Event: 7th IPI-FAI Round Table in collaboration with IPNI
Date and venue: 20/3/2012; NAAS Committee Room No.1, NASC Complex, New Delhi
Theme: Refinement of K recommendations in Vertisols

Assessment of Potassium availability in Vertisols and its implication on fertilizer K recommendations

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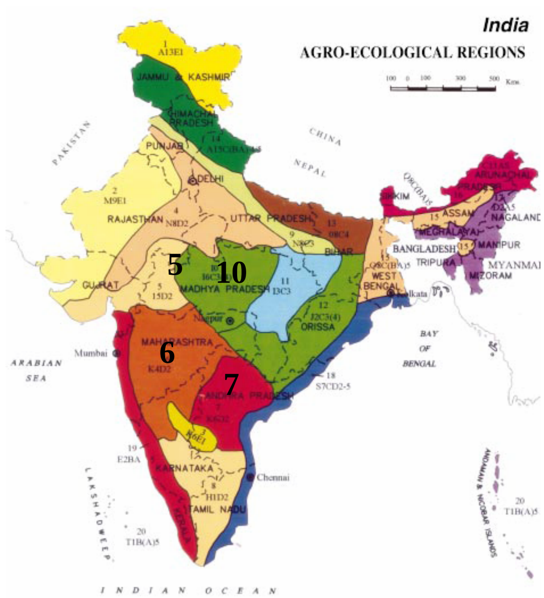
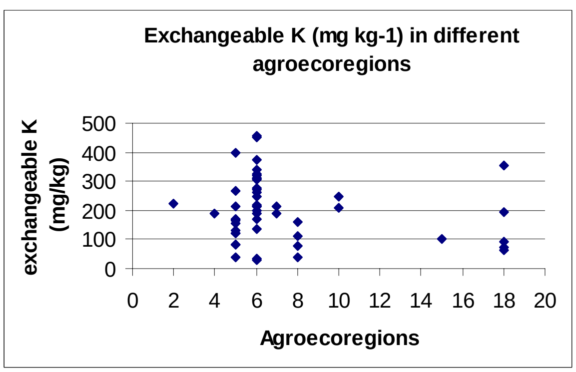
Occurrence



Some swell-shrink Soil (Vertisols/Inceptisols) Series

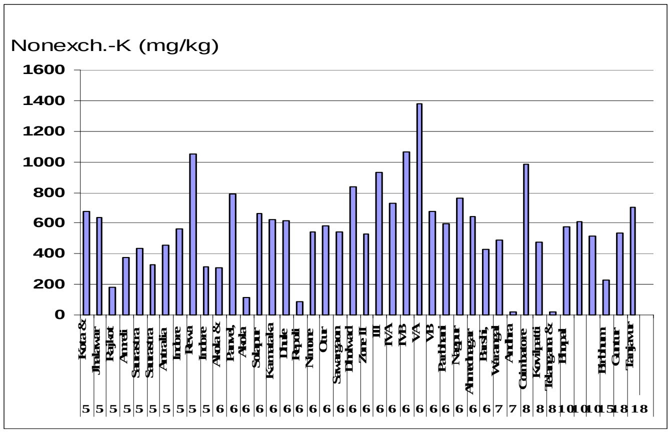
Sarol	**Typic Chromusterts**	**Basalt**	**Indore (M.P.)**
Kamliakheri	**Vertic Ustochrepts**	**Basalt**	**Indore (M.P.)**
Shendvada	**Typic Chromusterts**	**Alluvium**	**Dhule (M.S.)**
Kasireddipalli	**Vertisol**	**Basalt**	**Medak (A.P.)**
Pemberty	**Vertic Ustochrepts**	**Granitic alluvium**	**Warangal (A.P.)**
Periyanaickenpalayam	**Vertic Ustropepts**	**Calcic gneiss**	**Coimbatore (T.N.)**

Hence, swell shrink soils have developed on different parent materials mainly basalt, granite and gneiss.



The occurrence of exchangeable K in different agroecoregions is shown. (adapted from Subba Rao et al., 2010). A wide variation is observed even within an agroecoregion. Some lower values are from Maharashtra and Rajasthan. However, an average value (representative) of 400 kg K/ha can be taken. An interesting feature is that most of the Vertisols have exchangeable K more than 280 kg/ha, and therefore, according to present system of classification, have to be kept in high category (Muhr et al., 1965), however, it will be shown in this paper that many of these soils respond to K application.

Non-exchangeable K in Vertisols



Most of the Vertisols, however, come in the medium category of non-exchangeable K (300-600 mg/kg), indicating that the reserve of K in these soils is not high

Proportion of exchangeable and nonexchangeable K

Agroecoregion 5: **High in available K, but medium/ medium to high in nonexchangeable K. These soils have high CEC and relatively high available K, but the per cent K saturation is quit low.**
Agroecoregion 6: **High in available K but low to high in nonexchangeable K.**
Agroecoregion 7: **Often associated with red soils and are medium in nonexchangeable K.**
Agroecoregion 10: **Vertisols and Vertic Ustochrepts are dominant in this region and are high in both exchangeable and non exchangeable K.**

Lessons from Long-Term Field experiments

Contribution of exchangeable K to yield sustainability

Location	Crops	Control	N	NP	100 % NPK	150 % NPK	100 % NPK+FYM	Ym (t ha^{-1})
Coimbatore	Fingermillet	0.05	0.12	0.48	0.47	0.51	0.55	4.85
	Maize	0.05	0.07	0.40	0.43	0.45	0.50	5.60
Jabalpur	Soybean	0.18	0.20	0.38	0.44	0.38	0.47	3.72
	Wheat	0.13	0.13	0.49	0.53	0.54	0.57	6.20

Higher SYI indicates better sustainability of the system. **The sustainability of yield was affected more in soybean-wheat system at Jabalpur than fingermillet-maize system at Coimbatore. SYI was lower in NP when compared to NPK, depicting that the sustainability of the higher yield is threatened in the absence of K application in these soils**

Wanjari et al., 1994

Contribution of nonexchangeable K to K nutrition during 27 crop cycles of soybean-wheat maize fodder rotations at Jabalpur

Treatment	Fertilizer K added during 21 and 27 crop rotation	1 M NH_4OAc K (kg ha^{-1})	Total K uptake crops (kg ha^{-1})	Contribution of nonexch. K (kg ha^{-1})
Control	0	252	3247	3129
N	0	263	4418	4311
NP	0	235	10067	9932
NPK	2117	308	11826	9647
NPK+ FYM	4142	324	14094	9906

The plots which did not receive K fertilizer (control, N and NP) under continuous cropping with soybean-wheat-maize fodder exhibited relatively more contribution of soil reserve K to crops.

Rupa et al., 2003

Potash fertilizer recommendations for some crops in Vertisols

Location	Cropping system	Fertiliser rates (kg K_2O/ha)
Coimbatore	Finger millet	17
	Maize	33
Jabalpur	Soybean	20
	Wheat	40
Junagadh	Groundnut	0
	Wheat	60
Raipur	Rice	40
	Wheat	40
Akola	Sorghum	50
	Wheat	60
Parbhani	Soybean	30
	Safflower	0

Average crop yield (kg/ha) and K response (kg grain/kg K) in Vertisols at different locations of AICRP-LTFE

Location	Cropping system	NP	NPK	K_2O applied	Response (kg/kg)
Jabalpur	Soybean	1652	1818	20	8.3
	Wheat	4071	4419	40	8.7
Junagadh	Groundnut	838	951	0	-
	Wheat	2409	2536	60	2.1
Raipur	Rice	5055	5124	40	1.7
	Wheat	2140	2141	40	0.0
Akola	Sorghum	2701	3353	50	13.0
	Wheat	1398	2043	60	10.8
Parbhani	Soybean	2142	2272	30	4.3
	Safflower	1145	1346	0	-

Effect of various fertilizer treatments on yield levels of different crops (pooled data for 10 years)

S.No.	Treatment	Grounnut (pod yield) (kg ha^{-1})	Wheat (kg ha^{-1})	Fodder sorghum (t ha^{-1})
1	Control	669	840	8.3
2	Full does of N and P recommended for irrigated conditions but no K	668	2133	18.1
3	As per treatment 2 but with K	1226	3178	24.1
4	Application of N and P according to soil test but no K	693	2248	18.9
5	N and P according to soil test but with K.	1240	3132	24.4
SEm+		21.1	47.3	0.44
cv%		12.5	13.3	-

Responses to applied K were observed on groundnut, wheat and fodder sorgum in a long-term field experiment on a calcareous medium black soil in region 5. Further, the extent of response was more when K was applied with recommended or soil test based dose of NP (Malavia et al. 1993).

Response (kg/kg) of K in Vertisols at LTFEs in India

A.Vertisols of Jabalpur and Akola

Years	Jabalpur		Years	Akola	
	Soybean	Wheat		Sorghum	Wheat
1972-75	0.3	7.4			
1977-81	0.9	2.7			
1982-86	8.6	4.1	1989-92	3.0	3.8
1987-92	9.9	6.2	1993-96	8.0	4.0
1993-97	13.6	12.2	1997-00	8.3	11.0
1998-03	8.9	13.0	2001-04	18.7	12.6
2004-09	10.2	13.2	2005-08	25.6	19.6

Application of K resulted in increase in yield at Jabalpur and Akola, though soils were high in available K status.

Response (kg/kg) of K in Vertisols at LTFEs in India

B. Vertisols of Junagadh and Raipur

Years	Junagadh		Years	Raipur	
	Ground nut	Wheat		Rice	Wheat
1999-00	-	2.7	1999-01	0.8	3.5
2001-02	-	2.7	2002-04	1.9	-1.3
2003-04	-	4.3	2005-08	2.3	-1.0
2005-06	-	2.5			
2007-09	-	2.4			

Limited response at Junagadh due to K supply through irrigation water and no response at Raipur since soils were supplying adequate K to crops.

Response (kg/kg) of K in Vertisols at LTFEs in India

C. Vertisols at Parbhani

Years	Parbhani	
	Soybean	Safflower
2006-07	0.3	-
2007-08	1.5	-
2008-09	11.1	-

Response started in third year.

Response of K years after inception of experiment in Vertisol at Jabalpur and Akola

Crops	Response of K years after cultivation						
	Jabalpur						
	5	10	15	20	25	30	35
Soybean	6	18	172	198	272	177	203
Wheat	294	108	164	248	488	521	527
Available K	352	334	316	298	280	262	244
	Akola						
	4	8	12	16	20		
Sorghum	150	401	415	936	1279		
Wheat	230	241	659	757	1176		
Available K	341	324	308	291	272		

Available status of K with time was computed by calculating rate of decline in available K at Jabalpur and Akola. Soybean started showing response to applied K when available K status reached to 316 kg/ha whereas, wheat showed response to K even before. Similarly at Akola, sorghum started giving response to applied K at 324.4 kg/ha, whereas both the crops responded at available K status of 307.6 kg/ha. It means middle value of K status is 312 kg/ha could be considered critical values. This is greater than the threshold value of 280 kg/ha, currently being used as rating of Vertisols as high in K status. Thus for vertisols there is need to increase the threshold value of K in soil to get the actual recommendation of K to sustain the productivity and and maximized benefit from applied nutrients. The results of LTFE indicate the need to modify or raise the K limits for rating the Vertisols as high and accordingly k recommendation be made on Vertisols.

Potassium availability and responses

Critical values of available K and K fertilizer recommendations for vegetables

State (1)	Soil (3)	Crop (4)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of (5) (7)	Fertiliser requirement at (7) (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)
Maharashtra	Typic Haplusterts	Brinjal*	50	109	38	68	1235	312
Maharashtra	Typic Haplusterts	Cabbage	30	124	23	74	1055	15
Maharashtra	Typic Haplusterts	Caluliflower*	25	58	19	33	975	256
Chhattisgarh	Vertisol	Cauliflower	150	46	113	24	855	175
Maharashtra	Typic Haplusterts	Chilli*	7	135	5	72	851	27
Madhya Pradesh	Vertisol	Garlic	33	77	25	30	677	17
Maharashtra	Typic Haplusterts	Okra*	12	79	9	44	928	86
Maharashtra	Typic Haplusterts	Onion*	25	26	19	6	596	323
Madhya Pradesh	Vertisol	Pea	20	56	15	24	532	16
Maharashtra	Typic Haplusterts	Turmeric	70	160	53	66	694	19
Chhattisgarh	Vertisol	Potato	150	0	113	0	250	0
			Mean	75	38	38	799	107
			Min	0	5	0	250	0
			Max	160	113	74	1235	323

* Yield in tonnes/ha

Vegetables Contd…

The fertilizer K rate at a soil test value of 400 kg/ha available K is 75 kg K2O /ha. The average K fertilizer requirement is considerably less at 38 kg K2O /ha at yield targets 75% of the yield targets shown in column 5 (column 7). Column 9 shows the critical values of soil available K for achieving the yield targets shown in column 5. A critical limit of 800 kg K/ha appears high, but this is for the vegetable crops, many of which the yields are in tonnes. Column 10 shows the response of K over the yield targets shown in column 7. This response need a more careful interpretation as it is calculated from fertilizer prescription equations. This means that additional K fertilizers (6-8) would bring out the depicted responses when additional N, and P fertilizers are also applied for achieving the higher yield targets (Column 5). Columns 11 and 12 show the sensitivity of soil test values of K in computing the fertilizer K requirement of vegetable crops grown in Vertisols with respect to the yield targets shown in column 5. The average K requirement is 65 kg/ha and 84 kg/ha at a soil available K values of 450, and 350 kg/ha.

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Critical values of available K and K fertilizer recommendations for pulses

State (1)	Crop (4)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of (5) (7)	Fertiliser requirement at 7 (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)
Andhra Pradesh	Chickpea	20	37	15	5	566	16
Chhattisgarh	Chickpea	16	82	12	0	526	5
Maharashtra	Chickpea	20	10	15	3	645	78
Madhya Pradesh	Chickpea	25	27	19	3	559	26
Maharashtra	Green gram	12	22	9	12	847	28
Madhya Pradesh	Lentil	10	11	8	0	468	23
Andhra Pradesh	Pigeonpea	20	18	15	0	449	27
Madhya Pradesh	Pigeonpea	25	26	19	4	564	28
Maharashtra	Pigeonpea	20	59	15	27	745	16
		Mean	32	14	6	597	27
		Min	10	8	0	449	5
		Max	82	19	27	847	78

The average K requirement for pulses is 32 kg K2O /ha with chick pea and pigeonpea requiring higher doses. However, the K dose is only 6 kg/ha at yield targets 75% of those shown in column 5. This shows that K fertilization in the Vertisols is essential if higher yields are targeted and obtained in case of pulse crops. The critical limit of soil available K is at 597 kg/ha above which no K fertilization is required. The average response is 27 kg/ha if N, and P fertilizers are also increased in the balanced manner. The sensitivity soil test K is similar to that obtained in case of vegetable crops. There would be an increase of 10 kg K fertilizer requirement/ha if soil available K decreases by 50 units.

Critical values of available K and K fertilizer recommendations for oilseeds

State (1)	Crop (4)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)	Fertiliser recommendation at SK=450 (11)	At SK=350 (12)
Maharashtra	Groundnut	25	15	19	0	491	43	7	23
Madhya Pradesh	Linseed	20	32	15	0	527	16	19	44
Chhattisgarh	Mustard	20	0	15	0	250	0	0	0
Andhra Pradesh	Safflower	20	0	15	0	230	0	0	0
Chhattisgarh	Safflower	20	0	15	0	250	0	0	0
Karnataka	Safflower	15	25	11	6	374	20	0	5
Maharashtra	Soybean	25	47	19	22	762	25	41	54
Andhra Pradesh	Sunflower	15	17	11	3	570	26	12	22
Chhattisgarh	Sunflower	20	0	15	0	250	0	0	0
Madhya Pradesh	Sunflower	20	72	15	31	539	12	27	57
Maharashtra	Sunflower	18	39	14	17	723	21	33	45
		Mean	22	15	7	451	15	13	23
		Min	0	11	0	230	0	0	0
		Max	72	19	31	762	43	41	57

Oilseeds Contd…

The average fertilizer K dose for oilseed crops is 22 kg and 7 kg K_2O /ha at 100% and 75% of the yield targets, respectively. The critical value of available soil K is 450 kg/ha. The sensitivity of soil test values is 9 kg increase in K fertilizer dose for every 50 kg decrease in available soil K in the range 350 to 450 kg/ha. The average response is 15 kg grain per kg K_2O applied when N and P are also increased as obtained by prescription equations.

Critical values of available K and K fertilizer recommendations for rice

Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) 5-7/6-8 (10)	Fertiliser recommendation at SK=450 (11)	At SK=350 (12)
Mean	26.1	40.7	7.1	553.0	81.3	18.6	33.5
Min	0.0	30.0	0.0	250.0	0.0	0.0	0.0
Max	59.4	45.0	29.6	796.0	312.5	51.9	66.9

The average K requirement is 26 kg K_2O at a yield target of 50-60 q/ha, but it reduces substantially to 7 kg/ha at 75% of the yield targets. These doses are calculated at a soil test value of 400 kg/ha. The critical level of available soil K is 583 kg/ha. The critical limit at Raipur, however, is 250 kg/ha. The sensitivity of K fertilization to soil test values is 7 kg K_2O/ha for every 50 kg/ha change in K soil test value for achieving the yield targets shown on column 5.

Critical values of available K and K fertilizer recommendations for wheat

State (1)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) 5-7/6-8 (10)	Fertiliser recommendation at SK=450 (11)	At SK= 350 (12)
Chhattisgarh	50	0.0	37.5	0.0	250.0	0.0	0.0	0.0
Karnataka	30	36.2	22.5	2.2	851.3	22.0	64.2	80.2
Madhya Pradesh	40	37.2	30.0	11.9	632.5	39.5	29.2	45.2
Maharashtra	50	36.5	37.5	5.4	565.9	40.2	25.5	47.5
	Mean	27.5	31.9	4.9	574.9	25.4	29.7	43.2
	Min	0.0	22.5	0.0	250.0	0.0	0.0	0.0
	Max	37.2	37.5	11.9	851.3	40.2	64.2	80.2

The average K requirement is 26 kg K_2O at a yield target of 50-60 q/ha, but it reduces substantially to 5 kg/ha at 75% of the yield targets. These doses are calculated at a soil test value of 400 kg/ha. The critical level of available soil K is 575 kg/ha. The critical limit at Raipur, however, is 250 kg/ha. The sensitivity of K fertilization to soil test values is 7 kg K_2O/ha for every 50 kg/ha change in K soil test value for achieving the yield targets shown on column 5.

Critical values of available K and K fertilizer recommendations for maize

State (1)	Crop (4)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)	Fertiliser recommendation at SK=450 (11)	At SK=350 (12)
Andhra Pradesh	Maize	50	10.5	37.5	0.0	465.6	119.0	2.5	18.5
Andhra Pradesh	Maize	50	9.0	37.5	0.0	430.0	138.9	0.0	24.0
Chhattisgarh	Maize	50	0.0	37.5	0.0	250.0	0.0	0.0	0.0
Maharashtra	Fodder maize	40	46.0	30.0	21.5	753.8	40.8	39.5	52.5
		Mean	16.4	35.6	5.4	474.9	74.7	10.5	23.8
		Min	0.0	30.0	0.0	250.0	0.0	0.0	0.0
		Max	46.0	37.5	21.5	753.8	138.9	39.5	52.5

The average K requirement is 16 kg K_2O at a yield target of 40-50 q/ha, but it reduces substantially to 5 kg/ha at 75% of the yield targets. Fodder maize in Maharashtra has higher K requirement. The critical level of available soil K is 475 kg/ha. The sensitivity of K fertilization to soil test values is 7 kg K_2O/ha for every 50 kg/ha change in K soil test value for achieving the yield targets shown on column 5.

Critical values of available K and K fertilizer recommendations for cotton

State (1)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)	Fertiliser recommendation at SK=450 (11)	At SK=350 (12)
Andhra Pradesh	10	12.5	7.5	0.0	441.1	20.0	0.0	27.7
Karnataka	40	0.0	30.0	0.0	106.4	0.0	0.0	0.0
Madhya Pradesh	20	38.2	15.0	14.7	672.9	21.2	31.2	45.2
Maharashtra	20	99.4	15.0	56.6	952.2	11.7	90.4	108.4
	Mean	37.5	16.9	17.8	543.1	13.2	30.4	45.3
	Min	0.0	7.5	0.0	106.4	0.0	0.0	0.0
	Max	99.4	30.0	56.6	952.2	21.2	90.4	108.4

The average K requirement is 38 kg K_2O at an average yield target of 20 q/ha, but it reduces substantially to 18 kg/ha at 75% of the yield targets. The critical level of available soil K is 543 kg/ha. The sensitivity of K fertilization to soil test values is 7 kg K_2O/ha for every 50 kg/ha change in K soil test value for achieving the yield targets shown on column 5.

Critical values of available K and K fertilizer recommendations for sugarcane

State (1)	Target (q/ha) (5)	Fertiliser requirement (kg K_2O /ha) (6)	Target (q/ha) 75% of 5 (7)	Fertiliser requirement at 7 (kg K_2O/ha) (8)	Critical value (kg K/ha) (9)	Response (kg/kg) (5-7)/(6-8) (10)	Fertiliser recommendation at SK=450 (11)	At SK=350 (12)
Chhattisgarh	800	68.0	600.0	38.0	923.1	666.7	61.5	74.5
Madhya Pradesh	140	12.0	105.0	0.0	422.6	291.7	0.0	38.5
Maharashtra	200	224.0	150.0	131.0	1005.4	53.8	205.5	242.5
Andhra Pradesh	80	4.0	60.0	0.0	412.1	5000.0	0.0	20.5
	Mean	77.0	228.8	42.3	690.8	1503.0	66.8	94.0
	Min	4.0	60.0	0.0	412.1	53.8	0.0	20.5
	Max	224.0	600.0	131.0	1005.4	5000.0	205.5	242.5

The average K requirement is 77 kg K_2O at an average yield target of 480 q/ha, but it reduces substantially to 42 kg/ha at 75% of the yield targets. The critical level of available soil K is 691 kg/ha. The sensitivity of K fertilization to soil test values is 15 kg K_2O/ha for every 50 kg/ha change in K soil test value for achieving the yield targets shown on column 5.

Critical limits of potassium and responses to added K: a critical analysis

Usually soils analysing less than 120 kg ha^{-1} K (144 kg K_2O) are rated low in available K, between 120 and 280 kg ha^{-1} K (144-336 kg K_2O) medium and above 280 kg ha^{-1} K (336 kg K_2O) as high in available K (Muhr et al., 1965). Unfortunately, these ratings limits are irrespective of crops or soils. We have seen that these limits in Vertisols are not only higher than the earlier reported values but differ considerably from crop to crop and location to location. Similar results have been reported by other workers also who tried to find out the critical limits of different forms of K.

Solankey et al. (1992) studied the response of two wheat varieties to potassium on farmers' fields in swell-shrink soils. Though these soils were adequate in ammonium acetate extractable K, crop responded to 30 kg ha^{-1} K_2O. They have established a critical limit of 14.4 kg^{-1} K water-soluble K but failed to establish a critical limit based on ammonium acetate K. Similarly, Gajbhiye et al. (1993), using cotton, sorghum and wheat as a test crops, established a critical limit of 165 mg kg^{-1} soil of ammonium acetate K in vertisols. They also showed that yield of the test crops increased beyond the level of 200 mg K kg^{-1} soil. They attributed the lack of response below 200 mg kg^{-1} NH4OAc K to the state of 'soil hunger' for K. For delineation of fertility status, to isolate responsive soils from non-responsive ones and to recommend fertilizer K, critical limits for different crops in soils of various agroecological regions are needed.

Critical levels of available (NH_4OAc) K in different soils for different crops

Crop	Soil and state	Critical level (mg kg^{-1})	Reference
Rice	Medium black soil (A.P.) Red soils (A.P.) Dubba & Chalka Alluvial soils (A.P.)	100 75 190	Venkatasubbaiah et al. (1976) Subba Rao et al. (1976) Subramanyeswara Rao and Rajagopal (1981)
Sorghum	Islamnagar series 3 & 4 (M.P.) Typic Chromusterts (Maharashtra)	240 335	Srinivasarao and Takkar (1997) Akolkar and Sonar (1994)
Pearl millet	Medium black soil (A.P.) Black calcareous soils (Gujarat) Alluvial soils (A.P.)	95 60 160	Venkatasubbaiah et al. (1976 Meisheri et al. (1995) Sailakshmiswari (1984)

Subba Rao and Sammi Reddy (2005) provide critical limits of available K in different crops on some well-defined soils. The data show a great diversity in the critical limits ranging from 60 to 335 mg kg^{-1} soil (134 to 750 kg ha^{-1}).

We found that the fertilizer K requirement is 34 kg K_2O/ha at a soil test value of 350 kg/ha for achieving the yield target of 50-60 q/ha for rice, and this requirement reduces to 26 kg, and 19 kg if the soil test values are 400, and 450 kg/ha, respectively. Care has to be taken to also apply N and P doses as per the prescription approach. The current yield of rice harvested by farmers, however, is much below the yield targets used in calculating the critical limits. If the farmers' resources are insufficient, a reduced rate K fertilizers is recommended. Wheat requires almost similar K fertilization as rice. The K fertilizer requirement for maize crop is much less though. It is only 16 kg K_2O/ha at a soil test value of 400 kg/ha and 11 kg K_2O/ha at a soil test value of 350 kg/ha. The recommendations for cotton is 38 kg K_2O/ha. The K requirement is very high in Maharashtra, and almost nil in Karnataka. Such results are difficult to interpret only on the basis of exchangeable K.

Categorization of black soils on the basis of nonexchangeable K status

Category	Nonexchangeable K (mg/kg0	Soil Series	Description
Medium	301-600	Kamliakheri, Sarol, Pemberty, Pithvajal	Smectite rich swell shrink soils
High	601-1200	Shendvada	Smectite soil with appreciable amount of illite
Very high	>1200	Noyyal	Smectite soil with high mica

Vertisols have also been categorized on the basis of nonexchangeable K content. Special attention should be paid on Vertisols that are in medium category.

Conclusion and future line of work

The critical limit of exchangeable K varies for soil to soil and crop to crop. The comprehensive analysis of the data reveal that responses to added K can be obtained in the range of soil test values found in Vertisols of India, if good agronomic practices are followed and soil test K fertilization is done for achieving higher yield targets. Most of the research work so far has been related to critical limit of available K, however, response could be better explained if we included non-exchangeable K also into fertilizer recommendations. Knowing soil K reserve and distribution of K forms coupled with mineralogical data can help in comprehending K replenishment capacity of soils under intensive cropping. There is an urgent need for broad based field studies to address K response in the areas where the biotite reserves are low or the K release rates reached the limiting values.

Thanks