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Available Potassium Content in Soil under Intensive Fertilizer use as revealed by Some Soil Tests

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An investigation was undertaken to examine the changes in available potassium status in an alluvial soil under intensive cropping and fertilizer use for seven years, using water, 0.01M $CaCl_2$, neutral normal ammonium acetate and NH_4F plus DTPA as soil tests. While all the four tests employed were found fairly effective, ammonium acetate proved to be the best in detecting the treatmental differences. $CaCl_2$ (0 01M), ammonium acetate and NH_4F plus DTPA showed highly significant positive relationships with yield of crops raised in the eighth rotation.

Cropping without potash fertilizer depletes available potassium in the long run and more rapidly so at high fertility levels (Findley, 1973; Biswas *et al.*, 1977). Annual losses of K from soil increase as a result of N and P application and the high yields obtained (Cooke *et al.*, 1958; Milcheva, 1975) but in most cases the extent of decline in soil potassium was not commensurate with the crop removal. Some studies revealed significant increase in available K with continuous application of cattle manure, compost and green manuring (Sahu and Nayak, 1971) and in several experiments the effect of potassic fertilizer use in this regard was readily seen (Findley, 1973; Ghosh and Biswas, 1978) and also without any benefit in some others (Lutz and Jones, 1971; Biswas *et al*, 1977). However, it seemed that not much information is available as regards which soil test is better to reveal the changes brought about by intensive fertilizer use under continuous multiple cropping.

EXPERIMENTAL

A long term field experiment at the Indian Agricultural Research Institute Farm, New Delhi was initiated in 1971 under an All India Coordinated Project of the I.C A R. to study the direct and cumulative effect of fertilizers and manures in a multiple cropping system of fixed rotation, consisting of *bajra* (pearl millet), wheat and cowpea (fodder) in sequence. The soil was sandy loam in texture (clay 15%, silt 16% and sand 69%), slightly alkaline in reaction (pH 8.0) and low in CEC (10 6 me/100 g). Initial soil test values of the experimental area showed that it was low in available N (organic carbon 0.44%), medium in available P(16 kg/ha) and K (155 kg/ha).

The experiment was laid out in randomised block design with 10 treatments (Table 1) replicated 4 times and the plot size was 21 x 8m (168 sq. m). Fertilizer doses were based on soil test values and applied to each crop in the rotation. The optimum recommended NPK being 120 : 60 : 40 for pearl millet and wheat and 20 : 40 : 20 for cowpea. Urea, diammonium phosphate

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and muriate of potash were the sources of nutrients applied, except where otherwise specified. Soil samples from 0-15cm depth were collected from individual plots in November 1971 before wheat sowing and in May 1978 after its harvest. Representative soil samples were also drawn from an adjacent fallow land in 1978. Standard methods of analysis (Jackson, 1967) were followed for initial characterization of the soil. Available potassium status was determined adopting the following methods.

Neutral ammonium acetate extractable K : The procedure was based on extraction of K with 1 N NH_4OAC (pH 7.0) as described by Hanway and Heidal (1952).

Water soluble K: Potassium was extracted with distilled water (soil to water ratio 1 : 5) and estimated with flame photometer (Jackson, 1967).

$CaCl_2$-soluble K: The extracting reagent employed was 0.0 1M CaCl (soil to solution ratio 1 : 20) and concentration of K in solution was found out after 17 hours equilibration. This test serves as an intensity parameter of K in soil (Halevy, 1977).

NH_4F plus DTPA soluble K K was extracted with neutral 0.5M ammonium fluoride (Bray and Kurtz, 1945) and 0.005M DTPA solution (1 : 20 soil to solution ratio) for 30 minutes (Subba Rao and Ghosh, 1981). This test, originally developed for assessing the status of availaple P, was adopted to see its suitability as a common test for both P and K. The quantity of K extracted was expressed in the same unit (kg/ha) to get an idea about the comparative efficiency of extraction

RESULTS AND DISCUSSION

The results pertaining to the quantities of K extracted by the different procedures have been presented in Table 1. The depletion of available potassium under continuous cropping with no fertilizers, nitrogen alone or with NP was clearly detectable by the capacity parameters viz., ammonium acetate and NH_4F + DTPA extractants while the intensity measures tried, 0.01M $CaCl_2$ and water remained insensitive to this. However, the enhancement in available K resulted from added potash was well reflected in all the four tests. Interestingly, only ammonium acetate could detect the benefit derived from 50% NPK dose but the increase in available K achieved through 100 per cent NPK was reflected in all the tests. Further increase in the dose of NPK by 50% (150% NPK) did not bring about any change in available K. This could be due to fixation of some portion of added K in non exchangeable form over a period of seven years (1971-1978). In general, out of the tests tried, only ammonium acetate could more effectively detect the treatmental effects (Cook e *et al.* 1958, Biswas *et al.*, 1977).

There were significant positive relationships between the four tests tried for the assessment of available K and yields of crops grown in the eighth rotation (1978-79 (Table II). Both the capacity tests (ammonium acetate and NH_4F + DTPA) had shown high order of correlation coefficients than K intensity parameters (water and 0.01M $CaCl_2$). Of the two intensity tests, 0.01M $CaCl_2$ seemed to be a better index of soil fertility and productivity. Both ammonium acetate and NH_4F + DTPA proved equally effective in detecting the level of available K which in turn reflected in yield of test crops. The latter test had also proved equally good to trace the changes in available phosphorus status in the soil (Subba Rao and Ghosh, 1981). Since this extractant contains DTPA, a chelate, further studies are needed to test its suitability for the evaluation of availble micronutrient cations viz, iron, manganese, zinc and copper in alluvial soils.

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TABLE-1 Effect of various treatments on potassium availability after seven years of multiple cropping

Treatment	Extracted K in kg/ha			
	Water (1:5)	0.01 M $CaCl_2$ (1:20)	NH_4OAC (1:5)	NH_4F+DTPA (1:20)
50% NPK based on soil test	5.88	44.8	166 8	181 6
100% NPK (ST)	7.70	65.0	190.4	228.9
150% NPK (ST)	8.40	68.7	204.4	233.8
100% NPK + hand wedding	7.70	62.7	184 8	231.4
100% NPK + Zinc	7 98	66.1	189,0	221.4
100% NP	5.60	43.1	117.6	146.8
100% N	5.60	42.6	116.2	146.8
100% NPK + FYM	8.40	66.1	193.2	251.3
100% NPK with sulphur single super phosphate	7.70	62.7	190.4	218.9
Control (with crop)	5.60	43.7	119 0	156·7
C. D.	1 13	8.95	19.1	29.20
Control (without crop)	5 70	40.3	148.8	174.3

Table II Correlation between various soil tests for available K and crop yields.

Soil test	Correlation coefficient		
	Cowpea (dry fodder)	Pearl millet (total dry matter)	Wheat (grain)
Water soluble K	0.700**	0.400*	0 591**
0·01 M $CaCl_2$ soluble K	0.720**	0.581**	0.410**
Ammonium acetate extractable K	0.800**	0.710**	0.641**
NH_4F + DTPA extractable K	0.660**	0,600**	0,600**

**Significant at P = 0.01
*Significant at P = 0.05