

Residual Effects of Organic Manure and Mineral Nutrients on Yield of Wheat and Nutrient Status of Soil in Cowpea-wheat Sequence

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Abstract: The application of FYM and mineral nutrients to cowpea significantly increased the grain and straw yields of subsequent wheat crop. The interactive effects were significant for grain and straw yields of wheat, available nitrogen and iron for both the years and cobalt during 2000-2001 with highest values under the application of FYM @ 10 t ha⁻¹ + mineral nutrient combination, i.e., @ 20, 1.0, 50, 25 and 0.5 kg ha⁻¹ elemental sulphur, sodium molybdate, ferrous sulphate, zinc sulphate and cobalt nitrate, respectively.

Key words: Organic manure, mineral nutrients, *Bradyrhizobium*, wheat, nutrient uptake.

The integrated plant nutrient system helps in the maintenance and improvement of soil fertility for sustainable crop production. The legume cultivation improves soil fertility. Cultivation of kharif pulses benefit the succeeding wheat crop to the extent of 40 kg N ha⁻¹ (Gill *et al.*, 2000). The organic manure contains both macro and micronutrients and ensures high crop yields. The application of organic manure improves soil conditions N fixed.

Among summer pulses, cowpea showed more beneficial effects in succeeding cereal crops. These benefits in succeeding crop are more when summer pulses are raised with optimum dose of fertilizers (Massood Ali and Mishra, 2000). Legume-*Rhizobium* symbiosis has been expected to be influenced by host-genotype and also by certain macro and micronutrients such as

phosphorus, cobalt and molybdenum (Pandher *et al.* 1976).

Application of crop residues in the form of FYM, compost, green manure, etc. (Landon, 1992) and the use of biofertilizers (Dixit and Gupta 2000) in the soil, may substantially improve availability of nutrients in the soil. The efficiency of native or inoculated strains of biofertilizers is further improved when used in conjunction with organic manures (Anonymous, 2000) and micronutrients like S, Mo, Co (Gill *et al.*, 2000). The present investigation was an attempt to study the residual effect of organic manure and mineral nutrient application in cowpea on sandy loam soil under cowpea-wheat crop sequence.

Materials and Methods

The field experiments were conducted at SKN College of Agriculture, Jobner, during kharif seasons of 1999 and 2000

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using cowpea cv. C-152 as a test crop. The seeds were inoculated with carrier-based *Bradyrhizobium* sp. @ 500 g ha⁻¹ (2.1 x 10⁸ cfu g⁻¹). The experimental soil was loamy sand in texture with good infiltration rate (22.4 cm h⁻¹) and saturated hydraulic conductivity (10.20 cm h⁻¹). The soil was low in available nitrogen, phosphorus, potassium, sulphur, molybdenum and zinc (135.80, 18.30, 190.40 kg ha⁻¹ and 8.7, 0.12 and 0.44 mg kg⁻¹, respectively). DTPA extractable iron and cobalt were 4.30 and 0.23 mg kg⁻¹. The soil was non-saline with pH 8.1 and low in organic carbon 0.16%.

Treatments consisted of 18 combinations. The same layout was used for both the years of experimentation. As per treatment elemental sulphur and FYM were applied three weeks before sowing. Remaining treatments and recommended doses of nitrogen (20 kg ha⁻¹) and phosphorus (40 kg ha⁻¹) were applied prior to cowpea sowing. The succeeding wheat crop received only 120 kg N and 30 kg P₂O₅ ha⁻¹ through urea and DAP. Grain and straw yields were recorded for both the years at harvest. The soil samples were analyzed for nitrogen (Subbiah and Asija, 1956), phosphorus (Olsen *et al.*, 1954) and sulphur (Williams and Steinbergs, 1959). Molybdenum (Chapman and Pratt, 1961) DTPA iron, zinc and cobalt were determined using AAS (Lindsay and Norvell, 1978).

Results and Discussion

Grain and straw yield of wheat

The residual effect of cowpea grown with varying levels of FYM and nutrients showed significant influence on grain and

straw yields of wheat for both the years (Table 1).

The wheat yield increased from 2601 to 3922 kg ha⁻¹ during 1999-2000 and 2378 to 3740 kg ha⁻¹ during 2000-2001 due to residual effect of FYM applied to the previous crop of cowpea. Yaduvanshi (2000) also reported that application of FYM to rice crop gave significant benefits to the succeeding wheat crop. Incorporation of 10 t ha⁻¹ of crop residue increased the wheat yield by 36.8% over the control (Gaur and Mukerjee, 1979). Significant residual effect of various nutrients in increasing the wheat yield could be attributed to improved fertility status of soil as recorded at harvest of the crop (Masood Ali and Mishra, 2000; Subba Rao *et al.*, 1999).

Available nutrient content in soil

Application of FYM and nutrients to cowpea in a cowpea-wheat sequence (Tables 2 and 3) had significant influence on available status of nutrients at the harvest of wheat crop during 1999-2000 and 2000-2001 with F₂ (10 t FYM ha⁻¹) being significantly superior to other FYM treatments. The M₅ (S + Fe + Mo + Zn + Co) and M₄ (S + Fe + Mo + Zn) treatments significantly improved in the nitrogen and phosphorus status of soil, respectively. Interaction was significant for available N and Fe for the both years and cobalt during 2000-2001 with highest status under F₂M₅ while it was non-significant for rest of the nutrients.

Organic manure releases complexing agents, which play an important role in transformation of insoluble micronutrients (Mann *et al.*, 1978) and also possess fairly

Table 1. Residual effect of FYM and mineral nutrients on grain and straw yield of wheat

Treatments	1999-2000				2000-2001			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
Grain (q ha⁻¹)								
M ₀	18.31	25.84	34.14	26.10	16.74	24.13	32.47	24.45
M ₁	20.41	36.38	35.77	30.85	18.65	33.97	34.66	29.10
M ₂	22.89	37.63	37.96	32.83	20.92	35.14	36.10	30.72
M ₃	24.79	39.42	40.51	34.90	22.65	36.82	38.53	32.66
M ₄	34.34	41.06	42.89	39.43	31.39	38.35	40.79	36.84
M ₅	35.34	42.20	44.05	40.53	32.30	39.42	41.89	37.87
Mean	26.01	37.09	39.22		23.78	34.64	37.40	
	F	M	FxM		F	M	FxM	
SEm±	0.730	1.033	1.789		0.608	0.860	1.490	
CD at 5%	2.099	2.969	NS		1.748	2.472	4.281	
Straw (q ha⁻¹)								
M ₀	24.47	38.76	51.21	39.15	24.67	35.81	48.24	36.24
M ₁	30.20	53.84	53.93	45.99	27.12	49.75	50.80	42.56
M ₂	33.65	55.31	55.80	48.25	30.22	51.11	52.56	44.63
M ₃	35.96	57.15	58.74	50.61	32.27	52.81	55.33	46.61
M ₄	49.45	59.13	61.76	56.78	44.41	54.63	58.18	52.41
M ₅	50.36	60.35	62.98	57.90	45.23	55.76	59.33	53.44
Mean	37.85	54.09	57.41		33.99	49.98	54.08	
	F	M	FxM		F	M	FxM	
SEm±	0.957	1.353	2.344		0.881	1.246	2.158	
CD at 5%	2.750	3.889	6.735		2.532	3.580	6.202	

F₀: no FYM, F₁: 5 t ha⁻¹ FYM, F₂: 10 t ha⁻¹ FYM

M₀: no nutrient, M₁: 20 kg S ha⁻¹, M₂: M₁ + 1 kg ha⁻¹ sod molybdate; M₃: M₂ + 50 kg ha⁻¹ Ferrous sulphate; M₄: M₃ + 25 kg ha⁻¹ zinc sulphate; M₅: M₄ + 0.5 kg ha⁻¹ cobalt nitrate.

high amount of macro and micronutrients, which may supplement the nutrients in soil solution. Organic manure is effective in improving the physical and chemical properties of soil, which lead to enhanced microbial activity and consequent release of organic complexing substances (chelating agents) which would make the micronutrients more stable (Shuman and Hargreover, 1985).

Conclusion

The present study revealed that the soil need multinutrient supplementation as well as organic manure for sustainable crop production. The incorporation of FYM @ 10 t ha⁻¹, mineral nutrients viz., S, Fe, Zn, Mo and Co along with recommended dose of N, P and inoculation to cowpea crop provided beneficial residual effects to subsequent wheat crop.

Table 2. Residual effect of FYM and mineral nutrients on available nitrogen, phosphorus and sulphur content (kg ha^{-1}) in soil after harvest of wheat crop

Treatments	1999-2000				2000-2001			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
Nitrogen								
M ₀	130.00	135.00	141.00	135.33	136.50	156.15	167.79	153.48
M ₁	135.00	138.00	142.00	138.33	141.75	161.46	168.98	157.40
M ₂	138.00	145.00	150.00	144.33	144.90	169.65	178.50	164.35
M ₃	139.00	148.00	156.00	147.67	145.95	173.16	185.64	168.25
M ₄	140.00	153.00	170.00	154.33	147.00	173.16	185.64	168.25
M ₅	144.00	159.00	184.00	162.00	151.20	186.03	218.96	185.40
Mean	136.67	146.33	157.17		144.55	170.91	187.03	
	F	M	FxM		F	M	FxM	
SEm±	1.55	2.19	3.79		1.79	2.53	4.38	
CD at 5%	4.44	6.28	10.88		5.13	7.25	12.56	
Phosphorus								
M ₀	18.50	22.40	24.60	21.83	20.05	24.35	26.79	23.73
M ₁	18.90	22.80	25.00	22.23	20.49	24.78	27.23	24.17
M ₂	19.20	23.20	25.20	22.53	20.81	25.22	27.44	24.49
M ₃	19.70	23.60	25.60	22.97	21.35	25.65	27.88	24.96
M ₄	19.80	23.80	26.00	23.20	21.46	25.87	28.31	25.22
M ₅	20.10	24.20	27.50	23.93	21.79	26.31	29.95	26.01
Mean	19.37	23.33	25.65		20.99	25.36	27.93	
	F	M	FxM		F	M	FxM	
SEm±	0.33	0.47	0.81		0.36	0.51	0.88	
CD at 5%	0.94	1.34	NS		1.03	1.45	NS	
Sulphur								
M ₀	8.50	9.70	10.10	9.20	9.62	10.22	11.47	10.44
M ₁	9.70	10.20	11.00	10.30	10.98	11.58	12.50	11.68
M ₂	10.10	10.90	11.80	10.93	11.43	12.37	13.40	12.40
M ₃	10.70	11.80	12.20	11.57	12.11	13.39	13.86	13.12
M ₄	11.00	12.10	12.90	12.00	12.45	13.73	14.65	13.61
M ₅	11.40	12.70	13.20	12.43	12.90	14.41	15.00	14.10
Mean	10.23	11.12	11.87		11.58	12.62	13.48	
	F	M	FxM		F	M	FxM	
SEm±	0.16	0.22	0.38		0.16	0.25	0.44	
CD at 5%	0.45	0.64	NS		0.51	0.71	NS	

Table 3. Residual effect of FYM and mineral nutrients on available molybdenum, DTPA available iron, zinc and cobalt (mg kg^{-1}) in soil after harvest of wheat crop

Treatments	1999-2000				2000-2001			
	F ₀	F ₁	F ₂	Mean	F ₀	F ₁	F ₂	Mean
Molybdenum								
M ₀	0.128	0.131	0.144	0.134	0.106	0.110	0.125	0.114
M ₁	0.129	0.133	0.149	0.137	0.107	0.112	0.130	0.116
M ₂	0.148	0.171	0.171	0.164	0.122	0.145	0.154	0.140
M ₃	0.160	0.175	0.180	0.172	0.131	0.152	0.161	0.148
M ₄	0.165	0.181	0.200	0.182	0.136	0.150	0.170	0.152
M ₅	0.171	0.185	0.209	0.188	0.143	0.157	0.185	0.161
Mean	0.150	0.163	0.176		0.124	0.138	0.154	
	F	M	FxM		F	M	FxM	
SEm±	0.004	0.006	0.010		0.003	0.005	0.008	
CD at 5%	0.012	0.016	NS		0.010	0.014	NS	
Iron								
M ₀	5.550	5.585	5.980	5.705	5.800	5.870	5.895	5.855
M ₁	5.580	5.585	5.980	5.715	5.831	5.870	6.297	5.999
M ₂	5.600	5.615	6.620	5.945	5.852	5.901	6.971	6.241
M ₃	5.630	5.655	6.665	5.983	5.883	5.943	7.018	6.281
M ₄	5.950	6.100	6.115	6.055	6.218	6.411	6.439	6.356
M ₅	5.980	6.150	6.263	6.115	6.249	6.464	6.544	6.419
Mean	5.715	5.782	6.263		5.972	6.077	6.527	
	F	M	FxM		F	M	FxM	
SEm±	0.027	0.038	0.065		0.028	0.039	0.068	
CD at 5%	0.076	0.108	0.186		0.080	0.113	0.196	
Zinc								
M ₀	0.410	0.460	0.530	0.467	0.433	0.489	0.569	0.497
M ₁	0.420	0.490	0.620	0.510	0.444	0.520	0.665	0.543
M ₂	0.440	0.540	0.690	0.557	0.465	0.573	0.740	0.593
M ₃	0.490	0.630	0.770	0.630	0.518	0.689	0.826	0.671
M ₄	0.550	0.720	0.840	0.703	0.581	0.765	0.901	0.749
M ₅	0.620	0.790	0.910	0.773	0.655	0.839	0.976	0.823
Mean	0.488	0.605	0.727		0.516	0.643	0.780	
	F	M	FxM		F	M	FxM	
SEm±	0.015	0.021	0.036		0.016	0.022	0.038	
CD at 5%	0.042	0.060	NS		0.045	0.063	NS	
Cobalt								
M ₀	0.174	0.179	0.185	0.179	0.189	0.202	0.204	0.198
M ₁	0.176	0.181	0.188	0.182	0.193	0.205	0.208	0.202
M ₂	0.181	0.187	0.190	0.186	0.197	0.209	0.214	0.207
M ₃	0.182	0.189	0.194	0.188	0.199	0.213	0.218	0.210
M ₄	0.184	0.190	0.197	0.190	0.205	0.217	0.222	0.215
M ₅	0.229	0.236	0.257	0.241	0.234	0.266	0.279	0.260
Mean	0.188	0.194	0.202		0.203	0.219	0.224	
	F	M	FxM		F	M	FxM	
SEm±	0.0015	0.0022	0.0038		0.0015	0.0021	0.0036	
CD at 5%	0.0044	0.0062	NS		0.0042	0.0060	0.0103	

References

- Anonymous 2000. Annual Report. Use of bioinoculants in integrated nutrient management. Department of Agricultural Chemistry and Soil Science, Rajasthan College of Agriculture, Udaipur, pp. 33.
- Chapman, H.D. and Pratt, P.F. 1961. *Methods of Analysis of Soils, Plants and Waters*. Division of Agriculture Science, University of California, USA.
- Dixit, K.G. and Gupta, B.R. 2000. Effect of farmyard manure, chemical and biofertilizers on yield and quality of rice (*Oryza sativa* L.) and soil properties. *Journal of Indian Society of Soil Science* 38: 773-780.
- Gaur, A.C. and Mukerjee, D. 1979. Note on the effect of straw on the yield of groundnut and the following wheat. *Indian Journal of Agricultural Science* 49: 984-987.
- Gill, M.S., Mankotia, B.S. and Walia, S.S. 2000. Production technology for sustaining pulses productivity. *Fertilizer News* 45: 33-43.
- Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA-soil test for Zn, Fe, Mn and Cu. *Soil Science Society of America Journal* 42: 421-428.
- Mann, M.S., Takkar, P.N., Bansal, R.L. and Randhawa, N.S. 1978. Micronutrient status of soil and yield of maize and wheat as influenced by micronutrient and farmyard manure application. *Journal of Indian Society of Soil Science* 26: 208-214.
- Masood Ali and Mishra, J.P. 2000. Nutrient management in pulses and pulse based cropping systems. *Fertilizer News* 45: 59-69.
- Olsen, S.R., Cole, V.C., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium carbonate. United State Department of Agriculture, Circular No. 939.
- Pandher, M.S., Chahal, V.P.S. and Gupta, R.P. 1976. Effect of molybdenum on yield of moong (*Phaseolus aureus* L.) crop. *Indian Ecology* 3: 189-190.
- Shuman, L.M. and Hargrover, W.L. 1985. Effect of tillage on the distribution of manganese, copper, iron and zinc in soil fractions. *Soil Science Society of America Journal* 49: 1117-1121.
- Subba Rao, A., Damodar Reddy, D., Sammi Reddy, K. and Takkar, P.N. 1998. Crop yield and phosphorus recovery in soybean-wheat cropping system on Typic Haplustert under integrated use of manure and fertilizers phosphorus. *Journal of Indian Society of Soil Science* 46: 249-253.
- Subbian, B.V. and Asija, G.L. 1956. A rapid procedure for estimation of available nitrogen in soil. *Current Science* 25: 259-260.
- Tandon, H.L.S. 1992. Fertilizers and their integration with organic and biofertilizers. In *Fertilizers, organic Manure, Recyclable Wastes and Biofertilizers* (Ed. H.L.S. Tandon), pp. 12-36. Fertilizer Development and Consultation Organization, 204-204A, Bhanot Corner, New Delhi.
- Williams, C.H. and Steinbergs, A. 1959. Soil sulphur interactions as chemical indices of available sulphur in some Australian Soils. *Australian Journal of Agriculture Research* 10: 340-353.
- Yaduvanshi, N.P.S. 2000. Sustainability of rice-wheat system in gypsum treated alkali soils through organic and inorganic fertilizer. In *Proceedings International Conference on Managing Natural Recourse for Sustainable Agricultural Production in the 21st Century*, New Delhi. 3: 1261-1262.