

EFFECT OF WATER DEFICIT ON MORPHOLOGICAL CHARACTERS, GRAIN AND STRAW PROTEIN CONTENT IN CULTIVATED BARLEY (*HORDEUM VULGARE L.*)

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المخلص :

تم في هذا البحث دراسة الميزات الزراعية الخاصة بمقاومة الجفاف من الجوانب التالية : المحصول ومكوناته، المحتوى البروتيني، ومعامل الأزوت عند الحصاد في كل من النباتات المسقية والمعرضة للجفاف. وقد تم في هذه الدراسة مقارنة 25 صنف من الشعير 6 منها ذات أصل فرنسي و 7 من أصل سوري وإثنان من أصل جزائري، بالإضافة إلى صنف من القمح الصلب (دورال - فرنسا) و صنف من نوع (ترتيكال - كليركال - فرنسا) وذلك خلال سنتين متتاليتين.

أظهرت النتائج تأثيرا لنقص الماء على أغلب الخصائص الزراعية المدروسة باستثناء وزن الألف حبة في التجارب التي أجريت خلال السنة الثانية. وقد سمحت شروط الإجهاد المائي المعتدل وهي الشروط الخاصة بمنطقة مونبوليه بفرنسا للأصناف ذات الأصل الفرنسي بإعطاء محصول أحسن مقارنة بالأصناف الجزائرية والسورية التي تعتبر أكثر مقاومة للجفاف.

Summary : In this study an attempt is made to study agronomic characters of adaptation to drought in yield and its components, protein content, nitrogen harvest index under dry land and in irrigated conditions : 25 barley varieties (16 of French origin, 7 of Syrian origin and two Algerian varieties), one variety of durum wheat (Durelle, France) and 1 variety of triticale (Clercal, France) were compared during two successive years (1986/87 and 1987/88).

A net effect on most of agronomic characters was noticed, with exception of thousand-kernel weight in the second year trial. The moderate water deficit (conditions of the Montpellier zone, France) allowed French varieties to perform better in both conditions than Algerian and Syrian varieties considered as tolerant to drought.

Keys words : water deficit, irrigation, yield components, harvest index, protein content, nitrogen harvest index.

Résumé : Cette approche synthétique consiste à étudier les caractères agronomiques d'adaptation observés, au rendement (et à ses composantes), la teneur en protéines, l'indice de répartition de l'azote, en conditions sèches et/ou en irrigués : 25 variétés d'orge (16 d'origine françaises, 7 d'origine Syriennes et 2 Algériennes, 1 variété de blé tendre (Frando, France) et 1 variété de Triticale (Clercal, France) ont été comparées pendant deux années (1986/87 et 1987-88). Un effet net sur la plupart des caractères agronomiques étudiés a été observé, à l'exception du poids de mille grains dans l'essai réalisé en 1987/88. Un déficit hydrique modéré (conditions de la zone de Montpellier, France), a permis aux variétés françaises de mieux se comporter dans les deux conditions par rapport aux variétés algériennes et syriennes considérées comme tolérantes à la sécheresse.

Mots clés : déficit hydrique, irrigation, composantes du rendement, indice de récolte, teneur en protéines, indice de répartition de l'azote.

List of abbreviations used in the text

I :	Irrigated
NI :	Non irrigated
GY :	Grain yield
TKW :	Thousand kernel weight
GPC :	Grain protein content
GPY :	Grain protein yield
PH :	Plan height
G/M2 :	Grain number/ m ²
G/S :	Grain number spike
S/M2 :	Spike number/m ²
SPC :	Straw protein content
SPY :	Straw protein yield
SY :	Straw yield
BY :	Biomass yield
NHI :	Nitrogen harvest index
LG :	Lodging
DH :	Days of heading
a, b, c, ab, abc...:	Statistical groups ranked according test of DUNCAN

INTRODUCTION

The level of sensitivity to water deficit exists at all stages of plant development as reported by Weltzien and Srivastava (1981), although it appears that in barley there are several critical stages of sensitivity. The first stage appears at germination (bad stand and low density), the second one coincides with floral initiation, which reduces primordia number per surface unit and reduces tillers number, the third level is at anthesis (reduction of grain number per spike, due to pressure on reproduction efficiency). The fourth critical stage is located at the beginning of the milky stage of the grain and reduces kernel weight.

The few days following flowering are a very sensitive phase for grain number component (Herbert, 1969). For Grignac (1981), water deficit during shooting stage affects spike number and particularly spike fertility (Grignac, 1986). Nutritional troubles induced by the lack of nitrogen and also by low photosynthesis (light and temperature) (Herbert, 1969) can be seen from the decrease in grain number per spikelet, due mainly to abortion.

Jonard (1964), showed an evidence of a negative effect of high evapotranspiration if it stays within a 2 mm per day limit. In contrast, he found a positive correlation between growth speed and grain number per spike. Varlet-Granchet and Pluchard (1986), who worked on bread wheat, found that the number of grain per spike is determined early at shooting stage. Unfavourable conditions during shooting stage affect mainly grain number per spikelet. For Ines and Blackwell (1981), water deficit during the early stage of plant development induces a reduction in spikelet primordia, whereas water deficit late in plant development increases flower and the entire spikelet death. The number of

grain per spike (fertility) depends on the availability of water during the early vegetative phase and during the shooting stage (Thorne et al., 1988). If water deficit occurs after the flowering stage, it induces a decrease of kernel weight and thus yield (Day et al., 1978). The plumpness of the grain depends on receiving photosynthates from green parts of the plant (one to two leaves, the last internode and the spike) and on the translocation of accumulated substances in the rest of the plant (Grignac, 1981). For Thorne (1962), most of the dry matter stored in the grain comes mainly from photoassimilates produced during the post-flowering stage. In general the climatic conditions (water, temperature and evapotranspiration) play an essential role and are a larger contributor to grain filling.

The higher evapotranspiration during the 20 days prior flowering, the lesser the ovary weight is and thus the decrease of grain weight. Chery and Berbigier (1978), showed that translocation of photosynthates can be affected by high temperature (heat) in barley, the results of Geslin and Jonard (1968), indicate that exposure of wheat to 30°C during two days induced shrivelling of the grain, particularly at the milky stage. The grain weight is then the result of the speed and time (duration) of the filling process (Varlet-Granchet and Pluchard, 1986). Remy and Viaux (1983), and Grignac (1981), believe that grain weight during maturity stage is affected by water stress and high temperatures. The effect is as important as the critical water level (stress level) is high and long. It is independent of grain number/m² and grain number/spike (Grignac, 1987).

The decrease in straw height is a common response to water deficit in regions such as north Africa and middle east where the straw

is heavily used in feed stock. The reduction in straw height affect the overall yield of the crop (Ceccarelli, 1987). It seems that straw height in itself has no specific effect on plant water relations (Pepe and Welsh, 1979 ; Holbrook, 1980).

Barley varieties with high grain yield in water deficit conditions are significantly taller than those with short straw (Ceccarelli, 1987). We think that straw height is related to the biomass and consequently to leaf area index (LAI), which in turn has an effect on transpiration.

MATERIEL AND METHODS

Two field trials were set up at the station "génétique et Amélioration des Plantes" of l'INRA at Melgueil in Maugio (10 Km from Montpellier). The soil was clay-sandy low in organic matter (2.07% of DM) and nitrogen (1.19 % of DM).

The sites in Montpellier were characterised by a mild winter and by a considerable winter and spring rainfall and a summer drought accompanied by high temperature at variable dates (table1). Montpellier had a Mediterranean type of weather.

The trials were conducted in irrigated and non-irrigated treatments. Irrigation was applied by sprinkles. In the first trial, 22 varieties of barley were used together with 1 variety of durum wheat (durelle) and 1 variety of bread wheat (Frando) and 1 variety of triticale (clercal). In the second trial the experiment was conducted using 16 varieties of barley. The names and some characteristics of these varieties are presented in table2.

Experimental design

The trials were conducted in a "split plot" design composed of two treatments : irrigated and non-irrigated , each treatment was replicated 3 times. The varieties were distributed randomly, in all the blocks.

Measurements

The observations and measurements made in the two treatments were as follows :

- Lodging : the scale ranging from 1 to 9 (1 : resistant ; 9 : very sensitive) ;
- Mean plant height in cm from the base to the top of the main strand ;
- Heading : in number of days from 1st January to heading ;
- Number of fertil spikes in 1 square meter ;
- grain number harvested in 1 square meter ;
- Samples harvested in 2 linear meters which allowed the calculation of harvest index (the ratio of grain weight harvested and biomass excluding the roots) ;
- Straw weight in (g.h-1) ;
- Thousand kernel weight ;
- Protein content (the estimation was made using an instrument called "Infraanalyser-450 " type "Technicon". The samples were fed into a computer ; and the instrument was calibrated with standard samples analysed by the Kjeldahl method. The results obtained allowed the calculation of protein yield per hectare for the grain and straw as well as the NHI (nitrogen harvest index of the biomass in %) ;
- No diseases and insects problems observed on the two trials.

Harvesting the plots was made with a reaping machine, the grain had a 12 % humidity.

Statistical interpretation

The statistical method used for the interpretation of the data is based on the analysis of variance using a statistical package "SAS".

RESULTS

The trials were conducted in two successive years. For this reason, results common to the two trials will be presented first, then the results of the variables studied only in the second trial.

The different results are presented in tables 3 & 4.

1 - Variables common to the two trials (field trials)

The total means (irrigated & non-irrigated) revealed a highly significant varietal effect ($p=0.00001$) for grain yield/Ha (GY), thousand kernel weight (TKW), days to heading (HD), lodging and grain protein content (GPC). The variety effect was significant for protein yield/Ha (PY/Ha) ($p=0.01$) in both trials.

The analysis of variance revealed highly significant water effect ($p=0.0001$) for GY, plant height (pH), DH, lodging, GPC and TKW for this last variable the effect is less significant during the first trial ($p=0.03$).

On the other hand, the interaction between variety-water effect (tables 3 & 4) is not significant for the variables GY, GPC, GPY, GPY/Ha. For these variables the varieties behave similarly in response to water. The interaction is highly significant for the variables : pH, lodging ; but for DH the effect is significant only in the first trial.

2 - Variables of the second trial only

A variety effect highly significant ($P=0.0001$) (table 3),) was observed for the variables : Grain yield (GY), Thousand kernel weight (TKW), Plant height (PH), Days of heading (DH), Lodging (LG), Grain protein content (GPC), spike number/m² (S/m²), Spike number/m² S/m², Grain number/m² G/m², Grain number/ spike (G/S). The effect was significant for Harvest index (HI) ($P=0.01$), biomass yield/Ha (BY/Ha), NHI in the grain ($P=0.02$). For the variables: SPC, SPY, SY, the effect was not significant.

The analysis of variance also revealed a water effect highly significant ($P=0.0001$) for the variables: Grain yield (GY), Thousand kernel weight (TKW), Plant height (PH), Days of heading (DH), Lodging (LG), Grain protein content (GPC), Grain protein yield (GPY),

Spike number/m², Straw yield/Ha (SY/Ha), biomass yield/Ha (BY/Ha), Harvest index (HI), Nitrogen harvest index (NHI).

On the other hand the effect was not significant for the variables : Grain number/spike G/S, Straw protein content (SPC), Straw protein yield (SPY).

The interaction variety x water effect (table 3) was no significant for the variables Grain yield (GY), Thousand kernel weight (TKW), Grain protein content (GPC), Grain protein yield (GPY), Spike number/m² (S/m²), Grain number/spike (G/S), Straw yield (SY), Biomass/ha (BY), Harvest index (HI), Straw protein yield (SPY). It was significant for the variables Straw protein content (SPC) ($P=0.03$) and Nitrogen harvest index (NHI) ($P=0.0009$). The results for the first trial (tables 5,6,7) and the second trial (8, 9 & 10) of total means per treatment revealed an effect of water on the yield and on yield components and on certain morpho-physiological characteristics of the variety.

For the non-irrigated treatment the Grain yield (GY) was reduced by 34.1 % in the first trial and by 30.9% in the second trial. Straw yield/Ha was also reduced by 16.4 % in the first trial and the biomass by 24.4 % in the second trial.

Concerning the yield components except for the null effect of irrigation on Thousand kernel weight (TKW) ($P=0.85$) during the first trial (in contrast to the second trial where it was reduced by 7.12%), almost all the other yield components were affected by water deficit.

SN/m² was also reduced by 26.9 %. The number of grain/spike (i.e. spike fertility) was reduced by 2.44 % and GN/m² by 49.9 %.

Concerning the morpho-physiological characteristics, the pH in the non-irrigated treat-

ment decreased by 5.2 % and 24.4 % in the first and the second trial respectively.

It was noticed that earliness in the non-irrigated treatment was higher compared to the irrigated treatment by a mean of 1.02 day in the first trial and by a mean of 2 days in the second trial. The HI decreased by 24.4 % during the second trial, for both trials there was higher lodging in the irrigated treatment.

The results concerning the grain and straw nitrogen content shows an increase during the two experiment years for grain protein content (ms/%) under irrigation respectively of 16.7 % and 12.28 % comparing to the non irrigated treatment. Protein content of the irrigated grain was lower than the non-irrigated grain due to the dilution of proteins in a dry matter decreased by the effect of water. In this case, the late irrigation enhance nitrogen absorption from the soil which led to its mobilisation to the grain by a significant amount increasing the content to 13.8 % instead of 11.8 % in non-irrigated conditions. During the two trials, Grain protein yield (GPY)/HA decreased by 42.7 % and 38.8 % respectively in the non-irrigated compared to the irrigated treatment. However, the

Straw protein content (SPC) did not increase in the irrigated treatment while straw yield (SY)/Ha decreased by 11.5 % compared to the controls. A significant water effect was noticed in the varieties.

DISCUSSION

Yield and yield component

The results showed an effect of water on grain yield (GY)/Ha. The reduction was 32.5 % in the non-irrigated treatment content could have been higher if there hadn't been a rainfall during the grain filling period which generally occur in barley in the Montpellier zone between 1/05 and 15/06. The level of rainfall was almost the same in the two years (48.8mm in the first year and 51.2mm in the second year).

evapotranspiration potential during this period is relatively around the mean and a little higher (228.1 mm) in the first year than in the second year (189mm). The positive effect on grain yield was more apparent in the first year, the rapid calculation of difference in evapotranspiration and the quantity of water during the grain filling show that water deficit was higher in the first trial.

PET - (Rainfall + Irrigation) = Water deficit

First year : $228.5 - (48.4 \text{ mm} + 125 \text{ mm}) = 54.7 \text{ mm}$

2nd year : $189.5 - (51.2 \text{ mm} + 115 \text{ mm}) = 23.3 \text{ mm}$

The comparison made using Duncan test (tables 5 to 10) show the presence of differences among varieties inside and between treatments. However, and due to the high number of varieties used in the two trials and since not all the varieties were used in both trials, it will be difficult to discuss the differences in yield of each variety in each

treatment. We preferred the discussion in-groups of varieties.

During the first trial (table 5), French varieties Baraka (a), Alpha (ab), Barberousse (ab), Thibault (ab) and Alaric (ab), Fedora (ab) showed better performance in the non-irrigated treatment. Under irrigation the

original french varieties also showed better performance.

In the second trial (table 8) French varieties Alpha (a), Plaisant (ab), and Jaidor (ab) in both treatments were in the top of the classification. In the dry treatment only the two Algerian varieties (Saïda and Tichedrett) tend to reach the yield of French varieties. This difference in favour of French varieties was not significant. In contrast, Syrian varieties showed a yield significantly lower than those of French origin and a degree lower than those of Algerian origin. This difference is less clear in the first trial with exception of Syrian variety Harmal which stayed always in bottom position of the classification.

It is not surprising that French varieties showed better performance than Algerian and middle east varieties taking into account the amount of rainfall during the grain filling stage (table 1) and due to the fact that French varieties gave a better fertility (GN/spike) and grain number / m². (table 9)

The variety Faiz (Syria/Tunisia) and Harmal (Syria) showed a significantly higher number of spikes/m² than all the varieties tested. In contrast they had the lowest GY/Ha. Ear number/m² is an important yield component in water deficit conditions (Hadjichristodoulou, 1985). It was found in this study that this yield component together with TKW in the conditions of our experiment do not seem to play an important role in the determination of yield potential.

However, spike fertility and grain number/m² seem to favour French varieties in yield.

The absence of rainfall deficit and the mild temperatures (less than 25°C) (table 1) during grain filling stage (May-1st half of June), the

absence of dry winds, average mean potential evapotranspiration during the same period (238 and 185 mm respectively) during the first and second trial, all explain the results obtained in our experiment which show that the effect of water deficit on TKW was null during the first trial since the reduction was only by 7.12 % compared to the controls.

Algerian varieties (Saïda and Tichedrett) (which are late varieties) have a longer grain filling period are significantly higher TKW than the others. The correlation between DH and TKW (table 11) in the non-irrigated treatment was not significant compared to that found in the irrigated treatment. In contrast GN/m² and spike fertility (GN/S) appear to be the most important yield component and seem to contribute most to the elaboration of yield.

In the Montpellier conditions (sub-humid Mediterranean climate) the varieties selected under these climate present a better agronomic expression than varieties originated from the middle east and north Africa region. In contrast, in semi-arid conditions (Algerian high plateaux) and despite low yield potential, Algerian varieties have better performance which is partly due to their lateness and to the size of the grain.

The lack of certain data on water status do not allow us to make definite conclusions on the role played by the variations of water reserves in the plants.

Harvest Index

The total mean of HI in non-irrigated conditions decreased by 24.4 % compared to the irrigated treatment. This reduction was noticed in most varieties while an increase was noticed in other varieties (Rihane and Saïda). Kanemasu, 1983 in his review on HI under water deficit conditions noticed a tendency

towards a reduction in HI in water deficit conditions, this observation agree totally with our results.

The results could be explained by a genotype effect. The vegetative growth may be relatively more sensitive than reproductive growth.

Study of phenotypic correlation between variables

The study of correlation between variables may lead to the full explanation of the effect of water. The results should be treated with prudence because of the random choice of varieties made on the basis of their origin and agronomic performance (yield and drought tolerance).

It should be noted that there is no correlation between the measured yield by mechanical harvest and the biological yield. This situation is due to the lodging, broken spikes and shattering. In the case where samples are taken by hand the risks are minimal.

Our study show the existence of negative correlation (table 11 & 12) between HI & biomass, this correlation is strong in irrigated conditions ($r=0.364^*$). There was no correlation between harvest index (HI) and grain yield in both treatments.

Our results also show that despite the large genotype variations in biomass (grain + straw) in both treatments, harvest index (HI) is widely influenced by yield of the straw with an effect more apparent in non-irrigated conditions.

A negative correlation of $r = -0.420^{**}$ was also found in non-irrigated treatment and $r = -0.428$ in irrigated treatment between GPC & HI during the second trial (table 10).

On the other hand HI was not related to GY in both treatments. Our results agree with those of Chery, 1982.

Harvest index is negatively correlated ($r = -0.358$) in non-irrigated conditions and in

irrigated conditions ($r = -0.273$) with HD which is the classical case in the conditions of Montpellier, i.e. irrigation had favoured the transfer of assimilates to the grain in the late varieties.

We also noted that in the first trial (tables 11&12) the varieties with high straw had a higher yield compared to those with short straw in irrigated conditions ($r = -0.429^{**}$) while in the non-irrigated conditions the correlation was not significant.

Despite what was shown by Gallagher et al. 1975 that reserves in the stem play a role in the elaboration of yield. For Blum, 1988 these reserves in the stem and the capacity of their mobilisation under conditions of water deficit improve HI.

This idea joins that of Gallagher et al. 1975 which show that translocation of reserves contained in the stem towards the grain in unfavourable conditions can increase the weight of the grain by 70 % at the end of the cycle.

For Hsiao, 1973 reserve translocation is the least affected by water deficit than other physiological processes.

Concerning GPC, we observed an effect of water highly significant during the two years while the interaction variety-water effect was not significant.

This may prove that each variety behave differently in non-irrigated and in irrigated conditions.

The correlation between GPC and GY was not significant. GY and GPC were independent despite the fact that a negative correlation between these two parameters is often reported as also shown by the results of McNeal et al. 1972 and Löffler et al. 1985 on wheat.

GPC is negatively correlated with HI in non-irrigated treatment ($r = -0.434^{**}$) and

with irrigated treatment ($r = -0.428^{**}$) (tables 11&12). The changes in dry matter distribution which characterise the yield was attributed to a fall in GPC in non-irrigated as well as in the irrigated conditions.

Nitrogen harvest index (NHI)

NHI in the plant corresponded with the ratio of grain nitrogen and dry matter of the straw. Grain nitrogen come from the remobilization of N accumulated before anthesis in the vegetative parts and from direct assimilation after anthesis (Robin, 1983). From the date of the two treatments (table 9) we noticed a reduction of NHI in non-irrigated conditions.

In general; GPC and NHI were dependent on the mobilisation of sugars in these organs. A significant proportion of nitrogen often indicates a lack of synthesis and translocation of hydrocarbon assimilates.

However, the late nitrogen fertilisation accompanied by a supplemental irrigation led to a significant migration of nitrogen compounds. This explains the positive correlation (although low) $r = 0.271^*$ which links NHI to HI which in turn indicates that the distribution of nitrogen between the straw and the grain depends on partitioning of dry matter.

This correlation was also noticed on wheat grown in non-irrigated conditions (Austin et al. 1977 ; Desai and Bathia , 1978 ; Dubois and Forssati, 1981 ; Ioffler et al. 1985).

NHI was also positively correlated with grain yield/Ha in non-irrigated conditions ($r = 0.298^*$) and in irrigated conditions ($r = 0.518^{***}$).

This indicate that irrigation facilitates N storage in the straw rather than in the grain. In contrast, there was no correlation between NHI & GPC in the irrigated treatment as well as in non-irrigated treatment.

For Chery et al. 1981 a late N fertilisation increase NHI as well as GPY. If water was not a limiting factor, a late N fertilisation allow an important in grain proteins without an effect on grain yield.

If this is true for the first trial, we should notice a higher total mean of GPC in the irrigated treatment despite the slightly higher weight in the non-irrigated treatment (table 10).

We notice that the varieties with higher yield have higher NHI an then an accumulation of nitrogen more important in the grain.

On the other hand, the varieties with higher yield perform better in the usual way and will dilute their nitrogen in an increased amount of grain.

This correlation analysis provides us with a comprehensive information to add to the information obtained from the analysis of variance where we noticed an important transfer of N towards the grain in irrigated conditions. For all the varieties we noticed a positive interaction (variety * water effect) for NHI which confirm the correlation analysis (study).

CONCLUSION

With the exception of TKW especially in the first trial and much less for the second trial all agrophysiological characteristics (variables) were affected by water deficit. Grain yield in non-irrigated conditions decreased by 30 % and 34 % in the first and the second trials respectively compared to control conditions.

It was also noticed that French varieties perform better than middle east and algerian varieties in mild water deficit conditions (zone of Montpellier) despite the fact that these varieties are considered as tolerant to drought. Yield components which seem to favour French varieties are : spike fertility, grain number/m². In addition to the late rainfall during the grain filling stage & mild temperature (>25°C) and medium evapotranspiration potential.

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LEGENDS

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Tableau I : Climatic data of the trial zone for the two trials.

	MONTPELLIER 1986/87		MONTPELLIER 1986/87	
	Rainfall (mm)	Temperature (°C)	Rainfall (mm)	Temperature (°C)
February	149.0	12.0	5.2	14.0
March	40.9	13.1	4.1	15.6
April	27.4	17.7	85.5	17.5
May	30.2	20.7	32.5	21.5
June	18.6	25.3	18.7	25.2
July	30.1	29.1	19.1	28.8

Tableau II : Some characteristics of the varieties used in the trials.

Name / Type	Origin	Spike Type (2 or 6 rows)	Earliness
ALPHA (W)	France	2	Early
PLAISANT (W)	France	6	Early
BELIVIA (W)	France	2	Early
JAIDOR (W)	France	6	Too Early
BARBEROUSSE (W)	France	6	Too Early
FAIZ (S)	Syria /Tunisia	2	Too Early
CYTRIS (S)	France	2	Early
THIBAUT (_ W)	France	6	Early
FEDORA (alt to S)	France	2	Early
SMASH (_ W)	France	6	Too Early
RIHANE(S)	Syria	6	Too Early
TICHIDRETT (S)	Algeria	6	Late
SAIDA(S)	Algeria	4	Late
MATNAN(S)	Syria	6	Late
HARMAL(S)	Syria	2	Late
EXPRESS(_alternative)	France	6	Late
BARAKA (W)	France	2	Late
ALARIC (W)	France	6	Late
SELMAS(S)	Syria	2	Late
SARRAS(S)	Syria	2	Late
CF 359 = CLERIX (S)	France	2	Late
FRANDOC(S)	France	Bread Wheat	Late
DURELLE(S)	France	Durum Wheat	Late
CLERCAL (S)	France	Triticale	Late

(W) : winter, (S) : spring, (alt): alternative

Tableau III : Analysis of variance of the data from the second trial.

Variables	Variety effect		water effect		Interaction Varieties x water effect	
	F	Pr > F	F	Pr > F	F	Pr > F
GY	3,65	0.0002	178,20	0.0001	1,32	0,20
TKW	14,70	0.0001	32.51	0.0001	1.07	0.39
PH	26.68	0.0001	7.93	0.0001	1.75	0.06
DH	132.49	0.0001	67.85	0.0001	2.42	0.007
LG	7.53	0.0001	255.06	0.0001	5.59	0.0001
GPC	8.15	0.0001	89. 15	0.0001	0.92	0.50
GPY	2.53	0.005	247.29	0.0001	1.55	0.115
S/m2	18.89	0.0001	64.84	0.0001	0.82	0.65
G/S	7.65	0.0001	0.01	0.90	0.92	0.54
SY	1.95	0.30	14.75	0.0003	0.57	0.88
BIOMASS	1.82	0.05	51.50	0.0001	0.46	0.95
HI	2.20	0.01	13.97	0.0004	0.97	0.49
SPC	1.62	0.09	0.97	0.32	1.98	0.03
SPY	1.50	0.13	3.07	0.08	1.56	0.14
NHI	2.10	0.02	27.89	0.0001	2.35	0.009

F = *F* calculated *Pr* > *F* = Significance probability value associated to *F* value

Tableau IV : Analysis of variance of the data from the first trial.

Variables	Variety effect		water effect		Interaction Varieties x water effect	
	F	Pr > F	F	Pr > F	F	Pr > F
GY	5.04	0.0001	289.3	0.0001	1.64	0.07
TKW	20.34	0.0001	0.03	0.85	1.62	0.07
PH	46.10	0.0001	9.66	0.0001	3.99	0.0001
DH	12.31	0.0001	2.92	0.09	1.16	0.32
LG	27.56	0.0001	33.85	0.0001	7.34	0.0001
GPC	2.11	0.01	33.85	0.0001	1.23	0.26
GPY	1.61	0.07	148.70	0.0001	0.90	0.60

F = *F* calculated *Pr* > *F* = Significance probability value associated to *F* value

Tableau V : Means per variety for the variables : grain yield and thousand kernel weight in the first trial.

Varieties	Yield (q.ha-1)		TKW (g)	
	Irrigated	Non irrigated	Irrigated	Non irrigated
ALPHA	52.59 bed	40.00 ab	39.70 ghij	40.30 fgghi
PLAISANT	57.03 abc	31.85 cdef	38.20 hij	36.90 ijkl
BELIVIA	55.33 bed	36.30 abcde	44.00 cdefg	45.80 abdc
JAIDOR	55.55 abcde	38.15 abc	40.60 efghi	38.80 hij
BARBEROUSSE	50.37 bcde	40.74 ab	33.20 k	34.20 ki
FAIZ	52.96 bcd	34.44 bcde	40.10 fghij	47.00 abc
CYTRIS	55.33 bcd	38.15 abc	41.80 defghi	42.80 defg
THIBAUT	55.55 abcd	40.00 ab	40.80 efghi	40.60 fgghi
FEDORA	62.22 a	41.11 ab	45.90 abcd	46.90 abc
SMASH	41.85 de	28.89 af	40.10 fghij	38.50 hij
RIHANE	49.63 bcde	35.92 abcde	44.70 cdef	43.90 cdef
TICHEDRETT	37.78 e	29.26 def	46.70 abcd	47.40 abc
MATNAN	54.07 bed	38.15 abc	37.30 ijk	35.40 jkl
SAIDA	43.70 cde	31.11 cdef	50.10 ab	49.00 a
HARMAL	37.78 e	31.48 cdef	42.20 defghi	43.90 cdef
EXPRESS	68.14 a	36.44 abcd	42.60 defgh	41.50 efgh
BARAKA	62.22 ab	43.33 a	48.20 abc	48.20 ab
CF 356	53.33 bed	35.92 abcde	43.00 defgh	44.80 bcde
ALARIC	52.22 bed	40.37 ab	38.58 hij	39.70 ghi
SELMAS	50.37 bcde	31.11 cdef	45.40 bcde	45.90 abcd
SARRAS	49.63 bcde	34.07 bcde	38.30 hij	38.00 hij
FRANDOC (BW)	48.52 bcde	38.15 abc	38.70 jk	34.00 l
CLERCAL (TCL)	44.81 cde	30.74 cdef	35.60 jk	40.60 fgghi
CF 256	44.81 cde	38.15 abc	38.40 hij	40.60 fgghi
DURELLE (DW)	51.48 bcde	26.30 f	50.60 a	44.90 bcde
Mean	51.33	35.60	41.78	41.95
CV%	11.28	8.62	4.93	3.71
F	2.95	4.09	8.77	17.45
Pr F	0.005	0.0005	0.0001	0.0001

F = F calculated Pr > F = Significance probability value associated to F value CV% = Coefficient of variation (%)

Tableau VI : Means per variety for morphological characters in the first trial.

Varieties	ph (cm)		DH		LG
	Irrigated	Non irrigated	Irrigated	Non irrigated	Non irrigated
ALPHA	95.00 e	87.50 degf	116.00 ef	116.50 abc	1.00 c
PLAISANT	105.000 cd	97.50 bc	116.00 ef	115.00 bcd	1.00 c
BELIVIA	105.50 bc	90.00 cdef	115.50 ef	115.00 bcd	2.00 c
JAIDOR	97.50 de	82.50 fghi	111.00 h	113.00 bcde	1.00 c
BARBEROUSSE	97.50 de	85.00 efgh	114.50 fg	112.00 bcde	2.00 c
FAIZ	70.00 gh	70.00 k	107.00 j	107.00 def	1.50 c
CYTRIS	85.00 f	80.00 ghij	108.00 ij	111.00 bcde	2.00 c
THIBAUT	97.50 de	95.00 cd	117.00 de	115.00 bcd	1.00 c
FEDORA	75.00 g	72.50 jk	117.00 de	117.50 abc	2.50 c
SMASH	105.00 cd	90.00 cdef	114.50 fg	115.00 bcd	1.50 c
RIHANE	92.50 e	95.00 cd	105.00 k	107.50 cdef	2.50 c
TICHEDRETT	97.50 de	95.00 cd	113.00 g	113.00 bcde	4.50 b
MATNAN	85.00 f	95.00 efgh	109.50 hi	109.50 cdef	2.00 c
SAIDA	112.50 b	105.00 c	111.00 h	111.00 bcde	7.50 a
HARMAL	65.00 h	75.00 ijk	104.00 k	103.50 ef	1.00 c
EXPRESS	105.00 cd	95.00 cd	115.00 efg	100.50 f	1.50 c
BARAKA	95.00 c	87.50 defg	114.00 fg	112.00 bcde	1.00 c
CF 356	100.00 de	87.50 defg	118.50 cd	116.00 abc	1.50 c
ALARIC	92.50 e	92.50 cde	113.00 g	112.00 bcde	2.50 c
SELMAS	92.50 e	92.50 cde	108.00 ij	108.00 cdef	1.50 c
SARRAS	75.00 g	82.50 fghi	104.00 k	103.50 ef	2.00 c
FRANDOC (BW)	75.00 g	77.50 hijk	120.00 bc	117.50 abc	1.00 c
CLERCAL (TCL)	125.00 a	120.00 a	121.00 b	120.00 ab	2.00 c
CF 256	97.50 de	92.50 cde	115.50 ef	114.50 bcd	2.00 c
DURELLE (DW)	95.00 e	85.00 efgh	125.00 a	125.00 a	1.00 c
Mean	93.60	88.70	113.32	112.34	1.96
CV%	3.49	4.19	0.8	3.69	31.24
F	34.53	15.30	67.35	3.49	10.12
Pr F	0.0001	0.0001	0.0001	0.001	0.0001

F = F calculated Pr > F = Significance probability value associated to F value

Tableau VII : Means per variety of grain protein content (% Dry matter) and grain protein yield in the first trial.

Varieties	G.P.C (% D.M)		G.P.Y (Q/ha)	
	Irrigated	Non irrigated	Irrigated	Non irrigated
ALPHA	12.60 ab	10.95 a	6.65 ab	4.40 a
PLAISANT	12.50 ab	9.75 a	7.15 ab	3.15 ab
BELIVIA	14.25 ab	11.90 a	7.55 a	4.35 a
JAIDOR	12.55 ab	9.45 a	6.95 ab	3.60 ab
BARBEROUSSE	11.10 ab	4.60 b	5.55 ab	2.05 b
FAIZ	13.50 ab	10.60 a	7.15 ab	3.60 ab
CYTRIS	12.85 ab	11.05 a	6.86 ab	4.20 a
THIBAUT	12.55 ab	10.95 a	6.95 ab	4.40 a
FEDORA	12.10 ab	10.90 a	7.50 a	4.50 a
SMASH	12.00 ab	10.75 a	4.95 ab	3.10 ab
RIHANE	13.00 ab	10.00 a	6.50 ab	3.60 ab
TICHEDRETT	13.40 ab	10.35 a	5.05 ab	3.05 ab
MATNAN	13.50 ab	9.00 a	7.30 a	3.75 ab
SAIDA	13.05 ab	10.30 a	5.70 ab	3.20 ab
HARMAL	14.60 ab	11.55 a	5.45 ab	3.65 ab
EXPRESS	10.95 ab	10.60 a	7.50 a	3.90 ab
BARAKA	6.65 c	11.05 a	4.05 b	4.85 a
CF 356	15.00 ab	11.50 a	8.05 a	3.75 ab
ALARIC	13.55 ab	11.25 a	7.05 ab	4.45 a
SELMAS	15.20 a	13.20 a	7.65 a	4.10 a
SARRAS	12.35 ab	10.50 a	6.10 ab	3.60 ab
FRANDOC (BW)	10.65 bc	9.05 a	5.15 ab	3.75 ab
CLERCAL (TCL)	12.20 ab	10.75 a	5.45 ab	3.30 ab
CF 256	14.75	11.30 a	6.60 ab	4.35 a
DURELLE (DW)	10.60 bc	11.80 a	5.50 ab	3.15 ab
Mean	12.66	10.54	6.4	3.75
CV%	14.73	14.56	20.30	20.30
F	2.15	1.77	1.38	1.30
Pr F	0.03	0.08	0.21	0.26

F = F calculated $Pr > F$ = Significance probability value associated to F value

Tableau VIII : Means per variety for the variables : grain yield components in the second trial.

Varieties	GY		TKW		S/M2		G/S		G/M2		SY		BY	
	I	NI	I	NI	I	NI	I	NI	I	NI	I	NI	I	NI
ALPHA	53,32 a	38,27a	42,30bcd	37,93 cdef	941b	573,3bcdg	18,59cde	23,49cd	17316abcd	12299bcd	74,40abc	71,47ab	127,73ab	109,74ab
PLAISANT	50,86 ab	36,29ab	37,26de	35,65 efg	660,0cdef	392,0defg	34,33a	36,66a	22530abc	14443be	87,73abc	63,87ab	138,59ab	100,16ab
JAIDOR	49,38 abc	36,54ab	35,93e	34,70 fgh	810,7bcd	616,0bcde	25,51abcd	27,17abc	19775abcd	16383ab	80,27abc	79,33ab	129,65ab	115,88ab
BELIVIA	49,37abc	28,89def	42,63bc	40cd	901,3bc	632bcd	15,89de	15,70de	14310bcde	9142cd	69,07bc	62,13ab	118,44ab	91,02b
BARBEROUSE	46,90abcd	31,60bcd	35,53e	30,50gh	784bcd	564,3bcdef	29,41abc	34,63ab	23119b	19770a	76abc	70,93ab	122,91ab	102,4ab
FAIZ	46,41abcd	28,14def	37,83cde	31,30gh	1184a	1148a	14,02de	11,08e	15092bcd	12720bcd	69,33bc	67,07ab	115,75ab	95,21b
CYTRIS	46,41abcd	28,39def	39,06bcde	34,96efg	850,7bcd	593,3b	17,82cde	17,11cde	16543abcd	11828bcd	87,73abc	69,2b	134,15ab	97,6ab
THIBAUT	46,41abcd	33,58abcd	41,83bcd	40,06cd	634,7def	440,0cdef	24,49abcd	26,21bed	15946abcd	11446bcd	101,47ab	81,47ab	147,88a	115,05ab
PEDORA	45,42abcd	30,12cde	42,56bc	37,53cdef	836,0bcd	598,7bcdef	32,35ab	18,21cde	25486a	10874bcd	76,80abc	61,33ab	122,23ab	91,46b
ACSAD 176	44,93abcd	24,19ef	39,70bcde	37,70cdef	762,7bcde	538,7cdefg	22,70abcd	23,97cd	17302abcd	12425bcd	89,47c	78,53ab	134,40ab	112,73ab
SMASH	41,97 bcd	26,64def	43,70ab	39,30cde	421,3f	354,7fg	29,22abc	34,92ab	12297d	12396bcd	67,07c	68,53ab	109,04ab	97,17ab
RIHANE	40,98 bcd	29,13de	41,26bcd	41,20be	653,3cdef	386,7efg	25,48abcd	24,74bcd	16610a	9373cd	81,74abc	66,13ab	122,45ab	95,27b
TICHEDRETT	39,50 cd	32,59abcd	43,56ab	44,86ab	519,3ef	357,3fg	29,77abc	23,63cd	15528bcd	8463d	106,67a	78,27ab	146,17a	110,86ab
MATNAN	39,00cd	29,13de	35,60c	31,66gh	909,3be	666,7bc	20,47bcde	18,95cde	186,35cde	12633bcd	82,27abc	59,33b	121,27ab	88,47b
SAIDA	38,02d	35,80abc	47,53a	46,76a	465,3f	552,0g	25,34abcd	24,72bcd	11719d	8890cd	108,13a	94,27a	146,15a	130,00a
HARMAL	37,03d	2,96f	40,16bcde	36,46def	1322a	944,0a	9,51e	10,93e	12594cd	10174cd	101,47ab	64,13ab	138,50ab	87,09b
Mean	44,74	30,89	40,40	37,52	791,43	578,5	23,44	23,29	17197	12078,6	84,95	71,00	129,70	101,89
CV%	12,62	10,37	06,63	06,24	016,73	21,85	28,05	23,80	30,03	24,85	20,35	23,71	13,95	16,79
F	2,11	7,93	4,32	10,16	8,83	8,07	3,29	5,25	1,80	2,25	2,27	0,24	1,72	1,42
Pr F	0,035	0,0001	0,0002	0,0001	0,0001	0,0001	0,002	0,0001	0,07	0,01	0,02	0,63	0,09	0,19

F = F calculated Pr > F = Significance probability value associated to F value CV% = Coefficient of variation (%)

Tableau IX : Means per variety for morphological characters in the second trial.

Varieties	PH		DH		HI		LG	
	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated
ALPHA	93.33 ab	93.33 b	112.00 cf	111.00 de	0.51 ab	0.39 abc	7.00 ab	1.00 b
PAISANT	98.33 a	100.00 a	110.66	110.33 efg	0.48 b	0.44 a	2.00 a	1.00 b
JAIDOR	86.66 bcde	83.33 c	113.00 cd	111.33 de	0.47 b	0.42 ab	6.33ab	1.00 b
BELIVIA	88.33 abcd	76.66 d	111.00 fg	110.66 def	0.47 b	0.37 bed	3.66be	1.00 b
BARBEROUSSE	86.66 bcde	85.00 c	112.00 ef	112.00 ef	0.51 ab	0.44 a	7.33 a	1.00 b
FAIZ	66.66 g	56.66 f	119.00 a	118.00 a	0.47 b	0.37 ab	6.00 b	1.00 b
CYTRIS	80.00 def	75.00 d	118.00 b	115.66 b	0.40 b	0.37 bed	1.00 g	1.00 b
THIBAUT	91.66 abc	90.00 bc	112.00 ef	110.66 def	0.39 b	0.36 cd	7.33 a	1.00 b
FEDORA	76.66 efg	68.33 e	109.00 h	109.33 fg	0.73 a	0.40 abc	2.33 c	1.00 b
ACSAD 176	85.00 bcdef	85.00 c	120.00 a	118.00 a	0.43 b	0.37 bdc	8.66 a	1.00 b
SMASH	90.00 abcd	90.00 bc	111.00 fg	109.00 g	0.44 b	0.42 ab	8.00 a	1.00 b
RIHANE	86.66 bcde	83.33 c	120.00 a	117.66 a	0.46 b	0.37 bcd	7.33 a	1.00 b
TICHEDRETT	98.33 a	105.00 a	114.00 d	113.00 c	0.38 cd	0.33 a	8.33 a	2.66 a
MATNAN	81.66 cdef	75.00 d	115.33 e	115.33 b	0.45 b	0.40 abc	8.66 a	1.00 b
SAIDA	95.00 ab	101.66 a	115.66 c	113.00 c	0.34 b	0.30 c	3.66bc	2.33 a
HARMAL	75.00 fg	56.66 f	120.00 a	118.00 a	0.38 b	0.36 bcd	1.33 c	1.00 b
Mean	86.25	83.22	114.58	113.31	0.45	0.34	5.56	1.87
C.V %	6.93	4.56	0.61	0.61	27.33	7.57	33.10	27.33
F	5.92	34.46	78.00	47.50	1.91	4.52	6.18	6.66
Pr F	0.0001	0.0001	0.0001	0.0001	0.05	0.0002	0.0001	0.0001

F = F calculated Pr > F = Significance probability value associated to F value

Tableau X : Means per variety of qualitative characters of the grain and straw in the second trial.

Varieties	PH		DH		HI		LG		LG	
	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated	Irrigated	Non irrigated
ALPHA	12.44 def	11.30 bc	6.60 abc	4.30 ab	3.26 ab	3.17 d	2.81 ab	2.27 bc	72.86 bc	65.79 a
PAISANT	13.53 bcd	11.66 abc	6.86 ab	4.24 ab	4.60 ab	4.18 abcd	4.21 ab	2.59 abc	63.25 abc	62.21 a
JAIDOR	13.26 bcd	11.16 bc	6.60 abc	4.04 abc	3.85 ab	3.57 bcd	3.17 ab	3.01 abc	68.59 abc	60.11 ab
BELIVIA	14.53 ab	11.93 abc	7.18 a	3.47 bcde	4.95 ab	3.21 d	3.38 ab	&çé c	68.00 abc	64.94 a
BARBEROUSSE	11.53 f	9.60 d	4.40 abc	3.03 de	3.78 ab	2.91 d	2.90 ab	2.06 c	65.92 abc	59.59 ab
FAIZ	13.42 bcd	11.33 bc	6.19 abc	3.19 cde	2.65 b	5.92 a	1.82 ab	3.19 abc	78.45 a	45.17 bc
CYTRIS	14.50 ab	12.90 ab	6.73 abc	3.66 bcd	4.62 ab	5.07 abcd	3.98 ab	3.51 abc	63.12 abc	51.24 abc
THIBAUT	13.56 bcd	11.66 abc	6.28 abc	3.87 abcd	4.33 ab	5.08 abcd	4.46 a	4.11 ab	58.30 bc	49.23 abc
FEDORA	11.01 f	10.63 cd	5.01 c	3.19 cde	5.53 ab	5.39 abc	4.05 ab	3.23 ABC	55.29 c	50.39 abc
ACSAD 176	13.06 bcd	11.33 bc	5.88 abc	2.74 e	5.35 a	5.60 ab	2.78 ab	4.43 a	67.73 abc	38.34 c
SMASH	13.83 bcd	11.39 bc	5.83 abc	3.32 cde	3.83 ab	4.21 abcd	2.61 ab	2.93 abc	70.15 abc	52.90 abc
RIHANE	12.83 cde	12.26 abc	5.23 bc	3.59 bcde	4.74 ab	3.01 ab	3.85 ab	2.07 C	58.19 bc	64.67 a
TICHEDRETT	14.33 abc	12.26 abc	5.66 abc	4.000 abc	2.90 b	3.34 cd	3.03 ab	2.66 abc	65.02 abc	60.91 ab
MATNAN	13.20 bcd	12.56 ab	5.15 c	3.68 cde	3.14 ab	4.97 abcd	2.43 ab	2.86 abc	67.89 abc	55.77 ab
SAIDA	14.26 abc	13.16 a	5.43 abc	4.71 a	4.23 ab	3.69 bcd	4.44 a	3.42 abc	55.09 c	58.39 ab
HARMAL	15.56 a	13.33 a	5.76 abc	3.05 de	4.29 ab	4.51 abcd	4.20 ab	2.89 abc	55.77 bc	51.76 abc
Mean	13.43	11.78	5.94	3.63	4.00	4.24	3.38	2.99	64.92	55.71
C.V %	6.09	7.51	15.14	12.83	31.33	26.04	35.92	33.85	12.97	15.20
F	5.60	3.24	1.52	5.48	1.40	2.26	1.16	1.46	1.66	2.36
Pr F	0.0001	0.002	0.15	0.0001	0.20	0.20	0.34	0.17	0.1	0.01

F = *F* calculated

Pr > *F* = Significance probability value associated to *F* value

Tableau XI : Correlation matrix for the non irrigated treatment in the second trial.

	GY	LG	DH	PH	S/M ²	G/S	TKW	HI	SPC	GPC	GPY	SY	SPY	G/M ²	NHI	BY
GY	-	NS	0.304*	NS	NS	NS	NS	NS	NS	NS	0.795***	-0.246*	NS	NS	0.298*	NS
LG			NS	0.335*	-0.495***	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
DH				-0.385**	-0.357*	-0.468***	NS	-0.358*	NS	0.303*	NS	NS	NS	-0.316*	NS	NS
PH					-0.622***	0.418**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S/M2						-0.598***	-0.346*	NS	NS	NS	NS	NS	NS	NS	NS	NS
G/S							NS	-0.642*	NS	-0.364*	NS	NS	NS	0.675***	NS	NS
TKW								NS	NS	NS	NS	NS	NS	-0.402**	-0.292*	NS
HI									0.326**	-0.428**	NS	-0.522***	NS	0.827**	NS	-0.469***
SPC										NS	NS	NS	0.781***	NS	-0.676***	NS
GPC											NS	NS	NS	-0.452**	NS	NS
GPY												NS	NS	NS	NS	NS
PPQHA													0.553***	NS	-0.893***	0.584***
SPY														NS	-0.893***	0.584***
G/M2															NS	NS
NHI																-0.507***
BY																-

F = F calculated

Pr > F = Significance probability value associated to F value

Tableau XII : Correlation matrix for the irrigated treatment in the second trial.

	GY	LG	DH	PH	S/M ²	G/S	TKW	HI	SPC	GPC	GPY	SY	SPY	G/M ²	NHI	BY
GY	-	NS	0.416**	0.429**	NS	0.315*	NS	NS	NS	NS	0.868***	NS	NS	NS	-0.518***	0.480***
LG			NS	0.504***	NS	NS	0.622***	-0.476***	NS	NS	0.311	0.408	NS	-267	NS	0.426
DH				-0.418	0.469	0.448	-0.272*	-0.272	NS	0.354	NS*	NS	NS	NS	-0.319	NS
PH					0.790***	0.638***	0.529***	NS	-0.380**	NS	0.447**	0.315*	NS	NS	0.322*	0.421**
S/M ²						0.677***	-0.535***	NS	0.332*	NS	NS	NS	NS	NS	-0.352*	NS
G/S							NS	0.446***	-0.278*	NS	NS	NS	NS	-0.668***	NS	NS
TKW								-0.573***	NS	NS	NS	NS	NS	-0.668***	NS	NS
HI									NS	-0.428**	NS	NS	-0.354*	0.549***	0.271*	-0.364*
SPC										NS	NS	NS	0.753***	NS	0.710***	NS
GPC											0.392**	NS	0.265*	-0.318*	NS	NS
GPY											-	NS	NS	NS	0.442**	0.504***
SY												-	0.558***	0.318*	0.387**	0.946***
SPY													-	NS	-0.845***	0.464***
G/M ²														-	NS	0.354*
NHI															-	NS
BY																-

F = F calculated **Pr > F** = Significance probability value associated to F value

Tableau XIII : Correlation matrix for the irrigated treatment of the first trial.

	GY	LG	DH	PH	TKW	GPC	GPY
GY	-	-0.409**	N.S	N.S	N.S	0.347**	0.394***
LG		-	N.S	0.320 **	N.S	N.S	N.S
DH			-	0.458***	N.S	-0.263*	N.S
PH				-	N.S	N.S	N.S
TKW					-	N.S	NS
GPC						-	0.628***
GPY							-

* Significant at $P = 0,05\%$; ** Significant at $P = 0,001\%$; *** Significant at $P = 0,0001\%$; NS = no significant

Tableau XIV : Correlation matrix for the non irrigated treatment of the first trial.

	GY	LG	DH	PH	TKW	GPC	GPY
GY	-	N.S	N.S	N.S	N.S	N.S	0.575***
LG		-	N.S	0.421 **	N.S	N.S	N.S
DH			-	N.S	N.S	N.S	N.S
PH				-	N.S	N.S	N.S
TKW				-	-	0.326*	NS
GPC						-	0.742***
GPY							-

* Significant at $P = 0,05\%$; ** Significant at $P = 0,001\%$; *** Significant at $P = 0,0001\%$; NS = no significant