Compare to Planting on Bed and Flad Surface Systems in Wheat and Barley

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Abstarct: The main principle of a bed planting system is basically of sowing crops on beds or ridges instead of sowing on the flat surface. The aim of the study was to compare the new (bed) and traditional planting system for wheat and barley in Southeastern Anatolia Region and to identify and quantify potential grain yield and quality, because this planting system is becoming common in farming areas. On the other hand; it was compared with the cost of sowing, seed, irrigation, chemical struggle, harvest and observed the germination of seeds in both the flat surface and bed systems. Traditional, all agricultural applications were sown in flat surface, but special applications were used in bed planting systems. The study was conducted in Diyarbakir ecological conditions in the 2010-2011 production season. Acording to the combined analysis, significant differences were determined at the level of 1% and 5%, in the planting system, genotype and genotype x planting system interactions in terms of grain yield and quality parameters in wheat and barley. The results showed that grain yield and quality were higher in the conventional method than planting on bed (new) system, but, irrigation, struggle with weeds, disease and pest management, the operation of harvesting can be made more comfortable in the bed planting system than conventional system. According to the result of this study, bed planting system can be applied successfully as economic savings for growers through reduced crop inputs and improved production efficiency in wheat and barley, depending on hard conditions (alternation planting cotton, irrigated areas and when the price of seed is high).

Keywords: Planting, Bed, Conventional, Barley, Wheat, Biplot.

1. INTRODUCTION

Wheat and barley are important cereal crops in many countries including Turkey. Durum wheat is a traditional crop in Southeastern Anatolia Region of Turkey. The importance of it, still continues due to production and export potential for bulghur, macarony and pasta bussines. Barley is produced for feed and livestock for conturies in this region. Therefore, studies of cereal crops focus on both the breeding and planting techniques in Southeastern Anatolia Region. In the studies, until now a very efficient and high quality durum wheat and barley varieties were developed to suitable conditions in region. But the cost of agricultural production has increased over the years and will likely continue; from land prices to fuel and water costs. The cost of fertilizers is very volatile and has risen sharply during the last few years. The rising energy prices have increased the cost of producing and delivering fertilizers. In small grain production, where planting can make up a significant part of the production costs after cotton and maise, it is critically important to develop improved production systems that can reduce inputs or improve efficiency of their use. Southeastern Anatolia Region farmers face another difficulty, which is determining their water allocations to ensure they have enough water to last the entire season. Water requirements have been increasing in urban, industrial, environmental, and recreational uses, reducing available water for agriculture [4].

In resent years, new varieties developed in breeding programs and most of these varieties are high quality and yielding. Besides the high quality and yielding varieties, they will be useful and economically. They should focus on agronomic packages to reduce the cost. Planting on bed system was developed and implemented for this purpose. This system was developed as alternative planting technique. It offers the opportunity for conservation tillage, direct sowing on permanent beds and reduced cost of tillages. On the other hand, conservation tillage methods prevents erosion, and save time and fuel. Thus, producers who contribute to the country's economy, can spend their time on both agricultural operations and perform other agricultural businesses as soon as possible [2]. Existing research has demonstrated that with good management of resources and adoption of appropriate practices, including improved water conservation, production of quality, high-yielding crops are possible [14].

Historically in Southeastern Anatolia Region of Turkey, the majority of wheat and barley has been planted on flat surfaces, with flood irrigation after cotton and maize. Flood irrigation on flat ground has been associated with water loss, soil erosion, seed loss and

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without proper nutrient management, it has led to soil salinization [4]. Planting on beds has been used in fields with water management issues, It has also been used to provide save on the amount of seed used, facilitate cultural operations, could allow planting at a late period after harvesting of cotton or maize. There is currently no research data available on bed planting versus flat stands in barley. However, several studies in wheat have identified important yield and cost-saving benefits of bed planting in Southeastern Anatolia Region. A study by [28] concluded that raised bed and mulched ridge planting decreased water consumption, increased water use efficiency, and had higher yields than flat planting in winter wheat. [5] found that bed planted wheat offered crop rotation opportunities and field- access flexibility for fertilizer application and weed control. They found no difference in grain yield for conventional flat stand versus raised beds. By switching, they were able to reduce water requirements by 25%, offer more opportunity for mechanical weed control, reduce tillage, and reduce the incidence of lodging. A study by [24] also found that bed planted wheat varieties demonstrated over 50% less lodging compared with flat planting.

The aim of this study was to determine the potential for local implementation of cost-saving alternative practices that will reduce and more efficiently manage the most costly inputs for durum wheat and barley production in Southeastern Anatolia Region of Turkey.

2. MATERIALS AND METHODS

The experiments were conducted in 2010 – 2011 as randomized complete block design with three replications and four treatments: 1) wheat-flat, 2) wheat-bed, 3) barley-flat, and 4) barley-bed and using a split plot treatment arrangement at GAP International Agricultural Research and Training Center in Diyarbakir of Turkey (Latitude:37° 56'36"N, longitude: 043°15'.13"E at an elevation of 602 m above sea level).

The cultivars were randomized in the main plots and seed rate in the sub-plots. The seeding rates were chaged depending on the sowing methods. The seeding rate was 450 seeds m^{-2} in traditional sowing on flat, but 225 seed m^{-2} in bed sowing method. Sowing time, was held on 25 October 2010 in the traditional n flat system and on 25 November 2010 in bed system. The plots were planted with a grain drill for both the flat and bed system. For the bed system, the wheat and barley were also planted between the rows in the furrow. The extend of the beds were 70 cm from furrow bottom to furrow bottom. The space between each row on the ridge was 15 cm. The net plot size was 2.8 × 5 m. There was higer rainfall and lower average temperatures after planting in 2010 - 2011 as compared to long term averages. Irrigation is important during the production season in planting of bed, but the precipitation was high during growing season. The whole dose of P (60 kg P ha^{-1}) with half dose of nitrogen (60 kg N ha^{-1}) were applied at sowing time and

Table 1: The Name and Origin and Time of Registered of Wheat Varietes used Inexperiment

Crop	Name of Cultivar	Origin	Time of registered
Wheat	Altıntoprak	GAPUTAEM	1998
	Artuklu	GAPUTAEM	2008
	Eyyubi	GAPUTAEM	2008
	Fırat 93	GAPUTAEM	1993
	Güneyyıldızı	GAPUTAEM	2010
	Sarıçanak	GAPUTAEM	1998
	Şahinbey	GAPUTAEM	2008
	Zühre	GAPUTAEM	2010
Barley	Şahin	GAPUTAEM	1991
	Sur	GAPUTAEM	1990
	Samyeli	GAPUTAEM	2011
	Altıkat	GAPUTAEM	2011
	Kendal	GAPUTAEM	2013

GAPUTAEM: GAP International Agricultural Research and Training Center

Figure 1: The shape of bed planting system.

the remaining nitrogen (60 kg N ha^{-1}) was top-dressed as urea with the first irrigation. All other agronomic practices like irrigation, weeding etc. were kept normal and uniform for all the treatments.

The shape of bed planting system was gived in (Figure **1**). Weather conditions during the crop cycles are presented in (Fgure **2**) and the cultivars used in thestudy are presented in (Table **1**).

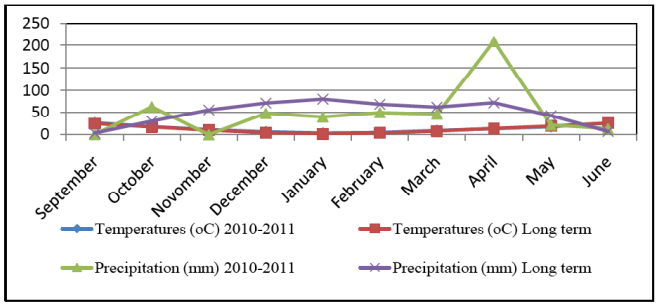

Figure 2: The average monthly rainfall (mm) and temperature (^{0}C).

3. RESULTS AND DISCUTION

3.1. Results of Durum Wheat

Acording to the combined analysis on the data of planting system; genotype, genotype x planting system interactions had significance at the level of 1 to 5%.

Grain Yield

The effect of planting system, variates and varietes x planting system interactions(VPSI) were significant on grain yield (Table **2**). The results showed that maximum grain yield (8.0 t/ha) was obtained from the conventional sysem followed by bed (7.4 t / ha^{-1}). Because the precipitation during experimental period was high; the grain yield was higher in the conventional planting system than normal conidions. There were great differences in grain yield between the varieties. The yield of wheat varieties ranged from 5.8 to 9.0 t/ ha^{-1}. Şahinbey, Sarıçanak and Zühre were productive cultivars with high grain yield. Altıntoprak is older than the highly productive cultivars, so, the yield of this variety was low. The varietes and planting system interactions (VPSI) had a significant effect on grain yield. The best grain yield (9.6 t / ha^{-1}) was obtained from in Şahinbey cultivar planting on flat. The minimum grain yield (5.7 t / ha^{-1}) was obtained from in Altıntoprak cultivar planting on bed. [17] and [23] reported that seed rate did not have significant effect on grain yield of wheat in bed planting conditions. However, [23]) reported that some farmers had been using seed rates as low as 50-75 kg ha^{-1}, while Kabakçi (1999) suggested that 100 kg ha^{-1} seeding rate was appropriate for wheat on bed planting system. The study of [14], showed that grain yield were changed between 2.7- 5.4 t / ha^{-1}. But the precipitation of their study season was lower than our study. According to [8, 18, 19], factors like weather conditions and soils are important causes for crop yield variability.

Test Weight

The effect of planting system variates and varietes x planting system interactions were significant to a level of 5%, and to a level of 1% respectively (Table **2**). The test weight results showed that the maximum value (81.1 kg hl^{-1}) was obtained from planting in the flat system followed by planting in the bed system (80.9 kg hl^{-1}). Because the number of spikes per plant and kernels per spike were low in the flat sytem, the results of test weight were higher in the flat system than in the bed system. The test weight of wheat varieties ranged from 79.5 to 82.3 kg hl^{-1}. The maximum test weight was obtained from Şahinbey cultivar, while the minimum test weight was from the Sarıçanak cultivar. The Şahinbey cultivar is newer than the Sariçanak cultivar

Table 2: The Means of Data of Planting on Flat and Planting on Bed in Durum Wheat Varieties

Cultivar	Grain Yield (t/ha^{-1}) GY						Hektoliter Weight (kg/hl^{-1}) HW						Thousant Grain Weight (g) TGW					
	Flat		Bed		Mean		Flat		Bed		Mean		Flat		Bed		Mean	
Altıntoprak	5.8	h	5.7	h	**5.8**	**E**	80.5	fg	79.9	h	**80.2**	**E**	44.3	ef	47.7	cd	**46.0**	**C**
Artuklu	6.4	fg	5.9	gh	**6.2**	**D**	81.2	e	81.2	e	**81.2**	**C**	44.5	ef	49.0	c	**46.7**	**CC**
Eyyubi	8.0	de	7.8	e	**7.9**	**B**	81.9	c	80.5	fg	**81.2**	**C**	44.1	ef	44.1	ef	**44.1**	**DD**
Fırat 93	7.5	e	6.7	f	**7.1**	**C**	81.5	d	80.3	g	**80.9**	**D**	51.8	ab	46.4	de	**49.1**	**B**
Güneyyıldızı	8.5	cd	7.5	e	**8.0**	**B**	80.4	fg	81.4	de	**80.9**	**D**	41.7	g	43.0	fg	**42.4**	**E**
Sarıçanak	9.3	ab	8.4	cd	**8.9**	**A**	79.7	ı	79.3	j	**79.5**	**F**	42.5	fg	43.6	fg	**43.1**	**DE**
Şahinbey	9.6	a	8.5	cd	**9.0**	**A**	83.1	a	81.4	de	**82.3**	**A**	49.7	bc	54.0	a	**51.8**	**A**
Zühre	8.4	cd	8.9	b	**8.6**	**A**	80.6	f	82.7	b	**81.6**	**B**	38.5	h	49.0	c	**43.8**	**DE**
Mean	**8.0**	**A**	**7.4**	**B**	**5.8**	**E**	**81.1**	**A**	**80.9**	**B**			**44.7**		**47.1**	A		
CV(%)	4.43						0.16						3.03					
System(LSD)	21.01301*						0.240524*						1.053552*					
Cultivar(LSD)	40.32398**						0.159407**						1.650056**					
SCI(LSD)	57.02671*						0.223133**						2.333528 ns					

LSD:Least significant(0.05), SCI:System cultivar interaction, **:p<0.01, *: p<0.05, ns :not significant.

(Table **1**). When these new cultivars were registered, the breeders especially concentrated on technologicial qualty criteria (test weight and thousand grain yield). So, these new cultivars have a high test weight. The varietes x planting system interactions had significant effect on the test weight. Maximum test weight (83.1 kg hl^{-1}) was obtained from planting in the flat system using Şahinbey, while the minimum test weight (79.3 kg hl^{-1}) was obtained from planting in the bed system using the Sarıçanak cultivar. According to [1] and [22] (22), test weight is change under different planting systems, varietes, ecological conditions, cultural practices, pests and diseases. On the other hand, [11] studied ten durum varietes in the same region to determine test weight. The results were changed between 77.3-81.7 kg hl^{-1}. The results of this study supported our study and the values were changed between same values.

Thousand Grain Weight (TGW)

The efect of planting system and variates was significant to a level of 5 % and 1% respectively. There was no significiant effect in varietes x planting system interaction (Table **4**). The TGW showed that the maximum value (47.1 g) was obtained from planting in the bed system followed by planting in the flat system (44.7 g). According to the result of TGW, the values were higher in the bed system than in the flat system without the Fırat cultivar. These results are in agreement with (7), (13), and Kiliç and Gursoy (2010). The TGW of durum wheat varieties ranged from 42.4 to 51.8 g. The maximum TGW was obtained from the Şahinbey cultivar, while the minimum TGW was obtained from Güneyyıldızı. The varietes x planting on system interactions had no significant effect on thousand grain weight. Maximum thousand grain weight (54.0 g) was obtained from the method of saddle sowing in Şahinbey, while the minimum weight (41.7 g) was obtained by the method of conventional sowing in the Güneyyıldızı cultivar. The method of bed planting gave a high TGW [26]. This might be due to that line method of sowing producing more healthy plants, which in turn synthesizes healthier and plumper seeds. Secondly it may be due to more favorable environmental conditions. According to [11, 14, 15], and TGW values are change depending on the planting system, varietes, ecological conditions, cultural practices, pests and diseases.

Bed-planting offers many advantages in irrigated wheat production systems. It can play an important role in environments characterized by prolonged water logging as a result of excessive rainfall. The role of bed-planting may be important in areas where water is a limiting factor. This has yet to be determined, but applications of permanent beds, residue retention, and tied ridges may increase its feasibility. The great

benefit for wheat production resulting from bed-planting tremendously enhanced field access, which facilitates controlling weeds and other pests, handling nutrients, reducing tillage, and managing crop residues [23].

3.2. Result of Durum Wheat

a) The Results of AMMI Analyses of Grain Yield

The variance of AMMI analysis showed that at p<0.01, all factors had a significant effect on wheat grain yield of eight cultivars tested in two planting systems. The total sum of squares explained 71.7% for Cultivar effects, 25.1% for genotypic effects and only 3.3% for CPSI effects (Table **3**).

The high addition of genotipic effects showed that there were important differences among the cultivars for grain yield. On the other hand, the planting system effect was high than the CPSI effect. The results of AMMI analysis showed similar results to [21], who showed 89.6%, 8.6% and 1.8%. Moreover, [9] and [26], reported that the environment effect had the highest effect compared with other factors on barley and soybean grain yield respectively. In the AMMI model, x-axis represents the cultivars and planting systems main effect and y axis represents the effects of interaction (Figure **3**). The planting systems and genotypes indicated much more variability in both main effect and interaction. According to AMMI, the majoritiy of genotypes (Eyyubi, Güneyyıldızı, Zühre, Sarıçanak and Şahinbey) showed good performance; because they took place above on axis (mean yield). It is believed that these genotypes were high yielding and desirable. On the other hand, Fırat Artuklu and Altıntoprak demonstrated low performance, because they are located under an axis (mean yield). So, these cultivars and environments, which are located under an axis (mean yield), were low yielding and undesirable. Moreover, planting in flat system had both high yield potential and positive IPCA1 scores; it means that this planting systemis was desirable in optimum conditions. While Şahinbey had highest grain yield amongst the cultivars, Sarıçanak was very stable with positive IPCA scores (Table **3**). According to [16], the genotypes having small IPCA1 values are more stable. Therefore, Sarıçanak can be recommended for both planting systems, while Şahinbey is recommended for high yield potential condition (on flat). Similar outputs were recorded by [10], in triticale.

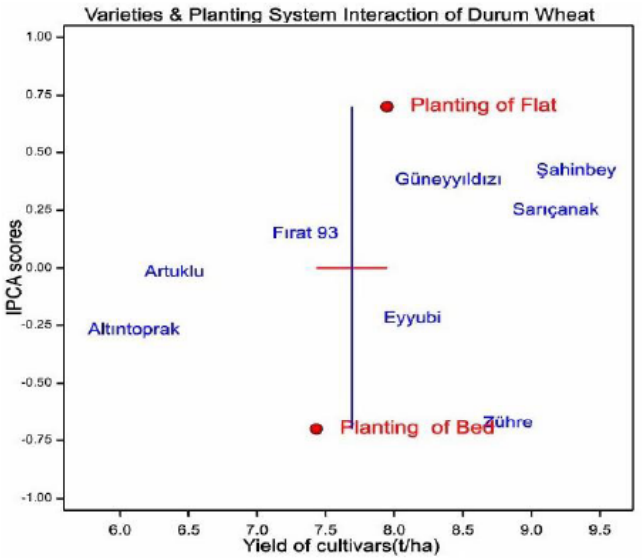

Figure 3: AMMI model based on stability of cultivars and planting system in GY.

Table 3: The Variance of AMMI Analysis on Grain Yield of Planting Sysem in Eight Durum Wheat Cultivars

Source of Variance	DF	Sum of square	Mean of squares	F Ratio	Explained (%)
Total	47	73.05	1.554		
Treatments	15	69.52	4.634	39.86	
Cultivars	7	63.44	9.063**	77.96	71.7
Planting System	1	3.17	3.17**	46.12	25.1
Block	4	0.27	0.069	0.59	
CPSI	7	2.9	0.415*	3.57	3.3
Interaction PCA 1	7	2.9	0.415*	3.57	
Residuals	0	0			
Error	28	3.26	0.116		

CPSI: Cultivarx Planting System Interaction df, degrees of freedom; **, p<0.01; G, Genotypes; E, Environments.

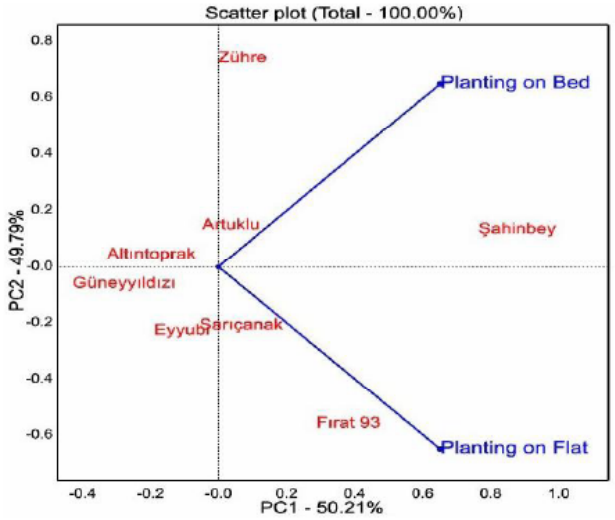

Figure 4: GGE biplot model based on relationships cultivar and traits.

b) The GGE Biplot Analysis of genotypes by traits

In this analysis, the results of traits were examined by GGE Biplot analysis using a different figure. The biplot of the principal component analysis illustrates relationships between the studied wheat traits and cultivars of two planting systems (on flat, on bed) (Figure **4**)

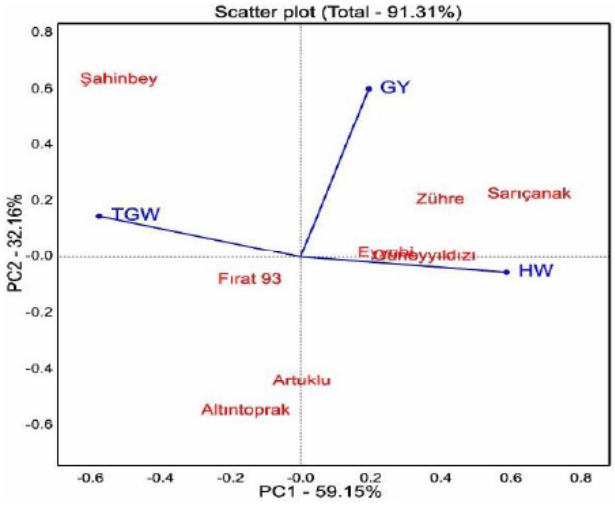

Figure 5: GGE biplot model based on relationships cultivar and traits.

First PCA explained 59.15% of the total variation, while the second PCA explained 32.16%. Together, both axes accounted for 91.31% of the total variation in the data. According to the biplot figures, the relations between cultivars and traits were examined by traits. The GGE Biplot showed that the breeders could select best cultivars for all traits and specific cultivars for specific trait in these planting systems. Eyyubi, Sarıçanak, Güneyyıldızı and Zühre had good performance on hectoliter (HW) and grain yield (GY) on both planting system, while Fırat and Sahinbey had good performance on thousant grain weight (TGW) (Figure **5**). On the other hand; Artuklu and Altıntoprak showed low performance on both planting systems, therefore these two cultivars could not be advised to cultivate in both planting system (Figures **4** and **5**).

3.3. Results of Barley Varieties

a) The results of Variance Analyses in Barley

The results of barley cultivars are shown in Table **4**. According to the combined analysis on the values, the planting system had a significant affect, at the 5% level, on ears per square meter (ESM), plant height (PH) and at the 1% level on yield of spike, number of spikelet per spike (NSS), length of spike (LS), and hektoliter weight (HW) respectivelly (Table **4**). On the other hand; there were no significant effects of the planting system on other traits. The cultivar effect was significant at the 1% level in all traits, while in the yield of spike at the 5% level. The effect of SCI was significant at the 1% level in all traits, except in plant height.

The grain yield of planting on the flat system (6.6 t / h^{-1} was higher than planting on bed, the best yield was obtained from Kendal variety (8.1 t ha^{-1}) both mean of cultivars as well as in ınteraction (8.8 t ha^{-1}). The ear per square meter of planting in the flat system (690) was higher than planting in the bed system. On the other hand, the best ear square meter (900) was obtained from the Altıkat variety, as well as in interaction (900). The plant height of planting in the flat system (116 cm) was lower than planting in the bed system (118 cm). On the other hand, the highest plant height was obtained from Şahin (131.3 cm). More over, the highest plant height in CPS interaction was obtained from the flat planting system in Şahin 91 (133.3 cm). The number of grains per spike were between 23.7 and 64.9. The highest number of grains per spike for Altıkat (64.9) was higher than other cultivars. The highest yield of per spike was obtained from Altıkat (2.3). Moreover, the highest plant height in CPS interaction was obtained from planting in the bed system using Şahin 91 (2.4). The highest number of spikelet per spike was obtained from Şahin (28) and Sur (27.2) variety. Moreover, the highest plant height in CPS interaction was obtained from the bed planting system with the Şahin 91 (28.5) vaiety. The length of spike for planting in the bed system (8.8 cm) was higher than planting in the flat system (7.6 cm). On the other hand, the highest length of spike was obtained from Şahin (9.2 cm). Moreover, the highest length of spike in CPS interaction was obtained from planting in

Table 4: The Means of Values of Planting on Flat and Planting on Bed in Barley Varieties

Cultivars	Grain Yield (t / ha^{-1}) GY						Ear per Square Meter (m^2)ESM						Plan Height (cm)PH					
	Flat		Bed		Mean		Flat		Bed		Mean		Flat		Bed		Mean	
Şahin	5.0	g	5.6	f	5.3	E	7.8	b	8.0	b	7.9	B	133.3	a	129.3	ab	131.3	A
Sur	5.7	f	5.5	f	5.6	D	5.9	c	5.8	c	5.9	C	123.0	ac	122.0	bd	122.5	B
Samyeli	6.8	d	7.8	b	6.5	C	5.8	c	4.9	e	5.3	D	111.7	de	117.0	ce	114.3	C
Altıkat	6.2	e	6.9	d	7.3	B	9.0	a	9.0	a	9.0	A	98.0	f	110.0	e	104.0	D
Kendal	8.8	a	7.4	c	8.1	A	6.0	c	5.5	d	5.7	C	112.7	ce	111.3	de	112.0	C
Mean	**6.5**		**6.6**				**6.9**	**A**	**6.6**	**B**			**115.7**	**B**	**117.9**	**A**		
CV(%)	**2.30**						**2.4**						**5.3**					
System(LSD)	**17.97ns**						**23.54***						**1.74***					
Cultivar(LSD)	**24.08****						**19.66****						**7.57****					
SCI(LSD)	**34.06****						**27.81****						**10.71ns**					
Cultivars	**Number of Grain Spike NGS**						**Yield of spike YS**						**Number of Spikelet Spike NSS**					
	Flat		**Bed**		**Mean**		**Flat**		**Bed**		**Mean**		**Flat**		**Bed**		**Mean**	
Şahin	26.3		28.9		27.6	C	1.2	cd	1.4	c	1.3	C	28.5	a	27.5	ab	28.0	A
Sur	25.9		21.4		23.7	C	1.3	cd	1.1	de	1.2	CC	27.3	ab	27.1	ab	27.2	A
Samyeli	22.3		27.2		24.8	C	0.9	e	1.1	de	1.0	D	23.2	d	23.9	cd	23.5	B
Altıkat	65.1		64.7		64.9	A	2.2	ab	2.4	a	2.3	A	23.7	cd	25.5	bc	24.6	B
Kendal	43.3		51.3		47.3	B	1.5	c	2.0	b	1.7	B	25.3	bd	20.8	e	23.1	B
Mean	**36.6**		**38.7**				**1.4**		**1.6**				**25.6**		**24.9**			
CV(%)	**15.1**						**12.4**						**1.14ns**					
System(LSD)	**2.80ns**						**0.05ns**						**1.58****					
Cultivar(LSD)	**6.97****						**0.23****						**2.23****					
SCI(LSD)	**9.86ns**						**0.32***						**12.4**					
Cultivars	**Lenght of Spike (cm) LS**						**Hektoliter Weight (kg/hl^{-1}) HW**						**Thousand Grain Weight (g) TGW**					
	Flat		**Bed**		**Mean**		**Flat**		**Bed**		**Mean**		**Flat**		**Bed**		**Mean**	
Şahin	7.9	cd	9.2	a	8.5	B	65.0	a	61.2	d	63.1	AC	44.6	ab	45.4	ab	45.0	A
Sur	9.1	ab	9.2	a	9.2	A	64.8	a	60.8	d	62.8	BC	41.9	cd	46.8	a	44.0	A
Samyeli	8.1	cd	9.0	ab	8.6	B	63.8	ac	63.4	bc	63.6	AB	44.2	bc	43.8	bc	44.3	A
Altıkat	7.6	d	8.5	bc	8.1	C	60.2	d	64.4	ac	62.3	C	36.6	f	38.7	ef	37.6	B
Kendal	5.3	e	7.9	cd	6.6	D	64.6	ab	63.2	c	63.9	A	39.4	de	38.8	ef	39.1	B
Mean	**7.6**	**B**	**8.8**	**A**			**63.6**	**A**	**62.6**	**B**			**41.7**		**42.3**			
CV(%)	**4.49**						**1.19**						**3.53**					
System(LSD)	**0.55****						**0.58****						**2.0 ns**					
Cultivar(LSD)	**0.45****						**0.92****						**1.82****					
SCI(LSD)	**0.63****						**1.30****						**2.57****					

the bed system using Şahin (9.2 cm) and Sur (9.2 cm) vareties. The hektoliter weight of planting in the flat system (63.6 kg hl^{-1}) was higher than planting in the bed system (62.6 kg hl^{-1}). On the other hand; the highest hektoliter weight was obtained from the Kendal (63.9 kg hl^{-1}) variety. Moreover; the highest hektoliter weight in the CPS interaction was obtained from planting in the bed system using Şahin (65.0 kg hl^{-1}) and Sur (64.8 kg hl^{-1}) vareties. The highest thousand grain weight was obtained from Şahin, Samyeli, Sur and varieties (45.0, 44.3 and 44.0 g respectively). Moreover; the highest thousand grain weight in the CPS interaction was obtained from planting in the bed system using the Sur (46.8 g) variety.

a) The Results of GGE Biplot Analyses in Barley

In this analysis, the results of planting system and cultivars interaction (Figure **6** and Figure **7**) and the relationship of traits by cultivars (Figure **8**) were examined by GGE Biplot analysis using different figures, using the *"which-one-where"* pattern to identify the best genotypes in planting system in Figure **6**: dividing the target planting system into meaningful mega-planting systems. Deploying different cultivars for different planting systems is the only way to utilize positive GPSI and avoid negative GPSI, which is the sole purpose for genotype by planting system interaction analysis [20, 25].

The GGE biplot analyses showed that planting systems took places in different sectors with cultivars (Figure **6**). Mainly, four lines divided the biplot into four sectors. The planting in the flat system and Kendal variety located in the first sector, while the planting in the bed system, Samyeli and Altıkat varieties took places in second. On the other hand; the Şahin took placed in third sector and Sur in fourth. Both of these cultivar did not related with any planting system. Consequently, the planting system on genotypes seperated with each other and different cultivars adapted on every planting system. The same result of relationship of planting system and cultivars can be seen in Figure **7**. The Kendal variety can be recommended for planting in the flat system, while Altıkat and Samyeli are recommended for planting in the bed system. Different cultivars should be prefer in defferent planting systems, because of the different planting system conditions (Figure **6** and **7**).

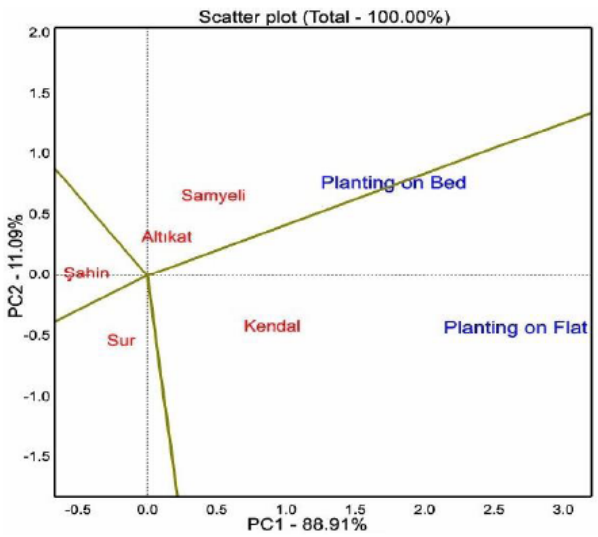

Figure 6: GGE biplot model based onsectors of planting system and genotypes.

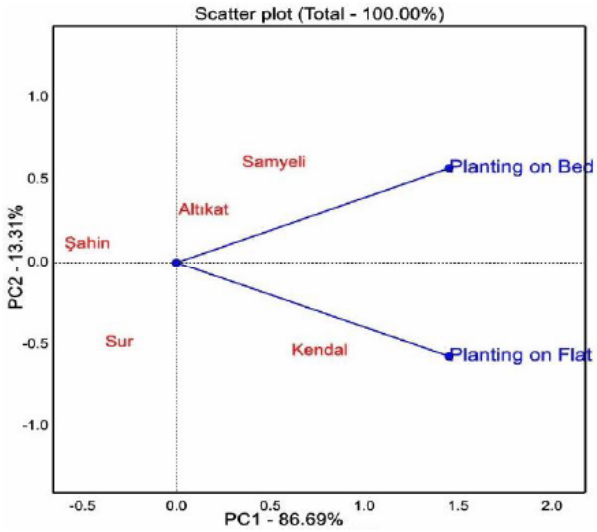

Figure 7: GGE biplot model based on relationships planting system and genotypes.

The Relationship Each Genotype by Each Trait

Both the genotype vectors and trait vectors are drawn in Figure **8**, so that the specific interactions between a genotype and traits (*i.e.*, the performance of each genotype in each trait) can be visualized. Figure **8** can be used to: (1) rank the genotypes based on performance in any trait, and (2) rank traits on the relative performance of any genotype. The interpretation of performance a genotype in a trait is better than average if the angle between its vector and the trait's vector is <90°; it is poorer than average if the angle is >90°; and it is near average if the angle is about 90° [3, 27]. When the angle between two genotypes is >90°, then these two genotypes are genetically different. Therefore, the results of traits showed that there is high variation among genotypes.

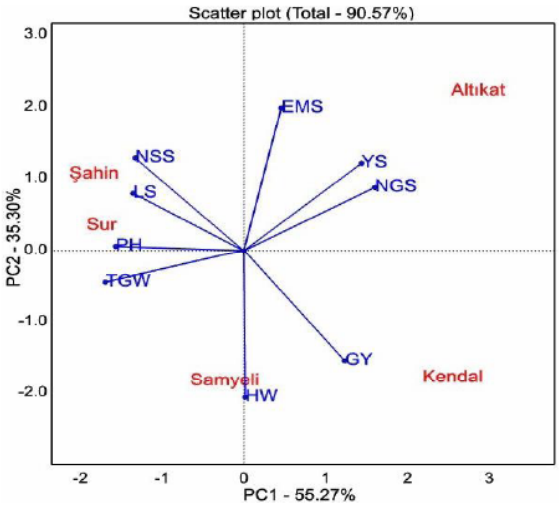

Figure 8: GGE biplot model based on relationships traits and genotypes.

According to these results, the Kendal variety is desirable for GY, Samyeli for HW, Altıkat for NGS, YS and EMS, Şahin and Sur varieties for NSS, LS, PH, and TGW. So they can be recommended for these traits. On the other hand, the cultivars showed special adaptation for traits. There was not any relation between any genotype with all traits. The cultivar which located near to the biplot center have less contribution to G or GT, while genotypes having longer vectors show the most contribution of G and/or GT [27]. So, Şahin with the longest vectors is the best genotypes for NSS, LS, PH and TGW than Sur variety. There are negative correlation between two cultivars, are opposite to each other on graph and the angles of vector is >90°. Therefore, there is major contribution of cultivar to cultivars; because of they have opposite direction, so they can make up different genetic contribution [12].

CONCLUSıON AND RECOMMENDATıONS

The results of study indicated that grain yield and quality were high in conventional method than planting on bed (new) system in wheat and barley. On the other hand; the biplot results showed that some of wheat and barley varieties (Samyeli, Altıkat and Zühre) are very useful for planting on bed system, while some others varieties (Kendal and Fırat) for planting on flat. Moreover, the bed planting system only can be used in irrigated area of Southeastern Anatolia Region condition. While, the irrigation, struggle to weed, disease and pest management, the operation of harvesting can be made more comfortable in the bed planting system than conventional system. According to result of this study, bed planting system can be applied successfully as economic savings for growers through reduced crop inputs and improved production efficiency in wheat and barley, depending on hard conditions (alternation planting cotton, irrigated areas and when the price of seed is high).

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