www.biodicon.com Biological Diversity and Conservation

ISSN 1308-8084 Online; ISSN 1308-5301 Print 8/3 (2015) 42-53

Research article/Araştırma makalesi

Determination of relationships between *Cicadellidae* population and plant diversity-environmental structure in the Erzurum/Turkey province grasslands

Celalettin AYGÜN [*1], Murat OLGUN [2]

[1] Geçitkuşağı Agricultural Research Institute, Ziraat Street, 6. km, 26200 Tepebaşı, Eskişehir, Turkey
[2] Osmangazi University, Faculty of Agriculture, 26160 Eskişehir, Turkey

Abstract

The purpose of this study was to reveal insect populations belonged to *Cicadellidae* family, existing in declining, replicator and invasive plant groups, to determine the effect of distance to village, stoniness, slope, grazing level, altitude, erosion, soil depth and grassland quality degree on insect population in grasslands of central district of Erzurum province. Insect population and diversity are commonly different in declining, replicator and invasive plant groups, *Circulifer haematoceps, Ulopa trivia, Batrachomorphus irroratus, Handianus procerus, Stenometopiellus angorensis, Doratura stylata Doratura exilis* were seen and observed in all three grassland groups. *Cicadellidae* population are important in productivity of grassland, they are significantly influenced from slope, erosion and grassland quality grade. Plant protecting studies will help improvement of grasslands.

Key words: insects, grassland, erosion, grazing and grassland quality grade

---------- * ----------

Erzurum Meralarında *Cicadellidae* populasyonu ile bitki çeşitliliği-çevresel koşullar arasındaki ilişkinin belirlenmesi üzerine bir araştırma

Özet

Bu çalışmanın amacı Erzurum ili merkez meralarında azalan, çoğalan ve istilacı bitki türleri üzerinde mevcut olan *Cicadellidae* familyasına bağlı böcek türlerini ve bunların yoğınluğunu tespit etmek, ayrıca mera özelliklerinin (köye uzaklık, taşlılık, eğim, otlatma derecesi, yükseklik, erozyon oranı, toprak derinliği, ve mera kalite derecesi) böcek populasyonu üzerine olan etkilerini belirlemektir. Araştırma sonuçlarına gore böcek türleri ve yoğunluğu azalan, çoğalan ve istilacı bitki türlerinde farklılıklar gösterniştir. *Circulifer haematoceps, Ulopa trivia, Batrachomorphus irroratus, Handianus procerus, Stenometopiellus angorensis, Doratura stylata Doratura exilis* böcek türleri azalan, çoğalan ve istilacı bitki türlerinin her üçünde de en çok görülen böcek türleri olarak belirlenmiştir. *Cicadellidae* meralarda mera verim üzerinde olumsuz etki yapan önemli böcek familyası olup, bu familyaya ait böceklerin meradaki yoğunlukları eğimden, erozyon derecesinden, mera kalite dercesinde önemli oranda etkilenmektedir. Bitki koruma çalışmalaları meraların iyileştirilmesine önemli oranda katkı sağlayacaktır.

Anahtar kelimeler: böcekler, mera, erozyon, otlatma, mera kalite derecesi

1. Introduction

With largest geographical region, Eastern Anatolia is high and mountainous area in Turkey. These mountain ranges separate the region from the sea and indicate the average annual temperatures to be low and the winters to be severe. In the region, the main economic activities are animal husbandry and agriculture mostly based on pastures. Vastness of pastures allows increases in the number of animals and animal production Anonymous, 1998 and 2000). Acreage of pastures has been tremendously decreasing losing their productivity and health in the Eastern Anatolia (Anonymous, 2004). Living organisms are extremely diverse in healthy ecosystems. This diversity keeps system stable

* *Corresponding author* / Haberleşmeden sorumlu yazar: Tel.: +902223243000; Fax.: +902223243000; E-mail: caygun @gktaem.gov.tr

and as a whole. But productivity and health of pastures are under presence of many harmful factors and with 12%, insects occupy important place in yield loss (35%) in agricultural grasslands (Aygün et al., 2004). Balanced grazing, protecting grassland against over grazing, insects, and erosion will assist increase in yield and keep grassland more healthy and productive (Aygün et al., 2004).

Cicadellidae (*Homoptera*) family is one of the harmful insects in meadows and pastures and this family is commonly seed and causes yield losses in grasslands of Eastern Anatolia. Family is commonly seed and causes yield losses in grasslands of Eastern Anatolia. *Cicadellidae* feed on almost any kind of plant, and meanwhile also carry some disease agents (Bakır, 1970). Especially, by sucking, they cause wilting, wrinkle and desiccations in leaves. Due to low information about losses of them, they are not taken into consideration (Borror and Triplehorn, 1981; Balabanlı et al., 2005; Çetiner et al., 2012). Species belonged to *Erythroneura, Tyhplocyba* and *Empoasca* genuses could be well examples of such damage (Borror and Triplehorn, 1981). It is therefore important to determine existence and amount/frequency of plant and insect species in grasslands.

Studies reported that insect population is significantly related to grazing intensity, erosion, degeneration of grassland; positive relationship were found between insect population and grassland quality degree, while insect population had negative correlation with grazing intensity, slope, erosion and degeneration of grassland (Field, 1989; Gökkuş et al., 1995; Gökkuş and Koç, 2001; Hawkins et al., 2003; Haddad et al., 2009; Gillespie and Wratten, 2012). It was reported that low, medium and heavy grazing in grassland made decrease in *Cercopidae* (*Homoptera*) family as 25%, 50% and 75%, respectively (Herms and Mattson, 1992). The aim of this study was (i) to determine presence of insect species and population densities of insect species showing plant preference in declining, replicator and invasive plant groups; (ii) to determine the effect of distance to village, stoniness, slope, grazing level, altitude, erosion, soil depth and grassland quality degree on insect population in grasslands of central district of Erzurum province.

2. Materials and methods

This study was conducted on 27 study points that were determined by analyzing similarities/dissimilarities for distance to village, stoniness, slope, grazing level, altitude, erosion, soil depth and grassland quality degree in grasslands of Erzurum central district in May-August season of 2001. Map of study area were given in Figure 1.

Figure 1. Map of study area showing grasslands in Erzurum province

Vegetation surveys were performed to determine botanic composition by modified loop method along the 100 m lines on the basis of east, west, north and south directions, and these surveys were made in flowering period of dominant plants by diagnosing plant species in each study point (Gökkuş et al., 1995; Holmann and Peck, 2002). Botanic composition was calculated by dividing each plant to total plant number in declining, replicator and invasive plants (Kansu, 1982; Holmann and Peck, 2002; Joern, 2005). Insect species and their populations were determined in lines in where botanic compositions were performed. To determine insect population, insect samples were taken by sweeping method all study points. Insects were gathered by taking the samples on plants (in the leaves and stems). 100 sweepings in one direction-total 400 sweeping in four directions were made. Collected samples were transferred to direct killing bottle, and were put into paper bag including information about collecting place, collecting time and number, than were transferred to laboratory. Alien materials were removed and insects belonged to *Cicadellidae* were glued in the right side facing down, were pinned and labeled in 5 x 15 cm framed cartoon. Then insects were diagnosed by experts. Means of plant and insect species in all directions were calculated in each study point. Besides, percentage of plant species, insect population, slope, altitude, grazing level, soil depth, and distance to village, grassland quality degree and erosion in each study point were determined. Path analysis to determine the effect of slope, altitude, grazing level, soil depth, and distance to village, grassland quality degree and erosion on insect population and bi-plot analysis to evaluate and classify traits were made by Minitab 15 statistical program.

3. Results

Insect diversity and frequency are closely linked to plant species composition and habitat structure (Kirkland, 2001) and richness in plant composition and variations in environmental structure evidently affects diversity and frequency in insects (Kişlalioğlu and Berkes, 1985; Koç et al., 2003). Besides plant composition representing quality of grassland is one of the important factors affecting insect frequency in natural grasslands (Lodos, 1986; Kruess and Tscharntke, 2002).Minimum and maximum and mean values in traits in study area were given in Table 1.

Table 1. Maximum and minimum and mean values in traits in study area

Variables	Minimum	Maximum	Mean
Distance to Village	1,0	4,0	2,89±1,01
Stoniness	1,0	4,0	2,81±0,88
Slope	6,0	55,0	27,52±13,51
Grazing	0,0	5,0	2,48±1,16
Altitude	1890,0	3133,0	2334,4±373,1
Erosion	0,0	4,00	1,89±1,12
Soil Depth	1,0	4,0	2,41±0,78
Insect Population	0,0	39,0	13,85±11,08
Grassland quality grade	6,0	76,0	43,15±17,37

Minimum and maximum and mean values in distance to village (km), stoniness (%), slope (%), grazing, altitude (m), erosion (%), soil depth (cm), insect population (%) and grassland quality grade (%) were 1,4 and 2,89±1,01; 1,0 4,0 and 2,81±0,88; 6,0 55,0 and 27,52±13,51; 0,0 5,0 and 2,48±1,16; 1890,0 3133,0 and 2334,4±373,1; 0,0 4,00 and 1,89±1,12; 1,0 4,0 and 2,41±0,78; 0,0 39,0 and 13,85±11,08; 35,0 and 6,0 76,0 and 43,15±17,37 respectively (Table 1).

Botanic Composition and Insect Population in Grassland

The *Cicadellidae* (*Homoptera*) family in insects are known as one of the important harmful groups and this family feeds all kinds of plants and also carry some disease agents (Bakır, 1970; Borror and Triplehorn, 1981; Aygün et al., 2004). Damage of insects of grassland is closely related to plant composition and grassland quality degree that significantly affect nutritional value of grassland (Maçan, 1984).

Plant species in grassland could be classified as declining, replicator and invasive species. Plant compositions and strategies reverberate environmental factors such as insects, slope, grazing (Nielson, 1975; Malschi and Mustea, 1998). Life structures of plants show themselves as declining, replicator and invasive plant species (Pimentel and Pimentel, 1979; Petit and Usher, 1988). Studies reported that *Festuca ovina, Andropogon gryllus, Hedysarum varium, Thymus squarrosus, Artemisia fragrans, Medicago sativa, Poa bulbosa* var.*vivipara, Bromus erectus, Onobrychis armena, Cynodon dactylon, Stipa lagascae, Teucrium polium, Globularia orientalis, Agrostis* sp., *Bromus erectus, Stipa pennata, Convolvulus compactu* and *Noaea spinosissima* are common and effective plant species in grasslands of Anatolia (Pottinger, et al., 1993; Pykala, 2003).

Declining species were *Lotus aegaeus, L. corniculatus, Medicago falcata, M. sativa, Onobrychis armena, Onobrychis oxyodonta, Agropyron cristatum, Agrostis stolonifera, Alopecurus arundinaceus, Bromus tomentellus, Bothriochloa ischaemum, Chrysopogon gryllus (Andropogon gryllus), Dactylis glomerata, Elymus hispidus, Elymus repens ve Koeleria cristata*; replicator plants were *Cynodon dactylon, Festuca valesiaca, Poa bulbosa* ve *Stipa holosericea*; invasive plants were, *Alyssum desertorum, A. pateri, Artemisia austriaca, Astragalus condensatus, A. microcephalus, A. physodes, A. plumosus, Bromus japonicus, Carex atrata, Hordeum murinum, Taeniatherum caput-medusae, Capsella bursa-pastoris, Eryngium campestre, Euphorbia macroclada, Potentilla recta, Salvia cryptantha, Teucrium chamaedrys, Thymus sipyleus* (Pykala, 2005). Besides declining species that have good nutritional quality are commonly preferred by animals (Siemann, 1998; Şimşek, 1988). Factors liable for degeneration of grassland can be assumed as heavy, uncontrolled and continuous grazing, severe drought and cold, burning, damage of invasive plants and insects (Tidmarsh and Havenga, 1955).

Depending upon degeneration grade, delicious/preferred species declines fast, then replicator and in later phases invasive plants locate in vegetation (Siemann, 1998; Şimşek, 1988). Insect frequency one of the damaging factors on grassland quality is significantly from factors such as slope, erosion, grassland plant composition, soil quality. It is hence important that the relationship between plant composition and insect frequency, the effect of detrimental factors on insect frequency should be determined (Uluocak, 1977; Tokluoğlu, 1979; Tscharntke et al., 2012). Relationship between plant composition and insect frequency on declining, replicator and invasive plant species were given in Table 2, 3 and 4. Table 2 shows relationship between plant composition and insect frequency on declining plant species. The highest plant frequencies belonged to *Agropyron intermedium* (15.3%), *Bromus erectus* (14.7%), *Dactylis glomerata* (9.6%), *Koeleria cristata* (13.1%), *Trifolium ambigium* (10.0%), *Medicago varia* (16.1%), *Trifolium*

repens (4.5%), *Lotus corniculatus* (3.2%) and these plant species were determined as more widely than the other ones. Besides, *Agropyron intermedium, Dactylis glomerata, Medicago varia, Poterium sangiosorba, Vicia caracca* were found more preferred plants by insect populations. Moreover, insect species, determined on the declining plants were *Circulifer haematoceps, Ulopa trivia, Laburrus handlirschii, Batrachomorphus irroratus, Aphrodes bicinctus, Handianus procerus, Selenocephalus sp, Arocephalus longiceps, Rohoananus hypoclorus, Stenometopiellus angorensis, Graphocraerus ventralis, Doratura stylata* and *Doratura exilis. Agropyron intermedium, Dactylis glomerata, Medicago varia, Poterium sangiosorba* as declining plants were the most preferred plants by insect species (Table 2). Declining species, delicious plants are known as the first preferred by farm animals. Contents of dry matter, protein, minerals, flavoring agents in plant determine quality of plant (Hawkins et al., 2003). In declining plants, dry matter, NDF, crude protein, Ca, P, K, S, Cu, Mn and Zn in *Medicago sativa, Trifolium repens, Lotus corniculatus* were 75-85%, 40-42%, 25-30%, 1.40-1.50%, 0.20-0.30%, 2.40-2.75%, 0.30-0.40%, 13,17 ppm, 35-40 ppm and 40-45 ppm, respectively (Anon., 2000).

In replicator plants, *Festuca ovina* (61.1%), *Poa bulbosa* (9.9%), *Stipa lagascae* (16.0%), *Plantago atrata* (3.8%), *Poa trivalis* (4.3%) had higher frequencies than the other replicator plants. Meanwhile, *Festuca ovina, Poa bulbosa, Stipa lagascae, Coronilla varia* and *Plantago atrata* were determined as preferred by insects. *Circulifer haematoceps, Ulopa trivia, Batrachomorphus irroratus, Handianus procerus, Selenocephalus sp, Stenometopiellus angorensis, Eupteryx cuspidate, Hardya anatolica, Doratura stylata* and *Doratura exilis* were more common insect species (Table 3). Table 4 denotes relationship between plant species and insect population.

In *Festuca ovina, Poa bulbosa* and *Plantago atrata* as replicator plants, dry matter, NDF, crude protein, Ca, P, K, S, Cu, Mn and Zn in *Medicago sativa, Trifolium repens, Lotus corniculatus* were 24-27%, 55-60%, 17-22%, 0.40-0.45%, 0.20-0.30%, 2.40-2.75%, 0.30-0.40%, 13,17 ppm, 35-40 ppm and 40-45 ppm, respectively. However, *Thymus parviflorus, Galium verum* and *Astragalus lineatus* (invasive plants) had 24-27%, 55-60%, 17-22%, 0.40-0.45%, 0.20-0.30%, 2.40-2.75%, 0.30-0.40%, 13,17 ppm, 35-40 ppm and 40-45 ppm in dry matter, NDF, crude protein, Ca, P, K, S, Cu, Mn and Zn (Anonymous. 2000). While grassland quality grade is important not only for farm animals such as cattle and sheep; it could be affected in different rates by factors, grazing, soil depth, slope, erosion. We found that insect species were observed and their frequency and distribution varied in declining, replicator and invasive plants. While degradation in grassland quality grade also directly/indirectly affects insect population (Zechmeister et al., 2003; Ünal et al., 2012).

Frequencies of plant species were *Astragalus eriocephalus* with 6.3%, *Galium verum* with 4.5%, *Phleum montarum* with 3.3%, *Thymus parviflorus* with 13.2%, *Artemisia spicigera* with 9.7%, *Astragalus lineatus* with 5.0%, *Eryngium campestre* with 2.1%, *Alyssum pateri* with 4.1%, *Alyssum desertorum* with 2.6% and *Chrisanterum sp.* with 3.0%. Besides, *Circulifer haematoceps, Ulopa trivia, Laburrus handlirschii, Batrachomorphus irroratus, Handianus procerus, Stenometopiellus angorensis, Micantulina stigmatipennis, Hardya anatolica, Doratura stylataand* and *Doratura exilis* were found the most determined insects in the grasslands (Table 4). Although, insect frequency and diversity were found to be different in each plant groups (declining, replicator and invasive plant groups), *Circulifer haematoceps, Ulopa trivia, Batrachomorphus irroratus, Handianus procerus, Stenometopiellus angorensis, Doratura stylata Doratura exilis* were seen and observed in all three grassland class.

Path and Bi-plot Analyses of Traits

Existence of plant species are closely related to grazing intensity, soil geographic and climatic conditions including slope, erosion etc. and they draw the fate of grassland quality degree. Looseness of plant tissues, quality and level of sap and nectar, flower color mostly have influence captivation of insect population. This could be elucidation why insect species were observed and their frequency and distribution varied in three plant groups. Correlations showing relationship between insect population and some factors and path analysis denoting the effect of factors in insect population was given in Table 5 and Figure 2.

Insects make considerable harms in plants. By sucking, they cause wilting, wrinkle and desiccations in leaves in grasslands (Bakır, 1970). It is therefore vital to reveal factors having significant effect in insect population. Relationships between erosion and slope, grassland quality grade and insect frequency, altitude and distance to village were found as positive and significant at 1%. While relationships between insect frequency and slope, grassland quality grade and slope, insect frequency and erosion, grassland quality grade and erosion were negative and significant at 1%; relationships between insect frequency and grazing, grassland quality grade and grazing were negative and significant at 5% (Table 5).

Table 2. Relationship between plant composition and insect frequency in declining plant species

Insects / Plants		Plant Frq. %	*Circulifer haematoceps*	*Ulopa trivia*	*Laburrus handlirschii*	*Batrachomorphus irroratus*	*Platymetopius henribauti*	*Aphrodes bicinctus*	*Handianus procerus*	*Handianus* sp.	*Selenocephalus* sp.	*Psammotettix provincialis*	*Psammotettix confinis*	*Psammotettix striatus*	*Psammotettix cephalotes*	*Arocephalus longiceps*	*Handianus arnoldii*	*Rohoananus hypoclorus*	*Diplocolenus nigrifrans*	*Stenometopiellus angorensis*	*Balclutha punctata*	*Diplocolenus* sp.	*Anaceratagallia laevis*	*Anaceratagallia venosa*	*Platymetopius* sp.	*Micantulina stigmatipennis*	*Eupteryx cuspidata*	*Diplocolenus frauenfeldi*	*Sorhoanus medius*	*Ebarrius cognatus*	*Limotettix striola*	*Graphocraerus ventralis*	*Hardya anatolica*	*Doratura stylata*	*Doratura impudica*	*Doratura exilis*	Total
A.intermedium	**Declining Plant Species**	*15.3*				1		1			1							1																		4
Bromus erectus		*14.7*									1																									1
Dactylis glomerata		*9.6*	1																														1		1	3
Koeleria cristata		*13.1*																																		0
Lotus corniculatus		*3.2*																																		0
Onobrychis hajastana		*2.5*																																		0
Trifolium ambigium		*10.0*																																		0
Trifolium hybridum		*0.2*																																		0
Medicago varia		*16.1*	1	1		1			1		1							1		1												1	1		1	10
Trifolium repens		4.5																																		0
Vicia caracca		2.3														1		1																		2
Hedisarum hedysaruides		*0.4*																																		0
Poterium sangiosorba		*1.9*	1	1	1	1		1			1							1		1															1	9
Trifolium pratense		1.9																																		0
Festuca pratensis		*1.9*																																		0
Onobrychis viciifolia		*1.4*																																		0
Trifolium trichocephalum		*1.0*																																		0
Trifolium sp.		*0.6*																																		0
Total		100,0	3	2	1	3	0	2	1	0	4	0	0	0	0	1	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3	29

Table 3. Relationship between plant composition and insect frequency in replicator plant species

Insects / Plants		Plant Frq%	*Circulifer haematoceps*	*Ulopa trivia*	*Laburrus handlirschii*	*Batrachomorphus irroratus*	*Platymetopius henribauti*	*Aphrodes bicinctus*	*Handianus procerus*	*Handianus* sp.	*Selenocephalus* sp.	*Psammotettix provincialis*	*Psammotettix confinis*	*Psammotettix striatus*	*Psammotettix cephalotes*	*Arocephalus longiceps*	*Handianus arnoldii*	*Rohoananus hypoclorus*	*Diplocolenus nigrifrans*	*Stenometopiellus angorensis*	*Balclutha punctata*	*Diplocolenus* sp.	*Anaceratagallia laevis*	*Anaceratagallia venosa*	*Platymetopius* sp.	*Micantulina stigmatipennis*	*Eupteryx cuspidata*	*Diplocolenus frauenfeldi*	*Sorhoanus medius*	*Ebarrius cognatus*	*Limotettix striola*	*Graphocraerus ventralis*	*Hardya anatolica*	*Doratura stylata*	*Doratura impudica*	*Doratura exilis*	Total
Festuca ovina	**Replicator Plant Species**	61.1	1	1		1	1	1	1	1	1	1		1	1		1	1	1	1			1				1				1		1	1	1	22
Poa bulbosa		9.9		1		1			1		1									1							1						1	1			8
Stipa lagascae		16.0	1		1				1																										1	4
Coronilla varia		1.2	1																														1		1	3
Plantago atrata		3.8									1																						1			2
C.oronilla orientalis		1.0																																		0
Alepecurus sp.		0.4																																		0
Teucrium polium		0.6																																		0
Poa trivalis		4.3																																		0
Areneria gypsophiloides		1.2																																		0
Dianthus multicaulus		0.2																																		0
Plantago benzeri		0.4																																		0
Total		100.0	3	2	1	2	1	1	3	1	3	1	0	1	1	0	1	1	1	2	0	0	1	0	0	0	2	0	0	0	1	0	2	4	1	3	39

Table 4. Relationship between plant composition and insect frequency in invasive plant species

Insects / Plants	Plants Frq %	*Circulifer haematoceps*	*Uploa trivia*	*Laburrus handlirschii*	*Batrachomorphus irroratus*	*Platymetopius henribauti*	*Aphrodes bicinctus*	*Handianus procerus*	*Hadrianus* sp.	*Selenocephalus* sp.	*Psammotettix provincialis*	*Psammotettix confinis*	*Psammotettix striatus*	*Psammotettix cephalotes*	*Arocephalus longiceps*	*Handianus arnoldii*	*Rohananus hypoclorus*	*Diplocolenus nigrifrans*	*Stenometopiellus angorensis*	*Balclutha punctata*	*Diplocolenus* sp.	*Anaceratagallia laevis*	*Anaceratagallia venosa*	*Platymetopius* sp.	*Micantulina stigmatipennis*	*Eupteryx cuspidata*	*Diplocolenus frauenfeldi*	*Sorhoanus medius*	*Ebarrius cognatus*	*Limotettix striola*	*Graphocraerus ventralis*	*Hardya anatolica*	*Doratura stylata*	*Doratura impudica*	*Doratura exilis*	Total
Achillea biebersteinii	2.0																																			0
Achillea millefolium	1.1																																			0
Astragallus lineatus	0.6																																			0
Astragalus eriocephalus	6.3	1						1																			1								1	4
Capsella bursa pastoris	0.2																																			0
Cotaniester nummularia	0.2																																			0
Galium verum	4.5	1							1		1							1								1									1	6
Helichrysum plicatum	1.1	1						1																1											1	4
Marabium sp.	1.3																																			0
Phleum montanum	3.3		1																1																	2
Salvia verticillata	0.6	1	1														1		1																1	5
Thymus parviflorus	13.2	1	1	1	1			1								1	1	1	1	1					1		1					1	1	1	15
Astragalus lagurus	1.1																																			0
Taraxacum officinale	2.9																																			0
Artemisia spicigera	9.7	1		1	1					1																									1	5
Astragalus lineatus	5.0	1	1																1										1				1		1	6
Euphorbia esula	1.4																																			0
Onobrychis armena	2.4																																			0
Poligonum alpinum	0.2																																			0
Silene sp.	1.0	1	1					1				1	1	1					1														1	1	1	10
Teucrium orientale	2.1																																			0
Alyssum pateri	0.1																																			0
Artemisia austriaca	0.4																																			0

İnvasive Plant Species

Table 4. continued

Centaurea sessilis	**İnvasive Plant Species**	1.0																		0
Cichorium intybus		0.4																		0
Eryngium campestre		2.1																		0
Falcaria vulgaris		1.0																		0
Lamium macrodan		0.2																		0
Nepata nuda		1.1																		0
Onosma sericeum		0.1																		0
Polygonum auriculare		1.2																		0
Veronica ariantalis		0.4	1	1		1		1		1				1		1			1	8
Alyssum pateri		0.2																		0
Astragalus globosus		0.1																		0
Carex sp.		0.6																		0
Hedysarum elegans		0.1																		0
Hypericum perforatum		0.8																		0
Potentilla bifurca		1.0																		0
Alyssum pateri		4.1	1	1		1			1			1		1			1		1	8
Bromus tectorum		1.7	1		1	1	1												1	5
Trifolium sp.(Annual)		0.7																		0
Veronica orientalis		1.4	1	1		1		1		1				1		1			1	8
Astragalus microcephalus		2.1																		0
Ajuga chamaepitys		0.1																		0
Draba bruneiifolia		0.1																		0
Talicrium minus		0.1																		0
Alchemilla		0.2																		0
Anchusa azurea		0.1																		0
Cephalaria christata		0.6	1			1		1										1	1	5
Rumex crispus		0.1																		0
Tanecetum balsamita		3.1																		0
Cerinthe minor		1.4																		0
Chenopodium sp.		0.4																		0
Equisetum ramosisium		0.6																		0

Table 4. continued

Gundelia orientalis			0.1																																				0
Alyssum desertorum			2.6		1						1												1																	3
Acantholimon caryophylla	**İnvasive Plant Species**	0.8	1																																			1	2
Ajuga sp.		0.1																																					0
Ferula orientalis		0.9																																					0
Centaurea carduiformis		0.1																																					0
Chrisantemum sp.		3.0																																					0
Hypericum linarioides		0.2																																					0
Rosa canina		0.4																																					0
Stachys lavandafolia		2.0	1	1					1		1							1		1	1	1						1				1		1					11
Poa longifolia		0.1																																					0
Campanula rapunculoides		0.1																																					0
Trogopogon prantensis		0.1																																					0
Carum caru		0.2																																					0
Galium cognatum		0.1																																					0
Salvia candidissima		0.2																																					0
Nepata racemosa		0.2																																					0
Cephalaria christatum		0.2	1			1			1																							1							4
Melva neglecta		0.2																																					0
Xeranthemum annuum		0.1	1		1																																		2
Cotaniester nummularia		0.1																																					0
Astragalus microflorus		0.6																																					0
Poligonum aviculare		0.2																																					0
Total		100.0	17	10	4	8	0	1	10	1	3	1	3	1	1	0	1	5	2	9	2	1	0	0	1	3	1	2	0	2	0	0	4	5	0	15	112

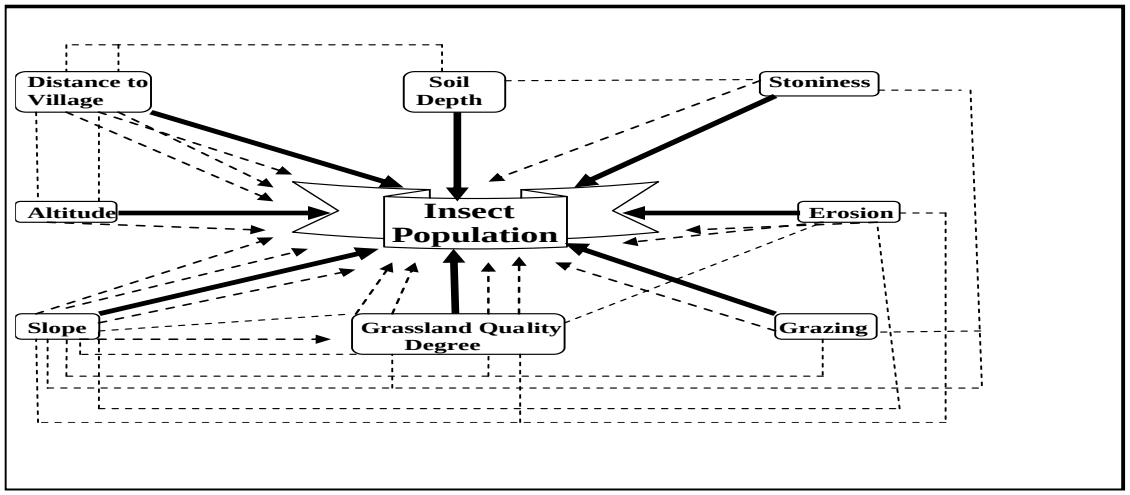

Figure 2. Direct and indirect effects of factors in insect population

Direct effect of distance to village in insect population was 83.8186%, the highest indirect effects were via slope (3.8778%) and altitude (8.1674%) moreover, direct effect of stoniness in insect population was 46.2347%, the highest indirect effects were via slope (13.2072%), grazing (10.8135 and grassland quality grade (12.9811%) slope had 31.9490% direct effect and the highest indirect effects via grassland quality degree (44.4275%) and erosion (12.4993%) besides grazing had 25.9554% direct effect and the highest indirect effects via grassland quality degree (44.4020%) and slope (13.7348%). Direct effects of altitude and erosion were 12.9931% and 14.6754%; indirect effects were via distance to village (53.6904%), stoniness (7.6684%), and grassland quality grade (7.1505%) in altitude, slope (22.9922%), and grassland quality grade (54.5732%) in erosion. Soil depth had 22.5089% direct effect; indirect effects were 20.18415% in distance to village 22.1738% in stoniness and 13.3771% in altitude. With 58.9558% grassland quality grade had great importance on insect population. the highest indirect effects belonged to slope with 19.4997% and erosion with 13.0215% (Table 5 and Figure 2). It could be made inference that slope, erosion and grassland quality grade are important factors insect population. Biplot analysis of factors were given in Figure 3.

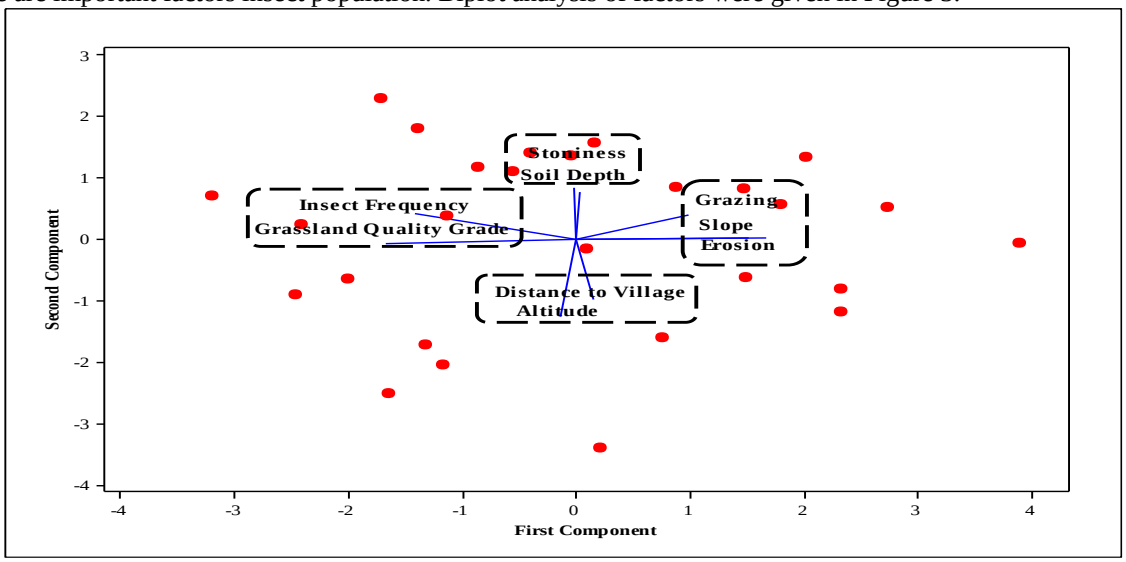

Figure 3. Biplot analysis of factors in grasslands

Figure 3 denotes that four groups were observed. Insect population and grassland quality grade, stoniness and soil depth, distance to village and altitude created groups of twos; only grazing, erosion and slope joined in same group. This study has understandably demonstrated that a widely diversity distribution in insect species and their frequencies in plant species belonged to all three plant class. While degradation in grassland quality grade also directly/indirectly affects insect population (Kirkland, 2001; Balabanlı et al., 2005). Looseness of plant tissues, quality and level of sap and nectar, flower color mostly have influence captivation of insect population and This is answer that insect species were observed in different frequency and distribution in declining, replicator and invasive plants found in three plant groups.

Table 5. Relationship between insect population and some factors and path analysis denoting the effect of factors in insect population

	Di.to Vil.	Stoniness	Slope	Grazing	Altitude	Erosion	Soil Dep.	Ins.Fre.
Stoniness	-0.024ns							

Slope	-0.069ns	-0.130ns						
Grazing	0.021ns	0.198ns	0.285ns					
Altitude	0.635**	-0.298ns	-0.099ns	-0.284ns				
Erosion	0.056ns	0.030ns	0.783**	0.278ns	-0.044n			
Soil Dep.	-0.087ns	0.314ns	-0.056ns	0.027ns	-0.375ns	0.039ns		
Insect Fre.	-0.318ns	0.094ns	-0.530**	-0.399*	-0.138ns	-0.587**	0.085ns	
Li.Qu.Gra	0.005ns	-0.063ns	-0.678**	-0.449*	0.062ns	-0.906**	-0.024ns	0.618**

For Distance to Village			**For Stoniness**		
	Path Coeff.	**%**		**Path Coeff.**	**%**
Direct Effect	-0.3721	83.8186	**Direct Effect**	0.1132	46.2347
Indirect Effects	**Path Coeff.**	**%**	**Indirect Effects**	**Path Coeff.**	**%**
Via Stoniness	-0.0027	0.6122	**Via Distance to Village**	0.0089	3.6495
Via Slope	0.0172	3.8778	**Via Slope**	0.0323	13.2072
Via Grazing	-0.0028	0.6259	**Via Grazing**	-0.0265	10.8135
Via Altitude	0.0363	8.1674	**Via Altitude**	-0.0170	6.9535
Via Erosion	0.0070	1.5762	**Via Erosion**	0.0038	1.5373
Via Soil Depth	-0.0031	0.7060	**Via Soil Depth**	0.0113	4.6232
Via Grassland quality grade	0.0027	0.6160	**Via Grassland quality grade**	-0.0318	12.9811
For Slope			**For Grazing**		
	Path Coeff.	**%**		**Path Coeff.**	**%**
Direct Effect	-0.2480	31.9490	**Direct Effect**	-0.1336	25.9554
Indirect Effects	**Path Coeff.**	**%**	**Indirect Effects**	**Path Coeff.**	**%**
Via Distance to Village	0.0258	3.3284	**Via Distance to Village**	-0.0077	1.5045
Via Stoniness	-0.0148	1.9017	**Via Stoniness**	0.0224	4.3605
Via Grazing	-0.0381	4.9045	**Via Slope**	-0.0707	13.7348
Via Altitude	-0.0056	0.7278	**Via Altitude**	-0.0162	3.1510
Via Erosion	0.0970	12.4993	**Via Erosion**	0.0345	6.6992
Via Soil Depth	-0.0020	0.2617	**Via Soil Depth**	0.0010	0.1926
Via Grassland quality grade	-0.3448	44.4275	**Via Grassland quality grade**	-0.2285	44.4020
For Altitude			**For Erosion**		
	Path Coeff.	**%**		**Path Coeff.**	**%**
Direct Effect	0.0571	12.9931	**Direct Effect**	0.1239	14.6754
Indirect Effects	**Path Coeff.**	**%**	**Indirect Effects**	**Path Coeff.**	**%**
Via Distance to Village	-0.2361	53.6904	**Via Distance to Village**	-0.0210	2.4886
Via Stoniness	-0.0337	7.6684	**Via Stoniness**	0.0034	0.4072
Via Slope	0.0245	5.5744	**Via Slope**	-0.1941	22.9922
Via Grazing	0.0379	8.6175	**Via Grazing**	-0.0372	4.4004
Via Erosion	-0.0054	1.2299	**Via Altitude**	-0.0025	0.2954
Via Soil Depth	-0.0135	3.0759	**Via Soil Depth**	0.0014	0.1677
Via Grassland quality grade	0.0314	7.1505	**Via Grassland quality grade**	-0.4608	54.5732
For Soil Depth			**For Grassland quality grade**		
	Path Coeff.	**%**		**Path Coeff.**	**%**
Direct Effect	0.0361	22.5089	**Direct Effect**	0.5085	58.9558
Indirect Effects	**Path Coeff.**	**%**	**Indirect Effects**	**Path Coeff.**	**%**
Via Distance to Village	0.0323	20.1841	**Via Distance to Village**	-0.0020	0.2321
Via Stoniness	0.0355	22.1738	**Via Stoniness**	-0.0071	0.8204
Via Slope	0.0140	8.7154	**Via Slope**	0.1682	19.4997
Via Grazing	-0.0037	2.2909	**Via Grazing**	0.0600	6.9591
Via Altştude	-0.0214	13.3771	**Via Altitude**	0.0035	0.4098
Via Erosion	0.0049	3.0364	**Via Erosion**	-0.1123	13.0215
Via Grassland quality grade	-0.0124	7.7133	**Via Soil Depth**	-0.0009	0.1016

R^2:55.00%, Resudial: 45.00%

4. Conclusions

Productivity and yield sustainability in grassland are closely related to factors, grassland quality grade, stoniness, soil depth, distance to village, altitude, grazing, erosion, slope and insect population. Declining, replicator and invasive plant groups were found to be different in insect frequency and diversity, *Circulifer haematoceps*, *Ulopa trivia, Batrachomorphus irroratus, Handianus procerus, Stenometopiellus angorensis*, *Doratura stylata Doratura exilis* were seen and observed in all three grassland groups. Having important effect health and productivity of grassland, *Cicadellidae* are significantly influenced from slope, erosion and grassland quality grade. Further detailed studies are needed to reveal reasons of changes and interaction in plant and communities.

References

Anonymous, 1998. Agricultural Structure And Production. T.C. State Institute Of Statistics, Pub. No: 2103. Ankara.
Anonymous, 2000. Nrc, Nutrient Requirements Of Beef Cattle (7th Ed.). National Academy Press, Washington, Dc.
Anonymous, 2004. Agricultural Structure and Production. T.C. State Institute of Statistics, Pub. No: 3032, Ankara

Antonelli, A. A.M. Humphreys, W.G. Lee, H.P. Linder. 2011.Absence Of Mammals And The Evolution Of New Zealand Grasses. P. Roy. Soc. B: Biol. Sci., 278: p. 695.
Aygün, C., R, Hayat., Ş, Güçlü., M, Olgun. 2004. The effect of grassland quality on population of Cicadellidae (Homoptera) in Erzurum. Turkey I. Plant Protection Congress, 8-10 September 2004, Samsun, p. 133 .
Bakır, Ö. 1970. A Pasture Study In Middle East Technical University. Ankara University, Faculty Of Agriculture, Pub. No: 382, Ankara.
Balabanli, C., M. Türk., O. Yüksel. 2005. Relationship of erozyon ve pasture. Süleyman Demirel University, J. Faculty of Forest, 2, 23 (2005).
Borror, D. J., D. M.De Long., C. A. Triplehorn. 1981. An Introduction To The Study Of Insects. Hold. Rinerhard And Winston, Usa,p. 827.
Çetiner, M., A. Gökkuş., M. Parlak. 2012. Effect Of Grazing On Plant Cover And Soil Properties In Artificial Pasture. Anadolu J. Agric. Sci., 27(2), 80 (2012).
Field, T. R. O. 1989. Vegetational Survey Of Management Pastures In New Zealand. Proceedings Of Xvi International Grassland Congress, 1407-1408, Nice, France .
Gillespie, M., S. D. Wratten. 2012. The importance of viticultural landscape features and ecosystem service enhancement for native butterflies in New Zealand vineyards. J Insect Conserv., 16: p.13
Gökkuş, A., A. Koç. 2001. Management Of Pasture. Atatürk University, Faculty Of Agriculture, Pub. No: 228, Erzurum, p.329
Gökkuş, A., A. Koç., B. Çomakli. 1995. Application Guide of Pasture. Atatürk University, Faculty Of Agriculture, Pub. No, 142, Erzurum., p.12.
Hawkins, B.A., E. E. Porter., J. A. F. Diniz-Filho. 2003. Productivity And History As Predictors Of The Latitudinal Diversity Gradient Of Terrestrial Birds. Ecology, 84:, p. 1608
Haddad, N.M., M. C. Gregory., G. Kevin., H. John., M. H. K. Johannes., T. David. 2009. Plant Species Loss Decreases Arthropod Diversity And Shifts Trophic Structure. Ecology Letters, 12 (10), p. 1029.
Herms, D.A., W. J. Mattson. 1992. The Dilemma Of Plants: To Grow Or Defend. Q. Rev. Biol., 67: p. 283.
Holmann. F., D.C. Peck. 2002. Economic Damage Caused By Spittlebugs (Homoptera: Cercopidae) In Colombia: A First Approximation Of Impact On Animal Production In Brachiaria Decumbens Pastures. Neotropical-Entomology, 31 (2):, p. 275.
Joern, A. 2005. Disturbance By Fire Frequency And Bison Grazing Modulate Grasshopper Assemblages In Tallgrass Prairie. Ecology, 86:, p.861.
Kansu, İ. A. 1982. Entomogy. Ankara University, Faculty Of Agriculture, Department Of Plant Protection, Ankara Univ. Press, p.244.
Kirkland, P.H. 2001. Endangered Butterfiles And Moths Of Scottish Woodlands. Scottish Foresty, 56 (1):, p. 21.
Kişlalioğlu. M., F. Berkes. 1985. Ecology And Environmental Sciences, Foundation Of Turkey Environmental Problems Pub. No:19, p.132.
Koç. A., A. Gökkuş., M. Altın. 2003. Comparison Of Commonly Used Methods On Determination Of Grassland And An Advice To Turkey. 5. Congress Of Field Crops.13-17 September, Diyarbakır, p.36.
Kruess. A., T. Tscharntke. 2002. Contrasting Responses Of Plant And Insect Diversity To Variation In Grazing Intensity. Biological Conservation, 3:, p. 293.
Lodos, N. 1986. Entomolgy Of Turkey (General, Practical And Faunistic). Ege University Press, Bornova, İzmir, Vol: Ii, p. 105.
Maçan, S. 1984. Insect Species Harmful On Vineyards In South Anatolia Region. Studies On Their Description, Diagnosis, Distribution And Economic Importance. Diyarbakır Regional Plant Protection Research Institute. Pub. No. 3, Diyarbakır, p. 47.
Malschi. D., D. Mustea. 1998. Entomocoenotic Specific Features Of The Cereal Crop Agroecosystem With Anti-Erosion Protective Forestry Belts. Analele Institutului De Cercetari Pentru Cereale Si Plante Tehnice, Fundulea, 65:,p. 295.
Nielson, M.W. 1975.The Leafhooper Vectors Of Phytopathogenic Viruses (Homoptera: Cicadellidae) Taxonomy, Biology, And Virus Transmission. Agricultural Research Service, United States Depertment Of Agriculture. Tech. Bul. No: 13,p. 82.
Petit. S., M.B. Usher. 1988. Biodiversity In Agricultural Landscapes: The Ground Beetle Communities Of Woody Uncultivated Habitats Department Of Environmental Science, University Of Striling, Uk. Biodiversity And Conservation, 7 (12):, p. 1549.
Pimentel. D., M. Pimentel. 1979. Food, Energy And Society. Resource And Environmental Science Series, Edward Arnold, London. Pimentel (Editor), Handbook Of Energy Utilization, p.53.
Pottinger. R.P., M.J. Barbetti., T.J. Ridsdill-Smith. 1993. Invertebrate Pests, Plant Pathogens And Beneficial Organisms Of Improved Temperate Pasture. In: Baker, M.J. (Ed.) Proceedings Of The Xvii International Grassland Congress, New Zealand And Australia, Vol. I. New Zealand Grassland Association Et Al., Palmerston North,.8-11 February: 909.
Pykala, J. 2003. Effects Of Restoration With Cattle Grazing On Plant Species Composition And Richness Of Semi-Natural Grasslands. Biodiversity And Conservation, 12: p.2211.
Pykala, J. 2005. Cattle Grazing Increases Plant Species Richness Of Most Species Trait Groups In Mesic Semi-Natural Grasslands. Plant Ecology, 175 (2): p. 217.
Siemann, E. 1998. Experimental Tests Of Effects Of Plant Productivity And Diversity On Grasslandarthropod Diversity. Ecology, 79 (6): p. 2057.
Şimşek, Z. 1988. Studies On Description, Lossess And Growing Areas Of Pests, Harmful In Corns And Sorgums In Eastern And South Anatolia Regions. Diyarbakır Regional Plant Protection Institute, Pub. No:6, Diyarbakır, p.87.
Tidmarsh, C. E. M., C.M. Havenga. 1955. The Weel-Point Method Of Survey And Measurement Of Semi-Open Grasslands And Karoo Vegetation In South Africa. Memoirsof. The Botanical Survey Of South Africa, 29:, p. 49.
Tokluoğlu, M. 1979. Studies On Morphological, Biological And Agricultural Characters In Some Grassland Plants. Ankara University, Faculty Of Agriculture, Pub. No: 728, Ankara, p.80.
Tscharntke. T., et al.,2012. Landscape moderation of biodiversity patterns and processes - eight hypotheses.Biol Rev Camb Philos Soc. 2012 Aug;87(3):661-85. doi: 10.1111/j.1469-185X.2011.00216.x. Epub 2012 Jan 24.Uluocak, N. 1977. Natural Pastures And Forest Pastures. Ministry Of Food-Agriculture And Livestock General Directorate Of Agriculture. No: 6, Ankara. p. 60.
Ünal. S., Z. Mutlu., A. Mermer., U. Öztekin., E. Ünal., A. Özaydin., A. Avağ., H. Yildiz., O. Aydoğmuş., B. Şahin., S. Arslan. 2012. Determination Of Pasture Conditions And Health In Çankırı Province. Tabad-Research J. Agric. Sci., 5 (2): p.131.
Zechmeister. H.G., I. Schmitzberger., B. Steurer., J. Peterseil., T. Wrbka. 2003. The influence of land-use practices and economics on plant species richness in meadows. Biological Conservation (Impact Factor: 3.76). 12/2003; 114(2):165-177.

(Received for publication 18 November 2014; The date of publication 15 December 2015)