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Rationalising fertilizer rates for Sorghum I. Screening of suitable soil test methods[1] */

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Resumen

Se realizó un experimento de campo en suelos rojos de poca profundidad en Bhavanisagar, utilizando al sorgo como cultivo testigo para seleccionar las pruebas de suelo más apropiadas para la predicción precisa del estado de fertilidad del suelo. Se probaron 20 combinaciones diferentes, incluyendo dos métodos para N, dos para P y cinco para K, usando la técnica de regresión múltiple. Solo tres de las combinaciones se encontraron superiores a las otras. Estas combinaciones seleccionadas indicaron la superioridad del método de Olsen para el P disponible, y mostraron ser igualmente buenos para nitrógeno disponible tanto el permanganato alcalino de nitrógeno como el carbono orgánico. En el caso del K disponible, se encontró que el acetato de amonio y el ácido nítrico O.IN resultaron ser soluciones extractoras igualmente superiores.

Introduction

The yield of any crop plant and yield increases due to fertilizer additions depend upon many factors such as soil, plant, climate and cultural practices. The level of nutrient availability to plant is of prime importance in determining crop yields. The ability, dependability and rapidity to extract proportional amounts of available nutrients, are axioms of a successful soil test. Hence, screening for a suitable method and calibration of soil tests against crop response are essential for deciding on fertilizer requirements. In this paper, an attempt has been made to screen the suitable soil test methods for sorghum for the precise prediction of the fertility status of the soil.

Materials and methods

A field experiment was conducted in shallow red soils of Bhavanisagar (Typic Ustorthents). Fertility gradients were created adopting a methodology akin to that of Ramamoorthy and Velayutham (7) with Ganga 5 Maize. Then, the test crop trial with sorghum var. CSH 5 (having selected 12 treatments including controls involving 5 levels of N and 4 levels of P and K) was superimposed and replicated three times for each of the four fertility gradients. The levels tested were 0, 50, 100, 150 and 200 kg/ha for N; 0, 13, 26 and 39 kg/ha for P and 0, 16, 32 and 48 kg/ha for K. Plotwise soil samples (0–15 cm) were collected and were analysed for available nutrients prior to sowing the sorghum, using the following methods:

Available N:

Alkaline permanganate – N	: Subbiah and Asija (10)
Organic carbon	: Walkley and Black (11)

Available P:

Olsen's extractant	: Olsen et al. (6)
Bray's extractant	: Bray and Kurtz (3)

Available K:

1 N Ammonium acetate	: Stanford and English (9)
0.1 N Nitric acid	: Ramanathan (8)
0.01 M Calcium cloride	: Beckett (2)
Morgan's Universal extractant	: Morgan (5)
Boiling 1 N Nitric acid	: Wood and De Turk (12)

Multiple regression analysis was done to relate the soil test values with yield so as to study the number of parameters simultaneously, using Fortran IV language in an IBM 370/155-II Computer.

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Results and discussion

The general characteristics of the soil in which the experiment was conducted is given in Table I. Twenty different combinations involving two methods for N, two for available P and five for available K were tested against yield, using the multiple regression technique.

TABLE 1

Physico-chemical characteristics of the soil

pH	:	7.90
EC x 10^3	:	0.18
Texture	:	Sandy loam
CEC (me/100 g)	:	22.50
Organic carbon (%)	:	0.18

Total nutrient content (%)

Nitrogen	:	0.039
Phosphorus	:	0.049
Potassium	:	0.250

Available nutrient content (kg/ha)

N (alkaline permangante N)	:	235
P (Olsen's P)	:	9.40
K (Ammonium acetate K)	:	220
Ca Co_3 content (%)	:	1.40

Considering the type and magnitude of response along with the R^2 values, the following three combinations, viz., SN_1 SP_1 SK_2; SN_2 SP_1 SK_2 and SN_2 SP_1 SK_1, were found to be equally superior over other combinations. The significance of response types have already been established under the All India Co-ordinated Soil Test Crop Response Correlation Scheme (1).

SN_1 SP_1 SK_2 ($R^2 = 0.934$ **)

$$Y = 2312 - 27.61\ SN + 184.59^{***}\ SP + 6.28\ SK + 79.86^{***}\ FN + 40.71^{**}\ FP - 8.61\ FK + 0.06\ SN^2 - 4.23^{*}\ SP^2 - 0.01\ SK^2 - 0.15^{***}\ FN^2 - 0.80^{**}\ FP^2 + 0.11\ FK^2 - 0.11^{*}\ SN\ FN - 0.14\ SP\ FP + 0.05\ SK\ FK$$

SN_2 SP_1 SK_2 ($R^2 = 0.932$**)

$$Y = -1391 + 2517.94\ SN + 182.40^{***}\ SP + 11.07\ SK + 57.85^{***}\ FN + 45.37^{**}\ FP - 7.36\ FK - 3166.53\ SN^2 - 4.58\ SP^2 - 0.02\ SK^2 - 0.16^{***}\ FN^2 - 0.89^{***}\ FP^2 + 0.05\ FK^2 - 8.35\ SN\ FN - 0.24\ SP\ FP + 0.05\ SK\ FK$$

SN_2 SP_1 SK_1 ($R^2 = 0.930$**)

$$Y = 29 + 211.02\ SN + 191.47^{***}\ SP - 5.11\ SK + 56.89^{***}\ FN + 42.50^{**}\ FP + 6.03\ FK + 2565.05\ SN^2 - 4.47^{*}\ SP^2 + 0.02\ SK^2 - 0.16^{***}\ FN^2 - 0.91^{***}\ FP^2 + 0.08\ FK^2 - 3.88\ SN\ FN - 0.05\ SP\ FP - 0.03\ SK\ FK$$

SN_1 – Alkaline permanganate N	SP_1 – Olsen's P
SN_2 – Organic carbon	SP_2 – Bray's P
SK_1 – Ammonium acetate K	FN – Fertilizer N
SK_2 – 0.1 N nitric acid K	FP – Fertilizer P
	FK – Fertilizer K

In evaluating the techniques, most workers have correlated the various soil test values of one nutrient alone with the yield of the crop. But the field of a crop is influenced not only by the availability of one nutrient but also by the availability of other nutrients. Hence, multiple regression analysis using all three nutrients simultaneously was carried out between all possible combinations of soil test methods and yield, along with fertilizer nutrients to give a vivid picture of complementary native soil and fertilizer nutrients as two sources of supply, the effect of one being supplemented by the other.

As seen, out of twenty different combinations, only three combinations were found to be superior over the others. The superiority of Olsen's extractant is evident, from its presence in all the three selected combinations. According to Jackson (4), in addition to extracting some P from surface Ca-P by changing the solubility product of Ca-P, the Olsen's reagent extract some P from the surfaces of Al and Fe phosphates by repression of Al and Fe activities; this possibly accounts for its superiority.

Both alkaline permanganate nitrogen and organic carbon are widely employed to measure the available nitrogen status of soils. The present study also has established the usefulness of both methods for adoption.

Owing to the complexity of the existence of potassium in dynamic equilibrium among its various forms, selection of a particular soil test method for universal adoption still remains unsolved, although

0.1 N nitric acid and ammonium acetate extractants were found to be superior over the other three extractants used in the present study. Among the two, ammonium acetate is already widely used as an extractant; 0.1 N nitric acid has also been claimed to be superior by Ramanathan (8) in his studies on the dynamics of soil potassium.

Summary

A field experiment was conducted in shallow red soils of Bhavanisagar with sorghum as test crop to screen suitable soil tests for the precise prediction of the fertility status of soil. Twenty different combinations involving two methods for N, two for P and five for K were tested, adopting the multiple regression technique; only three combinations were found to be superior over others. These selected combinations showed the superiority of Olsen's for available P while for available N both alkaline permanganate nitrogen and organic carbon were found to be equally good. For available K, ammonium acetate and 0.1 N nitric acid extractants were found to be equally superior.

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Reseña de Libros

KATZ J. Ozone and chlorine dioxide technology for disinfection of drinking water. Noyes Data Corporation, Park Ridge, New Jersey. 1980. 659 p.

Este es el volumen 67 de la serie Pollution Tecnology Review y a la vez el número 164 de Chemical Technology Review. Los capítulos se presentan como reproducciones de los manuscritos mecanografiados originales.

Los temas generales que cubren son: Uso de otros desinfectantes; aspectos microbiológicos de la desinfección; determinación de residuos; química y costo del proceso de desinfección. La segunda parte del libro trata de manera concreta los aspectos químicos, biológicos, de salud pública, y de ingeniería, en el uso del ozono y del dióxido de cloro en el tratamiento de aguas.

La información contenida en este libro es bastante completa, lo cual lo hace valioso como obra de referencia para personas que ya trabajan en el campo del tratamiento de aguas, ya que además presenta una extensa recopilación de información bibliográfica referente al uso del ozono y del dióxido de cloro en aguas. Los mecanismos de acción de estos oxidantes sobre la materia orgánica están descritos en forma adecuada, lo cual le da valor adicional a esta obra para aquellos lectores interesados en conocer, más a fondo, la naturaleza química de los procesos descritos.

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