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Durum wheat production and quality in Syria

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SUMMARY - A morpho-physiological study was conducted with Syrian durum landraces and improved cultivars. Large variations were found for most of the traits studied. Correlations between grain yield and traits demonstrated the importance of earliness and early growth vigour. Newly developed varieties showed better yielding abilities than the landrace ("Haurani") and the commercial variety ("Gezira 17"). Durum in general had higher protein content, 1,000 kernel weight and water flour absorption than aestivum. In contrast, aestivum had longer stability and vigour of dough than durum. Grain quality of durum improved when sown in semi-arid zones (especially protein %, absorption degree, and stability, vigour of dough), whereas productivity components improved when sown in irrigated and favourable areas (hectolitre weight, 1,000 kernel weight). The results emphasize the importance of the breeding of stress tolerance for the semi-arid areas, and of grain quality for the irrigated and favourable ones.

Key words: Morpho-physiological traits, landraces, earliness, early growth vigour.

RESUME *- "Production et qualité du blé dur en Syrie". Une étude morphophysiologique a été menée sur des espèces autochtones syriennes de blé dur et des cultivars améliorés. De grandes variations ont été trouvées pour la plupart des caractères étudiés. Les corrélations entre le rendement en grain et les autres caractères ont montré l'importance de la précocité et de la vigueur pendant la croissance précoce. Des variétés nouvellement mises au point ont montré de meilleures aptitudes au rendement que la race autochtone ("Haurani") et que la variété commerciale ("Gezira 17"). Le blé dur d'une façon générale avait une plus forte teneur en protéine, un poids de 1000 grains plus élevé, et une meilleure absorption de l'eau par la farine que le blé de printemps. Par contre, le blé de printemps avait une stabilité plus longue, ainsi qu'une meilleure fermeté de la pâte, que le blé dur. La qualité du grain chez le blé dur était meilleure lorsque celui-ci était semé dans des zones semi-arides (spécialement % de protéine, degré d'absorption, et stabilité, fermeté de la pâte), tandis que les composantes de productivité étaient meilleures lorsqu'il était semé dans des zones irrigués et favorables (poids d'un hectolitre, poids de 1000 graines). Les résultats ont souligné l'importance d'une sélection pour la tolérance au stress en zones semi-arides, et pour la qualité du grain en zones irriguées et favorables.*

Mots-clés : *Caractères morphophysiologiques, races autochtones, précocité, vigueur pendant la croissance précoce.*

Introduction

Durum wheat covers in the world about 20 million hectares with a production of about 30 million tons annually (1500 kg ha^{-1}). The Mediterranean basin region produces 19 million tons (75% of the world production). In Syria more than 80% of the total wheat area is grown to improved durum cultivars. Durum wheat has direct and effective role on national economy. The annual production average is about 1.3 million tons. Durum wheat cultivation is subject to several abiotic (i.e. drought, cold, and terminal stress) and biotic stresses (i.e. diseases and insects). These stresses cause reduction in grain yields and annual fluctuation in total production. Further, the grain yields differ not only from year to year but also from area to area (Table 1).

Table 1. Average grain yields (t ha^{-1}) of improved varieties in different agroecological zones

Variety	1987	1988	1989	Average	Increase (%)
Semi-arid areas					
Haurani	2.8	0.8	1.1	1.6	100
Cham 1	3.4	0.9	1.1	1.8	112
Douma 300	3.6	0.8	1.1	1.8	110
Omrabi 3	3.5	1.1	1.2	1.9	117
Favourable areas					
Gezira 17	4.3	1.8	2.9	3.0	100
Cham 1	4.3	2.1	3.0	3.1	104
Omrabi 3	4.8	2.1	3.3	3.4	112
Irrigated areas					
Gezira 17	6.6	5.5	6.7	6.3	100
Cham 1	7.5	6.4	7.6	7.2	114
Sabil	7.4	6.4	7.4	7.1	113
Brachoua	7.3	6.7	7.8	7.3	116

Material and methods

The cultivars (Table 2), which are grown by farmers or have been introduced on farm trials, were studied in a trial carried out at the Tel Hadya station, in the 1992 season, using a simple lattice design with two replications, a plot size of 7.5 m^2. Fertilizers were applied before sowing (60 kg ha^{-1} N and 40 kg ha^{-1} P).

The following traits were studied: (i) number of kernels per spikelet; (ii) number of kernels per spike; (iii) number of spikes per m^2; (iv) spike weight; (v) kernels weight per spike; (vi) 1000 kernels weight; (vii) growth habit, plant vigour, leaf colour, leaf waxiness, and leaf rolling, according to a scale 1-9 scores (1 = weak, deep green, light colour, non waxy, and unrolled); (viii) earliness (number of days from sowing to heading, and number of days to physiological maturity); (ix) plant height (cm); (x) peduncle length (cm); (xi) spike length (cm); (xii) awns length (cm); (xiii) grain quality (% protein content, sedimentation test (SDS), % vitreousness); (xiv) grain yield (kg ha^{-1}).

Results and discussion

Table 3 shows the means and ranges of cultivar traits. Large ranges were shown for most traits, especially for grain yield components, and grain quality traits. These cultivar differences indicate the possibility of improvements in durum to obtain high yielding genotypes with high grain quality and grain yield. The mean of grain yield was 2819 kg ha^{-1}. Significant differences were noticed for grain yields.

Improved varieties showed high yielding ability in various environments (Table 1). These results demonstrate the progress made in selecting varieties adapted to Syrian environmental conditions during the last decade. Associations analyses (Table 4) for traits related with productivity under stress conditions indicated the importance of earliness, leaf rolling, and plant vigour. The contributions of these traits were 18%, 14%, and 9%, respectively. Table 4 shows further correlations between grain yield and the morpho-physiological traits. Negative values of correlations were found between yield, protein %, percentage of vitreousness, and sedimentation test (SDS).

Table 5 shows correlations among traits, where high correlations were found between number of plants per m^2 and number of spikes per m^2; spike weight and kernel weight per spike; number of kernels per spike and number of kernels per spikelet; spike length and number of spikelets; spike length and kernel weight per spike; spike weight and 1000 kernels weight.

Table 2. Varieties tested for relationship between grain yield and morpho-physiological traits

Landrace	Improved varieties
Haurani B	Douma 12219
Haurani 27	Douma 15491
Haurani A	Bohouth 5
Haurani Normal	Omrabi 3
Short Haurani	Marout
Senator Capelli	Chahba 83
Faroni	Awalbit
Koko	Omlahn 3
	Cham 1
	Douma 13715
	Stojocri 5
	Douma 300
	ACSAD 65
	Jori 69
	Gd/Bit
	Douma 11337
	Sabil 1
	Omtel
	Cham 3
	Rufom
	Bohouth 1
	Lahn
	Daki
	Gezira 17
	Brachoua

The analysis of some grain quality traits was studied for durum, and aestivum wheat (Table 6). Kernel weight, protein content, water absorption of flour were higher in durum than in aestivum. In contrast, parameters of dough stability and vigour were more important in aestivum wheat.

When environmental effects were studied, kernel weight and specific weight were higher in irrigated and favourable than in the semi-arid areas (Table 7). Whereas, protein %, water absorption of flour, dough stability and vigour were higher in the semi-arid areas than in the moisture favourable ones.

These results emphasize the importance of the stress tolerance breeding for the semi-arid areas of Syria, and the grain quality improvement for the irrigated and favourable areas.

Table 3. Means and ranges for some morpho-physiological traits of Syrian durum wheat cultivars

Trait	Mean	Range
Grain yield	2819	2198-326
Phenological traits		
Growth habit	6.7	3.5-9.0
Days to heading	105.6	103-108
Days to maturity	139.7	138-142
Morpho-physiological traits		
Early plant vigour	6.5	2-9
Plant height	74.4	60-110
Peduncle length	12.6	8.5-21.0
Spike length	6.3	5.2-9.0
Awns length	9.4	5.7-12.2
Waxiness	7.7	6.5-9.0
Leaf colour at tillering	5.6	3.5-8.0
Leaf colour at heading	6.2	3.5-8.5
Leaf rolling	6.3	3.0-8.5
Yield parameters		
Spikes per m^2	297	207-375
Spike weight	2.1	1.7-2.5
Grains per spike	36.8	20.5-49.0
Grains weight per spike	1.5	1.2-1.8
Grains per spikelet	2.1	1.7-2.8
Spikelets per spike	17.1	15.5-23.0
Quality parameters		
Protein content (%)	12.5	11.1-14.1
1000 grain weight	43.3	31.6-55.0
Vitreousness	99.3	96.5-100.0
Carotene content	32.8	24.4-40.0

Table 4. Correlations between grain yield and some traits

Trait	r
Days to heading	-.43
Days to maturity	-.33
Plant vigour	.42
Spikes per m^2	.37
Leaf colour at tillering stage	.29
Leaf colour at generative stage	.24
Plant height	-.17
Vitreousness	-.25
Spike length	-.27
Spikelets per spike	.30
Growth habit	.18
No. seed per spike	.12
Seed weight per spike	.16
Leaf rolling	-.01
Sedimentation test (SDS)	.15
Protein content (%)	.08

Table 5. Correlations among some morpho-physiological traits

Trait	r
Number plant per m^2 x spikes per m^2	.80
Spike weight x seed weight	.65
Spike length x No. of spikelets	.60
Spike length x seed weight	.63
Spike weight x 1000 kernel weight	.55
Spike weight per spike x 1000 kernel weight	.49
Number seed per spike x 1000 kernel weight	-.43
Number seed per spike x number of seed per spikelets	.72
Seed weight per spike x number of seed per spike	.42
Seed weight per spike x number of seed per spikelets	.38
1000 kernels weight x number of spikes per m^2	-.23
1000 kernels weight x number of seeds per spike	-.32
Days to heading x days to maturity	.51
Days to maturity x number of plants per m^2	-.37
Days to maturity x number of spikes per m^2	-.42
Postrate habit x plant vigour	.59
Leaf colour x plant vigour	.38
Leaf rolling x plant height	.46
Leaf rolling x plant vigour	.45
Plant height x peduncle length	.61
Spike length x days to maturity	.42
Number of seed per spike x protein content %	.03
Number of seed per spike x SDS	-.14
Number of plants per m^2 x vitreousness	.28
Number of spikes per m^2 x vitreousness	-.31

Table 6. Mean of 1000 kernel weight (TKW), hectolitre weight (HIW), protein content (PC), water absorption (WA), dough stability (DS), Brabender number (BN) for some durum and aestivum varieties, in 8 sites, Syria, 1989/90

Variety	TKW	HIW	PC	WA	DS	BN
Durum						
Cham 3	35.7	78.1	15.1	67.1	3.0	74.7
Haurani	40.7	80.3	15.9	74.8	4.3	107.5
Cham 1	31.1	79.7	12.9	68.5	2.5	111.7
Gezira 17	41.0	76.9	14.3	67.8	2.2	98.6
Bohouth 1	39.8	74.5	15.6	71.2	2.1	120.0
Aestivum						
Cham 2	33.1	79.2	12.9	64.0	5.3	87.5
Bohouth 4	30.9	77.5	14.1	67.6	8.4	64.2
Cham 4	30.7	77.9	13.1	62.1	5.5	47.7
Mexipak	32.9	78.6	12.9	67.1	4.2	81.2
Douma 8815	36.1	78.6	12.6	65.0	5.6	82.0

Table 7. Variations of some grain quality traits in relation to site, Syria, 1989/1990

Site	TKW	HIW	PC	WA	DS	BN
Izra	27.7	79.4	16.2	72.5	5.3	80.8
Kamishli	27.8	71.7	16.5	68.1	4.3	82.4
Aleppo	29.0	74.8	15.3	66.6	5.0	85.0
Gellin	27.1	76.6	15.3	71.6	6.4	55.8
Idleb	38.9	81.4	12.1	64.5	4.0	109.2
Ghab	44.2	82.5	11.7	64.9	4.7	91.6
Karahta	41.3	79.8	14.1	68.2	3.2	120.0
Deirzor	44.7	82.3	10.6	63.6	2.9	110.0

TKW: 1000 kernel weight, HIW: hectolitre weight, PC: protein content, WA: water absorption, DS: dough stability, BN: Brabender number