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Soil fertility evaluation in Sreeramsagar Project Command area of Andhra Pradesh

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Abstract

The soil fertility of Alfisols and Vertisols under paddy has been evaluated through analysis of 300 soil samples for NPK (initial and post harvest) in Karimnagar (230 fields), Warangal (25 fields), Nizamabad (15 fields) and Adilabad (30 fields) districts of Andhra Pradesh during 1994 and 1995. The estimates of correlation were determined between initial and post-harvest soil test values and fertilizer doses of N, P and K (applied nutrients) and grain yield of rice for assessing the usefulness of variables for predicting the soil test values without performing chemical analysis. Significant correlations of yield existed with initial soil test values and fertilizer doses in the study. The initial soil test values had a positive and significant correlation with post-harvest soil test values for all the three nutrients in all the four districts. The regression models of post-harvest soil test values through initial soil test values, applied fertilizer doses and harvested grain yield of the previous season calibrated for each nutrient in each district indicated that the post-harvest soil test values could be predicted with a predictability ranging between 54 to 84 % for soil N, 62 to 85 % for soil P and 48 to 88 % for soil K. The rate of change in post-harvest soil test values for a unit change in initial soil test values was found to be positive and significant for all the three nutrients.

Additional key words : Soil fertility evaluation, correlation and regression analysis, post-harvest soil test prediction.

Introduction

Rice (*Oryza sativa*) is an important crop grown in Karimnagar, Nizamabad, Warangal and Adilabad districts under the Sreeramsagar Command Area of Andhra Pradesh. Farmers apply fertilizers in their own way without taking either soil or crop requirements. They vary widely among the different districts with nitrogen being applied in larger quantities than phosphorus and potassium. There is an urgent need for judicious application of fertilizers based on soil testing as advocated in the All India Coordinated Soil Test Crop Response Correlation Project (Ramamoorthy *et al.* 1967 ; Velayutham 1979; Maruthi Sankar *et al.* 1983). The post-harvest soil test values of any nutrient would depend on the initial soil test values and the fertilizer application schedules apart from the harvested grain yields (Randhawa and Velayutham 1982; Velayutham *et al.* 1985). The soils of farmers' fields if evaluated for both initial and post-harvest soil fertility, and further the rice responses are taken into account, a sound data base can be developed for calibrating soil test based fertilizer recommendations for

rice. With this objective, a field survey has been conducted in 300 farmers' fields from 60 villages under Sreeramsagar Project Area Command Area covering different soil types belonging to Alfisols and Vertisols in four districts of Andhra Pradesh. The soil fertility information collected under the detailed field survey made in the study would be greatly useful to the Soil Testing Laboratories in the four surveyed districts for refining and prescribing optimal fertilizer doses based on soil test values.

Materials and methods

A detailed field survey was conducted in 300 farmers fields to evaluate soil fertility in the four districts of Telangana region viz., Karimnagar (230 fields), Nizamabad (15 fields), Warangal (25 fields) and Adilabad (30 fields) under Sreeramsagar Project Command Area of Andhra Pradesh during 1994 and 1995 (Bhaskar Rao 1997). A detailed questionnaire was prepared for conducting the survey and information on rice yields, fertilizer doses applied, soil fertility status and other information of different soil and crop factors was collected mostly by contact and discussion with farmers and in very few cases through correspondence.

Soil samples were collected from all the 300 respondent farmers' fields spread over 60 villages in the four districts. Surface (0-15 cm) soil samples were collected from farmers' fields by dividing the area into different grids both before transplanting and at harvest. The samples were analysed by alkaline permanganate method for soil N (Subbiah and Asija 1956), Olsen's method for soil P (Olsen *et al.* 1954) and ammonium acetate method for soil K (Jackson 1973). At harvest grain yield was recorded.

The data collected on crop yield, soil test values and fertilizer doses have been analysed for assessing the variation in the data and also for predicting the post-harvest soil test values through initial soil test values. The post-harvest soil test values can be regressed through initial soil test values, applied fertilizer doses and grain yield for predicting changes in soil fertility after harvest of the rice crop by standard statistical procedures (Draper and Smith 1967 ; Maruthi Sankar 1986 ; Maruthi Sankar and Sonar 1987). Using the Technical Programme of All India Coordinated Soil Test Crop Response Project (Ramamoorthy *et al.* 1967) the information collected in the field survey were examined for making an assessment of predicting soil test values in farmer's fields.

Results and discussion

Soil fertility evaluation: The soil fertility evaluation was carried out in 230 fields in Karimnagar district comprising of clay loam (51 fields), clay (2), loamy sand (4), sandy clay loam (123), sandy loam (36), silty clay loam (4) and silt loam (10) textures (0-15 cm) of soil. It was carried out in 15 fields in Nizamabad district comprising of clay loam (1 field), sandy clay loam (5), sandy loam (2), silty clay loam (5), silt loam (2) textures whereas Warangal district had clay loam (8 fields), loamy sand (3), sandy clay loam (10), sandy loam (2) and silty clay loam (2) textures. The soil fertility evaluation was carried out in 30 fields in Adilabad district comprising of clay loam (21 fields),

loamy sand (2), sandy clay loam (4), sandy loam (1), silty clay loam (1) and silt loam (1) textures.

The mean (standard deviation) pH and electrical conductivity were found to be 7.63 (0.82) and 0.29 (0.13) in Karimnagar, 7.03 (0.45) and 0.24 (0.12) in Nizamabad, 8.26 (0.58) and 0.26 (0.11) in Warangal and 6.83 (0.69) and 0.24 (0.14) in Adilabad district, respectively. Similarly, clay, silt and sand in the soils were found to be 16, 9 and 75 percent in Karimnagar, 30, 16 and 54 per cent in Nizamabad, 47.5, 15 and 37.5 percent in Warangal and 46, 13 and 41 per cent in Adilabad district, respectively.

The descriptive statistics like range, mean, standard deviation and coefficient of variation (%) of initial and post-harvest soil test values of N, P and K nutrients and grain yield have been determined and given in table 1.

Correlation analysis of soil fertility parameters: The estimates of correlation have been determined between grain yield, initial and post-harvest soil test values and applied fertilizer N, P and K nutrients and are given in table 2. The results indicated that significant correlations existed between grain yield and initial soil P and K at Karimnagar and Warangal, and only soil P at Nizamabad. Signifcant correlations of yield were found to exist with fertilizer N, P and K at Karimnagar, N and P at Adilabad, and only K at Warangal. The correlations between initial and post-harvest soil N, P and K nutrients were found to be positive and significant in all the four districts surveyed.

Soil fertility evaluation based on regression analysis: The prediction equations and the coefficient of predictability (R^2 value) of each nutrient are given in table 3. The R^2 values were found to be highly significant in all the four districts which ranged between 0.54 and 0.84 for soil N, 0.62 and 0.85 for soil P, and 0.48 and 0.88 for soil K. While the regression coefficients (slopes) of initial soil N, P and K nutrients were significantly contributing to the post-harvest soil N, P and K nutrients, the regression coefficients of fertilizer nutrients and grain yield were not significant in all the four districts. This indicated that the changes in soil fertility of nutrients after harvest of a crop could be directly evaluated based on the initial soil test values to a large extent.

Table 1. Descriptive statistics of soil test values and yield based on survey in farmers' fields

Variable	Minimum	Maximum	Mean	S.D.	CV (%)
Karimnagar					
GY	12.0	52.8	25.9	11.1	42.8
OC (I)	0.09	1.97	0.95	0.03	34.6
KM (I)	75.3	360.6	186.0	49.7	26.7
OL (I)	4.0	55.0	23.2	11.5	49.5
AM (I)	96.0	528.0	255.3	90.8	35.6
KM (PH)	62.0	316.0	167.1	42.2	25.2
OL (PH)	6.0	80.0	27.2	12.6	46.3
AM (PH)	220.0	546.0	264.7	93.5	35.3
Nizamabad					
GY	14.0	21.0	17.6	2.5	14.1
OC (I)	0.73	1.66	1.02	0.25	24.8
KM (I)	106.6	404.5	226.9	70.4	31.0
OL (I)	18.0	46.0	25.3	7.9	31.1
AM (I)	189.0	645.0	376.9	129.1	34.2
KM (PH)	124.0	410.0	213.7	75.7	124.0
OL (PH)	19.0	46.0	30.4	8.6	28.5
AM (PH)	162.0	616.0	323.8	141.2	162.0
Warangal					
GY	16.0	42.0	25.6	8.1	31.7
OC (I)	0.3	2.0	0.8	0.5	57.9
KM (I)	116.0	279.1	183.5	43.2	23.6
OL (I)	7.0	38.0	22.4	9.2	41.2
AM (I)	102.0	382.0	246.8	70.4	28.5
KM (PH)	128.0	305.0	189.3	46.4	24.5
OL (PH)	10.0	46.0	28.1	9.2	32.8
AM (PH)	102.0	402.0	219.6	68.0	31.0
Adilabad					
GY	14.0	28.0	19.8	4.0	20.2
OC (I)	0.7	1.9	1.1	0.3	28.3
KM (I)	131.7	266.6	202.6	38.6	19.1
OL (I)	10.0	61.0	30.9	14.6	47.2
AM (I)	109.0	502.0	232.9	127.6	54.8
KM (PH)	138.0	270.0	206.6	40.4	19.6
OL (PH)	12.0	60.0	37.3	16.4	43.9
AM (PH)	88.0	486.0	190.9	107.8	56.5

OC : Organic carbon (%)
KM : $KMnO_4$-N (kg ha^{-1})
OL : Olsen-P (kg ha^{-1})
AM : Ammonium acetate-K (kg ha^{-1})

GY : Grain yield (q ha^{-1})
I : Initial soil test values
PH : Post-harvest soil test values

Table 2. Correlation between soil test values, fertilizer doses and grain yield based on survey data of farmers' fields

Variables	Karimnagar	Nizamabad	Warangal	Adilabad
GY , IOC	0.03	-0.61 *	0.02	-0.33
GY , IKM	-0.03	-0.46	-0.28	-0.03
GY , IOL	-0.33 **	-0.60 *	-0.41 *	-0.15
GY , IAM	-0.25 **	-0.21	0.40 *	-0.21
GY , FN	0.39 **	0.44	0.27	0.49 *
GY , FP	0.21 *	0.12	0.25	0.48 *
GY , FK	0.46 **	-0.33	0.39 *	0.34
IOC , FN	0.01	-0.38	0.21	-0.31
IKM , FN	0.01	-0.39	0.04	-0.35
IOL , FP	0.05	0.03	0.04	-0.36
IAM , FK	-0.24	0.04	-0.30	-0.31
IKM , PHKM	0.83 **	0.87 **	0.92 **	0.71 **
IOL , PHOL	0.78 **	0.84 **	0.82 **	0.90 **
IAM , PHAM	0.72 **	0.61 *	0.73 **	0.93 **

GY : Grain yield (kg ha^{-1})
FN, FP and FK : Fertilizer N, P and K doses (kg ha^{-1})
IOC : Initial organic carbon (%)
IKM : Initial soil N (kg ha^{-1}) ($KMnO_4$-N)
IOL : Initial soil P (kg ha^{-1}) (Olsen-P)
IAM : Initial soil K (kg ha^{-1}) (Ammonium acetate-K)
PHKM : Post-harvest soil N (kg ha^{-1}) ($KMnO_4$-N)
PHOL : Post-harvest soil P (kg ha^{-1}) (Olsen-P)
PHAM : Post-harvest soil K (kg ha^{-1}) (Ammonium acetate-K)

Table 3. Prediction equations of post-harvest soil test values through intial soil test values in different districts

District	Multiple regression equation	R^2
Karimnagar	KM (PH) = 29.65 + 0.704 KM (I) ** + 0.134 FN - 0.149 GY	0.69 **
	OL (PH) = 10.60 + 0.884 OL (I) * - 0.115 FN + 0.063 GY	0.62 **
	AM (PH) = 100.8 + 0.712 AM (I) ** - 0.348 FN - 0.324 GY	0.52 **
Nizamabad	KM (PH) = -180 + 1.075 KM (I) ** + 0.001 FN - 8.553 GY	0.82 **
	OL (PH) = 5.22 + 0.114 OL (I) ** + 0.209 FN + 0.638 GY	0.66 **
	AM (PH) = -245 + 0.679 AM (I) * + 5.411 FN + 2.554 GY	0.48 *
Warangal	KM (PH) = -0.60 + 1.000 KM (I) ** - 0.033 FN + 0.369 GY	0.84 **
	OL (PH) = 14.95 + 0.933 OL (I) ** - 0.307 FN + 0.286 GY	0.77 **
	AM (PH) = 5.01 + 0.573 AM (I) * - 0.001 FN + 2.856 GY	0.63 **
Adilabad	KM (PH) = 16.27 + 0.747 KM (I) ** - 0.001 FN + 1.958 GY	0.54 **
	OL (PH) = -13 + 1.055 OL (I) ** + 0.606 FN - 0.867 GY	0.85 **
	AM (PH) = -30.2 + 0.788 AM (I) ** - 0.001 FN + 1.889 GY	0.88 **

KM(I), OL(I), AM(I) : Initial soil test values of $KMnO_4$-N, Olsen's P, Ammonium acetate K (kg/ha)

KM(PH), OL(PH), AM(PH) : Post-harvest soil test values of $KMnO_4$-N, Olsen's P, Ammonium acetate K (kg/ha) GY : Grain yield (kg/ha)

FN, FP and FK : Applied fertilizer N, P and K nutrients (kg/ha)

* and ** : significance at 5 and 1 % level respectively

Using the regression equations, a ready reckoner showing the post-harvest soil test values at different initial soil test values of N, P and K nutrients, average yield and fertilizer N, P and K doses has been developed and is given in table 4. The predicted post-harvest soil test values were found to range between 93 to 339 kg/ha for soil N, 9 to 71 kg/ha for soil P and 152 to 550 kg/ha for soil K in Karimnagar district. The predicted post-harvest soil test values at a given initial soil test value of N, P and K nutrients of other districts have also been calibrated (Table 4). The prediction equations would serve in forecasting the changes in soil fertility through available soil test values, applied fertilizer doses and harvested rice yield. The predicted post-harvest soil test values could be used for deriving the optimum fertilizer doses for rice in the surveyed districts by using the targeted yield equations of rice developed in the All India Coordinated Soil Test Crop Response Correlation Project (Velayutham *et al.* 1984). This would avoid soil testing for a few seasons after harvest of the crop for prescription of optimal fertilizer doses for the subsequent crops in the surveyed locations of the four districts under Sreeramsagar Project Command Area in Andhra Pradesh.

Table 4. Ready Reckoner showing predicted post-harvest soil test values at varying initial soil test values in rice soils of Sreeramsagar project command of Andhra Pradesh

Initial soil test values (kg/ha)			Post-harvest soil test vlues (kg/ha) when applied N -P-K are 100-60-40 kg/ha and harvested rice yield is 20 q/ha											
			Karimnagar			Nizamabad			Warangal			Adilabad		
SN	SP	SK	SN	SP	SK	SN	SP	SK	SN	SP	SK	SN	SP	SK
75	5	100	93	9	152	72	31	90	78	7	119	111	11	86
100	10	140	110	14	180	99	32	118	103	12	142	130	17	118
125	15	180	128	18	209	126	33	145	128	16	165	149	22	149
150	20	220	146	23	237	152	33	172	153	21	188	167	27	181
175	25	260	163	27	266	179	34	199	178	26	211	186	32	212
200	30	300	181	31	294	206	35	226	203	30	234	205	38	244
225	35	340	198	36	322	233	36	253	228	35	257	223	43	275
250	40	380	216	40	351	260	36	281	253	40	280	242	48	307
275	45	420	234	45	379	287	37	308	278	44	303	261	53	339
300	50	460	251	49	408	314	38	335	303	49	326	279	59	370
325	55	500	269	54	436	341	38	362	328	54	349	298	64	402
350	60	540	286	58	465	367	39	389	353	58	372	317	69	433
375	65	580	304	62	493	394	40	416	378	63	394	335	75	465
400	70	620	322	67	522	421	41	444	403	68	417	354	80	496
425	75	660	339	71	550	448	41	471	428	72	440	373	85	528

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