POTASSIUM REQUIREMENTS OF MAIZE IN NATAL

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Abstract

Present K use patterns in the Natal maize industry are examined and suggestions are made as to how these can be expected to change in the future. Fertilizer consumption figures are presented to show that K is used by the majority of maize farmers and proposals are made as to why the use of K is so widespread. Notwithstanding the paucity of K calibration data and numerous problem areas in the assessment of K requirement, the necessity for such widespread K usage is questioned. A survey of 3 000 soil samples analysed for advisory purposes during 1976 indicated that while approximately 30% of Natal's maize soils are probably under-fertilized with K, 17% do not require K and a further 33% would be unlikely to benefit. The probable K requirements of the various bioclimatic groups in which maize is produced are discussed and the proposal is made that changed in the availability and composition of fertilizer mixtures might be beneficial to both the maize and fertilizer industries.

Introduction

Although K is presently of lesser importance in South African agriculture than either N or P*, the fact that the Republic is totally dependent on foreign suppliers for its K requirements makes optimum utilization both economically and strategically important. The Natal maize industry accounts for only approximately 2% of the country's total consumption, but even this amounts to an annual investment by farmers of over R500 000. A not inconsiderable sum.

It is not the objective in this paper to discuss the nutritional rôle of K in maize, but rather to examine some of the more practical aspects of K fertilization in relation to the maize and fertilizer industries in Natal. An attempt will be made to review past and present K use patterns and suggestions will be made as to how these can be expected to change in the future.

*According to figures released by the Department of Agricultural Technical Services consumption of N, P and K during 1975 was 295 880, 159 749 and 113 719 metric tons respectively.

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Past and Present Use Patterns

Notwithstanding the fact that experimental responses to K or symptoms of K deficiency are not common in the major maize growing areas of Natal, considerable emphasis has historically been placed on the rôle of K in maize production. The majority of progressive maize producers have traditionally included K in their fertilization programmes and there are today relatively few who exclude it. This situation is well borne out by the consumption patterns for N, P, and K in Natal's maize areas over the past decade (Figure 1).

In recent years N use has increased somewhat relative to P and K, but K use since 1966 has essentially paralled that of P and it is apparent that an insignificant number of producers altered their P : K input ratios during this period, notwithstanding a marked increase in total fertilizer use.

An examination of consumption figures provided by the Natalse Landboukoöperasie for the 1976/77 growing season (Table 1) further indicates that relatively few producers use P to the exclusion of K. Not only was 78% of the total P and K consumption contained in NPK mixtures, but in all probability only a small percentage of producers made use of N and P only, as ammoniated superphosphates constituted only 7% of all the mixtures used and P is included in all maize fertilization programmes. Very few farmers mix their own fertilizers and it is unlikely that significant quantities of N and P were used in this way. In fact, the quantities of straight P and K fertilizer consumed were probably largely used in the build-up of particularly deficient soils prior to planting and are likely to have been employed in conjunction with planting mixtures.

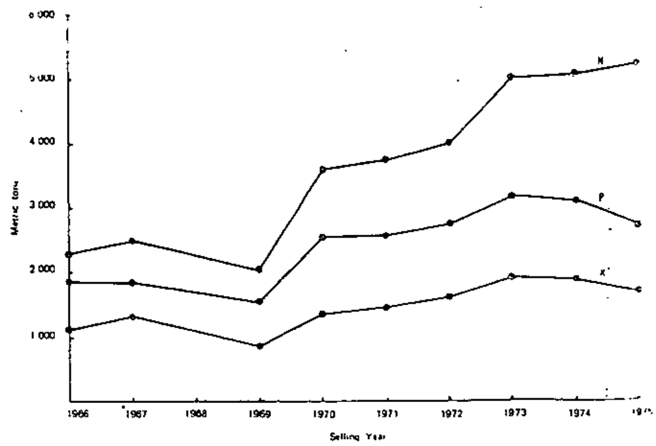

FIG 1 Nutrient consumption in the maize areas of Natal (1966 – 1975)

Research Evidence and Problem Areas

Ironically, notwithstanding an intensive research effort into the methodology of soil K assessment by the University of Natal (Stanton, 1958; Sumner 1965; le Roux, 1966; Koch, 1968; Skeen, 1968; Farina, 1970), very little work relating soil K levels to maize yields has been conducted and much of that currently being carried out has due to the absence of yield responses, not provided the information required. Consistent yield responses have only been obtained on the sandy Avalon soils of Northern Natal and in this instance soil tests have been shown to be meaningless (Farina & Graven, 1972). Due to the sandy nature of the topsoil, applied K leaches rapidly to subsoil horizons (Figure 2) and soil tests conducted on surface horizons are unrelated to K availability. On these sandy hydromorphic soils K is consequently applied according to crop requirement and no attempt is made to fertilize to specific soil test values. Research data obtained over more than a decade has shown annual applications of 50 kg K/ha to be adequate for maize grain yields of 6 000 kg/ha and 100 kg K/ha annually is recommended for silage production.

The critical level of 100 ppm currently used by the Department of Agricultural Technical Services in Natal has, in the absence of yield responses, resulted from non-response situations encountered in calibration trials on Normandien and Farningham clay loams testing 86 ppm and 120 ppm respectively. The results obtained on the Normandien clay loam are considered particularly meaningful as K check plots have tested lower than 100 ppm since the experiment was initiated four seasons ago and mean grain yields have exceeded 8 000 kg/ha. It is admitted, however, that extrapolation of data from one soil-bioclimatic system to others, albeit of similar textural class, is a highly suspect procedure, K availability being determined among other things by the ability of the soil to release non-exchangeable K, subsoil K test levels, cation exchange capacity, soil drainage, and K release/fixation phenomena.

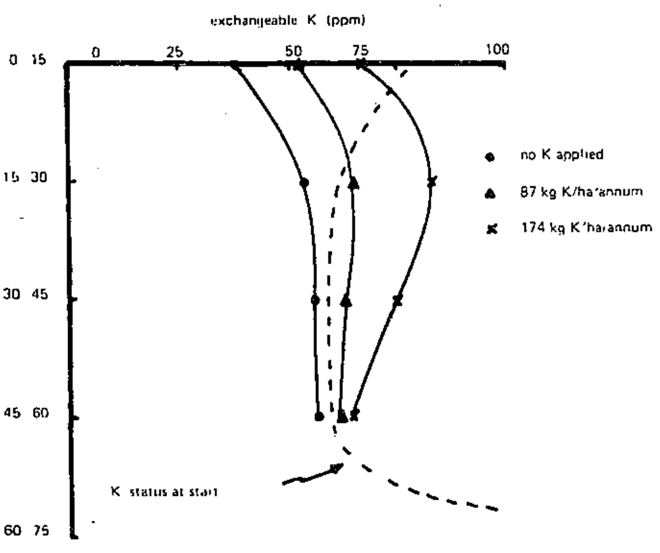

FIG 2 *K status of a sandy Avalon soil after two seasons of fertilisation and cropping*

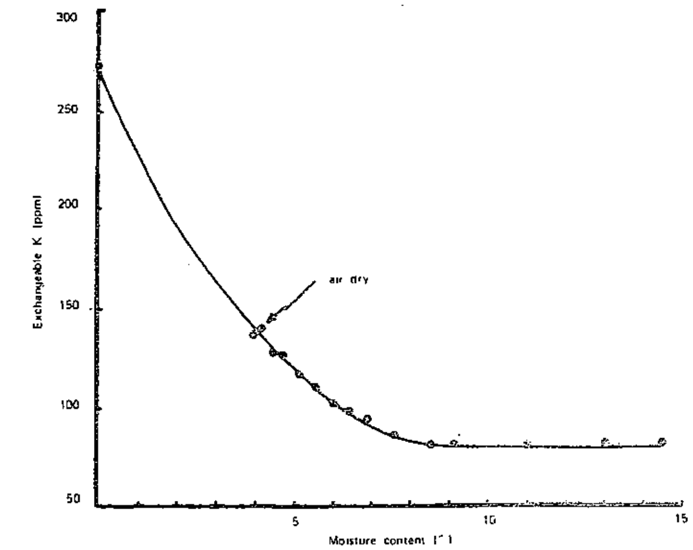

FIG 3 *Effect of drying on exchangeable K content of a Rensburg clay*

Very little information regarding the importance of these factors in Natal maize soils is available, but subsoil K reserves are known to build-up in sandy hydromorphic soils and significant K release on air-drying prior to analysis has been demonstrated in several Natal soils (Farina & le Roux, 1974).

Nelson (1967) described moist analysis as ".....one of the greatest breakthroughs in soil testing in recent years......" and it is considered that this phenomenon may account for the not infrequent anomalies encountered by field advisors. A soil sample from the Rensburg series, for example, was found to exhibit 72% release on air-drying and 228% release on oven-drying (Figure 3). Significantly, from an advisory viewpoint, this sample would have been considered K deficient when analysed in the moist state, but non-deficient when subjected to analysis in the air-dry state.

There are, thus major deficiencies in present knowledge regarding the determination of K requirement and the following assessment of future use patterns must be tempered accordingly.

Future Use Pattern

It has already been stated that K is presently considered to be too widely used by the Natal maize industry. In the light of acknowledged deficiencies in the assessment of K requirement this view may be regarded as questionable. However, a survey of 3 000 soil samples submitted by farmers to the Cedara Soil Test Laboratory during 1976 provides strong supporting evidence.

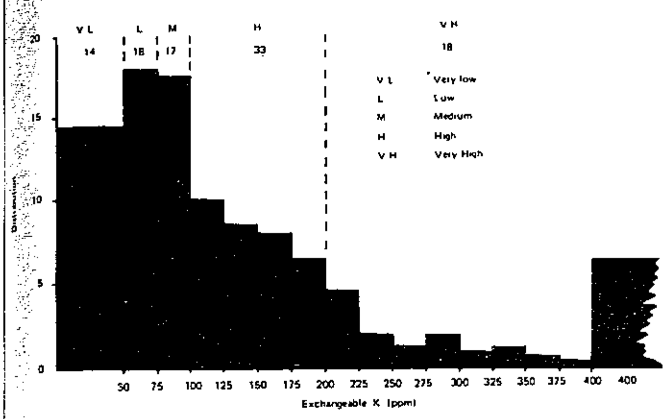

FIG 4 *Distribution of K soil test values from Natal in 1976*

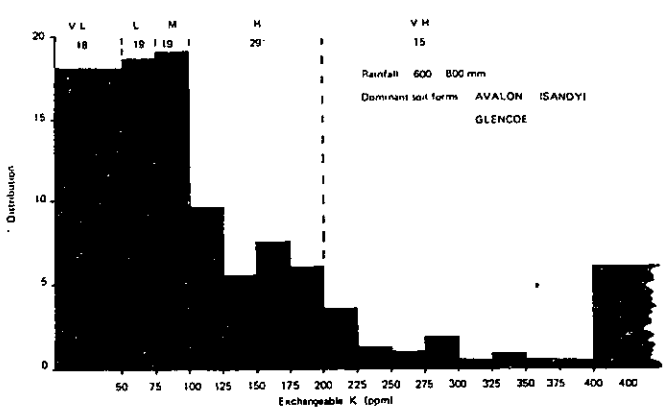

FIG 6 *Distribution of K soil test values from bioclimatic group 8 in 1976*

The distribution of K soil test levels for all maize growing areas in Natal (Figure 4) indicates that 14% would be classed as very low and requiring in excess of 100 kg K/ha, 18% would be considered low and requiring 50 – 100 kg K/ha, and approximately the same percentage would be regarded as medium and likely to respond to K applications of up to 50 kg/ha. The remaining 50% would be regarded as high to very high and K would not be recommended. Significantly, 17% fall into the very high class where even the most conservative advisor would not anticipate a response to K. While this data supports the contention that K is too widely used, the fact that few maize producers apply more than 50 kg K/ha also suggests that insufficient K is probably being used by an appreciable percentage of farmers. Total K consumption may not, therefore, be excessive and the problem may rather be one of distribution.

Further subdivision of the data into Phillip's (1969), bioclimatic areas (Figures 5 – 9) and a separation of bioclimatic group 8 into predominantly clayey and sandy areas (Figures 5 & 6) reveals further patterns considered noteworthy.

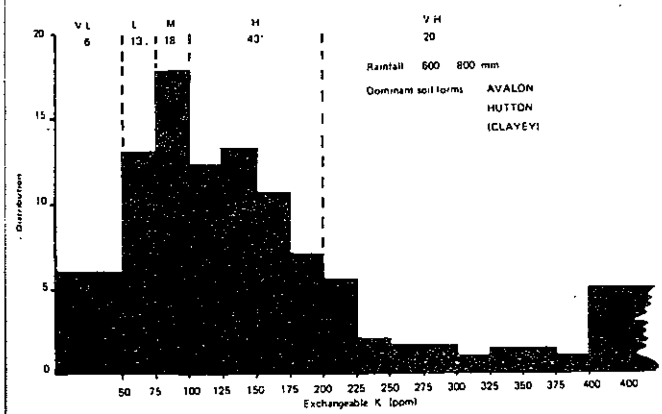

FIG 5 *Distribution of K soil test values from bioclimatic group 8 in 1976*

The differences between the predominantly clayey and sandy areas of bioclimatic group 8 are striking and bear out comments already made regarding the analysis of sandy soil samples. The high percentage of samples falling into the very low and low classes undoubtedly results from the low capacity of these soils for K retention.

Comparison of Figure 5 with the others clearly indicates a generally higher K status in the less leached clayey soils of bioclimatic group 8, 64% of the samples falling into the high and very high classes. This is not unexpected and it is interesting to note that the Bergville-Winterton area which falls into this group consumes the greatest quantity of ammoniated superphosphate (Table 1). It would, thus, appear that soil testing has already had an effect on K use in the heart of the Natal maize industry and a strong market for zero K mixtures containing adequate N could reasonably be anticipated.

The relatively high consumption of ammoniated superphosphate in the Dundee-Wasbank-Utrecht area (Table 1 and Figure 6) on the other hand, is difficult to explain and cannot be seen in the same light as the consumption in the Bergville-Winterton area. It seems more probable that this pattern reflects a situation of poor fertilizer use and under fertilization with K.

Not unexpectedly, bioclimatic group 3, the area of highest rainfall, contains the highest percentage of soils testing very low in K (Figure 7) and encouragingly Greytown, which is representative of this group, used the highest percentage of K containing mixtures (Table 1). However, very few farmers use as much as 100 kg K/ha and indications are that K is probably under-utilized by a large percentage of farmers in this bioclimatic group. It is particularly noteworthy that even in this highly leached area 21% of the soils fall into the very high K soil test class.

TABLE 1 Fertilizer sales through Natalse Landboukoöperasie depots in 1976/77 (metric tons)

Form of fertilizer and nutrient	Depots				
	Dundee-Wasbank-Utrecht	Vryheid-Paulpieter.	Greytown	Bergville-Winterton	Total for all areas
Straights					
N	1 343	946	159	1 160	3 608
P	177	136	33	154	500
K	66	63	9	35	173
Total N + P + K	1 586	1 145	201	1 349	4 281
NPK mixtures					
N	721	574	813	1 170	3 278
P	680	682	327	681	2 370
K	513	556	335	466	1 870
Total N + P + K	1 914	1 812	1 475	2 317	7 518
Amm supers					
N	44	14	5	58	121
P	141	57	15	189	402
Total N + P	185	71	20	247	523
Grand Total N + P + K	3 685	3 028	1 696	3 913	12 322
%P + K in mixtures	74	82	91	73	78
$\frac{\text{amm super}}{\text{mixtures}} \times 100$	10	4	1	11	7

Today there is a growing awareness among research personnel that established views regarding the need for K require considerable revision. Information becoming available from calibration trials indicates a zero K requirement on many maize soils and an examination of factors which have contributed towards current use patterns is perhaps warranted.

First and foremost among these has been the lack of reliable soil test norms, which are only now starting to become available, and poor use of soil tests as an aid in determining requirement. Up until the late 1960's maize fertilization was largely based on *ad hoc* experimentation conducted at the Cedara and 'n'Thabamhlope research stations on highly leached soils inherently low in K. No attempt was made to relate nutrient requirement to soil test values and chemical differences between the experimental soils and soils in the major maize areas were not generally appreciated by farmers or fertility advisors. There was, consequently, a tendency to believe that the responses obtained experimentally justified K use in all maize areas. Even where reasonable doubts regarding the need to use K existed most farmers and fertility advisors preferred, in the absence of reliable calibration data, to "cover their bets" by using fertilizer mixtures containing K.

Probably also contributory was the considerable amount of research conducted into aspects of K nutrition during the fifties and sixties. Not only was the Potash Institute actively conducting field research in Natal, but the University of Natal was devoting a considerable research effort into methods of assessing K availability. Through the popular and scientific literature generated both farmers and fertility advisors became very aware of the role played by K in crop production.

Recently there has also been a tendancy to explain this situation in the light of the unavailability in Natal of zero K mixtures, which also contain desirable quantities of N. The highly competitive nature of the fertilizer market makes the validity of such criticism questionable, but continued unavailability of zero K mixtures will undoubtedly mitigate against any change in current use patterns.

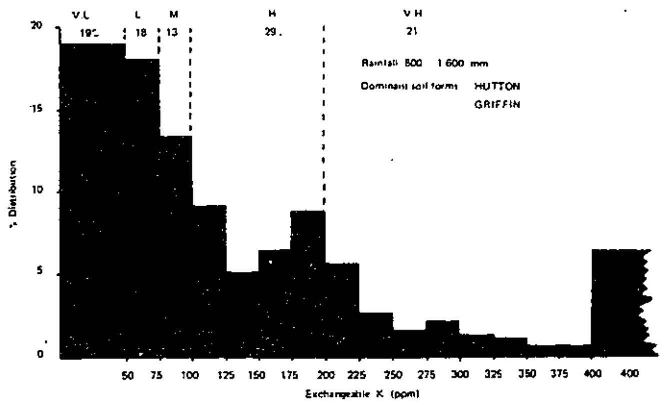

FIG 7 *Distribution of K soil test values from bioclimatic group 3 in 1976*

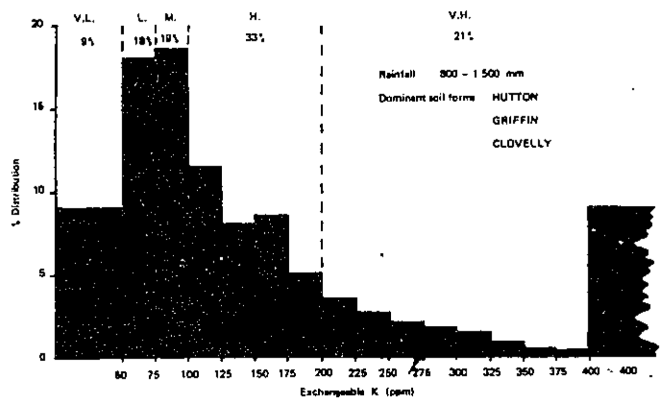

FIG 8 *Distribution of K soil test values from bioclimatic group 4*

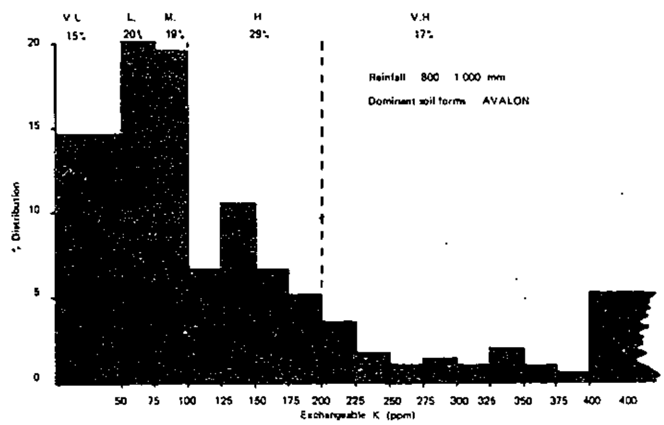

FIG 9 *Distribution of K soil test values from bioclimatic group 6*

Bioclimatic group 4, an area very similar to 3 as far as soils and rainfall are concerned, surprisingly has a very different K distribution pattern (Figure 8). An identical percentage of the soils fall into the very high K class, but this group has an unexpectedly low percentage of soils falling into the very low K category and has a very much higher percentage testing more than 400 ppm. Fertilizer consumption figures could not be obtained for this area, but the only explanation which can be offered is that farmers in this area also produce significant quantities of potatoes and cultivated pastures, crops which have historically received K applications considerably higher than those applied to maize.

Finally, bioclimatic group 6 (Figure 9), represented by Vryheid-Paulpietersburg in Table 1, reflects a highly leached situation with a preponderance of K deficient soils. As would be expected with the somewhat lower rainfall however, the percentage of soils in the very low soil K class is considerably lower than in bioclimatic group 3. Here again, it is encouraging to note that this area was second only to Greytown in the consumption of K containing fertilizer mixtures (Table 1).

Conclusions

Notwithstanding the speculative nature of much of the above discussion, it is considered that certain conclusions regarding optimal utilization of K by the maize and fertilizer industries in Natal can be reached.

Due to the exceptionally wide range of K soil test values throughout the Natal maize industry there would appear to be a very real need for both zero and high K fertilizer mixtures. The latter requirement has been largely fulfilled by recent State authority for the inclusion of Zn in 2:3:4 fertilizer mixtures and a marked increase in consumption of this fertilizer can reasonably be expected during the coming season. Similarly, an appreciable market for zero K fertilizer mixtures, and ammoniated superphosphates are nor included here due to their inadequate N content, could be anticipated if fertilizer manufacturers were to make such products available in Natal. Evidence for the need of zero K mixtures is irrefutable and continued unavailability will inevitably lead to dissatisfaction among maize producers and needless conflict with the fertilizer industry.

Acknowledgements

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