THE ROLE OF CHLOROPHYLL SPRAYING ACCORDING TO THE EVOLUTIONARY STANDARD ZADOKS IN THE GROWTH CHARACTERISTICS OF TWO CULTIVARS OF BREAD WHEAT

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ABSTRACT

A pilot study in the field was conducted within the study station of the Field Crops Department / College of Agricultural Engineering Sciences / University of Baghdad during winter season of 2022-2023 .In order to find out the role of chlorophyll nutrient spraying on some growth traits of two varieties of bread wheat. Using RCBD design. The results showed a significant superiority of the V1 variety in all studied traits such as (Plant height measured in centimeters, number of tillers per square meter, and dry weight flowering100%, "the growth rate of the crop is g.m^2.d^{-1}, the hay yield in "ton .ha^{-1} biological yield ton. ha^{-1}", flag leaf area (cm^2), chlorophyll concentration (SPAD), dry weight flag leaf g. , flag leaf' specific gravity (g.), spike length (cm) which amounted to (100.04 cm, 281.34 g .m^2.d^{-1}, 242 .06 g.m^2.d^{-1}, 5.96 ton. ha, 11.79 ton .ha , 32.68 cm, 48.73 SPAD , 0.131 g. , 0.0039 g. and 12.13 cm). respectively . comparative V2 . chlorophyll nutrient concentrations showed that the level of Ch1 (1500) mg. L^{-1} represented a considerable improvement in most of which comprise the following attributes "plant height cm", "number of tillers m^2", dry weight at flowering 100% g.m^2, "crop growth rate g. m^2.d^{-1}, yield of straw ton. ha., The biological yield ton. ha., flag leaf area (cm), chlorophyll concentrations (SPAD) and spike length (cm) that reached (93.15 cm, 315.00 tillers m^2, 257.08 g.m^2, 1.904 g.m^2, 5.96 ton. ha., 12.85 ton. ha. , 29.30 cm, and 12.07 cm) respectively, compared to the concentrations of Ch2 and Ch3.

Keywords: strategic crop, phonological metrics, developmental scales, photosynthesis.

دور رش الكلوروفيل وفق معيار زادوكس التطوري في صفات النمو لصنفين من حنطة الخبز

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المستخلص

طبقت تجربة حقلية في محطة بحوث قسم المحاصيل الحقلية – كلية علوم الهندسة الزراعية – جامعة بغداد اثناء الموسم الشتوي 2022–2023. بهدف معرفة دور رش مغذي الكلوروفيل على بعض صفات النمو لصنفين من حنطة الخبز. باستعمال تصميم RCBD. اظهرت النتائج تفوق الصنف V1 (k5180 m) معنويا في جميع الصفات (ارتفاع النبات سم، عدد الفروع . م2، الوزن الجاف عند تزهير 100%، معدل نمو المحصول غم .م^2.يوم$^{-1}$، حاصل القش طن. هكتار، الحاصل البيولوجي طن. هكتار، مساحة ورقة العلم (سم)، محتوى الكلوروفيل (SPAD)، الوزن الجاف لورقة العلم (غم)، الوزن النوعي لورقة العلم غرام، طول السنبلة سم) والتي بلغت (100.04 سم، 281.34 غم. م2.يوم–1، 242.06 غم . م2. يوم–1، 5.96 طن. هـ$^{-1}$، 11.79 طن .هكتار، 32.68 سم، 48.73 SPAD، 0.131 غم، 0.0039 غرام و 12.13 سم) بالتتابع قياسا بالصنف V2 (Adinah). أظهرت تراكيز الكلوروفيل ان التركيز Ch1 (1500) ملي غرام لتر –1 تفوقا معنويا في اغلب الصفات التالية (ارتفاع النبات سم، عدد الفروع .م2، الوزن الجاف عند تزهير100% غم .م2، معدل نمو المحصول غم .م^2.يوم$^{-1}$، حاصل القش طن .هكتار، الحاصل البيولوجي طن. هكتار، مساحة ورقة العلم (سم)، محتوى الكلوروفيل (SPAD) وطول السنبلة سم) والتي بلغت قيمها (93.15سم، 315.00 فرع .م2 ، 257.08 غم .م2 ،1.904 غم .م2 ، 5.96 طن .هكتار ،12.85 طن /هكتار، 29.30 سم، و12.07 سم) بالتتابع قياسا بالتراكيز Ch2 وCh3.

الكلمات المفتاحية: محصول استراتيجي، مقاييس مظهرية، مقاييس تطورية، بناء ضوئي.

Received: 14/9/2023, Accepted:27/12/2023

INTRODUCTION

The Earth we live on is described as a green Earth. The reason for its greenness lies at the existence of plants. In fact; plants gain great importance for life and well-being of humanity. It is difficult to imagine that life could exist or arise without absorbing and converting radiation energy into (chemical energy). The continued existence of plants as living organisms depends on their efficiency in capturing, converting, transporting, storing and consuming energy. The sun is the source of all forms of energy in our atmosphere (17). All living organisms also need energy not only for the purpose of growth and reproduction, but also to help sustain life itself. The source of this energy is the chemical energy that available in food, which is the basis for photosynthesis. Through green plants, living organisms have the opportunity to benefit from the energy of sunlight. Photosynthesis is the only process by which organic materials can be made from inorganic materials and some energy can be stored. In any case, photosynthesis is the manufacture of sugar from two simple primary substances: carbon dioxide and water, in the presence of chlorophyll (the green substance in plants) in addition to sunlight as a source of energy. The importance of chlorophyll lies in that it is a photoreceptor that plants cannot do without in the process of photosynthesis. Chlorophyll is also considered a physiological indicator that is widely used in botany research because it is closely linked to the process of photosynthesis in leaves (14). Chlorophyll concentration in plant leaves at a certain stage of its lifecycle and according to its variety and type is a measure of the effectiveness of carbon metabolism, and leaf aging results from the chlorophyll content decrease, followed by a lack of anabolic metabolism. Chlorophyll controls the reduction in the number of dead leaves and is associated with their N content (24). Wheat plant described as a food security compass overseas. In Iraq; economics indicate a noticeable drop in wheat productivity in last decade because of desertification and lack of water (11, 13). As a result; sustainable technologies should be involved to overcome this crisis and manage this crop smartly; such as developing resistant varieties and investing in multipurposing fertilizers (9, 10, 12). The priority in the past few decades has shifted to using clean fertilizers with natural substances and extracts (6). Chlorophyll as a natural compound is one of the desirable addition to any organic fertilizer. Moreover; amino acids reinforce chlorophyll work by their potent bioavailability as a natural source of nitrogen that approved their efficiency by many results on many crops (1). Even more; some vitamins and micronutrients that work as receptors or coenzymes in many plant reactions conducive to supreme results in various plants (30). Leaf area is generally considered an indicator of the photosynthetic system. In light of the above, the role of the photosynthetic system and its importance on the growth, development and survival of the vegetative parts of the plant becomes apparent. It contributes for a longer period to enhance the role of sources and thus sinks, and an attempt to answer some questions: - Knowing the response of the best varieties to chlorophyll nutrient spraying and whether it reflects positively on growth characteristics. Do higher concentrations give the best results or vice versa? What is the contribution rate of chlorophyll nutrient concentrations for both varieties based on the contrast handling for the area of the standard spray in cm^2 and spike length (cm).

MATERIALS AND METHODS

This research was conducted at the field of research affiliated with the College of Agricultural Engineering Sciences - University of Baghdad during the winter season of 2022-2023. with the intention of researching the role of chlorophyll nutrient spraying upon the traits associated with growth of two varieties of wheat according to the scale of Zadoks. The experiment included planting two varieties, the first (1V) = (KM 5180) and the second variety (2V) = (Adinah), for the purpose of testing them with three concentrations of chlorophyll nutrient, except for the comparison (Control), which is (Ch1) = 1500 milligrams per liter, (Ch2 = 3000 milligrams per liter). (Ch3), = 4500 mg/L.The source of chlorophyll nutrient was from CEON Chemical Company (a bio stimulant of chlorophyll function), which is composed of natural chlorophyll extract 40%, 20% amino acids, 22%vitamins, and 2% molybdenum. As measured by area, the

experimental unit was 2 x 2 = 4m^2. Each experimental device included 10 lines. The space between the planting lines was 20 cm for every experimental unit and for all treatments included in the study. Chlorophyll nutrient was sprayed according to the Zadoks developmental growth scale for small grains in two stages (ZGS:13,21) and (ZGS:60). On 1/14/2023 and 3/10/2023, respectively (31). The spraying concentration, according to the manufacture, 250 to 300 grams per 100 liters of water. The experimental had urea fertilizer applied to it. (46%N). Triple super phosphate fertilizer (P2O5%64) was added at 100 kg/ha, given once just before the plants were thinned, and they were fertilized with potassium (K2O). at two growth stages (7).The following growth characteristics (plant height (cm.), number of branches (m.^{2}), dry weight at 100% flowering, crop growth rate (grams per day), straw production ton. ha, The biological yield ton. ha., flag leaf area cm2, chlorophyll content (SPAD), "flag leaf dry weight" (g), 'flag leaf specific gravity' in grams and spike length (cm). The aforementioned traits were calculated, for every individual or object that is part of the experiment beneath the effect of the two reasons of the study, for the purpose of achieving the research goal to know the role of chlorophyll in Wheat's growth characteristics, to reach the best and most comprehensive understanding of the research.

Statistical analysis

The results were analyzed and then the averages were arranged to compare among themselves according to the least significant difference method, according to the factual arrangement Within R.C.B.D. (16).the means were compared using LSD 0.05.

RESULTS AND DISCUSSION

Plant height (cm): Table (1) indicates a significant differences among varieties , chlorophyll concentrations and their interaction. The superiority of the V1 variety by producing highest average of this trait compared to V2 variety, with (100.4 and 88.71) cm receptivity could be due to the fact is responsible for the growth in plant height is related to the nature of the genotype and growth factors, in particular nutrition with the nitrogen (8). While Ch3 exceeded by producing the tallest plants (102.49 cm.) compared to other concentrations ch2, ch1. However, the interaction treatment ch3V1 shows the highest mean (107.88 cm). These results are compatible to the results of (2, 5), The results of Table (3) indicate a positive correlation with the following traits (dry weight.g.m^2 , growth rate of the crop g. m^2 , length of the spike, The straw produced ton. ha^{-1} and biological produced ton. ha^{-1} . the correlation values ("R. = 0.536**, R. = 0.536**,R. = 0.443*, R. = 0.706**, R. = 0.616** and R. = 0.529**)" receptivity.

Table 1. Effect of cultivars and chlorophyll nutrient on wheat growth and productivity traits

Treatment	'Plant height (cm)'	'Number tillers m^2'	'Dry weight' g .m^2	'Crop growth rate g .m^2'	Yield of straw (t/ha)	Biological yield (t/ha)
Cultivars						
V1(KM5180)	**100.4**	**281.34**	**242.06**	**1.793**	**5.96**	**11.79**
V2(Adinah)	**88.71**	**265.27**	**171.19**	**1.268**	**3.20**	**8.52**
LSD(0.05)	**2.69**	**10.967**	**7.494**	**0.0555**	**0.157**	**0.992**
(Chlorophyll m.g^{-1})						
Control	**88.04**	**228.22**	**169.97**	**1.259**	**3.37**	**7.79**
(Ch1)1500	**93.15**	**315.00**	**257.08**	**1.904**	**5.87**	**12.85**
(Ch2)3000	**94.55**	**286.67**	**214.64**	**1.590**	**5.02**	**10.73**
(Ch3)4500	**102.49**	**263.33**	**184.80**	**1.369**	**4.07**	**9.24**
LSD(0.05)	**2.13**	**13.086**	**9.070**	**0.0672**	**0.331**	**1.023**
V1 (Control)	**94.56**	**236.07**	**192.21**	**1.424**	**4.06**	**8.36**
V1(Ch1)	**100.97**	**365.00**	**325.38**	**2.410**	**8.03**	**16.26**
V1(Ch2)	**98.40**	**296.67**	**242.89**	**1.799**	**6.55**	**12.14**
V1(Ch3)	**107.88**	**283.33**	**207.75**	**1.539**	**5.21**	**10.38**
V2 Control)	**81.51**	**220.36**	**147.74**	**1.094**	**2.67**	**7.22**
V2(Ch1)	**85.33**	**265.00**	**188.78**	**1.398**	**3.70**	**9.44**
V2(Ch2)	**90.70**	**276.67**	**186.40**	**1.381**	**3.49**	**9.32**
V2(Ch3)	**97.30**	**243.33**	**161.85**	**1.199**	**2.93**	**8.09**
LSD (0.05) V×Ch.	**2.91**	**16.713**	**11.568**	**0.0857**	**0.434**	**1.329**

Number of tillers m^2

The highest ability to produce shoots is a desirable characteristic in small grain crops, including wheat (4, 20). Table (1) indicates significant differences among study factors and their interaction. V1 among produced significantly the highest number (281.34 tillers.m^2) in comparison to the V2, which had the minimum mean of 265.27 tillers.m^2, with an increases rate of 5.71%. These increases in number of tillers could be due to the variety's tillering ability (3, 19). The first concentration of chlorophyll nutrient (Ch1) was significantly higher than the other concentrations (control, ch2. ch3), with an increases rate of (27.55, 8.99 and 16.39)%, respectively. While the interaction shows the superiority of the treatment between the first concentration and the V1 variety, which gave the highest average compared to the other averages, the percentage increases over the comparison treatment for the V1 variety reached 35.32, and the percent increases relative to the treatment being compared for the V2 variety amounted to 39.73%. The results agree with (20).The correlation analysis findings in Table (3) indicates that "there is a significant positive 'correlation with the following traits (dry weight in g.m^2, crop growth rate in g.m^2, spike length cm.

Dry weight g^2

The findings of Table (1) indicate important variances between the research factors and the interaction among them. The first factor shows that the V1 variety was significantly superior than V2 diversity by producing the highest regular of dry weight, with an increases rate of (29.28%). While the concentrations of the second factor in the research shows that the first concentration (Ch1) was significantly superior than the other concentrations of chlorophyll nutrient, with an increase rate that reached (33.88, 16.51 and 28.12%) to the others concentrations (control, Ch2 and Ch3) respectively. As for the interaction among the research factors, the first (ch1) with V1 gave a significant result compared to the other averages, and the results were similar to (21). The results also indicated a positive significant correlation with the following characteristics (flag leaf area cm, SPAD, and length The spike is cm, The straw produced "ton. ha^{-1} and biological produced ton. ha^{-1}.The correlation values reached (r=0.87, r=0.79, r=0.865, r=0.946 and r=0.963)", ,respectively.

Crop growth rate, g.m^2

Plant growth occurs as a result of cell division, expansion, elongation, and differentiation. All physiological processes accompanying growth depend primarily on the availability of elements, including N, which is essential in the synthesis of the chlorophyll molecule, and the lack of plant dry matter leads to a decrease in plant growth rates and yield (25). The V1 performed noticeably better than the V2, with an increases rate of 29%. The concentrations of the second factor were significantly higher than the concentration (Ch1), as it provided the greatest average in contrast to the averages of the concentrations (Ch2, Ch3 and the control), with an increases rate of (16.49, 28.49 and 33.87%), respectively. The interaction between the research factors, it was significantly superior to the treatments of the V1 variety with the concentration (ch1), giving the highest average 2.410 g.m^2, compared to the averages of the other interactions, and it is similar to the results of others (21 ,22, 23) . The results in Table (3), show that there is positive important connection among the following traits ('plant height cm', number of tillers m^2, 'dry weight' g., flag leaf area cm^2, SPAD, The straw produced a ton. ha^{-1} and biological produced ton. ha^{-1} .The correlation values reached (r= 0.536 , r.= 0.800, r.= 1.000 and r.= 0. 871, r.= 0.793, r.= 0.865, r = 0.946 and r. = 0. 963) , separately.

Straw yield (t/ha)

The findings of the study in Table (1) show variations between the research variables. V1 variety was significantly superior to other varieties, with an increases rate of 46.31%. As for the chlorophyll nutrient concentrations, the (Ch1) concentration was significantly superior, had the highest average compared to the concentrations (Control, Ch2, Ch3), which reached increase rates of (42.59, 14.48, and 30.66%), respectively. the results of (18). The results in Table (3) reveal a positive correlation with the following traits ('plant height cm', a number of tillers m^2, a dry weight g., crop growth rate g^2 d^{-1}, SPAD and spike length cm). The correlation values

reached (r.= 0.616, r.= 0.965, r.= 0.946, r.= 0.732, r.= 0.793 and r.= 0.892) ,separately.

Biological yield (t/ha)

It is a dimension of the overall total of dry matter that a plant produces through its development under the effect of genomic and environmental features, resulting from The distinction between the mechanisms of photosynthesis and respiration. Table (1) shows that there is a significant difference among the research factors and their interaction. V1 variety outperformed significantly compared to the V2 variety, with an increases rate of (27.74%). The results are similar to (3, 26, 28). As for the effect of chlorophyll nutrient concentrations on this trait, the concentration (ch1) was significantly superior, producing the highest average compared to the concentrations (ch2, ch3, and Control), with an increases rate of (16.49%, 28.09%, and 39.38%), respectively. As for the interaction, the variety V1 treatment excelled with ch1 significantly, giving a higher average compared to the other averages. The results of the correlation analysis in Table (3) also shows that there is a strong positive significant correlation with the following traits (plant height cm, number tillers m^2, dry weight g, crop growth rate $g.m^2\ d^{-1}$, SPAD, spike length (cm) and The straw produced ton. ha^{-1} .Which reached correlation values (r= 0.529, r= 0.832, r= 0.963, r= 0.963, r= 0.811 and r= 0.824 and r = 0.824) respectively.

Table 2. Effect of cultivars and chlorophyll nutrient on some vegetative growth traits

Treatment Cultivars	Flag leaf area (cm^2)	Chlorophyll content (Spad unite)	Dry weight flag leaf (g.)	Specific weight flag leaf (g.)	Spike length (cm)
V1(KM5180)	**32.68**	**48.73**	**0.131**	**0.0039**	**12.13**
V2(Adinah)	**31.77**	**42.65**	**0.113**	**0.0035**	**9.17**
LSD(0.05)	**2.465**	**10.702**	**0.0296**	**0.00055**	**1.807**
(Chlorophyll $m.gl^{-1}$)					
Control	**27.25**	**36.42**	**0.088**	**0.0033**	**8.80**
(Ch1)1500	**29.30**	**53.78**	**0.099**	**0.0034**	**12.07**
(Ch2)3000	**36.39**	**52.08**	**0.145**	**0.0039**	**10.98**
(Ch3)4500	**35.96**	**40.47**	**0.154**	**0.0043**	**10.73**
LSD(0.05)	**1.304**	**4.173**	**0.209**	**0.00041**	**1.256**
V1 (Control)	**25.91**	**38.18**	**0.633**	**0.0035**	**9.94**
V1(Ch1)	**29.07**	**63.43**	**0.101**	**0.0035**	**14.08**
V1(Ch2)	**40.53**	**52.08**	**0.173**	**0.0043**	**12.50**
V1(Ch3)	**35.22**	**40.47**	**0.158**	**0.0045**	**12.00**
V2 Control)	**28.58**	**34.66**	**0.090**	**0.0030**	**7.66**
V2(Ch1)	**29.54**	**44.13**	**0.098**	**0.0033**	**10.07**
V2(Ch2)	**32.26**	**46.57**	**0.117**	**0.0036**	**9.47**
V2(Ch3)	**36.71**	**41.70**	**0.150**	**0.0041**	**9.47**
LSD (0.05) V×Ch.	**2.084**	**8.268**	**0.287**	**N.S**	**1.781**

Flag leaf area cm^2

Table (2) shows the presence of significant differences among the research factors and their interaction. V1 cultivar had the highest average (32.68 cm^2) in compare to V2 cultivar, which had the flag leaf area 31.77 cm^2. As for the concentrations, the concentration of ch2 significantly exceeded the concentrations (ch3, ch1, control), with an increase of (25.12 % , 19.48%,35.40%) and it did not differ with ch3 . As for the interaction, the treatment surpassed cultivar V1 with a concentration of ch2, giving the highest average for this trait of 40.53 cm, consistent with the rest of the averages . The results of Table(3) indicate the presences of a significant positive correlation with the attributes (dry weight of the flag paper (cm^2) and specific weight of the flag leaf and the correlation values were (r=0.662** ,r=0.900**) respectively . The results were similar to (29).

Chlorophyll content (Spad unite)

The findings of Table (2) display that there are important changes between the research

factors and their interaction. The first factor shows superiority of cultivar V1 by producing higher average than cultivar V2 with an increase 12.48 %. As for the second factor, Ch1 exceeded by giving the highest average (53.78) compared to the rest of the concentrations Control, Ch3, with an increase of (24.75%, 32.28%) respectively and did not differed with the concentration Ch2. As for the interaction between the factors, v1ch1 exceeded by giving the highest average interaction (3.43) compared to the other averages. The results of Table (3) indicate a positive correlation among those traits (number of tillers m^2, dry weight g. m^2, yield growth rate (g .m^2, d^{-1}) spike length cm , straw yield , Tan. ha. The biological quotient is Tan. Ha. (r=0.057**, r=0.793**, r=0.793**, r=0.670**, r=0.732**, r=0.811**) ,separately.

Dry weight of flag leaf (g)

Plant dry matter is a measure of the efficiency of intercepting light and using it in building the various parts of the plant (17). Table (2) indicates significant differences between the research factors and the interaction between them. cultivar V1 outperformed significantly by giving the highest average compared to cultivar V2, with an increases rate of (47.39%). The results were similar to (15 , 26). As for the second factor, the control treatment was significantly superior to the rest of the concentrations until it did not differ significantly while (ch3, ch2, ch1) with an average of (0.099, 0.145 and 0.154) respectively. The results of the correlation analysis, Table (3), shows that there is a highest, progressive association with the following traits (plant height cm, flag leaf area cm^2, and flag leaf specific gravity, grams r = 0.596, r = 0.900, and r = 0.912**) ,individually.

Specific weight flag leaf (g.)

The dry weight per unit area of the leaf is expressed as $g.cm^2$. This characteristic indicates the thickness of the leaf wall, as the density of the leaf in carrying out the process of photosynthesis increases with its thickness. The results of Table (2) show that there was a significant difference between the varieties and chlorophyll nutrient concentrations, while no significant difference appeared for the interaction between the two factors. As for the chlorophyll nutrient concentrations, it was significantly higher than the Ch3 concentration, giving the highest average for this trait compared to the rest of the concentrations and the comparison, and an increase rate of (9.30, 20.93%, 23.26%) for the concentrations of (Ch2, Ch1 and the comparison) respectively. The results were similar to (28). The results of the correlation that demonstrated in Table (3) show positive, significant correlation with the traits (plant height cm, area of the flag leaf cm2, dry weight of the flag leaf $g.cm^2$), whose correlation values reached (r=0.715**, r=0.662**and r=0.912) ,correspondingly.

Spike length (cm)

The spike is measured a basis and a sink at the same time, as its parts, such as the axis of the spike, the stem, the stem, and the stem, contribute to photosynthesis. Table (2) indicates that there are important differences between the types and concentrations and the interaction between them. The V1 cultivar was meaningfully superior to the V2 cultivar, with an advance rate of (24.40%). The Ch1 concentration was significantly superior, giving the highest average compared to the rest of the concentrations, with percentages of increases reaching (27.09%, 9.03%, 11.10%) for the (Ch3, Ch2, control) concentrations, respectively.The results of the correlation analysis in Table (3) show the presence of a significant correlation with the following traits (plant height cm, number of tillers m^2, dry weight in g, crop growth rate in $g.m^2$.day, SPAD, straw yield in tons/ha and biological yield in tons/ha. And values Correlation amounted to (= 0.706** r, r.=0.659**, r.=0.865**, r.=0.865** r.=0.670, r.=0.892** and r.=0.824) ,correspondingly.

Table 3. Correlation values for some of the studied traits by the influence of varieties and chlorophyll nutrient spray for the 2022-2023 season

traits	Correlations										
	Plant height (cm)	The number of tillers .m^2	Dry weight at flowering 100% (g.m^2)	Crop growth rate g .m2.d-1	Flag leaf area (cm)	Dry weight flag leaf (g.)	Specific weight flag leaf (g.)	SPAD	Spike length (cm)	Straw yield (t/ha)	Biological yield (t/ha)
Plant height (cm)	1										
The number of tillers .m^2	.326	1									
Dry weight at flowering 100% (g.m^2)	.536**	.800**	1								
Crop growth rate g .m2.d-1	.536**	.800**	1.000**	1							
Flag leaf area (cm)	.443*	.211	.035	.035	1						
Dry weight flag leaf (g.)	.596**	.130	.056	.056	.900**	1					
Specific weight flag leaf (g.)	.715**	.079	.116	.116	.662**	.912**	1				
SPAD	.275	.857**	.793**	.793**	.315	.202	.074	1			
Spike length (cm)	.706**	.659**	.865**	.865**	.261	.254	.277	.670**	1		
Straw yield (t/ha)	.616**	.695**	.946**	.946**	.180	.211	.244	.732**	.892**	1	
Biological yield (t/ha)	.529**	.832**	.963**	.963**	.110	.154	.196	.811**	.824**	.937**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

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