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RESIDUAL EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON SOIL FERTILITY, GROWTH AND YIELD OF WHEAT UNDER RECLAIMED SODIC SOIL

MUKESH KUMAR, N.P.S. YADUVANSHI[1] AND Y.V. SINGH[2]

Central Soil Salinity Research Institute Karnal -132001(Haryana)
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ABSTRACT

A field experiment was conducted on a reclaimed sodic soil at experimental farm of Central Soil Salinity Research Institute, Karnal (Haryana) to assess the residual effects of organic sources and NP fertilizer on yield of wheat and soil fertility. The experiment was laid out in randomized block design with four replications. The treatments included in two levels of NP fertilizer (75 and 100% RD of N and P) with and without residual effects of different organic manures. Application of N, P and organic sources significantly increased the tillers, plant height and yield of wheat over control. The grain yield of wheat (4.36 t ha^{-1}) increased significantly with 100% NP+10 t FYM ha-^{1}) over 100% NP (3.88 t ha-^{1}) and 100% NP + wheat residue (4.12 t ha-^{1}). The 100% NP with organic sources (FYM, PM, GM, and WR) recorded higher N content in grain by 18.3, 23.6, 17.8, and 6.3 % and in straw by 12.0, 15.9, 19.3 and 7.7%, respectively as compared to 100% NP alone. Application of NP along with FYM or SPM or GM or WR resulted in higher content of nutrients (N, P, K, S, Zn, Cu, Mn and Fe) in wheat crop. Incorporation of organic manure decreased soil pH and its combined use with inorganic fertilizer was significantly reflected in the build up of available N, P, K, organic carbon and DTPA –extractable Zn, Cu, Mn and Fe in the soil.

Key word: Reclaimed sodic soil, organic, inorganic fertilizers, yield, wheat, soil fertility.

INTRODUCTION

Rice-wheat crop rotation in the Indo-Gangetic plains is practiced with different management regimes in India. In the northern India (Punjab, Haryana and Western Uttar Pradesh), an intensification of land use and a reduction in the traditional fallow period, continuous use of high inputs and irrigation have resulted into declining soil fertility and productivity. Green manuring (*Sesbania aculeata*), farm yard manure (FYM), press-mud (a waste by sugar product) and wheat residue (WR) are important sources of organic matter. Availability of farmyard manure is seriously constrained due to used as a major source of fuel in India. As an alternative, the green manure crop dhaincha has an advantage due to vigorous growth habit, N-fixation capacity and the general ability of the plant to withstand soil related conditions such as salinity, alkalinity, water logging, etc. Wheat straw is often burned or removed from the field after harvest. The necessity of organic manuring increases many fold in salt - affected soils because of their high pH, adverse physical properties and reduced availability of some essential plant nutrients. The recommended dose of NPK fertilizers alone does not sustain soil productivity under continuous intensive cropping (Kumar *et al.* 2009), whereas inclusion of organic manures improves soil fertility and crop yields (Swarup and Yaduvanshi 2004), physical properties (Kumar and Tripathi 1990) and biological status of the soil (Batra 2004). The present experiment was, therefore, carried out to investigate the residual effect of deferent organic manures on wheat yield, soil fertility and mineral composition of plant in the reclaimed sodic soil.

MATERIALS AND METHODS

A field experiment was conducted in gypsum-amended sandy loam (Acquic Naturstafs) sodic soil at the experimental farm of CSSRI, Karnal, (29.43^{0}N and 76.58^{0} E) Haryana. Initial soil characteristics (0-15 cm depth) of the experimental soil were: pH 9.05 (1:2 soil and water suspension) electrical conductivity 0.26 dS m^{-1} (1:2 soil and water suspension), organic carbon 2.8 g kg^{-1}, available N 142 kg ha^{-1}, available P 24 kg ha^{-1}, available K 192 kg ha^{-1}. The DTPA–extractable available Zn, Cu, Mn and Fe contents were 0.84, 1.12, 5.21 and 15.9, mg kg^{-1}, respectively. The treatments consisted of $T_{1,}$ Control; $T_{2,}$ N_{90} $P_{19.5}$ kg ha^{-1} (75% recommended doses of NP); T_{3}, N_{120} P_{26} kg ha^{-1} (100% recommended doses of NP); $T_{4,}$ T_{2} + FYM (10 t ha^{-1}); $T_{5,}$ T_{2} + sulphitation pressmud (10 t ha^{-1}); $T_{6,}$ T_{2} + green manuring (dhaincha) in situ; $T_{7,}$ T_{2} + wheat residue (2.5 t ha^{-1}); $T_{8,}$ T_{3}+ FYM (10 t ha^{-1}); $T_{9,}$ T_{3} + sulphitation preesmud (10 t ha^{-1}); $T_{10,}$ T_{3} + Green manuring (dhaincha) in situ; $T_{11,}$ T_{3} + wheat residue (2.5 t ha^{-1}). The experiment was laid out in a randomized block design with four replications .The green manure as dhaincha (2.12% N, 0.26% P, 2.16% K), wheat residue (0.5% N, 0.12% P, 1.05% K), farmyard manure (0.56% N, 0.23% P, 0.87% K) and sulphitation pressmud (1.52% N, 0.53% P, 1.22 % K) were incorporated during kharif season before

[1] *Indian Agricultural Research Institute, New Delhi, Corresponding author e-mail: npsyaduvanshi@gmail.com*
[2] *Institute of Agriculture Sciences, B.H.U., Varanasi (UP)*

transplantation of rice. Wheat crop (CV HD 2329) was sown during second week of November at a row spacing of 20 cms in both the years. One third of N and full doses of P and K were added at the time of sowing as per treatments. The remaining dose of nitrogen was top dressed in two equal splits at 21 and 40 days after sowing. The sources of N and P were urea and single superphosphate, respectively. The effective tillers and plant height were recorded at earring stage of wheat crop. Yields of both grain and straw were recorded at harvest. Soil sample collected before sowing and after harvest of wheat were analyzed for pH in 1:2 soil:water suspension; organic carbon; available N; available P, available K (Jackson 1973) and DTPA-extractable Fe, Zn, Mn, and Cu (Lindsay and Norvell 1978.) Grain and straw samples were wet digested in a di-acid mixture (HNO_3: $HClO_4$) and analysed for phosphorus by vanadomolybdo-phosphoric yellow colour methods, K by flame photometer and Zn, Cu, Mn and Fe by atomic absorption spectrophotometer. Nitrogen was determined by modified micro-Kjeldahl methods.

RESULTS AND DISCUSSION

Growth and yield

The effective tillers, plant height and test weight of wheat were significantly influenced by N, P and organic sources (Table 1). Application of 100% NP with 10 t FYM ha^{-1} recorded maximum number of effective tillers (98.8 m^{-1}), plant height (90.8 cm), test weight (44.7 g) and yield of wheat grain 4.36 t ha^{-1}) and straw (4.95 t ha^{-1}) than recommended doses of NP alone and the control. However, the yield of wheat was more or less equal in among the organic sources. This might be due to supply of N applied and slowly released nutrients through all organic manures which helped to produce more number of effective tiller m^2 and higher grain yield of wheat. Application of organic sources with 75% NP recommended doses was produced less wheat grain yield as compared 100% NP. The 100% NP along with organic sources (FYM, SPM, GM, and WR) recorded higher grain yield by 12.4, 10.3, 11.3, and 6.2 per cent and straw by 12.0, 15.9, 19.3 and 7.7 per cent, respectively as compared to 100% NP alone. On the basis of pooled mean data of two years the superiority of the treatments may be arranged as $T_8 > T_{10} > T_9 > T_{11} > T_3 > T_7 > T_6 > T_5 > T_4 > T_2$ and T_1 for grain yield of wheat. The yield of wheat from residual effect of FYM or SPM or GM or WR with 100% NP was similar to that from 100% NP recommended dose as reported by Patra *et al.* (2000), Singh *et al.* (2005).

Table 1: Effect of different treatments on growth, yield attributes and yield of wheat crop (mean of two years)

Treatment	Plant height (cm)	Effective tillers (m^{-1})	1000 grain weight (g)	Yield (t ha^{-1})	
				Grain	Straw
T_1-Control	80.7	75.5	40.5	0.98	2.05
T_2- 75 % NP	88.1	86.3	42.6	2.78	3.64
T_3- 100 % NP	88.2	88.2	43.4	3.88	4.15
T_4- 75 % NP + 10 t ha^{-1} FYM	88.5	89.3	43.6	3.19	4.05
T_5- 75 % NP + 10 t ha^{-1} SPM	89.3	93.2	43.7	3.23	4.35
T_6- 75 % NP + GM (in situ)	89.7	94.7	43.9	3.25	4.33
T_7- 75 % NP + 2.5 t ha^{-1} WR	88.5	89.1	43.5	3.45	4.78
T_8- 100 % NP +10 t ha^{-1} FYM	90.8	98.8	44.7	4.36	4.65
T_9- 100 % NP +10 t ha^{-1} SPM	90.4	98.7	44.6	4.28	4.81
T_{10}- 100 % NP + GM (in situ)	90.2	98.5	44.5	4.32	4.95
T_{11}- 100 % NP + 2.5 t ha^{-1} WR	90.1	98.3	44.3	4.12	4.47
CD (P=0.05)	4.3	3.9	1.55	0.22	0.24

Note: GM = Green manuring, FYM = Farm yard manure, SPM = Sulphitation press mud and WR = Wheat residue

Nutrient Content

Application of 100% NP with organic sources significantly increased the total content of N in grain and straw of wheat crop as compared to control (Table 2). Combined use of 100% NP and organic sources (FYM, SPM, GM, and WR) recorded higher content of N in grain by 18.3%, 23.6%, 17.8%, and 6.3%, respectively as compared to 100% NP alone. Higher N concentration in wheat was observed with combined application of residual effect of organic sources with 100% recommended NP which help to absorb more nitrogen by plants (Table 1). Yaduvanshi (2003) also reported that per cent recovery of N by the crop was inversely related to the rate of N application. Among the treatments with residual of organic sources with 75% and 100% NP alone, there was significant difference in N, K and S contents except P in grain of wheat. The concentration of N

was similar with application of 75% recommended NP with residual effect of organic sources (FYM, PM, GM and WR) as compared to 100% NP. Thus, it suggests that higher concentration of N in wheat could be achieved with smaller amount of N applied through organic sources. The content of K and S in grain and straw of wheat increased significantly with application of 100% NP and residual organic sources as compared to 75 and 100% NP alone and control. However, the content of P in grain and straw did not differ significantly with 100% NP with organic sources and 100% NP alone. This may be due to less content of these nutrients in organic sources.

Table 2: Effect of different treatments on content of nutrients (%) in wheat crop (mean of two years)

Treatment	N		P		K		S	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	1.58	0.20	0.52	0.027	0.48	1.54	0.13	0.12
T_2	1.91	0.36	0.61	0.043	0.49	1.94	0.14	0.12
T_3	2.08	0.40	0.63	0.046	0.50	2.20	0.16	0.12
T_4	2.10	0.45	0.65	0.051	0.53	2.42	0.17	0.13
T_5	2.05	0.46	0.65	0.056	0.54	2.37	0.17	0.13
T_6	2.01	0.47	0.65	0.053	0.55	2.43	0.17	0.13
T_7	1.96	0.43	0.64	0.044	0.52	2.13	0.17	0.13
T_8	2.46	0.52	066	0.059	0.56	2.74	0.19	0.14
T_9	2.57	0.53	0.69	0.063	0.57	2.75	0.19	0.14
T_{10}	2.45	0.47	0.68	0.056	0.58	2.89	0.18	0.14
T_{11}	2.21	0.47	0.66	0.040	0.55	2.72	0.10	0.13
CD (P=0.05)	0.12	0.02	0.04	0.003	0.03	0.13	0.01	0.01

The total concentration of Zn, Cu, Mn and Fe ranged between 14.0 and 27.5, 3.25 and 12.20, 29.0 and 46.0 and 137.0 and 173.5 mg kg^{-1} in grain of wheat respectively (Table 3). The content of Zn, Cu, Mn and Fe in grain and straw increased significantly with the conjoint application of residual effect of organics and 100% NP in comparison to 100% NP alone and control. However, the content of Zn, Cu, Mn and Fe in grain and straw with 75% NP plus residual of organic sources was found significantly greater than 100 NP alone except Mn content in grain and straw. Similar results were reported by Kumar and Singh (2010). The lowest Zn, Cu, Mn and Fe content in wheat was recorded in control.

Table 3: Effect of different treatments on content (mg kg^{-1}) of micronutrients in wheat (mean of two years)

Treatments	Zn		Cu		Mn		Fe	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	14.0	11.5	3.25	5.85	29.0	84.5	137.5	161.0
T_2	16.5	13.5	6.55	6.00	31.0	90.0	150.5	168.0
T_3	18.5	14.0	6.65	6.10	31.5	90.5	151.5	176.0
T_4	21.5	17.0	8.80	7.45	35.0	93.5	165.5	220.0
T_5	23.0	16.8	8.85	7.50	36.5	94.0	165.0	219.0
T_6	23.5	17.0	8.90	7.55	37.5	95.0	164.5	216.0
T_7	21.0	16.6	8.75	7.40	34.0	91.5	162.5	207.5
T_8	25.0	18.5	12.10	10.70	44.0	98.0	173.5	270.5
T_9	26.5	19.0	12.15	10.75	45.0	98.5	172.5	264.5
T_{10}	27.5	19.5	12.20	10.80	46.0	99.5	172.0	264.0
T_{11}	24.0	19.5	12.00	10.60	39.5	96.0	166.0	257.5
CD (P=0.05)	2.61	2.55	0.51	0.46	8.99	5.21	8.99	7.47

Available nutrients in soil

Application of organic sources with fertilizers slightly decreased the soil pH from initial value of 9.05 to 8.94. However, the soil pH was higher in inorganic fertilizer treated plots as compared to NP plus organic sources treated plots. The decrease may be attributed to the higher production of CO_2 and organic acids (Table 4). The organic carbon reduced from initial value of 2.8 to 2.6 g kg^{-1} in control and inorganic fertilizer treated plots. However, the use of NP plus organics increased the organic carbon, from 2.8 to 3.0 g kg^{-1}. Incorporation of organic sources (FYM, GM, SPM and WR) with 75% or 100% NP significantly increased the organic carbon content.

The increase in soil organic carbon content with the use of organic source like WR, FYM and GM was reported by Yaduvanshi *et al.* (2013); Yadvinder-Singh *et al.*(2004) ; Balwinder *et al.* (2008). Application of organic sources with 100% NP significantly increased the available N content of soils over 100% NP alone and higher amount was recorded in 100% NP plus GM treatment (Table 4). The increase in available N content with the incorporation of organic sources is attributed to enhanced mineralization of organic sources which might helped in build-up of higher available N (Yaduvanshi *et al.* 2013).

Table 4: Effect of different treatments on pH, EC, OC and status of available nutrients of post harvest soil (mean of two years)

Treatment	pH	EC (dSm^{-1})	OC ($g\ ha^{-1}$)	Available nutrients ($kg\ ha^{-1}$)			DTPA – extractable ($mg\ kg^{-1}$)			
				N	P	K	Zn	Cu	Mn	Fe
T_1	9.10	0.31	2.6	129	22.6	195	0.82	1.08	5.18	15.56
T_2	9.05	0.31	2.7	134	25.2	193	0.84	1.18	5.20	15.80
T_3	9.06	0.30	2.7	139	26.3	197	0.83	1.20	5.14	15.89
T_4	8.97	0.30	3.1	142	28.6	212	0.89	1.42	5.91	17.12
T_5	8.95	0.30	3.0	142	28.5	212	0.90	1.45	5.92	16.85
T_6	8.95	0.30	3.0	143	28.4	210	0.94	1.46	5.85	16.67
T_7	8.99	0.29	3.0	140	27.9	210	0.88	1.41	5.76	16.00
T_8	8.98	0.31	3.0	149	30.2	218	0.95	1.49	5.85	17.36
T_9	8.99	0.31	3.0	150	29.9	215	0.96	1.52	5.88	17.34
T_{10}	8.98	0.31	3.1	151	29.7	216	0.97	1.54	5.87	17.31
T_{11}	8.94	0.30	3.0	148	28.9	212	0.91	1.48	5.77	17.25
CD (P=0.05)	0.21	NS	0.20	7.91	1.57	11.57	0.10	0.18	0.33	0.92

Available P content of the soil increased with inorganic and organic fertilizers as compared to its initial status of 24 to 30.2 kg ha^{-1}. Higher amount of available P in soil was recorded in 100% NP with FYM, which was at par with 100% NP + SPM, 100% NP + GM and 100% NP + WR (Table 4). The increase in P status due to addition of organic sources can be attributed to the high content of these nutrients. The results conform to the findings of Yaduvanshi *et al*. (2013). Incorporation of organic sources with fertilizers (75% and 100% NP) significantly increased the available K content of soil as compared to its initial status of 192 kg ha^{-1}. The maximum available K was recorded in the treatment receiving GM along with 100% NP. Similar results were reported by (Singh *et al.* 2005). The DTPA-extractable Zn, Cu, Fe and Mn in soils significantly increased with application of organic sources as compared to control and inorganic fertilizer treated plots (Table 4). However, incorporation of organic sources with 75 % or 100% NP did not significantly differ with organic manure alone in respect of these micro - nutrient. The highest Fe content in FYM and Mn content in SPM treatment was recorded which was at par with GM and WR treatment. The increase of DTPA (Zn, Cu, Mn and Fe) in post-harvest soil with the application of FYM was also reported by Kumar and Singh (2010).

On the basis of results, it can be concluded that incorporation of organics (FYM, SPM, GM and WR) with fertilizers could maintain sustainable wheat yield as well as soil fertility build up in reclaimed sodic soils. Application of 100% recommended NP plus GM (in situ) or SPM (10 t ha^{-1}) or FYM (10 t ha^{-1}) treatments were most effective for maximizing grain yield of wheat.

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