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Statistical Analyses of the Outputs of 24 Varieties of Hard Wheat Experimented on Several Sites and During Two Successive Years in Algeria

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Abstract: A project of improvement and backing of adaptation of the national varietal system of the hard wheat in Algeria, duct jointly by the Instituto Agronomico per the Otremare (IAO) of Italy and l'Institut Technique des Grandes Cultures (I.T.G.C) of Algeria, the area of survey covers the whole north Algeria with total surface of about 250291 km^2, where 24 local and introduced varieties of hard wheat have been tested through 17 sites of experimentations in order to study the influence of the pedoclimatic variability on the productivity of every variety. The statistical analysis of the middle outputs gotten of the 24 varieties of hard wheat on 2 consecutive years showed that some very highly significant differences exist, on the one hand, between years for practically the two third of the sites and, on the other hand, between sites for each of the two years and this for the set of the 24 varieties. Whereas only some significant differences exist between the 24 varieties for each of the two years and for every site of survey.

Key words: Hard wheat, test of student, ANOVA, (l.s.d) test

INTRODUCTION

Algeria possesses a global surface of 2.380.000 km^2 and has topographic and bioclimatic features that permit to show a diversity of the landscapes and the systems of cultures. In particular, a big part of the cereal production meets inside the country, on the high plains. These last are characterized per cold winters, an irregular raining régime, of the very frequent vernal frosts and hot and dry winds at the end of cycle of the culture. All these factors influence on the cereal production which is characterized by a stagnant national average since more of one century and in the same way very variable from one year to the other. Also, the improvement of the production to the level of these zones or at least, its stability can see itself by the research of new varieties more adapted, that react positively to the pedoclimatic variations to give an acceptable output to every harvest.

This is how in the setting of the improvement of adaptation of the national varietal system of the hard wheat in Algeria, a project initiated by the I.A.O. (Italy) and by the I.T.G.C. (Algeria). This project permitted to experiment 24 varieties of hard wheat on 17 sites during two consecutive years (1998/1999 and 1999/2000) in order to study the productivity of every variety and to compare the outputs of these varieties, on the one hand, between sites and, of other hand, in the sites.

MATERIALS AND METHODS

The 24 varieties of hard wheat that have been experimented during the two successive years to the level of the sites appear in the Table 1.

The sites: The sites of experimentations are given by the Table 2 and are represented by the Fig. 1.

Table 1: List of experienced hard wheat varieties

Varieties	Code	Origin	Place of selection
GTA Dur	V1	CIMMYT	Guelma
Ardente	V2	France	Sidi Bel Abbés
Chen's	V3	CIMMYT	El Khroub
B.Dur1.94	V4	CIMMYT	Sétif
Oum Rabi 09	V5	ICARDA	Sidi Bel Abbés
Belikh 02	V6	ICARDA	Sidi Bel Abbés
Sahel 77	V7	CIMMYT	El Khroub
Eider	V8	CIMMYT	Guelma
Waha	V9	ICARDA	Sétif
Bidi17/Waha/Bidi17	V10	Algeria (ITGC)	El Khroub
Vitron	V11	Spain	Tiaret Sebain
Ofanto	V12	Italy	Tiaret Sebain
Duilio	V13	Italy	Italy
Hedba 03/GDO	V14	Algeria (ITGC)	El Khroub
Mexicali 75	V15	CIMMYT	East Algeria
INRAT 69	V16	Tunisia	East Algeria
Simeto	V17	Italy	Tiaret Sebain
Kebir	V18	ICARDA	Sidi Bel Abbés
T.Polonicum x Z.B	V19	Algeria	El Khroub
Mohamed Ben Bachir	V20	Algeria (landrace)	Sétif
Bidi 17	V21	Algeria (landrace)	Guelma
Oued Zenati 368	V22	Algeria (landrace)	Guelma
Polonicum	V23	France	Algiers
Hedba 03	V24	Algeria (landrace)	East Algeria

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Table 2: List of survay sites

Sites	Symbols	Department	Code
Guelma	S1	Guelma	24
Souk Ahras	S2	Souk Ahras	41
El Khroub	S3	Constantine	25
Oum El Bouaghi	S4	Oum El Bouaghi	04
Sétif	S5	Sétif	19
EAC Dehal	S6	Batna	05
Beni Slimane	S7	Médéa	26
Ain Bessam	S8	Bouira	10
Oued Smar	S9	Alger	16
Tipaza	S10	Tipaza	42
Khemis Miliana	S11	Ain Défla	44
Djendel	S12	Ain Défla	44
Tiaret	S13	Tiaret	14
Rahouia	S14	Tiaret	14
Tessala	S15	Sidi Bel Abbés	22
Sidi Bel Abbés	S16	Sidi Bel Abbés	22
Abdelkader	S17	Sidi Bel Abbés	2 2

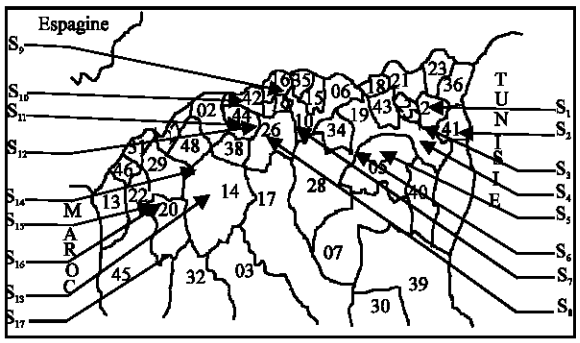

Fig. 1: Localization map of the survey sites

The experimental protocol: For each of the 2 years and for each of the sites the adopted experimental device was the complete uncertain blocks or the Fisher's blocks or randomized blocks with four repetitions (Dagnékie, 2003). The 24 varieties of hard wheat have been distributed at random in each of the blocks. Each of the parcels has 10 m of length on 1.2 m of width with 6 lines of wheat distant of 0.2 m. Only the 4 central lines have been harvested for the purpose of the survey.

This kind of experiences multi-local and multi-annual have for aim to verify out station the behavior of the 24 varieties of hard wheat selected and it in the whole region of potential diffusion of these varieties and during several successive years (Dagnékie, 2003). In agronomy the research programs conclusions are very often intended to be applying for whole region or a territory given and during a certain time.

Collection of data: To the level of every site and for each of the two years we arrange:

- Of the yearly middle output in quintals by hectare for every variety of hard wheat.

Table 3: Basis statistical parameters of the outputs per year for the set of the 24 varieties

Sites	Year	n	m	SD	X_{min}-X_{max}
S1	98/99	24	32.390	5.170	22.50-41.20
	99/00	24	26.350	6.590	13.70-34.30
S2	98/99	24	23.467	3.579	18.20-31.80
	99/00	24	11.254	2.905	06.90-18.30
S3	98/99	24	32.450	4.806	24.90-40.80
S4	98/99	24	20.338	2.578	16.90-26.70
	99/00	24	11.296	1.428	08.90-15.30
S5	98/99	24	11.338	2.130	06.30-15.00
	99/00	24	17.042	1.598	12.70-20.60
S6	98/99	24	04.621	1.425	02.60-07.60
	99/00	24	20.258	4.115	08.20-28.20
S7	98/99	24	10.700	1.412	09.20-13.60
	99/00	24	06.667	1.803	02.60-09.50
S8	98/99	24	11.025	2.017	08.20-15.10
	99/00	24	04.829	1.473	01.10-08.80
S9	98/99	24	35.870	14.12	10.30-51.00
	99/00	24	33.060	4.940	23.00-41.80
S10	98/99	24	16.137	2.426	12.10-20.20
	99/00	24	21.829	4.781	13.00-29.40
S11	98/99	24	14.988	3.613	08.40-20.90
	99/00	24	20.996	3.463	14.17-28.40
S12	98/99	24	24.492	3.226	17.70-30.30
	99/00	24	25.267	3.222	20.50-31.20
S13	99/00	24	08.433	1.229	06.10-10.20
S14	98/99	24	22.558	2.333	17.80-26.30
	99/00	24	31.629	2.744	26.70-36.40
S15	98/99	24	16.050	3.421	10.00-22.80
S16	98/99	24	14.829	4.718	08.10-24.90
	99/00	24	15.229	2.968	09.20-20.10
S17	98/99	24	16.150	4.458	08.70-27.70
	99/00	24	16.858	2.063	12.90-21.90

- Of the morphophysiological characteristics of plants,
- Of the Station data.
- Of the soils analysis data.

In the present research we are only interested in the yearly means outputs of the different varieties of hard wheat.

Statistical analyses of data: The description of data consists in calculating some statistical parameters as the average (m), the Standard Deviation (SD), the smallest value (x_{min}) and biggest value (x_{max}). These parameters have been determined on the outputs: "By site and per year for the set of the 24 varieties (Table 3), By variety, for all sites and for the two years (Table 4) (Litim, 2005).

The test (t) of Student for matched samples. This test has been used to compare, between years, the middle outputs of the set of the 24 varieties of hard wheat for each of the sites (Table 5) (Dagnékie, 1999).

The analysis of the variance to criteria of classification. This test has been applied:

- To compare between them the middle outputs of the varieties for the set of the sites and per year (Table 6 and 7) (Dagnekie, 1999).
- To compare the middle outputs between sites for the set of the 24 varieties and per years (Table 8 and 9) (Dagnékie, 1999).

Table 4: Basis statistical parameters by variety of hard wheat. for the set of the sites and for the set of the 2 years (1998/1999 and 1999/2000)

Variety	n	m	SD	X_{min}-X_{max}
V1	17	21.95	09.95	08.00-43.55
V2	17	17.64	08.34	07.20-32.70
V3	17	22.02	09.60	10.00-43.15
V4	17	20.50	09.49	08.70-42.95
V5	17	19.67	08.24	09.90-37.50
V6	17	20.13	09.50	08.30-38.60
V7	17	20.38	08.66	08.20-40.20
V8	17	20.28	09.06	09.80-42.35
V9	17	20.63	09.93	08.30-40.85
V10	17	20.58	09.43	06.50-39.85
V11	17	19.38	08.93	07.10-38.90
V12	17	20.80	08.74	10.20-41.25
V13	17	20.28	09.32	09.65-42.30
V14	17	17.51	08.61	08.20-35.85
V15	17	20.38	10.42	07.80-40.80
V16	17	17.35	08.46	05.40-32.15
V17	17	20.94	10.41	08.30-44.65
V18	17	18.09	07.73	07.90-33.05
V19	17	15.95	06.40	07.35-27.50
V20	17	15.23	06.39	06.10-28.50
V21	17	15.93	05.97	07.30-26.40
V22	17	15.22	05.95	06.90-26.40
V23	17	15.90	05.39	08.60-27.10
V24	17	14.76	05.48	06.10-24.90

Table 5: Comparison between years for the same sites of the middle outputs of the set of the 24 varieties

Sites	1998/1999 (m)	1999/2000 (m)	t_{obs}	p
Guelma	32.390	26.350	6.40	0.000***
Souk Ahras	23.467	11.254	13.48	0.000***
Oum El Bouaghi	20.338	11.296	16.50	0.000***
Sétif	11.338	17.042	18.23	0.000***
EAC Dehal	4.621	20.258	19.92	0.000***
Beni Slimane	10.946	6.667	12.95	0.000***
Ain Bessam	11.025	4.829	12.07	0.000***
Oued Smar	35.87	33.060	1.27	0.217 ns
Tipaza	16.137	21.829	7.44	0.000***
Khemis Miliana	14.988	20.996	6.52	0.000***
Djendel	24.492	25.267	0.98	0.337 ns
Rahouia	22.558	31.692	13.56	0.000***
Sidi Bel Abbés	14.829	15.229	0.39	0.701 ns
Abdelkader	16.150	16.858	0.71	0.701 ns

***: Very height significant differences/ns: not significant differences m: mean tobs: student (t) test p: probability

Table 6: Analysis of the variance: Comparison between the middle outputs of the 24 varieties of hard wheat for the set of the 16 sites (1998/1999)

Source of variation	DL	SCE	CM	F_{obs}	p
Differences between	23	2925.6	127.2	1.37	0.211 ns
varieties	360	33446.7	92.9		
Residual variation					
Total variation	383	36372.3		-	

Ns: Not significant differences Fobs: Fisher's test p: probability

Table 7: Analysis of the variance: Comparison between the middle outputs of the 24 varieties of hard wheat for the set of the 15 sites (1999/2000)

Source of variation	DL	SCE	CM	F_{obs}	p
Differences between varieties	23	1187.7	51.6	0.62	0.918 ns
Residual variation	336	28154.4	83.8		
Total variation	383	29342.1	-		

Ns: Not significant differences Fobs: Fisher's test p: probability

Table 8: Comparison of the middle outputs of the set of the 24 varieties between the 16 sites for the year (1998/1999)

Source of variation	DL	SCE	CM	F_{obs}	p
Differences between					
sites	15	27865.2	1857.7	18036	0.000***
	368	8507.0	23.1		
Residual variation					
Total variation	383	36372.2	-		

***: Very height significant differences Fobs: Fisher's test p: probability

Table 9: Comparison of the middle outputs of the set of the 24 varieties between the 16 sites for the year (1999/2000)

Source of variation	DL	SCE	CM	F_{obs}	p
Differences between sites	14	25420.60	1815.8	159.75	0.000
***Residual variation					
	354	3921.5	11.4		
Total variation	359	29342.1	-		

***: Very height significant differences Fobs: Fisher's test p: probability

Table 10: Distribution of the sites by groups of homogeneous outputs according to the method of the (l.s.d) of the 2 years

Year 1998/1999			Year 1999/2000		
Group	Site	Output	Group	Site	Output
G1	S6	4.621	G1'	S7	4.829
				S6	6.667
G2	S7	10.946			
	S8	11.025			
	S5	11.338	G2'	S6	6.667
				S12	8.433
G3	S15	14.829	G3'	S2	11.254
	S11	14.988		S3	11.296
	S14	16.050			
	S10	16.137			
	S16	16.150			
G4	S4	20.338	G4'	S14	15.229
	S13	22.558		S15	16.858
				S4	19.042
G5	S13	22.558	G5'	S5	20.258
	S2	23.467		S10	20.996
	S12	24.492		S9	21.829
G6	S1	32.392	G6'	S11	25.265
	S3	32.450		S1	26.350
G7	S9	35.870	G7'	S13	31.692
			G8'	S8	33.058

The test of the least significant difference (l.s.d): This test has been used to search for the homogeneous groups of sites of outputs (Table 10) (Dagnekie, 1999).

It is important to signal that all calculations have been achieved with the help of the software MINITAB of analysis and statistical treatment of data (X, 2000).

RESULTS AND DISCUSSION

The analysis of the results of the Table 3 shows that the outputs gotten for the first year (1998/1999) are better than those gotten for the second year (1999/2000), excepted for the sites EAC Dehal, Tipaza, Khemis Miliana and Rahouia.

The best outputs for the 2 years are gotten on the sites of Guelma, Oued Samr and Rahouia. Whereas the bad outputs appear at the level of the sites of Beni Slimane, Aïn Bessam, Tiaret and Sidi Bel Abbès. Otherwise, the best middle outputs of the hard wheat varieties for the set of the 2 years and for the set of the studied sites are gotten for the seven following varieties: GTA Dur, Chen's, B. Dur 1.94, Waha, Bidi17/Waha/Bidi17, Ofanto and Simeto (Table 4). The bad middle outputs are given by the varieties: T. Polonicum xZ.B, Mohamed Ben Bachir, Bidi 17, Oued Zenati 368, Polonicum and Hedba 03 (Table 4).

The results of the Table 5 show that some very highly significant differences exist between years for 10 sites and those significant differences don't exist between years for 4 sites that are: Oued Smar, Djendel, Sidi Bel Abbés and Abdelkader.

The results of the analysis of variance gotten for 1998/1999 (Table 6) and for the year 1999/2000 (Table 7), show that significant differences don't exist between the middle outputs of the 24 varieties of hard wheat and this for each of the two years. The value of the (p) probability is, every time, superior to the level of significance $\alpha = 0.05$.

The exam of the results of the Table 8 and 9 relative to the comparison of the middle outputs of the set of the 24 varieties of hard wheat between the sites for the first year and between the sites for the second year show the existence of, every time, very highly significant differences between the sites. The value of the probability $p = 0{,}000$ being lower in every case to the level $\alpha = 0{,}001$.

The method of least significant difference (l.s.d) gives 7 homogeneous groups of sites of middle outputs for the year 1998/1999 and 8 groups of sites for the year 1999/2000 (Table 10). We note that the groups of sites are not, the same for the 2 years.

CONCLUSION

The statistical analysis of the middle outputs of the 24 varieties of hard wheat experimented on 17 sites during 2 successive years show:

- The existence of very highly significant differences, on the one hand, between years for 10 sites and, on the other hand, between sites for each of the 2 years for the set of the 24 variety of wheat.
- The non-existence of significant differences between the middle outputs of the 24 varieties of wheat for each of the 2 years for the set of the studied sites.
- The existence of 7 groups of sites of homogeneous outputs for the first year and 8 groups for the second year.

It is well obvious that the results gotten on two years are insufficient to be able to pull very reliable conclusions on the different varieties of hard wheat tested. However, our survey constitutes a first step for a big program of genetic improvement of the studied varieties of hard wheat.

In agronomy this kind of experimentation is achieved during several years and on several sites in order to have data that reflect the real conditions of the middle sufficiently.

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