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Effects of Removal of Some Photosynthetic Structures on Some Yield Components in Wheat

Melahat AVCI BİRSİN[1]

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Abstract: Present study was carried out in the experimental field of the Field Crops Department, Faculty of Agriculture, Ankara University during 1999 and 2001. Two wheat cultivars, Gerek-79 and Gün-9, were studied to investigate the impacts of the removal of some photosynthetic structures including flag leaf, second upper leaf blade and awneds, on some yield related components. The experiment was laid out in a randomized complete block desing of split-plot restriction with four replications. According to results obtained, removal of flag leaf resulted approximately 13, 34, 24 % reduction in grain per spike, grain weight per spike and 1000-grain weight, respectively and 2.8% increase in grain protein contents in both years. Studies indicated that significant reductions in these traits and increases in grain protein contents resulted from removal second upper leaf blade and awneds.

Key Words: Wheat, flag leaf, awneds, photosynthates

Buğdayda Fotosentez Organlarının Uzaklaştırılmasının Bazı Verim Ögelerine Etkisi

Öz: Anakara Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü deneme tarlalarında 1999-2001 yıllarında yapılan çalışmada; iki ekmeklik buğday (Gerek-79 ve Gün-91) çeşidinde başaklanma döneminde, kılçık, bayrak yaprak ve bayrak yaprak altındaki yaprağın uzaklaştırılmasının bazı verim öğelerine etkisi araştırılmıştır. Deneme tesadüf blokları bölünmüş parseller desenine göre dört tekrarlamalı olarak yürütülmüştür. Elde edilen sonuçlara göre; kontrole karşılaştırıldığında bayrak yaprağı uzaklaştırılan bitkilerde; başakta dane sayısı, başakta dane ağılığ ve bin dane ağırlığında her iki yılda da yaklaşık olarak sırasıyla % 13, % 34 ve % 24 oranında azalma ve protein içeriğinde % 2.8 artış ortaya çıkmıştır. Bu öğelerdeki azalma ve protein oranındaki artış kılçığı ve bayrak yaprak altındaki yaprağı alınan bitkilerde de önemli bulunmuştur.

Anahtar Kelimeler: Buğday, bayrak yaprak, kılçık, fotosentez

Introduction

The number of plants per unit area, number of ears per plant, number of grains per ear, and weigth per grain are the most important yield components in cereals. After ovule fertilization in wheat, the embryo grows rapidly, and organic food material accumulates. The building up of dry matter in the grain which depends upon potential assimilation of CO_2 and accumulation of photosynthates during the grain filling period. The stem, leaves, spike and the awneds are the photosynthetic organs of the plants. Several studies have been conducted to study the effects of different plant parts on wheat kernel development. (Saghir et al. 1968, Hsu and Walten 1971, Ledent and Moss 1979, Winzeler et al. 1989, Blade and Baker 1991, Chowdhry et al. 1999).

In wheat, major photosnythetic organs are leaves; especially the flag leaves. Mostly lower leaves are shaded by the upper ones and maximum solar absorption occurs in flag leaves. Thus, flag leaf and photosnythetic area above flag leaf was indicated the importance of these structures to increase grain yields (Hsu and Walton 1971, Mohiuddin and Croy 1980, Sen et al. 1996, Cruz-Aguoda et al. 1999). The flag leaf blade and total photosnythetic area above the flag leaf node have possitive correlation with weight of grain per plant (Briggs and Aytenfisu 1980, Mohuiddin and Croy 1980).

When top leaves are removed, the lower ones supply assimilates to the grain. Effect of flag leaf removal has been reported primarily to reduce grain yield. Removal of flag leaf and its combination with awneds affected grain yield more adversely in dwarf genotypes than taller ones (Chhabra and Sethi 1989). Das and Mukherjee (1991) reported that contribution to yield of flag leaf alone is 19%. Mahmood et al. (1991) reported that there was 16.1% reduction in grain yield after flag leaf removal at the heading. Up to 13.2- 22.9 % grain yield reduction has been reported by Singh and Singh (1992) and 34.5% grain reduction was shown by Mahmood and Chowdhry (1997).

The awneds can greatly increase the ratio of net photosnythesis of wheat ear and their contributions to grain dry matter (Olugbenim et al. 1976.a). Awneded wheat genotypes gave significantly higher yield and heavier kernels than that of awnedless genotypes. This difference in yield was great under drought conditions.

[1] Üniv. of Ankara Dept. of Field Crops, Faculty of Agriculture - Ankara

Saghir et al. (1968) reported that clipping full awneds at anthesis had the most significant effect on the grain yield and 1000-kernel weight of wheat, reducing the yield 20.8% and thousand kernel weight 13.4% . Singh and Singh (1992) reported 3-9% reductions in grain yield when awned were removed 10 days after anthesis. Das and Mukherjee (1991) reported that contribution of awneds towards grain yield was 8.6%. Although, awneds, flag leaf, and 3rd nodal leaf are the potentially efficient photosynthetic organs in terms of economic production of the wheat plant, how much these structures contribute to final grain weight are usually dependent on the enviroment and genetic potential of the variety (Olugbenim et al. 1976b, Mahmood and Chowdhry 1997).

The main objective of this study was to determine the effect of the removal of main photosynthetic organs of wheat plants on some of the yield components in two wheat varieties grown in dry Anatolian ecological conditions of Turkey.

Materials and Methods

The study was conducted at the Department of Field Crops, Faculty of Agriculture, in Ankara, during 1999 and 2001. The texture of the soil in the experimental area was clay- loam, pH value was 7.85, organic matters were 1.96%, lime ratio was 0.855, total salt ratio was 0.02%, available plant nutrients (P_2O_5 and K_2O) were 6 and 78.3 kg/da, respectively. The climatic data of the experimental area are given in Table 1. Winter wheat seeds were sown at Ankara in the second or third week of October and matured toward the second or third week of July.

The experiment was laid out in randomized complete block design in split-plot restriction with four replications. Two winter wheat (*Triticum aestivum* L.) cultivars (Gerek-79 and Gün-91) were used. These varieties were sown in main plots consisting of 12 rows of four meter length with 20cm spacing between the rows. The varieties under main plots were subjected to following treatments under split-plots:

T1= Control (intact plants)
T2=Flag leaf blade removed at heading (Spike emergence)
T3=2nd upper leaf blade removed at heading
T4= awneds removed at heading

At spike emergence flag leaves of 10 randomly selected plants, 2 upper leaves from other 10 plants and awneds from another set of 10 plants were removed and plants were individually tagged. Similarly 10 intact plants were also tagged as control. Observations; number of total spikelets per spike, number of fertile spikelets per spike, number of grains per spike, number of grains weight per spike, 1000-grain weight were also recorded in main spike at maturity. The grain protein content was measured by modified micro-kjeldahl system. Data collected were subjected to analysis of variance and least significant difference (LSD) tests (Düzgüneş et al. 1987). Percent reduction for significantly affected traits was also calculated in each treatment in comparison with control.

Results and Discussion

As seen in Table 2; in the levels of both variety and application, the grain number in the spike in both years, the grain weight of the spike, and the weight of a thousand grains and in the level of variety, the spike number and in the level of applications, the protein content were statistically important. The LSD values for the difference between the variety and applications is important has been given in the Table 3.

While approximately total 23 spikelet were obtained from Gün 91 variety in both years, this number was found approximately 18 in Gerek-79 (Table 3). The fertile spikelet number of variety was rather low in second year than the first year. When flag leaf was removed, the number of fertile spikelet to minimum (15.93) in comparison with the maximum (16.85) intact plants in second year.

While grain number per spike was high (50,54) in Gün 91 in both years, the first year values were higher than the second year values. When treatment averages were compared for grain number per spike; the highest reduction occurred by 12.8 % and 12.4% in the flag leaf removal in the first year and the second year in accordance with the control, respectively, the lowest reduction occurred by 5.5 % and 5.1% in the 2nd upper leaf blade removal in the first year and second year, respectively.

The highest grain weight per spike in intact plants was 1.84 g and 1.37 g in the first and second years, respectively; and the lowest grain weight was 1.22 g and 0. 95g in the flag leaf removed plants in first and second years, respectively. In accordance with the control, the grain weight in awneds removed plants, reduced between 8.8 % and 13.1 %; and the grain weight in the second upper leaf blade removed plants, reduced between 4.4-8.7 % (Table 3).

According to results obtained; flag leaf removal significantly reduced number of grains per spike, grain weight per spike and 1000-grain weight, and it is in agrement with reports of Saghir et al. (1968), Mohiuddin and Croy (1980), Das and Muhkerjee (1991), Mahmut et al. (1991), and, Sen et al (1996). Mahmood et al (1991) reported 16.1% reduction in grain yield after flag leaf removal at the heading. A loss of grain yield up to 13.2-22.9% has been reported by Singh and Singh (1992) and 34.5 % by Mahmood et al. (1997). It was also declared that there was a positive correlation between flag leaf area and yield (Briggs and Aytenfisu 1980, Chowdhry et al. 1999). A reduction in grain yield was reported 3-9% when awneds were removed 10 days after anthesis by Singh and Singh (1992). These reductions were reported 20.8 % by Saghir et al. (1968) and 16.8 % by Mahmood and Chowdhry (1997). It is pointed out that the yield and the grain size in the awned wheat variety are higher than the awnedless one and this increasing is more determinative in the dwarf genotypes and under conditions of drought (Atkins and Norris 1955, Olugbemi et al. 1976b, Ledent and Moss 1979, Chhabra and Sethi 1989).

Table 1. Climatic data of experimental area for 1999,2000 and 2001 growing period

Months	Precipitation (mm)			Temperature(^{0}C)			Relative humidity (%)		
	1999	2000	2001	1999	2000	2001	1999	2000	2001
January	27.9	47.3	6.8	3.3	-3.4	3	72	79	72
February	86.2	42.6	43.0	3.2	-1.1	4.1	72	77	69
March	54.5	41.4	32.8	6.6	4.5	11.5	63	63	59
April	14.2	75.6	27.3	12.1	13.1	12.6	60	66	61
May	7.3	17.3	110.0	16.9	15.5	14.8	52	59	63
June	35.4	34.6	-	20.0	19.8	21.9	60	60	40
July	44.7	-	2.5	24.4	26.5	26.3	51	37	42
August	31.0	24.4	19.3	23.8	22.8	24.7	52	49	46
September	20.8	4.5	13.0	18.8	18.6	20.8	55	55	46
October	43.3	20.5	1.0	13.9	12.2	13.2	64	65	48
November	31.1	7.4	64.8	6.7	8.7	6.9	68	62	72
December	38.9	31.1	116.9	5.0	2.2	2.5	73	81	79

Table 2. Analysis of variance for number of total and fertile spikelets, grains per spike, grains weight per spike 1000-grain weight and grain protein content in winter wheat varities (mean squares)

Source	Df	Number of total spikelet	Number of fertile spikelet	Grains per spike	Grains weight per spike	1000-Grain weight	Grain protein conten
				1999–2000			
Replication	3	4.68	5.59	33.79	0.02	3.27	0.045
Varieties	1	174.84*	144.07*	2048.00**	4.47*	75.03*	0.047
Error	3	1.77	1.40	15.56	0.01	4.51	0.214
Treatment	3	0.11	0.35	60.41*	0.15*	6.92*	10.68**
VxT	3	0.49	0.73	6.39	0.01	1.23	0.252
Error	18	0.42	0.51	14.95	0.03	2.07	0.146
C.V. %		3.16	3.88	9.09	10.88	3.68	2.86
				2000 - 2001			
Replication	3	0.75	1.37	15.62	0.04	7.07	0.144
Varieties	1	202.50**	69.32**	1195.60**	3.32**	149.64**	0.001
Error	3	0.11	0.63	10.81	0.01	3.03	0.007
Treatment	3	0.31	1.44**	33.93**	0.04*	4.64*	11.271**
VxT	3	0.14	0.61	6.02	0.03	2.75	0.211
Error	18	0.24	0.35	5.64	0.01	1.40	0.112
C.V. %		2.41	3.67	7.34	9.58	3.06	2.45

**p≤ 0.01
*p≤ 0.05

Table 3. Mean values of the traits studied showing statistical significance values in parentheses represent the percent decrease and increase as compared to control*

	Number of Total Spikelet	Number of Fertile Spikelet	Grains Per Spike	Grains weight Per Spike	1000-Grain Weight	Grain Protein Conten
Varieties			1999–2000			
Gerek-79	18.19 b	16.28 b	34.54 b	1.29 b	37.56 b	13.41
Gün-91	22.86 a	20.53 a	50.54 a	2.03 a	40.62 a	13.33
LSD	1.49	1.33	4.42	0.132	2.38	NS
			2000 - 2001			
Gerek-79	17.88 b	14.78 b	26.26 b	0.96 b	36.56 b	13.68
Gün-91	22.91 a	17.73 a	38.49 a	1.60 a	40.88 a	13.67
LSD	0.380	0.894	3.68	0.117	1.95	NS
Treatments			1999–2000			
Control (intact plant)	20.65 a	18.61 a	46.02 a	1.84 a	40.21 a	11.84 d
Flag leaf blade removed	20.41 a	18.12 a	40.13 b (12.8)	1.22 c (34.0)	30.50 c (24.0)	14.54 a (2.7)
2nd upper leaf blade removed	20.61 a	18.51 a	43.45 ab (5.5)	1.68 ab (8.7)	38.61 b (4.0)	13.22 c (1.4)
Awneds removed	20.45 a	18.38 a	40.56 b (11.9)	1.60 b (13.1)	39.45ab (1.9)	13.89 b (2.1)
LSD	0.68	0.75	4.06	0.19	1.51	0.401
Treatments			2000 - 2001			
Control (intact plant)	20.50 a	16.85 a	34.93 a	1.37 a	39.81 a	12.08 d
Flag leaf blade removed	20.33 a	15.93 b (5.5)	30.63 c (12.4)	0.95 c (31.0)	30.6 c (23.0)	14.90 a (2.8)
2nd upper leaf blade removed	20.60 a	16.28 ab (3.4)	33.16 ab (5.1)	1.31 ab (4.4)	38.06 b (4.4)	13.65 c (1.6)
Awneds removed	20.15 a	15.96 b (5.3)	30.78 bc (11.9)	1.25 ab (8.8)	38.63 ab(3.0)	14.09 b (2.0)
LSD	0.51	0.62	2.49	0.12	1.24	0.351

*) Mean values assinged with the same letter are statistically in significant

At the heading; while the flag leaf, the second upper leaf blade and awneds removal reduces 1000- grains weight at the proportion of 1.9- 24 %, it increases the proportion of grain protein. This increase was approximately 2.8 % in the flag leaf removed plants and 1.5 % in the awneds removed plants and 2 % in the second upper leaf blade removed (Table 3). Results were similar to the results of Mahmood et al (1991) who declared that flag leaf removal at heading, reduced the thousand kernel weight by 11.2% and increased the grain protein content by 1.70%. It is pointed out while the flag leaf removal was reducing grains per spike, the weight of a thousand grains and the yield, it significantly increases grain protein content and there is a positive correlation between the weight of a thousand grains and grain yield and a negative correlation between the grain protein content and grain yield (Chowdhry et al.1999).

As a result, the flag leaf, the awned and the second upper leaf blade are the most important photosynthesis organs of the plant and approximately half of the dry material which is accumulated by the grain is obtained by these organs. How much dry material will be stored in the grain by these organs is dependent on the genetic structure of the variety and the environmental conditions.

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Correspodence address:
Melahat AVCI BİRSİN
Ankara University, Faculty of Agriculture,
Department of Field Crops-Ankara
Phone: + 90 312 596 12 63
e-mail: mbirsin@yahoo.com