PHENOTYPICAL EXPRESSION IN THREE DURUM WHEAT VARIETIES ASSOCIATED TO DROUGHT TOLERANCE TRAITS

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Abstract.- *Phenotypical markers have been used on three durum wheat varieties in the field conditions, in order to much more understand the morphological characterization. The objective was also to link the results obtained in the field with others concerning physiological ones for drought tolerance. Results that have been obtained showed that dates of heading and flowering were almost the same for the three varieties. Around fifteen days were separating the two phenological phases. In a morphological point of view, varietal phenotype shows different leaves as far as texture is concerned. Presence or absence of waxiness appears as being a specific parameter to each cultivar. Leaf area is more important for Simeto, followed by Vitron and Ammar 6. Tillering is higher for Simeto. Height of plants does not seem to be discriminating between varieties. This contribution allowed us to characterize main differences in terms of phenotyping; with the objective to incorporate and integrate such relevant traits in wheat breeding program, under water deficit conditions. By doing this, useful morphological traits can be further used for modeling adapted genotypes.*

Key words: *Durum Wheat, Phenotyping, Morphology, Yield, Water Deficit*

EXPRESSION PHÉNOTYPIQUE CHEZ TROIS VARIÉTÉS DE BLÉ DUR ASSOCIÉE AUX TRAITS DE TOLERANCE AU STRESS HYDRIQUE

Résumé.- *Des marqueurs phénotypiques sont utilisés sur trois variétés de blé dur, en conditions de plein champ, dans le but de mieux comprendre la caractérisation morphologique. L'objectif était aussi de lier les résultats obtenus au champ, avec d'autres traits physiologiques en rapport avec le stress hydrique. Les résultats obtenus ont montré que les dates d'épiaison et de floraison étaient similaires pour les trois variétés. Il y a eu 15 jours entre les deux phases phénologiques. Sur un plan morphologique, le phénotypage variétal montre différents types de feuilles, concernant la texture foliaire. La présence ou l'absence de cire (waxiness) apparait comme étant un paramètre spécifique à chaque cultivar. La surface foliaire est plus importante chez la variété Simeto, suivie de Vitron et de Ammar 6. Le tallage est plus élevé chez la variété Simeto. La hauteur des plantes ne semble pas avoir été discriminante entre les variétés. Cette contribution a permis de caractériser les principales différences en terme de phénotypage; avec l'objectif d'incorporer et d'intégrer de tels traits déterminants dans un programme d'amélioration génétique du blé, sous les conditions de déficit hydrique. En adoptant une telle démarche, des traits morphologiques utiles peuvent être utilisés pour la modélisation de génotypes adaptés.*

Mots clés: *Blé dur, Phénotypage, Morphologie, Rendement, Stress hydrique.*

Introduction

Water deficit represents a major abiotic constraint to wheat cultivars. SIAL *et al.* (2017) reported that genotypes showed a variable response to various water deficit conditions for their physiological traits [1]. Water stress affects every factor of plant growth and the productivity of a crop, modifying it's morphology and phenology as well

SIAL *et al.* (2017), TURNER and BEGG (1981), BLUM (1988), AKRAM *et al.* (2004), SAYRE *et al.* (1995), REYNOLDS *et al.* (1999) and MIRBAHAR *et al.* (2009) have pointed out the fact that several morphological traits, such as coleoptiles length, seed size, early ground cover, thickness of the stem, had something to do with the level of the genotypes tolerance to drought [1-7]. Leaf anatomical traits (waxiness, leaf rolling, thickness) are considered as a reliable drought adaptative parameter [5] Water deficit can occur at any phenological stage of the plant [8;9]. Tolerance to drought is becoming a so complicated mechanism by which plants build their own specific adaptative strategies [10,11]. Among those, a variety can withstand to drought by escape strategy, by modifying the cycle, becoming either earlier or later [12]. Plant may behave during water stress by maintaining a high hydric potential. This may result in the reduction of the transpiration occurring in the cuticles and stomates [13]. Glauscesceness, waxiness are genetic traits that may be expressed during water stress [14]. Reduction of leaf area tends, according to ARRAUDEAU (1989) [15], to minimize transpiration but can also lead to yield decrease because of the reduction of photosynthetic capacity [16]. According to CASALS (1996) and EL MOURID (1988), plants accumulate osmoticum, such as proline, in order to maintain osmotic strength balance after decrease of hydric potential had occurred [17,18]. WANG *et al.* (2003) [19] report other factors, such as reduction of the transpiration by getting stomates closed and reducing leaf area [20]. This may maintain turgor high [21,22]. In the presence of water deficit, hydric potential may decrease because of the maintaining turgid status [23]. SUHEB (2011) have established mapping waxy for wheat drought lines [24]. Leaf epicuticular wax deposition is, according to SUHEB *et al.* (2018) and BOWNE *et al.* (2012) one of the several traits important, during drought tolerance due to its relationship with decreased water loss from the leaf surface [25,26]. Water deficit is one of the primary causes of decreasing wheat yields [27]. Leaf epicuticular wax has a determinant role in the adaptation of wheat to high temperatures and moisture deficit conditions. According to HUSEYNOVA (2012), many individual compounds are increased to provide osmoprotective functions which prevent the desiccation of enzymes [28]. NIO *et al.* (2011) have shown that cuticle wax accumulation is associated with drought tolerance in wheat near isogenic lines. The authors reported that there was a relationship between wax deposition and grain yield. Plant water status goes progressively through three main stages according to development of water stress [29]. During initial phase, transpiration and assimilation will be functioning as there was no water limit. This phase will continue until the level of root absorption cannot anymore satisfy climatic demand undergone by leaf canopy [30].

In order to restore equilibrium between climatic demand and soil availability, stomatal regulation seems to be a relevant pathway for specific mechanism to be steadily used [31]. LEBON *et al.* (2006) have shown that when water deficit is severe, stomata will be closed and photosynthetic activities are inhibited [32]. Plant growth stops before a decrease in water content [33]. The first effects of water deficit is a reduction of growth speed of the stem cells [34] and an important reduction of the size of leaf surface as well [35]. Feakins and Sessions (2010) emphasized on water deficit on yield components, in particular, number of grain/spike and mean kernel weight [36]. FAKHRI *et al.* (2008) have shown that the number of spike/m2 is not affected by water deficit during the 3 nodes stage [37]. However, waxiness represents, according to [38], a physiological way by which plant can avoid desiccation when water is a limiting factor Glauscesness of the leaves is linked to the presence of waxy cuticle [32]. The presence of trichomes, by increasing radiations reflectance, limits increase of leaf temperature and contributes to limit loss of water by transpiration [39]. Other researchers [40], working on wheat, report that a high wax accumulation on the flag leaf, leads to a weak water retention. Limitation of water loss can be attributed to reduction of transpiration surface [41].

1.- Material and Methods

Plant material

Three durum wheat varieties have been used for the trial. It concerns: Vitron, an improved cross from CIMMYT and selected in Spain; Simeto from Italy and Ammar6, line from CIMMYT genetic material.

Experimental design

The trial: was conducted in a farm located at 15 km, southwest Annaba a randomized complete bloc was chosen. The varieties were sown in three replications, six rows each, 2.5 m length and 1m width. Space between rows was 20cm and 50 cm between plots (varieties). Density or rate of planting was 120kg/ha and depth 8cm. The trial was under rainfall conditions and no irrigation was provided. Fertilization was applied at seedling stage. Ammo nitrate was added at rate of 2qx/ha.

Field notations

The notations have been made on: morphological parameters: stem- leaf (table I), Phenological parameters: heading and flowering stage (tab. II).
and some yield components (tab. II).

Morphological characteristics

Leaf characteristic

Type and texture of the leaf: these two parameters were evaluated at naked eye. (table I).
Leaf area (cm^2): Leaf area concerned the flag leaf and was determined by [42] which consisted in cutting a fresh leaf, cutting the space occupied by the leaf in paper, weighting it. At the same time we take $1cm^2$ of the paper, weight it and get the appropriate total weight of the leaf by deduction. (tab. I).

Stem characteristic

Height of the plant: was measured from the bottom to the plant to end of the spike. Three replications were done for getting the mean of the plant height. (tab. I).
Nature of the stem: we have made transversal cut between the 4^{th} and the 5^{th} internode and we have estimated whether or not the stem was: filled or semi filled. (tab. I).
Diameter of the stem: (expressed in mm) is measured after flowering isoccurred, between the 4^{th} and 5^{th} internode with pied à coulisse (tab. I).
Thickness of the stem: measured after flowering has occurred, between 4^{th} and 5^{th} internode, we make transversal cross section and read the thickness of the stem using pied à coulisse dial (tab. I).

Phenological parameters

Heading: number of days from seeding up to heading stage. This stage is scored when 50% of the spikes appear (tab. II).
Flowering: this stage is scored at the apparition of the stamens in almost half of the spikes. (tab. II).

Yield components

Tillering number: it was determined by direct count of tillers, three replications by genotype (tab. II).
Number of spike/m^2: it was determined also by direct count of the number of spike present in one m^2 (tab. II).

2.- Results and discussion

The results we are presenting concern exclusively some aspects by which we wanted to discuss what is happening in the field, in terms of genotypes responses to specific environment. These are expressed through numerous morphological and phenological traits as well. In order to get some supplementary explanation on how some durum wheat varieties are behaving through its organs, we have chosen main traits, which are stem leaf and spike. Often, researchers spend useless time in making numerous analysis in lab to predict future yield performance or tolerance to abiotic and biotic stress imposed to the varieties. To our conviction, in a plant breeder point of view, it is suitable to take in account what happen first in the field. In doing this, it surely help to give better explanation whenever yield and tolerance are concerned. So, these results are to be considered as pre requisite research aspect before going deeply in fundamental details, even though they are necessary and reliable too.

Leaf characteristic

Type of the leaf: cv Vitron has flag leaf. At the mean time cv Ammar 6 has erect leaf and cv Simeto has semi- erect leaf (tab. I). This trait is considered as important because it participates to adaptative strategies of the varieties under water deficit. Varieties that have erect leaf are those that will regulate their transpiration.
Leaf texture: waxiness and glauscesness. According to the results that have been obtained in the present study, a phenotypic diversity does exist. (tab. I).
Vitron: waxy (medium)
Ammar 6: waxy (excessive, pronounced wax)
Simeto: lack of wax and glauscesness.
Leaf area: Leaf area is more important for Simeto (54.67cm^2). Vitron (54.17cm^2) followed by Ammar 6 (53.55cm^2) (tab. I).

Stem characteristic

Height of the plant: In a general manner, the three genotypes responded similarly. Height of plants translates a semi dwarf biological model, as compared to traditional and local varieties which all are tall varieties. Height is a useful parameter in phenotypic study because it may help in predicting yields through different levels of fertilization, especially nitrogen; tall varieties being sensitive to mechanical lodging. Also, as far as stem is concerned, the three varieties have semi- filled stem with however slight thicker stem for Ammar 6 and Simeto compared to Vitron (tab. I).

Table I.- Morphological traits of three durum wheat varieties

Traits / Variety	Leaf			Stem			
	Type of leaf - Erect -Semi erect -flag	Leaf texture - Waxiness - glaucesness	Leaf area (cm^2)	Stem - filled - semi -filled	Height of plant (cm)	Stem diameter (4-5 Nodes)	Thickness of stem (mm)
Vitron	Flag	Waxy +	54,17	Semi -filled	107,83	4,25	1,04
Ammar 6	Erect	Waxy ++	53,55	Semi -filled	111	3,62	1
Simeto	Semi- erect	Glauscesnes- Waxiness -	54.67	Semi-filled	108,66	4,33	1,06

Diameter of the stem: diameters are different in size. Simeto has 4.33mm; Vitron has 4.25mm and Ammar 6 has 3.62mm (tab. I). These variations may have been due to origin or even the pedigree of the variety.
Thickness of the stem: stems have a thickness around 1mm, no major difference appears from one variety to another (tab. I).
Tillering: is expressed as number of tillers/plant: Concerning this specific trait, Simeto seems to have an advantage (12 tillers/ plant), as compared to Ammar 6 with 10 tillers/ plant and Vitron with 9tillers (tab. II). Tillering is in fact an agronomic component which has something to do in yield determination. However, some varieties may be well performing, with a high yield potential even though number of tillers are low [43]. Under some environmental conditions, when water supply is not a limiting factor, yield may be attained by other parameters such as thousand kernels weight or number of grains / spike. Under the conditions where the trial was realized, number of tillers may justify a high yield because of the irregular rainfall conditions. Thus, the more tillers we have higher will be the productivity.
Number of spike/ m^2: the parameter seems to be correlated with tillering. In fact, Simeto which had the highest tillering, had also a higher number of spike/m^2 (421spikes) (tab. II).

Table II.- Phenological traits of three durum wheat varieties

Traits / Variety	Phenology	
	Heading (days)	Flowering (days)
Vitron	137	153
Ammar 6	139	151
Simeto	141	152

Phenological parameters

Heading stage: the three varieties headed at the same time because they are improved varieties, so called intensive ones and have almost a similar trend for their phenology (137days, 139days and 141days for respectively Vitron, Ammar6 and Simeto (table II).
Flowering stage: were 153 days for Vitron, 151 days for Ammar 6 and 152 days for Simeto (tab. II). It appears that phenology, as shown by these results, at least for the present experiment, has not to be taken as a reliable tool of selection. We aim to confirm

this in using more genotypes in the same trial in order to better discriminate between those parameters that are worth to be used in a wheat breeding improvement program.

As far as yield components are concerned, Ammar 6 seems to be the best in its expression of giving more spike/m2, more grains per spike and ultimately estimate yield (55.28 Qx/ha) (tab. III). Simeto is also well expressing its agronomic potential through number of spikes/m^2 (421) (tab. III) and through its thousand kernel weight (60g) (table III). The current study aims to emphasize on how much important is to explain the final end product, grain yield, using other characteristics than classic ones such as yield components. These are other morphological traits that are associated in elaborating such yield. As we have seen, waxiness had determinant role in helping varieties to withstand abnormal conditions during cropping. Also physical nature of the stem contributes and enhances plants to support heavy load of grains and by mean, in getting higher yield.

Table III.- Yield components and estimate yield for three durum wheat genotypes

Traits / Variety	Tillering	Number of spikes/ m^2	Number of grain/spike	TKW (g)	Theoritical Yield (Qx /ha)
Vitron	9	390	21	55	45, 04
Ammar 6	10	437	23	55	55,28
Simeto	12	421	19	60	48

Conclusion

Characterization of certain phenotypic traits allowed us to identify genotypic diversity of three durum varieties. Among conclusions that may be brought, in a morphological stand of point, the varieties that have been used for this purpose, showed differences in their respective traits. It was somewhat expected to get these differences because of their genetic polymorphism.

Among those results, variability does exist for leaves (surface and texture), stem (in relation to their thickness) and their height. These traits are to be used in plant breeding improvement for wheat program. In doing this, appropriate crosses can be made in order to introduce desirable traits in some specific cultivars. We shall progressively reach this in matching such traits, obtention of «ideotype», a variety that may gather more than one desirable character. However, study of such traits has to be performed in order to know their inheritance.

Among genetic traits, some are monogenic while others are polygenic. Actually we emphasize on looking after these desirable traits in order to correct varieties in which such character are lacking. To make more efficient the strategy of the current research, we aim to use more scientific tools, in terms of physiological and biochemical analysis of the plants for a much better understanding of the endogenous responses expressed as adaptative pathways.

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