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NEWER EXPERIMENTS ON THE TECHNOLOGICAL
VALUE OF GREEK DURUM WHEAT

[Following is a translation of an article by B. Kokolios, Director of the Wheat Institute, Thessaloniki, and Technology Laboratory of the Wheat Institute, in the Greek-language journal Gheoponika (Agriculture), Vol 94-95, Thessaloniki, May-June 1962, page 1-10.]

Summary

Report contains
Reference is made to the special technological characteristics of the wheat tr. Durum, which lead to its exclusive use for the production of semolina flour and macaroni products. Bibliographical data are summarized concerning factors which affect the industrial value of the products (varieties, soils, fertilizers), and mention is made, according to latest available data, of qualitatively-improved producing varieties. Concerning the planned acreage expansion of Greek durum earmarked for export, the following points are studied in this article:

1. The qualitative yield and classification of the new improved varieties, as well as of the latest experimental varieties of Greek durum wheat, based on samples taken from five experimental plots.

are made
Following measurements involving color, one hundred liter weight, weight of 1,000 kernels, ash and protein content, plastic qualities of semolina and color of semolina in B carotene (p. p. m.) (parts per million), three varieties:

Γ -58123, Γ -58301, Γ -46049 (Γ = gamma), are listed at the top. The newest varieties, tried for the first time, did not show up as well, with Γ -63848 and Γ -66290 being the best among them.

2. The favorable influence of fertilizing with 3 + (2 + 1) - 6 - 0 upon the above chemical-technological characteristics, which is considered significant as to the protein content of the wheat and the plastic qualities of the semolina flour, as well as the relative influence of the time of harvest.

3. Finally, the data of this paper are compared to parallel values of well-known foreign hard wheats, (Amber Durum), (Spanish Hard Wheat), and methods are suggested for the systematic control of Greek durum wheat and particularly for that wheat which is destined for export.

(End of Summary)

Botanically, we know that Durum hard wheat comprises a particular species, characterized by 28 chromosomes, as against the 48 chromosomes of soft wheat (Vulgare) (1). Regardless of this basic difference, Durum wheat is further characterized by other properties, some of which concern the technology of the product. It is mainly due to these qualities that Durum wheat is utilized for the production of semolina flour and macaroni products.

After milling, Durum wheat produces a flour with flowing gluten, qualities of fluidity which are substantially inferior, and a bread-making capacity much inferior to that of Vulgare wheat, and it is thus not utilized for bread-making. However, because of their chemical composition, Durum wheats are richer in total protein, fats, inorganic salts, cellulose, dissolving sugars, dextrin, and the fatty-soluble yellow color of the endosperm, due to B carotene (provitamin A).

Durum wheat is unique in terms of its structure and mechanical qualities. The protein and starch molecules of the endosperm are distributed and arranged homogeneously, thus creating an endospermic whole which is characterized by great compactness and hardness, as well as crystalline section and texture. The result of this arrangement of molecules is the high weight per hundred liters, the high specific

gravity, the increased weight of 1,000 kernels, and the great yield in semolina flour which is the raw material for macaroni products.

During production of semolina flour, the compression of the endosperm leads mainly to the production of small or large grains of semolina and only to a very limited extent of a certain quantity of very inferior flour. Considering the conditions under which the newer macaroni producing mills operate (2), they require as raw material semolina from the second commercial category, which harmoniously combines the best possible physical, chemical and plastic qualities.

Therefore, the desirable semolina should come from Durum wheat which has the following characteristics: amber color, the highest possible weight per one hundred liters, crystalline section, great hardness of the endosperm, highest protein content, lowest possible ash content, highest possible yield in yellow semolina, and good plastic qualities. This yields the best possible macaroni products.

Two groups: the A. A. C. C. (4) ([Note]: American Association of Cereal Chemistry) and the I. G. G. (5) ([Note]: Internationale Gesellschaft fur Getreide Chemie - Vienna -), are working with the foremost institutes and wheat products industries towards the development of methods and controls concerning the manufacturing value of Durum wheat and its products. The above is significant in view of the fact that today nowhere is there any uniformity of approach concerning appropriate laboratory methods.

Bibliographical Study

Concerning the development and choice of strains of wheat, and the effect of geography and fertilizers on the chemical composition of the kernel, we can be totally guided by findings published in the latest study of the Foundation under the title of "Bread-making (panifiable) qualities of certain varieties of Greek wheat" (6). In addition, we can refer to the more specific studies and communiques of the Wheat Institute concerning the effect of fertilizers, in which it is stated that nitrogen fertilization, in particular the application of nitrogen in the form of nitrate in the spring, contribute to the increase of the protein content and the improvement of the fluidity characteristics of the product (7). An extensive bibliography is devoted to the above studies. Beyond that, research dealing with Durum

wheats is being directed now to factors affecting compactness, hardness, crystalline qualities of the kernel, yield in semolina flour and, as far as it is possible to ascertain, characteristics of the macaroni-products deriving from it. We learn from a relevant article of Professor Fabriani and his co-workers (8) that the most important laboratories in the world do not follow similar methods of research.

The problem of variation in the particular properties of Durum wheat as they relate to strains and ecological conditions has been of special interest to international research. One phenomenon in particular was noticed and studied, namely, the appearance totally or in part of flour-bearing kernels, which is internationally known as "mitadinage". This phenomenon involves a change in the desired structural condition of the kernel. According to Leclerc's (9) work, there is a correlation between the protein content and percentage of crystalline kernels, and an increase of the flour-bearing kernels following an increase in rainfall or irrigation. We notice, moreover, the beneficial effect of previous leguminous cultivation and the resultant supplying of nitrogen, and it appears that the shorter the growing period, the larger the nitrogen content and hardness of the kernels.

According to Persival, heavy soils contribute to the appearance of "mitadinage" (1), whereas, as far as varieties are concerned, it appears that those most susceptible to "mitadinage" are the most productive, the most desirable and the best adapted (1). Christiansen, Weniger (10) and Emre, after painstaking research in Turkey, reached the conclusion that the appearance of "mitadinage" is favored by heavy soils, fertility of the area, rainfall in combination with low temperatures, irrigation, and all the factors which lengthen the biological cycle of the plant. The latest research by Sallans and Simmonds (11) correlates the yield with "mitadinage," unless a factor subject to variation is the nitrogen present.

Nitrogenous fertilizing applied on the surface until flowering limits the appearance of "mitadinage" without a decrease in yield. The above conclusion has been reached by other researchers (12) (13). According to E. Valdeyron and Seguela (17), who drew up the most complete bibliography and experimental study on the question of "mitadinage," and more generally on factors affecting the commercial value of Durum wheat, the desired mechanical characteristics of the kernel (hardness, crystalline quality, resistance to breaking), the protein content, and plastic qualities of the resulting

semolina flour are improved principally by the following:

1. the creation or selection of the proper strains;
2. the abundant application of basic nitrogenous fertilizer or green fertilizer, essentially a surface application of nitrogen both until flowering and shortly before the drying out of the flowers, since the structural damage and the ensuing qualitative decrease is due to nitrogen shortage during the above-mentioned periods. If, during the ripening period, the kernel enters into contact with water (for example, because of rain), it assumes a specific aspect, similar to the phenomenon of "mitadinage". However, the "washed" kernel undergoes only an undesired structural change which is not accompanied by a decrease in its protein content. Naturally, the damage caused by washing, with a resultant decrease in the semolina yield, cannot be dealt with by fertilizer application.

The Evolution of Research

The Wheat Institute, aside from its above-mentioned research on fertilizers, has made further advances in the study of the technological value of the Greek durum wheat (14), and in particular of the improved varieties, among which are varieties T-46049, T-58301, T-58128. These strains are in the seed-production stage and show a very satisfactory qualitative yield. Similar results are apparent in the related studies made by the Special Laboratory of the Ministry of Commerce (20).

Broader horizons have already been opened for the expansion of Greek Durum wheat acreage, aimed at increasing the production of macaroni products and their sale in the world market as a result of their satisfactory industrial value. Similar thoughts and perspectives are developing in other countries of the Mediterranean basin (North Africa, Middle East, Italy, France).

In view of the above, efforts applied to Greek Durum wheat aimed at uniformity and improvement of its qualities are expanded by developing new strains of Durum, setting up of special experimental plots of Durum wheat, experimental applications of fertilizers, and adopting, in the laboratory, the newest applications of chemical-technological methods (see methods), in conjunction with recently developed equipment.

At the present time, research work covers two areas, which will be described under (A) Strains, and (B) Fertilizers.

A) Strains

During the period 1960-1961, five special experimental plots were set up in Thessaloniki, Dhourouti, Larissa, Kopaida, and Messara (Crete), from whose production 12 varieties were specifically studied. Among them, we mention here the improved Γ -5770, Γ -46049, Γ -58128, Γ -58301, and some newer ones which have been technologically tested because of their encouraging agricultural characteristics. The results obtained from laboratory analyses of the relative samples are given in tables 1A, 1B, 1C, 1D, 1E.

B) Fertilizers and Date of Harvest

Two experimental fertilized fields were set up during 1960-1961 in Thessaloniki and Nea Zoi under trial fertilizing with $3 + (2 + 1) - 6 - 0$, one variety (Γ -58128), the application of four cuttings and experimental parceling "split-plot" (one strain, two applications of fertilizer control + trial, four cuttings, three repetitions.) The fertilizing consisted of: A) basic application of sulphuric ammonia and six units of diluted phosphate and, B) surface application of calcium nitrogen ammonia in January and February. The production from both experimental plots, amounting to a total of 48 samples ($2 \times 2 \times 2 \times 3$), was examined in the laboratory. These data are presented in Tables IIa and IIb.

Discussion

A. Strains - Geography

The strain Γ -58128 stands out among the improved varieties of Durum which have been earmarked for production, because of its very satisfactory industrial value. This variety is at the head of all the others from all basic criteria in each experimental plot, and it shows excellent plastic qualities in its semolina flour. Next comes the variety Γ -58301, and then follows the variety Γ -46049, whose protein content was not satisfactory. The variety Γ -5770 (Limnos) was found wanting in specific basic traits concerning the crystallinity of the kernels and the plastic qualities of the semolina.

The locally found strains, including Y/11 (Deves) and Roussias, never came close to the leading variety Γ -58128 for most characteristics to the other two, but they surpassed Γ -5770 in all comparisons. The seven newly-tested strains

(Γ-63848, Γ-63849-IA3, Γ-65874, Γ-66187, Γ-66287, Γ-66289, Γ-66290) did not evidence superior characteristics. Even though they were not found inferior as to color, one-hundred-liter weight, weight of 1,000 kernels, crystallinity of kernel, ash content, and color of semolina or protein content, they showed a low semolina yield, and had insufficient plastic qualities not generally surpassing those of the strain Γ-5770. In order of quality, the first three of the above are: 1) Γ-66187, 2) Γ-66290, and 3) Γ-66289.

Significant differences in different experimental plots were observed among the data collected for this strain. The most substantial variation took place in the values dealing with the weight of 1,000 kernels, ash content, protein complex and plastic qualities of the semolina. In terms of qualitative yield, the experimental plots may be ranged in the following order:

1) Messara experimental plot, 2) Kentrikou experimental plot, 3) Larissa experimental plot, 4) Dhourouti experimental plot, 5) Kopais experimental plot.

The production of the first three plots is very satisfactory, whereas the production of the last two does not appear desirable for industrial use. This means that the choice of proper terrain is very significant, in order to guarantee the efficient combination of yield and quality of product.

Table 1F was drawn up for purposes of comparison. It contains values presented in this paper which describe the most important varieties, and the characteristic values of Spanish Durum wheat imported into Greece two years ago. Finally, Table 1F contains the range of certain values of Amber Durum wheat, which today is considered best for industrial purposes. These data were derived from the publications of the Winnipeg (Canada) [see note] Wheat Institute, in which Canadian export wheat was subjected to chemical-technological study on a quarterly basis.

[Note:] The values of Amber Durum are determined according to methods used by the Greek Wheat Institute. Beyond that, the Wheat Institute in Winnipeg determines the plastic qualities by means of a special farinograph, and engages in experimental production of macaroni products (16).

From this comparison, the following conclusions are reached:

The superiority of Canadian Durum wheat is due to the achievement, after long experimentation, of standardization of production. The basic technological characteristics of the wheat are kept within a very narrow range which is very favorable to utilization by industry, independent of geographical and time factors.

A one-hundred-liter weight above 79, a protein content above 14, a corresponding satisfactory range of the color of the endosperm, and high plastic qualities guarantee for Amber Durum wheat a consistently high yield in semolina having high nutritional value and macaroni-making qualities. However, and in spite of existing opinions on this subject, the crystalline kernels of Amber Durum show a great range of variability. Spanish wheat does not present any particular interest.

Compared to the above varieties, Greek Durum wheat presents wide variations in relation to geography and season. It ranges in quality from as good as Amber to unsatisfactory, due to the peculiar climatological and geographical heterogeneity of Greece.

In spite of the above, the average level of the Greek varieties remains very satisfactory.

B. Fertilizers - Mowings

Factors affecting the color of the kernel, the one hundred liter weight, the weight of 1,000 kernels, and the ash content were so much due to fertilizers as to the time of harvest. This factor has a direct bearing on: 1) the protein content of the kernel, 2) the plastic properties of the semolina (energy - greatest height of the extensogram) (see methods, 3) and the color of the semolina spectrophotometrically determined, as given in Table IIc, which includes average values and S. S. D.

Comparable to our similar research on Vulgare wheat (7), significant and substantial differences affecting the protein complex and plastic properties, independent of harvest, were noted for fertilizers.

The time of harvest, dependent on the humidity condition of the kernel, is relevant. A decrease in the protein content of the kernel has been noticed in all cases from the first to the last harvest. This decrease was found to be

significant in the Nea Zoi experimental plot (fertilizers having been applied).

On the other hand, the extensiographic energy comprising the plastic properties of the semolina assumes its greatest value between the second and third harvest, except in the case of the Kentrikou experimental plot (fertilizer having been applied).

The above data, along with the observed decrease in the total protein content with respect to date of harvest, may suggest exploring the advisability of harvesting hard wheat when the average humidity of the kernel is greater than the usual one, and within a range of about 14-18%. The application of fertilizer contributed appreciably, regardless of time of harvest, to the maintenance of the color of the semolina within desirable limits comparable to the characteristics of Amber Durum. Concerning the percentage of crystalline kernels, the variations which were expected from fertilizer application were not observed (17). This is admittedly due to the fact that the proper date and quantity of fertilizer to be applied superficially has not been determined. The research effort to the Wheat Institute is now being applied in this direction.

C. Concerning the whole area under study

Concerning the existing need for a systematic technological control and standardization of Durum wheat, the following could be adopted in view of our ecological conditions:

1. During the harvesting of hard wheat, in addition to establishing the one-hundred-liter weight and the crystallinity of the kernels, determination must also be made, by means of dry analysis or standard wet analysis, of the protein content of the ashes and of moisture for the evaluation of results.

2. More specifically, large samples of Durum wheat earmarked for export must be tested in a more systematic way, as the increasing availability of equipment permits, by means of special tests and semolina-making and macaroni-making test batches which the Wheat Institute is gradually including in its procedures.

The analyses, tests and relative criteria applied for this purpose are as follows: [Note:]

[Note:] The proposed analyses and tests go beyond those required by the existing Agricultural Code, and they represent a selection or application of methods used by researchers Anderson (Canada), Guneo (Italy), Faoriani (Italy), McKay (England), Matweef (France), Navellier (France), Palshenke (West Germany), Silvela (Spain), Schmutz (Switzerland), and Thomas (East Germany), as presented to the Vienna Conference of the I.G.G. in 1960 (5) (8).

<u>Tests on wheat</u>	<u>Cat. A1</u>	<u>Cat. A2</u>
Color (see methods)	A or B	--
-- 100 liter weight	≥78	≥74
-- 1,000 kernel weight, dry analysis	≥35	≥30
-- Crystalline kernels	≥80	≥65
-- Protein content (5.7 xN) dry analysis	≥12%	≥10%
-- Ashes dry analysis	≤1.6%	≤2.0%

<u>Tests on semolina</u>	<u>Cat. A1</u>	<u>Cat. A2</u>
-- Color in B carotene, dry analysis (p.p.m.)	4--6%	--
-- Energy, extensiographic method	≥30	≥15
-- Lipoxydation (The determination has a particular value for the semolina intended for macaroni products, but the relative method is still under study everywhere).		

Tests on products of experimental macaroni-making

-- Taste and odor before and after boiling:	Pleasant
-- Surface	Smooth, without roughness or breaks
-- Cut	Crystalline
-- Color (evaluated before and after boiling)	Yellow - amber and not ash-colored, capable of being objectively tested by means of the proper analytical method.
-- Boiling trial -- Time	Within 20 minutes at most, giving an elastic product not sticky or runny.

- Boiling trial -- Swelling After boiling the volume should double, and the absorbed liquid must correspond to one half the weight of the sample before boiling.
- Percentage of material contained in the water after the boiling trial 7% (for determination of solid remnant)
- Quality indicator Guneo (Italy) $Q = \frac{T.A_v.A_p}{S}$

Whereas:

Q = Quality indicator
 T = time of boiling in minutes
 A_v = solid remnant found in boiled water
 A_p = absorption of water

METHODS

The laboratory methods applied to this study, most of which have been presented in detail in the general or special articles and journals of Food Chemistry or of the Chemistry and Technology of Wheat, are hereby greatly summarized:

1. Weight of 1,000 kernels: By counting of 500 and weighing.
2. 100-liter weight: By special arrangement (4).
3. Color of kernels: estimated as follows (A: yellow, B: amber, C: reddish, D: dark red).
4. Moisture: According to Brabender at 130° C/1h (27).
5. Ashes: At 585° C/24h (4).
6. Protein content (N x 5.7): A.A.C.C. (Kjeldahl) (4).
7. Extensiography on semolina to determine plastic properties (energy - greatest height):

The alveographic method demonstrated by the Chopin Company according to the requirements of the Comite Professionnel de la semoulerie francaise (2) (Professional Committee of French Semolina makers) applied to the study of French Durum wheats cannot be utilized for the good quality Greek varieties because of the limited height

potential of the Alveograph.

In view of this, the method was adapted to utilize the Brabender extensiograph with great success without any change of conditions. (Water 45%, without NaCl, applied to 15% humidity unsalted semolina, kneading in a farinograph and homogeneization for eight minutes, taking of sample of 150 grams of wet semolina paste, and extensiography after one half-hour stay in the kneading chamber of the extensiograph.)

8. Experimental production of semolina:

Achieved in a Brabender automatic test mill especially set and fed with hard wheat having a moisture content of 16.5%.

The semolina achieved after sifting and separation from the residue and flour corresponds in terms of the size of the grains to the second and third commercial grades. The yield obtained, which fluctuates between 45-55%, is indicative and does not reflect the commercial yield.

9. Color of semolina;

According to the Ferrari method applied to the chemistry of wheats (19), five grams of semolina are soaked for one night in 25 cubic centimeters of butyl alcohol and are analyzed on the following day.

The same is studied in the Beckman B spectrophotometer and has a wave length of 236 m.
(Yield in B carotene p.p.m.)

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Appendix: Tables

Table 1a: Experimental Plot
Kentrikou

(1) ΠΟΙΚΙΛΙΑ	(2) ΕΠΙΣΤΟΙΧΙΑ	(3) ΕΙΣΟΔΟΣ										(4) ΣΥΝΟΛΙΚΑ			
		ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ
1	ΥΕ-41	Β	76,54	38,31	86	12,44	1612	431	323	360	4,34	3,34	3,34	3,34	3,34
2	Υ-5770	Α	76,54	38,31	84	11,17	1453	532	192	320	7,40	3,34	3,34	3,34	3,34
3	Υ-46049	Β	77,73	42,10	85	9,20	1597	520	360	589	3,34	3,34	3,34	3,34	3,34
4	Υ-50128	Β	77,50	40,00	93	13,70	1507	520	510	4,90	3,34	3,34	3,34	3,34	3,34
5	Υ-58301	Β	76,50	38,18	88	11,42	1625	523	400	587	3,34	3,34	3,34	3,34	3,34
6	Υ-63848	Α	77,25	36,72	60	11,28	1519	538	-	7,06	3,34	3,34	3,34	3,34	3,34
7	Υ-63849-183	Α	77,73	39,53	53	10,23	1359	430	102	754	3,34	3,34	3,34	3,34	3,34
8	Υ-65874	Β	77,00	39,58	82	10,19	1505	440	140	631	3,34	3,34	3,34	3,34	3,34
9	Υ-46187	Β	77,50	33,31	83	11,54	1370	452	110	501	3,34	3,34	3,34	3,34	3,34
10	Υ-66287	Β	79,30	39,33	91	11,60	1284	451	220	615	3,34	3,34	3,34	3,34	3,34
11	Υ-66289	Β	78,00	38,89	85	13,57	1301	440	282	587	3,34	3,34	3,34	3,34	3,34
12	Υ-66290	Β	78,30	43,45	89	10,79	1345	422	170	677	3,34	3,34	3,34	3,34	3,34

Table 1b: Experimental Plot
Messara

(1) ΠΟΙΚΙΛΙΑ	(2) ΕΠΙΣΤΟΙΧΙΑ	(3) ΕΙΣΟΔΟΣ										(4) ΣΥΝΟΛΙΚΑ			
		ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ	ΕΠΙΣΤΟΙΧΙΑ
1	ΕΜΦΩ102	Α	78	50,68	83	12,60	1725	480	283	355	3,34	3,34	3,34	3,34	3,34
2	Υ-5770	Β	80	50,31	88	11,82	1570	500	120	516	3,34	3,34	3,34	3,34	3,34
3	Υ-46049	Β	80	48,44	71	9,78	1501	503	270	519	3,34	3,34	3,34	3,34	3,34
4	Υ-50128	Β	803	48,40	94	15,00	1675	513	425	472	3,34	3,34	3,34	3,34	3,34
5	Υ-58301	Α	815	48,10	91	12,36	1596	520	351	564	3,34	3,34	3,34	3,34	3,34
6	Υ-63848	Α	803	47,04	78	11,45	1392	520	165	605	3,34	3,34	3,34	3,34	3,34
7	Υ-63849-183	Α	81	47,16	92	9,29	1474	503	150	642	3,34	3,34	3,34	3,34	3,34
8	Υ-65874	Α	80	47,75	90	12,21	1665	490	110	538	3,34	3,34	3,34	3,34	3,34
9	Υ-46187	Β	705	43,30	92	11,31	1715	500	150	435	3,34	3,34	3,34	3,34	3,34
10	Υ-66287	Β	81	51,36	98	10,06	1677	493	210	599	3,34	3,34	3,34	3,34	3,34
11	Υ-66289	Β	80	47,73	97	12,30	1744	463	180	476	3,34	3,34	3,34	3,34	3,34
12	Υ-66290	Β	803	54,71	94	12,33	1680	513	210	408	3,34	3,34	3,34	3,34	3,34

[See legend for tables and figures on last page]

Table 1c: Experimental Plot
Larissa

①	②	③	④										⑤			
			⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	77-11	A	77°	4310	27	11.45	1284	44.40	25°	280	4.68					
2	7-5770	B	79°	4277	46	10.34	1291	44.80	125°	220	6.31					
3	7-46049	A	-	5080	29	10.39	1245	-	-	-	-					
4	7-58128	A	80°	4014	88	11.83	1385	47.40	44°	460	3.22					
5	7-58301	A	81°	4068	79	11.03	1509	48.70	285°	340	-					
6	7-65848	A	84°	3787	57	10.34	1158	46.00	173°	220	7.52					
7	7-65849 (A)	A	78.5	3478	58	9.37	1309	49.00	69°	200	7.00					
8	7-65876	A	79.5	3674	70	11.00	1361	47.70	125°	180	6.10					
9	7-66107	B	78.5	3734	78	10.00	1351	46.60	175°	260	5.84					
10	7-66287	B	80°	4174	82	11.70	1271	50.30	175°	220	5.04					
11	7-66289	B	79.5	4034	69	11.11	1349	48.00	150°	220	5.25					
12	7-66290	B	79.5	4080	73	11.05	1090	49.40	120°	220	5.09					

Table 1d: Experimental Plot
Dhourouti

①	②	③	④										⑤			
			⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7-5770	A	-	4945	28	9.98	1954	-	-	-	-					
2	7-46049	A	78.25	4811	21	9.85	1910	45.5	120°	260	10.63					
3	7-58128	A	81.00	4657	46	10.37	1804	51.9	340°	380	7.33					
4	7-58301	B	81.00	4571	57	10.41	1768	51.4	280°	360	9.08					
5	7-65848	A	77.75	4307	15	9.43	1873	-	95°	200	9.66					
6	7-65849-1A3	A	78.20	4561	11	9.16	1815	46.9	80°	180	8.45					
7	7-65876	A	79.00	4160	16	10.36	1899	51.4	60°	200	9.94					
8	7-66187	A	77.30	4199	27	9.67	1915	49.0	115°	260	11.04					
9	7-66287	A	79.50	3797	14	10.07	1836	50.9	60°	200	8.19					
10	7-66289	A	78.50	4378	24	9.99	1980	52.0	115°	260	11.93					
11	7-66290	A	79.50	4434	30	10.01	1899	48.9	125°	260	11.78					

Table 1e: Experimental Plot
Kopais

(1) ΠΟΙΚΙΛΙΑΙ	(2) ΕΠΙ ΣΙΤΟΥ						(3) ΕΠΙ ΣΕΜΙΔΑΛΕΩΣ			
	ΣΥΣΤΗΜΑ	ΕΚΑΤΟΜΕΤΡΙΚΟΝ ΒΑΡΟΣ ΕΠΙ ΣΗΡΟΥ	ΒΑΡΟΣ 1000 ΚΟΚΚΩΝ ΕΠΙ ΣΗΡΟΥ	ΚΟΚΚΩΝ ΥΑΛΩΔΕΙΣ ΕΠΙ ΣΗΡΟΥ	ΠΡΟΤΕΙΝΙ-ΚΟΝ ΠΕΡΙΕΧΟΜΕΝΟΝ ΕΠΙ ΣΗΡΟΥ	ΤΕΦΡΑ ΕΠΙ ΣΗΡΟΥ	ΑΠΟΔΟΣΙΣ ΕΙΣ ΣΕΜΙΔΑΛΗΝ	ΕΝΕΡΓΕΙΑ	ΜΕΓΙΣΤΟΝ ΥΨΟΣ	% Β. Καρπί-νιου (P.F.M.)
1 Γ-5770	B	-	43.35	40	9.81	1870	-	-	-	-
2 Γ-46049	B	-	43.10	38	10.81	1998	-	-	-	-
3 Γ-58128	B	78.50	43.10	45	12.77	1994	47.8	200	260	5.07
4 Γ-58301	B	79.30	40.74	57	10.87	1842	44.0	140	240	4.78
5 Γ-63848	A	78.30	41.80	22	9.18	1843	43.7	70	160	4.46
6 Γ-63849-1A3	A	77.00	41.30	21	10.05	1834	43.8	140	220	4.30
7 Γ-66187	B	78.30	42.73	40	8.30	1859	48.7	75	180	4.09
8 Γ-66187	A	76.30	36.74	74	10.89	1967	49.5	90	200	4.39
9 Γ-66289	A	78.30	40.73	49	11.98	1848	44.9	130	220	4.16
10 Γ-66289	A	78.00	45.21	26	10.88	1942	47.5	105	228	5.19
11 Γ-66290	B	78.25	42.88	30	10.86	2000	48.9	110	220	6.80

Table 1f: Range of Certain Values of Amber Durum Wheat

(1) ΠΟΙΚΙΛΙΑΙ	(2) ΕΠΙ ΣΙΤΟΥ						(3) ΕΠΙ ΣΕΜΙΔΑΛΕΩΣ			
	ΣΥΣΤΗΜΑ	ΕΚΑΤΟΜΕΤΡΙΚΟΝ ΒΑΡΟΣ ΕΠΙ ΣΗΡΟΥ	ΒΑΡΟΣ 1000 ΚΟΚΚΩΝ ΕΠΙ ΣΗΡΟΥ	ΚΟΚΚΩΝ ΥΑΛΩΔΕΙΣ ΕΠΙ ΣΗΡΟΥ	ΠΡΟΤΕΙΝΙ-ΚΟΝ ΠΕΡΙΕΧΟΜΕΝΟΝ ΕΠΙ ΣΗΡΟΥ	ΤΕΦΡΑ ΕΠΙ ΣΗΡΟΥ	ΑΠΟΔΟΣΙΣ ΕΙΣ ΣΕΜΙΔΑΛΗΝ	ΕΝΕΡΓΕΙΑ	ΜΕΓΙΣΤΟΝ ΥΨΟΣ	% Β. Καρπί-νιου (P.F.M.)
1 Γ-5770	A-B	76.5-80.0	38.79-50.51	28-88	9.61-11.82	1291-1934	44.8-53.2	12.0-19.5	220-320	5.16-7.49
2 Γ-46049	A-B	77.7-80.0	38.80-48.49	21-85	9.28-10.91	1243-1998	49.5-52.0	12.0-36.0	260-380	5.19-10.6
3 Γ-58128	A-B	77.5-81.0	40.14-48.10	44-95	10.37-13.70	1383-1984	47.3-52.0	20.0-51.0	260-480	4.72-5.22
4 Γ-58301	A-B	76.5-81.5	38.10-48.10	57-91	10.41-12.36	1509-1842	44.0-52.3	14.0-40.0	240-420	4.76-9.09
5 Γ-66187	A-B	76.3-78.5	33.34-43.30	27-92	9.67-11.34	1351-1967	44.6-50.0	9.0-19.5	200-340	4.33-11.0
6 Γ-66289	A-B	78.0-80.0	39.85-47.73	20-92	9.91-13.37	1301-1980	44.4-52.0	10.5-20.5	220-320	4.76-11.9
7 Γ-66290	A-B	78.2-80.5	40.80-54.71	20-94	10.04-12.79	1090-2000	42.2-51.5	11.0-21.0	220-300	5.89-11.7
Διαφοροι C.W.										
8 AMBER-DURUM Καναδά (15)	B	79-83	39-40	60-95	15.0-17.0		50.0			4.5-6.5
9 Ξυλινός λαγυ-νίας τελευ-ταιας εισα-γωγής (16)	B	79.5	56.0	65		1837	44.8	41.5	420	7.22

Table II a: Experimental Plot
Thessaloniki

[illegible]

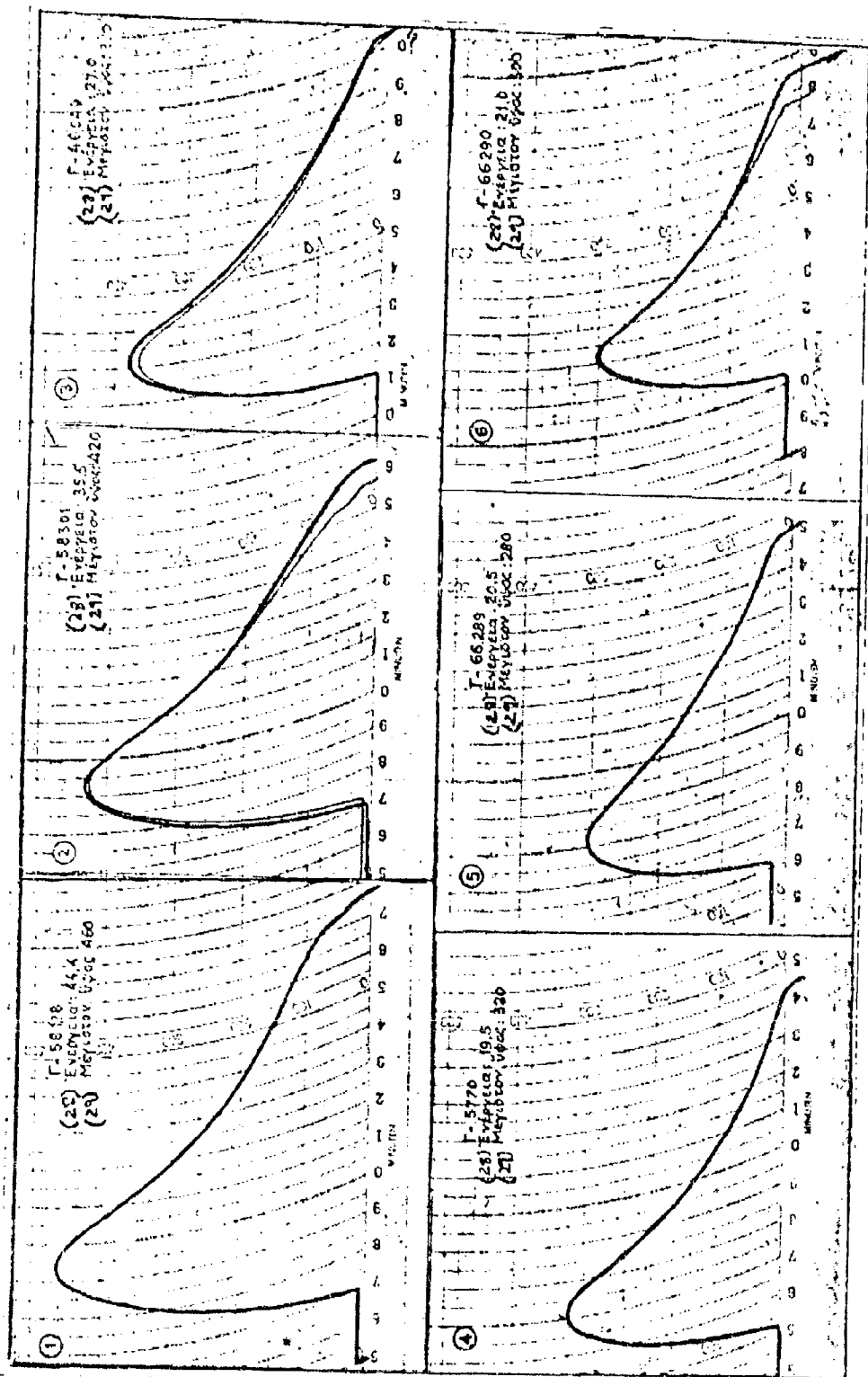
Table II b: Experimental Plot
Nea Zoi

[illegible]

Table II c:

(9)	(31) ΧΑΡΑΚΤΗΡΕΣ	ΑΝΕΞΑΡΤΗΤΟΙ ΘΕΡΙΣΜΟΙ (25)			ΚΑΤΑ ΘΕΡΙΣΜΟΥΣ (10) ΑΝΕΥ ΑΙΠΑΝΙΕΣ (26)					ΚΑΤΑ ΘΕΡΙΣΜΟΥΣ (11) ΜΕΤΑ ΑΙΠΑΝΙΕΣ (27)				
		Λο	Λ1	SSD	1ο	2ο	3ο	4ο	SSD	1ο	2ο	3ο	4ο	SSD
(11)	Α' ΠΕΙΡΑΜΑΤΙΚΟΣ ΚΕΝΤΡΙΚΟΥ													
(21)	Υαλώδεις κόκκοι	86	85	NS	86.5	86.3	87.7	82.3	NS	86.0	85.2	84.0	84.3	NS
(22)	Πρωτεϊνικών σύνολον	13.47	15.83 +++	5% 1.134 1% 1.223	14.21	14.15	13.33	12.18	NS	17.21	16.19	15.94	14.23	NS
(23)	Έξτανσιογραφ. ενέργεια	49.5	64.46 +	5% 16.32	45.0	51.7	54.8	48.7	NS	59.5	63.5	65.8	67.6	NS
(24)	Β. Καροτίτιον (p.p.m.)	7.52	5.46 ++	5% 0.478 1% 0.658	8.16	7.40	7.55	6.96	NS	5.55	5.45	5.45	5.49	NS
(20)	Β' ΠΕΙΡΑΜΑΤΙΚΟΙ Μ. ΣΩΜΕ													
(21)	Υαλώδεις κόκκοι	86	89	NS	86	88	87	82	NS	90	92	88	86	NS
(22)	Πρωτεϊνικών σύνολον	13.98	15.0 ++	5% 0.154 1% 0.213	14.81	14.53	13.39	13.19	NS	16.07	15.47	14.48	14.02	5% 1.29 1% 1.88
(23)	Έξτανσιογραφ. ενέργεια	48.7	55.8 ++	5% 4.81 1% 6.63	53.0	54.5	53.3	34.0 ++	5% 5.54 1% 8.06	56.5	66.7	59.7	40.3 ++	5% 1.38 1% 2.01
(24)	Β. Καροτίτιον (p.p.m.)	7.21	5.97 ++	5% 0.411 1% 0.567	7.67	6.85	7.38	6.96	NS	6.26	5.90	6.10	5.63	NS

REPRESENTATIVE DIAGRAMS OF CENTIM VARIETIES



[Legend:] 1) Varieties; 2) Experiments on Wheat; 3) Experiments on Semolina; 4) Color; 5) 100-liter Weight; 6) 1,000 Kernal Weight, Dry Analysis; 7) % of Crystalline Kernels; 8) Protein Content, Dry Analysis; 9) Ash Content, Dry Analysis; 10) Semolina Yield; 11) Energy; 12) Greatest Height; 13) B Carotene (p.p.m.), Dry Analysis, 14) Experiments on Semolina; 15) Various C. W. (Canadian wheats), Amber Durum, Canada, 16) Spanish Durum from latest imports; 17) Data Without Fertilizers; 18) Data After Application of Fertilizers; 19) Data Collected from "Kentrikou" plot; 20) Data Collected from "Nea Zoi" plot, 21) Crystalline Kernels; 22) Protein Content; 23) Extansio-graphic Energy; 24) B. Carotene (p.p.m.); 25) Date Independent of Harvest; 26) Data of Harvest Without Fertilizer; 27) Data of Harvest With Fertilizer; 28) Harvests; 29) Date; 30) Repetitions; 31) characteristics.

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