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Study of Physico-Chemical Properties of Soil and Availability of Nutrients in Maize-Wheat Cropping Sequence

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A B S T R A C T

The present study was conducted to know the physico-chemical properties of soil and availability of nutrients. It was observed that physico-chemical properties of soil significantly influenced by various treatments. pH values varies from 8.18 to 8.30 during 2015-16 and 8.18 to 8.34 during 2016-17. It is evident from the data, the application of 150% NPK in treatment T_{11} significantly increases to 0.88 as compared to 0.84 under control plot). A critical perusal of data indicate that the highest organic carbon 0.92 and 0.97 per cent was obtained during 2015-16 and 2016-17, respectively with application of FYM 20 t ha^{-1}. The bulk density varies from 1.30 to 1.42 Mg m^{-3} and 1.26 to 1.41 Mg m^{-3} during 2015-16 and 2016-17 under different treatments. The significantly maximum water holding capacity was recorded (48.88, 49.00 and 48.94 %) with the application of FYM 20 t ha^{-1} (T_{12}). The sand content of experimental plots ranged from 37.68 to 38.65 per cent with a mean value of 38.11. The highest available nitrogen 457 and 453 kg ha^{-1}, potassium 596 and 595 kg ha^{-1}, sulphur 23.76 and 23.68 mg ha^{-1}, DTPA extractable zinc 3.66 and 3.59 ppm, DTPA extractable iron 3.72, copper 2.52, 2.48 and 2.50 ppm was recorded by application of 100% NPK + FYM 10 t ha^{-1} (T_9) treatments and manganese 13.52 and 13.36 ppm were recorded.

Introduction

Indian agriculture is passing through a critical phase. It is confounded with increasing crop production, sustainability and environmental quality issues. Answers to these questions can be sought by the long-term experiments, which are valuable repositories of information regarding the sustainability of intensive agriculture. Sustainability in crop production has always been tough task. It requires a deep knowledge and wisdom of pedo-edapho-meteorological interactions under investigation. Besides irrigation, nutrient management is the single most important factor affecting crop yields for the particular genotype. It is more so in the intensive cropping. Indian soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in micronutrients such as zinc, boron and to a limited extent iron, manganese, copper and molybdenum have also been reported to be deficient. Nitrogen occupies a unique position among the elements essential for all plants because of its large amounts requirement by most agricultural crops and accounts for 1 to 4 per cent of dry matter in plants. The available nitrogen status in soils increased with increased supply of nitrogen in the form of either fertilizers or organic manures which ultimately increased the productivity of crop. Transformation of added nitrogen through fertilizers or manures into different forms of nitrogen in soil and their availability to crops depends on soil properties and nature of nitrogen sources added to soils. Shilpashree *et al.,* (2012) study the effect of integrated nutrient management practices on distribution of nitrogen fractions in soil. Except inorganic nitrogen fractions, organic nitrogen fractions were recorded high in integrated treatments compared to the treatment which received nitrogen only in the form of fertilizers.

Materials and Methods

The present study was conducted at the Instructional farm, Rajasthan College of Agriculture, Udaipur during 2015-16 and 2016-17. The experimental site is a permanent manurial trial and its layout is on fixed site, at block B_2, situated at 24°34N' latitude, 73°42E' longitude and 582.17 m about mean sea level. The area comes under sub-humid southern plain (Zone-IVa) of Rajasthan. The climate of the region is subtropical, characterized by mild winters and distinct summers associated with high relative humidity particularly during the months of July to September. The mean annual rainfall of the region varies from 650 to 750 mm, most of which is received in rainy season from July to September. The mean maximum and minimum temperature are 35.45°C and 17.41°C, respectively.

Results and Discussion

Physico-chemical properties of soil

An experiment of data in Table 1 to 6 revealed that physico-chemical properties of soil significantly influenced by various treatments. The significant influence on soil properties was obtained by integrated application of 10 t ha^{-1} FYM with recommended dose of NPK during both years of experimentation.

pH of soil

It is evident in data presented in Table 1 that application of different treatments significantly influences the pH among different treatments. pH values varies from 8.18 to 8.30 during 2015-16 and 8.18 to 8.34 during 2016-17. However the differences were found statistically not significant. Talashilkar *et al.,* (2006) found that all the fractions of nitrogen decreased with increase in soil pH.

EC of soil

Data pertaining to the effect of different treatments on EC presented in Table 1. It is evident from the data, the application of 150% NPK in treatment T_{11} significantly increases to 0.88 as compared to 0.84 under control plot. Application of 20 t ha^{-1} FYM (T_{12}) lowers the EC values significantly as compared to control plot. Same trend was observed during both years of experimentation (Table 1).

Organic carbon of soil

Organic carbon contents after harvest of wheat crop under maize-wheat cropping sequence influenced significantly during both years of experimentation at 0-15 cm depth (Table 2). A critical perusal of data indicate that the highest organic carbon 0.92 and 0.97

per cent was obtained during 2015-16 and 2016-17, respectively with application of FYM 20 t ha^{-1}. This treatment was significantly superior to other treatments during both years under pooled analysis. Other treatments also influenced organic carbon content significantly as compared to control plot.

Bulk density

Data presented in the Table 2 revealed that the bulk density varies from 1.30 to 1.42 Mg m^{-3} and 1.26 to 1.41 Mg m^{-3} during 2015-16 and 2016-17 under different treatments. The bulk density significantly decreased 1.30 and 1.26 Mg m^{-3} during 2015-16 and 2016-17, under FYM 20 t ha^{-1} application. This treatment was at par with 100% NPK + FYM 10 t ha^{-1} (T_9) and FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM) treatment (T_{10}) during 2015-16 and 2016-17. The pooled data revealed that application of FYM 20 t ha^{-1} gave lowest bulk density *i.e.* 1.28 Mg m^{-3} and at par with FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM) treatment (T_{10}). This treatment gave 9.21 and 7.24 per cent less bulk density as compare to control (1.41 Mg m^{-3}) and recommended dose of fertilizer (1.38 Mg m^{-3}).

Water holding capacity

Data related to water holding capacity under the influence of different treatment of fertilizers and manures are presented in Table 3. Data revealed that the application of different treatments differed significantly with respect to water holding capacity of the experimental soil during both the years and pooled basis. The significantly maximum water holding capacity was recorded (48.88, 49.00 and 48.94 %) with the application of FYM 20 t ha^{-1} (T_{12}) and at par with 100% NPK + FYM 10 t ha^{-1} (T_9) and FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM) treatment (T_{10}) during both the years 2015-16, 2016-17 and in pooled.

Nutrients availability

Available nitrogen

The available nitrogen content varies from 252 to 457 kg ha^{-1} during 2015-16 and 2016-17 under different treatments of fertilizer application alone or in combination with FYM (Table 4). Critical perusal of data revealed that the highest available nitrogen 457 and 453 kg ha^{-1} was recorded under 100% NPK + FYM 10 t ha^{-1} treatment (T_9) during 2015-16 and 2016-17, respectively and significantly higher than other treatments. The pooled analysis also reveals that this treatment gave 79.73 and 31.41 per cent higher available nitrogen as compare to control (253 kg ha^{-1}) and recommended dose of fertilizer (346 kg ha^{-1}). Begum *et al.* (2007) reported that the available N increased with increased application of fertilizer during all the sampling stages of maize.

Available phosphorus

The highest available phosphorus 30.42 and 30.56 kg ha^{-1} was recorded under 100% NPK + FYM 10 t ha^{-1} treatment (T_9) during 2015-16 and 2016-17, respectively (Table 4). It was followed by 27.85 and 28.00 kg ha^{-1}, respectively by application of 150% NPK (T_{11}) in both the year. The pooled analysis reveals that this treatment gave 91.47 and 22.66 per cent higher available phosphorus as compared to control (15.83 kg ha^{-1}) and recommended dose of fertilizer (24.71 kg ha^{-1}).

Available potassium

It was apparent from the data (Table 4) that the highest available potassium 596 and 595 kg ha^{-1} was recorded under 150% NPK treatment (T_{11}) during 2015-16 and 2016-17, respectively.

Table.1 Effect of fertilizers and manures on pH and EC (dS m^{-1}) after harvest of wheat under maize –wheat cropping sequence

Treatments	**pH**			**EC**		
	2015-16	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
T_1 = Control	8.28	8.29	8.29	0.81	0.86	0.84
T2 = 100% N	8.30	8.34	8.32	0.80	0.84	0.82
T3 = 100% NP	8.26	8.29	8.27	0.84	0.89	0.86
T4 = 100% NPK	8.27	8.29	8.28	0.83	0.85	0.84
T5 = 100% NPK + Zn	8.24	8.22	8.23	0.83	0.86	0.85
T6 = 100% NPK+ S	8.18	8.20	8.19	0.84	0.86	0.85
T7 = 100% NPK+ Zn + S	8.20	8.23	8.22	0.84	0.87	0.86
T8 = 100% NPK + *Azotobacter*	8.22	8.26	8.24	0.85	0.87	0.86
T9 = 100% NPK + FYM 10 t ha^{-1}	8.24	8.18	8.21	0.81	0.85	0.83
T10 = FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM)	8.24	8.25	8.25	0.84	0.86	0.85
T11 = 150% NPK	8.27	8.30	8.29	0.86	0.89	0.88
T12 = FYM 20 t ha^{-1}	8.24	8.19	8.22	0.79	0.82	0.81
S.Em.±	NS	NS	NS	0.013	0.011	0.009
C.D. (P = 0.05)	NS	NS	NS	0.037	0.033	0.024

Table.2 Effect of fertilizers and manures on bulk density (Mg m^{-3}) and organic carbon (%) after harvest of wheat under maize –wheat cropping sequence

Treatments	**BD**			**OC**		
	2015-16	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
T_1 = Control	1.42	1.41	1.41	0.54	0.54	0.54
T2 = 100% N	1.38	1.37	1.38	0.66	0.66	0.66
T3 = 100% NP	1.36	1.35	1.35	0.69	0.69	0.69
T4 = 100% NPK	1.39	1.37	1.38	0.74	0.74	0.74
T5 = 100% NPK + Zn	1.40	1.37	1.38	0.75	0.75	0.75
T6 = 100% NPK+ S	1.37	1.36	1.37	0.74	0.74	0.74
T7 = 100% NPK+ Zn + S	1.36	1.36	1.36	0.76	0.76	0.76
T8 = 100% NPK + *Azotobacter*	1.40	1.38	1.39	0.74	0.75	0.74
T9 = 100% NPK + FYM 10 t ha^{-1}	1.32	1.29	1.31	0.87	0.88	0.88
T10 = FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM)	1.31	1.28	1.30	0.87	0.90	0.88
T11 = 150% NPK	1.39	1.36	1.38	0.57	0.62	0.60
T12 = FYM 20 t ha^{-1}	1.30	1.26	1.28	0.92	0.97	0.95
S.Em.±	0.03	0.03	0.02	0.01	0.01	0.01
C.D. (P = 0.05)	0.09	0.09	0.06	0.05	0.05	0.03

Table.3 Effect of fertilizers and manures on water holding capacity (%) after harvest of wheat under maize –wheat cropping sequence

Treatments	WHC		
	2015-16	2016-17	Pooled
T_1 = Control	39.90	39.92	39.91
T2 = 100% N	44.58	44.86	44.69
T3 = 100% NP	45.70	45.96	45.83
T4 = 100% NPK	46.44	46.88	46.66
T5 = 100% NPK + Zn	43.09	44.36	43.72
T6 = 100% NPK+ S	46.59	47.62	47.11
T7 = 100% NPK+ Zn + S	42.76	43.48	43.12
T8 = 100% NPK + *Azotobacter*	43.73	45.23	44.48
T9 = 100% NPK + FYM 10 t ha^{-1}	48.83	48.92	48.88
T10 = FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM)	48.48	48.56	48.52
T11 = 150% NPK	46.65	47.38	47.02
T12 = FYM 20 t ha^{-1}	48.88	49.00	48.94
S.Em.±	1.07	1.08	0.62
C.D. (P = 0.05)	3.08	3.11	1.76

Table.4 Effect of fertilizers and manures on available N, P_2O_5, K_2O (kg ha^{-1}) and S (mg ha^{-1}) after harvest of wheat under maize –wheat cropping sequence

Treatments	Available N			Available P_2O_5			Available K_2O			Available S		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T_1 = Control	254	252	253	15.76	15.90	15.83	479	478	478	15.73	15.72	15.73
T2 = 100% N	268	266	267	15.98	16.12	16.05	487	485	486	15.83	15.83	15.83
T3 = 100% NP	279	276	277	22.86	23.00	22.93	495	494	494	16.69	16.55	16.62
T4 = 100% NPK	348	345	346	24.64	24.78	24.71	553	552	553	17.49	17.45	17.47
T5 = 100% NPK + Zn	342	340	341	26.88	27.02	26.95	556	555	556	16.76	16.65	16.70
T6 = 100% NPK+ S	340	338	339	25.82	25.96	25.89	549	547	548	23.76	23.68	23.72
T7 = 100% NPK + Zn + S	343	339	341	25.42	25.56	25.49	562	561	562	23.64	23.58	23.61
T8 = 100% NPK + *Azotobacter*	355	351	353	24.68	24.82	24.75	576	575	576	16.81	16.72	16.77
T9 = 100% NPK + FYM 10 t ha^{-1}	457	453	455	30.24	30.38	30.31	595	593	594	18.34	18.25	18.30
T10 = FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM)	403	399	401	26.98	27.12	27.05	584	583	584	18.05	17.98	18.02
T11 = 150% NPK	358	354	356	27.85	28.00	27.93	596	595	596	17.42	17.37	17.40
T12 = FYM 20 t ha^{-1}	368	364	366	23.56	23.27	23.42	580	579	580	19.15	19.07	19.11
S.Em.±	8.35	8.27	5.88	0.568	0.571	0.403	12.996	12.967	9.179	0.424	0.422	0.299
C.D. (P = 0.05)	24.03	23.80	16.60	1.635	1.644	1.138	37.394	37.309	25.919	1.219	1.215	0.844

Table.5 Effect of fertilizers and manures on available Zn, Cu, Mn and Fe (ppm) after harvest of wheat under maize –wheat cropping sequence

Treatments	Available Zn			Available Fe			Available Cu			Available Mn		
	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled	2015-16	2016-17	Pooled
T_1 = Control	2.02	1.95	1.99	2.62	2.60	2.61	1.62	1.60	1.61	9.02	9.02	9.02
T2 = 100% N	2.18	2.11	2.15	2.69	2.62	2.66	1.61	1.61	1.61	9.72	9.67	9.70
T3 = 100% NP	2.48	2.41	2.44	3.08	2.95	3.01	1.92	1.89	1.90	9.46	9.36	9.41
T4 = 100% NPK	2.40	2.33	2.37	2.98	2.96	2.97	1.89	1.82	1.86	9.64	9.55	9.60
T5 = 100% NPK + Zn	3.66	3.59	3.62	3.16	3.08	3.12	2.12	2.05	2.08	9.76	9.70	9.73
T6 = 100% NPK+ S	2.42	2.35	2.39	3.32	3.26	3.29	2.22	2.20	2.21	10.26	10.14	10.20
T7 = 100% NPK+ Zn + S	3.62	3.55	3.59	3.48	3.38	3.43	2.18	2.18	2.18	11.06	10.78	10.92
T8 = 100% NPK + *Azotobacter*	2.52	2.45	2.48	3.28	3.24	3.26	1.72	1.68	1.70	11.04	10.88	10.96
T9 = 100% NPK + FYM 10 t ha^{-1}	3.48	3.41	3.45	3.72	3.66	3.69	2.52	2.48	2.50	12.94	12.65	12.80
T10 = FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM)	3.42	3.35	3.39	3.56	3.48	3.52	2.46	2.44	2.45	12.76	12.48	12.62
T11 = 150% NPK	2.44	2.37	2.41	2.89	2.82	2.86	1.78	1.72	1.75	9.46	9.34	9.40
T12 = FYM 20 t ha^{-1}	2.72	2.65	2.69	2.98	2.88	2.93	2.32	2.28	2.30	13.52	13.36	13.44
S.Em.±	0.06	0.06	0.04	0.07	0.07	0.05	0.05	0.05	0.03	0.26	0.26	0.19
C.D. (P = 0.05)	0.19	0.19	0.13	0.22	0.21	0.15	0.14	0.14	0.09	0.76	0.76	0.53

It was at par with FYM 20 t ha^{-1} (T_{12}), FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM, T_{10}), 100% NPK + FYM 10 tha^{-1} (T_9) and 100% NPK + Zn (T_5) treatments during both the years and also in pooled analysis. The pooled analysis reveals that this treatment gave 24.68 and 7.77 per cent higher available potassium as compare to control (478 kg ha^{-1}) and recommended dose of fertilizer (553 kg ha^{-1}).

Available sulphur

It was apparent from the data (Table 4) that the highest available sulphur 23.76 and 23.68 mg ha^{-1} was recorded under 100% NPK+ S treatment (T_6) during 2015-16 and 2016-17, respectively. It was at par with 100% NPK +Zn+ S (T_7), FYM 20 t ha^{-1}(T_{12}), FYM 10 t ha^{-1} + 100% NPK (T_9) and 100% NPK + FYM 10 t ha^{-1} (– NPK of FYM) *i.e.* T_{10}treatmentsduring both the years and also in pooled analysis. The pooled analysis reveals that this treatment gave 50.79 and 35.77 per cent higher available sulphur as compare to control (15.73 mg ha^{-1}) and recommended dose of fertilizer (17.47 mg ha^{-1}).

Available zinc

It was apparent from the data (Table 5) that the highest DTPA extractable zinc 3.66 and 3.59 ppm was recorded at 100% NPK + Zn (T_5) treatment during 2015-16 and 2016-17, respectively.

This treatments is closely followed and statistically at par with 100% NPK + Zn +S (T_7), 100% NPK + FYM 10 t ha^{-1} (T_9) and FYM 10 t ha^{-1} + 100% NPK (-NPK of FYM) (T_{10}) treatments during both the years and also in pooled analysis. The pooled analysis reveals that this treatment gave 81.90 and 56.03 per cent higher available zinc as compare to control (1.99 ppm) and recommended dose of fertilizer (2.37 ppm).

Available iron

It was apparent from the data (Table 5) that the highest DTPA extractable iron 3.72 and 3.66 ppm was recorded at 100% NPK + FYM 10 t ha^{-1} (T_9) treatment during 2015-16 and 2016-17, respectively. It was at par with 100% NPK+ FYM 10 t ha^{-1} (-NPK of FYM, T_{10}) treatments during both the years and also in pooled analysis. This both treatments were significantly superior to all other treatments during both years of experimentation and it was also observed in pooled analysis. The pooled analysis reveals that this treatment gave 41.37 and 24.24 per cent higher available iron as compare to control (2.61 ppm) and recommended dose of fertilizer (2.97 ppm). Rao and Sitaramayya (1997) indicated a significant correlation of nitrogen uptake by rice with total and available nitrogen forms at 45 and 60 DAT.

Available copper

Data pertaining to the available copper in soil after completion of maize – wheat rotation as effected by different treatment presented in (Table 5). The highest available copper 2.52, 2.48 and 2.50 ppm was recorded by application of 100% NPK + FYM 10 t ha^{-1} (T_9) treatments during 2015-16, 2016-17 and pooled analysis, respectively. This treatment (T_9) was at par with 100% NPK+ FYM 10 t ha^{-1} (-NPK of FYM, T_{10}) treatments during both the years and also in pooled analysis. This both treatments was found statistically significant than other treatments during both years of experimentation.

Available manganese

Pooled available manganese in the soil varies from 9.02 to 13.44 ppm with different treatments (Table 5). The highest manganese 13.52 and 13.36 ppm was recorded by application of FYM @ 20 t ha^{-1} (T_{12})

treatment during 2015-16 and 2016-17, respectively. This treatment was found superior than all other treatments significantly. Data also indicated that either application of NPK alone or with manures treatments significantly improve manganese content in soil.

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