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Evaluation of physico-chemical properties of soil in Karauli district of Rajasthan

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Abstract
Soil fertility plays a key role in increasing crop production in the soil which comprises not only in supply of nutrients but also their efficient management. The research study was conducted for evaluate the Physico-chemical properties and soil fertility status of 171 soil samples taken from Masalpur, hindaun city and Mandrayal block in Karauli district of Rajasthan under CFLD'S of NMOOP and NFSM Project during 2017-2018. Soil samples were taken from demonstrator's fields of 10 villages (0-15 cm depth) and analyzed for their physico-chemical properties to prepare the map on the basis of nutrient status in the soil. The average pH, EC and organic carbon percent of soil samples were observed 7.65, 0.45 dSm^{-1} and 0.50% respectively in Masalpur block followed by Hindaun city block (7.54, 0.47 dSm^{-1} and 0.53% respectively) and Mandrayal block (7.66, 0.49 dSm^{-1} and 0.52% respectively). The pH was showed in neutral range while EC and organic carbon percent was low range for cultivated land of three blocks. Available nitrogen $kgha^{-1}$, phosphorus $kgha^{-1}$, potassium$kgha^{-1}$ were found in Masalpur block (228.79 $kgha^{-1}$, 17.98 $kgha^{-1}$ and 127.67 $kgha^{-1}$ respectively) followed by Hindaun city block (232.86 $kgha^{-1}$, 16.09 $kgha^{-1}$ and 176.49 $kgha^{-1}$) and Mandrayal block (212.62 $kgha^{-1}$, 15.60 $kgha^{-1}$ and 152.79 $kgha^{-1}$ respectively). The Available Nitrogen, Potash$kgha^{-1}$was showed in low range fertility status while Available Phosphorus$kgha^{-1}$ was showed medium range fertility status from three blocks of research study. Hence, use of chemical fertilizers, Vermicompost, Micronutrients in the soil for improvement the fertility status of soil required for a specified crop.

Keywords: Soil fertility status, nitrogen, phosphorus, potassium, soil ph

Introduction
Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields (Doneriya *et al.*, 2013) [5]. The Karauli district is located in the eastern part of Rajasthan which is bounded in the north by Dausa and Bharatpur districts, by Dhaulpur district in the east, by state of Madhya Pradesh in south and Sawai Madhopur district in the west with covering an area of 4,985 square kilometers. Most of soil was categorized under alluvial soil order in Mandrayal, Hindaun city and Masalpur blockinKarauli district which is best for agriculture crop production green gram, cluster bean, groundnut, Bajra, black gram, wheat, barley, mustard and vegetable crop etc.
Macronutrients (N, P**,** K) and micronutrients (Zn, Fe, Cu, Mn) are important soil elements that control its fertility. Soil fertility is one of the important factors controlling yields of the crops. Soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in context of sustainable agriculture production. Because of imbalanced and inadequate fertilizer use coupled with low efficiency of other inputs, the response (production) efficiency of chemical fertilizer nutrients has declined tremendously under intensive agriculture in recent years. The results of numerous field experiments in different parts of India have, therefore indicated "fertilizer-induced un-sustainability of crop productivity" (Yadav, 2003) [29].
The term 'micronutrients' represents some essential nutrients that are required in small quantities for the normal growth and development of plants in which include zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), nickel (Ni), boron (B), molybdenum (Mo) and chlorine (Cl). Importance of micronutrients has been realized during the past four decades when widespread micronutrient deficiencies, particularly of Zn and B, were observed in most of the soils in our country, especially under intensive agriculture (Katyal, 2018) [11].
Variation in nutrient supply is a natural phenomenon and some of them may be sufficient where others deficient. The stagnation in crop productivity can't be boosted without judicious use of macro- and micronutrient fertilizers to overcome existing deficiencies/imbalances. Although widespread macro- and micronutrients deficiency has been observed in the soils of

Rajasthan, specially zinc (46%) and iron (51.5%) (Sharma *et al.* 2003) [22] The present investigation was done for evaluate the fertility level of different Physico-chemical properties, Macro and Micro nutrients in the soils of three blocks of Karauli district in Rajasthan.

Materials and Methods

The soil research study was conducted in three blocks of Karauli district in Rajasthan for evaluated this research study. To evaluate the fertility status in study area the total no. of 171 representative composite soil samples were collected from selected farmers fields with the help of a khurpi. A surface soil sample from 0 to 15 cm was collected at 250 m x 250 m grid samples in the study area. The soil samples were mixed thoroughly and about 500 gram of composite soil samples were taken for soil analysis. Soil samples were air-dried, passed through 2 mm and 0.5 mm sieve and stored in properly labeled plastic bags for physical and chemical analysis. The prepared samples were analyzed for physical-chemical properties and different nutrients using standard procedures. Soil pH was determined by pH meter, EC by conductivity meter, organic matter content was determined by Walkey and Black (1934) method, available nitrogen was estimated by alkaline KMnO4 method, available phosphorus was extracted by 0.5 M NaHCO3 solution pH 8.5, Available potassium was determined by neutral normal ammonium acetate method, with the help of flame photometer whereas Sulfur was estimated by complex metric titration.

Results and Discussion

Physico-chemical properties of soil

The data revealed on soil pH which showed the soil of Hindaun city block was neutral with mean value of 7.54 followed by Masalpur block (7.65) and Mandrayal block (7.66) in soil reaction. So, the data obtained under research study was clearly showed that the soils of Hindaun city, Masalpur and Mandrayal block of Karauli district were neutral in soil reaction and useful for mostly grown of field and horticulture crop. Soil pH denotes soil's acidity or alkalinity and is the measure of Hydrogen ions (H+) in the soil solution. Higher the H+ ion concentration, lower is the pH value and vice-versa (Alvarez *et al*; 2005) [1]. The pH range of 6.8 to 8.0 has been recommended optimum for plant's growth (Jain *et al*; 2015; Raman & Sathiyanarayanan, 2009) [7, 21]. The data revealed on EC of soil under research study was showed that the soil of Masalpur block with mean value of 0.45 dSm^{-1} followed by Hindaun city block with mean value of 0.47 dSm^{-1} and Mandrayal block with mean value of 0.49 dSm^{-1}. So, the research study was showed that the soil electrical conductivity no harm in germination of seed, as maximum number of soil sample under research study. Electrical Conductivity (EC) is a good sign for the crops as it helps in the absorption of the nutrients (Martin *et al;* 2011) [17]. Greater the ion concentration in soil solution; more is the EC (Ashraf *et al*; 2012) [2]. Low value of EC is found to be appropriate for growth of plants indicating higher fertility (Jain *et al;* 2015) [7]. Proper amount of pH and EC leads to the maximum availability of the nutrients, reduced accessibility of the toxic elements and increased activity of micro-organisms (Raman & Sathiyanarayanan, 2009) [21]. The data showed on per cent organic carbon content in Masalpur block with mean value of 0.50% followed by Mandrayal block with mean block of 0.52% and Hindaun city block with mean value of 0.53% were found in organic carbon. Thus, majority of the soil samples of three blocks were low range in organic carbon per cent due to the arid area responsible for low organic matter. The higher pH in soil might be due to presence of various salts which is also clearly visible from the EC values. Krishna, N.R., *et al.* (2017) [15] reported that the Soil pH was found in ranged from 6.8 to 8.7 which are neutral to alkaline medium in Nicchapura-2 Micro Watershed of Davanagere District, Karnataka, India. Deshmukh, K. K., (2012) [4] evaluate the soil fertility status from Sangamner area, Ahmednagar district; Maharashtra on 62 surface soil samples analyzed that EC in the downstream part reflecting low flushing rate and sluggish ground water movement in the area.

Fertility Status of Primary & secondary nutrients in soil

The research data on fertility status of primary nutrients in soil has been depicted in table 2 in which Available N content present highest in the soils of Hindaun city block with mean value of 232.86 kg ha^{-1} followed by Masalpur block with mean value of 228.79 kg ha^{-1} and Mandrayal block with mean value of 212.62 kg ha^{-1} so most of the soil samples were found in low range in Available N content. Climate has a major impact on availability of nitrogen, maximum soil samples were found in low category, it may be due to leaching and denitrification dry climate and use of low amount of bio fertilizers, green manures and use of nitrogenous fertilizers. Gurjar, O.P., *et al*. (2017) [6] conducted a study for assess the fertility status of cultivated land soils in which Available nitrogen was low (194.23 $kgha^{-1}$), phosphorus was low to medium (14.05 $kgha^{-1}$), potassium was high (456.59 $kgha^{-1}$), sulphur was low to high (16.81 $mgkg^{-1}$) in range in soils of Mandal block of Bhilwara district of Rajasthan, India.

The available phosphorus content under research study was showed highest in Masalpur block with mean value of 17.98 kg ha^{-1} followed by Hindaun city with mean value of 16.09 kg ha^{-1} and Mandrayal block with mean value of 15.60 kg ha^{-1} respectively in which maximum soil samples were low range in Phosphorus content under research study. Phosphorous acts as a limiting nutrient present in plant nuclei & serves as storage for energy (Jain *et al*; 2014) [8]. It high concentration in the soil leads to good growth of plants (Tautua *et al*; 2014) [27]. Soils rich in organic matter deliver organic phosphates to the plants as compared to the soils with low organic content (Miller & Donahne, 2001) [20]. High amount of phosphorus is found in soils with minimum leaching effect in comparison to the soils with maximum leaching (Ashraf *et al;* 2012) [2]. Krishna *et al*., (2017) [15] reported that the available N_2O, P_2O_5, K_2O was found in ranged from 135 to 236 $kgha^{-1}$, 10 to 34 $kgha^{-1}$, 130 to 415 $kgha^{-1}$, respectively in Nicchapura-2 Micro Watershed of Davanagere District, Karnataka, India.

The potassium content under research study soils was showed highest in Hindaun city with mean value of 176.43 kg ha^{-1} followed by Mandrayal block with mean value of 152.79 kg ha^{-1} and Masalpur block of 127.67 kg ha^{-1}. So, potassium content under research study was low in range due to absence of potash bearing minerals (muscovite, biotite and feldspar). Increase in K might be due to soil saturation which resulted in widening of clay minerals, releasing previously fixed K and large storage of fertilizers resulted in dissolution of these within the flood water. This could also be related to increased phosphorus and secondary nutrient Mg on the sediment soils of flooded lands (Kalshetty *et al* (2012) [10]. Increased quantity of potassium in the soil leads to high osmotic pressure in the plant, thereby increasing its water absorptive capacity (Joseph, 2005) [9]. Khan, A.I., *et al*.,(2017) [13]

evaluate soil fertility status from Kanchanpur district of Nepal on sixty seven surface soil samples were analyzed the soil PH value ranged from 5.5–6.8 reflecting slightly acidic to neutral nature of soils, E.C. ranges between 0.16–0.40 dSm^{-1} and organic carbon ranges from 0.96–4.20%. All the samples of study were showing high organic carbon status. The 55.22% medium and 54.88% high status in available N and most of the soils sample has high status in P, 88.05% samples are high in phosphorous, while 34.32% samples are low, 58.20% medium and 7.46% high in available K.

The data on fertility status of available Sulfur in soils of three blocks of Karauli district were presented in table 2 in which the available sulphur content in research soils was showed in Masalpur block with mean value of 16.28 mg kg^{-1} followed by Mandrayal block with mean value of 15.29 mg kg^{-1} and Hindaun city with mean value of 14.52 mg kg^{-1}. Out of total soil samples under research study were found medium range in sulfur content in soils of three blocks of Karauli district in Rajasthan. The available sulphur status in the soil ranged from medium to high but majority of the area indicate medium in available sulphur content. The coarse-textured sandy soils generally have low total S-content as compared to fine textured soils however also had no opinion that sufficiency of available sulphur is directly proportional to the organic matter content of the soil. Kothyari, H.S., *et al.* (2018) [14] evaluate the soil properties and macro nutrient fertility status viz. Soil PH, Electrical Conductivity, Organic carbon of soil samples were found with an average of 7.75, 0.54 dS m^{-1}& 0.38% respectively. Available nitrogen, Phosphorus, Potash and Sulphur content of soil samples were reported with a mean value of 213.70 $kgha^{-1}$, 22.35 $kgha^{-1}$, 125.57 $kgha^{-1}$ and 15.34 $mgkg^{-1}$ respectively and found the soil samples were neutral to slightly alkaline in PH, whereas organic carbon, electrical conductivity, Available N_2O, P_2O_5, and K_2O were low to medium range and sulphur content was found in medium range from three blocks in Sawai Madhopur district of Rajasthan with total No. of 120 soil samples.

Fertility Status of micro nutrients in soil

The data revealed on fertility status of available Zn mg kg^{-1} in soils of three blocks of Karauli district were presented in table 2 in which the available Zn content in research soils was showed in Mandrayal block with mean value of 1.66 mg kg^{-1} followed by Hindaun city block with mean value of 1.49 mg kg^{-1} and Masalpur block with mean value of 1.39 mg kg^{-1}. Majority of soil samples under research study were found high range in Zn content in soils of three blocks of Karauli district in Rajasthan. Similar findings were reported by Singh and Kumar, 2012 [24]; Singh *et al.*, 2017 [25], Singh *et al.*, 2015 [23] in Mirzapur district and Meena *et al.*, (2006) [19] that the available Zn content in soils of Tonk district, Rajasthan and found that it varied from 0.19 to 1.93 mg kg-1. The lowest (0.23 mg kg-1) Zn content was recorded in Grid No 2, while highest (0.9 mg kg-1) Zn content was observed in soil of Grid No 12 with S.D. value of ±0.15 and C.V. 5.56. Out of 52 Grids soil samples 75% soil samples were found deficient, 25% soil samples were found marginal in Zn content.

The data depicted on fertility status of available Boron mg kg^{-1}in soils of three blocks of Karauli district were presented in table 2 in which the highest Boron content in research soils was found in Mandrayal block with mean value of 1.55 mg kg^{-1} followed by Hindaun city block with mean value of 1.33 mg kg^{-1} and Masalpur block with mean value of 1.28 mg kg^{-1}. Most of the soil samples under research study were found highest range in Boron content in soils of three blocks under research study. The availability of B is greatly influenced by soil characteristics, like pH, EC, organic matter, texture, free Al and Fe oxides and calcium carbonate content (Keren and Bingham 1985) [12]. Mathur *et al.* (1964) [18] reported that in irrigated soils of western Rajasthan, total and available B contents were much higher as compared with that in rainfed soils. Since then no report is available on the status of B in rainfed soils of the western Rajasthan. However, a few studies have been conducted in early 80s to assess the available B status in case of irrigated soils of western Rajasthan. Therefore, an attempt has been made to appraise the status of B in the arid soils of western Rajasthan. D.R. Chaudhary *et al.*, (2004) [3] reported Boron Status of Arid Soils of Western Rajasthan in which the results indicated available B content varied from 0.26 (Petrogypsid) to 7.10 mg kg^{-1}soil (Haplosalid), and 0.22 (Petrogypsid and Petrocalcid) to 1.15 mg kg^{-1}soil (Haplocambid) with mean values of 1.51 and 0.51 mg kg^{-1} soil for irrigated and rainfed soils, respectively. High content of B in irrigated soils is due to high B content in irrigation water.

The data on fertility status of available Fe mg kg^{-1} in soils of three blocks were presented in table 2 in which the maximum available Fe content under research soils was found in Hindaun city block with mean value of 1.56 mg kg^{-1} followed by Masalpur block with mean value of 1.47 mg kg^{-1} and Mandrayal block with mean value of 1.38 mg kg^{-1}. Mostly soil samples under research study were found low range in Fe content in soils of three blocks. The data on fertility status of available Mn content mg kg^{-1}in soils of three blocks were presented in table 2 which the maximum available Mn content under research soils was showed in Masalpur block with mean value of 16.28 mg kg^{-1} followed by Mandrayal block with mean value of 15.29 mg kg^{-1} and Hindaun city with mean value of 14.52 mg kg^{-1}. Most of the soil samples under research study were found low range in sulfur content in soils of three blocks of Karauli district in Rajasthan. Meena, H.B., *et al*. (2006) [19] reported the fertility status of Zn, Fe, Cu and Mn varied from0.19 to 1.93, 2.23 to 14.16, 0.21 to 1.87 and 6.85 to 45.25 mg kg^{-1} with mean values of 0.83, 5.38, 0.61and 21.56 mg kg^{-1}, respectively in some soils of Tonk District of Rajasthan. Sumedh R. Kashiwar *et al.*, (2018) [26] reported that the available Fe, Mn, Cu, and Zn were ranged from 19.2 - 38.12,2.31 - 6.94, 0.67 - 0.98 and 0.23 - 0.9 mg kg^{-1}, respectively at Agricultural Farm of Rajiv Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh, India during the pre-monsoon season of 2014-2015.

Table 1: Characterization of soil test values for different nutrients

Nutrients	Status of the soil testing values		
	Low	Medium	High
Organic carbon (%)	<0.5	0.5-0.75	>0.75
Available N (kg/ ha)	<280	280-560	>560
Available P_2O_5 (kg/ ha)	<12.5	12.5-25	>25
Available K_2O (kg/ ha)	<135	135-335	>335
Available S (kg/ ha)	<22.4	22.4-35	>35
Available Zn (mg/kg)	<0.6	0.6-1.2	>1.2
Available Mn (mg/kg)	<3.5	3.5-7.0	>7.0
Available B (kg/ha)	<0.5	0.5-1.0	>1.0
Available Fe (mg/kg)	<4.5	4.5-9.0	>9.0

Table 2: Status of physico-chemical soil properties of Kauroli district of Rajasthan

Soil Properties	Range			Mean		
	Masalpur	Hindaun city	Mandrayal	Masalpur	Hindaun city	Mandrayal
Soil pH	6.8-8.2	6.8-8.2	6.9-8.6	7.65	7.61	7.66
EC (dSm-1)	0.19-0.70	0.25-0.70	0.25-0.85	0.45	0.47	0.49
Organic carbon (%)	0.22-0.69	0.23-0.69	0.23-0.74	0.50	0.53	0.52
Available N (kg/ ha)	160.9-310.2	175.8-310.2	118.5-310.2	228.79	232.86	212.62
Available P_2O_5 (kg/ ha)	10.20-25.20	10.20-22.4	10.20-23.4	17.98	16.09	15.60
Available K_2O (kg/ ha)	102.3-180.2	110.2-285.3	102.3-260.1	127.67	176.43	152.79
Available S (mg/kg)	10.35-24.50	9.95-20.58	10.23-21.03	16.28	14.52	15.29
Available Zn (mg/kg)	0.58-2.59	0.63-2.45	0.51-2.89	1.39	1.49	1.66
Available Mn (mg/kg)	1.11-1.98	1.24-2.13	1.12-1.91	1.47	1.56	1.38
Available B (kg/ha)	0.56-1.89	0.65-2.11	0.74-2.18	1.28	1.33	1.55
Available Fe (mg/kg)	0.69-1.59	0.53-1.41	0.61-1.52	1.23	1.10	1.12

Conclusion

The results obtain under research study concluded that the soils of three blocks of Karauli district is categorized under neutral in soil pH with low to medium fertility status. Majority of the soil samples in research study were having medium in organic carbon, Phosphorus and low in available nitrogen, Sulphur contentand Potash, low to medium range in Electrical conductivity during research study and also availability of micronutrients *viz* Zn and Boron were found in high range and Fe and Mn content were found low range in the soil. Thus use of organic matter, compost or vermin-compost manure in the agricultural fields as an important source of N_2nutrient, use of phosphorus, micronutrients and potash rich fertilizers as required by a specific crop.

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