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Effect of Organic, Inorganic and Bio fertilizers on Soil Physicochemical Properties in Rainfed Maize-wheat Cropping System of Jammu

Bhoye Ranjanabai Chhagan, M.P. Sharma, K.R. Sharma, Abhijit Samanta, Owais Ali Wani*, Dileep Kachroo, Manish Kumar, V.K. Razdan, Vikas Sharma, A.K. Mondal and V.M. Arya

Division of Soil Science and Agricultural Chemistry, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu- 180009 (J&K), India

**Corresponding author*

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An experiment was conducted during 2015-2016 in sandy loams at Jammu under the INM in maize-wheat system. The results revealed that the application of recommended levels of NPK to maize-wheat with FYM, VC and biofertilizers (Azotobacter and phosphate solubilizing bacteria) resulted in grain 66.53 per cent and straw 13.00 per cent increase over control in maize and wheat yields, respectively. Increasing levels of 50% N+recom.P+K+S+Zn+B +VC+Azoto+PSB significantly increased the yield of both the crops. Integrated use of organic, inorganic and biofertilizers improved the soil status of available N, P, K, S over the initial values. A declining trend (70.05, 9.14, 110.13, 8.14 kg ha^{-1}) from the initial value of available nutrients indicates a considerable mining of INM from the soil and suggest the need to adopt judicious organic, inorganic and biofertilizers.

Introduction

Maize-wheat system in the sub-mountainous western Himalayan region of India comprises the state of Jammu and Kashmir. The contribution of this cropping system to total food grain production of the country is considerably large, amounting to 36.49% of wheat (93.90 million tonnes) and 8.38% of maize (21.57 million tonnes) which makes it one of the predominant cropping systems in India (Ramesh *et al.,* 2014). However, in spite of the significant achievement made in research and development productivity of Maize-wheat system is still very low. Maize-wheat is dominant cropping sequence covering 2, 21,773 and 2, 88,842 ha area, respectively under rainfed condition of Jammu region. The average productivity of this system is being 3.44 tonnes/ha which is quite low as compared to national average of 5.6 tonnes/ha. It may be due to little use of organics, poor soil fertility because of coarse texture, and low organic matter content, heavy requirement of nutrients by these crops. Out of these, imbalanced application of nutrients is a major factor affecting crop productivity and soil characteristics in the

region. In the present day of intensive agriculture, the crop plant is unable to use all the applied nutrients in its short lifespan. Therefore, fertilizer scheduling should be done on the bases of cropping sequence rather than individual crop to utilize residual plant nutrients for their efficient, economical and judicious use

The occurrence of deficiency of secondary nutrient viz., S and micronutrients viz., Zn and B is being observed increasingly under heavy feeder maize-wheat cropping sequence. Balanced fertilization to any crop or cropping sequence played vital role to attain optimum crop yield, enhance crop quality, corrects inherent soil nutrient deficiencies, sustain soil fertility, improve nutrient and water use efficiency, avoid damage to the environment and restore fertility of land that has been degraded by wrong and exploitative practices in the past. Adoption of such practices may influence carbon sequestration in soil because of their progressive effect on crop growth. Balanced nutrient management on the bases of soil testing can be achieved in better way by adopting integrated application of organic and inorganic for enhancing soil quality, input use efficiency and crop productivity which is the all most important for food and nutrient security. Maize-wheat is one of the most important double cropping systems being practiced under rainfed condition of Jammu region. Both, being exhaustive crops, required a huge amount of nutrients for producing higher yield. The best option in respect to balanced application of nutrients through organic and inorganic may come out for making the judicious fertilizer recommendations for realizing higher inherent yield potentials of both the crops as well as the outcome of this investigation will facilitate the stakeholders to maximize crop yield, nutrient use efficiency, water use efficiency, and soil quality under rainfed conditions of Jammu region.

Materials and Methods

The present investigation is a part of an ongoing experiment with maize-wheat cropping system in progress since kharif and rabi 2015 and 2016 at Advance center for rainfed Agriculture Rakh Dhainsar, SKUAST-Jammu and Department of Soil Science and Agricultural Chemistry, Chatha, Jammu Jammu and Kashmir (32^0 39' N and $74^0$58 E). Dhainsar, Jammu has a sub-tropical climate with a characteristic feature dry and cold winter. In winter season i.e Oct to March the temperature 2 to 20 0c and the relative humidity 41 to 65%.Gernerally, dry and warm weather prevails during the months of March to June. The temperature in the month of May reaches as high as 48 0C. Monsoon season extends from first of July to mid-September. Total annual rainfall varies from 1049.2 mm to 1304 mm with the mean value of around mm. The length of growing period of both the crops ranges from 200 to 210 days. The soil of the experimental field is sandy loam in texture having pH (6.67), Bulk density (1.64 Mg m^{-3}), Water holding capacity(11.01 %), organic carbon (2.05g kg^{-1}) and available nitrogen (70.05kg ha^{-1}), Phosphorus (9.14 kg ha^{-1}), Potassium (110.13 kg ha^{-1}) were, Sulphur (8.14 kg ha^{-1}) and Zinc (0.36 mg kg^{-1}), Boron (0.34 mg kg^{-1}), respectively. There were eleven treatments viz., T_1 Control, T_2 Recommended NPK T_3 Reco. NPK+ S + Zn + B, T_4 50% N + Reco. P + K + S + Zn + B + 50% N through FYM, T_5 50%N + Reco. P + K + S + Zn + B + 50% N through VC, T_6 75% N + Reco. P+ K +S +Zn + B+25% N through FYM, T_7 75% N + Reco. P +K +S +Zn +B+25% N through VC, T_8 50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB, T9 50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB,T_{10}75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB, T_{11} 75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB. Each treatment was replicated

thrice in a randomized block design. The recommended P, K, S, Zn and B doses, based on initial soil test, maize and wheat. The sources of N through FYM and VC were incorporated treatment. (Sowing time) in the soil sowing time of maize and wheat during kharif and rabi season since 2015-16. Treatments T_8, T_9, T_{10} and T_{11} involved inoculation by Azotobacter and PSB culture (@ 5g kg^{-1} seed). Maize- wheat varieties used were Vivak Maize-25 and PBW-175 respectively, maize in general was sown on the set of monsoon (third week of July) as rainfed crop during kharif and wheat in the to fourth week of October as irrigation crop during rabi. The maturity and yield data were recorded after harvested at maturity and yield data were recorded after threshing. Soil samples from 0-15 cm depth were collected after harvest of maize in the 2th cropping year (2015-16 and 2017) and were analyzed for available N by alkaline permanganate method (Subbiah and Asija, 1956), available P (Olsen *et al.*, 1954) and available K (ammonium acetate extract). All observations were recorded for both the crops and soil properties were analyzed statistically

Results and Discussion

The highest magnitude of BD after harvesting of maize and wheat was recorded in T_1 (1.54) to lowest in T_6 (1.41) and T_1 (1.52) to lowest in T_6 (1.40). The highest BD may be due to high sand content and poor organic matter and clay content whereas lowest BD in T_6 (1.41) could be due to addition of organic carbon and significant improvements of addition of organic, inorganic and biofertilizers which collectively influenced the BD in soils (Table 1–4).

Table.1 Integrated effect of inorganic, organic and biofertilizers on bulk density (mg m^{-3}) of soil after harvesting maize wheat cropping system

Sr.No	Treatments	I st year	II nd year	Overall	I st year	II nd year	Overall
		(mg m^{-3})			(mg m-3)		
T1	**Control**	1.54	1.52	1.53	1.51	1.53	1.52
T2	**Recommended NPK**	1.50	1.52	1.51	1.50	1.51	1.51
T3	**Reco. NPK+ S + Zn + B**	1.49	1.50	1.50	1.47	1.46	1.47
T4	**50% N + Reco. P + K + S + Zn + B + 50% N through FYM**	1.46	1.45	1.46	1.42	1.45	1.44
T5	**50% N + Reco. P + K + S + Zn + B + 50% N through VC**	1.48	1.47	1.48	1.40	1.41	1.41
T6	**75% N + Reco. P+ K +S +Zn + B+25% N through FYM**	1.41	1.38	1.40	1.46	1.47	1.47
T7	**75% N + Reco. P +K +S +Zn +B+25% N through VC**	1.45	1.44	1.45	1.47	1.46	1.46
T8	**50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB**	1.44	1.40	1.42	1.45	1.43	1.44
T9	**50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB**	1.46	1.42	1.44	1.41	1.42	1.41
T10	**75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB**	1.43	1.40	1.42	1.42	1.41	1.41
T11	**75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB**	1.46	1.40	1.43	0.022	0.011	0.008
	± S.E.(m)	0.003	0.014	0.012	0.064	0.033	0.025
	C.D. (P=0.05)	0.010	0.042	0.037	1.51	1.53	1.52

Table.2 Integrated effect of inorganic, organic and biofertilizers on water holding capacity (%) soil after harvesting maize wheat cropping system

9.5	Treatments	Ist year	IInd year	Overall	Ist year	IInd year	Overall
		(%)			(%)		
T1	Control	11.25	11.29	11.27	11.11	11.19	11.15
T2	Recommended NPK	11.34	11.43	11.39	11.15	11.33	11.24
T3	Reco. NPK+ S + Zn + B	11.37	11.94	11.66	11.19	11.63	11.41
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	12.51	13.32	12.92	12.20	12.65	12.43
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	11.34	12.41	11.88	11.23	11.26	11.25
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	11.56	11.39	11.48	11.19	11.30	11.24
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	11.27	11.24	11.26	11.08	11.15	11.19
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	14.31	14.29	14.30	13.62	13.88	13.75
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	13.08	13.44	13.26	12.98	13.30	13.14
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	11.62	11.68	11.65	11.32	11.55	11.44
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	11.54	11.64	11.59	11.22	11.42	11.32
	± S.E.(m)	0.07	0.14	0.19	0.09	0.16	0.07
	C.D. (P=0.05)	0.010	0.042	0.037	0.27	0.49	0.22

Table.3 Integrated effect of inorganic, organic and biofertilizers on soil reaction (1:2.5) soil after harvesting maize wheat cropping system

Sr.No	Treatments	Ist year	IInd year	Overall	Ist year	IInd year	Overall
		(1:2.5)			(1:2.5)		
T1	Control	6.54	6.61	6.58	6.55	6.51	6.53
T2	Recommended NPK	6.59	6.58	6.59	6.53	6.49	6.51
T3	Reco. NPK+ S + Zn + B	6.56	6.50	6.53	6.58	6.48	6.53
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	6.54	6.56	6.55	6.52	6.47	6.50
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	6.42	6.33	6.38	6.48	6.47	6.48
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	6.46	6.33	6.40	6.47	6.45	6.46
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	6.48	6.38	6.43	6.45	6.41	6.43
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	6.50	6.44	6.47	6.42	6.48	6.45
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	6.49	6.50	6.50	6.41	6.46	6.44
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	6.42	6.39	6.41	6.39	6.44	6.42
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	6.22	6.42	6.32	6.43	6.39	6.41
	± S.E.(m)	0.02	0.03	0.05	0.02	0.01	0.02
	C.D. (P=0.05)	0.06	0.09	0.15	0.07	0.04	0.08

Table.4 Integrated effect of inorganic, organic and biofertilizers on organic carbon (g kg^{-1}) soil after harvesting maize wheat cropping system

Sr.No	Treatments	Ist year	IInd year	Overall	Ist year	IInd year	Overall
		(g kg-1)			(g kg-1)		
T1	**Control**	2.22	2.28	2.25	2.23	2.26	2.26
T2	**Recommended NPK**	2.27	2.34	2.31	2.28	2.33	2.31
T3	**Reco. NPK+ S + Zn + B**	2.35	2.41	2.38	2.37	2.45	2.41
T4	**50% N + Reco. P + K + S + Zn + B + 50% N through FYM**	3.02	3.44	3.23	3.09	3.48	3.29
T5	**50% N + Reco. P + K + S + Zn + B + 50% N through VC**	2.82	3.23	3.03	3.04	3.06	3.05
T6	**75% N + Reco. P+ K +S +Zn + B+25% N through FYM**	2.49	2.68	2.58	2.79	2.94	2.87
T7	**75% N + Reco. P +K +S +Zn +B+25% N through VC**	2.51	2.55	2.53	2.64	2.79	2.72
T8	**50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB**	4.11	4.12	4.12	4.14	4.19	4.17
T9	**50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB**	4.09	4.02	4.06	4.00	4.05	4.03
T10	**75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB**	2.69	2.85	2.77	2.79	3.00	2.89
T11	**75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB**	2.66	2.86	2.75	2.67	2.69	2.68
	± S.E.(m)	0.03	0.13	0.16	0.07	0.06	0.03
	C.D. (P=0.05)	0.11	0.40	0.53	0.20	0.20	0.11

These observation corroborate the results obtained by Rehman *et al.,* 2017 and Thangasamy *et al.,* 2017.

The highest WHC after harvesting of maize and wheat was found in T_8 (14.31) to lowest in T_1 (11.25) and T_8 (13.62) to lowest in T_1 (11.11)can be due to addition of organic, inorganics and biofertilizers which catalyzed to enhanced organic carbon, and thereby increasing water holding capacity these findings are corroborate the observation of Sharma *et al.,* (2017).

The highest pH of soil after harvesting of maize and wheat crop was noticed in T_2 (6.59) to lowest T_{11} (6.22) and T_3(6.58) to lowest in T_{10} (6.39) the significant improvements in soil pH under treatments, might be due to integrated application of organic, inorganic and biofertilizers which brought significant enhancement in soil pH under aforesaid treatments. were These observation are in agreement with the results of Mishra *et al.,* (2008), Chesti *et al.,* (2013) and Rehman *et al.,* (2017).

The highest value of organic carbon after harvesting of maize and wheat crop was recorded in overall organic carbon found highest in T_8 (4.12) to lowest in T_1 (2.25) and highest in T_8 (4.17) to lowest in T_1 (2.26). The highest value of organic carbon in T_8 (4.12) may be due to integrated uses of organic, inorganic and biofertilizers which released its higher uptake whereas lowest

value of organic carbon may be due its scanty retention. The decreasing pattern of overall organic carbon under different treatments might be due to its slow release pattern responsible for decreasing trend. These observations are supported by Kumari *et al.*, (2011) and Lakaria *et al.*, (2012).

It is concluded that over two year of maize-wheat cropping system respect the treatments receiving integrated use of organic, inorganic and biofertilizers improved the soil status of soil properties viz, pH, Organic carbon, water holding capacity, bulk density improved significantly under treatments received integrated nutrient application.

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