

# INFLUENCE OF FERTILIZERS ON THE YIELD AND COMPOSITION OF THE GRAIN IN WHEAT CULTIVATION IN CALCAREOUS SOILS

by

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Included in the series of experiments which the "Centro de Edafología y Biología del Cuarto" (Sevilla) is carrying out to establish the response of the regional soils to the different mineral fertilizers are those realized in the agriculture year 1954-55 with wheat cultivation, which are hereby presented. In them we have tried to establish the influence of fertilizers on the yield, and composition of the grain obtained.

## EXPERIMENTAL TECHNIQUE

Two experimental methods have been adopted. In the first one different fertilizers (nitrogen, phosphorus and potassium) alone, and all their possible combinations have been tried out. In the second we have tried to fix the best level of phosphorus, employing increasing doses of this fertilizer over a uniform base of nitrogen-potassium.

In both tests the method of "chance blocking" has been used, with three repetitions. The uniformity of the ground in each one of the tests has permitted to use plots of 120 m<sup>2</sup>. The crop has been estimated by total weighing in each plot and study of samples in the laboratory. The results which we present correspond to three series of experiments in "Alcalá de Guadaira" ("Hacienda Majada-Alta"), Sevilla ("Cortijo de Cuarto") and Gelves ("Vega"), all in the province of Sevilla (Spain).

### *Characteristics of the experimental soils.*

The three soils have a good physical texture, that of "Cuarto" is rather heavy because of its greater content of clay. They are slightly alkaline (pH 7,58 to 7,80). They have an appreciable content of lime, that of Gelves being rich (25% approx.). The content of nitrogen varies from 0,05 to 0,14% and that of carbon from 0,80 to 0,97% all the soils are very poor in available phosphorus (from 5 to 8 mg/100 g.). The soil from Cortijo de Cuarto is poor and the other two medium in available potassium.

TABLE 1

ANALYSIS OF THE SOILS OF "ALCALA", "CUARTO", AND "GELVES".  
RESULTS EXPRESSED IN % OF THE AIR DRY SOIL AND SIEVED  
BY A 3 MM. SIEVE

	Mechanical analyses				CO <sub>3</sub> Ca %	pH	N %	C org. %	C/N	P <sub>2</sub> O <sub>5</sub> available	K <sub>2</sub> O available
	Clay	Silt	Fine sand	C. sand							
Alcalá..	16,41	39,25	33,10	11,30	5,99	7,80	0,14	0,97	7,0	0,008	0,023
Cuarto..	46,90	19,32	30,50	2,95	5,30	7,58	0,13	0,81	6,2	0,007	0,005
Gelves .	25,12	36,15	38,00	0,70	24,82	7,62	0,05	0,80	16,0	0,005	0,025

Doses of fertilizers applied in the experiments.

A) Experiment with various fertilizers (N-P-K).

The quantities are expressed in kg/ha. of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O respectively.

	Alcalá	Cuarto	Gelves
N	52,5	70	52,5
P <sub>2</sub> O <sub>5</sub>	80	100	100
K <sub>2</sub> O	58	116	232

B) In the tests with increasing doses of phosphorus a common nitrogen and potassium fertilization in each experimental block was used, in the following doses:

	Alcalá	Cuarto	Gelves
N K <sub>2</sub> O	52,5 58	70 116	52,5 46,4

The variation of phosphorous extended from 0 to 1,200 kg/ha. of superphosphate of 16% in P<sub>2</sub>O<sub>5</sub> (0 to 192 kg/ha. of P<sub>2</sub>O<sub>5</sub>).

We used the following wheat varieties:

Alcala: "Capelli".

Cuarto: "Florence-Aurora".

Gelves: "Florence-Aurora" (in the first experiment).

Capelli (in the second type of experiment).

The first experiment at Gelves was carried out in the agricultural year 1953-54 and all the rest in 1954-55.

*Results obtained.* The figures indicated in the following tables express the average yield from the three plots of identical treatment in each locality, in kg/ha.

Table II.

Production in the experiments with different fertiliser  
(N.P.K.) and differences with the control plots.

Fertiliser	Alcala		Cuarto		Gelves	
	Product.	Différ.	Product.	Différ.	Product.	Différ.
K	798	-	1.158	-	1.356	-
N	802	4	1.436	278	1.447	91
N	1.011	213 *	1.627	469 *	1.729	373 *
P	1.066	208 *	1.724	566 **	1.817	461 *
N K	894	.96	1.599	441 *	1.572	216
P K	858	60	1.542	384 *	1.860	504 *
N P K	1.190	392 **	1.663	505 *	2.102	746 **
N P	1.076	278 *	1.589	431 *	2.065	709 *

The significant differences are marked with \*

The differences of maximum significance are marked \*\*

Table III.

Production in the experiments with progressive augmentation of phosphorous fertiliser, expresses Kg/Ha, and differences with the control plots.

Fertiliser	Alcala		Cuarto		Gelves	
	Product.	Différ.	Product.	Différ.	Product.	Différ.
N, K +	896	-	1.129	-	1.142	-
200	921	25	1.247	118	1.222	80
350	986	90	1.350	221	1.272	130 *
500	1.118	222 *	1.674	545 **	1.313	170 *
650	1.158	262 **	1.533	404 *	1.468	326 **
800	1.128	232 *	1.573	444 *		
850					1.405	263 *
950			1.535	406 *		
1.000	1.145	249 *			1.426	284 *
1.200	1.100	204 *				

Figures I et 2 show graphically the first results expressed in percentages of the average yield taking 100 as the value of the control plot.

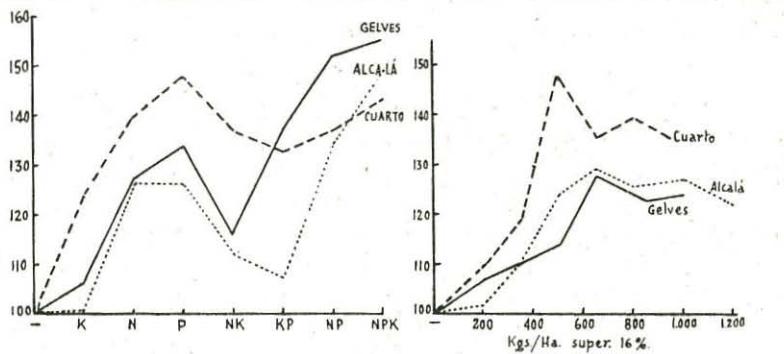


FIG. 1

FIG. 2

Examination of Fig. 1 gives us the following results:

Potassium fertilizer by itself only causes a higher yield in soils deficient in potassium ("Cortijo de Cuarto"). When it is associated with phosphorous or nitrogen, smaller crops were obtained than with these elements alone.

The use of nitrogen as the only fertilizer produces in all the experiments a noteworthy increase of yield, which is slightly greater in general, when it is associated to phosphorus, although a significant interaction of P and N is not indicated.

Phosphorus seems to be, in all soils, the most significant fertilizer, as much used alone, as in conjunction with nitrogen.

Complete fertilization is shown as the most efficient to increase yield, even in the soils well provided with potassium.

#### Influence of fertilizers on the composition of the grain.

The analysis of the wheat grain obtained in each one of the experimental plots has been carried out, and its content in ashes, phosphorus, nitrogen and potassium has been determined. The results are resumed in Table 4 and the figures 3 to 10, expressed in % of weight of the grain.

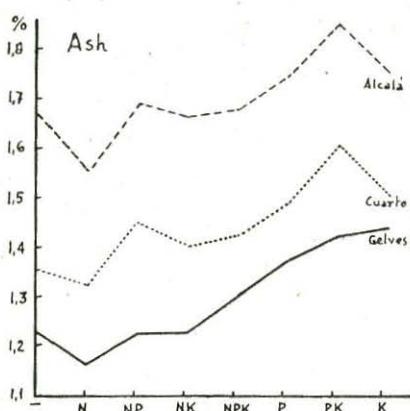


FIG. 3

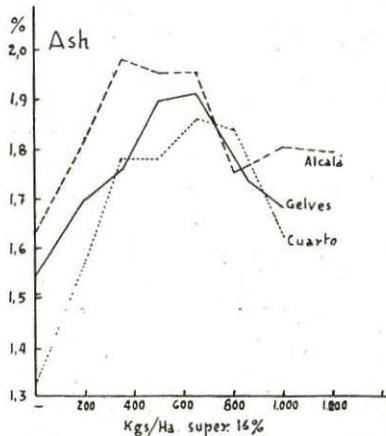


FIG. 4

TABLE IV

Chemical analysis of the wheat grain of the fertilization experiments in Sevilla

Fertiliser	Loca tion*	Ash %	P <sub>2</sub> O <sub>5</sub> %	K <sub>2</sub> O %	N %
-	A	1,66	0,360	0,272	1,97
	C	1,35	0,257	0,278	1,92
	G	1,22	0,380	0,259	1,36
K	A	1,74	0,402	0,291	2,26
	C	1,50	0,306	0,285	1,93
	G	1,43	0,364	0,279	1,54
N	A	1,55	0,295	0,260	2,32
	C	1,32	0,212	0,232	2,17
	G	1,16	0,278	0,249	1,97
P	A	1,74	0,473	0,295	1,98
	C	1,49	0,340	0,309	1,86
	G	1,37	0,447	0,289	1,36
N K	A	1,65	0,385	0,293	2,38
	C	1,40	0,259	0,300	2,23
	G	1,22	0,329	0,268	1,87
P K	A	1,84	0,563	0,304	2,14
	C	1,60	0,401	0,333	1,85
	G	1,42	0,526	0,285	1,70
N P	A	1,68	0,408	0,269	2,32
	C	1,45	0,300	0,304	2,09
	G	1,22	0,334	0,262	1,89
N P K	A	1,67	0,440	0,313	2,32
	C	1,42	0,285	0,326	2,18
	G	1,30	0,470	0,285	1,66

\* A = Alcala ; C = Cuarto ; G = Gelves

Fertiliser	Loca tion*	Ash %	P <sub>2</sub> O <sub>5</sub> %	K <sub>2</sub> O %	N %
without phos- phorous	A	1,62	0,324	0,276	2,36
	C	1,34	0,258	0,303	2,02
	G	1,54	0,309	0,252	2,32
200 Kg/ha. superphosphate 16 %	A	1,82	0,335	0,280	2,27
	C	1,58	0,260	0,305	1,91
	G	1,70	0,363	0,271	2,14
350 Kgs/Ha	A	1,97	0,338	0,290	2,27
	C	1,78	0,277	0,306	1,91
	G	1,76	0,441	0,271	2,17
500 Kgs/Ha	A	1,95	0,403	0,300	2,23
	C	1,78	0,373	0,319	1,93
	G	1,90	0,446	0,362	2,12
650 Kgs/ha.	A	1,95	0,430	0,319	2,23
	C	1,86	0,517	0,361	1,89
	G	1,91	0,470	0,370	2,01
800 Kg/ha	A	1,75	0,521	0,325	2,15
	C	1,84	0,452	0,361	1,89
850 Kg/ha	G	1,74	0,473	0,340	1,98
	C	1,62	0,448	0,325	1,82
1.000 Kg/ha	A	1,80	0,539	0,317	2,10
	G	1,68	0,486	0,340	2,00
1.200 Kg/ha	A	1,79	0,517	0,323	2,14

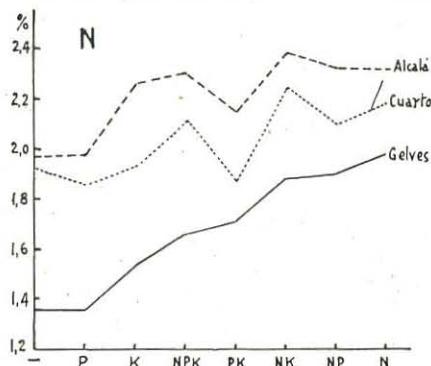


FIG. 5

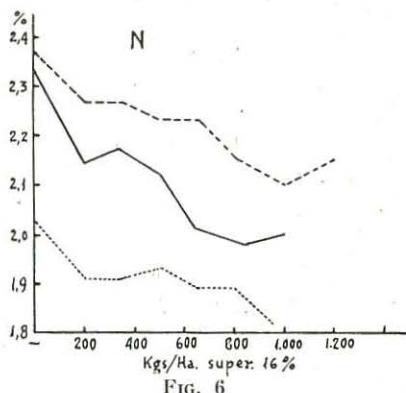


FIG. 6

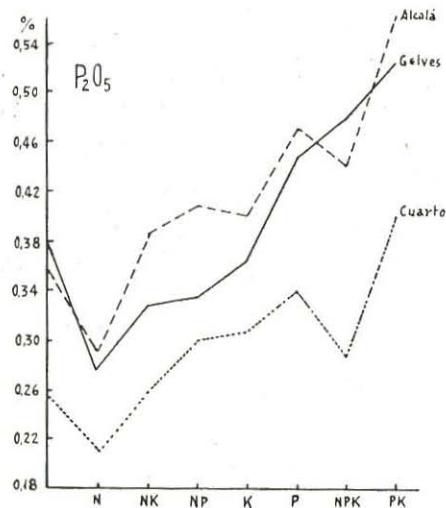


FIG. 7

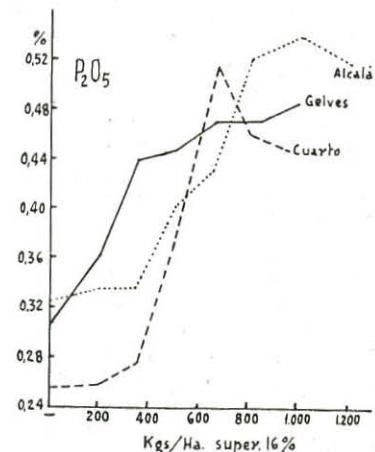


FIG. 8

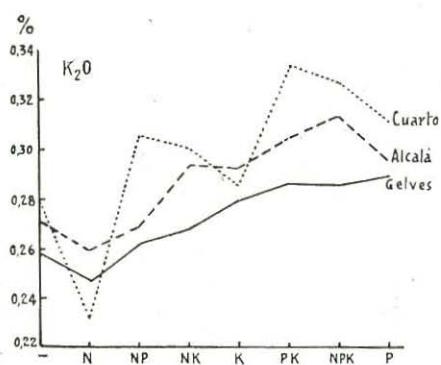


FIG. 9

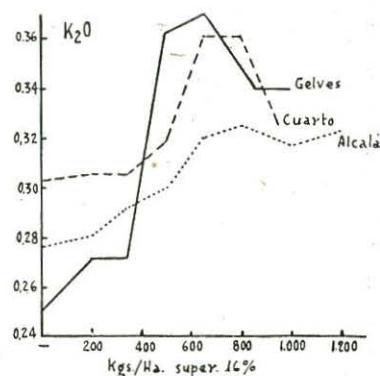


FIG. 10

From examination of these illustrations the following observations are made:

1) The content of ashes of the grain diminishes when nitrogen fertilizers are applied exclusively. On the contrary, it increases with fertilizers of phosphorus and potassium presenting a great increase when both are used simultaneously.

2) The use of nitrogenous fertilizers leads to an elevation of nitrogen in the grain and a lessening of the content of phosphorus and potassium.

3) Phosphate fertilizers determine a marked increase in the content of phosphorus and potassium; a strong interaction between these two elements being noted, and whose combined use leads to the highest percentages of phosphorus. The action over the content of nitrogen is moderate, the percentages of nitrogen presenting a tendency to diminish.

4) Potassium fertilizers influence favourably the assimilation of nitrogen by the grain, raising its content, like that of potassium and phosphorus. The interaction P and K produces also the highest percentages of potassium.

5) The use of increasing doses of phosphorus reveals a progressive diminishment of the content of nitrogen in the grain, a rapid increase in the percentages of phosphorus and potassium as also of ashes, but all present a maximum, to stabilize themselves or to diminish when high doses of  $P_2O_5$  were given. In general, these maximums seemed to coincide noticeably with the larger productions of grain.

6) Assuming that the obtainment of wheat with good contents of nitrogen and phosphorus is of interest it would be convenient to carry out an adequate fertilization so that at the same time as achieving this purpose it would be possible to raise adequately the grain yield. Among the treatments which could be carried out in this double commission N-P and N-P-K are particularly interesting.

### ZUSAMMENFASSUNG

Um die Wirkung von verschiedenen Düngegaben an Böden von Sevilla (Spanien) festzustellen, wurden Versuche an Weizenkulturen in den Jahren 1953-54 und 1954-55 durchgeführt. Die besten Ertragsergebnisse wurden mit P-N- und N-P-K-Dünger erzielt. Der Phosphor zeigt sich am wirksamsten. Mittlere Gaben an Phosphor sind die günstigsten (500-650 kg/ha. von 16 %-igen  $P_2O_5$ ).

Die Analysen der Weizenkörner zeigen den Einfluss des Dunges auf ihre Zusammensetzung. Bei Düngung mit P und K ist eine Zunahme des Aschegehaltes zu beobachten. N verursacht die gegenteilige Wirkung. Die Wechselwirkung von P und K zeigt sich sehr wirksam in der Erhöhung des Gehaltes dieser beiden Elemente im Korn. Steigende Düngegaben an PO zeigen regelmässige Verringerung des N-Gehaltes; während bei mittleren Düngegaben der P- und K-Gehalt in den Körnern stark zunimmt.

**RÉSUMÉ**

Dans le but de connaître la réponse des sols calcaires à Séville (Espagne) à diverses fertilisations, on a effectué des expériences pendant les années agricoles 1953-54 et 1954-55, sur des cultures de blé. Les meilleurs rendements sont obtenus avec les fertilisations P-N et N-P-K. Le phosphore est le plus efficient. Les doses moyennes de phosphore sont les plus avantageuses (500-650 kg/ha de superphosphate 16 %).

L'analyse du blé obtenu démontre l'influence de la fertilisation sur la composition du grain. On constate une augmentation de cendres avec l'emploi de P et K. L'azote produit un effet contraire. L'interaction P×K est très marquée dans l'augmentation de la teneur de ces deux éléments dans le grain. Les doses progressives de  $P_2O_5$  dans la fertilisation montrent une diminution régulière d'azote et des augmentations de P et K, les plus fortes pour doses moyennes.