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Effects of Conventional and Reduced Tillage Methods on Some Traits of Wheat in Cotton-Wheat System

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ABSTRACT
Tillage is one of the most important agronomical practices especially for plant height (PH), grain yield (GY) and yield components in wheat production. This study was carried out in 2007–08 and 2008–09 growing seasons in Kahramanmaras, Turkey, to investigate response of five wheat cultivars (Adana, Ceyhan, Dogankent, Menemen and Yuregir) to conventional (CT) and reduced tillage (RT) systems after cotton harvest for PH, number of fertile spikes per m^2 (SM), spike length (SL), number of fertile spikelets spike^{-1} (SS), number of grains spike^{-1} (GS), 1000–kernel weight (KW) and GY components. The soil was ploughed at a depth of 25–30 cm in CT system, while it was not used in RT. The results indicated that all traits had greater values in 2008–09 than in 2007–08 except KW and GY. The tillage systems significantly affected PH, SM, SL, SS, GS and GY except KW. Over the two years, values of all traits in CT were higher than those of RT. There was a significant and positive correlation for GY, SS, GS and KW between CT and RT. The cultivars were affected by year and tillage system. Dogankent cultivar had better performance and stable for most of the traits compared to others under CT and RT in both years.

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Pamuk-Buğday Sistemlerinde Buğdayın Bazı Özellikleri Üzerine Geleneksel ve Azaltılmış Toprak İşlemenin Etkileri

ÖZET
Buğdayda toprak işleme sistemi, özellikle bitki boyu (PH), tane verimi (GY) ve verim unsurları açısından en önemli tarımsal uygulamalardan biridir. Bu çalışma, pamuk hasadından sonra geleneksel (CT) ve azaltılmış toprak işleme (RT) sistemlerinin beş buğday çeşidinde (Adana, Ceyhan, Doğankent, Menemen ve Yüreğir) PH, metre karede fertil başak sayısı (SM), başak uzunluğu (SL), başakta fertil başakçık sayısı (SS), başakta tane sayısı (GS), 1000 tane ağırlığı (KW) ve GY unsurları üzerine etkilerini araştırmak için 2007-08 ve 2008-09 ürün sezonlarında Kahramanmaraş'ta yürütülmüştür. Toprak, CT sisteminde 25-30 cm derinlikte sürülürken, RT'de yapılmadı. Sonuçlar, KW ve GY hariç diğer tüm özellikler 2008-09 sezonunda 2007-08 sezonundan daha yüksek değerlere sahip olmuşlardır. Toprak işleme sistemleri KW dışındaki PH, SM, SL, SS, GS ve GY özellikler üzerinde önemli derecede etkili olmuşlardır. İki yıla ait sonuçlara göre, CT'deki tüm özelliklere ait verilerin RT'ye göre daha yüksek olduğu gözlemlendi. CT ve RT sistemleri altında GY, SS, GS ve KW özellikleri açısından önemli ve pozitif korelasyonlar vardı. Çeşitler yıl ve toprak işleme sisteminden etkilenmiştir. Doğankent çeşidi her iki yılda da CT ve RT altında diğerler çeşitlere kıyasla özelliklerin çoğunda daha en iyi bir performansa ve stabiliteye sahipti.

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INTRODUCTION

Cotton and wheat have important roles in field crops production of Turkey. Cotton is produced only in western and southern regions of the country while wheat is produced country-wide. In the southern regions, wheat is produced fallowing cotton as a winter crop.

Depending on the climate of the year, the planting date of wheat is delayed in some years because of the delay of cotton harvest to late November (Nasrullah *et al.,* 2010). Some studies reported that delaying in sowing of wheat decreases the yield (Gangwar et al., 2004; Buttar et al., 2012). After cotton harvest, reduced tillage may be a solution to prevent delayed wheat sowing (Nasrullah et al., 2010). Reduced tillage system, also known as limited tillage, is any type of farming system that involves less cultivation than conventional tillage (Buttar et al., 2012). Normally, reduced tillage system does not involve plowing and disc cultivation, and it is generally used in the second crop soil preparation (shallow disc cultivator and harrow) after the first crop harvest (Nasrullah et al., 2010). Reduced tillage has some advantages such as higher profits from reduced inputs including labor and fuel costs, reduced land degradation, improvements of soil structure and organic matter (Micucci and Taboada, 2006), improved soil moisture retention and less leaching of chemicals and nutrients (Logsdon et al., 1987; Varsa et al., 1997; Dexter, 2004; Humphreys *et al.*, 2010; Dexter and Czyż, 2011). The soil compaction is reduced in reduced tillage compared to conventional tillage system because of less traffic in the field (Zhang et al. 2006; Ji 2013). In addition, Buttar et al. (2011) and Ram et al. (2012) reported that reduced tillage system reduced wheat production cost. Jug et al., (2011) said that the effect of reduced tillage system on wheat yield is dependent on where it is applied. Under a no-tillage conservation system, the soil conditions were better for plants compared to under conventional system in arid and semi-arid conditions (Mosaddeghi et al., 2009). In contrast to the above opinion, Vita et al. (2007) found that plough tillage gives better results for grain yield under higher rainfall. Khan and Khaliq (2005) compared conventional wheat production after cotton harvest to delayed surface seeding of wheat and reported that surface seeding yielded higher than conventional production.

In Turkey, early fall precipitations after cotton harvest causes difficulties in soil preparation for wheat planting. Therefore, growers frequently use reduced tillage after cotton harvest. In this study, reduced tillage after cotton harvest was performed to determine the effects on the traits such as plant height, yield and yield components of wheat compared to conventional tillage.

MATERIALS and METHODS

The study was conducted during 2007–08 and 2008–09 winter wheat growing seasons at Agricultural Research Station of The Eastern Mediterranean Transition Zone in Kahramanmaras (located at 37° 36' N latitude, 36° 55' E longitude at an altitude of 568 m above sea-level), Turkey. The total rainfall was 594.4 mm in 2007–08 growing season while it was 855.8 mm in 2008–09 (Table 1). The total rainfall in growing season of 2008–09 was 16.8% higher than average of long-term while rainfall of the growing season of 2007–08 was 19.9% lower than average of long-term. April is an important month for anthesis and grain filling period of wheat in this region. Unlike in the growing season of 2007–08 and the usual trend in long-term, dry and warm southern winds in the growing season of 2008–09 caused grain yield reductions. The experimental field soil was loamy, slightly alkaline and highly limy, and containing adequate potassium but low organic matter.

The experiment was a randomized complete block in a split plot design with three replications. The main plots were two levels of tillage, one of which was conventional tillage (CT) and the other was reduced tillage (RT). The sub-plots were five bread wheat cultivars which were Adana, Ceyhan, Dogankent, Menemen and Yuregir. Mentioned cultivars were used because of being widely grown in Kahramanmaras. CT and RT were applied after harvesting the previous cotton crop on November in both growing seasons. In CT system, the soil was firstly ploughed at a depth of 25–30 cm (1), then shallow disc cultivator at a depth of 10–15 cm was applied (2) and it was harrowed for flatting (3). Under RT System, shallow disc cultivator tillage at a depth of 10–15 cm was applied (1) and it was harrowed (2). Under each tillage system, cotton stalks were mixed into the soil by shallow disc cultivator. Wheat cultivars were sown on 17 November 2007 and 12 November 2008 via seed plotter. Each sub-plot was sown in 6 rows, 7 meters length and 20 cm apart. The sowing density was 500 seeds m^{-2}. Fertilization process was made according to farmers' application. Fertilizer DAP (150 kg ha^{-1}) was applied before planting and AN (200 kg ha^{-1}) was used at the shooting stage, while weed-control was performed by herbicide application at the main shoot stage (Zadoks et al., 1974). Irrigation was one time applied with flood water system in milk stage in both CT and RT.

In the study, plant height (PH), number of fertile spikes per m^2 (SM), spike length (SL), number of fertile spikelets $spike^{-1}$ (SS), number of grains $spike^{-1}$ (GS), 1000-kernel weight (KW) and grain yield (GY) were determined. PH and SL were measured (cm) with average of ten plants. SM was counted in one meter square prior to harvest. SS and GS were counted in ten spikes and their means were calculated.

Table 1. The total rainfall, number of rainy days and maximum and minimum temperatures per month during 2007–08 and 2008–09 growing seasons and over the long-term (between 1970 and 2011) in Kahramanmaras*.

Seasons	Sources	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Mean
2007–2008	Max. Temp.	41	34	25	15	15	19	29	36	36	42	–
	Min. Temp.	16	8	0	– 2	– 5	– 4	4	4	8	17	–
	Wind direction	WNW	WNW	W	NNW	SSE	SSE	WNW	WNW	WNW	WNW	
	Total precipitation	–	19.1	101.7	125.6	78.6	121.5	69.5	54.7	23.7	–	594.4
	Number of rainy days	–	6	10	10	4	9	9	6	8	–	62
2008–2009	Max. Temp.	40	32	25	18	15	17	24	25	36	39	–
	Min. Temp.	14	10	5	– 2	– 6	– 1	1	7	10	16	–
	Wind direction	WNW	WNW	W	S	SSW	WNW	WNW	S	WNW	WNW	
	Total precipitation	23.6	13.8	105.9	96.2	107.5	221.2	158	82.5	43.4	3.7	855.8
	Number of rainy days	6	5	9	6	16	17	15	10	7	2	93
1970–2011	Max. Temp.	42	38	27	24	19	22	29	36	38	42	–
	Min. Temp.	9	2	– 4	– 8	– 8	– 10	– 8	– 1	5	11	–
	Total precipitation	6.6	50.2	86.1	123.4	118.5	109.9	94.2	79.3	37.7	6.5	712.4
	Wind direction	NNE	NNW	NNE	NNW	N	N	N	N	NNE	NNE	–

*The Kahramanmaras Meteorology Station located at 37° 35' N latitude, 36° 56' E longitude at an altitude of 572 m above sea-level W = West; E = East; S = South; N = North

KW was determined by counting of 1000 seeds and were weighted in gram. Plot yields in harvest were converted to hectare yields.

The data collected were subjected to statistical analysis using MSTAT-C software.

RESULTS

Plant height (PH)

According to the results, PH was significantly affected by year (Y), tillage system (T), cultivar (C), and C × T and Y × C × T interactions (Table 2). The amount of precipitation in 2008–09 was considerably higher than 2007–08 (30.5%). Therefore, the mean PH in 2008–09 was higher than in 2007–08 (5.5%). The mean PH values of cultivars were found significantly different between CT and RT in each year (Table 3). PH was found significantly different under CT in both years, while it responded significantly different only under RT in 2008–09. Dogankent cultivar had the highest PH under CT in 2008–09 (106.3 cm) and it was followed by Menemen cultivar in the same year and Ceyhan cultivar in 2007–08 (101.7 cm). Interestingly, Menemen cultivar had the lowest PH under RT in 2007–08 (70.1 cm).

Spike length (SL)

Spike length varied throughout the years, tillage systems, and interactions of Y and T (Table 2). But, there were insignificant differences between the cultivars, and among all of traits interactions for the mean of SL. In 2008–09 growing season with the highest rainfall, the mean SL of cultivars was higher than in 2007–08 (2.7%). Conventional tillage was also higher in SL than RT (8%) in the mean of years. In the contrary, the mean values of cultivars were found insignificant between CT and RT in each year (Table 3).

Number of fertile spikes per m² (SM)

Number of fertile spikes per m² responded significantly to the years, tillage systems, cultivars, and Y × C, C × T and Y × G × T interactions (Table 2). In 2008–09 growing season, the mean of SM of cultivars was higher than in 2007–08 (5.5%). Also, in respect to SM values CT was significantly higher than RT (10.6%). A measure of SM was highly affected by tillage systems in 2008–09, while it was not affected in 2007–08 (Table 4). Dogankent cultivar had the highest SM under CT in both two years, while it had less under RT. In the contrary, Adana cultivar had the highest SM under RT in both experiment years.

Number of fertile spikelets spike⁻¹ (SS)

The results show that SS was significantly affected by the years, tillage systems, cultivars, and Y × C and C × T interactions (Table 2). The mean SS value of cultivars was higher in 2008–09 compared to 2007–08 (Table 4). Numbers of fertile spikelets was affected by tillage systems in each year. Dogankent cultivar had 18.3 fertile spikelet spike^{-1} in 2008–09, while Ceyhan and Dogankent cultivars had 17.1 fertile spikelet spike^{-1} in 2007–08 (Table 4). In addition, Dogankent and ceyhan cultivars were characterized by high SS stability under CT and RT for both two years.

Table 2. The average data of years, cultivars and tillage systems for studied traits.

Variable		PH (cm)	SM (no)	SL (cm)	SS (no)	GS (no)	KW (g)	GY (kg ha^{-1})
Year (Y)	2007–08	84.9	606	7.1	16.3	37.7	38.0	6755
	2008–09	89.8	641	7.3	17.0	39.4	36.9	5940
	Mean	87.4	624	7.2	16.7	38.6	37.5	6348
	LSD $_{(0.05)}$	3.3*	28.5**	0.2**	0.3**	0.5**	0.4**	396**
	CV (%)	7.4	5.0	7.0	3.3	2.4	1.7	7.7
Cultivar (C)	Adana	82.7	648	7.4	15.6	38.7	37.4	6623
	Ceyhan	91.4	613	7.1	16.7	38.5	37.9	6257
	Dogankent	88.7	646	7.4	17.6	40.1	37.9	6909
	Menemen	83.9	595	7.2	16.3	36.8	36.7	5982
	Yuregir	90.1	614	6.9	15.9	39.1	37.3	5969
	Mean	87.4	623	7.2	16.4	38.6	37.4	6348
	LSD $_{(0,05)}$	5.4**	26.1**	0.4 ns	0.5**	0.7**	0.5**	553**
Tillage (T)	CT	94.9	658	7.5	17.3	39.0	37.6	6733
	RT	79.7	588	6.9	16.0	38.1	37.3	5961
	Mean	87.3	623	7.2	16.7	38.6	37.5	6347
	LSD $_{(0.05)}$	3.3**	28.5**	0.2**	0.3**	0.5**	0.4 ns	396**
Interaction [a]	Y × C	ns	36.9**	ns	ns	ns	0.7**	ns
	Y × T	ns	ns	0.2*	0.1*	ns	ns	ns
	C × T	7.7*	36.9**	ns	0.6*	ns	ns	ns
	Y × C × T	10.7**	52.2*	ns	ns	ns	ns	ns

**Significant at 1%, * significant at 5% and ns: not significant

CT: conventional tillage; RT: reduced tillage,

[a] Including probability level and LSD$_{(0.05)}$ value

Table 3. Effects of two level tillage systems and five cultivars on plant height and spike length of wheat.

	Plant height (cm)						Spike length (cm)					
	2007–08			2008–09			2007–08			2008–09		
Cultivars	CT	RT	Mean[b]	CT	RT	Mean[b]	CT	RT	Mean[b]	CT	RT	Mean[b]
	**	ns	*	*	**	**	ns	ns	ns	ns	ns	ns
Adana	84.3	75.6	80.0	91.7	79.3	85.5	7.4	7.0	7.2	8.9	6.6	7.7
Ceyhan	101.7	74.0	87.9	94.6	95.3	95.0	7.3	6.6	7.0	7.7	6.9	7.3
Dogankent	97.3	78.0	87.7	106.3	73.3	89.8	7.6	6.9	7.2	8.0	7.3	7.6
Menemen	86.0	70.0	78.0	101.7	78.0	89.9	7.4	7.0	7.2	7.5	6.9	7.2
Yuregir	95.7	85.6	90.7	91.8	87.3	89.6	7.3	6.4	6.9	7.4	6.7	7.0
LSD $_{(0.05)}$	4.2	–	8.8	11.5	9.4	6.8	–	–	–	–	–	–

**Significant at 1%, * significant at 5% and ns: not significant
[b]Tillage system × Cultivar in each year

Number of grains spike^{-1} (GS)

A measure of GS was significantly influenced by years, tillage systems and cultivars. But, GS was not affected by their interactions (Table 2). Cultivars responded separately to the precipitation. All cultivars in 2008–09 had higher GS numbers than in 2007–08 except Yuregir (Table 5). Dogankent cultivar had higher mean number of GS in both 2007–08 and 2008–09 years (39.2 and 40.9 grains spike^{-1}, respectively) and was also higher under CT and RT. Yuregir cultivar had similar values for GS (39.1 grains spike^{-1}) between tillage systems and years.

According to the results, KW was significantly affected by years and cultivars, and their interactions (Table 2). However, KW was not affected by tillage systems. In the contrary, to expectations, in 2007–08 growing season, the mean KW of cultivars were higher (38 g) than in 2008–09 (37 g) (Table 2). In each years, KW values of cultivars were significantly varied by tillage systems except RT in first year (Table 5). The KW values of cultivars under CT were higher than under RT except Adana cultivar in second year. Ceyhan cultivar had the highest KW values under CT and RT in 2008–09. Under CT in first year, Dogankent cultivar had the highest KW (39.2 g) which was followed Ceyhan, Adana and Menemen (38.0, 37.9 and 37.9 g, respectively).

Grain yield (GY)

The analysis of variance revealed that GY was significantly affected by years, tillage systems and cultivars (Table 2). However, GY was not affected by interactions of experimental factors. Although, high rainfall in 2008–09, the mean GY of cultivars in this year was lower than in 2007–08. GY values were found variable for each year and cultivars. In average of two years, the highest GY was obtained from Dogankent cultivar (6909 kg ha^{-1}) which was followed by Adana and Ceyhan (6623 and 6257 kg da^{-1}, respectively).

Irrespective of the cultivar, wheat had a higher GY under CT than under RT. GY of CT was increased at the rate of 11.5% compared to RT in both combined and separated years (Table 2 and Table 6).

In higher rainfall year, GY values of cultivars under RT were significant compared to CT, while it was vice-versa in 2007–08 (Table 6). Dogankent cultivar was the most stable cultivar under CT compared to other cultivars in both experiment years, which was followed by Adana cultivar.

Table 4. Effects of two level tillage systems and five cultivars on number of fertile spikes per meter-square and number of fertile spikelets per spike of wheat.

	Spikes m^2 (no)						Number of fertile spikelets spike^{-1} (no)					
	2007–08			2008–09			2007–08			2008–09		
Cultivars	CT	RT	Mean^b	CT	RT	Mean^b	CT	RT	Mean^b	CT	RT	Mean^b
	ns	*	ns	**	**	**	**	ns	**	**	*	**
Adana	623	598	611	712	660	686	16.1	14.9	15.5	15.6	15.6	15.6
Ceyhan	645	557	601	636	613	625	18.0	16.3	17.1	18.5	16.3	17.4
Dogankent	679	596	638	721	589	655	18.2	16.0	17.1	18.5	18.0	18.3
Menemen	600	534	567	634	610	622	17.0	15.3	16.2	18.1	16.4	17.3
Yuregir	646	573	610	681	554	618	16.4	14.9	15.6	16.8	16.1	16.5
LSD (0.05)	–	43	–	37	25	20	0.7	–	0.7	0.8	1.1	0.6

**Significant at 1%, * significant at 5% and ns: not significant

[b]Tillage system × Cultivar in each year

Table 5. Effects of two level tillage systems and five cultivars on number of grains per spike and 1000-kernel weight of wheat.

	Grains spike^{-1} (no)						1000-kernel weight (g)					
	2007–08			2008–09			2007–08			2008–09		
Cultivars	CT	RT	Mean^b	CT	RT	Mean^b	CT	RT	Mean^b	CT	RT	Mean^b
	*	*	**	**	*	**	*	ns	*	**	**	**
Adana	38.5	36.0	37.3	40.8	39.5	40.2	37.9	38.8	38.3	36.4	36.4	36.4
Ceyhan	38.3	36.7	37.5	39.2	39.6	39.4	38.0	37.3	37.6	38.5	38.1	38.3
Dogankent	39.6	38.8	39.2	41.6	40.2	40.9	39.2	38.6	38.9	37.7	36.3	37.0
Menemen	36.3	35.9	36.1	37.7	37.4	37.6	37.9	37.6	37.7	35.7	35.6	35.7
Yuregir	39.1	37.9	39.1	39.2	39.0	39.1	37.0	37.4	37.2	37.8	36.9	37.4
LSD (0.05)	2.0	1.9	1.3	1.7	1.4	1.0	1	–	0.9	0.8	1.1	0.6

**Significant at 1%, * significant at 5% and ns: not significant

[b]Tillage system × Cultivar in each year

1000-kernel weight (KW)

Table 6. Effects of two level tillage systems and five cultivars on grain yield (kg ha^{-1}) of wheat.

	Grain yield (kg ha^{-1})					
	2007–08			2008–09		
Cultivars	CT	RT	Mean[b]	CT	RT	Mean[b]
	*	ns	**	ns	*	**
Adana	7324	7018	7171	6402	5747	6075
Ceyhan	6823	6017	6420	6296	5890	6093
Dogankent	8024	6507	7266	6734	6369	6552
Menemen	6903	5817	6360	6254	4954	5604
Yuregir	7174	5943	6559	5400	5357	5379
LSD $_{(0.05)}$	633	–	564	–	701	629

**Significant at 1%, * significant at 5% and ns: not significant

[b]Tillage system × Cultivar in each year

Correlations among traits in tillage systems

There was a significant and positive correlation for GY, SS, GS and KW between CT and RT (r = 0.724*, r = 0.727, r = 0.854** and r = 0.0814**, respectively) (Table 7). Under RT system, KW and GY were correlated highly and positively (r = 0.732*). There was a positive and significant relation between SS and GS (r = 0.603*). Under CT, there was a positive and significant relation between PH and SM (r = 0.638*). The correlation between SM and SL was significant and positive (r = 0.669*). In addition, there also was a positive correlation between SM and GS (r = 0.922**) and SL and GS (r = 0.642*).

DISCUSSION and CONCLUSION

Results of current experiment indicated that all traits were highly significant between the CT and RT system except KW which had higher values under CT than RT (Table 2). There were also significant differences among cultivars for all traits except SL. There were differences between two experimental years for SM, SL, SS, GS, KW and GY and PH. All studied traits sustained greater values in 2008–09 than in 2007–08 except KW and GY.

The years were also evaluated separately for each trait for their differences. There was a difference for plant height for both experiment years. The mean PH of cultivars under CT was higher than under RT in both 2007–08 and 2008–09 growing seasons. Similar results also reported in a study by Buttar et al. (2012). In 2008–09 growing season, the cultivars were found variable in both CT and RT while they were found variable only in CT in 2007–08.

The mean SM of the cultivars was higher in the first year than the second year. Besides, in both 2007–08 and 2008–09 growing seasons, the SM performance of the cultivars under CT was higher than those of RT which was consistent with the findings of Malecka et al. (2012). Dogankent cultivar had the highest SM under CT while Adana cultivar had the highest SM under RT. CT showed in a significantly higher SL than RT in the mean of years. Contrarily, the mean values of cultivars were found insignificant between CT and RT for each year. Interestingly; SL was not affected by tillage systems in each experiment year. CT system had higher the mean of GS than RT in combined years. Malecka et al. (2012) reported that GS was not significant in combined years. All cultivars in 2008–09 sustained higher GS numbers than in 2007–08 except Yuregir. Yuregir cultivar was stable between tillage systems and in both experiment years. Dogankent cultivar had the higher number of GS in both years and also under CT and RT.

CT system had higher GY than RT in combined years (Malecka et al., 2004; Malecka et al., 2012; Woźniak, 2013). The cultivars under CT except Adana were higher than under RT for GY in second year. Dogankent cultivar was the most stable cultivar for GY under CT compared to other cultivars in both experiment years and it was followed by Adana cultivar. CT system had higher KW than RT in combined years. In contrast to our result, Malecka et al., (2012) found that CT system had lower KW than RT. The highest KW were recorded in Ceyhan under CT and RT in 2008–09. Under CT in first year, Dogankent cultivar had the highest KW value and was followed by Ceyhan, Adana and Menemen cultivars. Although high rainfall in 2008–09, the mean GY of cultivars in 2008–09 was lower than in 2007–08. There was also similar result for KW. The climatic conditions of Kahramanmaras was extremely different in 2008–09 winter wheat growing season compared to 2007–08 and the long-term (Table 1). In April 2009, there was extremely a dry southern wind, and furthermore there was high moisture in the soil caused by high rainfall. In Kahramanmaras, the early milk stage of grain filling period is in April. Therefore, the climatic changes in 2008–09 growing season caused environmental stress on early milk stage of wheat, and negatively affected KW and GY. Sharma and Smith (1986) and Lihua et al. (2013) reported negative effects of dry winds on GY. Additionally, Jia et al. (2009) reported negative effect of high precipitation and soil moisture on milk stage and GY of wheat. On the contrary, Vita et al. (2007) reported positive effect of higher precipitation on grain yield. Barasel et al (2008) and Woźniak (2013) reported that yield and yield components are greatly influenced by plant genotype and environmental conditions.

Between CT and RT there was a significant and positive correlation for GY, SS, GS and KW. There was a positive relation between KW and GY under RT system. Virk and Anand (1970), Iftikhar (2012) and Haq et al. (2010) reported similar results while Khan et al. (1999) reported otherwise. There was a positive and significant relation between SS and GS and this finding was in agreement with Cantrell's (1986). Under CT, there was a positive and significant relation between PH and SM. These findings were comparable to Eunus et al. (1986) and Belay et al. (1993). However, Iftikhar (2012) reported negative relation between these traits. The correlation between SM and SL was significant and positive just as Cantrell and Haro-Arias (1986) indicated despite the fact that Mohsin et al. (2009) reported a negative correlation for the two traits. In addition, there was also a positive correlation between SM and GS and SL and GS. Cantrell and Haro-Arias (1986) also reported a positive correlation between SM and GS which supported our findings. Eunus et al. (1986) and Sahah et al. (1988) reported positive relation between SL and GS, while Iftikhar et al. (2012) and Narwal et al. (1999) found negative correlations.

All of the investigated traits of bread wheat cultivars in this study were affected by tillage systems, except KW, and climate at different levels. According to the results, plant height, grain yield and yield components under RT system decreased depending on cultivars compared to CT. Repeating the study with multi locations and years including economic analysis and different sowing dates in upcoming years is needed.

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