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Research
Araştırma

EVALUATION ACREAGE, PRODUCTION AND YIELD ON BARLEY BY KRIGGING METHOD IN TURKEY

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ABSTRACT: The purpose of this study was to classification similarities/dissimilarities of provinces and to determine the potential of provinces on barley for acreage, production and yield by using Krigging method in Turkey. Results revealed that barley is important crop in Turkey and could play important role in crop production, food industry and animal husbandry whether it is given greater importance in production marketing and valorization. Climatic conditions have significant effect on barley yield and production. Adverse effect of climatic factors could be diminished by using cultivars, more tolerant to drought and have a shorter growing period allowing rapid development. Significant relationship coexists between acreage, production and crop yield. Besides in the long run, strong relationship occurs between barley area planted and barley price, significantly affecting barley acreage.
Key Words: Barley, Acreage, Crop production, Crop yield, Krigging method.

TÜRKİYE'DE KRİGGİNG METODUYLA ARPANIN EKIM ALANI, ÜRETİM VE VERİMİNİN BELİRLENMESİ

ÖZET: Bu çalışmanın amacı, arpada Krigging metodunu kullanarak Türkiye için iller bazında ekiliş, üreim ve veriminin benzerlik/farklılıklarının sınıflandırılmasıdır. Sonuçlara göre, arpanın Türkiye'de önemli bir bitki olduğu ve hayvancılık ve gıda endüstrisinde önemli bir yer tuttuğu belirlenmiştir. Öte yandan iklim koşulları arpada verim ve üretimi etkileyen önmeli faktörlerden biridir. Iklim faktörlerinin olumsuz etkilerini kısa gelişme periyoduna sahip, kurağa toleranslı bitkilerin kullanımıyla gidermek mümkün olabilir. Ayrıca verim, ekiliş alanı ve üretim arasında önemli bir ilişki mevcuttur. Uzun periyotta arpa ekim alanlarıyla arpanın fiyatı arasındaki kuvvetli ilişki, arpanın ekiliş alanını etkileyen önemli bir unsur olarak ortaya çıkacaktır.
Anahtar Kelimeler: Arpa, Ekim alanı, Üretim, Verim, Krigging metodu.

1. INTRODUCTION

Barley *(Hordeum vulgare L.*) is cultivated in almost all parts of the world except the tropical regions. It is also known as so important cereal for animal production, industry including beer and certain distilled beverages and various health foods in the world (Poehlman, 1985). With about 140 million tons, barley is assumed as fourth cereal in seed production (Anonymous, 2006). In Turkey, production and acreage in barley are roughly 7 - 9 million ton and 3-3,5 million ha, although 20% of the barley crop is used for malting and 80% are used as animal feed. Barley including two rows (*H.distichum*) and six rows (*H.hexastichum*) seems the second important crop due to shorter growing period and adaptability to inappropriate climatic conditions and these phenomena make it possible to spread in vast areas, especially in Central Anatolia and South-East Anatolia Regions in Turkey.

Even though there are many areas having different climatic conditions, production performance of barley crop is not well in excessive rainfall areas. Extremely hot and dry weather are not desired, hot and humid climate is deleterious, since such conditions cause greater prevalence of disease problems. Barley is also tolerant to moderately high temperatures if humidity is low (Ludlow and Muchow, 1990). Unique climates, long warm summer days, clean environment and the large fertile lands in Aegean Region, Central Anatolia and South-East Anatolia Regions provide better growing conditions and these areas are known as better productive barley-growing areas in Turkey (Kün, 1988).

Studies reported that changes in climatic conditions causes substantial variations in yield and changing weather causing leading conclusions on farmers to shift crops. Especially drought, like other stress conditions, causes barley yield reductions affecting the majority of the farmed regions around the world. (Koornneef et al., 1997; Kovacevic et al., 2005;.Paunovic et al., 2008) Malekiani and Jafarzadeh (2011) stated the importance of climatic changes in crop spectrum in Iran. Most areas in Iran are surrounded arid/semiarid climate with an average annual precipitation of about 250 mm where cereal production depends largely on climate, soil, and

topography. Global changes could impact the formation of cereal biomass in several ways could be reflected on achieved results of last years in barley yield amount and quality (Molnarova, 2008). Winter barley are capable for environment factors, changes in these factors reflect barley yield amount and quality (Molnarova, 2008); therefore grain production and yield are low and highly variable (Benaouda 1992). In fact the effect of environmental conditions (climate, soil etc.) have been studied and concluded that increasing barley yield and production for at least 60% is possible by using proper production system (Prochazkova at al. 1997; Kubinec and Kovat, 1998; Sleziak and Horevaj, 2000). The purpose of this study was to classify similarities/dissimilarities of provinces and to determine the potential of provinces on barley for acreage, production and yield by using krigging method in Turkey.

2. MATERIALS AND METHOD

This study was carried out to classification similarities/dissimilarities of provinces and to determine the potential of all provinces in Turkey on barley for acreage, production and yield by using krigging method in Turkey. Data (2006-2010 years) in acreage (ha), production (ton) and yield (ton/ha) for all provinces of Turkey were taken from Turkish Statistical Institute (Anon., 2012) and map of Turkey showing all provinces are given in Figure 1.Cluster and biplot analyses were made in Minitab 15 software.

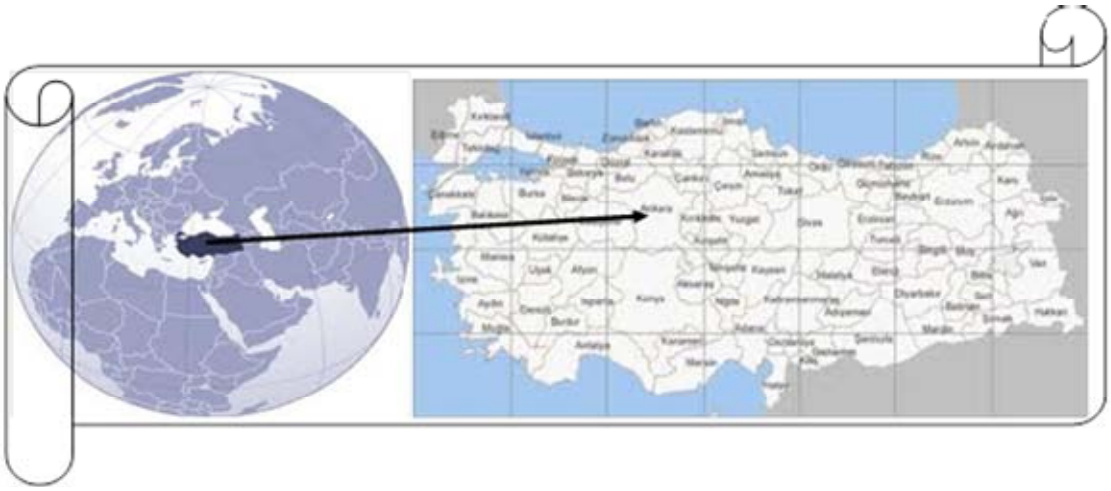

Figure 1. Map of Turkey showing all provinces

Kriging interpolation method is used in the study. Interpolation is the procedure of predicting the values of attributes at unsampled sites from measurements made at a set of locations within the same region. Kriging, interpolation technique is the stochastic geostatistical method that takes into account both the distance and the degree of variation between measurement points. It uses a semivariogram to define the weights that determine the contribution of each data point to the prediction of new values at unsampled locations (Erdogan, 2010). The accuracy of the interpolation process can be evaluated from different aspects. The most straightforward is to predict some single, global accuracy measures that characterize the interpolation accuracy via validation techniques. Therefore the RMSE indice calculated from the difference between the surveyed and the predicted values for each point were examined to understand the distribution of the error.

$$\text{RMSE}= \sqrt{\frac{1}{N}\sum_{i=1}^{N}\{ z(x_i) - \hat{z}(x_i)\}^2}$$

It should be noted that the accuracy reported with these validation methods assumes uniform error values for the entire surface. The best way to examine the spatial distribution of error is to obtain a graphical representation of the accuracy by generating error maps. So that error maps generated to understand the spatial distribution of the error in the country.

3. RESULTS AND DISCUSSION

Minimum, maximum and mean values in barley for all provinces on acreage (ha), production (ton) and yield (t/ha) in Turkey were given in Table 1.

Table 1. Minimum, maximum and mean values) in barley for provinces in acreage (ha), production (ton) and yield (t/ha) in Turkey

	Minimum	Maximum	Mean
Acreage (ha)	69,48	260.835,08	35.474,72±2.289,28
Production (ton)	171,80	610.358,20	81.862,99±7.746,85
Yield (t/ha)	1.168	4.430	2.325±8,07

Table 2. Error table of acreage, production and yield in barley

Barley (*H.vulgare* L.)	Yield (t/ha)	Acreage (ha)	Production (ton)
Mean	0,1743	-438,0093	-309,7905
Root-Mean²	48,7629	392705,6007	90565,2488
Mean Standardized	-0,0003	0,0147	0,0124
Root-Mean² Standardized	0,9877	0,9416	0,9445
Average Standard Error	49,5224	394976,8635	91136,2897

As seen from Table 1, with about 35.000 ha mean maximum and minimum acreage values were determined as about 69 ha and 260.000 ha. Besides, mean values in production (about min. 171 ton, max. 610.000 ton) and in yield (about min. 1.1 t/ha, max. 4.4 t/ha) were about 82.000 ton and 2.3 t/ha, respectively. Figure 2 shows relationship between acreage, production and yield on barley in Turkey. Figure shows that there is a close relationship between acreage, production and yield draws different perspective. While increase was recorded with increasing acreage, yield should be under genotype x environment interaction. Ludlow and Muchow (1990) stated that yield amount is designed by genotype x environment interaction. Crop yield under the influence of environmental factors (climate, geography and topography) as well as genetic influence in cereals. Although the increase in acreage occurs, adverse environmental conditions may cause yield reductions (Karing et al., 1999; Kara et al. 2008; Macak et al., 2008). This reason could make yield different from acreage and production togetherness. On the other hand, classification in provinces by biplot analyses is shown in Figure 3 for acreage, in Figure 4 for production and in Figure 3 for yield.

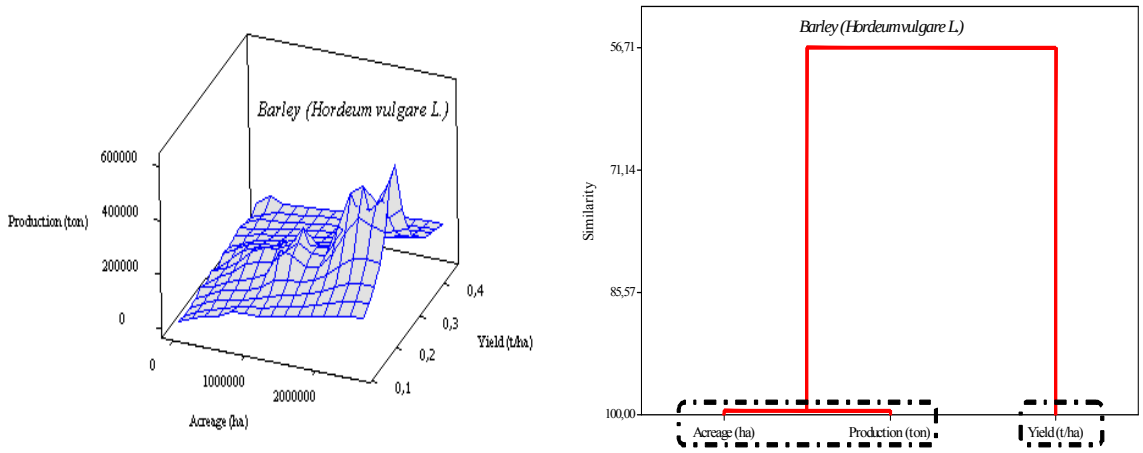

Figure 2. Relationship between acreage, production and yield in barley

Figure 3 shows that provinces are divided into six groups. Batman, Siirt provinces and Şırnak, Düzce provinces created binary groups. Besides, Erzurum, Yozgat, Çankırı, Mardin, Ordu, Iğdır, Ardahan, Van, Hakkâri, Kars, Muş, Kastamonu, Aydın, Erzincan provinces joined same groups; whereas Kırklareli, Artvin, Antalya, Diyarbakır, Bolu, Tekirdağ, Bilecik, Çorum, Eskişehir, Samsun, Afyon, Sakarya, Karaman, Gaziantep, Sinop, Edirne, Aksaray, Burdur, Bayburt, Balıkesir, Konya, Kütahya provinces created same groups.

Another group were created by Muğla, Kırıkkale, Isparta, Amasya, Giresun, Adıyaman, Adana, Mersin, Nevşehir, Manisa, Denizli, Uşak, Tokat, Zonguldak, Karabük, İstanbul, Sivas, Ağrı, Bursa, Bartın, Niğde, Kırşehir, Malatya, Şanlıurfa, Kocaeli, Gümüşhane, Elazığ, Çanakkale, Bingöl, Ankara provinces; Hatay, Tunceli, Kayseri, Kilis, Bitlis, Osmaniye, İzmir, Yalova, Kahramanmaraş provinces took part in same group. Biplot analysis in production for Turkey are given in Figure 4.

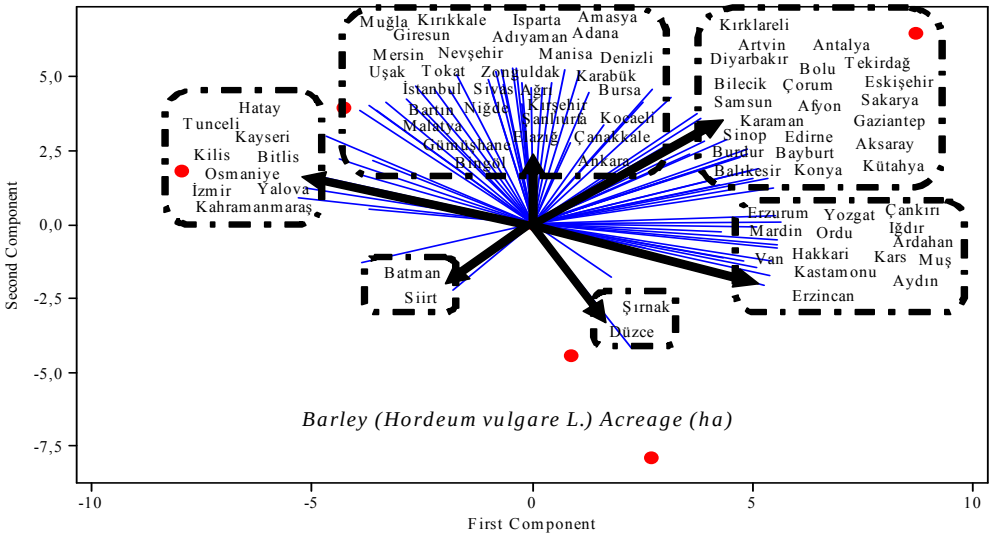

Figure 3. Biplot analysis of acreage in Turkey

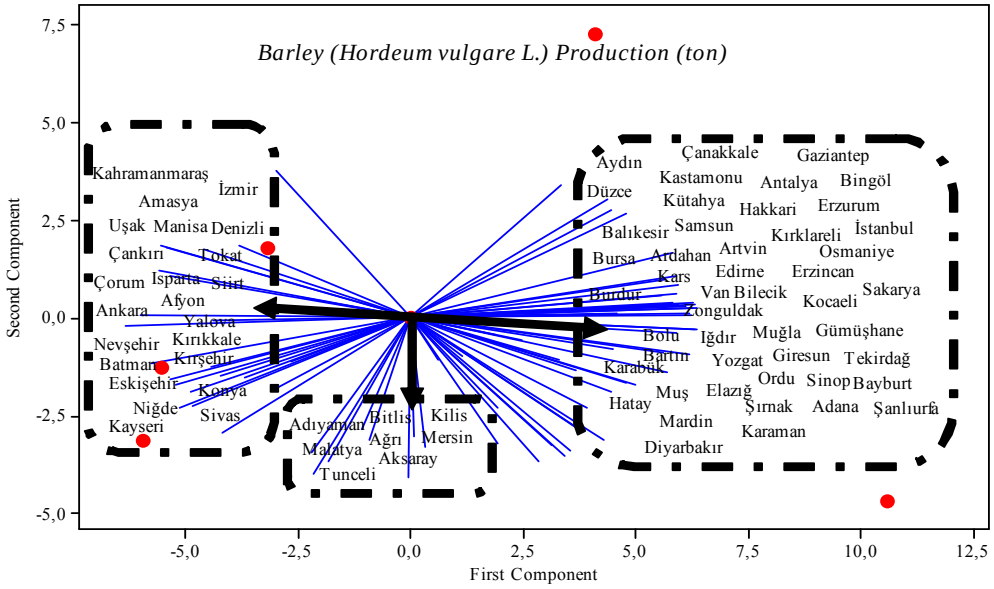

Figure 4. Biplot analysis of production in Turkey

According to Figure 4, provinces could be classified in three groups. First group contained Kahramanmaraş, İzmir, Amasya, Uşak, Manisa, Denizli, Çorum, Çankırı, Tokat, Siirt, Afyon, Isparta, Ankara, Yalova, Nevşehir, Kırıkkale, Batman, Kırşehir, Eskişehir, Konya, Niğde, Sivas, Kayseri provinces. While Bitlis, Kilis, Adıyaman, Ağrı, Mersin, Malatya, Aksaray, Tunceli provinces took part in one group; another group was created by Aydın, Çanakkale, Gaziantep, Kastamonu, Antalya, Bingöl, Düzce, Kütahya, Hakkari, Erzurum, Balıkesir, Samsun, Kırklareli, İstanbul, Bursa, Ardahan, Artvin, Osmaniye, Kars, Edirne, Erzincan, Burdur, Van Bilecik, Sakarya, Kocaeli, Zonguldak, Bolu, Iğdır, Muğla, Gümüşhane, Bartın, Yozgat, Giresun, Tekirdağ, Karabük, Ordu, Sinop, Bayburt, Muş, Elazığ, Hatay, Şırnak, Adana, Mardin, Şanlıurfa, Karaman, Diyarbakır.

Biplot analyses of yield in Turkey are given in Figure 5. Yield could be classified in eight groups in Turkey. The first group contained Şırnak, Şanlıurfa, Mardin, Gaziantep; while three provinces, Elazığ, Tunceli, Karaman created the second group. Çanakkale, Erzurum, Adana, Osmaniye, Samsun, Tekirdağ, Bartın, Ordu, Kahramanmaraş, Kırklareli, Iğdır, Aydın, Kocaeli, Karabük, Balıkesir, Bilecik, Giresun, Mersin, İstanbul, Edirne, Erzincan, Bursa, Van, Düzece, Artvin, Sakarya, Yalova, Hatay, Kars, Hakkâri, Gümüşhane, Bitlis, Ardahan, Zonguldak, Bolu, Bayburt joined same group; and another group had Kastamonu, İzmir, Tokat, Kayseri, Muğla, Kütahya, Burdur, Antalya, Bingöl provinces.

Manisa, Isparta, Denizli, Sinop provinces created one group and next group had Amasya, Uşak, Sivas provinces. Kırşehir, Çorum, Çankırı, Ankara, Nevşehir, Niğde, Afyon, Kırıkkale, Konya, Eskişehir, Yozgat provinces participated same group and Siirt, Malatya, Muş, Kilis, Aksaray, Diyarbakır, Batman, Ağrı, Adıyaman came in last group (Figure 5).

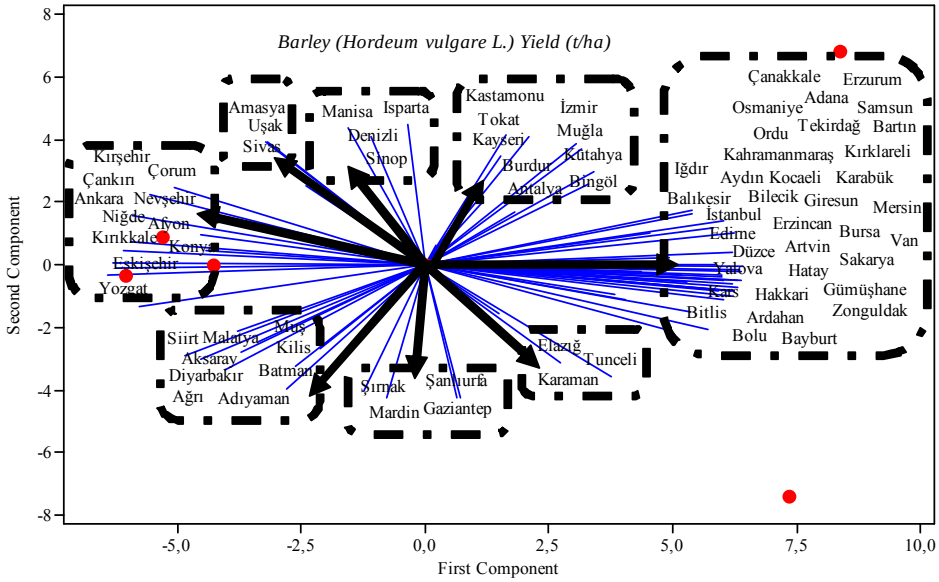

Figure 5. Biplot analysis of yield in Turkey

Maps of acreage, production and yield in barley for Turkey by Krigging Method are given Figure 6, 7 and 8. According to Figure 6 and 7, acreage and production maps gave similar results. Both criteria showed that Ankara, Eskişehir, Afyon, Konya, Sivas, Çorum, Yozgat, Kayseri, Aksaray, Kırşehir, Uşak, Denizli, Diyarbakır, Şanlıurfa, Elazığ, Erzurum, Kars, Mardin, Kütahya, Antalya and Kars provinces. Similar to our results studies revealed that results of acreage and crop production are mostly similar, since there is close relationship between them and production increases with increasing acreage (Fisunoğlu, 1998; Gençtan et al., 2006; Kınacı et al., 2010).

Bernaouda (1992) stated that acreage, production and hereby yield are commonly variable; they are mainly under many factors including climatic, geographic and economic factors. Sleizak and Horevaj (2000) stressed that increases in barley yield and relatively production are possible by allowing proper system and more suitable areas for malting barley. Figure 8 showed that provinces having high yield potential for barley are Ankara, Eskişehir, Afyon, Konya, Sivas, Çorum, Yozgat, Kayseri, Aksaray, Kırşehir, Uşak, Denizli, Diyarbakır, Şanlıurfa, Elazığ, Erzurum, Kars, Mardin, Kütahya, Antalya Burdur, Edirne, Tekirdağ, Bursa, Balıkesir,

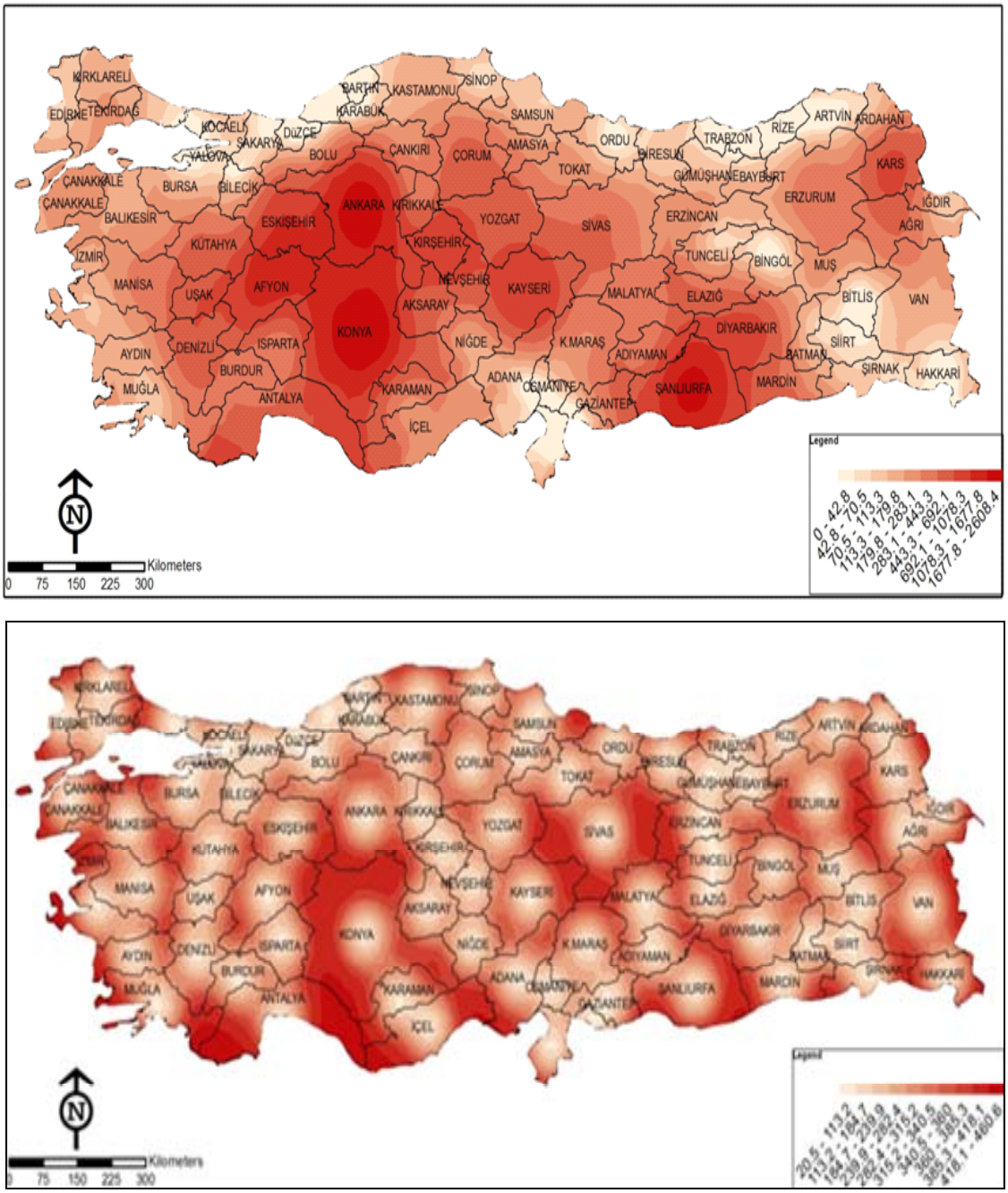

Figure 6. Maps of acreage and its error on barley in Turkey

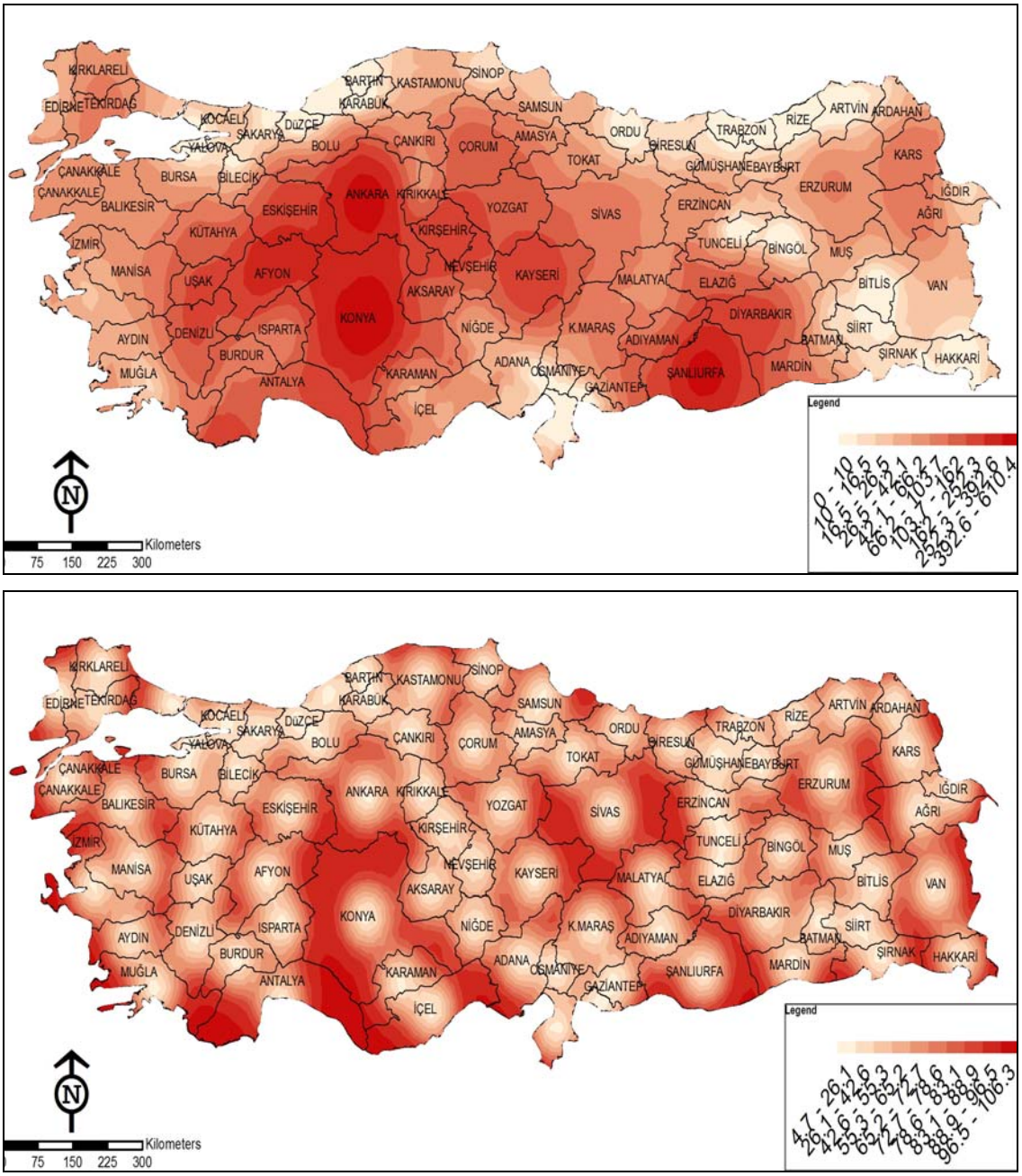

Figure 7. Maps of production and its error on barley in Turkey

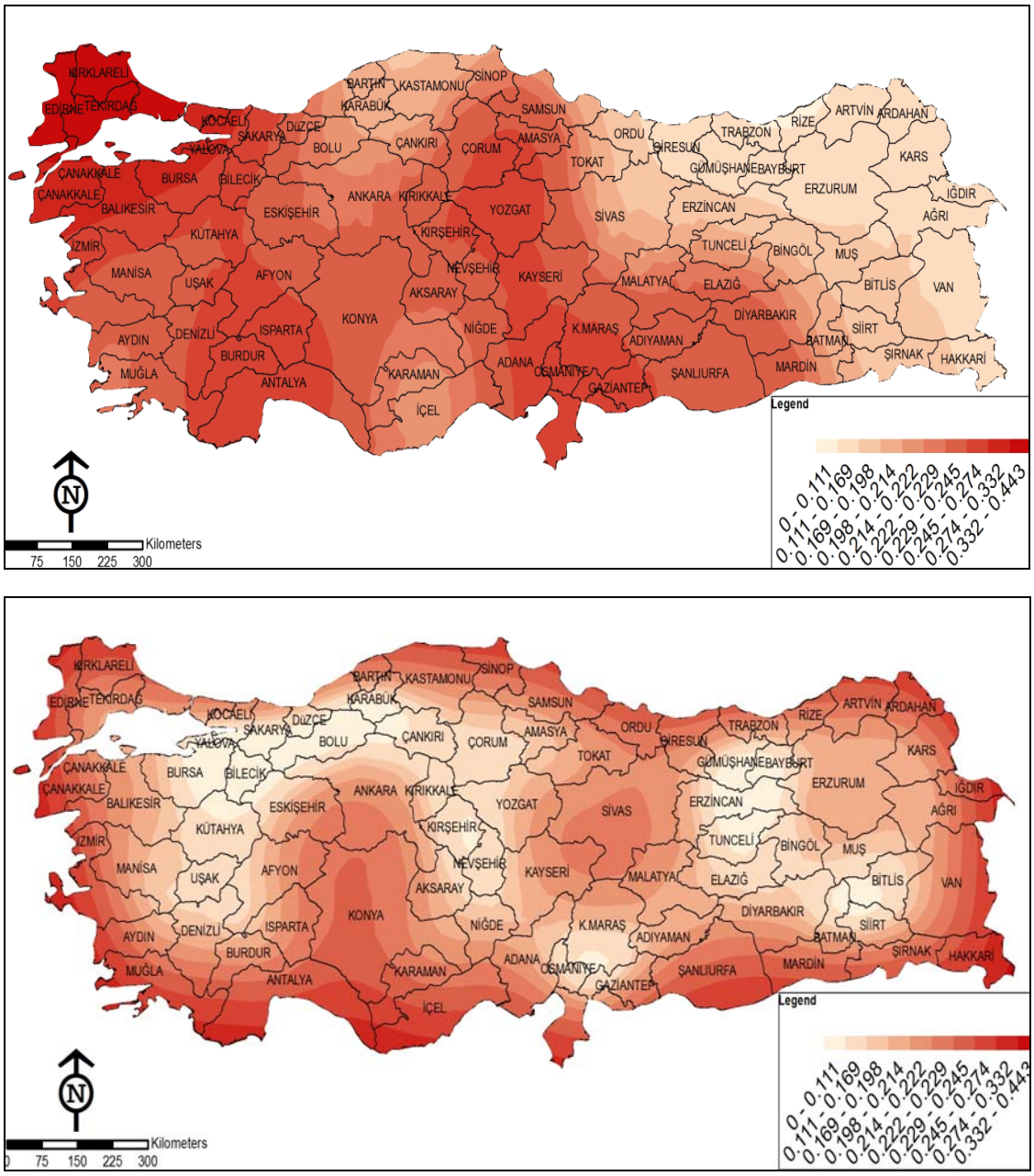

Figure 8. Maps of yield and its error on barley in Turkey

Çanakkale, Ankara, Isparta, and Sakarya provinces. Koornneef et al. (1997) warned that barley, as having economic importance is under danger of drought effect and low water input is main cause for crop yield decrease. It was conclude that climate topography and geography have about 60-80% rate on variability of acreage, production and yield in barley (Chmielewski and Kohn, 1999; Bielek, 2001; Spanik and Siska, 2004; Spanik, 2008). On the other hand six crops, wheat, rice, maize, soybeans, barley and sorghum are the most common grown crops in the world and production of them these crops accounts for over 40% of global cropland area (Anon., 2006).

So, barley is important crop in Turkey and could play important role in crop production, food industry and animal husbandry whether it is given greater importance in production marketing and valorization. Weather conditions have significant effect on barley yield and production. Adverse effect of climatic factors could be diminished by using cultivars, more tolerant to drought

and have a shorter growing period allowing rapid development. Good relationships coexist between acreage, production and crop yield. Besides in the long run, strong relationship occurs between barley area planted and barley price, significantly affecting barley acreage.

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