acknowledged. Grateful thanks are due to Dr. V. Santhanam, Head of Regional Centre, I. C. A. R. (Coimbatore) for his valuable guidance in the study.

REFERENCES

Brown, M. S.	1943	Haploid plants in *Sorghum J. Hered.*, 34 : 162–6.
Endrizz, J. E. and D. T. Morgan Jr.	1955	Chromosomal interchanges and evidence for duplication in haploid *Sorghum vulgare J. Hered.*, 46 : 201–8.
Erichsen, A. W. and J. G. Ross	1963	Inheritance of colchicine induced male-sterility in *Sorghum: Crop. Sci.* 3 : 335–8.
Kihara, H., and K. Tsunewaki	1962	Use of an alien Cytoplasm as a new method of producing haploids *Jap. J. Genet.*, 37 : 310–3.
Kimber, G., and R. Riley	1963	Haploid Angiosperms *Bot. Rev.*, 29 : 480–529.
Mazoti, L. B. and G. E. Mualenberg	1958	Natural haploids in maize *Rev. Argent. Agron.*, 25 : 171–8.
Meenakshi, K. and M. S. Thangam	1961	Personal communication.
Simantel, G. H. and J. G. Ross	1964	Colchicine induced somatic Chromosome reduction in *Sorghum*. IV-An Induced Haploid mutant *J. Hered.*, 55 : 3–5.
Smith, L.	1947	The Aceto-carmine smear technique. *Stain. Tech.*, 22 : 17–31.
Stephens, J. C. and R. F. Holland	1954	Cytoplasmic male-sterility for hybrid *Sorghum* Seed Production. *Agron. J.*, 46 : 20–3.

---

https://doi.org/10.29321/MAJ.10.A03740

Progressive Changes in Soil Available Phosphorus and Relationship with yield and Uptake in Co. 7 *Ragi* *

by

S. P. MUSTAFA [1] and D. J. DURAIRAJ [2]

Introduction: Phosphorus is highly susceptible to fixation in soils and a complex set of factors determine its availability. Three major groups of South Indian soils have been examined for availability of phosphorus in relation to yield and uptake in Co. 7 *ragi*.

Review of literature: Aldrich and Buchanan (1954) found a highly significant correlation between acid extractable and total phosphorus in Southern Californian soils. Moser and his associates (1959) gave the

[1] Assistant in Chemistry,
[2] Professor of Soil Science } Agricultural College and Research Institute, Coimbatore.

* Formed part of the dissertation submitted to Madras University by the first author in 1966 for M. Sc. (Ag.) degree.

Received on 7—1—1967.

following order of decreasing precision of predicting the yield: (i) Anion exchange resin method, (ii) Olsen's 0·5 M $NaHCO_3$ method (iii) Phosphate potential of Schofied and Aslyng, (iv) Phosphate concentration in the $0{\cdot}01Cl_2$ extract of Schofied and Aslyng, (v) 0·1 N Hcl and 0·03 N NH_4F of Bray and Kurtv, Breland and Sierra (1962) compared the various extractants for a group of Florida soils and found that Hcl with NH_4F, Hcl and H_2SO_4 solutions extracted more phosphorus than the other extractants.

Suski *et al* (1963) found that phosphorus values extracted with Osen and Bray and Kurtz reagent were highly correlated with 'A' values. Vittal Rao and Krishna Rao (1963) considered Truog's method as most suitable in red, black and laterite soils of Andhra. Williams and Knight (1963), obtained highest correlations by the lactate and 0·5 M $NaHCO^3$ methods. Fiskell and Hutton (1964) suggested fluoride-extractable phosphorus values as the most important analytical data for predicting maize yield. Jackson and his associates (1964) found that Olsen's method yielded highest correlation coefficient with phosphorus uptake.

Meterials and Methods: Three soils, namely red and black soils from Coimbatore and laterite soil from Nanjanad were taken for the main pot culture study. Under each soil there were seven treatments as follows:

1. Control
2. 20lb. P_2O_5 as Superphosphate
3. 40lb. P_2O_5 as Superphosphate
4. 20lb. P_2O_5 as Dicalcium phosphate
5. 40lb. P_2O_5 as Dicalcium phosphate
6. 20lb. P_2O_5 as Ammophos
7. 40lb. P_2O_5 as Ammophos

The experiment was statistically laid out. All the treatments were replicated twice. Soils samples were collected at regular fortnightly intervals and analysed for available phosphorus, available nitrogen and pH. Four methods were used for the determination of available phosphorus. They are (1) Olsen's method of extraction, (2) Bray and Kurtr No. 1 method, (3) Truog's method and (4) Dyer's method.

The grain and straw obtained on harvest were separately recorded. The results were statistically analysed to bring out significant differences. Correlation studies were made to study the various relationships that may

exist between the plant nutrient test values and yield and uptake by plants A list of various correlations obtained and their corresponding regression equations are presented in Table II.

TABLE II

Results of Statistical Analysis Correlation of Soil Test values with yield or uptake

S. No.	Relationship	No. of pairs of observation	Correlation coefficient
1.	Olsen (4) — grain yield ...	14	0·34 NS
2.	Bray (1) — grain yield ...	14	0·72 §
3.	Bray (3) — grain yield ...	16	0·83 †
4.	Citric acid — grain yield ...	21	0·62 §
5.	Olsen (1) — straw yield ...	5	0·94 *
6.	Olsen (4) — straw yield ...	17	0·92 †
7.	Bray (1) — straw yield ...	17	0·93 †
8.	Bray (3) — straw yield ...	19	0·83 †
9.	Bray (5) — straw yield ...	20	0·91 †
10.	Truog (2) — straw yield ...	20	0·71 †
11.	Truog (4) — straw yield ...	20	0·81 †
12.	Citric acid (4) — straw yield ...	21	0·79 †
13.	Olsen (2) — uptake ...	17	0·87 §
14.	Olsen (4) — uptake ...	18	0·78 †
15.	Olsen (5) — uptake ...	17	0·83 †
16.	Olsen (6) — uptake ...	14	0·91 †
17.	Bray (1) — uptake ...	16	0·81 *
18.	Bray (2) — uptake ...	18	0·48 *
19.	Bray (3) — uptake ...	15	0·82 †
20.	Bray (6) — uptake ...	16	0·80 †
21.	Truog (1) — uptake ...	20	0·56 §
22.	Truog (2) — uptake ...	18	0·93 †
23.	Citric Acid (4) — uptake ...	17	0·75 †

NOTE: *Significance:* † = 0·1%; § = 1%; * = 5%; NS = Not significant.

Results and Discussion: The reliability of any soil test should be revealed through the crop yield obtained from the soil on which the test was performed. A comparison of performance of the crop in relation to the individual soil tests conducted in the present study, considering the yield data and uptake is described below. Results of analysis of variance of soil test value also are given.

(a) *Olsen's method:* Effects of soils, periods and their interactions were found to be significant. The fourth period recorded the maximum available phosphoric acid and it was significantly superior to all other periods. The availability of the phosphoric acid during the initial and post-harvest periods and the first and second periods was on a par as shown by bar diagram.

Comparison of soils (Phosphorus ppm.)

	Red	Black	Laterite	S. E. D.	C. D.
Mean	8·71	7·83	20·25	1·03	2·05

Comparison of periods

I	II	III	IV	V	VI	S. E. D.	C. D.
10·31	8·55	2·92	22·74	16·33	12·74	1·45	2·90

Conclusions: IV, V, VI, I, II, III

The third period recorded the least amount of available phosphoric acid and was significantly different from the other periods.

The variations due to soils were found to interact with those of periods. Thus at the second, fourth, fifth and sixth periods, the laterite soils were significantly superior to the red and black soils.

Olsen's test values were not significantly correlated with the yield of grain or the logarithm of yield. But with straw yield, phosphorus test values for initial and fourth periods were significantly correlated. The yield data are given in Table I.

TABLE I

Yield of grain and straw and uptake of phosphorus.

Soil and treatment	Yield (gm. per pot)		Uptake of phosphorus as P_2O_5 (mgm./pot)	
	Grain	Straw	Grain	Straw
Red Soil Treatment 1	10·20	19·98	49·26	40·77
-do- -do- 2	12·25	21·16	67·74	43·16
-do- -do- 3	14·23	21·50	77·21	45·57
-do- -do- 4	13·43	20·84	73·33	22·30
-do- -do- 5	16·70	21·25	85·76	19·54
-do- -do- 6	15·85	23·26	79·89	21·86
-do- -do- 7	16·98	23·36	87·04	47·65

TABLE 1 *(Contd.)*

Soil and treatment	Yield (gm. per pot)		Uptake of phosphorus as P_2O_5 (mgm./pot)	
	Grain	Straw	Grain	Straw
Black Treatment				
Soil 1	17·55	20·95	52·64	43·37
-do- -do- 2	15·53	21·41	48·20	44·32
-do- -do- 3	18·40	24·93	57·95	49·85
-do- -do- 4	16·97	23·59	50·91	29·49
-do- -do- 5	22·17	23·14	86·48	31·93
-do- -do- 6	17·43	23·84	62·23	16·44
-do- -do- 7	22·03	25·10	88·12	51·21
Laterite Treatment				
Soils 1	4·92	21·60	22·54	44·72
-do- -do- 2	16·22	29·98	88·39	61·16
-do- -do- 3	12·99	24·65	66·13	50·28
-do- -do- 4	22·18	27·73	81·33	56·57
-do- -do- 5	20·72	32·75	64·66	66·80
-do- -do- 6	15·87	25·91	48·42	65·55
-do- -do- 7	20·72	32·25	82·68	90·63

The laterite soil group alone recorded correlation of soil test values with straw yield significantly during the initial period. During the fourth period of analysis all the soil groups gave correlation with straw yield this being very high ($r = 0·92$) and significant at 0·1 per cent level. This finding is in line with the work of Subramanian (1962).

At almost all the periods Olsen's phosphorus test values were significantly correlated with uptake of phosphorus. A number of investigators like Olsen and his associates (1959), Susuki *et al* (1964), Jackson and his colleagues (1964), and Thomas (1964) have reported that Olsen's method was least affected by pH fluctuations and generally yielded highest correlations with phosphorus uptake.

(b) *Bray and Kurtx No. I Method :* There was an increase in the available phosphorus status immediately after fertilization. The soils, periods and their interactions were all found to be significant.

In red soil there was a gradual increase in the available phosphorus status in all the treatments, except control, with a slight fall after harvest. In black soil also, there was a slight decrease in availability during the

second period, but there was an increase thereafter, with a decrease at the fourth period. Red and black soils were found to be on a par with each other. Laterite soil was superior to red and black soils.

Comparison of soil means (Phosphorus ppm)

Red	Black	Laterite	S. E. D.	C. D.
8·62	7·76	26·6	1·08	2·16

Conclusion : Laterite, Red, Black

Comparison of periods

I	II	III	IV	V	VI	S. E. D.	C. D.
15·84	10·99	10·12	18·85	15·66	14·62	1·52	3·04

Conclusion : IV, I, V, VI, II, III,

Bray and Kurtx No. I extraction during the third period of analysis was significantly correlated with the grain yield for red and black soils. With straw yield highly significant correlations were obtained with the same reagent for most of the periods. The finding is in concordance with the statement of Bray and Kurtz (1945) that the extractant is capable of extracting more readily soluble phosphorus from each of the forms of phosphate present in the soil.

During the third and post-harvest periods the test values were highly correlated with uptake of phosphorus. Both the correlations were significant at 0·1 per cent level. During the initial and second periods, correlations were significant at five per cent level for all the groups of soils. The results are similar to those obtained by Breland and Sierra (1962) and Fiskell and Hutton (1964).

(c) *Truog's method :* The laterite soil was found to be significantly superior to other soils with regard to the availability of phosphoric acid by Truog's extraction method. The effect of soils, periods and their interactions were found to be significant.

There was an increase in available phosphoric acid extracted by Truog's extractant in laterite and red soils with time. Available phosphorus increased up to the second period in laterite and red soils and decreased thereafter. In black soil, available phosphorus showed an alternate increasing and decreasing tendency throughout the crop growth period.

Comparison of soils (Phosphorus ppm)

Red	Black	Laterite	S. E. D.	C. D.
31·91	23·07	74·26	7·63	15·26

Conclusion : Laterite, Red, Black.

Comparison of periods

I	II	III	IV	V	VI	S. E. D.	C. D.
46·05	55·34	69·65	40·59	18·47	24·82	9·99	19·98

Conclusion : III II I IV VI V

Truog's test value for available phosphorus gave correlation neither with the yield of grain nor with the logarithm of yield at any period.

During the fourth period of analysis Truog's test values correlated with uptake of phosphorus and was significant at five per cent level. At all other periods there were no significant correlations with the uptake and phosphorus test values.

(d) *Dyer's method :* In red soil there was an increase in availability of phosphoric acid after the addition of fertilizers. In black and laterite soils there was no large difference between control and phosphate treatments.

In red and laterite soils, the maximum availability was noticed in the initial stages, i. e., during the first period. Afterwards, there was a gradual decrease up to and after harvest. In the case of the black soil, the same trend was observed up to the third period, but there was a steep increase afterwards.

Comparison of soil means (Phosphorus ppm.)

Red	Black	Laterite	S. E. D.	C. D.
15·75	39·61	22·82	2·49	4·98

Conclusion : Black, Laterite, Red.

Comparison of period means

I	II	III	IV	V	VI	S. E. D.	C. D.
19·94	47·02	25·34	12·96	32·17	19·05	3·52	7·04

Conclusion : II V III I VI IV

Citric acid extracted P_2O_5 was significantly correlated with grain yield at one per cent level for all the soil groups, during the fourth period of analysis. Similarly, straw yield was also correlated at 0·1 per cent level signifiance at the fourth period. When correlated with uptake of phosphorus, citric acid test values gave a correlation coefficient of 0·75, significant at 0·1 per cent level during the fourth period for all the soil groups. By comparison of the work of Mehta and Patel (1963) showed a correlation coefficient 0·47 significant at five per cent level for relationship between phosphorus uptake by *sorghum* plants and available phosphorus by the citric acid method.

Summary and Conclusions: The availability of phosphorus for *ragi* Co. 7 in red, black and laterite soils was studied in a statistically laid out experiment, with seven treatments. Soil samples collected at periodic intervals were analysed for available phosphorus by Olsen's, Bray and Kurtz No. 1, Truog's and Dyer's methods. A close correlation was obtained between soil test values with grain yield or phosphorus uptake. Olsen's and Bray and Kurtz No. 1 extractant were found to be the most suitable ones in predicting the grain yield and uptake of phosphorus in red and black soils. As citric acid extraction was closely correlated with grain yield and uptake in all the three soils, this method is advocated for predicting yield and uptake of phosphorus in all the three soils.

Acknowledgements: Our thanks are due to the members of the Chemistry Section, Agricultural College and Research Institute, Coimbatore for all the help rendered, and also due to the University of Madras for kindly granting permission to publish the above work.

LITERATURE CITED

Aldrich, D. G. and Buchanan, J. R. 1954 Phosphorus content of soils and their parent rocks in Southern California. *Soil Sci.*, 77: 369–76.

Bray, R. H. and Kurtz, L. T. 1945 Determination of total, organic and available forms of phosphorus in soils. *Soil Sci.*, 59: 39–45.

Breland, H. L. and Sierri, F. A. 1962 A comparison of amounts of phosphorus removed from different soils by various extractants. *Soil Sci. Soc. Amer. Proc.*, 26: 348.

Fiskell, J. G. A. and C. E. Hutton 1962 Multiple correlation of corn yields with certain soil analysis of Norfolk fine sandy loam previously treated with phosphate and lime. *Soil Crop Sci. Soc. Florida Proc.*, 223: 116–24.

Jackson, M. L. 1962 *Soil Chemical Analysis.* London, Constable & Co., Ltd.

Jackson, T. L., S. Vacharstayan L. A. Alban, *et al.* 1963 Phosphorus availability in reddish brown lateritic soils. *Agron. J.*, 56: 558–60.

Mehta, B. V. and J. M. Patel	1963	Some aspects of phosphorus availability in Gujarat soils. *J. Indian Soc. Soil Sci.*, **11** : 151–8.
Moser, V. S., W. H. Sutherland and C. A. Black	1959	Evaluation of laboratory indexes of absorption of soil phosphorus by plants. *Plant and Soil*, **10** : 356–74.
Susuki, A., K. Lawton and E. C. Doll	1963	Phosphorus uptake and soil tests related to forms of phosphorus in some Michigan soils. *Soil Sci. Soc. Amer. Proc.*, **27** : 401–3.
Thomas, J. R.	1964	Availability of reserve phosphorus as measured by alfalfa yields, phosphorus uptake and soil analysis. *Soil Sci.*, **98** : 78–84.
Vittal Rao, T. M. and K. Krishna Rao	1963	Correlation of available phosphoric acid in soils with grain yield and phosphorus uptake by rice. *J. Indian Soc. Soil Sci.*, **11** : 165–70.
Williams, E. G. and A. H. Knight	1963	Evaluation of soil phosphate status by pot experiments. *J. Sci. Food agric.*, **14** : 555–63.

A Report on the Natural Occurrence of Root-knot Nematodes (*Meloidogyne* Spp.,) on Some Plants in Madras State

by

M. THIRUGNANAM[1] and G. RANGASWAMI[2]

The root-knot nematodes are well known for their world wide occurrence and broad spectrum of host-range. Though specially designed surveys have been undertaken in other countries to assess the distribution and damage caused by *Meloidogyne spp.*, only limited work has been done in India in this direction. Nadakal (1963) and Nadakal and Thomas (1964) surveyed plants attacked by root-knot nematodes in Kerala and similar work was carried out by Seshadri and Kumaraswami (1963) in Madras State. Sethi *et al*, (1964) conducted a survey to find out the prevalence of *Meloidogyne spp.*, around New Delhi. In the present study, a survey for the occurrence of root-knot nematodes were made in and around Annamalainagar and the adjoining villages of South Arcot district, Madras State during different cropping seasons of 1962—1964. Of the thirty five plant species examined, twentysix species showed the presence of galls. Besides noting

[1] Lecturer in Agriculture, Annamalai University, Annamalainagar, Madras State.

[2] Dean, University of Agricultural Sciences, Bangalore.

Received on 3—3—1966.