J. Agric. Sci. Mansoura Univ., 25 (10): 5973 - 5979, 2000.

CONTRIBUTION OF FLAG LEAF AREA IN YIELD OF SOME WHEAT GENOTYPES

Salama, S. M.; Samia G. A. Mouhamed and Samiha A. H. Ouda
Central Laboratory for Experimental Design and Statistical Analysis Agricultural Research Center, Giza, Egypt

ABSTRACT

From plant breeding point of view, it is important to identify several characters, where plant breeder can use to perform early selection for yield. One of these characters is the area of flag leaf. The objective of this research was to study the contribution of flag leaf dimensions in plant yield of six wheat genotypes that were planted at Tag El-Ezz Research Station, Dakhlia Governorate during the two growing seasons of 1998/99 and 1999/00. Flag leaf length, and width were measured in three dates and used to calculate the area. Simple correlation coefficients and path coefficient analyses were used in addition to stepwise multiple linear regression. The results showed that the area of the flag leaf had higher correlation with the yield of the main spike, and grain number per main spike for 5 of the 6 genotypes. Either flag leaf area or any of its two components has the most prominent direct and indirect effects on the yield of the main spike for all genotypes. The area was the most important predictor for grain number per main spike for four genotypes. Whereas, the length was an important predictor in 2 genotypes. Over all the genotypes, flag leaf width seemed to be the most important predictor for yield of main spike.

INTRODUCTION

Leaf area influences both plant growth and final yield by determining the percentage of solar radiation intercepted by the plant. In wheat, flag leaf is the last to be emerged from shoot apex, and the last to be senescence (MacMaster, 1996). The importance of flag leaf is arisen from the fact that the amount of assimilate partitioning from it to grain increased as grain filling progressed (Gardner *et al*., 1985). Flag leaf area was significantly correlated with grain weight per plant, and 1000-grain weight (Talwar and Chadrappa, 1983). In addition, larger flag leaf area appeared to be associated with higher grain yield (Spagonlletti and Qualset, 1990). On the other hand, flag leaf removal after anthesis significantly reduced grain yield (Sen and Parasad, 1996). From plant breeding point of view, it is important to identify several characters, where plant breeder can use to perform early selection for yield. One of these characters is the area of flag leaf.

Many statistical procedures could be used to examine the direct and indirect contribution of yield component variables, such as simple correlation coefficients (Kim and Gary, 1985) and path coefficients analyses (Dewey and Lu, 1959). In addition, stepwise multiple linear regression could be used to determine the best prediction equation for yield by computing sequence of regression equations and adding one variable to the equation, which is the one that reduce the error mean squares (Draper and Smith 1966). The objective of this research was to study the contribution of flag leaf dimensions in plant yield of six wheat genotypes.

MATERIALS AND METHODS

Six wheat genotypes were planted at Tag El-Ezz Research Station, Dakhlia Governorate during 1998/99 and 1999/00 growing seasons. These genotypes were: Gemmeiza 3 (G3), Giza 155 (G155), Giza 157 (G157), Giza 160 (G160), Giza 163 (G163), and Giza 165 (G165). Sowing date was 5th of November in both seasons. A complete randomized blocks design with three replications was used. Plot was 6 m^2 with 15 rows. Each row was 2.0 m. length. Plant population was 400 plant/m^2. The optimum agricultural practices were performed. Flag leaf length, and width were measured in three dates (137, 144, and 151 days after planting) from five boarded plants and used to calculate flag leaf area according to MacMaster (1996) as follows:

$$\text{Leaf Area } (A, cm^2) = \text{Length } (L, cm) * \text{Width } (W, cm) * 0.74$$

Grain yield per main spike, grain number per spike, and weight of 1000-grain for the five plants were also recorded. The relationship between flag leaf length (L), width (W), and area (A) (Y's, each as dependent variable) and grain weight of main spike(GW), grain number per main spike (GN), and weight of 1000-grain (W1000) were studied by finding the simple correlation (Senedicor, and Cochran, 1980). Furthermore, path coefficient analysis (Dewey and Lu, 1959) and multiple linear regression analyses (Draper and Smith, 1966) were performed.

RESULTS AND DISCUSSION

The results in Table (1) showed the degree of association between flag leaf length and the yield of the main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) ignoring other factors i. e. correlation coefficients.

Table 1: Correlation coefficients between flag leaf length (L), and yield of main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) for six wheat genotypes planted in 1998/99 and 1999/00 seasons.

Genotype	GW	GN	W1000
G3	0.52439**	0.72457**	-0.27526
G155	0.67959**	0.64771**	0.00635
G157	0.42625**	0.28585	0.16143
G160	0.48684**	0.12141	0.23616
G163	0.52155**	0.24831	-0.11968
G165	-0.25402	-0.64410**	0.48300**

*** and ** Significant at 0.05 and 0.01 level of significance, respectively**

The association between flag leaf length and the yield of the main spike was positively significant for all genotypes except for Giza 165. Concerning grain number per main spike, the association between it and flag leaf length was positively significant for Gemaza 3 and Giza 155. Furthermore, it was positively significant for weight of 1000-grain for Giza 165.

Table 2 showed the degree of association between flag leaf width and the yield of the main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) ignoring other factors i. e. simple correlation coefficients. The association between flag leaf width and the yield of the main spike was positively significant for all genotypes except for Giza 157 and Giza 160. For grain number per main spike, the association between it and flag leaf length was positively significant for Giza 160 and Giza 165. Furthermore, it was negatively significant for weight of 1000-grain for Giza 165.

The results of Table 3 revealed the degrees of association between flag leaf area and the yield of the main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) ignoring other factors i. e. simple correlation coefficients. The association between flag leaf area and the yield of the main spike was positively significant for all genotypes except for Giza 157. For grain number per main spike, the association between it and flag leaf length was positively significant for all genotypes, except for Giza 157. Furthermore, it was negatively significant for weight of 1000-grain for Gemaza 3. There is a negative relationship between grain number and the weight of 1000-grain (MacMaster, 1996), where the increasing in grain number correlated with decreasing the weight of 1000-grain and vise versa (Table 1, 2, and 3). It was also regarded from these three tables, when either flag leaf length or width is significant that causes the area to be significant for all genotypes. These results were in agreement with Spagnoletti and Qualset (1990).

Table 2: Correlation coefficients between flag leaf width (W), and yield of main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) six wheat genotypes planted in 1998/99 and 1999/00 seasons.

Genotype	GW	GN	W1000
G3	0.40529**	0.09773	-0.10345
G155	0.50792**	0.14602	0.12474
G157	-0.15724	-0.22297	0.30060
G160	0.24346	0.33291*	-0.01123
G163	0.45351**	0.	-0.
G165	0.82260**	0.74164**	-0.32839*

*** and ** Significant at 0.05 and 0.01 level of significance, respectively**

Of the three predictors: length, width, and area of the flag leaf, the area has higher correlation with the yield of the main spike, and grain number per main spike for five of the six genotypes. From Tables 1, 2, and 3, it could be also concluded that the yield of main spike, and grain number per main spike were more correlated with flag leaf dimensions than the weight of 1000-grain.

Table 3: Correlation coefficients between flag leaf area (A), and yield of main spike (GW), grain number per main spike (GN), and weight of 1000-grain (W1000) six wheat genotypes planted in 1998/99 and 1999/00 seasons.

Genotype	GW	GN	W1000
G3	0.60884**	0.61086**	-0.32832**
G155	0.83758**	0.52671**	0.04463
G157	0.24250	0.15769	-0.05254
G160	0.65888**	0.49004**	0.01572
G163	0.84169**	0.54510**	-0.29501
G165	0.78960**	0.38640**	-0.01658

**** Significant at 0.01 level of significance**

Path coefficient analyses were used in this study to estimate the direct and indirect contribution of yield components (Dewey and Lu, 1959). Tables 4, and Table 5 showed that either flag leaf area or any of its components has the most prominent direct and indirect effect on the yield of the main spike for all genotypes, except for Giza 157, with relative contribution values ranged between 2.10-51.67% for direct effect and were between 0.29-15.56% for indirect effect. These results also indicated that the total contribution of the yield of the main spike due to the studied yield components ranged from 23.70 to 89.61% for the six genotypes. The residual values ranged from 10.39 to 73.82%, which account for either the studied yield components with negligible effects and/or slight contribution to the yield of the main spike, in addition to unstudied yield components.

Table 4: Direct and indirect contribution of yield components to the yield of the main spike for three wheat genotypes planted in 1998/99 and 1999/00 seasons according to stepwise results.

Source of variation	G3			G155			G157		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
L	-	-	-	-	-	-	5.74	4.97	10.71
W	-	-	-	-	-	-	2.10	0.29	2.39
A	33.44	15.16	48.60	51.67	8.53	60.20	-	-	-
SN	-	-	-	5.09	8.53	13.62	7.19	15.07	22.26
W1000	17.47	0.71	18.18	-	-	-	35.97	18.28	54.25
Total	50.91	15.87	66.78	56.76	17.06	73.82	51.97	38.61	89.61
Residual	49.09	84.13	33.22	43.24	82.94	26.18	49.00	61.39	10.39

For each genotype and over all the genotypes, multiple linear regression and stepwise analyses were estimated to determine the most contributing factors to the yield of main spike (Y). Multiple coefficient of determination (R^2) for full model i.e. the amount of y variability due to all independent variables, was estimated for all genotypes and was compared to R^2 of stepwise analysis (Table 6). The importance of stepwise analysis lays on the fact that it removes multicolinearty between predictor factors. Furthermore, it reduces the number of factors used to predict Y to the number that have the highest partial correlation with the dependent variable (Draper and Smith, 1966).

Table 5: Direct and indirect contribution of yield components in the yield of the main spike for three wheat genotypes planted in 1998/99 and 1999/00 seasons according to stepwise results.

Source of variation	G160			G163			G165		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
L	22.71	0.87	21.56	-	-	-	-	-	-
W	-	-	-	-	-	-	27.85	15.56	43.41
A	-	.	-	39.36	13.45	52.81	14.35	15.56	29.91
SN	-	-	-	8.85	13.30	22.15	-	-	-
W1000	0.20	0.12	0.32	3.13	6.4	9.53	-	-	-
Total	22.91	0.99	23.90	51.34	33.15	84.49	42.2	21.12	73.32
Residual	77.09	99.01	76.10	48.66	66.85	15.51	57.80	68.88	26.68

To obtain accurately precise prediction, coefficient of determination value (R^2) should be close to 1 and standard error of estimates value (SE%) should be near zero (Draper and Smith, 1966). In this experiment, R^2 values for all genotypes were between 0.6676-0.8967 for full model, whereas it was between 0.6476-8961 for stepwise (Table 6). SE% values were calculated by dividing overall standard error of estimates by the mean of dependent variable (Y, the yield of main spike) and were between 2.40-10.99 % for full model, whereas, it was between 2.53-5.85 % for stepwise for all genotypes (Table 6). Both R^2 and SE% values show no significant difference between the full model and stepwise techniques. However, the efficiency of stepwise technique is arisen from the reduction in number of variables in each prediction equation.

Table 6, also showed that flag leaf area was the most important predictor for four genotypes: Gemmeiza 3, Giza 155, Giza 163 and Giza 165, whereas Giza 157, and Giza 160 were the genotypes that flag leaf length was an important predictor for yield of main spike. Generally, it could be concluded that flag leaf area or either one of its components (length or width) was an important predictor for yield of main spike. In addition, over all the genotypes, flag leaf width seemed to be the most important predictor for yield of main spike. This is a physioloically sound conclusion because leaf width is more stable character, where it is less affected with environmental factors compared with the length.

Table 6: Coefficient of determination (R^2) for both full model and stepwise, standard error of estimates (SE%) and linear regression equations with the most contributing factors for six genotypes of wheat planted in 1998/99 and 1999/00 seasons.

Genotype	Full Model			Stepwise		Difference	Regression equation with the most Contributing factors
	R^2	$1-R^2$	SE%	R^2	SE%	$R^2_{Full} - R^2_{step}$	
G3	0.6865	0.3135	0.0460	0.6678	0.0460	0.0187	Y`=0.6975+0.0454A**+0.0193 W1000**
G155	0.7520	0.2480	0.0417	0.7383	0.0404	0.0137	Y`=0.9128+0.0336A**+0.0069 SN
G157	0.8967	0.1033	0.1099	0.8961		0.0006	Y`=2.1756 + 0.0496L** + 0.3054W * +0.0136SN** +0.0423W1000**
G160	0.6676	0.3324	0.0604	0.6494	0.0585	0.0182	Y`=-1.5701+0.0387L**+ 0.0569SN**
G163	0.8770	0.1230	0.0385	0.8449	0.0291	0.0321	Y`=1.6496 + 0.0253A**+0.0075SN* -0.0059W1000
G165	0.7881	0.2119	0.0240	0.7332	0.0253	0.0549	Y`=1.7054 + 0.3675W**+ 0.0171A*
Over all	0.6302	0.3698	0.1047	0.6277	0.1045	0.0025	Y`=1.4335-0.4447W**+0.0242NS** +0.0186W1000**

*** and ** Significant at 0.05 and 0.01 level of significance, respectively**

REFERENCES

Dewey, D. R. and K.H. Lu. 1959. A correlation and path coefficient analysis of vestal wheat grass seed production. Agron. J., 51:515-518.

Draper, N. R., and H. Smith. 1966. Applied Regression Analysis. John Wilay and Sons, Inc. New York. pp. 171-172, 397-402.

Gardner, F. P., R. B. Pearce, and R. L. Michell. 198. Physiology of crop plant. Iowa state University Press. Ames. Iowa. USA. pp. 58-75.

Kim, N. I. and M. P. Gary. 1985. Response of yield attributes of isogenic tall, semidwarf, and doubledwarf winter wheat to nitrogen fertilizer and seeding rates. Department of Agron. Kansas State University.

MacMaster, G. S. 1996. Phonology, development, and growth of wheat (Triticum aestivum L.) shoot apex: A review. Advances in Agron. 59:63-118.

Sen, A., and M. Prasad. 1996. Critical period of flag leaf duration in wheat (Triticum aestivum L.). India. J. of Agric. Sci. 66:599-602.

Sendicor, G. W., and W. G. Cochran. 1980. Statistical Methods. 7th Edition. Iowa State University Press. Ames. Iowa. USA.

Spagnolletti, Z. P., and C. O. Qualset. 1990. Flag leaf variation and the analysis of diversity in durum wheat. Plant Breeding. 105:189-202.

Talwar, S. N., and H. M. Chadrappa. 1983. Flag leaf relationship with yield and ear characters in tetraploid wheat. Madres Agric. J. 70:333-339.

مساهمة مساحة ورقة العلم فى المحصول لبعض التراكيب الوراثية فى القمح

سليمان محمد جمعة سلامة ، سامية جودة عطية محمد، سميحة ابو الفتوح حامد عوده
المعمل المركزى لبحوث التصميم والتحليل الأحصائى - مركز ا لبحوث الزراعية - ا لجيزة - مصر

يعتبر اخذ العديد من الصفات فى الاعتبار عند الدارسة هام جداً من وجهة نظر مربى النبات حيث يستطيع هذا المربى اجراء انتخاب مبكر للمحصول . ويعتبر مساحة ورقة العلم احدى هذة الصفات , وذلك لأنها ترتبط ارتباط معنويا مع وزن حبوب النبات , ووزن ١٠٠٠ حبة .

ويهدف هذا البحث الى دراسة مساهمة ابعاد ورقة العلم فى محصول النبات لسته ترا كيب ورا ثية من القمح والتى زرعت فى محطة البحوث الزراعية بتاج ا لعز بمحافظة الدقهلية , خلال موسمى الزراعة ٩٨ / ١٩٩٩ و ٩٩ / ٢٠٠٠ وتم قياس طول وعرض ورقة العلم فى ثلاثة مواعيد , وذلك لحساب مساحة الورقة وأجرى على البيانات المتحصل عليها تحليل معاملات الارتباط ومعامل المرور , وهذا بالأضا فة الى أجراء تحليل الانحدار الخطى المتعدد والمرحلى لأيجاد افضل معادلة تنبؤ بالمحصول .

وقد واضحت النتائج ا نه هناك ثلاثة متغيرات يمكن استخدامها فى هذا الصدد وهى طول وعرض ومساحة ورقة العلم . ووجد ان مساحة ورقة العلم كا نت أعلى ا رتباط مع محصول السنبلة الرئيسة وعدد الحبوب لهذة السنبلة , وذلك لخمسة ترا كيب وراثية من الستة تحت الدراسة , أ يضا لوحظ أن كل من مساحة ورقة العلم أو أى من المكونين (طول و عرض ورقة العلم) كانوا اكثر أسهاما (كتأ ثير مباشر وغير مباشر) فى محصول السنبلة الرئيسية فى خمسة من التراكيب الورا ثية تحت الدرا سه . و كانت مساحة ورقة العلم اكثر اهميه فى الاسهام فى عدد حبوب السنبلة الرئيسية لاربعة ترا كيب وراثية, بينما كان طول ورقة العلم اهم العوامل مساهمة فى محصول السنبلة الرئيسية لتركيبين ورا ثيين . وقد اظهر سعرض ورقة العلم اهمية ا كبر فى التنبؤ بالمحصول للسنبلة الرئيسية على مستوى جميع الاصناف .