Agriways 4 (2) : 185-193 (July - December, 2016)

ISSN: 2321-8614 (Print)
ISSN: 2454-2318 (Online)

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT PRACTICES ON CROP YIELD AND CHANGE IN PHYSICO-CHEMICAL PROPERTIES OF SOIL IN RICE- WHEAT CROPPING SYSTEM

R.V.S. Malik and Chaman Singh[1]

C.C.R. (PG) College, Muzaffarnagar

[1]R.S.M. (PG) College, Dhampur (Bijnor)

ABSTRACT

An experiment was conducted at Agriculture farm C.C.R. (P.G.) College, Muzaffarnagaf in *Kharif* and *Rabi* seasons during the year 2005-2007. The investigation was aimed to find out the effect of organic manures integrated with chemical fertilizers sources on rice find out the effect of organic manures integrated with chemical fertilizer sources on rice and their residual effect on succeeding wheat in rice-wheat cropping system. Two years of the study showed that highest rice and wheat, yield (8060 and 5770 Kg.ha-1 respectively) was obtained when 60% NPKZn with 10t. FYM ha-1 and blue green algae @5Kg ha-1 were applied . This increase in yield was more than the treatment, where 100% NPKZn with 10t FYM ha-1 and 5Kg. ha-1 blue green algae were applied. Significant residual effect of organic manure were found on the following wheat yield during Rabi season. Incorporation of organic sources considerably improved the soil properties such as decrease in pH, EC and bulk density (From 1.23-1.14 dSm-1, 7.8 - 7.5, 1.56 - 1.21 mg rn-3 respectively) and increase in organic carbon, N, P, K and Zn (From 0.34 - 0.58%, 153 - 258 Kg ha-1, 8.41, 8.41 - 3146 Kg. ha-1, 160 - 273 Kg. ha-1, and 0.30 - 0,66 mg. Kg-1 respectively status of the soil. High yield of rice- wheat system is possible by providing 40% recommended N through organic manures and 60% through chemical fertilizers to rice-wheat.

Keywords : **INM, productivity, physical and chemical properties of soil**

Of the 12.5 miillion hectares(ha) of estimated area managed under a rice-wheat cropping system (RWCS) in South Asia, India alone shares 10 million ha. As both the component crops are staple food grains, a sustained high productivity of RWCS is invitable for national food security. However for over a decade India[1] s RWCS has stagnated, or declined, in annual productivity growth. The most important reason is a decline in factor productivity owing to depletion of soil fertility and emergence of multiple nutrient deficiencies. In RWCS-dominated areas of the Yamuna-Upper- Gangetic plain revealed that farmers apply greater than recommended dose of N and recommended doses of P, but ignor the replenishment of other nutrients in this area of Meerut and Saharanpur regions of Western Uttar Pradesh (Dr. S.K.Sharma and K.N. Tiwari 2004).Such unbalanced fertilizer use note only aggravates the deficiency of potassium(K) and zinc(Zn) but also proves uneconomic and environmentally unsafe.

Both rice and wheat depend upon soi! and applied nutrients. Therefore to sustain as, well as to increase the productivity of this system, replenishment of nutrients drawn out from the crop harvest becomes imperative. Incorporation of organic matter, bio-fertilizer and crop residues along with N.P.K. and Zn. fertilizers are effective in alleviating the nutrient deficiency in soil .improving physical and chemical properties of soil. The objectives of the present study was to investigate the com bind effect of these organic sources with

inorganic fertilizers on physical and chemical properties of soil and yield under rice-wheat cropping system.

Materials And Methods

Field experiments were conducted for two Kharif - Rabi (Rice-wheat) seasons during 2005-2007 on a upper-Gangatic inceptisol soil at C.C.R.(PG) College, Muzaffarnagar (U.P.). The experimental soil was sandy clay loam, having, pH-7.8, organic carbon-0.45%, Alkaline KMNO, extractable, N- 215Kg. ha^{-1}, Olsen's, P-13.5 $Kg.ha^{-1}$ NH_4OAC extractable, K 223Kg. ha^{-1}, and DTPA extractable, Zn- 0.4 $mg.Kg^{-1}$. The experiment was laid out with three replication in a randomized block design 17 treatment [Control(No fertilizer/No manure) =T_1, 100% NPKZn = T_2,60% NPK Zn=T_3, T_2+FYM 10t.ha^{-1}=T_4,T_2+ Azotobactor 5$Kg.ha^{-1}$$T_2$+Vermicompost 5t.$ha^{-1}$=$T_6$ T2+blue green algae (BGA) 5$Kg.ha^{-1}$=T_7, T_3+FYM@10t.ha^{-1}=T_8, T_3 + Azotobactor = T_9, T_3+ vermicompost=T_{10}, T_3+ BGA=T_{11}, T_4+BGA@5$Kg.ha^{-1}$=T_{12}, T_5+BGA=T_{13}, T_6+BGA=T_{14}, T_8+BGA =T_{15},T_9 +BGA=T_{16} and T_{10}+BGA= T_{17}]. Half of the N and entire doses of P and K were applied through urea, single superphosphate and murate of potash .respectively The remaining N was applied equally at tiering and panide initiation stages in rice-wheat cropping system (The recommended doses on soil test base were applied 180-55-55-5Kg.N-P_2O_5-K_2O-Zn ha^{-1}). The organic sources were applied one month advance of transplanting, where as $ZnSo_4$ was applied in the last plough The seedling were inoclated with azotobactor culture by root dipping for over night and transplanted as per the treatments and blue green algae was also applied as per the treatments after transplanting ,high yielding variety of rice(cv.Kanti) and wheat (cv. Lok 1)seedling were transplanted and was sewed with a spacing of 15 x 10 cm. All the cultural practices were followed to raise a good crop. The grain and straw yield were recorded at maturity. The soil samples were collected after harvest of the second wheat crop and analysed For physical and chemical properties by following standard methods:

B.D. - Richards, L.A.(1960)method - Hand book No 60.

E.C. - Method No. 4, USDA - Hand book No. 60. - Richards (1954)

pH - Method No.21(b)USDA Hand book No. 60 - Richards (1954)

Organic Carbon-Walkley & Black Method (934)

Available N Alkaline $KMnO_4$ Method - Subbiah and Asija (1956)

Available $P2O_5$ Olsen's Method Olsen et. al. (1954)

Available K_2O Hanway and Heidal (1952)

Available Zn Lindsay and Norvell (1978)

Percent mortality was calculated by the formula :

$$\text{Mortality} = \frac{\text{Maximum number of tillers - minimum number of tillers at maturity}}{\text{Maximum number of tillers}} \times 100$$

Result And Discussion

PHSICAL AND CHEMICAL PROPERTIES OF SOIL:

<u>pH and E.G.</u>

Application of different treatments showed a decrease in soil pH and E.C. from 7.8 to 7.5 and 1.23 to 1.14 dSm^{-1} respectively but this decrease were not statistically after harvesting the second wheat crop (2006-2007) in rice- wheat cropping system the maximum decrease in pH and E.C. was noted under treatment consisting, FYM or vermicompost which might be due to production of organic acid from decomposition of FYM and vermicompost. The magnitude of decrease in E.G. and pH under FYM and vermicompost with 60% NPKZn (T_8 & T_9

treatments) were 7.32 and 6.5 percent over control. Dubey and Verma (1999) and Singh et. al (2008) **were** indicate that E.C.& pH of soil reduced under all treatments over its initial status but differences were not upto the level of significance. As regards the relationship between EC and yield of rice and wheat the latter generally decreased with increasing in yield of rice and wheat. Like EC., pH also decreased with increasing the yield of rice and wheat under all the treatments over control.

Bulk Density

Investigation showed that where , NPKZn were applied with FYM vermicompost and bio-fertilizer in rice - wheat cropping system, bulk density was significantly lowered as compared to the initial status and control plot at the time of wheat harvest. Soil bulk density decreased significantly with organic manures due to increase in organic carbon content in the soil and also possibly due to increase in root biomass produced, better soil aeration and improvement in mechanical composition of soil. Bhattacharyya et.al. (2004) and Bajpai et.at. (2006) also reported the similar results. Like pH and E.C., B.D. also decreased with increasing the yield of rice and wheat under all the treatments over control.

Organic Carbon :

Organic carbon content increased from 6.82 to 31.82% over the control by the application of fertilizer and manure respectively. The lowest of organic carbon content of soil was in control. The highest (0.58%) organic content was found in 40% N through FYM, 5 Kg. ha^{-1} blue green algae + 60% NPKZn through chemical fertilizer (T_{15}). These results in conformity with findings of Yduvanshi (2001). The organic content was found to be correlated with yield of rice and wheat. The data summarised in Tabnle-1 and-3 Indicate as the yield of rice and wheat increases, the organic carbon content also increased. The highest organic carbon content and @ highest yield of rice and wheat were recorded with treatment 60% NPKZn+FYM-10.ha^{-1}+blue green algae 5Kg ha^{-1} (T_{15}) over all the treatments and control.

Nitrogen:

The N content of soil increased significantly with integrating, FYM or vermicompost with chemical fertilizers. The highest available N status was recorded with T_{15} treatment followed by all of the treatment. Adding FYM, vermicompost and bio fertilizer favoured the soil conditions, and might have helped in the mineralization of soil N leading to build up of increased available N. Bajpai et.Al. (2006) were reported the similar results. The findings of the investigation indicate that like increasing in yield of rice and wheat available N concentration also increased under all the treatments over control.

Phosphorus :

The data on available P (Table) revealed an augmented value for available P under the combination of inorganic with organic manures, while an almost depleting action on available P in soil has been demonstrated in control. Incorporation of organic manure and 100% fertilizer dose (T_{14}) recorded significantly higher available P than all the treatment. The relatively higher value for the available P under combined treatment may be accounted for the fact that most of the P in FYM and vermicompost exists in an organic and available form and that the organic P present is fairly quickly mineralized in soil (Bajpai et.al., 2006). Like N, P also increased with increasing the yield of rice and wheat under all the treatments over control.

Potassium :

The increase in available K within T_1 and T_{17} treatments after the harvest of second last wheat crop in 2006-2007 was 108.0 Kg ha^{-1}. Application of all types of manures and fertilizers resulted in an appreciable increases in the content of available K, when compared with the control plots and the

Table-1 : Effect of different treatments on physico-chemical properties after harvest the wheat crop in rice-wheat cropping system (Two years pooled data).

Treatment	B.D. ($mg.m^{-1}$)	E.C. (dSm^{-1})	pH	OC (%)	N ($Kgha^{-1}$)	P ($Kgha^{-1}$)	K ($Kgha^{-1}$)	Zn ($Kgha^{-1}$)
1	1.23	1.56	7.80	0.34	153	8.41	160	0.30
2	1.23	1.40	7.80	0.47	245	18.67	259	0.46
3	1.22	1.38	7.75	0.48	215	14.64	231	0.35
4	1.16	1.26	7.60	0.56	250	24.56	270	0.56
5	1.17	1.31	7.80	0.48	246	23.21	267	0.54
6	1.16	1.21	7.60	0.52	248	25.42	269	0.51
7	1.18	1.29	7.75	0.48	240	19.65	264	0.50
8	1.14	1.25	7.60	0.54	249	2063	266	0.58
9	1.20	1.24	7.75	0.49	235	22.61	248	0.47
10	1.15	1.27	7.60	0.56	248	22.64	266	0.55
11	1.23	1.36	7.75	0.51	238	21.82	246	0.49
12	1.14	1.23	7.55	0.53	257	30.24	273	0.64
13	1.17	1.30	7.80	0.52	240	24.21	249	0.53
14	1.18	1.22	7.50	0.54	255	31.46	270	0.66
15	1.17	1.25	7.70	0.58	258	26.81	268	0.62
16	1.22	1.30	7.75	0.52	250	24.84	246	0.54
17	1.15	1.21	7.60	0.56	257	29.62	268	0.63
S.Em+1	N.S.	0.16	N.S.	0.084	24.32	3.34	26.08	0.066
C.D, at 5%	_____	0.39	-	0.21	59.78	8.17	63.83	0.16

maximum value of available K content was recorded with T_{12} (100% NPKZn + 10t. ha^{-1}FYM+5Kg ha^{-1} blue green algae) treatment. The beneficial effect of FYM on the available K might be due to the reduction of K Fixation and release of K due to the interaction of organic matter with clay. Similar results were reported by Jagadeeshwari and Kumaraswamy (2000). An examination of investigation data reveals that like increasing the yield under all the treatments the available K Content also Increased.

Zinc:

The amount of available zinc in soil increased when either vermicompost and FYM or fertilizer NPKZn was applied but this increase was enhanced when two were applied together. The higher value (0.66mg. Kg^{-1},T_{14} treatment) of available zinc with 100%NPKZn+ vermicompost $St.ha^{-1}$ + 5$Kg.ha^{-1}$ blue green algae may be attributed to release of organically bound micronutrients present in vermicompost as well as, formation of organic chelates which have lower susceptibility to adsorption, fixation and /or precipitation in soil(lee 1985). As well as the application of organic manures along with chemical fertilizer had an additive effect on increasing the yield of rice and wheat, The DTPA zinc also increased similarly.

Growth and yield study

The mortality and germination percent of rice and wheat respectively did not show significant variation either with organic sources or inorganic sources of nutrients (Table 2),However a slight increase'in germination count was recorded with majority of treatments(T_4,T_8,T_{12},T_{17} and T_{15} respectively). Incorporation of FYM, vermicompost and bio-fertilizer in combination with chemical fertilizer NPKZn increased the germination percentage which may be attributed to improve in physico - chemical conditions of soil due to addition of organic sources. Das and Ram(2005) were reported that due to increase in soil temperature by increasing heat absorbance from the sun in the presence of FYM and there by enhanced germination and growth (Rameshwar and singh,1998). Those treatment which contained organic manures with chemical fertilizers improve the germination and growth of crops. The minimum and maximum mortality percent were 89.5-92 Sana 79.5-82.7% respectively in rice-wheat crops all the fertilizer treatments showed significant increase at different growth parameters viz. height and number of tillers at all the growth stages over control.

Among the different treatments, 100% NPKZn + FYM10t ha^{-1} (T_4) was found superior or at the superior treatments in all the growth parameters of both crops viz. height and number of tillers. A marked response to FYM and bio fertilizers was noted on plant height and number of tillers. Super-optimal doses of NPKZn showed significant increase in height at all the growth stages which may be attributed to more availability of nutrients which increased the protoplasmic constituents and accelerated the process of cell division (Das and Ram 2005). When 60% NPKZn were applied with organic manures and bio fertilizers it produce number of tillers at par or more with treatments where 100% NPKZn with organic manures + bio-fertilizer were supplied and these treatments were better than where 100% NPKZn was supplied through chemical fertilizers alone. The plots, which were treated with blue green algae and azotobactor, individually or in combination with vermicompost, FYM and NPKZn produced significantly higher yield attributes in comparison to uninoculated treatments (control). The increase in yield attributes in increase in N availability on its fixation from atmosphere by blue green algae and azotobactor. The microbial inoculants produced higher N content vis-a-vis other treatments.

The plants attained only height within first 60 days (Table-2). There after there was a study

increase in the plant height continued till harvest. Treatment T_{12} (100% NPKZn+FYM+blue green algae) produced the tallest plants indicating superiority over all of the treatments at all the stages of growth during both crop seasons (2005-06 and 2006-07).

Dry Matter Yield

All the fertilizer treatments produced significantly higher grain and straw yield of rice and wheat in both crop seasons over control (Table-3). Application of FYM or adding vermi compost help in offer the twin benefits of soil quality and fertility enhancement and meeting a part of nutrients need of crops ,not only sustain the high yields required these days but also cut the cost on expensive fertilizer. Incorporation of FYM, vermis compost and bio fertilizers in combination with fertilizer NPKZn significantly increased the grain and straw yield of rice and wheat (Yadav and Kumar,2002,Bajpai, et. al.2006 and Gupta and Sharma 2006).Among the different sources of NPK substitution, highest yield of rice and wheat was obtained with the treatments in which 40% of NPKZn was substituted through FYM or vrmicompst with or without bio-fertilizers in kharif and rabi seasons. Treatment T_{15}, T_{16} and T_{17} produced significantly more yield than T_2 treatment (100% NPKZn). The magnitude of increase in yield T_{15}, T_{16}, and T_{17} treatments were 14.5, 7.2, 16.5% of rice grain and 11.0, 8.2, 14.5% of wheat grain In 2005-06 and 23.4, 18.5, 22.4% of rice grain and 16.9, 2.9,16.8% of wheat grain in 2006-07. Respectively as compared to T_2 (100% NPKZn) treatment. Yaduvansi (2001), Singh, et.al(2002) and Gupta and Sharma (2006) were reported that organic manures are important for sustaining rice - wheat yield. Nag et. al.(2007) were reported that pearl millet -wheat cropping system.

In term of wheat equivalent yield was generally found to be marginally higher where organic manures were applied in conjunction with chemical fertilizers. The organic manures not only supply nutrients but also increase the efficiency of chemical fertilizer and also maintain and improve the physical and biological properties of the soils. Hence greater attention should be paid to the development of integrated nutrient supply system involving an appropriate blend of organic manures, biological nitrogen fixation and chemical fertilizers

Table-2:Effect of different treatments on plant growth of rice-wheat(pooled data of two years).

Treatment	Rice M.%	Wheat G.%	Plant height (Cm.) at				Number of tillers			
			60 days		100 days		60 days		100 days	
			Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat
T_1	89.5	79.5	61.0	40.5	92.3	69.9	9	8	7	8
T_2	90.0	80.0	66.0	48.2	101.3	82.1	18	14	17	12
T_3	88.5	80.2	66.	46.0	97.0	81.0	17	13	17	13
T_4	90.5	79.6	69.3	48.9	100.0	83.4	24	17	23	16
T_5	90.5	80.5	67.5	42.3	94.4	76.5	19	12	17	11
T_6	89.5	79.7	68.0	44.4	100.5	80.0	24	13	23	13
T_7	89.5	81.2	66.0	43.3	98.0	77.5	20	13	19	12
T_8	90.7	81.4	65.5	42.5	97.5	78.0	25	18	24	17
T_9	90.0	80.0	65.5	45.0	98.5	79.5	20	15	20	15
T_{10}	89.5	79.9	65.0	47.3	96.5	80.6	24	17	23	17
T_{11}	89.5	79.5	66.5	45.9	98.5	81.9	20	16	19	16
T_{12}	91.0	82.7	70.5	50.0	101.5	83.5	26	19	25	19
T_{13}	88.5	81.0	66.5	48.5	95.5	82.8	20	16	19	15
T_{14}	89.5	81.5	67.5	48.4	101.3	81.5	24	18	22	17
T_{15}	92.5	82.0	66.5	46.3	100.5	79.9	27	21	27	21
T_{16}	89.5	82.4	66.5	44.5	100.5	79.0	21	17	20	16
T_{17}	91.5	80.7	66.3	45.0	100.0	78.6	26	20	26	20
$S.Em_{+-}$	-	N.S.	2.2	2.1	2.1	2.5	1.8	0.7	2.0	0.7
C.D. at 5%	N.S.	-	5.4	5.1	5.2	6.1	5.3	1.6	4.9	1.6

M% = Mortality percent, G% = Germination %

Table-3: Effect of different treatment on yield (Kg.ha^{-1}) of rice and wheat.

Treatment	2005-2006				2006-2007			
	Rice		Wheat		Rice		Wheat	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	3223	5852	4111	8382	3162	6057	4060	7824
T_2	6535	12813	4965	9954	6955	13422	4771	9232
T_3	5447	12637	4844	9730	6572	12850	4512	9146
T_4	7386	14178	5500	11246	7785	15046	5576	11172
T_5	6500	12916	4875	9642	7244	13935	5160	10112
T_6	7178	14006	5200	10604	7624	11346	5523	10946
T_7	6642	13032	5123	10240	7546	14923	5156	10442
T_8	7347	14126	5444	10994	7836	15434	5687	11473
T_9	7006	14076	5044	9972	6812	12740	4967	9644
T_{10}	7240	14374	5075	10156	7800	15520	5521	10847
T_{11}	6800	13422	5066	10300	7422	14943	5397	10934
T_{12}	7295	14351	5461	10946	8246	16620	5655	11430
T_{13}	6769	13488	5002	9970	8077	15915	5381	10606
T_{14}	7187	14016	4267	8527	8300	16476	5532	11147
T_{15}	7612	15046	5685	11200	8512	16842	5656	11374
T_{16}	7008	13977	5375	10834	8240	16335	4911	10070
T_{17}	7612	15000	5512	11125	8578	17000	5578	11440
S.Em+-	165.3	176.2	139.6	216.8	198.9	189.1	142.6	165.3
C.D. at 5%	405.9	430.6	343.5	527.7	513.8	462.3	348.5	385.9

References

Bajpai RK, Upadhyay S K and Urkurkar J S (2006). long term studies on soil Physico-chemical properties and productivity of rice-wheat system as influenced by integrated nutrient managememt in inceptisol of Chhattisgarh. *J. Indian Soc, Soil Sci.* :54 ,*24-29*

Bhattacharyya R, Prakash V, Kundu S, Srivastava AK and Gupta HS (2004). Effect of long-term manuring on soil organic carbon, bulk density and Water retention characteristics under soyabeen-wheat cropping sequence in North-Western Himalayas. *J. Indian Soc. Soil Sci.* :52: 238- 242.

Das OK and Ram N (2005). Effect of long-term fertilization and manuring on wheat productivity and soil fertility in a rice-wheat -cowpea cropping System. *Ann. PI. Soil Res.* 7:17-23.

Dubey RP and Verma BS (1999). Integrated nutrient management in rice-(Ory 3a Sativa)-rice-cowpea sequence under humid, tropical Andman. *Indian J. Agron.:* 44.73-76.

Gupta V and Sharma RS (2006). Effect of integrated nutrient management on productivity and nutrient balance of rice- wheat cropping system . *Ann. Pl. Soil Res.* 8:148-51.

Jagadeeshwari PV and Kumaraswamy K (2000). Long-term effect of manure, fertilizer, schedule on the yield and nutrient uptake by rice crop in permanent manorial experiment. *J. Indian Soc. Soil Sci:* 48 ; 833-36.

Lee KE (1985). Earthworm, their ecology and relationship with land use, *Academic press,* Sydney, P.P. 411.

Nag AK, Pathan ARK and Shekhwat VS (2007). Integrated nutrient management in pearlmillet wheat in sequence. *Ann. Pl. Soil Res.* 9:5054.

Rameshwar and Singh, C.M. (1998). Effect of FYM and fertilizer on the growth and development of maize and wheat in sequence. *Indian J, Agril. Res.* 32:65-70.

Sharma SK and Tiwari KN (2004). Fertilizer use in rice-wheat system in Indo-Gangatic Plains. FAI SEMINAR (2004).

Singh A, Verma, LP and Singh R (2008). Effect of integeated nutrient management in mustered on soil properties and fertility status, *Ann. PI. soil Res.* 10:86-88.

Singh G, Kumar T, Kumar V, Singh RG and Sharma RH (2002). Effect of integrated nutrient management on transplanted rice and its residual effect on succeeding wheat crop in rainfed lowland. *Indian J. of Agron.* 47: 311-317.

Yadav DS and Kumar Alok (2002). Long- term effect of organic manures on productivity and soil fertility in rice-wheat cropping system. ln:Extended Summary Vol.1,2nd International congress, November 26-30,2002 New Delhi, P.P.65-67.

Yaduvansi NPS (2001). Effect of five yearsn of rice-wheat cropping system and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. *J. Indian Soc. Soil Sci.* :49: 714-19.