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Status of available macro and micro nutrients and their correlation in soils of Eastern Plain Zone (Uttar Pradesh)

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Abstract
A bench mark field survey experiment was conducted to assess the availability of micronutrient (Fe, Cu, Zn, Mn, Mo and B), macronutrient (N, P, K Ca, Mg and S) status and their correlation in soils of Eastern Plain Zone (E.P.Z) of U.P. The 62 soils samples were collected and analysed. The range and average values of pH (7.3-8.5) 7.89, OC (2.1- 4.5) 3.59 g kg^{-1}, and E.C (0.19-0.69) 0.41dSm^{-1} were recorded. The ranged and average value of available macronutrient were recorded as N, (160-290) 224.8 kg ha^{-1}, P: (7.8-19.5) 13.8 kg ha^{-1}, K:(140-290) 203.3 kg ha^{-1},exchangeable Ca:(0.19-0.39) 0.28 cmol(p^+)kg^{-1} exchangeable Mg:(0.17-0.43) 0.30 cmol (p^+) kg^{-1} and S (7.4-22.8) 14.2 ppm. Micronutrients were recorded in sufficient range such as Zn (0.35-1.29) 0.71 ppm, Fe (1.75-9.10) 3.23 ppm and Mo (0.10-1.33) 0.68 ppm, Cu (0.20-1.45) 0.56 ppm whereas B and Mn were in deficient range and average value of B (0.11 -1.80) 0.43 ppm and Mn (0.11-2.86) 1.41 ppm. The significant positive correlation were found among Fe with Mn, B, N, and Ca; Zn with Cu and Mo; Cu with Mo; Mo with B, N with Ca; Mg and S; Ca with Mg and S; Mg with S; pH with K and Ca; Organic carbon with N, Mg, S and F; Cu with N; whereas significant negative correlation were observed among Mo with N; Zn with N; P with Ca; pH with N, Mg and S; and EC with Cu.

Keywords: Availability of Macro and Micro-nutrients, Correlation among nutrients, EPZ(U.P.).

Introduction
Soil characterization and their relationship to evaluate the fertility status of an area is an important for planning and management of soil for sustainable agriculture production. The sustainable production of a soil mainly depends upon its availability to supply essential nutrients to the growing plants. The quality of the soil is also controlled by physical, chemical and biological components of a soil and their interaction. The deficiency of micronutrients in the soil has become major constrain to productivity and sustainability. (Bell and Dell 2008). Some of the macro and micronutrients such as N, P, K, Ca, Mg and S. Fe, Zn, Cu, Mn Mo and B are important soil element that controls its fertility and yields of crops. The imbalance and inadequate use of fertilizer generate low efficiency of chemical fertilizer and nutrients have declined under intensive agriculture in recent years. Variation in nutrients supply is natural phenomenon and some of them may be sufficient where other deficient. The information on availability of micro, macro nutrients and their correlation with soil physico–chemical properties of the study area meager. Therefore, the present study was undertaken to know the micro, macronutrient status and their correlation of soils of the Eastern Plain Zone of Uttar Pradesh.

Method and Material
The study was designed as bench mark survey to assess the status soil physico- chemical properties available macronutrient and their correlation of soil of 9 district of Eastern Plain Zone of Uttar Pradesh. The soil samples were collected from the (0 to 15 cm depth) of 62 selected sites *viz*. Faizabad, Amabedkarnagar, Sultanpur, Amethi, Jaunpur, Gazipur, Varanasi, Baliya, Azamgarh, district. All samples were processed and packed in polythene bags for laboratory analysis. The soil pH and E.C was determined by the method describe in (USDA Hand book No. 60 Richards 1954). The organic carbon was determined by the Walkley and Black, 1934 method, The available N was determined by the Subbiah and Asija 1956 [15], available P by the Olsen's method described by Jackson 1973 [9], available potassium by neutral ammonium acetate method as described by Jackson, 1973 [9], exchangeable Ca and Mg was determined by neutral ammonium acetate extract by versanate titration as described by Black, 1965 [4] and available sulphur was determined by the method as given by Chesnin and Yien, 1950) using spectrophotometer (Spectronic20D) at 420 nm. The available micronutrient

(Fe, Zn, Cu and Mn) were determined by the DTPA extract estimation on AAS, AA6300 given by (Lindsay and Norvell 1978) [10] and Available Boron by the hot water extraction method given by (Berger and Truog 1939) [2, 3] and available Molybdenum was determined by the Ammonium oxalate extraction method given by (Grigg 1953) [7]. The correlation between different soil physico- chemical properties and micronutrients contents in soils were determined using correlation coefficients

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

Where x and y are the number of sample size.

Results and Discussion

The minimum and maximum range and average value of pH, OC, EC, available micronutrients (N, P, K, Ca, Mg and S) and micronutrients (Fe, Zn, Cu Mn, B and Mo) of collected soil sample of Eastern Plain Zone of Uttar Pradesh presented in Table-1. The perusal of data reveals that the range and mean of soil pH were (7.3 to 8.5), 7.89, Organic Carbon (2.1 to 4.5) 3.59 gkg^{-1} and Electrical conductivity (0.19 to 0.69) 0.41dsm^{-1}. The availability of macronutrients viz. N, P, K, Ca, Mg and S are presented in the table no.1 the data reveals that the availability of nitrogen varied from 160-290 $kgha^{-1}$ with an average value 224.8 kg ha^{-1}among the sample 82.2% of soil samples were found to be low (> 250 kg ha^{-1}) and remaining 17.74% N was found medium (< 250 kg ha^{-1}) on the basis of the ratings suggested by (Subbaih and Asija 1956) [15]. The availability of phosphorous varied from 7.8 to 19.5 kg ha^{-1} with mean value 13.8 kg ha^{-1}. Most of the soils samples (20.97%) were low (>20 P_2O_5 $kgha^{-1}$) range and 79.03% sample were under medium (50 to 20 $kgha^{-1}$) category,on the basis of the limitation suggested to (Muhar *et.al* 1965) [12]. Status of availability of potassium in the soil ranged between (140 to 290) kg/ha^{-1} and average value of 203 kg/ha^{-1}, Most of the soil samples (100%) were found under medium (125 to 300 Kg ha^{-1}) ranged as rating suggested by Muhar *et.al* (1965) [12]. The availability of sulphur varied from 7.4 to 22.8 ppm with mean value of 14.2 ppm. Among samples 11.29% samples were found under deficient and remaining 70.97% samples were found under medium category and 8.06% samples were found under sufficient category as per rating given by Hariram and Dewivedi (1994) [8]. The exchangeable Calcium and Magnesium status varied from, 0. 19 to 0.39 and 0.17 to 0.43 cmol(P^+)kg^{-1} and with an average value 0.28 and 0.30 cmol (P^+)kg^{-1} respectively. These finding could be corroborated with the finding as Singh *et.al.* (2012) [12]. In case of micronutrient the range and average Fe (1.75 to 9.10) 3.23 ppm, Zn (0.35 to1.29) 0.71 ppm and Cu (0.20 to 1.45) 0.56 ppm whereas, the Mn were found in range (0.11 to 2.86) 1.69 ppm, Mo range (0.10 to 1.33) 0.68 ppm and B range (0.11 to 1.80) 0.43 ppm. The ratings for Fe, Zn, Cu, and Mn were suggested by (Lindsay and Norvell, 1978) [10] and for B and Mo were suggested by (Berger and Troug, 1939) [2, 3].

Correlation Studies

The correlation studies among available macronutrients presented in the Table-2. The perusal of data revealed that the, N and Ca(r=0.532**), N and Mg, (r=0.623**) as well as N and S(r=0.403**), resulted significant positive correlation, it may be due the Calcium and Magnesium increased the activity of Nitrifies organisms hence it enhances nitrification activity. The significant positive correlation were also found among Ca and Mg (r=0.390**) were, significantly positive correlated, because the exchangeable Ca, Mg ratio of 5:1 to 1:1 are suitable with exchangeable Mg more than 0.2 me/100 in acid sandy soils above 1.5 me/100g clay soils. The Ca and S (r=0.339**) as well as Mg and S(r=0.306*) showed significantly and positive correlation, because the negatively charged sulphate ions (SO_4^{--}) are not held on the negatively charged soil particles. Thus sulphate ions (SO_4^{--}) are present in soil solution, in alkali soils and large amount of free calcium (Ca^{++}) is present. The sulphate ions (SO_4^{--}) react with free Calcium and Magnesium to form $CaSO_4$ and $MgSO_4$. P and Ca(r=-0.294*) were significantly negative correlated because not only the iron and aluminium phosphate exist in crystal form, but also various calcium phosphate, such as monocalcium phosphate, dicalcium phosphate, octacalcium phosphate and apatite's can exist in crystal form respectively. Similar results were also found by Srinivasarao *et al* (2004) [14], Mishra *et al.* (2007) [11].

The correlation among the micronutrients are presented in the Table-2 The perusal the data and reveals that The Fe and Mn(r=0.271*), Fe and B(r=0.463**) were significantly positive correlated, because excessive amount of other micro nutrients particularly Cu, Mn, Zn, and Mo can increase Iron availability. Similarly Zn and Mo(r=0.281*), Cu and Mo(r=0.351**), Mo and B,(r=0.245*), resulted significantly positive correlation. It may be because the high adsorption of Mo at low pH values could result in molybdenum deficiency likewise at high pH values the molybdenum is not adsorbed and is free to be taken up by plants. The results could be corroborated with the findings Goldberg *et al.* (1996) [6]. The Zn and Cu(r=0.363**) also showed significantly and positive correlation because Cu, can interfere with zinc uptake to the plant.

The correlation among the micronutrients and physico–chemical properties are given in the Table-3 and 4. The Soil pH and K(r=0.255*), Soil pH and Ca,(r=0.255*), OC and N,(r=0.314*), O.C and Mg,(r=0.269*) as well as OC and S (r=0.361**) showed significantly positive correlation. The reason behind positive correlation is that these three nutrients are closely related with OM and their mineralization by micro-organism to supply the elements N, P and S in soils. The availability of Mg reduces at higher soil pH due to fixation at higher soil pH in Ultisol, while the soil pH and N(r=-0.562**), soil pH and S (r=-0.594**) as well as soil pH and Mg (r=-0.344**) showed negative correlation. The availability of nutrients increase in neutral soil pH. Similar results were reported by Singh *et al* (2012) [12]**.** E.C and Cu (r=-0.365**) were significantly negative correlated because Cu is metallic element so it reduces the E.C. Similar results was found by (Singh *et. al* 2012) [13]. The OC and Fe (r=0.253*) showed significant positive correlation because well decomposed organic matter, such as compost or FYM contain chelating agents, these chelating agents form soluble complex with Fe which increase the availability of Fe. Similar results were also corroborated with findings of Mishra *et al*, 2007 [11].

Table 1: Maximum, minimum and average value of available macro, micro and standard deviation.

Soil characteristics	Minimum	Maximum	Mean	S.D
pH	7.3	8.5	7.89	0.205
OC g Kg^{-1}	2.1	4.5	3.59	0.28
E.C dSm^{-1}	0.19	0.69	0.41	1.29
N $kgha^{-1}$	160	290	224	27.66
P kg ha^{-1}	7.8	19.5	13.8	3.14
K kg ha^{-1}	140	290	203.3	38.31
Exch.Ca	0.19	0.39	0.28	0.05
Exch. Mg	0.17	0.43	0.30	0.06
Sulphur(ppm)	7.4	22.8	14.2	3.26
Fe (ppm)	1.75	9.10	3.23	1.56
Zn (ppm)	0.35	1.29	0.71	0.23
Cu (ppm)	0.20	1.45	0.56	0.20
Mn (ppm)	0.11	2.86	1.69	0.57
Mo (ppm)	0.10	1.33	0.68	0.23
B (ppm)	0.11	1.80	0.43	0.43

Table 2: Correlation among the available micro and macro nutrients

EPZ	Zn	Cu	Mn	Mo	B	N	P	K	Ca	Mg	S
Fe	-0.158	-0.158	0.274*	-0.218	0.366**	0.463**	-0.017	0.046	0.290*	0.048	0.232
Zn	1.000	0.3632**	-0.072	0.281*	0.064	-0.281*	0.177	0.143	-0.011	-0.025	-0.125
Cu		1.000	-0.018	0.3514**	0.031	-0.270*	0.183	-0.058	-0.138	-0.147	-0.166
Mn			1.000	0.058	-0.018	-0.120	0.002	0.156	0.156	-0.009	-0.014
Mo				1.000	0.245*	-0.253*	0.136	-0.033	-0.130	0.198	-0.180
B					1.000	0.184	0.160	-0.092	0.065	0.169	-0.004
N						1.000	-0.150	-0.162	0.532**	0.403**	0.623**
P							1.000	-0.148	-0.294*	-0.103	-0.106
K								1.000	0.058	-0.071	-0.136
Ca									1.000	0.390**	0.339**
Mg										1.000	0.306*

*and** significant at 5% and1%

Table 3: Correlation among the physico–chemical and available macro nutrients

	N	P	K	Ca	Mg	S
pH	-0.562**	0.0025	0.255*	0.2557*	-0.344**	-0.5949**
OC	0.3146*	-0.047	-0.064	0.0765	0.2698*	0.3614**
E.C	0.0330	-0.110	-0.043	-0.104	-0.178	0.0503

*and** significant at 5% and1%

Table 4: Correlation among the physico – chemical and available micro nutrients

	Fe	Zn	Cu	Mn	Mo	B
pH	-0.177	0.107	0.100	0.100	0.107	-0.212
OC	0.253*	0.126	0.057	0.076	0.209	0.060
E.C	0.193	-0.068	-0.365**	0.143	-0.168	-0.012

*and** significant at 5% and1%

Conclusion

1. The soils of eastern plain zone of Uttar Pradesh having pH neutral to slight saline-alkali, Low in organic carbon and EC low to moderate. The low in available nitrogen and medium in phosphorous, potassium, sulphur, calcium and magnesium. The available micronutrients *viz* Fe, Zn and Cu were low to moderate in range and B were analyzed in low range in maximum samples, whereas, Mn and Mo were found in moderate to low range.
2. The significant positive correlation were recorded among The significant positive correlation were found among Fe with Mn, B, N, and Ca; Zn with Cu and Mo; Cu with Mo; Mo with B, N with Ca; Mg and S; Ca with Mg and S; Mg with S; pH with K and Ca; Organic carbon with N, Mg, S and F; Cu with N;
3. Significant negative correlation were observed among Mo with N; Zn with N; P with Ca; pH with N, Mg and S; and EC with Cu.

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