RESULTS OF THE LONG-TERM EXPERIMENTS WITH FERTILIZERS IN MAIZE

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ABSTRACT

The paper presents certain the results obtained in the period 1967-1995, in maize, on the cambic chernozem soil from Fundulea, in a long-term experiment with nitrogen and phosphorus fertilizers. Yields and yield increases achieved in maize in 29 years of experimentation, for different rates of fertilizers applied have been analyzed. As data were available for a large number of years, the probability of obtaining a certain yield level or yield increase in maize, was established depending on the fertilizer rates. Correlation between yield increases obtained by applying fertilizers and the rainfalls registered in different periods of the year or between rainfalls and nitrogen fertilizers rates were estimated.

Key words: maize, fertilizers

INTRODUCTION

Agricultural research, as well as other kind of research, are usually based on short-term studies, but a sustainable agriculture requires long-term fields and laboratories experiments, capable of determining the complex soil - plant - climate - management interactions (Army and Kemper, 1991).

Long-term field experiments play an essential role in understanding the complex plant-soil-climate interactions and their effect on crop yields, as shown by Frye and Thomas (1991) and Southwood (1994).

As Sandor and Eash (1991) showed, long-term studies carried out in the field are essential for the development of sustainable agriculture systems, because they represent the primary sources of scientific knowledge regarding the agronomic conditions during a long period of time.

Some of the oldest long-term experiments set up in 1843 and conducted also at the present time are those of Rothamsted (England). The history of these experiments, the objectives aimed at and the results obtained were presented in numerous papers as for instance those written by Jenkinson (1991) and Johnston (1994).

Long-term experiments with fertilizers established in autumn of 1967 in our country, fulfil the three requirements mentioned by Frye and Thomas (1991):

- location in an experimental network;
- possibility of using statistical analysis;
- possibility to be extended in the future.

Part of results obtained in these experiments were published in numerous papers: Hera et al., (1976, 1986); Hera and Mihailă (1981); Idriceanu et al., (1985); Mihăilă and Hera (1992, 1994); Popescu et al. (1992) etc. The mentioned papers present mainly present the yields achieved, the determination of fertilizer rates depending on the previous crops and the soil type, the results regarding yield quality and the aspects concerning the modification of certain agrochemical soil indices under the influence of long-term application of fertilizers.

MATERIALS AND METHODS

The researches were performed under non irrigated conditions in maize, in a long-term experiment with fertilizers, located on a cambic chernozem at Fundulea site in the period 1967-1995. The experiment was bi-factorial of 5 x 5 type, containing 25 fertilization variants, whereby factor A consisted of 5 phosphorus levels (0, 40, 80, 120 and 160 kg P_2O_5/ha) and factor B of 5 nitrogen levels (0, 50, 100, 150 and 200 kg N/ha).

Among the 25 experimental variants, only 5 variants were analyzed: the control - unfertilized; a variant in which a smaller nitrogen and phosphorus rate was applied (50 kg N+40 kg P_2O_5 / ha); a unilaterally fertilized with nitrogen variant (150 kg N/ha); a unilaterally fertilized with phosphorus variant (80 kg P_2O_5 / ha) and a variant considered as being optimum (150 kg N + 80 kg P_2O_5/ha). In addition, nitrogen rates were calculated in which maximum yields were achieved on the basic dressing of 80 kg P_2O_5/ha.

Considering the fact that, under non-irrigation conditions, the amount and distribution of rainfalls have an important influence on maize yield and fertilizer effectiveness, we tried to establish the relationship between yields or yield increases obtained and the rainfalls in the different periods (months) of the year.

Based on the results obtained over a rather large number of years (29), under different climatic conditions, the probability of obtaining a certain yield level or yield increase, depending on fertilizer rate, was calculated.

Knowing that the fertilizer rate (especially with nitrogen) depends on the degree of water supply, correlations were established between the nitrogen fertilizer rates and rainfalls in different periods of the year.

RESULTS AND DISCUSSIONS

Maize yields achieved in the period 1967-1995 differed widely from one year to the other both for the unfertilized variant (control) and the variants in which various fertilizer rates were applied.

Thus, in the unfertilized variant and in the variant fertilized with 80 kg P_2O_5/ha, maize grain yields ranged between 2500 kg/ha in 1988 and 8800 kg/ha in 1982 (Figure 1).

When 150 kg N/ha were applied, maize yields differed from year to year, between 2550 kg/ha in 1988 and 10240 kg/ha in 1982 (Figure 1).

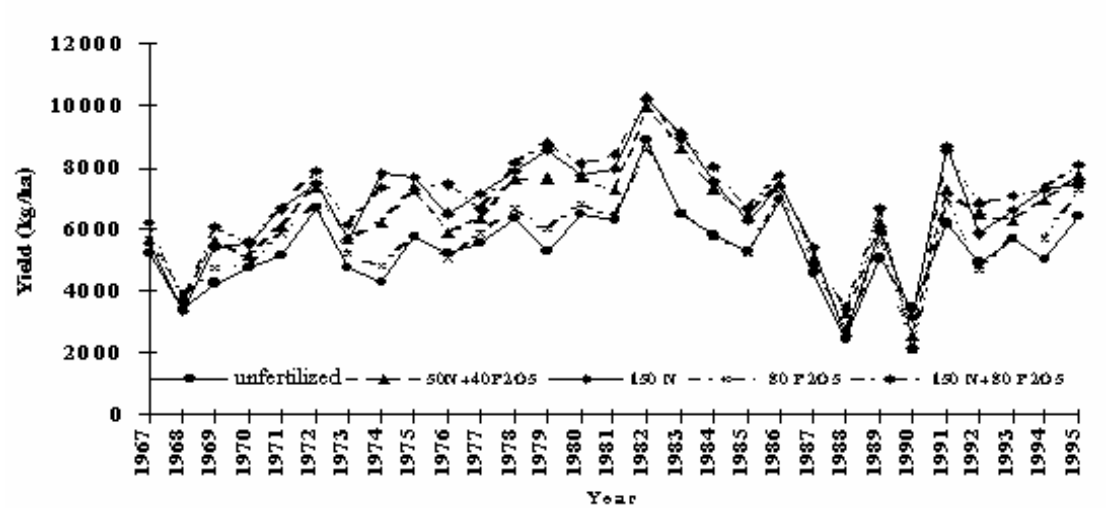

Figure 1. Maize yields on different basal dressings for fertilization. Fundulea, 1967-1995

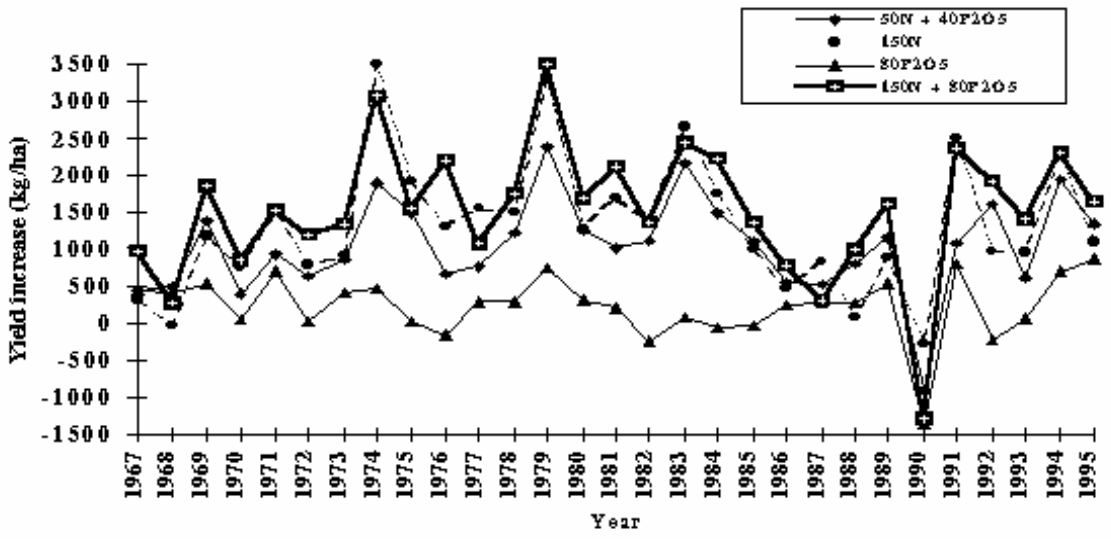

Figure 2. Maize yield increases, on different basal dressings for fertilization. Fundulea, 1967-1995

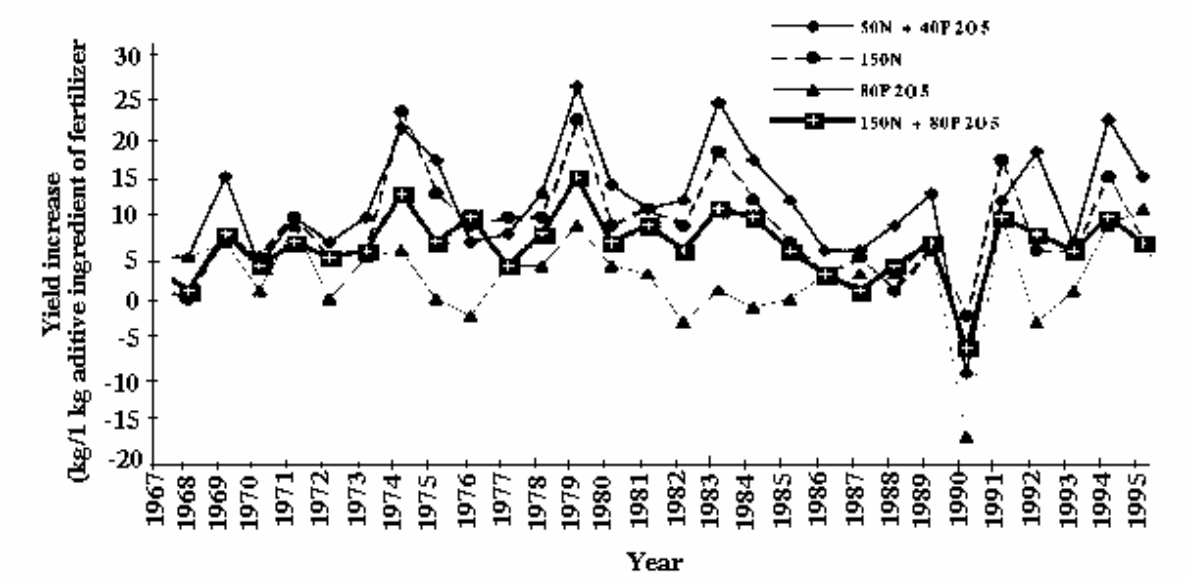

Figure 3. Maize increases, on different basal dressings for fertilization - Fundulea, 1967 – 1995

The yields obtained in the variant 150 kg N + 80 kg P_2O_5/ha varied between 2200 kg/ha and 10200-10400 kg/ha.

Yield increases obtained in maize as a result of fertilizer utilization also differend widely from year to year depending on the applied rate (Figures 2 and 3).

On the average of the 29 analysed years yield gains were of 230 kg/ha in the variant fertilized with 80 kg P_2O_5/ha, 1048 kg/ha when 50 kg N + 40 kg P_2O_5 were applied, 1308 kg/ha for the rate of 150 N/ha rate, 1530 kg/ha for 150 kg N + 80 kg P_2O_5/ha (Figure 2).

The smallest increases were obtained in the variant fertilized with phosphorus only when they didn't exceed 900 kg grains/ha, in any year.

When a small rate of nitrogen and phosphorus fertilizer was applied (50 kg N + 40 kg P_2O_5/ha), increases were higher, reaching up to 2380 kg/ha in 1979 (Figure 2).

In the case of using of 150 kg N or 150 kg N + 80 kg P_2O_5/ha, yield increases in the 29 experimental years were up to 3500 kg/ha in 1979, which provided the highest fertilization effectiveness (Figure 2).

The yield increases obtained per 1 kg of fertilizer active ingredient were on the average per the analysed period of 3 kg in the variant unilaterally fertilized with phosphorus, 7 kg for 150 kg N + 80 kg P_2O_5/ha, 9 kg in the case of 150 kg N/ha and 12 kg grains in the variant fertilized with 50 kg N + 40 kg P_2O_5/ha (Figure 3).

During the analysed period the increases due to 1 kg of fertilizer active ingredient were up to 11 kg in the case of 80 kg P_2O_5/ha, 15 kg for 150 kg N + 80 kg P_2O_5/ha, 23 kg in unilateral nitrogen fertilization (150 N/ha) and 26 kg grains in the variant fertilized with 50 kg N +

Table 1. Probability to obtaine a certain yield level in maize, under non-irrigation conditions, depending of fertilizer rate on the Fundulea cambic chernozem soil

Rate kg/ha	Yield level (grains, kg/ha with 15,5% moisture)							
	below 3,000		3,000-5,000		5,000-7,000		over 7,000	
	No. years	%	No. years	%	No. years	%	No. years	%
Unfertilized	1	3	8	28	19	66	1	3
50 N+40 P_2O_5	1	3	2	7	14	48	12	42
150 N	1	3	2	7	11	38	15	52
80 P_2O_5	2	7	6	21	17	58	4	14
150 N+80 P_2O_5	1	3	3	11	9	31	16	55

Table 2. The probability to obtaine a certain maize yield increase, under non-irrigation conditions, depending on fertilizer rate applied, on the Fundulea cambic chernozem soil

Rate kg/ha	Yield increase (kg/ha grains with 15,5% moisture)							
	below 1,000		1,000-2,000		2,000-3,000		over 3,000	
	No. years	%	No. years	%	No. years	%	No. years	%
50 N+40 P_2O_5	13	45	14	48	2	7	0	0
150 N	13	45	11	37	3	11	2	7
80 P_2O_5	29	100	0	0	0	0	0	0
150 N+80 P_2O_5	7	24	14	48	6	21	2	7

40 kg P_2O_5/ha (Figure 3).

From data previously presented both the yields and the yield increases (achieved per hectare, or by application of 1 kg of fertilizer active ingredient) differed significantly from year to year and with the fertilization variant applied.

Having data over a rather large number of years (29) the probability was calculated for obtaining a certain level of yield and yield increase, depending on the variant of fertilization (Table 1).

Thus, under the given conditions, in the unfertilized variant, in 66% of the cases (on an average, in 2 out of 3 years) the yields were of 5000 to 7000 kg grains /ha, in 28% of the cases (on an average, once in four years) yields were between 3000 to 5000 kg grains/ha and in only one year (3%) the yield was below 3000 kg/ha or over 7000 kg grains/ha (Table 1).

When 80 kg P_2O_5/ha were applied in most cases (58%) yields achieved were 5000 and 7000 kg/ha, but the probability of obtaining maize yields over 7000 kg/ha rose to 14%. In the variant fertilized with 50 kg N + 40 kg P_2O_5/ha, in most cases (48%) the yields were 5000-7000 kg/ha, and the probability of achieving yields above 7000 kg grains/ha increased to 42%. In the other fertilization variants, in most cases (over 52%) yields were higher than 7000 kg grains/ha, while in more than 30% of the cases yields achieved 5000 and 7000 kg grains/ha (Table 1).

In other words, under non-irrigation conditions on the Fundulea cambic chernozem soil, the probability of obtaining maize yield over 7000 kg grains/ha is very small, on an average once in 29 years, but the application of fertilizers with nitrogen and phosphorus on only with nitrogen (in a dose of 150 kg N/ha) increases the probability once in two years, to achieve yields exceeding 7000 kg grains/ha. Often the question regarding the amount of yield increases after fertilizer application arises but an answer is difficult to give due to the multitude of factors which fertilizer effectiveness depends on: soil type and its content in nutritive elements, the plant, variety or hybrid cultivated, degree of water supply, fertilizer rate applied etc.

Thus, in our case, maize yields obtained, under non-irrigation conditions, on the Fundulea cambic chernozem soil were in 100% of the cases, below 1000 kg/ha for 80 kg P_2O_5/ha applied (Table 2). When 50 kg N + 40 kg P_2O_5/ha were applied, as well as in the unilaterally fertilized variant with nitrogen (150 kg N/ha), in 45% of the cases the yield increases were below 1000 kg grains/ha.

In variants fertilized with 50 kg N + 40 kg P_2O_5 and 150 kg N + 80 kg P_2O_5/ha, in most cases (48%) yield increases achieved 1000-

Table 3. The probability to obtain a certain maize yield increase, under non-irrigated conditions, depending on fertilizer rate applied, on the Fundulea cambic chernozem soil

Rate kg/ha	Yield increase (grains, kg/1 kg active substance)							
	below 5		5-10		10-15		over 15	
	No. years	%	No. years	%	No. years	%	No. years	%
50 N+40 P_2O_5	2	7	9	31	9	31	9	31
150 N	5	17	13	45	6	21	5	17
80 P_2O_5	18	62	9	31	2	7	0	0
150 N+80 P_2O_5		28	14	48	6	21	1	3

Table 4. Correlation coefficients between maize yields obtained with different fertilizer rates, under non-irrigation conditions and rainfalls registered in different periods of the year. Fundulea 1967 – 1995

Period	Fertilizer rate applied (kg/ha)				
	Unfertilized	50N+40P_2O_5	150N	80 P_2O_5	150N+80 P_2O_5
IX - III	-0.086	-0.143	-0.217	-0.028	-0.141
IX - VI	-0.040	-0.031	0.026	0.087	0.040
IX - VIII	0.134	0.196	0.257	0.269	0.267
IV - VI	0.027	0.097	0.252	0.151	0.197
IV - VIII	0.221	0.330	0.446*	0.335	0.437*
VI - VIII	0.093	0.300	0.355	0.231	0.365*
VII - VIII	0.039	0.511***	0.541**	0.452*	0.537**

2000 kg grains /ha.

In order to obtain increases of 2000-3000 kg grains/ha there is a probability of: 7% in the case of 50 kg N + 40 kg P_2O_5/ha rate, 11% if only 150 kg N/ha is applied and 21% in a fertilization of 150 kg N + 80 kg P_2O_5/ha.

Increases of over 3000 kg grains /ha were obtained in 7% of the cases, when 150 kg N/ha were applied, either as such or together with 80 kg P_2O_5/ha.

In the variant fertilized with 80 kg P_2O_5/ha in none of the experimental years increases over 1000 kg grains/ha, were achieved, while the rate of 50 kg N + 40 kg P_2O_5/ha generated increases which did not exceed 3000 kg grains/ha.

A very important aspect in assessing economic efficiency of fertilizer application is the amount of yield increase obtained for every kg of fertilizer active ingredient. Considering the current prices, in order to have an efficient fertilizer application, it is necessary to obtain at least 5 kg maize grains per 1 kg active ingredient applied.

Data presented in table 3 point out that increases below 5 kg grains/1 kg active ingredient were obtained as follows: in 62% of the cases, when fertilization was made with 80 kg P_2O_5/ha; in 28% of the cases when 150 kg N + 80 kg P_2O_5/ha was applied, in 17% of the years in the fertilization variant with 150 kg N + 80 kg P_2O_5/ha and only in 7% of the cases at the rate of 50 kg N + 40 kg P_2O_5/ha.

The highest increases per 1 kg fertilizer active ingredient were obtained in the fertilization variant with 50 kg N + 40 kg P_2O_5/ha, where in 31 % of the cases increases over 15 kg grains/1 kg a.s. were achieved.

One of the yield limitative factors and yield increases observed after fertilizer application in maize on the Fundulea cambic chernozem soil, is the degree of water supply which depends on rainfalls under non-irrigation experimental conditions.

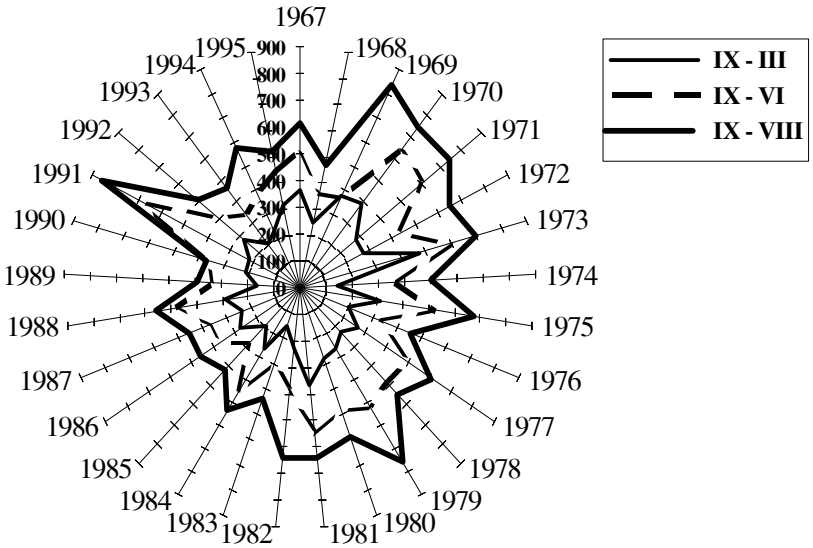

Figure 4. Rainfalls (mm) - Fundulea, 1967-1995

It has been observed that in the years with reduced rainfalls such 1990, with 373 mm precipitation during August - September period and only 13 mm in the months July- August, fertilizers did not show efficiency; even more, they contributed to reducing maize yields in all 5 variants while in other years, with heavy and well distributed rainfalls during the vegetation period of maize, the highest yields were obtained in the fertilized variants.

This is the reason we tried to establish the relationship that exists between maize yields or yield increases and rainfalls from different periods of the year September-March; September-June; April-June; April-August; June-July; July-August.

Rainfalls of the periods mentioned above, during 1967 - 1995 years are presented in figure 4.

Data presented in the chart emphasize the great differences among years in all periods. Thus, in the period autumn-winter (September-March), as compared to 267 mm which is the average of the 29 years, rainfalls varied between 145 mm in 1974 to 479 mm in 1973; in the September-June period, between 286 (in 1985) and 672 (in 1991), as compared to the 29 year average of 454 mm; and in the September-August period the limits were between 373 mm in 1990 and 856 mm in 1991.

In the vegetation period of maize there were also great differences between rainfalls in various years. Thus, in April-June period while the average of 29 years was 311 mm, rainfalls ranged between 156 mm in 1990 and 637 mm in 1991.

Great differences between rainfalls of various years were recorded also in the months July-August, a critical period for maize crop. Thus, the lowest rainfalls were recorded in 1990 (only 13 mm), while the highest rainfalls (262 mm) were registered in 1982, for the same months.

The significance analysis of correlation coefficients shows that yields of the unfertilized control do not significantly correlate with the rainfalls of any period of the year (table 4).

Yields obtained in the fertilized variants with 80 kg P_2O_5/ha or with 50 kg N + 40 kg P_2O_5/ha correlated positively significantly or distinct significantly with the rainfalls of the months July-August. The yields obtained in the fertilized variants with 150 kg N and 150 kg N + 80 kg P_2O_5/ha correlated positively significantly or distinct significantly both with the rainfalls of the months July-August and with those of June-July or April-August.

In order to see whether the efficiency of fertilizers depend on rainfalls, we correlated the increases obtained after fertilizer application, with rainfalls of the same periods of the year, whereby a much closer correlation was observed than between yields and rainfalls (Table 5).

Yield obtained by phosphorus fertilizer application correlate with rainfalls in all periods of the year with the exception of September-March and July-August.

Increases obtained in the variant with 50 kg N + 40 kg P_2O_5/ha correlated positively distinct significantly with the rainfalls of June-July and July-August and significantly with July-August. In the variants with 150 kg N/ha applied as such or together with 80 kg P_2O_5/ha, yield increases correlated distinct significantly, positively with rainfalls of the periods April-August, June-July or July-August.

Table 6 presents the correlations between maize yields obtained with various fertilization rates and rainfalls recorded in June-July period. As seen previously, there is a positive, significant correlation for the rate of 80 kg P_2O_5/ha and distinctly significant for the other

Table 5. Correlation coefficients between maize yield increases with different fertilizer rates, under non-irrigation conditions and rainfalls registered in different periods of the year. Fundulea, 1967 – 1995

Period	Fertilizer rate applied (kg/ha)			
	50 N+40 P_2O_5	150 N	80 P_2O_5	150 N+80 P_2O_5
IX - III	-0.175	-0.299	0.161	-0.150
IX - VI	0.003	0.105	0.385*	0.132
IX - VIII	0.208	0.310	0.447*	0.325
IV - VI	0.178	0.447*	0.387*	0.337
IV - VIII	0.365*	0.593***	0.401*	0.507**
VI - VIII	0.537**	0.556**	0.448*	0.561**
VII - VIII	0.474	0.511**	0.289	0.500**

Table 6. Correlation coefficients between maize yield increases with different fertilizer rates, under non-irrigation conditions and rainfalls in June - July. Fundulea, 1967 – 1995

Fertilizer rates, kg/ha	Equation	Correlation coefficient	Increase achieved	
			x = 50 mm	x = 300 mm
50 N+40 P_2O_5	y = 319 + 4.80 . x	0.573**	559	1759
150 N	y = 253 + 6.95 . x	0.556**	600	2338
80 P_2O_5	y = -177 + 2.69 . x	0.448*	-42	630
150 N+80 P_2O_5	y = 459 + 7.06 . x	0.561**	812	2577

three rates.

If yield increases are calculate by means of regression equations, in the case in which rainfalls are of 50 mm and 300 mm, they range between 42 and 812 kg/ha in drought years (when rainfalls are only 50 mm) and 630 to 2577 kg/ha in the rainy years (300 mm rainfalls), depending on fertilization variant. Therefore, depending on the rainfalls of June - July it is possible to anticipate the fertilizer effectiveness and maize yield.

Nevertheless it is much more interesting to know the way the fertilizers were used by maize crop related to rainfalls, in various periods of the year, in order to be able to correct the fertilizer rates that should be applied.

It has been observed that maize uses smaller amounts of fertilizers in the drought years, while in the rainy years fertilizer rates, especially those with nitrogen, should be higher.

The calculated nitrogen rates with which maximum maize yields were achieved (on a basic dressing of 80 kg P_2O_5/ha) ranged between 44 kg N/ha (in the year 1968) and 578 kg N/ha (in the year 1970) (Table 7).

nificantly positively with the rainfalls from September-June period: N = 10.2 + 0.38x; r = 0.380*.

Considering that the rainfalls in Fundulea area exceed 286 mm, in this period we conclude that in maize it is possible to apply up to 120 N/ha, but the correction of nitrogen rate should be done at the end of June, or earlier, depending on the rainfalls.

Later applications of nitrogen fertilizers could no longer be used by the plant due to drought that frequently comes up in this area in summer months.

CONCLUSIONS

Maize grain yield and yield increases varied consistently with the annual climatic conditions and fertilization variant used.

Grain yield at non-fertilized variant varied between 5000-7000 kg/ha in 66% of the years, between 3000-5000 kg/ha in 28% of the years and in only in 3% of the years exceeded 7000 kg/ha.

Grain yields between 5000 and 7000 kg/ha were recorded also on 58% from the

Table 7. Nitrogen rates* (calculated) with maximum maize yields achieved, under non-irrigation conditions. Fundulea, 1976-1995

Year	N rate (kg/ha)	Year	N rate (kg/ha)	Year	N rate (kg/ha)	Year	N rate (kg/ha)
1967	159	1975	214	1983	150	1991	133
1968	44	1976	144	1984	151	1992	170
1969	360	1977	120	1985	130	1993	137
1970	578	1978	147	1986	121	1994	141
1971	176	1979	224	1987	102	1995	127
1972	146	1980	150	1988	131		
1973	178	1981	185	1989	223		
1974	440	1982	171	1990	96		

*) On basal dressing of 80 kg P_2O_5/ha

The nitrogen rate (N) with which the maximum maize yield was achieved (on a basic dressing of 80 kg P_2O_5/ha) and rainfalls (x) in different periods of the year, correlate sig-

years in the variant fertilized unilaterally with phosphorus (80 kg P_2O_5/ha); grain yield higher than 7000 kg/ha were obtained only in 14% from the years in this variant.

In the variant fertilized with small rates (50 kg N + 40 kg P_2O_5/ha), yield between 5000 and 7000 kg were obtained with almost the same frequency as the previous two variants (48%), but grain yields over 7000 kg/ha were recorded in 42% from the experimental years.

Yield over 7000 kg/ha were obtained with a frequency of 52% when the fertilization was made unilaterally with 150 kg/ha or in the variant with 150 kg N + 80 kg P_2O_5/ha.

Yield increases do not exceed 1000 kg/ha in 45% from the cases in the variants fertilized unilaterally with nitrogen or with 50 kg N + 40 kg P_2O_5/ha.

With the variants fertilized with 50 kg N + 40 P_2O_5/ha and 150 kg N + 80 kg P_2O_5/ha, in many cases (48%) yield increased with 1000-2000 kg/ha.

Yield increases less than 5 kg/1kg active ingredient of fertilizer, which generally are considered inefficient, were computed in 62% from the cases with the variant fertilized unilaterally with 80 kg P_2O_5/ha; in 28% from the cases when 150 kg N + 80 kg P_2O_5/ha were applied; in 17% from the years with the variant fertilized unilaterally with 150 kg N/ha; and in only 7% from the case when fertilization was made with 50 kg N + 40 kg P_2O_5/ha.

The highest yield increasing per 1 kg active ingredient fertilizer was obtained in 31% from the years with the variant fertilized with 50 kg N + 40 kg P_2O_5/ha.

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Table 1. Probability of obtaining a certain yield level in maize, under non-irrigated conditions, depending of fertilizer rate on the Fundulea cambic chernozem soil.

Rate (kg/ha)	Yield level (grains with 15,5% moisture, kg/ha)							
	below 3.000		3.000-5.000		5.000-7.000		over 7.000	
	No. years	%	No. years	%	No. years	%	No. years	%
Unfertilized	1	3	8	28	19	66	1	3
50N+40P_2O_5	1	3	2	7	14	48	12	42
150N	1	3	2	7	11	38	15	52
80 P_2O_5	2	7	6	21	17	58	4	14
150N+80 P_2O_5	1	3	3	11	9	31	16	55

Table 2. The probability to obtain a certain maize yield increase, under non-irrigated conditions, depending on fertilizer rate applied, on the Fundulea cambic chernozem soil

Rate (kg/ha)	Yield increase (grains with 15,5% moisture, kg/ha)							
	below 1.000		1.000-2.000		2.000-3.000		over 3.000	
	No. years	%	No. years	%	No. years	%	No. years	%
50N+40P_2O_5	13	45	14	48	2	7	0	0
150N	13	45	11	37	3	11	2	7
80 P_2O_5	29	100	0	0	0	0	0	0
150N+80 P_2O_5	7	24	14	48	6	21	2	7

Table 3. The probability to obtain a certain maize yield increase, under non-irrigated conditions, depending on fertilizer rate applied, on the Fundulea cambic chernozem soil

Rate (kg/ha)	Yield increase (grains, kg/1 kg active substance)							
	below 5		5-10		10-15		over 15	
	No. years	%	No. years	%	No. years	%	No. years	%
50N+40P_2O_5	2	7	9	31	9	31	9	31
150N	5	17	13	45	6	21	5	17
80 P_2O_5	18	62	9	31	2	7	0	0
150N+80 P_2O_5		28	14	48	6	21	1	3

Table 4. Correlation coefficients between maize yields obtained with different fertilizer rates, under non-irrigated conditions and rainfalls of certain periods of the year. Fundulea (1967 - 1995)

Period	Fertilizer rate applied (kg/ha)				
	Unfertilized	50N+40P_2O_5	150N	80 P_2O_5	150N+80 P_2O_5
IX - III	-0.086	-0.143	-0.217	-0.028	-0.141
IX - VI	-0.040	-0.031	0.026	0.087	0.040
IX - VIII	0.134	0.196	0.257	0.269	0.267
IV - VI	0.027	0.097	0.252	0.151	0.197
IV - VIII	0.221	0.330	0.446*	0.335	0.437*
VI - VII	0.093	0.300	0.355	0.231	0.365*
VII - VIII	0.039	0.511***	0.541**	0.452*	0.537**

Table 5. Correlation coefficients between maize yield increases with different fertilizer rates, under non-

irrigated conditions and rainfalls of certain periods of the year. Fundulea (1967 - 1995)

Period	Fertilizer rate applied (kg/ha)			
	$50N+40P_2O_5$	150N	$80\ P_2O_5$	$150N+80\ P_2O_5$
IX - III	-0.175	-0.299	0.161	-0.150
IX - VI	0.003	0.105	0.385*	0.132
IX - VIII	0.208	0.310	0.447*	0.325
IV - VI	0.178	0.447*	0.387*	0.337
IV - VIII	0.365*	0.593***	0.401*	0.507**
VI - VII	0.537**	0.556**	0.448*	0.561**
VII - VIII	0.474	0.511**	0.289	0.500**

Table 6. Correlation coefficients between maize yield increases with different fertilizer rates, under non-irrigated conditions and rainfalls in June - July. Fundulea (1967 - 1995)

Fertilizer rates	Equation	Correlation coefficient	Increase achieved	
			x = 50 mm	x = 300 mm
$50N+40P_2O_5$	y = 319 + 4.80 □ x	0.573**	559	1759
150N	y = 253 + 6.95 □ x	0.556**	600	2338
$80\ P_2O_5$	y = -177 + 2.69 □ x	0.448*	-42	630
$150N+80\ P_2O_5$	y = 459 + 7.06 □ x	0.561**	812	2577

Table 7. Nitrogen rates* (calculated) with maximum maize yields have been achieved, under non-irrigated conditions. Fundulea (1976-1995)

Year	N rate (kg/ha)	Year	N rate (kg/ha)	Year	N rate (kg/ha)	Year	N rate (kg/ha)
1967	159	1975	214	1983	150	1991	133
1968	44	1976	144	1984	151	1992	170
1969	360	1977	120	1985	130	1993	137
1970	578	1978	147	1986	121	1994	141
1971	176	1979	224	1987	102	1995	127
1972	146	1980	150	1988	131		
1973	178	1981	185	1989	223		
1974	440	1982	171	1990	96		

*) On basal dressing of 80 kg P_2O_5/ha

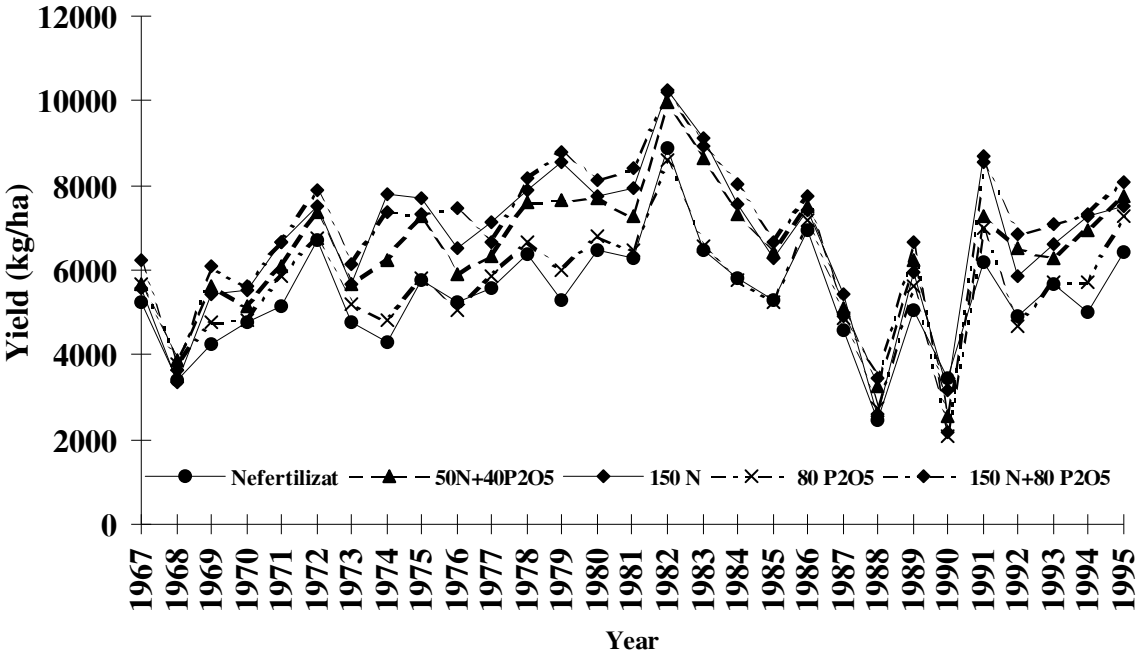


Figure 1. Maize yields on different basal dressings for fertilization - Fundulea, 1967-1995

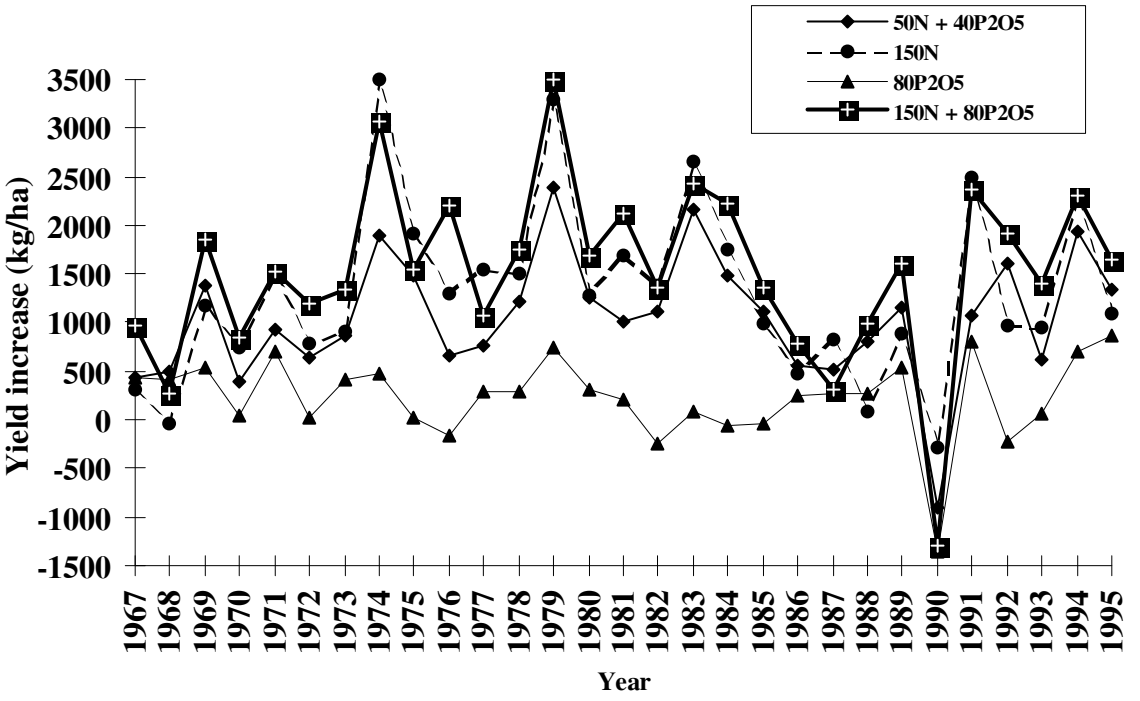


Figure 2. Maize yield increases, on different basal dressings for fertilization - Fundulea, 1967-1995.

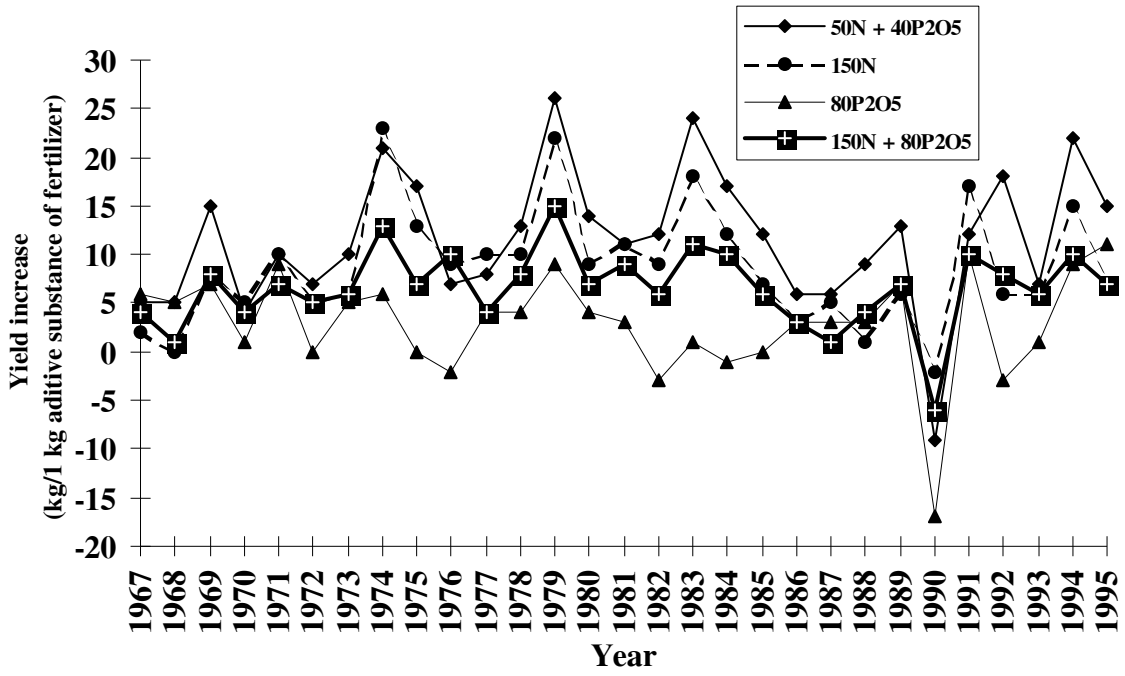


Figure 3. Maize increases, on different basal dressings for fertilization - Fundulea, 1967 - 1995.

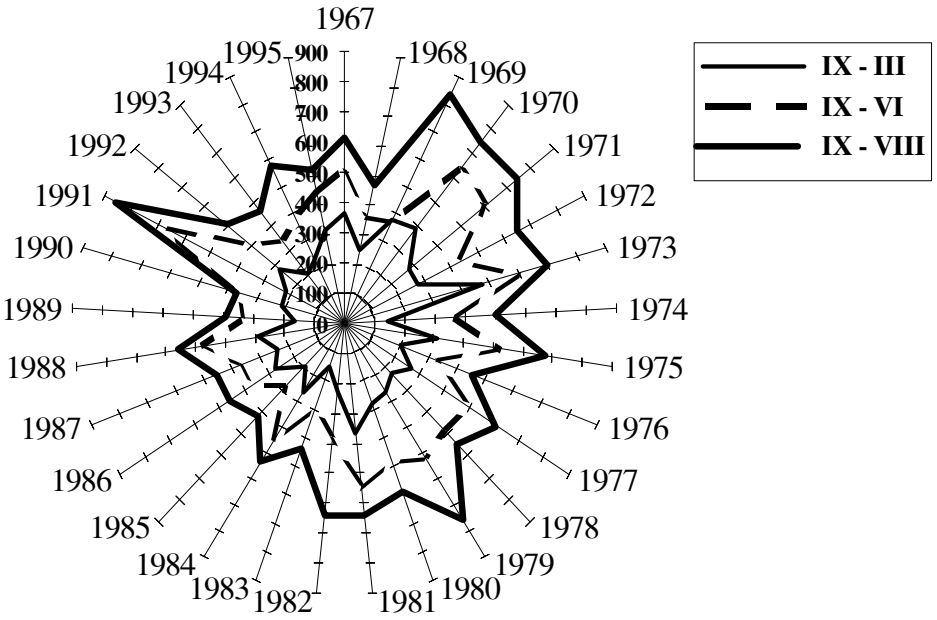
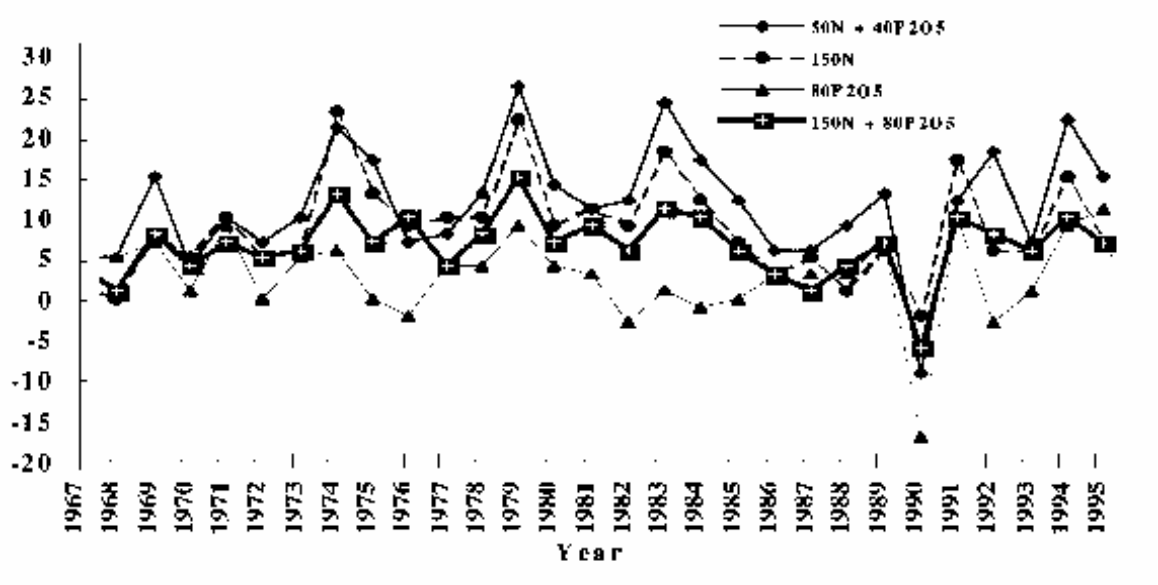


Figure 4. Rainfalls (mm) - Fundulea, 1967-1995.


50N + 40P2O5
150N
80P2O5
150N + 80P2O5
30
25
20
15
10
5
0
-5
-10
-15
-20
1967
1968
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