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Role of the Assimilates of the Stem to the Durum Wheat Yield in the Conditions of Culture of the High Eastern Plains of Algeria

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Abstract: The year effect is significant in semi-arid climate what explains the fluctuation of the conditions of one year growth to another. The yield grain is associated a great quantity of assimilates stored and transferred from the stems for the filling of the grains, the MBB genotype which has an important height of the stem transfers more assimilates. The present study was led on the experimental site of station ITGC of Sétif. The objective is to determine the differences of duration and speed of filling and the contribution of the assimilates of the stems to the yield of 5 durum wheat genotypes (*Triticum durum* Desf.). The genotypes Ads497 and Deraa present sheets standard of great dimension. The beginning of the active phase of the filling of the grain corresponds to the beginning of the foliar senescence. MBB presents rhythm of dry out foliar slower, the speed of dry out stationary recorded by Ads497 is of -0.5957 cm^2 day^{-1}. The speed of filling of the grains is negatively related to the duration of filling. The participation of the assimilates coming from the stem is less and less that the medium allows the expression of a better yield in grain.

Key words: *Triticum durum*, assimilates, yield grain, filling grain, semi-arid

INTRODUCTION

The culture of the durum Wheat in the semi-arid areas is subjected to various abiotic constraints which minimizes in very significant ways the yield grain. The transfer of the soluble sugars stored in the stalk of ear is a factor very reported by several authors and who remains to be checked in the present study. The objective is to determine the differences of duration and speed of filling and the contribution of the assimilates of the stems to the yield of 5 durum wheat genotypes (*Triticum durum* Desf.).

A height of important straw is a desirable characteristic in semi-arid zone. This characteristic is generally related to a system of root able to go in-depth, on a production of more important biomass and on the transfer and storage capacity of the carbonaceous substrates for the completion of the grain (Bahlouli *et al*., 2005).

The quantity of the translate assimilates depends on the operating condition of the conducting vessels, of the capacity of the genotype to use concerning the filling of the grain and the variation of the weight of the grain of its potential following the deficit of the activity of photosynthesis of the after anthesis (Wardlaw, 2002).

Balkema-Boomstra, (1988), mention that the accumulation of sugars during the before anthesis contributes of 13 to 70% of the yield grains, under stress the collar of ear represents a site of storage of the reserves of assimilates which help for a better filling of the grains, these accumulated sugars come from the hydrolysis of the starch reserves of the roots.

The share of the transferred assimilates is relatively marginal in good years to become important at the time of the unfavorable years, when the stress strongly affects the photosynthetic apparatus.

Dakheell *et al*. (1993) mention that the length of the collar of ear was positively correlated with the output grain under stress. They explain why under stress a long collar, though it enters in competition with ear, just after the rise, represents nevertheless a site of storages of the reserves of assimilates produced before the anthesis and that the plant makes profitable to help with a better completion of the filling of the grain under hydrous and thermal stress.

The yield in grains, under rain farming systems and constraining environments, is the resultant of the duration, the speed of filling and of the capacity of translocation of the assimilates stored in the stem Under such conditions of production, the duration of filling and consequently the weight of the grain seldom their maximum values reach, from where a fall of the yield grains (Abbassenne *et al*., 1998).

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MATERIALS AND METHODS

Installation of the experimentation: The experimentation was led on the experimental site of station ITGC of Sétif (Algeria), on five varieties of durum wheat. The test is set up in a device in randomized blocks, with four repetitions and out of three consecutive crop years 2000/01 to 2002/03. The farming precedent is an integral fallow. The varieties concerned with the study are Mohammed Ben Bachir, Waha, Derraa, Heider and 439/ADS-97, Waha is a line selected in 1984 jointly by the ITGC (Algeria) and ICARDA (International Center of the Agronomic Research and Development in Arid region, Syria). Derraa and Heider are advanced lines resulting from selections made in 1997 inside seedbeds of observations received from ICARDA by Station ITGC of Sétif. 439/ADS-97 is an introduced fixed line of Italy (Bouzerzour *et al*., 2000).

Follow-up and Notations: The notations related to, the date of realization of the spike stage, the Duration of the Vegetative Phase (DVP), the dry matter is obtained after passage to the drying oven with 85°C during 24 h. The difference between the weight of the total dry matter of the sample and that of seeds is taken as being the weight of the dry matter accumulated in the stems. The Speed of Vegetative Growth (SVG). With maturity one determines the yield grains, the produced total biomass, the index of harvest and the height of thatch. The speed of filling grain (S, mg day) is estimated by linear regression. Duration of filling (D, day). The speed of filling brought back to the number of grains m^{-2} (SFG, g day m^{-2}). The dry matter accumulated in the stems was given with the spike stage, its maximum and maturity. The quantity of dry matter of the stems transferred towards the grain is estimated by the difference between the maximum weights of the dry matter accumulated in the stems (g m^{-2}) less the weight of the measured dry matter of the stems at maturity (g m^{-2}).

It is then relatives compared to the yield grain m^{-2} and the average weight of a grain:

$$T\,(\%GY) = 100(T/GY)$$

$$T\,(\%P1G) = 100[(10000T/NGM^2)/P1G]$$

The speed of the foliar senescence (Sfs, cm^2 day^{-1}) was given at the time of marketing year 2002/03. It is estimated by regression of green surface over the time, counted in days calendar starting from the date of spike stage. The Duration (Dfs) of the green surface of the sheet standard is calculated by the ratio of green surface (GS, cm^2) at the spike stage divided by the speed of drying (Sfs, cm^2 day^{-1}):

$$Dfs\,(d) = GS/S\,fs$$

Soluble sugars of the collar were given at the spike stage. Two hundred dry matter mg of the collar of ear are fixed in 10 mL absolute ethanol during 60 min. One adds to the various treated test tubes 3.5 mL of distilled water. One place the various tubes closed well, during 2 h, in a Marie bath in the temperature was carried as a preliminary to 65°C.

After treatment the temperature, one leaves the tubes with the darkness during 48 h then one makes react the extract with the sulphuric acid solution and the anthrone during 8 min to 92°C. Then one carries out the reading of the absorptance to the spectrometer with 528 nm, with ethanol like witness.

The readings obtained are then represented into μg mL^{-1} of solution, by using the calibration curve, are established following reading of the absorptance of the solutions of known concentrations of glucose variable from 5 to 50 μg mL^{-1} of solution (Brinis, 1995).

Analyze data an analysis: The variance two not controlled criteria of classification, environment and genotype, (Table 1) was made for the variables measured on the various repetitions. The model adopted in the analysis is the additive model (Steel and Torrie, 1982):

$$Y_{ijk} = \mu + E_i + G_j + GxE_{ij} + B(E)_{jk} + e_{ijk}$$

Y_{ijk} = Is the value measured in environment i, on the genotype j, of the block k, for a given character.

μ = Is the general average of the character measured on i environments, the j genotypes and k blocks.

E_i = Is the effect of the environment I

Gj = Is the effect of the genotype j

GxEij = Is the interaction between the genotype j and the environment i

B(E)jk = Is the effect of the blocks k, hierarchical with environments I

eijk = Is residual model

Table 1: Skeleton of the table of the analysis of the variance adopted in the study of the interaction genotype×environment (McIntosh, 1983)

Source of variation	df	Average hopes
Environment (E)	E-1	$\sigma^2_e + r\sigma^2_{GxE} + G\sigma^2_{B/E} + rG\sigma^2_E$
Blocs/E (B/E)	E(r-1)	$\sigma^2_e + G\sigma^2_{B/E}$
Genotypes (G)	(G) G-1	$\sigma^2_e + r\sigma^2_{GxE} + rE\sigma^2_G$
GxE	(G-1) (E-1)	$\sigma^2_e + r\sigma^2_{GxE}$
Residual	E(r-1) (G-1)	σ^2_e

G, B/E, E, r = respectively a nnmber of genotypes, blocks hierarchical with the environments, environments and repetitions

RESULTS AND DISCUSSION

The analysis of the variance of the measured variables indicates a significant year effect which explains an important part of the variation available in the data subjected to the analysis (Table 2). This effect highlights the influence of the fluctuations of the conditions of growth of one countryside at the other and the differences in sensitivity with respect to these fluctuations exteriorized by the evaluated genotypes.

Marketing year 2000/01 was more favorable to the expression of the yield grain, of the number of ears m^2, the grains m^2 and the fertility of ears but not of the weight of 1000 grains. There were a greater quantity of assimilates transferred associated a shorter duration from the vegetative phase, a speed of more reduced vegetative growth and a better index of harvest. Few differences for the height of thatch appear between the years (Table 3).

Year 2001/02 was more unfavorable in particular for the yield grain. The speed of vegetative growth was higher but the weakness of the index of harvest indicates that the biomass accumulated at the spike stage was not indeed developed in the form of grains following the effect of the intense stresses acting as after anthesis and who have especially affected the number of grains per ear (Table 3).

The average response of the genotypes to the conditions of growth of marketing year 2002/03 was near to that of marketing year 2001/02. The averages observed are very similar except for the duration of the vegetative phase which was longer 5 days (Table 3).

The effect average genotype, tested compared to the variance of interaction, is significant only for the weight of 1000 grains and the duration of the vegetative phase.

Table 2: Analyzes variance of the yield, components and translate quantities of dry matter

Source of variation	df	GY	NE	NGE	WTG	$NGM^2 \times 10^3$
Year	2	156303.8**	32951.2**	517.8**	276.1**	127243.5**
Genotype	4	3385.0ns	20230.9ns	47.6ns	72.2*	2474.6ns
G x A	8	4876.2**	10630.9**	33.9**	13.8ns	3186.7**
Error	28	1021.1	1863.0	6.3	12.9	237.3
Source of variation	**df**	**T**	**DVP**	**HT**	**SVG**	**IH**
Year	2	7235.8**	111.8**	16.5ns	26.3**	1846.9**
Genotype	4	297.0ns	75.6**	121.9ns	1.4ns	25.4ns
G x A	8	276.9**	46.5ns	102.3**	1.2**	56.9**
Error	28	66.1	35.8	26.8	0.8	12.6
Year	2	7235.8**	111.8**	16.5ns	26.3**	1846.9**
Genotype	4	297.0ns	75.6**	121.9ns	1.4ns	25.4ns
G x A	8	276.9**	46.5ns	102.3**	1.2**	56.9**
Error	28	66.1	35.8	26.8	0.8	12.6

GY = Grain Yield (g m^{-2}), NE = Number of ears m^{-2}, NGE = Number of grains/ear, WTG = weight of 1000 grains, NGM2 = Number of Grains/m2, T = quantity of dry matter transferred from the stems (g m^{-2}), DVP = duration of the vegetative phase (d), HT = height of thatch (cm), SVG = speed of vegetative growth (g day^{-1} m^{-2}), IH = index of harvest. * and ** significant coefficient at 5 and 1%, respectively level probability. ns = no significant

For the other characters the importance of the variance of interaction makes no significant the effect average genotype and thus the differences between genotypes must be approached by countryside (Table 3).

Waha presents the best yield grain into 2000/01. This performance is associated the rise of a great number of ears m^2 leading to a number of grains m^2 and an index of harvest high. Ads makes a success of a good fertility ear, Heider the best PMG and MBB the greatest quantity of assimilates translate (Table 3).

Heider gives the best yield grain during the consecutive second and third year. These performances are associated an improvement of the three components, ears m^{-2}, grains ear^{-1}, weight of 1000 grains and the capacity of translocation but with an index of similar harvest to that of the other genotypes (Table 3).

The increase in the yield grain of this genotype is proportional to that of the air biomass leading to little variation of the index of harvest. From the point of view lasted of the vegetative phase and for the three campaigns, Ads and Waha are earlier, Derraa is intermediate and Heider and MBB are later.

The height of thatch is with the advantage of MBB and Heider. Ads and Waha are shorter and Derraa is serious intermediate. The values taken by the vegetative growth rate and the speed of filling of the grain vary according to the genotypes and years (Table 3 and 4).

During March until June, which coincides with the phase of enlargement of the grain, the quantity of rain fallen for this period is more important during marketing years 2000/2001 and 2002/2003. The sugar rate accumulated in the collar of ear follows the same pattern, it increases also on average these three campaigns with 204, 1 μg mL^{-1} for marketing year 2000/2001, 264,4 μg mL^{-1} for marketing year 2001/2002 and 303,6 μg mL^{-1} for marketing year 2002/2003. The accumulated sugar rate is increasingly important when the medium is relatively lenient (Table 3).

The same idea persists, each genotype improves its rate of sugar transferred from marketing year 2000/2001 to 2002/2003; this behavior genotypic is thus general, the plant answers the improvement of the medium by increasing its transferred sugar rate. Heider and MBB show a sugar rate higher than the three other genotypes for the three campaigns (Table 3).

The level of the starch and the fructose of ear and the sheets is prone to rapids flow during the filling. The starch and the fructose are carbohydrates of storage. The starch is stored in the chloroplasts whereas the fructoses are stored in the foliar sheaths and ear. The accumulation of these two polysaccharide shapes is suggestive of a high activity of clear photosynthesis (Judel and Mengel,

Table 3: Average Effect year and interaction genotype x year of the yield, the components and the translate quantities of dry matter

Effect	GY	NE	NGE	WTG	NGM^2	T	DVP	HT	SVG	IH	Sug
Effect year											
2000/01	352.1	416.7	22.7	38.4	9197.0	98.9	118.0	65.5	5.1	36.9	204.1
2001/02	168.6	359.6	12.3	38.8	4344.4	59.0	117.4	63.5	7.7	15.8	264.4
2002/03	182.7	323.8	12.8	46.0	3980.2	62.7	122.4	64.5	6.0	20.5	303.6
Genotype×Year											
2000/01											
ADS	359.0	325.0	30.8	35.8	10014.3	89.8	114.7	56.0	4.9	38.7	196
Waha	431.7	533.7	21.6	37.5	11512.4	100.8	114.3	66.6	4.6	44.9	142
Derraa	284.3	391.7	19.2	37.8	7513.7	90.1	119.7	65.0	5.2	31.8	212
Heider	356.3	351.7	25.0	40.9	8784.9	101.8	120.0	66.7	5.6	34.9	240
MBB	326.0	481.6	17.0	39.9	8160.1	111.9	121.3	73.3	5.2	34.4	261
2001/02											
ADS	161.3	293.3	13.6	40.4	3993.1	59.1	115.3	59.0	6.4	17.9	276
Waha	149.7	350.0	12.5	34.6	4318.9	58.9	115.0	61.3	7.9	14.2	158
Derraa	179.9	370.0	13.4	36.9	4867.2	62.9	116.3	58.8	7.4	16.7	213
Heider	204.6	428.3	11.0	43.6	4695.5	60.1	120.3	64.6	8.2	17.7	387
MBB	147.4	356.6	10.9	38.4	3846.9	53.8	120.3	73.3	8.7	12.5	288
2002/03											
ADS	140.5	295.2	11.5	42.3	3322.7	45.9	120.0	53.3	6.3	15.5	210
Waha	180.9	390.4	10.9	42.7	4244.1	60.9	120.0	57.6	6.4	20.1	256
Derraa	216.2	347.6	13.2	47.1	4593.9	71.3	123.0	64.5	5.1	25.7	299
Heider	204.9	233.3	17.4	52.6	3967.6	80.7	124.0	67.3	5.5	22.6	357
MBB	171.4	352.4	11.1	45.4	3967.6	54.9	124.0	70.6	6.7	18.6	396
MG	234.5	366.7	15.9	41.1	3772.5	75.5	119.3	64.5	6.3	24.4	257
Ppds5%	30.1	40.7	2.3	3.4	459.3	7.7	4.7	4.8	0.8	3.3	

GY = Grain Yield (g m^{-2}), NE = Number of ears m^2, NGE = Number of grains ear $^{-1}$, WTC = weight of 1000 grains, NGM^2 = Number of grains m^2, T = quantity of dry matter transferred from the stems (g m^{-2}), DVP = duration of the vegetative phase (d), HT= height of thatch (cm), SVG = speed of vegetative growth (g day^{-1} m^{-2}), IH = index of harvest (%). sug = sugar (µg mL^{-1})

Table 4: Duration (D) and speeds of filling of the grain (S) and the grains m^2 (SFG)

Season	2000/01			2001/02			2002/03		
Genotype	S±Et	SFG	D	S±Et	SFG	D	S±Et	SFG	D
ADS	1.84±0.05	21.18	19.4	1.59±0.10	6.87	20.7	1.44±0.08	6.16	28.2
Waha	1.94±0.04	15.83	19.6	1.83±0.07	7.04	19.9	1.57±0.04	5.92	27.5
Derraa	1.90±0.10	16.69	20.4	1.89±0.08	8.87	21.9	1.84±0.07	7.30	27.2
Heider	1.73±0.07	17.32	19.6	1.94±0.05	7.75	19.8	1.60±0.05	5.32	25.1
MBB	1.77±0.08	13.30	20.3	1.84±0.06	8.96	19.1	1.70±0.07	7.81	26.3

S = Speed of filling of grains (mg d^{-1}), SFG = speed of filling of the grains m^{-2} (g d^{-1} m^{-2}) D = Duration of filling (day)

1982). The sugar rate increases considerably following a hydrous deficit. These accumulated sugars come primarily from the hydrolysis of the starch reserves of the roots (Kameli and Losel, 1995).

According to Hossain *et al.*, 1990, the starch-based reserves are gradually used following theirs fast conversion into saccharine allotted to the activation of Saccharine Phosphates Synthétase (SPS) by a reversible phosphorylation of proteins.

Waha presents the best speed of filling of the grain into 2000/01, Heider into 2001/02 and Derraa into 2002/03. MBB less quickly fills the grain into 2000/01 and Ads in 2001/02 and 2002/03 (Table 4).

Brought back to the number of grains produced per unit of area, the differences from the speed point of view of filling become more obvious between genotypes. They are higher in 2000/01 and the least high during two years following. The duration of filling of the grain follows the opposite evolution (Table 4). The differences between genotypes are marked little for the duration of filling.

At the spike stage Ads497 and Derraa develop a sheet standard of great surface with an average of 15.5 and 16.5 cm^2, whereas Waha with 11.5 cm^2 presents a sheet of weak surface. MBB and Heider have sheets of dimensions close to those of Waha (Table 5).

Ten days after the spike stage, dice the beginning of the active phase of filling of the grain, the green surface of the sheet standard is reduced 33.9, 11.7, 14.1, 14.7 and 17.4%, respectively for Ads487, MBB, Heider, Waha and Derraa.

After 20 days, the relative reduction is 70.3, 47.0, 54.3, 57.3 and 58.0% for the same genotypes in the order above quoted (Table 5). Ads desiccates more quickly the sheet standard contrary to MBB which develops a rate/rhythm of drying relatively slower (Fig. 1).

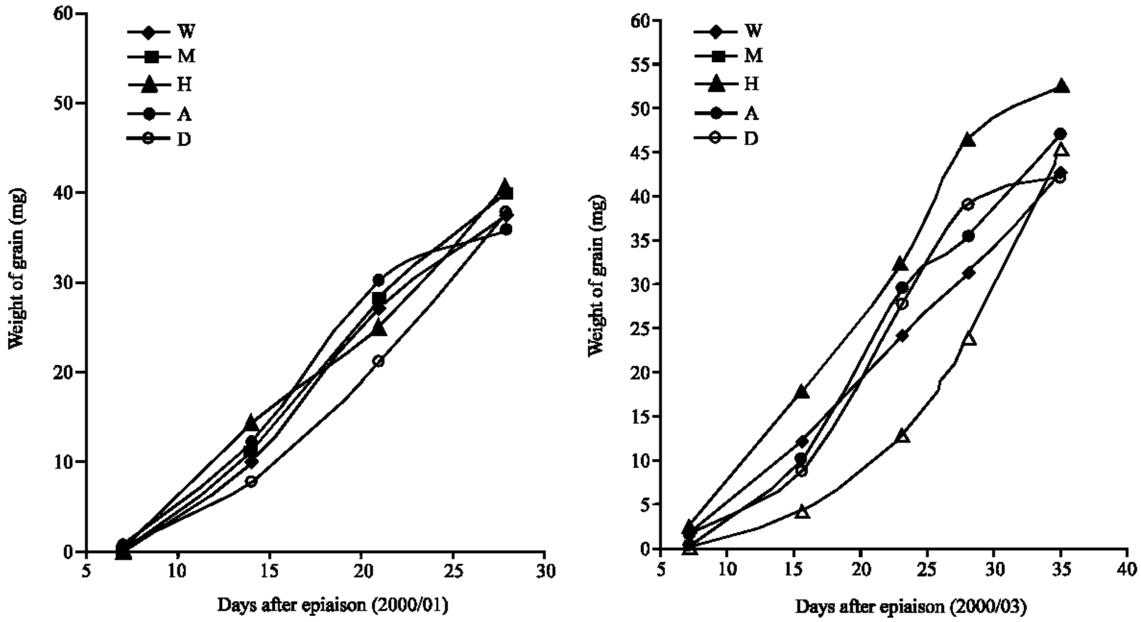

Fig. 1: Evolution of the filling of the grain (mg) of the five genotypes during the two extreme programs (2000/2001 and 2002/2003)

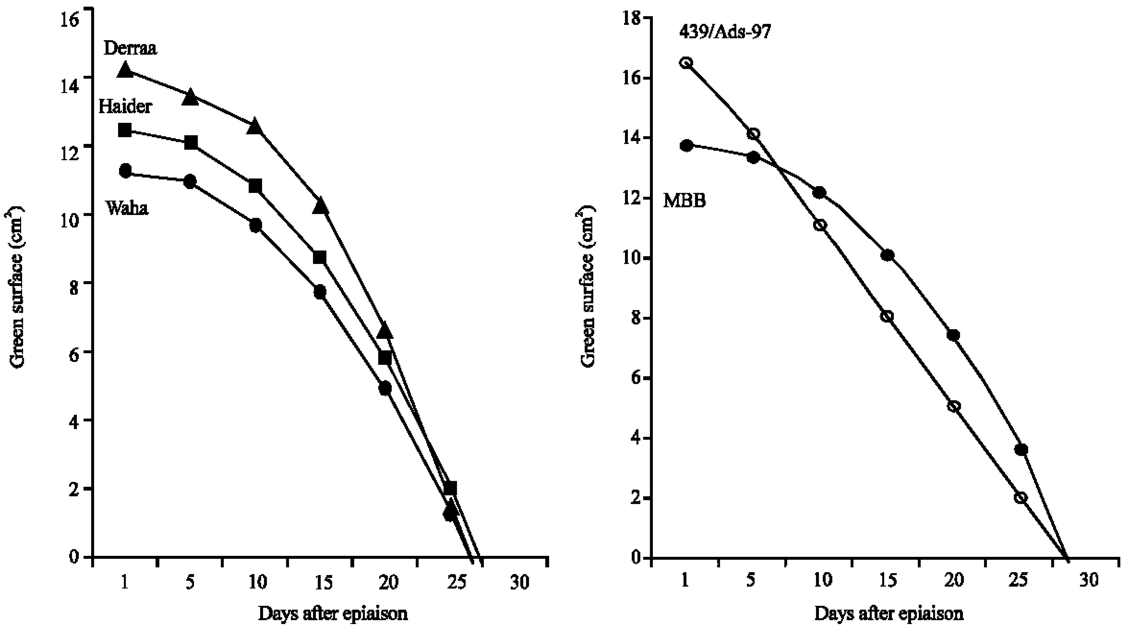

Fig. 2: Evolution of the senescence of the sheet standard of the studied genotypes

The speed of drying foliar is-0.5957 cm^2 day^{-1} for Ads487, that of the other varieties is variable in time, following the quadratic nature of the model (Fig. 2 and Table 5). It is modest spike stage until the spike stage +15 days, then it becomes faster after this (Fig. 2). the duration of the sheet standard varies 26.5 days for Waha at 31.9 days for Derraa (Table 5).

The study of the connections between the yield grain, the quantity of the transferred assimilates, speed and the duration of filling of the grain and the various analyzed variables indicates that the yield does not present significant connections with the duration and the speed of filling of the grain, the weight of 1000 grains, the duration of the vegetative phase and the height of thatch (Table 6).

It is however significantly correlated with the ears m^2, with the number of grains m^2, the number of grains ear^{-1}, at the speed of filling of the grains m^2 (Fig. 3) and with the quantity of the assimilates translate. It is negatively correlated with the relative quantity (T in % GY) of assimilates translate (Fig. 3), with the quantity transferred by grain, the quantity translated into % of the average weight of a grain and at the vegetative growth rate (Table 6).

The speed of filling of the grain is negatively related to the duration of filling. This last variable is positively related on the weight of 1000 grains and the duration of the vegetative phase. It is negatively related to the number of grains m^2 and at the speed of filling of the grains m^2 (Table 6).

Moreover the quantity of assimilates translate shows negative connections with the variables positively correlated with the yield grain, including inter alias the ears m^2, the grains m^2, the grains ear^{-1}, the speed of filling of the grains m^2 and the index of harvest. It is positively correlated with the share of the assimilates transferred by grain and in % of the weight of the grain (Table 6).

These results indicate that when the conditions of growth and the genotypic capacity lead to the realization of a number of grains m^2 raised via the ears m^2 or the grains ear^{-1}, they lead to the externalization a speed of filling of the grains m^2 and an index of harvest high whose resultant is the expression of a high yield grain.

These same conditions are associated a transfer of great quantities of assimilates stored in the stems. The share of the assimilates coming from the stems takes part, however, less and less as the medium allows the expression of a better yield grain.

Table 5: Surfaces green in cm^2 at the spike stage (E), E+10 days and E+20 days, duration of the sheet standard, explanatory model and the speed of senescence

Variety	Ads	MBB	Heider	Waha	Derraa
E	16.5	13.6	12.7	11.5	15.5
E+10j	10.9	12.0	10.9	9.8	12.8
E+20j	4.9	7.2	5.8	4.9	6.5
Model	-0.5957t	$-0.0159t^2$	$-0.0170t^2$	$-0.0163t^2$	$-0.0154t^2$
E.T	±0.06	±0.001	±0.002	±0.003	±0.001
Cte	+16.9	+13.59	+12.69	+11.49	+15.7
R^2	0.96	0.99	0.94	0.91	0.99
Speed (cm^{-2} d^{-1})	-0.5957	-0.0318t	-0.0340t	-0.0326t	0.0308t
Variety	Ads	MBB	Heider	Waha	Derraa

Table 6: Coefficient of correlation enters the yield, the capacity of translocation of the assimilates, the speed and the duration of filling of the grain (n = 15).

Yields	GY	V	D	T(%)
GY	1.00	0.39	-0.43	-0.76**
V	0.39	1.00	-0.65**	-0.35
DVP	-0.25	-0.41	0.67**	0.37
D	-0.43	-0.65**	1.00	0.21
T (g)	0.74**	0.35	-0.44	-0.45
T%	-0.76**	-0.35	0.21	1.00
T/NGM²	-0.63*	-0.21	0.40	0.58*
T% P1G	-0.60*	-0.21	0.09	0.63*
NE	0.58*	0.18	-0.39	-0.48
NGM²	0.97**	0.35	-0.56*	-0.71**
NGE	0.84**	0.31	-0.42	-0.58**
SFG	0.98**	0.47	-0.60*	-0.73**
WTC	-0.26	-0.06	0.80**	0.46
HT	0.02	-0.07	-0.13	0.09
SVG	-0.63*	0.08	-0.13	0.49

r5% = 0.56, r1% = 0.65 * and ** coefficient with the threshold of 5 and 1%, respectively

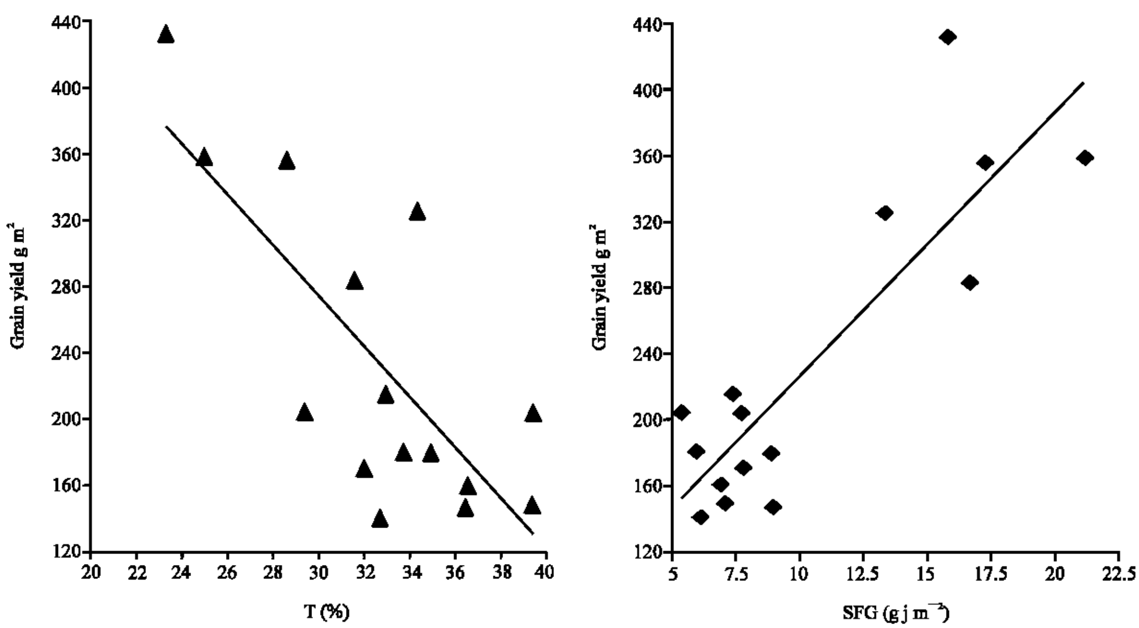

Fig. 3: Relations between the yield grain, the speed of filling of the grains m^2 and the relative quantity of the assimilates translate towards the grain

At the sample of studied genotypes, the participation of the transferable assimilates of the stems in the filling of the grain thus becomes relatively more important as the medium is constraining. On the other hand when the conditions of the medium allow it, the filling of the grain is primarily made assimilates coming from the photosynthetic activity at the time of the period of filling of the grain.

On this subject the results of the follow-up of the foliar senescence made over only one year do not show a significant effect of the lifespan of the sheet standard on the expression of the output in grain.

The phase of filling is the continuity of the production process set up dice the lifting and whose finality is the yield grain. The yield is him even the resultant of materialization of the sites of grains m^2 (ears m^2 and grains ear^{-1}) and of their filling (average weight of a grain).

During the course of the phase of filling, the kinetics of accumulation of the dry matter of the grain is under the dependence of two principal sources of assimilates which are the photosynthesis of the sheet standard and the share of the reserves produced at the time of the periods the pre one and after anthesis and stored in the stems which is translate.

The relative importance of these assimilates is dependent on the quantity of dry matter accumulated with the spike stage which determine the potential of the stored assimilates and that of sites to be filled. It is dependent also on the conditions of growth of the after anthesis which support or not an optimal photosynthetic activity.

A long duration of filling is often indicating of an optimal photosynthetic activity, on the other hand a high speed of filling is indicating effects of the stresses (Sofield *et al*., 1977).

Thus when the climatic conditions are less constraining at the time of the phase of filling, the plant calls less upon the reserves of assimilates and manages to ensure the filling of the grain with the product of the activity of photosynthesis of the after anthesis.

On the other hand when the climatic conditions at the time of this phase are constraining, the photosynthetic activity of the after anthesis is reduced or becomes null, the plant then called upon the assimilates stored in the stems, reduced duration of the vegetative phase and increases its rate of filling.

In this case of figure the yield obtained depends on the degree of reduction of the duration of filling, of that of the inhibition of photosynthesis, the increase the speed of filling and quantity of the translate assimilates. These characteristics are dependent genotypes.

For a variable environment, the desirable genotype is that which avoids the stress thanks to the modulation of its cycle of development. It must be able to maintain the activity photosynthetic under stress longest possible, ready to increase its rate of filling in the case where the duration is strongly reduced and uses the stored assimilates if its potential of weight of the grain is affected.

Contradictory results are reported in the literature with regard to the contribution the speed and duration of filling to the yield grain. Gebeyehou *et al*. (1982), find that the duration contributes much more than speed to the yield grain whereas, Nass and Reiser (1975) as Triboi *et al*. (1985) report on the other hand that the effect speed on the yield is by far that which is most important that of the duration of filling. What corroborates the results of this study?

Gebeyehou *et al*. (1982), values for the speed of filling varying of 12,4 to 15,5 g d^{-1} m^2 for two consecutive years and 11 durum wheat genotypes different, whereas the duration of filling varied from 33,0 to 40,3 days. These results are rather similar with those of this study except that the duration is shorter in the case of this study.

Gebeyehou *et al*. (1982), note a no significant phenotypical correlation between speed and duration and a significant and negative environmental correlation which explains why the conditions of growth which support the speed of filling disadvantage the duration of filling.

Sofield *et al*. (1977), mentions that the speed of filling is higher under high temperatures and that the duration is longer under moderate temperatures. Biddinger *et al*. (1977), Giunta *et al*. (1995), report that the contribution of the stems to the yield varied from 10 to 70% according to the genotypes and environments.

These stresses reduce assimilates stored in the stems after the spike stage and affect the photosynthetic apparatus during the phase of filling. Under such conditions the yield is the resultant of the photosynthetic activity of the after anthesis. The results of this study rather show than the assimilates take part in the filling of the grain but that this participation is relatively less during favorable years.

This corroborates what is brought back by Triboi *et al*. (1985) and Blum (1996), which mentions that the flow of the assimilates towards the grain depends on the one hand on the quantity of assimilates stored in the stems and on the other hand of the assimilation after anthesis. The quantity is a function of the number of stems produced per m^2, of the type of variety, the height of thatch and the climatic conditions specific to the year (Blum and Pnuel, 1990).

The results of this study indicate that at the restricted sample of studied genotypes the speed of filling contributes to the yield via the number of grains m^2, whereas the duration affects the weight of 1000 grains. These two variables are compensated mutually.

The contribution relative of the assimilates to the yield grain becomes important only when the yield is weak because the photosynthetic activity of the after anthesis is affected by the stress. Where also when the conditions of growth the before anthesis are such that the plant approaches the phase of filling strongly affected by the stress. The senescence of the sheet standard does not show a significant connection with the principal analyzed parameters.

In this context Fokar *et al.* (1998b) and Hossain *et al.* (1990), find that the genotypes which are characterized by an early foliar senescence, call more upon the Water Soluble Carbohydrates (WSC). This indicates that the capacity of use of the WSC is a constitutive characteristic.

Nicolas and Turner (1993) used the test of the desiccation of the foliage at the beginning of the period of filling for the selection of genotypes having the capacity to make correct use of the assimilates stored in the stem.

CONCLUSION

The choice of a genotype must be done per year, following the strong irregularities of the conditions of one year growth to another. The expression of a high yield is positively associated with a number of ears m^2, the number of grains m^2 and fertility of ears but negatively related to the weights of 1000 grains.

This situation also associated with a greater quantity with assimilates is transferred, a shorter duration of the vegetative phase, a speed of more reduced vegetative growth and a better index of harvest.

The speed of drying foliar is modest spike stage then becomes faster afterwards 10 days, it takes the same form for the 5 genotypes tested, with a higher rate/rhythm for the Ads genotype.

The study of the connections between the yield grain and the various analyzed variables indicates that the share of the assimilates coming from the stems takes part less and less as the medium allows the expression of a better yield grain, because when the climatic conditions are less constraining, the plant manages to ensure the filling of the grain with the product of the activity of photosynthesis of the after anthesis.

This surplus of carbohydrates coming from the sheet and other sites from storage is used for filling the remaining grains well. This participation is all the more high, in relative value, that the medium is constraining and that the photosynthetic activity of the post-anthesis is affected by the stress. The high temperatures, of end of cycle, accelerate the senescence of the sheet standard, which causes a reduction of the duration of filling associated with an increase the speed of filling of the grain.

The genotype ideal is that which will be ready to maintain under adverse conditions the photosynthetic activity and to increase its rate of filling thanks to using it the assimilates stored in the stem (Ehdaie *et al.*, 1988).

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