

Evaluation of basic properties of soil and major nutrient in soils of jhabua district of madhya pradesh

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Abstract

An experiment was conducted during the *kharif* seasons of 2014-15 under All India Coordinated Research Project for Dry land Agriculture at College of Agriculture, Indore Madhya Pradesh to study the major nutrient and other chemical properties of sampled vertisols and associated soils of Ralyawan village of Jhabua district of western Madhya Pradesh. Results showed that the Soils of Ralyawan village in Jhabua district of Madhya Pradesh were low in available nitrogen, low to medium available phosphorous and medium to high level in available potassium. Available nitrogen content in soils of Ralyawan village ranged from 152 to 298 kg ha¹ with an average of 236 kg ha Nutrient index values was in low fertility class in soil of village. Thus, the overall poor and or low status of available nitrogen was observed in this soil. The status of available phosphorous varied from 7.15 to 38.8 kg ha¹ with a mean value of 16.4 kg ha¹. The 22.47% village soil samples from the study area can be classified as low fertility class and 64.84 % in medium fertility class. The nutrient index value for P was in medium fertility class of village. The status of available potassium varied from 179 to 826 kg ha¹ with a mean value of 418 kg ha¹. The 0% village soil samples under the study were classified as low fertility class, 2.30% as medium and 97.69% as high fertility class. The pH of varied from 7 to 8 with the mean value of 7.5. The electrical conductivity of soil water suspension ranged from 0.17 to 0.86 dSm¹ with a mean value of 0.37 dSm¹. The variation in organic carbon content in this soil was from 0.23% to 0.80% with a mean value of 0.53%. In general, the organic carbon status of Ralyawan village soils of was low to medium.

Highlights

- The Soils of Ralyawan village in Jhabua district of Madhya Pradesh were low in available N, low to medium available P and medium to high level in available K.
- Nutrient index values were in low fertility class in soil of village. Thus, the overall poor and or low status of available nitrogen was observed in this soil.
- The nutrient index value for P was in medium fertility class of village. The status of available potassium 0% for village soil samples under the study were classified as low fertility class, 2.30% as medium and 97.69% as high fertility class.

Keywords: Electrical conductivity, Nutrient index, Organic carbon, Nitrogen, Phosphorous, Potassium, pH and Soil

At present, the greatest challenge before Indian agriculture is to boost food production and productivity as well as sustainability of agriculture as a whole. There are problems that impose limits on these objectives or goals which raise serious concerns about national food security. Soil fertility

is one of the major constraints in achieving high productivity goals. In both rain-fed and irrigated systems, nutrient replenishment through fertilizers and manures remains far below the crop removal, thus causing mining of native reserves over the years. Soil test-based fertility management is



an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability.

However, major constraints impede wide scale adoption of soil testing in most developing countries. In India, these include the prevalence of small holding systems of farming as well as lack of infrastructural facilities for extensive soil testing. This study presents the soil spatial variability maps for soil pH, EC, organic carbon, available nitrogen, available phosphorous and available potassium along with multi nutrient deficiency maps. Soil fertility is an important factor, which determines the growth of plant. In general soil chemical fertility and in particular lack of nutrient inputs is a major factor in soil degradation (Hartemink *et al.* 2010). The available nitrogen was measured by Jain and Singh 2014 from Madhya Pradesh, India its value ranges from 172 ± 2.1 to 193.3 Kg ha^{-1} for red, and brown soil and 197 ± 4.9 to $215 \pm 21 \text{ Kg ha}^{-1}$ for black soil, $183 \pm 19 \text{ Kg ha}^{-1}$ nitrogen investigate in yellow soil (Jain and Singh, 2014).

Phosphorus is a part of every living cell in plant. It is one of the most important micronutrient essential for plant growth. Phosphorus is most often limiting nutrients remains present in plant nuclei and act as a energy storage. It helps in transfer of energy (Jain *et al.* 2014). Adequate phosphorus availability for plants stimulates early plant growth and hastens maturity. The soil with minimum leaching are known to contain high amount of phosphorus as compared to the soil with maximum leaching (Ashraf *et al.* 2012). Potassium is not an integral part of any major plant component but it plays a key role in a vast array of physiological process vital to plant growth from protein synthesis to maintenance of plant water balance (Sumithra *et al.* 2013). overall this physico-chemical study of soil is based on various parameters like pH, electrical conductivity, soil organic matter, available nitrogen, phosphorus and potassium. This knowledge will create awareness among the farmers about economic productivity.

Materials and methods

The experiment was conducted during *kharif* seasons of 2014-15 under All India Coordinated Research Project for Dry land Agriculture at College of Agriculture, Indore Madhya Pradesh. Jhabua

is situated at an altitude of 428 meters above the mean sea level with latitude of $21^{\circ}30' - 22^{\circ}55' \text{N}$ and longitude of $73^{\circ}30' - 75^{\circ}01' \text{E}$ and Ralyawan is located in Jhabua district lying between $21^{\circ}30' \text{N}$ latitude and $73^{\circ}30' \text{E}$ longitude. Soil samples (0-15 cm) at random were collected during May 2014 in the help of soil augar.

Processed soil samples were analysed for nutrient availability by following standard analytical techniques. Total 250 soil samples covering all soil types. These samples were analyzed for pH, EC, OC, and available N, P, K of soil. Available Nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956). The electrical conductivity (dSm^{-1}) and pH analysis soil suspension used for pH determination was allowed to settle down and conductivity of supernatant liquid was determined by using conductivity meter (Jackson, 1967).

The results are expressed in dSm^{-1} at 25°C . Organic carbon content in soil was determined by Walkley and Black's rapid titration method (1934). Available phosphorus was determined by using Olsen's extractant (0.5 N sodium bicarbonate solution of pH 8.5, Olsen *et al.* 1954). Available potassium was determined by flame photometer as described by Jackson (1967). General statistics was calculated by Pearson correlation and one-way analysis of variance using SPSS Software 16.0.

Result and discussion

The pH of Soils of Ralyawan village varied from 7 to 8 with the mean value of 7.5 (Table 1).

Table 1: Soil reaction (pH) of soils of Ralyawan village

Soil pH class	No. of Samples	% Samples
Strongly acid (<5.0)	Nil	Nil
Moderately acid (5-6.0)	Nil	Nil
Slightly acid (6.1-6.5)	Nil	Nil
Neutral (6.6-7.5)	163	65.2
Slightly alkaline (7.6-8.5)	87	34.8
General statistics		
Range		7-8
Mean		7.5
Standard deviation		0.32
CV%		4.39



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General statistics		
Range		7-8
Mean		7.5
Standard deviation		0.32
CV%		4.39

Table 2: Electrical Conductivity of surface soils of Ralyawan village

EC dsm^{-1}	No. of Samples	% Samples
<0.1	Nil	Nil
0.1-0.2	4	1.6
0.2-0.3	108	43.2
>0.3	138	55.2
General statistics		
Range		0.17-0.86
Mean		0.37
Standard deviation		0.12
CV%		32.79

The electrical conductivity of soil water suspension ranged from 0.17 to 0.86 ds m^{-1} with a mean value of 0.37 dS m^{-1} (Table 2). The variation in organic carbon content in this soil was from 0.23% to 0.80% with a mean value of 0.53%. In general, the organic carbon status of Ralyawan village soils of was low to medium. Organic carbon content of Ralyawan soils ranged from 0.29 to 0.85% respectively, which in general accumulated in surface layers (Table 3 & 4).

Table 3: Distribution of available OC status in the soils of Ralyawan village

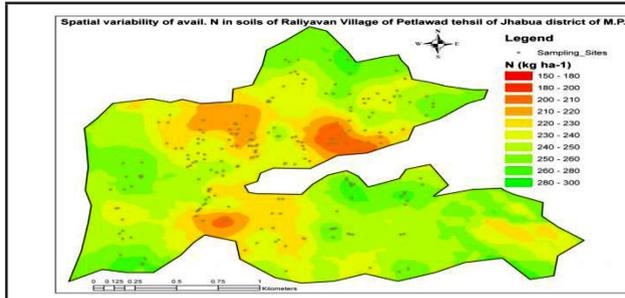
Available-OC (%)	No. of Samples	% Samples
Very Low (<0.25)	NIL	NIL
Low (0.25-0.50)	24	9.6
Medium (0.50-0.75)	180	72
High(>0.75)	46	18.4
General statistics		
Range (%)		0.29-0.85
Mean (%)		0.59
Standard deviation (%)		0.10
Coefficient of variation (%)		17.52

Table 4: Different organic Carbon availability classes of the soils of Ralyawan village

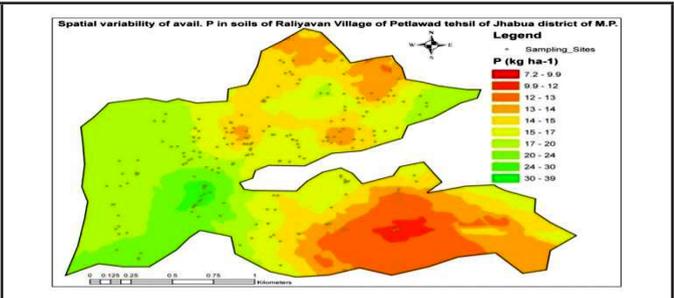
OC- availability Class	Available-OC%
I	<0.40
II	≥ 0.40 to < 0.45
III	≥ 0.45 to < 0.50
IV	≥ 0.50 to < 0.55
V	≥ 0.55 to < 0.60
VI	≥ 0.60 to < 0.65
VII	≥ 0.65 to < 0.70
VIII	≥ 0.70

The lower contents of organic carbon apparently resulted because of high temperature which induced rapid rate of organic matter oxidation, while the declining trend towards to accumulation of crop residues every year, without substantial downward movement. Observations in the line with the present findings have been reported in Nazif *et al.* (2006) showed that majority of the soil sites were medium amount of organic matter. The OC content ranged from 0.65 to 2.07 % (average 1.18 %) in the soils of District Bhimber (Azad Jammu and Kashmir) at 30 different locations. The organic carbon content of surface soil was greater than the sub-surface soils in most of the pedons due to high amount of litter and the crop residues at the surface. Organic carbon content of the soils followed by decreasing trend with depth in all the pedons. Its effects the rapid rate of organic matter mineralization in these soils. Out of 180.57 ha area about 180 ha area falls under low to medium (34.29% samples Low and 61.95% medium) status of available OC. Deshmukh (2012) also reported that the Organic carbon ranges from 0.165 to 1.575% in the soils. 29.03% and 48.38% of soils showed low and medium status of organic carbon respectively. Low status of organic carbon in some soils of the area is indicating that adequate nitrogen fertilization through organic manure, FYN etc are required.

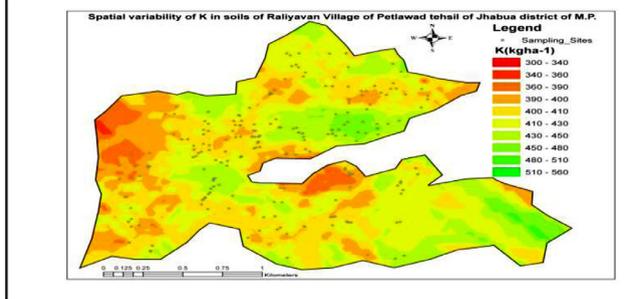
Similar findings were reported by Lathwal (2006) in district Kurukshetra, Haryana and Sharma *et al.* (2008) in soils of Amritsar District. The major proportion of the study area was low to medium in organic carbon (180 ha) (Fig. 4.) Low organic carbon in the soil is due to low input of FYM and crop residues as well as rapid rate of decomposition due to high temperature. The organic matter degradation and removal taken place at faster rate coupled with low vegetation cover thereby leaving less changes



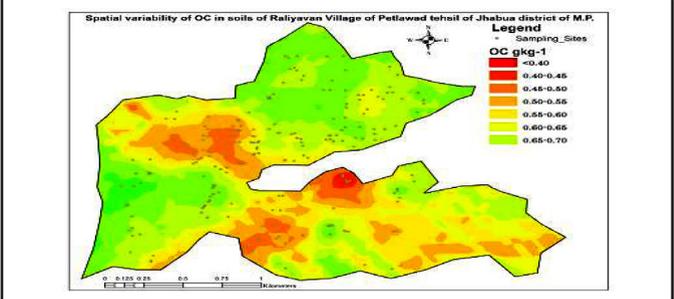
Map 1: Spatial distribution of Av.-N in village Ralyawan



Map 2: Spatial distribution of Av.-P in village Ralyawan



Map 3: Spatial distribution of Av.-K in village Ralyawan



Map 4: Spatial distribution of OC (%) in village Ralyawan

of accumulation of organic matter in the soil. High temperature and good aeration in the soil increased the rate of oxidation of organic matter resulting reduction of organic carbon content. The high temperature prevailing in the area is responsible for the rapid burning of organic matter, thus resulting in medium organic carbon content of these soils.

Table 5 : Distribution of available nitrogen status in the soils of Ralyawan village

Available -N (kg ha ⁻¹)	No. of Samples	% Samples
Low(<250)	138	55.2
Medium(250-400)	112	44.8
High (>400)	NIL	
General statistics:		
Range (kg ha ⁻¹)	152-298	
Mean (kg ha ⁻¹)	236	
Standard deviation (kg ha ⁻¹)	31.02	
Coefficient of Variation (%)	13.14	

Similar results were also noted by Sharma *et al.* (2008) in soil of Amritsar district and Lathwal (2006) in soil of Shahbad & Thaneshwar block. An average value of OC of the soil was found minimum i.e. 0.23%, in the village and maximum i.e. 0.80% in village of Ralyawan village.

Table 6: Different N availability classes of the soils of Ralyawan village

N- availability Class	Available-N , kg ha ⁻¹
I	<180
II	>= 180 to <200
III	>=200 to <210
IV	>=210 to <220
V	>=220 to <230
VI	>=230 to <240
VII	>=240 to <250
VIII	>=250 to <280
IX	>=280 to <300
X	>=300

Shivanna and Nagendrappa (2014) reported that the pH of the soil samples ranged from 7.07 to 7.87 and was on slightly alkaline side but within the limit of 6.5-8.5 which is optimum for crops. EC values ranged from 0.26dSm⁻¹ to 0.485dSm⁻¹ and were within the limit of 0.8dSm⁻¹ indicating low salinity status of the soils.

OC content ranged from 0.50% to 0.67% and all the samples were of medium rating. Kumar *et al.* (2014) also showed that the these soil samples were analyzed for electrical conductivity exhibited significant and positive relationship with available N, P, K and organic C showed significant and positive correlation with available N and K.



Available major nutrients

Available nitrogen

Available N content in soils of Ralyawan village ranged from 152 to 298 kg ha⁻¹ with an average of 236 kg ha⁻¹. Nutrient index values was in low fertility class in soil of village.

Table 7 : Distribution of available phosphorus status in the soils of Ralyawan village

Available-P (kg ha ⁻¹)	No. of Samples	% Samples
Low(<12.5)	30	12
Medium (12.5-25)	168	67.2
High (>25)	52	20.8
General statistics		
Range (kg ha ⁻¹)	7.15-38.8	
Mean (kg ha ⁻¹)	16.4	
Standard deviation (kg ha ⁻¹)	6.29	
Coefficient of variation (%)	38.44	

Table 8: Different P availability classes of the soils of Ralyawan village

P- availability Class	Available-P , kg ha ⁻¹
I	7.2 to 9.9
II	>=9.9 to <12
III	>=12 to <13
IV	>=13 to <14
V	>=14 to <15
VI	>=15 to <17
VII	>=17 to <20
VIII	>= 20 to <24
IX	>= 24 to < 30
X	>=30 to 39

Thus, the overall poor and or low status of available nitrogen was observed in this soil. The available Nitrogen content was low in major portion of the study area 97.11% samples which might be due to low organic matter content in these soils. The total nitrogen content in the soils is dependent on temperature, rainfall and altitude. Another possible reason may also be due to low organic matter content in these areas due to low rainfall and low vegetation facilitate faster degradation and removal of organic matter leading to nitrogen deficiency. The medium nitrogen status was noticed in some area may be due to application of N fertilizer coupled with high vegetative cover. Kumar *et al.* (2009) in

Dumka and Lachimpur series, Ashok *et al.* (2006) in Auraiya district of Uttar Pradesh observed a similar trend of nutrient status in study area soils. Shivanna and Nagendrappa (2014) also showed available nitrogen ranged from 54.825kg/ha to 85.72kg/ha; available phosphorous ranged from 5.33kg/ha to 10.79kg/ha and samples were nitrogen and phosphorous deficient. Kumar *et al.* (2014) also showed that these soil samples were analyzed for N categorized as low as per criteria followed in the soil testing laboratory.

Available N status of the soils of Ralyawan village

Considering the soil test rating for available N (<250 as low, 250-400 as medium and >400 as high in the status of N) the soils of Ralyawan fall under low status (<250 kg ha⁻¹) in available N content. In general out of 250 samples, 55.2% fall under low status and 44.8% samples were categorized under medium N status. The general statistics calculated from 250 soil samples revealed that the available N content ranged from 152–298 kg ha⁻¹ (Table 5) with a mean value of 236 kg ha⁻¹, standard deviation 31.02 kg ha⁻¹ and Coefficient of Variation (CV) 13.14 %.

Spatial distribution of available –N in the village soils

Spatial variability map of available N of the village soils is presented in map 1. To prepare the N variability map soils were divided in to ten categories (Table 6). The spatial variability map of available N of Ralyawan village (Map 1) showed that in whole village the available N content varies from < 150 to > 310 kg ha⁻¹. This kind of map will help the farmers for site specific nutrient management on the basis of soil test values (Table 2).

Available phosphorus

The status of available phosphorous varied from 7.15 to 38.8 kg ha⁻¹ with a mean value of 16.4 kg ha⁻¹. The 22.47% village soil samples from the study area can be classified as low fertility class and 64.84 % in medium fertility class. The nutrient index value for P was in medium fertility class of village. The available phosphorus content was medium (64.84% samples) in major parts of the village (172 ha), but it was low (22.47% samples) in 77.61 ha out of 185 ha total area of the village. Phosphorus is present in



soil as solid phase with varying degree of solubility. When water soluble P is added to the soil, it is converted very quickly to insoluble solid phase by reacting with soil constituents. These reactions affect the availability of P and as a result of these reactions, a very small amount of total P is present in soil solution at any time reflected by soil testing. However, a low to medium range of soil available P under study area may be mostly affected by past fertilization, pH, organic matter content, texture various soil management and agronomic practices (Verma *et al.* 2005). Nirawar *et al.* (2009) and Kumar *et al.* (2009) in Dumka and Lachimpur series of Jharkhand were medium in phosphorus content. Kumar *et al.* (2014) also showed that the these soil samples were analyzed for P categorized as medium as per criteria followed in the soil testing laboratory.

Available P status of the soils of Ralyawan village

The available P content (Table 3) of the soils of Ralyawan village ranged from 7.15 to 38.8 kg ha⁻¹ with an average value of 16.4 kg ha⁻¹. Considering the soil test rating for available P (< 12.5 kg ha⁻¹ as low, 12.5 – 25.0 kg ha⁻¹ as medium and >25.0 kg ha⁻¹ as high in the status of P) the soils of Ralyawan fall under low, medium and high status in available P content. In general out of 250 samples, 12 % samples fall under low status, 67.2% samples under medium P status and 20.8% samples were high in P status. The general statistics calculated from 250 soil samples revealed that the available P content ranged from 7.5– 38.80 kg ha⁻¹ with a mean value of 16.4 kg ha⁻¹, standard deviation 6.29 kg ha⁻¹ and Coefficient of Variation (CV) 38.44%. The variation in available P is quite large which might be due to variation in soil properties *viz.*, pH, organic matter content and various soil management and agronomic practices adopted by the farmers of the region.

Spatial distribution of available-P in the village soils

Spatial variability map of available P of the village soils is presented in map 2. To prepare the P variability map soils were divided in to ten categories (Table 7) The spatial variability map of available P of Ralyawan village (Map 2) showed that in the whole village the available P content varies from < 7.2 to 39 kg ha⁻¹.

Available potassium

The status of available potassium varied from 179 to 826 kg ha⁻¹ with a mean value of 418 kg ha⁻¹. The 0% village soil samples under the study were classified as low fertility class, 2.30% as medium and 97.69% as high fertility class. The available potassium content in major portion of the study area was under high category (180 ha) out of 181.57 ha total area of the village respectively. In general out of 250 samples, 97.69 % fall under high status were categorized under Ralyawan soils .show higher values due to predominance of K rich micaceous and feldspars minerals in parent material. Similar results were observed by Verma *et al.*(2005) in soils of Sardulgarh, Bhikhi and Budhlada blocksand Nirawar *et al.* (2009) in soils of Ahemedpur tahsil of Latur district. Major portion of area under high (180 ha) were seen in study soils, because these soils have less finer fractions in their soil. In addition Kaolinite type of clay mineralogy are the causes for their medium and low rating. Adequate (medium or high) available K in these soils may be attributed to the prevalence of potassium-rich minerals like Illite and Feldspars (Sharma *et al.* 2008). Shivanna and Nagendrappa (2014) also showed Potassium ranged from 156.18kg/ha to 434.38kg/ha and samples were of medium rating except one sample of high rating with respect to potassium. The highest and lowest mean values of available potassium were recorded 826 and 197 kg ha⁻¹ K in village respectively, of Ralyawan. Kumar *et al.* (2014) also showed that the these soil samples were analyzed for K categorized as high as per criteria followed in the soil testing laboratory.

Available K status of the soils of Ralyawan village

The available K content (Table 9) of the soils of Ralyawan village ranged from 179 to 826 kg ha⁻¹ with an average value of 418 kg ha⁻¹. Considering the soil test rating for available K (< 135 kg ha⁻¹ as low, 135 – 335 kg ha⁻¹ as medium and >335 kg ha⁻¹ as high in the status of K) the soils of Ralyawan fall under medium and high status in available K content. In general out of 250 samples, 6.4% samples fall under medium status and 93.6 % samples were high in K status. The general statistics calculated from 250 soil samples revealed that the available K content ranged from 179 to 826 kg ha⁻¹ with a mean



value of 418 kg ha⁻¹, standard deviation 66.25 kg ha⁻¹ and Coefficient of Variation (CV) 15.84%.

Table 9: Distribution of available potassium status in the soils of Ralyawan village

Available-K (kg ha ⁻¹)	No. of Samples	% Samples
Low (<135)	-	-
Medium (135-335)	16	6.4
High (>335)	234	93.6
General statistics:		
Range (kg ha ⁻¹)		179-826
Mean (kg ha ⁻¹)		418
Standard deviation (kg ha ⁻¹)		66.25
Coefficient of variation (%)		15.84

Table 10: Different K availability classes of the soils of Ralyawan village

K- availability Class	Available-K, kg ha ⁻¹
I	300 to 340
II	≥340 to <360
III	≥360 to <390
IV	≥390 to <400
V	≥400 to <410
VI	≥410 to <430
VII	≥430 to <450
VIII	≥450 to <480
IX	≥480 to <510
X	≥510 to 560

Spatial distribution of available-K in the village soils

Spatial variability map of Av-K of the village soils is presented in map 3. To prepare the K variability map soils were divided in to ten categories (Table 10) The spatial variability map of available-K of Ralyawan village (map 3) showed that in the whole village the Av-K content varies from < 300 to ≥560 kg ha⁻¹.

Conclusion

The Soils of Ralyawan village in Jhabua district of Madhya Pradesh were low in available N, low to medium available P and medium to high level in available K. Nutrient index values was in low fertility class in soil of village. Thus, the overall poor and or low status of available nitrogen was observed in this soil. The status of available phosphorous

for village soil samples from the study area can be classified as low fertility class and 64.84 % in medium fertility class. The nutrient index value for P was in medium fertility class of village. The status of available potassium 0% for village soil samples under the study were classified as low fertility class, 2.30% as medium and 97.69% as high fertility class.

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