

## THE INFLUENCE OF LONG TERM FERTILIZER APPLICATIONS ON ROOT ROT OF MAIZE

(Met opsomming in Afrikaans)

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### Abstract

The percentage root rot in maize plants was recorded over a 3 year period in a nitrogen, phosphorus and potassium fertilization (3 x 3 x 3 factorial) experiment. The incidence of root rot tended to increase at the highest levels of nitrogen, but decreased with increasing levels of potassium. Phosphorus appeared to have no effect, either alone or in combination with nitrogen and potassium, on the incidence of root rot.

### Introduction

Many research workers consider stalk and root rots of maize to be only manifestations of a disease complex resulting from invasion by any number of fungi usually found to be present wherever maize is grown. Resistance or susceptibility to infection may be partly due to genetically inherited characteristics, but is also considerably influenced by environmental conditions of which nutrition appears to be the most significant.

Although both forms of the disease may occur simultaneously, a number of workers have emphasised (Hooker, 1956; Whitney & Mortimore, 1957) that in a particular locality one phase of the disease complex or one particular organism may predominate. At Bapsfontein, the Agricultural Research Station of AE & CI, investigations have been carried out into a root rot complex of maize in which *Fusarium moniliforme* appears to be the dominant organism, but is associated with other species of *Fusarium*, *Diplodia zea* and *Trichoderma viride*. The initial symptoms are a cortical rot followed by a more progressive invasion of the root system. Frequently, the symptoms are accompanied by a proliferation of fibrous roots above the larger lesions which may compensate to some extent for the loss of root function resulting from infection.

As a number of agronomic experiments were available for an investigation of the effect of environmental conditions on this disease, the object of this paper will be a presentation of some of the results of a three-year investigation into the effects of fertilization on the incidence of root rot in maize.

### Materials and methods

The disease assessments were carried out in a crop rotation fertilization experiment initiated in 1958 and terminated in 1966. A full description of the history of this experiment is, however, irrelevant to this paper as only part of the experiment was used in the investigation. The basic design consisted of 4 blocks between which various crops were rotated. Each block was subdivided in the form of a partially confounded 3 x 3 x 3 factorial of 27 plots with 3 levels each of nitrogen, phosphorus and potassium applied as standard fertilizers.

Fertilizer levels in a particular block were not necessarily the same each year and were calculated to meet the requirements of a particular crop and plant population. Extreme deficiencies were avoided by ploughing in the residue of the previous crop and providing a small quantity of mixed starter fertilizer at planting.

In the final year, because of a severe drought experienced during the latter half of the growing season, only the starter fertilizer was applied. Growth was severely retarded by the drought, but with the exception of the nitrogen treatments, the influence of the residual levels of nutrients in the soil was clearly shown in the growth of plants.

Disease assessments were based on a visual scale of 0-5 and converted in the final results to a percentage with a class interval of 10 per cent. Although visual assessments have recognised limitations, this form of assessment was used over a number of years and proved to be satisfactory, even when used by inexperienced assessors. Assessments were made on 20 plants per plot (8 x 15yd) at the pollen-shedding stage.

### Results

The summarised results of the last three years of the experiment are presented in Table 1. For convenience, the percentage root damage is shown in the form of first order interaction tables together with overall treatment averages.

TABLE 1. Percentage root-rot recorded in a partially confounded 3 x 3 x 3 factorial crop rotation and fertilization experiment 1963/64

	N <sub>0</sub>			N <sub>1</sub>			N <sub>2</sub>			Treatment averages								
	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	N <sub>0</sub>	N <sub>1</sub>	N <sub>2</sub>	P <sub>0</sub>	P <sub>1</sub>	P <sub>2</sub>	K <sub>0</sub>	K <sub>1</sub>	K <sub>2</sub>
K <sub>0</sub>	34	35	50	54	36	41	72	66	61	N <sub>0</sub>	39		P <sub>0</sub>	43		K <sub>0</sub>	50	
K <sub>1</sub>	44	41	39	30	50	55	51	62	48	N <sub>1</sub>	39		P <sub>1</sub>	45		K <sub>1</sub>	47	
K <sub>2</sub>	40	49	16	27	33	21	36	36	50	N <sub>2</sub>	54		P <sub>2</sub>	42		K <sub>2</sub>	34	

1964/65

K <sub>0</sub>	72	48	64	68	72	72	84	64	56	N <sub>0</sub>	54		P <sub>0</sub>	57		K <sub>0</sub>	67	
K <sub>1</sub>	62	60	70	54	16	64	68	68	66	N <sub>1</sub>	53		P <sub>1</sub>	54		K <sub>1</sub>	59	
K <sub>2</sub>	28	56	24	44	48	38	36	54	66	N <sub>2</sub>	62		P <sub>2</sub>	58		K <sub>2</sub>	44	

1965/66

K <sub>0</sub>	42	16	14	22	38	24	37	19	34	N <sub>0</sub>	20		P <sub>0</sub>	21		K <sub>0</sub>	27	
K <sub>1</sub>	23	12	25	12	18	13	16	22	15	N <sub>1</sub>	19		P <sub>1</sub>	19		K <sub>1</sub>	17	
K <sub>2</sub>	11	22	14	12	10	19	18	16	18	N <sub>2</sub>	22		P <sub>2</sub>	20		K <sub>2</sub>	16	

### Discussion and conclusions

Although disease incidence was recorded in separate experimental areas and in different seasons some similarity is shown by the results. The overall effect of fertilizer treatments is that the incidence of root rot tended to increase at the highest levels of nitrogen fertilizer, but decreased with increasing levels of potassium. When analysed statistically these trends were significantly linear and no interactions of any consequence were revealed. Phosphorus was without effect on this phase of the disease although it was found to promote stalk rots following artificial inoculation, an observation that agrees with the results of Krüger, Grobler & du Plooy (1965) and others.

The absence of a trend in the nitrogen treatments of the final season is readily explained by the omission of the usual nitrogen side-dressing, whereas the effect of residual potassium in the soil was still evident although much reduced in comparison with previous seasons. No residual effect of nitrogen was, in fact, expected as this nutrient does not accumulate to any great extent in these soils.

The results of a number of studies can be quoted in an effort to explain the apparent role of potassium in reducing the extent of root and stalk rotting. For example, Koehler (1960) reported a high correlation between premature dying of parenchyma cells in the stalk and of severity of root rot; Pappelis & Smith (1963) showed a relationship between water content and living cells of the stalk to the spread of *Diplodia zaeae*, and later (Pappelis & Bone, 1966) that this pattern of cell death was more pronounced in plants receiving high nitrogen and phosphate, but was reduced in plants provided with potassium.

Other results could be quoted, but the picture that emerges from the literature is that physiological vigour is clearly the most important barrier to invasion by root and stalk rotting fungi. Any environmental factor, but particularly an imbalance or deficiency of an essential nutrient such as potassium, which is directly concerned with synthesis and mobilisation of carbohydrates in the plant, would lead to premature senescence of cells and would lower the barrier to infection. This resistance of physiologically active cells is by no means a new concept in plant disease control. It seems fairly clear that physiological vigour can be achieved through

balanced nutrition and can be one of the most readily available means of reducing disease incidence and subsequent yield losses.

### Opsomming

#### DIE INVLOED VAN LANGTERMYN GRONDBEMESTING OF DIE VOORKOMS VAN WORTELVROT BY MIELIES

Die persentasie wortelvrot in mielieplante in 'n 3 x 3 x 3 faktoriaal (stikstof, fosfor en kalium) eksperiment, is bepaal oor 'n periode van drie jaar.

Die voorkoms van wortelvrot is verhoog met die hoogste toediening van stikstof maar dit is verminder deur verhoogte toedienings van kalium.

Toedienings van fosfor met of sonder kalium of stikstof het blykbaar geen effek op die voorkoms van wortelvrot gehad nie.

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