17 December 2016
Final Accepted: 15 January 2017
Published: February 2017

Key words:-

Ecology, Fire-resistant, Climate, Soil, Kepsut.

Abstract

Fire-resistant forest projects (YARDOP) have been undertaken in different geographical regions of Turkey in recent years in order to protect forests against fires. In this study, YARDOP area in the district of Kepsut were evaluated in terms of ecology. Soil structure and climate characteristics in this area were investigated in ecological studies. With respect to the soil structure, the area had a sandy-loamy texture, pH was neutral, the soil was non-calcareous or slightly calcareous, salt-free and weak in terms of organic matters. The climate type and water balance of the area were investigated using Thornthwaite's and Erinc's methods. The annual average temperature in the area was found to be 14.5°C, whereas the average temperature was 24.5°C in July and 24.3°C in August. The annual total rainfall was found to be 602.2 mm, whereas the average rainfall was 9.1 mm in July and 8.7 mm in August. According to Thornthwaite climate classification, the climate type of the study area was dry/sub-humid, mesothermal and close to marine conditions with moderate water surplus in winter, represented with C1 B'2 s2 b'3. According to Erinc's rainfall efficiency index, Kepsut was observed to have a sub-humid climate and the natural cover was dry forest resembling a park. Species for planting in the area should be selected according to these climate and soil characteristics.

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Introduction:-

Forest fires affect approximately 350 million hectares of land in the world each year causing financial loss as well as loss of life. Fires may lead to acceleration in climate change (Stocks et al., 1998), air pollution (Ferrare et al., 1990), increase in carbon emission into the atmosphere (Zhang et al., 2003) and losses in products and services made possible by forests (Anderson et al., 1976; Garcia-Ruiz et al., 2013).

Fire-resistant forest projects (YARDOP) which have gained pace in our country in recent years, involve zoning works to protect various plant species against fire, changing the fire behavior and mitigating fire severity (Coşkuner and Bilgili 2013). To this end, fire-resistant areas have been created in the district of Kepsut, a rich area in terms of forests, and measures have been taken to mitigate the severity of forest fires (Yılmaz and Satıl, 2016).

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It is necessary to analyze ecological characteristics of the area prior to plant selection. Climatic data and soil structure, which are important in plant development, must be investigated in detail before determining appropriate plants.

Knowing the climate type of a region is necessary for planning of several activities from selection of plants to be cultivated and industrial facilities to be built (Şensoy and Ulupınar, 2008).

To the best of our knowledge, there is no study on the climatic data of the district of Kepsut. However, the climatic data of the Balıkesir Plain and its surroundings, 29 km from the district of Kepsut, have been investigated by Tağıl (2003).

The soil structure is as important as the climate for planting (Benek, 2006; Peker Say et al. 2012; Paksoy et al. 2016).

In this study, the climate and soil characteristics in Yılanlı Mountain and Boztepe localities in the district of Kepsut were investigated to create fire-resistant forests (YARDOP). Plant types suitable for this ecological environment were determined based on the results of the study.

Materials AndMethods:-

The climate type and water balance of the area were determined using Thornthwaite's (1948) and Erinç's (Şensoy and Ulupınar 2008; Demir et al. 2015) methods. The meteorological climatic data of the area between 1990-2015 were examined in the study. The climatic data used in the study were obtained from the records of the General Directorate of Meteorology (Anonymous, 2015). The general view of the study area and soil samples obtained from 5 different points can be seen in Figure 1.

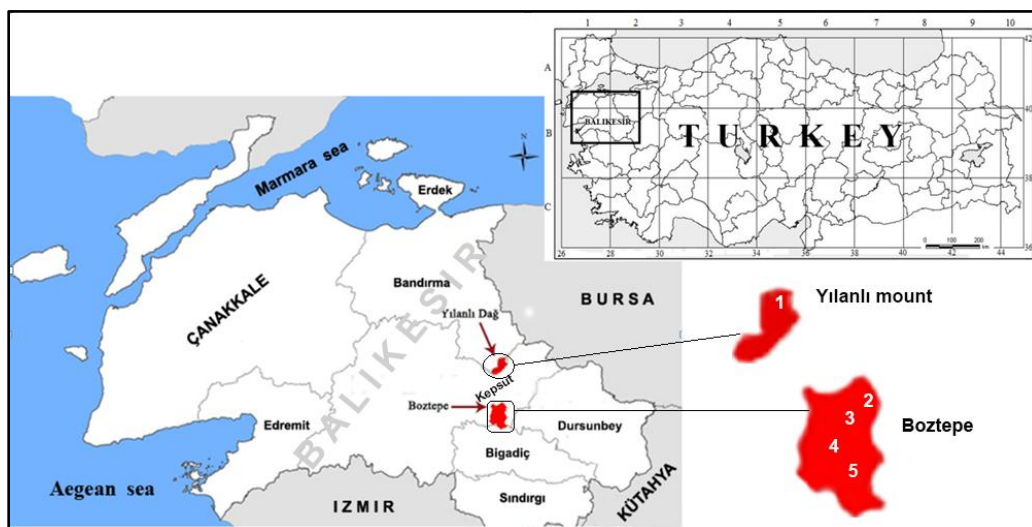


Figure 1:- The general view of the study area and soil samples obtained from trial areas.

Soil Analysis:-

Soil profiles were opened at five different trial areas and soil samples were obtained from these profiles at depths of 0 - 30 cm, 30 - 60 cm and 60 - 90 cm. Soil samples of about 1 kg each were brought to the Forest Sub-district Directorate in paper bags and kept until dry. The samples were then analyzed by the Ege Forestry Research Institute Directorate. Physical (texture, pH, calcitic lime (CaCO_3), total salt) and chemical (N, P, K, organic matter) analyses of the soil samples were performed according to standard methods (Bayraklı, 1984) and the samples were examined according to Kaçar (1972).

Discussion:-

The climatic data and observation data related to climatic factors such as rainfall, temperature and evaporation shown in Table 1 were received from the General Directorate of Meteorology (Anonymous, 2015) and assessed according to Thornthwaite and Erinc methods. The annual average temperature in the area was found to be 14.5°C, whereas the average temperature was 24.5°C in July and 24.3°C in August. The annual total rainfall was found to be 602.2 mm, whereas the average rainfall was 9.1 mm in July and 8.7 mm in August. The annual average relative was found to be 69% and the annual average wind velocity was 2.8 m/sec. The highest wind velocity was 29.6 m/sec and the wind direction was Northwest. Table 1 shows the climatic values in the study area between 1990-2015. The climate type and water balance of the area were determined using Thornthwaite's (1948) and Erinc's (Şensoy and Ulupınar 2008; Demir et al. 2015) methods.

As shown in Table 1, the potential evaporation was found to reach high values between May-September, when the temperature rises and solar energy increases. The annual average potential evaporation in Kepsut was found to be 861.2 mm. The evaporation was found to start increasing in May and reach its highest value (147.6 mm) in July, start decreasing in September and reach its lowest value (20.8 mm) in December.

Table 1:- The climatic values in the study area between 1990-2015.

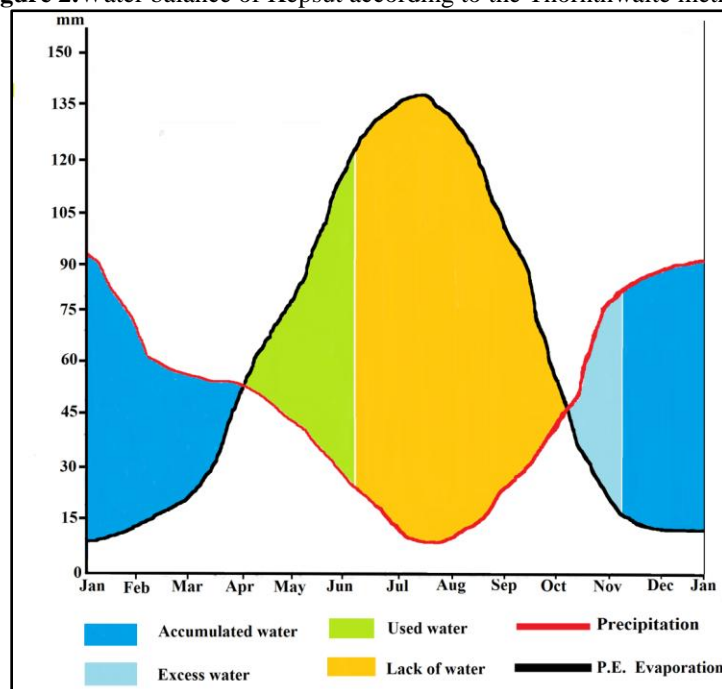
Meteorological observations	Months												Annual
	1	2	3	4	5	6	7	8	9	10	11	12	
Meantemp. (°C)	4,8	6,0	7,0	12,8	17,8	22,2	24,5	24,3	20,4	15,6	11	6,8	14,5
Maximum temp. (°C)	23,3	23,4	30,2	35,2	38,5	39,8	41,7	43,3	39,4	36,1	28,7	25,7	33,76
Means of max.temp. (°C)	8,6	10,6	13,2	18,9	24,5	28,8	30,9	31,0	27,2	21,8	16,2	10,8	20,2
Means of min.temp. (°C)	1,5	2,3	3,4	6,9	11,1	14,8	17,3	17,6	14,0	10,2	6,9	3,4	9,1
Min.temp. (°C)	-21,8	-13,1	-7,8	-2,8	0,6	4,0	9,1	6,0	4,5	-2,3	-2,6	-12,9	-21,8
Average humidity (%)	82	78	74	68	65	58	55	56	63	69	78	82	69
Average of days more than 10 mm of rainfalls	2,9	2,5	2,1	1,9	1,3	0,8	0,2	0,2	0,7	1,4	2,4	3,3	1,6
Total precipitation average (mm)	93,7	75,1	60,9	50,0	42,6	25,1	9,1	8,7	21,0	42,8	74,8	98,4	50,2
Max. precipitation (mm)	77,9	56,4	63,9	41,1	53,9	41,8	50,1	40,1	39,6	68,3	118	9,2	61,2
Average of rainy days	5,8	5,4	5,8	0,6	0,1	0,0	0,0	0,0	0,0	0,4	5,0	5,0	2,1
Average wind speed (m_sec)	2,7	2,8	3,1	2,5	2,1	2,7	3,7	3,7	3,1	2,4	2,0	2,4	2,8
Max. wind speed (m_sec)	SW	W	NESW	SW	SSW	N	NHE	N	NNE	NE	NW	SSSW	NESW
Max. wind speed (m_sec)	27,2	28,1	29,6	26,8	24,7	23,2	25,3	26,9	28,2	26,1	28,2	27,8	29,6
Average evaporation (mm)*	21,0	25,7	40,8	67,2	91,7	138	147	137	95,7	49,9	25,3	20,8	861,2
Average temperature (mb)	6,3	6,4	7,1	9,0	11,8	14,0	15,7	15,8	12,9	10,9	8,6	7,2	10,5

Table 2:- The water balance of the district of Kepsut (according to Thornthwaite)

Meteorological observations	Months												Annual
	1	2	3	4	5	6	7	8	9	10	11	12	
Temperature	4,8	5,6	7,6	12,2	17,8	21,9	23,6	22,9	19,6	14,6	9,2	6,2	13,8
Temperature index	0,94	1,19	1,89	3,86	6,84	9,36	10,48	10,01	7,91	5,07	2,52	1,39	61,46
Unamended PE	9	12	18	46	62	97	108	102	84	55	28	16	-
Amended PE	7,6	10	18,5	51,1	76,9	121,3	137,2	120,4	87,4	52,8	23,2	13,0	719,4
Precipitation	92,3	64,8	55,7	55,4	42	19,2	7,9	8	27,2	39,8	76,8	84,5	573,6
Change monthly of ditchwater	0	0	0	0	34,9	65,1	0	0	0	0	53,6	46,4	-
Ditchwater	100	100	100	100	65,1	34,9	0	0	0	0	53,6	100	-
Real PE	7,6	10	18,5	51,1	76,9	84,3	7,9	8	27,2	39,8	23,2	13	367,5
Water scarcity	0	0	0	0	0	37	129,3	112,4	60,2	13	0	0	351,9
Surpluswater	84,7	54,8	37,2	4,3	0	0	0	0	0	0	0	25,1	206,1
Flow	54,8	69,7	46	20,8	2,2	0	0	0	0	0	0	12,6	206,1

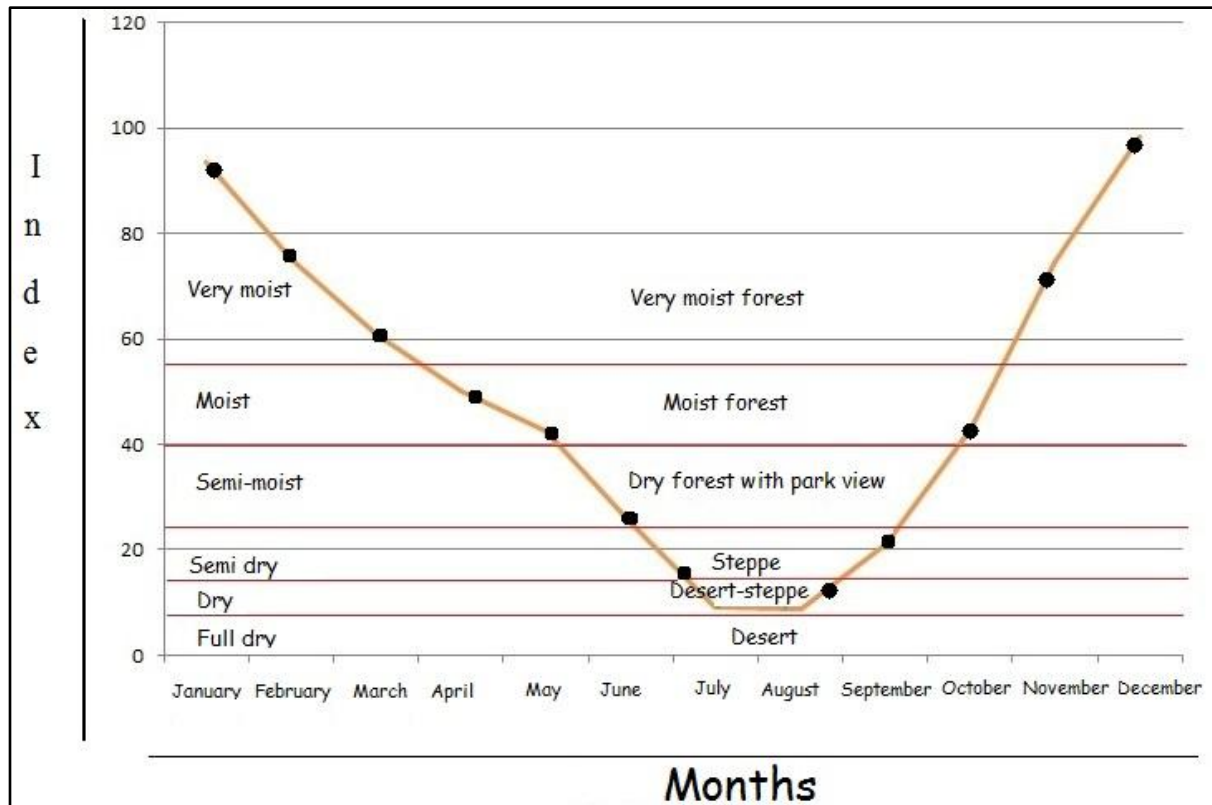
The water balance data of the trial areas were formed in order to determine the climate type of Kepsut based on the Thornthwaite method. The data can be seen in Table 2.

According to the results obtained using the Thornthwaite method, Kepsut had a dry/sub-humid and mesothermal climate type close to marine conditions with moderate water surplus in winter (C1 B'2 s2 b'3) (Table 2, Figure 2). The rainfall in November exceeds PE in Kepsut and the water surplus begins in this month. In December, the soil becomes saturated. The water surplus continues until the end of April. The situation changes in May and PE begins to exceed rainfall. However, there is not a lack of water in May since the soil is saturated in May. The low rainfall between May-June is compensated from the water accumulated in the soil. These months are when the accumulated water is consumed. There is no more accumulated water in the soil beginning from July. This situation continues until November, when the rainfall starts to exceed PE and these months are the time when lack of water is experienced (Table 2, Figure 2).

Figure 2. Water balance of Kepsut according to the Thornthwaite method.

According to Erinc rainfall activity index formula (Annual total rainfall / Annual average max. temperature), the area has an index value of 29.8 (Figure3). According to this value, Kepsut has a sub-humid climate and the natural cover is dry forest resembling a park (Şensoy and Ulupınar 2008). It was found that the climate is very humid in November, December, January, February and March; sub-humid in October, April and May; sub-arid in June and September; and arid in July and August (Figure 3).

Figure 3:- Diagram composed according to Erinc precipitation index formula.



It was determined as a result of the study that the climate of Kepsut is arid or sub-humid in general according to both classifications (Table 1). Climate demonstrates the characteristics and the state of a region in terms of weather events and also is accepted as a basic indicator of how the plant cover in the region is distributed (Usta et al., 2014). As shown in Table 1, plants selection should be made considering the lack of water and maximum evaporation level in June, July and August, high duty irrigation systems should be installed and an appropriate agricultural mechanization is required considering topographical conditions.

Analysis results are shown in Table 3-7. The texture of soils obtained from five different trial points was observed to be sandy-clayey and sandy-loamy in general and loamy in some places. The texture was observed to be sandy-loamy for soil samples obtained from a depth of 0-30 cm, sandy-clayey loam for soil samples obtained from a depth of 30-60 cm and sandy-loamy for soil samples obtained from a depth of 60-90 cm. The pH character of the soil samples obtained from trial areas were found to vary from slight acid to moderate alkali in general. The pH character was neutral in the trial area no. 1 and slight acid in the trial areas 2, 3 and 5 and moderate alkali in the trial area 4. Figure 1 shows the soil samples obtained from trial areas.

Table 3:- Results soil analysis of trial area no. 1

Depth (cm)	Texture				pH	Total CaCO ₃	Salt mS/cm	Organic matter	Total N (%)	Beneficial P (mg/kg)	Beneficial K (mg/kg)
	Sand	Clay	Silt	Kind							
0-30	55.5	26.05	18.45	Sandy – clayloam	6.95	0.07	0.203	0.76	0.062	0.83	14.8
30-60	57.38	28.04	14.58	Sandy – clayloam	6.97	0.05	0.017	0.73	0.056	0.54	0.6
60-90	75.42	11.17	13.41	Sandyloam	6.88	0.04	0.012	0.14	0.035	0.65	4.2
					Neutral	Lime-free	Saltless	Slightly	Poor	Slightly	Slightly

Table 4. Results soil analysis of trial area no. 2

Depth (cm)	Texture				pH	Total CaCO ₃	Salt mS/cm	Organic matter	Total N(%)	Beneficial P (mg/kg)	Beneficial K (mg/kg)
	Sand	Clay	Silt	Kind							
0-30	60.51	17.38	22.11	Sandy-loam	5.78	0.08	0.036	2.76	0.157	1.28	20.5
30-60	59.4	20.11	20.49	Sandy – clayloam	6.33	0.001	0.029	2.34	0.088	1.26	18.7
60-90	60.39	21.79	17.82	Sandy-clayloam	5.91	0.001	0.03	2.42	0.089	1.30	17.4
					Mild acid	Lime-free	Saltless	Medium	Poor	Slightly	Slightly

Table 5:- Results soil analysis of trial area no. 3

Depth (cm)	Texture				pH	Total CaCO ₃	Salt mS/cm	Organic matter	Total N(%)	Beneficial P(mg/kg)	Beneficial K (mg/kg)
	Sand	Clay	Silt	Kind							
0-30	63.23	14.98	21.79	Sandy-loam	6.43	0.01	0.031	1.60	0.081	1.43	2.9
30-60	46.68	16.54	36.78	Loam	6.56	0.01	0.026	0.05	0.015	0.28	2.5
60-90	77.91	6.51	15.58	Loam-Sandy	6.63	0.02	0.024	0.01	0.010	0.24	8.8
					Mild acid	Lime-free	Saltless	Poor	Poor	Slightly	Slightly

Table 6:- Results soil analysis of trial area no. 4

Depth (cm)	Texture				pH	Total CaCO ₃	Salt mS/cm	Organic matter	Total N (%)	Beneficial P (mg/kg)	Beneficial K (mg/kg)
	Sand	Clay	Silt	Kind							
0-30	61.41	15.28	23.31	Sandy-loam	8.35	5.68	0.092	2.23	0.113	1.53	19.5
30-60	78.60	2.10	19.30	Loam-Sandy	8.95	31.29	0.069	0.18	0.028	0.27	4.0
60-90	83.77	1.13	15.10	Loam-Sandy	9.01	36.68	0.068	0.29	0.025	0.34	4.1
					Alkali	Excess limy	Saltless	Poor	Poor	Slightly	Slightly

Table 7. Results soil analysis of trial area no. 5

Depth (cm)	Texture				pH	Total CaCO ₃	Salt mS/cm	Organic matter	Total N(%)	Beneficial P (mg/kg)	Beneficial K (mg/kg)
	Sand	Clay	Mil	Kind							
0-30	69.84	10.40	19.76	Sandy-loam	5.76	0.01	0.156	3.20	0.132	4.71	30.6
30-60	70.29	10.25	19.47	Sandy-loam	6.72	0.06	0.03	0.37	0.060	0.46	15.0
60-90	70.01	10.34	19.65	Sandy-loam	5.99	0.01	0.043	0.063	0.063	0.51	15.2
					Mild acid	Lime-free	Saltless	Slightly	Poor	Slightly	Slightly

Considering the lime (CaCO₃) structure of the trial areas, it was observed that the trial areas were generally non-calcareous, whereas the soil structure of the trial area no. 4 was found to contain moderate to high lime. The soil samples obtained from five different areas were found to have a salt-free character. All of the trial areas were found to have organic matter, albeit in low amounts. The organic matter content was moderate in the samples obtained from a depth of 0-30 cm in the trial areas no. 2, 4 and 5, whereas the organic matter content was low in the remaining trial areas. The organic matter content was moderate in the samples obtained from a depth of 30-60 cm in the trial area no. 2, the organic matter content was very low in all of the remaining trial areas. The organic matter content was moderate in the samples obtained from a depth of 60-90 cm in the trial area no. 2, the organic matter content was very low in all of the remaining trial areas. The N element was found in low levels in all of the trial areas. The rate of N was found to be similar in samples obtained from different depths (0-30 cm; 30-60 cm; 60-90 cm) and soils from all depths had a low rate of nitrogen. Whilst the rate of P was observed to be low in the soil samples obtained from a depth of 0-30 cm in the trial area no. 5, the rate of P was very low at all depths in all trial areas. Whilst the rate of P was observed to be moderate in the soil samples obtained from a depth of 60-90 cm in the trial area no. 5, the rate of P was very low at all depths in all trial areas.

Conclusion:-

In conclusion, the fire-resistant plant species to be selected for fire-resistant forest areas should be able to adapt to the arid or sub-humid climate type and regions close to marine conditions. These plant species should be suitable for salt-free, slightly acidic or neutral soils with poor organic matter content in order to create long-lasting YARDOP areas.

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