The Relationship between Soil Moisture and Temperature Vegetation on Kirklareli City Luleburgaz District A Natural Pasture Vegetation

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***Abstract*—** *This study was realized in 2014 – 2015 in two different sections of Kirklareli city Luleburgaz district Sakizkoy village natural pasture in order to research the effect of soil moisture and soil temperature on area covered by vegetation, plant species and dry yield. As research area, study was conducted in two different sections defined as A and B located to the north and south of village coppice forest area located within the borders of Kirklareli city Luleburgaz district Sakizkoy village. By this study, the relation between soil moisture and temperature with plant species were evaluated by CANOCO 4.5 computer program. Accordingly, the effect of ecological values on vegetative properties was presented. According to research results, soil moisture and temperature have significant effect on vegetation. In the first year when soil moisture was high, hay yield was 2901.9 kg/ha while the yield was detected as 480.1 kg/ha after soil temperature (which is inversely correlated with soil moisture) increased in the second year. It was determined that Lolium perenne (one of the dominant species of vegetation) is common in parcels with high moisture while Chrysopogon gryllus is common in parcels where soil temperature is high.*

Keywords*— *pasture, dry yield, soil moisture, soil temperature, CANOCO 4.5.

I. INTRODUCTION

Climate change is expected to affect agriculture very differently in different parts of the world (Parry et al., 2004). Climate change impacts on crop yield are often integrated with its effects on water productivity and soil water balance. Global warming will influence temperature and rainfall, which will directly have effects on the soil moisture status and groundwater level (Kang et al.2009). According to Valentine, (1990), livestock products provide the major economic return from most range and pasture lands and compared with harvested or purchased feeds, pastures and pasture provide a relatively inexpensive and energy-efficient feed source for livestock. Climate change is change the community structure of grasslands (Buckland et al., 2001; Lüscher et al., 2004). Grasslands will differ in their response to climate change depending on their type (species, soil type, management) (Olesen , 2006). Management and species richness of grasslands may increase their resilience to change (Duckworth et al., 2000). Particularly climatic factors, like mean annual precipitation and precipitation variability, have a huge impact on rangeland condition and fodder production (Williams and Albertson, 2006). Climate change in the form of decreasing mean annual precipitation accompanied by increasing variability has important consequences for rangeland productivity and thus pastoral livelihood security (Martin et al.2013). Soil moisture plays a key role in vegetation restoration and ecosystem stability in arid and semiarid regions. The response of soil moisture to rainfall pulses is an important hydrological process, which is strongly influenced by land use during the implementation of vegetation restoration. Soil moisture depended strongly on precipitation (Yu et al.2015). Soil moisture is a key rangeland health parameter as it is the principal limiting factor in semi-arid ecosystems (Weber and Gokhale, 2010) . Soil moisture and temperature are together referred to as "soil climate". The effects of soil climate are mainly the basic determining criteria that separate range ecosystems from other natural ecosystems. In addition, soil climate affects all soil-plant relationships in range ecosystems. Rooting depth, water potentials, nutrient intake and nutrient element distribution are affected by the amount and time of moisture availability associated with the critical temperatures at which the root activity is observed. The temperature and moisture near the soil surface affect the germination of range plants. Besides germination, settlement and continuity also depend on the temperature and moisture of the soil (Altin et al. 2011). Temperature is an important feature that has a significant effect on the biological events that take place in the soil and directs the physical and chemical processes. The root development of most plants ceases at temperatures below 5˚C. The availability of soil and air temperature data is necessary to understand plant-soil relationships and to be able to make comments on the use of the soil (Dinc and Senol, 1998) and therefore will create a basis for the projections to be drawn for range management and improvement in the future. The objective of this study is to determine the effects of I) different pasture sites and II) soil moisture and temperature on vegetation composition in a natural pasture. Fırıncıoglu et al. (2008) and Ababou et al. (2009) stated that, to perform a redundancy analysis (RDA) to determine the topographic and edaphic factors that influence plant species occurrence to understand the most important components affecting the segregation of plant species. For this purpose, RDA analyses were performed using CANOCO 4.5 computer program in this study.

II. MATERIAL AND METHOD

The study was carried out in Sakizkoy village of Luleburgaz district of Kırklareli province in 2014-2015. Although Luleburgaz is involved in the temperate climate zone by its latitudes, it has a cold and rainy character in winters and dry and hot character in summers. The region where the study area is located has a "Semi-Arid Climate" feature (Donmez, 1968). While the total annual rainfall was 788, 8 mm in Luleburgaz District of Kirklareli Province in 2014, which was the first year of the study, it was 493,0 mm in 2015, the second year. While the average relative humidity of the year 2014 was 84.4%, the average relative humidity of the year 2015 decreased to 75.2%. The average temperatures of the years 2014 and 2015 were measured as 14, 2 ^{o}C and 15, 6 ^{o}C, respectively. It was observed that the maximum temperature average of the year 2014 was 26.9 ^{o}C and the maximum temperature average of the year 2015 was 27.6 ^{o}C (Anonymous 2016). A sites,and B sites pasture of Sakizkoy village, Kirklareli (Europe Part) in Turkey; Latitude 41;46;24 N Longitude 27;48;66 E , 41;47;16N, 27;49;38 E , respectively.

FIGURE 1. GOOGLE EARTH IMAGE OF SAKIZKOY PASTURE

As research area, study was conducted in two different sections defined as A and B located to the north and south of village coppice forest area located within the borders of Kirklareli city Luleburgaz district Sakizkoy village. Regarding two separate regions designated as sites A and B located in the North and South part of the Village coppice forest which is within the borders of Sakizkoy Village where the study was carried out, Site A is closer to the Village settlement area, Site B is closer to the sheepfolds. While site A is generally exposed to cattle grazing pressure, site B is further exposed to small cattle grazing pressure although they are grazed on both sites. Presence/absence data of all vascular plant species were recorded in the sites. A total of 40 sites were sampled at two units to determine dry matter yield according to weight. For determination dry matter yield of the samples were harvested about 5 cm above the soil surface. All the plots in 0.25 m^2 were clipped from 20 sites in 2014 and 2015 year. The aboveground standing crop was measured by cutting herbaceous biomass (at ground level) and dried at hay yield was determined by drying the samples at 78ºC for 24 h. We also determined soil moisture and temperature these sites. We recorded soil temperature values using a portable electronic thermohygrometer (Mannix THPen , model PTH 8708) and soil moisture values were determined using "Economy Soil Moisture Tester".

Statistical Analysis

Multivariate relationships between environmental variables and vegetation composition were determined Redundancy analysis ***(***RDA***)*** using Lepsˇ and S ˇ milauer, (2003) and Monte Carlo permutation test was used to prove if the results of the ordination are significant All default parameters in CANOCO(Version 4.5) were used (Ter Braak and Smilau, 2002). An analyses of variance was conducted using SPSS, (Version 18.0).

III. RESULTS AND DISCUSSION

Soil moisture measurement results in the years 2014-2015, during which the study was carried out, are presented in Table 1.

TABLE 1
ANALYSES OF VARIANCE, SOIL MOISTURE (%) AND SOIL TEMPERATURE (^{o}C)

	Soil Moisture %		Soil Temperature ^{0}C	
Sites	2014	2015	2014	2015
A Sites	8.4a	5.6b	16.8b	24.5a
B Sites	7.6a	6.4b	16.8b	26.4a
	Year:22.814**	Year * Site 4.176*	Year * Site 462.352**	Site11.027** Year x S ite11.027**

*** P< 0.05,** P<0.01 , [a] Means within rows with different superscripts differ significantly**

Soil temperature measurement results in the years 2014-2015, during which the study was carried out, are presented in Table 1. Soil temperature measurement results in the years 2014-2015, It was observed that the soil temperature increased from 16,8 ^{0}C to 24,5 ^{0}C on site A and from 16,8 ^{0}C to 26,4 ^{0}C on site B (Table 1). When these measurement results were compared, while the soil moisture was 8.4% on site A in 2014, it decreased to 5.6% in 2015. While the soil moisture was 7.6% on site B, it was decreased to 6.4% (Table 1). Deeply-rooted plants are more likely to survive extended periods of drought by accessing lower soil layers that contain higher levels of soil moisture (Chaves et al. 2003). It is generally assumed that plants respond to drought in surface layers by shifting water and nutrient uptake to deeper soil layers (Garwood and Sinclair 1979; Sharp and Davies 1985), Soil temperature, a controlling factor for soil moisture as it affects evaporation, is also affected by the amount of litter (Davidson et al. 1998). During the dry period, deep-rooted plants can well utilise the water and nutrients in the lower layers of the soil (Hoekstra et al. 2014).

TABLE 2
ANALYSES OF VARIANCE, DRY YIELD (KG/HA) AND REDUCTION OF DRY YIELD (%)

	2014	2015	Reduction of Yield %
Sites	Grasses(kg/ha)	Grasses (kg/ha)	
A Sites	1509.2a	451.0b	70
B Sites	1091.3a	154.1b	85
Average	1300.2a	302.5b	76
	Legumes(kg/ha)	Legumes (kg/ha)	
A Sites	513.4a	128.0b	76
B Sites	831.7a	17.9b	97
Average	672.5a	72.9b	89
	Others(kg/ha)	Others(kg/ha)	
A Sites	1444.0a	177.8c	87
B Sites	414.1b	31.0d	95
Average	929.0a	190.4b	79
A SitesTotal	3466.6a	757.0c	
B Sites Total	2337.2b	203.0d	
	2901.5a	480.1b	
	GrassYear:17.816**	LegumesYear:31.633**	OthersYearxSites:7.453* Others Site:13.234** OthersYear:25.997**

*** P< 0.05, ** P<0.01, [a] Means within rows with different superscripts differ significantly**

In the first year when soil moisture was high dry yield was 2901.9 kg/ha while the yield was detected as 480.1 kg/ha after soil temperature (which is inversely correlated with soil moisture) increased in the second year. As it is understood from Table 2 above, there was a significant yield loss in dry yields in the second year of the study. In both years, the measurements were performed during the same vegetation period, and there was not any difference in grazing. Therefore, rainfall regime is estimated to be the effective factor for this yield loss. Indeed, it was determined that the effect of soil moisture factors on dry yields was very significant. Drought is usually the most important environmental stress for the range plants that try to survive against the constant consumption of the animals. Drought stress is characterized by reduction of water content, diminished leaf water potential and turgor loss, closure of stomata and decrease in cell enlargement and growth . Severe water stress may result in the arrest of photosynthesis, disturbance of metabolism and finally the death of plant (Jaleel et al., 2008). Thomas and Squires (1991) argue that soil moisture is the principal determinant of productivity and the primary driver of rangeland condition in semi-arid ecosystems. Seedling emergence rate and root and shoot growth were decreased by limiting soil water content, while root-to-shoot length ratio (43%) was increased (Gazanchian et al. 2006). Low water availability in arid and semiarid regions severely limits seed germination, seedling establishment, and persistence of perennial grasses (Bassiri et al., 1988). Johnson and Asay (1993) reported that water deficit also limits the establishment, growth, and production of cool season grasses on semiarid rangelands. There is a strong linear relationship between aboveground net primary productivity (ANPP) and annual precipitation in rangeland ecosystems (Le Houérou, 1984; Sala et al., 1988; Scholes, 1993). Annual forage pastures are seeded every spring (with the exception of fall-seeded winter cereals), have shallower root systems with lower biomass (Baron et al. 1999; Mapfumo et al. 2002), and therefore tend to use less water than perennial forages (Baron et al. 1999; Twerdoff et al. 1999). Differences in water use occur among perennial forage species. Root depth, root density, and timing of canopy closure impact procurement and evaporative demand for soil moisture among species (Bradshaw et al. 2007).

As a result of the study, according to dry yields, it was observed that the yield loss was less in grasses compared to legumes and other family members. In the results of the study, while the average yield loss in grasses between 2014-2015 was found to be 70%, this ratio was 89% in legumes and 79.4% in other families (Table 2). Olesen (2006) stated that climate variability is one of the most significant factors influencing year to year crop production, even in high-yield and high-technology agricultural areas .

Redundancy analysis (RDA) was performed to determinate which of the measured environmental variables would significantly explain the species composition.

TABLE 3
REDUNDANCY ANALYSIS (RDA) OF ENVIRONMENTAL-VEGETATION COMPOSITION

	Axis1	Axis2	Axis3	Axis4	Total
Eigenvalues	0.304	0.058	0.201	0.122	1.000
Species-environment correlations	0.926	0.602	0.000	0.000	
Cumulative percentage variance of species data	30.4	36.2	56.3	68.5	
of species-environment relation	84.1	100.0	0.0	0.0	

The RDA showed a high cumulative percentage variance of species occurrence data explained on the fi rst two axes of the RDA (34.4%) (Table3). With RDA of the vegetation data, eigen values of 0.304, 0.058, 0.201, 0.122 were found for axes one to four, respectively (Table 3). There was a strong relationship between the vegetation and the environmental factors, with species-environment correlations of 0.926 on the first axis and 0.602 on the second axis. The Monte Carlo permutation test was significant for the first axis (*P* = 0.002), the second axis (*P* = 0.002).

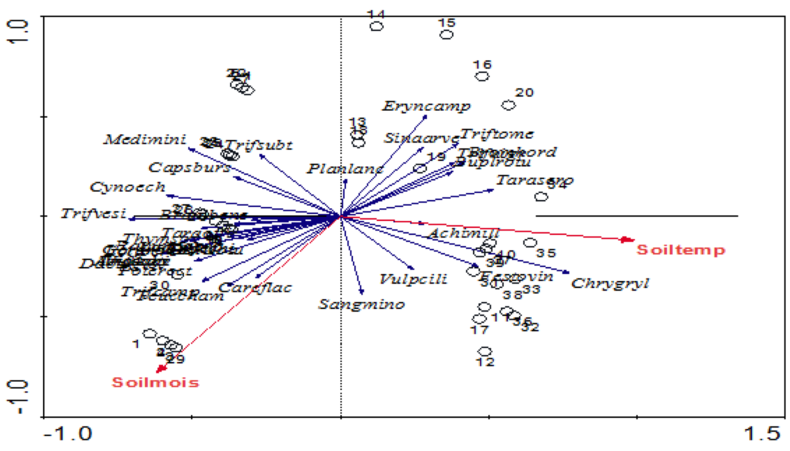

FIGURE 2. ORDINATION DIAGRAMS (SPECIES-SITES--ENVIRONMENT) OF RDA

Species:*Achillea millefolium* Achimill; *Aira caryophyllea* Airacary, *Bromus benekenii* Brombene, *Bromus hordelymus* Bromhord, *Bupleurum rotundifolium* Buplrotun, *Capsella bursa-pastoris* Capsburs,*Carex flacca* Careflac, *Cynosurus echinatus* Cynoech, *Chrysopogon gryllus* Chrygryl, *Dactylis glomerata* Dactyglom, *Eryngium campestre* Eryncamp, *Festuca ovina* Festovin, *Galium rotundifolium* Galirotu, *Geranium robertianum* Gerarobe, *Koeleria nitidula* Koelnitu, *Lamium purpureum* Lamipurp, *Lolium perenne* Lolipere, *Medicago minima* Medimini, *Plantago lanceolata* Planlanc, *Potentilla recta* Poterect, *Ranunculus neapolitanus* Ranuneap, *Sanguisorba minor* Sangmino, *Sinapis arvensis* Sinaarve, *Taraxacum officinale* Taraoffi, *Taraxacum serotinum* Tarasero, *Teucrium chamaedrys* Teuccham, *Thymus striatus* Thymstri, *Trifolium campestre* Trifcamp, *Trifolium echinatum* Trifechi, *Trifolium nigrescens* Trifnigr, *Trifolium ochroleucum* Trifochr, *Trifolium subterraneum* Trifsubt,*Trifolium tomentosum* Triftome, *Trifolium vesiculosum* Trifvesi, *Vicia sativa* Vicisati,*Vulpia ciliata* Vulpcili

Environmental variables: Soil mois Soil moisture, Soil temp Soil temperature

The distribution of the sites according to the soil temperature and moisture and species of the study area is presented in Figure 2. There is a mutual relationship between plant species and environmental factors such as soil temperature and soil moisture. Weniger (1973) stated that the excess of water in the soil leads to a decrease in soil temperature and that the soils with a higher amount of air presenting in soil pores get heated more quickly compared to water-saturated soils as the amount of heat the water needs to get heated is more with respect to the air.

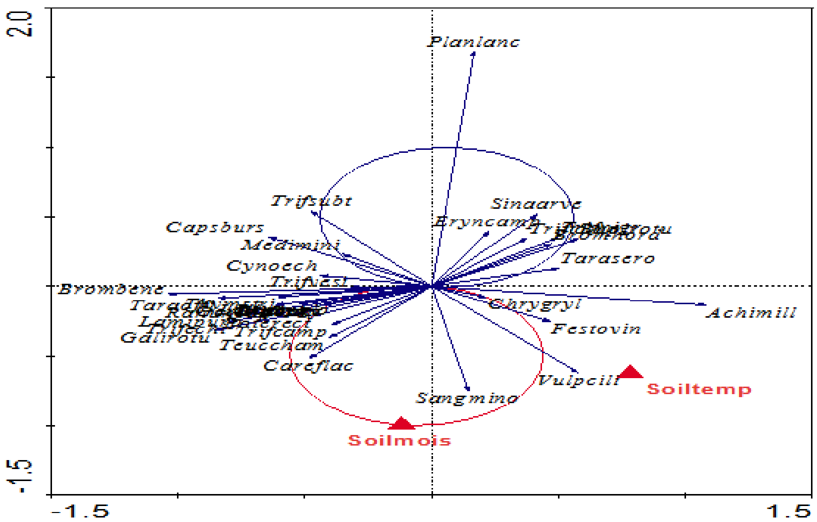

FIGURE 3. T- VALUE PLOT OF SOIL MOISTURE

Species: *Achillea millefolium* Achimill; *Aira caryophyllea* Airacary, *Bromus benekenii* Brombene, *Bromus hordelymus* Bromhord, *Bupleurum rotundifolium* Buplrotun, *Capsella bursa-pastoris* Capsburs, *Carex flacca* Careflac, *Cynosurus echinatus* Cynoech, *Chrysopogon gryllus* Chrygryl, *Dactylis glomerata* Dactyglom, *Eryngium campestre* Eryncamp, *Festuca ovina* Festovin, *Galium rotundifolium* Galirotu, *Geranium robertianum* Gerarobe, *Koeleria nitidula* Koelnitu, *Lamium purpureum* Lamipurp, *Lolium perenne* Lolipere, *Medicago minima* Medimini, *Plantago lanceolata* Planlanc, *Potentilla recta* Poterect, *Ranunculus neapolitanus* Ranuneap, *Sanguisorba minor* Sangmino, *Sinapis arvensis* Sinaarve, *Taraxacum officinale* Taraoffi, *Taraxacum serotinum* Tarasero, *Teucrium chamaedrys* Teuccham, *Thymus striatus* Thymstri, *Trifolium campestre* Trifcamp, *Trifolium echinatum* Trifechi, *Trifolium nigrescens* Trifnigr, *Trifolium ochroleucum* Trifochr, *Trifolium subterraneum* Trifsubt, *Trifolium tomentosum* Triftome, *Trifolium vesiculosum* Trifvesi, *Vicia sativa* Vicisati, *Vulpia ciliata* Vulpcili

Environmental variables: Soil mois Soil moisture, Soil temp Soil temperature

In Figure 3, the t-values of the statistical significance relation between soil moisture and plant species are presented by a Van-Dobben circle. It was found out that the plants such as *Carex flacca*, *Trifolium campestre* and *Lolium perenne* had a positive relationship with soil moisture, and *Eryngium campestre* and *Sinapis arvensis* had a negative relationship with soil moisture. In addition to this, it was observed that especially *Lolium perenne*, *Carex flacca* developed better in moist soils. These plants are dominant especially in areas where soil moisture is high. Annual legumes such as *Trifolium campestre*, *Trifolium echinatum*, *Trifolium vesiculosum*, remaining in the circle can also utilise the water in the soil with the taproot systems in the drought period.

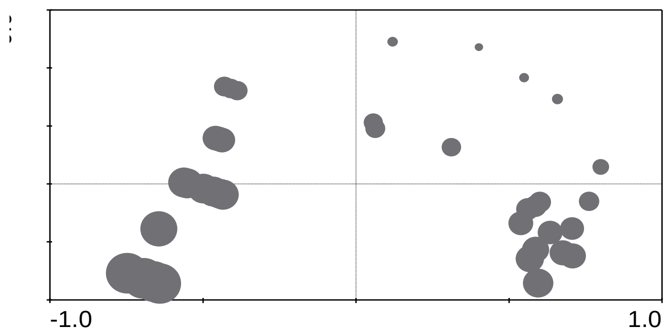

FIGURE 4. DISTRIBUTION OF SITES ACCORDING TO SOIL MOISTURE

The distribution of the parcels according to the soil moisture of the study area is presented in Figure 4. The soil moisture in the parcels displayed with dark-colored symbols in the biplot parcel refers to high values. The parcels with the high ratios of *Lolium perenne (Figure 5)* generally show parallelism with the parcels with high soil moisture (Figure 4)

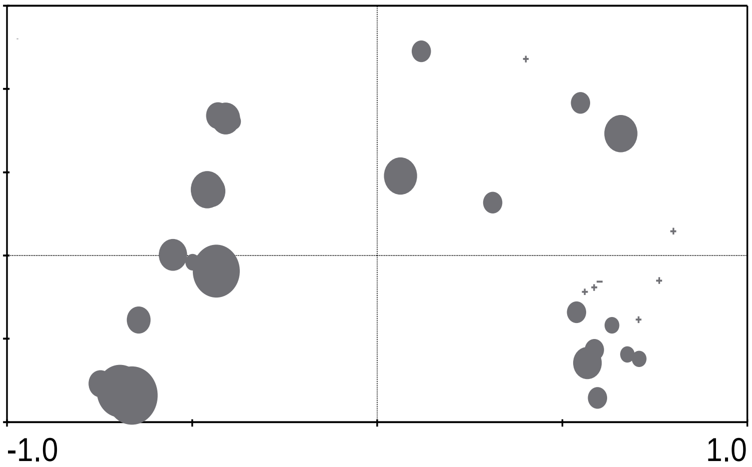

FIGURE 5. PRESENCE OF *LOLIUM PERENNE* IN SITES

Lolium perenne among common plants was selected as an example, and their statuses of presence in sites are shown in Figure 5. The *Lolium perenne* in the parcels displayed with dark-colored symbols in the biplot parcel refer to high values. *Lolium perenne, Carex flacca,* and *Trifolium repens* among the plant species in these shaped pasture sites are more common in wet soils. *Lolium perenne* is a graminae that prefers damp, fertile and heavy soils Altin (1992)**.** Dengler *et al.* (2014) reported that water limitation reduces productivity as it reduces the ability of dominants to develop sufficient growth, even under nutrient-rich conditions. At the same time, taller plants were probably favoured by deeper soils which were more frequent in abandoned grasslands (Vassilev *et al.*2011).

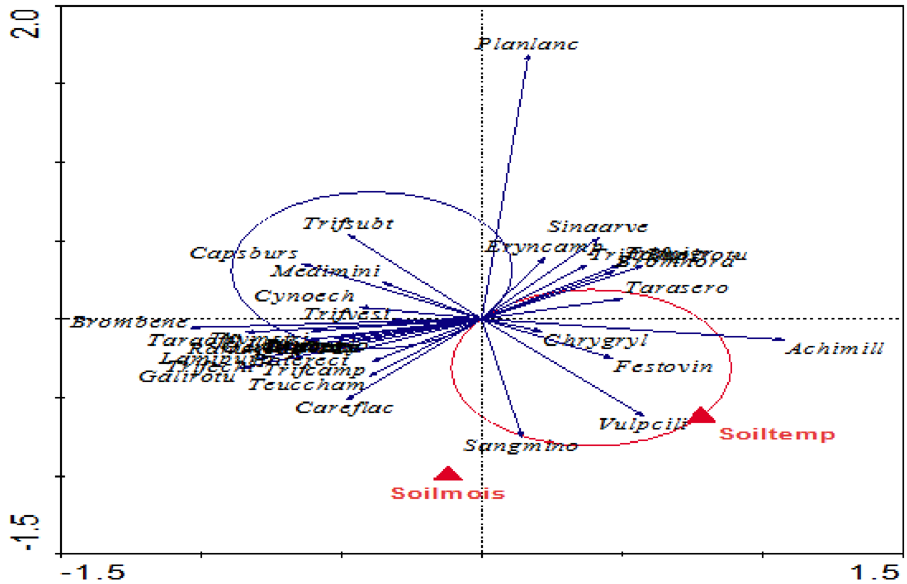

FIGURE 6. T- VALUE PLOT OF SOIL TEMPERATURE

Species:*Achillea millefolium* Achimill; *Aira caryophyllea* Airacary, *Bromus benekenii* Brombene, *Bromus hordelymus* Bromhord, *Bupleurum rotundifolium* Buplrotun, *Capsella bursa-pastoris* Capsburs,*Carex flacca* Careflac, *Cynosurus echinatus* Cynoech, *Chrysopogon gryllus* Chrygryl, *Dactylis glomerata* Dactyglom, *Eryngium campestre* Eryncamp, *Festuca ovina* Festovin, *Galium rotundifolium* Galirotu, *Geranium robertianum* Gerarobe, *Koeleria nitidula* Koelnitu, *Lamium purpureum* Lamipurp, *Lolium perenne* Lolipere, *Medicago minima* Medimini, *Plantago lanceolata* Planlanc, *Potentilla recta* Poterect, *Ranunculus neapolitanus* Ranuneap, *Sanguisorba minor* Sangmino, *Sinapis arvensis* Sinaarve, *Taraxacum officinale* Taraoffi, *Taraxacum serotinum* Tarasero, *Teucrium chamaedrys* Teuccham, *Thymus striatus* Thymstri, *Trifolium campestre* Trifcamp, *Trifolium echinatum* Trifechi, *Trifolium nigrescens* Trifnigr, *Trifolium ochroleucum* Trifochr, *Trifolium subterraneum* Trifsubt,*Trifolium tomentosum* Triftome, *Trifolium vesiculosum* Trifvesi, *Vicia sativa* Vicisati,*Vulpia ciliata* Vulpcili

Environmental variables: Soil mois Soil moisture, Soil temp Soil temperature

It was found out that there was a positive relationship between soil temperature and *Sanguisorba minor, Chrysopogon gryllus, Vulpia ciliata*. Annual legumes such as *Medicago minima, Trifolium vesiculosum, Trifolium subterraneum* have a negative relationship with soil temperature (Figure 6).

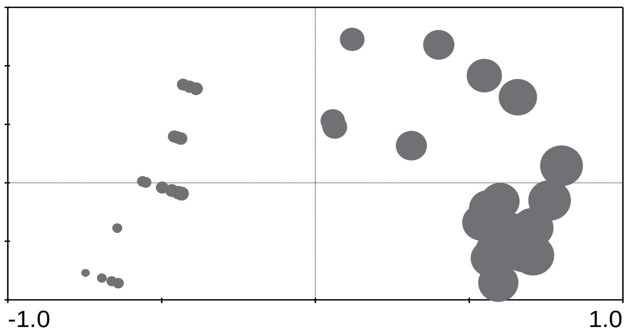

FIGURE 7. DISTRIBUTION OF SITES ACCORDING TO SOIL TEMPERATURE

The distribution of the parcels according to the soil temperature of the study area is presented in Figure 7. The soil temperatures in the parcels displayed with dark-colored symbols in the biplot parcel refer to high values. These parcels include the soil temperatures during the second year of the study. It is observed in Figures 6 and 3 that *Sanguisorba minor* efficiently benefits from the soil temperature and soil moisture. The distribution (Terri and Stowe, 1976; Tieszen et al., 1979) and seasonal activities of C3 and C4 grasses (Kemp and Williams, 1980; Hicks et al., 1990) often are highly correlated with temperature(IPCC, 1995). According to previous research Adams et al. (1986), grasses are usually dominant in pastures all over the world. Indeed, it was determined that *Chrysopogon gryllus* among these common species are found in grazed dry pasture sites (Figure 8).

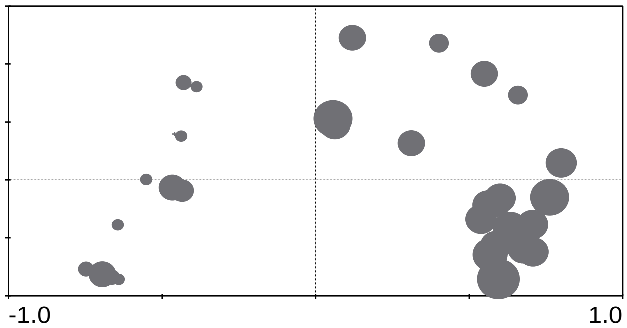

FIGURE 8. PRESENCE OF CHRYSOPOGON GRYLLUS IN SITES

The distribution of the hot climatic plant *Chrysopogon gryllus* (C4), one of the important species in the study area, is presented in figure 8. The *Chrysopogon gryllus* in the parcels displayed with dark-colored symbols in the biplot parcel refer to high values. The parcels with the high ratios of *Chrysopogon gryllus* (Figure 8) generally show parallelism with the parcels with a high soil temperature (Figure 7). *Chrysopogon gryllus,* grows on warm, dry, illuminated, sandy grassy slopes and hills as well as on dry pasture land (Djurdjevıć et al.2005, Dajıć Stevanovıć et al. 2008). The most widely spread species on Buzagici(Tekirdag) pasture was scented grass *(Chrysopogon gryllus*) (Uluocak, 1974; Davis, 1985; Tuna et al. 2011). Actually, there is a mutual relationship between plant species and environmental factors as is known.

IV. CONCLUSION

According to our study results, it was determined that the annual amount of rainfall affected the soil moisture and temperature. Indeed, during the two years of the study, rainfall differences caused significant changes in the soil moisture and temperature. Accordingly, decreases were found in dry yields along with the decreasing soil moisture and increasing temperature, and this was found to have a significant effect on plant species distribution. Such studies will create a resource for the studies to be carried out from now on for the ranges of arid and semi-arid regions. In addition, they will allow us to reach more information about climate, soil and pasture interactions by extending the study area and scope and ensuring their continuity for many years. Such studies will also allow the determination of species that can adapt to the arid conditions in the pastures.

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