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Effect of long-term of nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command area

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Abstract

The long term experiment was conducted since 1987-88 on permanent site at Agricultural Research Station, Siruguppa, Karnataka to assess the effect of long-term nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command area. The experimental treatments consisting 3 levels of nitrogen (40, 80 and 120 kg N/ha), 3 levels of phosphorus (0, 40 and 80 kg P₂O₅/ha) and 2 levels of potassium (0 and 40 kg K₂O/ha) and with one absolute control, it was laid out in partially confounded design with 4 replications. The experiment was conducted in *vertisols*, which is slightly alkaline (8.12), low in soluble salts (0.36 dS/m), soil organic carbon (0.38), and available nitrogen (165 kg/ha) and medium in phosphorus (16.6 kg/ha) and rich in potassium (341 kg/ha). The maize was sown during *khari* followed by wheat during *rabi* after harvest of the main crop in zero cultivation practice. The treatments were imposed as per the treatment combination. Maize hybrid NK 6240 and wheat variety DWR 162 were used in the trial. Experimental results revealed that maximum maize grain yield (4240 kg/ha), MEY (7291 kg/ha) and system productivity (19.97 kg/ha/day) were observed with application of 120 kg N/ha compared to 40 kg N/ha. Similarly, 80 kg P₂O₅/ha produced higher grain yield (4742 kg/ha), MEY (8420 kg/ha) and system productivity (23.07 kg/ha/day) and potassium application @ 40 kg/ha recorded higher grain yield (4244 kg/ha), MEY (6998/ha), system productivity (19.17 kg/ha/day) compared to lower levels of nutrients. In case of wheat, application of N @ 120 kg/ha, 80 kg P₂O₅/ha and 40 kg K₂O/ha produced maximum yields (1861, 2243 and 1679 kg/ha, respectively) compared to their corresponding lower doses. Similar trend was also observed in 28 years mean data. Higher availability of N, P, K and S were observed in soil fertilized with higher level of N, P and K compared to lower doses.

Keywords: Cropping system, long-term nutrient management, maize, wheat, maize equivalent yield, system productivity and nutrient availability.

Introduction

Tungabhadra command area is one of the most potential irrigated areas in Karnataka where in rice - rice is the predominant cropping system, continuous cultivation of this system has led to various deleterious effects on soil health in addition emerging challenges of natural resource-base degradation, declining crop productivity, and ecological problems with the existing rice-rice system, the maize based cropping systems are emerging as an alternative option for diversification of rice-rice production systems in command area in general and in India too. As maize has wide adaptability and compatibility under diverse soil and climatic conditions and therefore it is cultivated in sequence with different crops under various agro-ecological regions of the country. Besides with the improvement of high yielding varieties and hybrids in maize which are competitive to rice with respect to farm–profitability and resource–use–efficiency under diverse climatic conditions. The maize–wheat cropping system is gaining importance as a predominant maize based system occupied an area of 1.8 m ha ranks third next to rice-wheat and rice-rice that contributes about 3 in the national food basket in India (Jat *et al.* 2013)^[5].

Cropping system involving cereal and cereal had led to mining nutrient from soil which resulted in deterioration of soil health (Porpavai *et al.*, 2011)^[11]. Both maize and wheat are fertilizer responsive and exhibit full yield potential when supplied with adequate quantities of nutrients at proper time.

Among the various production factors, fertilizer management is a key factor for increasing the yield of crop. The nitrogen requirement of crop is more than any other nutrients and its deficiency at any stage of growth, especially tasseling and silking stage of maize may leads to virtual crop failure. However, continuous application of only nitrogen drastically reduces the grain yield of maize and wheat over years due to gradual increase in exchangeable acidity, deficiency of basic cations and imbalance among the nutrients (Sahay and Singh, 2004)^[12].

The average yield of rice in command area reveals low productivity. Therefore, to meet the demand of food grain for burgeoning population, there is need of sustainable production through the resource management and to maintain the soil fertility by judicious application of fertilizer. Keeping all these points in mind the present trial was carried out to assess the effect of long-term nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command area.

Materials and methods

The long term experiment was conducted since 1987-88 on permanent site at Agricultural Research Station, Siruguppa, Karnataka to assess the effect of long-term nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command area. The experimental treatments consisting 3 levels of nitrogen (40, 80 and 120 kg N/ha), 3 levels of phosphorus (0, 40 and 80 kg P₂O₅/ha) and 2 levels of potassium (0 and 40 kg K₂O/ha) and with one absolute control, it was laid out in partially confounded design with 4 replications. The experiment was carried out in *vertisols*, which is slightly alkaline (8.12), low in soluble salts (0.36 dS/m), soil organic carbon (0.38), and available nitrogen (165 kg/ha) and medium in phosphorus (16.6 kg/ha) and rich in potassium (341 kg/ha). The maize was sown during *kharif* followed by wheat during *rabi* after harvest of the main crop in zero cultivation practice. The treatments were imposed as per the treatment combination. Maize hybrid NK 6240 and wheat variety DWR 162 were used in the trial. Nitrogen, phosphorus and potassium were applied through urea, diammonium phosphate, single super phosphate and muriate of potash respectively. In maize, one-third dose of nitrogen and full doses of phosphorus and potassium were applied at the time of sowing, while remaining nitrogen was equally side dressed at knee high (days after sowing) and tasseling stages. At physiological maturity, cobs were harvested manually. After drying in the Sun, the grains were separated out and weighed to record economic yield. After harvesting of the *kharif* crop, wheat was sown in the same plots in the *rabi* season with same fertilizer dose. Half dose of nitrogen and full doses of phosphorus and potassium were applied at the time of sowing, while remaining nitrogen in 2 equal split was top-dressed at the first and second irrigation. Wheat was harvested at physiological maturity stage and after Sun drying and threshing, weighed to record grain and straw yields. Finally economic crop yields were recorded. Maize equivalent yield (MEY) and system productivity was calculated. 28 consecutive years data recorded in the cropping sequence were presented as mean data and data of 2014-15 were statistically analyzed using the F test, the procedures given by Gomez and Gomez (1984).^[2]

Results and discussion

Grain yield of maize

Significantly superior grain yield of maize was recorded in crop supplied with 120 kg N/ha (4240 kg/ha) which was 6.1 and 23.5% higher than 80 and 40 kg N/ha, respectively (Table 1). Similar trend was also observed in 28 years mean data.

This yield advantage might be owing to favourable effect of N on growth parameter and yield attributing characters. These results are in cognizance with finding of Nasrollahzadeh *et al.* (2015)^[10] and Majhi *et al.* (2018)^[8].

Among phosphorus levels, the maximum grain yield of maize was registered with 80 kg P₂O₅/ha (4742 kg/ha), being which was 13.3 and 73.0 more than 40 and 0 kg P₂O₅/ha, respectively. Similar trend was also observed in 28 years mean data. Extreme increase in yield might be owing to better nutritional environment in soil, positive and significant effect in root formation, proliferation and their functional activities. These results are in line with findings of Sepat and Rai (2013)^[13] and Majhi *et al.* (2018)^[8].

The maximum grain yield of maize was recorded with potassium application of 40 kg K₂O/ha (4244 kg/ha) which was 20.1 5 more than maize fertilized with 0 kg K₂O/ha. Similar trend was also observed in 28 years mean data. This was mainly attributed to healthy plant growth which keeps plant cells turgid by controlling osmotic processes in cell-sap, reduces lodging and resistant to diseases and pest. Similar results were also reported by Hanway (1962)^[3] and Karlen *et al.* (1988)^[6] and Majhi *et al.* (2018)^[8] who opined that, the majority of K accumulation occurs before silking might have positive effect on yield increase

Grain yield of wheat

Grain yield of wheat was significantly influenced by application of N. Maximum grain yield was recorded with application of N @ 120 kg/ha (1861 kg/ha) compared to application of N @ 80 and 40 N kg/h with an advantage in yield of 18.1 and 35.4, respectively. Significantly lowest grain yield was registered with application of N@ 40 kg/ha (Table 1). Similar trend was also observed in 28 years mean data. Singh and Agarwal (2001)^[15] and Majhi *et al.* (2018)^[8] who are also reported the similar findings.

Among P levels, application of 80 kg P₂O₅/ha registered maximum grain yield of wheat which was 24.9 and 190.1 higher than 40, 0 kg P₂O₅/ha (Table 1). Similar trend was also observed in 28 years mean data. This remarkable increase in yield might be owing to cell elongation, root development, increased number of tillers and ultimately increased dry-matter accumulation. These results are in cognizance with findings of Mumtaz *et al.* (2014)^[9] and Majhi *et al.* (2018)^[8]. Potassium application has also greatly influenced the wheat yield (Table 1). Application of 40 kg K₂O/ha produced higher grain yield (1679 kg/ha) compared to without application of K. The per cent increase in maize grain yield was to the extent of 9.9 than maize fertilized with 0 kg K₂O/ha. Similar trend was also observed in 28 years mean data. This was mainly attributed to healthy plant growth which keeps plant cells turgid by controlling osmotic processes in cell-sap, reduces lodging and resistant to diseases and pest. Similar results were also reported by Hanway (1962)^[3] and Karlen *et al.* (1988)^[6] and Majhi *et al.* (2018)^[8] who also opined that, the majority of K accumulation occurs before silking might have positive effect on yield increase

Maize equivalent yield (MEY)

Significantly higher MEY (7291 kg/ha) was noticed with application of N @ 120 kg/ha and it showed 10.8 and 28.2 higher yield advantage over 80 and 40 kg N/ha, respectively (Table 1). Similarly among the phosphorous levels, maize fertilized with 80 kg P₂O₅/ha produced maximum MEY (8420 kg/ha) when compared to other phosphorous levels with yield increment of 18.0 and 110.2 higher than 40, 0 kg P₂O₅/ha, respectively. Among the potassium level, maize fertilized with potassium@ 40 kg/ha gave higher MEY (6998/ha) when compared without potassium with yield increment of 15.8

than 0 kg K₂O/ha. These results are in line with findings of Sharma *et al.* (2015)^[14] and Majhi *et al.* (2018)^[8].

System productivity

Maize fertilized with N @ 120 kg/ha produced significantly higher system productivity (19.97 kg/ha/day) compared to other N levels. Minimum system productivity was noticed with application of N @ 40 kg/ha (15.58 kg/ha/day) compared to other levels of N. Similarly among the phosphorous levels,

application of 80 kg P₂O₅/ha registered significantly superior system productivity (23.07 kg/ha/day) compared to other P levels. Further, application of potassium also followed the same trend in system productivity. Significantly higher system productivity was found with application of potassium @ 40 kg K₂O/ha (19.17 kg/ha/day) than 0 K₂O/ha (16.55 kg/ha/day). Similar trend was also noticed under 28 years mean data (Table 1). These results are in cognizance with findings of Sharma *et al.* (2015)^[14] and Majhi *et al.* (2018)^[8].

Table 1: Grain yield of maize and wheat (kg/ha), maize equivalent yield (kg/ha) and system productivity in effect of long-term of nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command area.

Treatments	2014-15				1987-88 to 2014-15(28 years)			
	Maize (kg/ha)	Wheat (kg/ha)	MEY (kg/ha)	System productivity (kg/ha/day)	Maize (kg/ha)	Wheat (kg/ha)	MEY (kg/ha)	System productivity (kg/ha/day)
N levels(kg/ha)								
40	3434	1374	5688	15.58	2156	1086	4539	12.43
80	3995	1575	6579	18.02	2640	1316	5544	15.19
120	4240	1861	7291	19.97	3083	1441	6260	17.15
SEm+/-	69	39	84	0.23				
CD@5%	195	110	237	0.65				
P₂O₅ levels(kg/ha)								
0	2741	771	4006	10.98	1763	855	3642	9.98
40	4186	1796	7131	19.54	2804	1446	5998	16.44
80	4742	2243	8420	23.07	3217	1599	6738	18.46
SEm+/-	69	39	84	0.23				
CD@5%	195	110	237	0.65				
K₂O levels(kg/ha)								
0	3535	1528	6041	16.55	2372	1276	5191	14.24
40	4244	1679	6998	19.17	2800	1393	5873	16.08
SEm+/-	56	32	68	0.19				
CD@5%	159	90	194	0.53				

Nutrients availability in soil

Long-term (1988 to 2014) fertilizer applications of N, P and K through inorganic fertilizer as influence soil reaction and nutrient availability in soil. The experiment block soils were alkaline in soil reaction and low in soluble salt content and were ranged from 8.21 to 8.38 and 0.38 to 0.46 dSm⁻¹, respectively (Table 2). The organic carbon content of soil was significantly influenced by application of N @ of 120 kg/ha (0.55%) compared to other levels of N and there is also

improvement of C compared to initial soil organic C content. Similarly the availability of N, P and K were more in maize crop fertilized with higher level of N, P and K compared to lower levels of N, P and K. Significantly low availability of N, P and K were noticed in application of lower levels of N, P and K (Table 2). The results confirm the findings of Gathala *et al.* (2007)^[1], Kumari *et al.* (2013)^[7] and Singh and Wanjari, (2013)^[16].

Table 2: pH, EC, SOC and available nutrients of post-harvest soils in effect of long-term of nutrient management on productivity and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Tungabhadra command are during 2014-15(end of 28th year)

Treatments.	pH (1:2.5)	EC (dS/m)	SOC (%)	Available nutrients (kg/ha)			
				N	P	K	S
N Levels (kg/ha)							
40	8.22	0.37	0.46	177	14.8	358	26.3
80	8.22	0.38	0.51	194	15.5	359	28.7
120	8.20	0.4	0.55	204	18.3	357	27.3
SEm±	0.011	0.007	0.009	1.7	0.39	2.89	0.56
CD (0.05)	NS	NS	0.026	4.83	1.11	NS	1.59
P₂O₅ Levels (kg/ha)							
0	8.21	0.38	0.46	177	12.5	363	25.2
40	8.21	0.39	0.52	192	15.9	354	27.6
80	8.22	0.39	0.55	206	20.2	356	29.4
SEm±	0.01	0.007	0.009	1.7	0.39	2.89	0.56
CD (0.05)	NS	NS	0.026	4.83	1.11	NS	1.59
K₂O Levels (kg/ha)							
0	8.21	0.38	0.5	188	15	356	27.1
40	8.22	0.39	0.52	195	17.4	360	27.7
SEm±	0.008	0.005	0.008	1.39	0.32	2.36	0.46
CD (0.05)	NS	NS	NS	3.94	0.91	NS	NS
Interaction (N x P x K)							
SEm±	0.025	0.016	0.023	4.17	0.96	7.08	1.38
CD (0.05)	NS	NS	NS	NS	NS	NS	NS
Control/Initial	8.32	0.38	0.4	171	10.8	355	25

Conclusion

The experiment results is concluded that balanced application of fertilizer with 120 kg N, 80 kg P₂O₅ and 40 kg K₂O/ha in maize–wheat cropping system on long-term basis recoded maximum individual crop yield of maize and wheat, maize equivalent yield and system productivity as well as improvement in the soil nutrient availability in Tungabhadra project area of Karnataka.

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References

- Gathala MK, Kanthaliya PC, Verma A, Chahar MS. Effect of integrated nutrient management on soil properties and humus fractions in the long-term fertilizer experiments. *Journal of Indian Society of Soil Science*. 2007; 55:360-363.
- Gomez KA, Gomez AA. *Statistical Procedures for Agricultural Research*, Edn 2, An International Rice Research Institute Book. Wiley-Inter-Science Publication- John Wiley & Sons, New York, 1984, 97-107.
- Hanway JJ. Corn growth and composition in relation to soil fertility: III. Percentages of N, P and K in different plant part in relation to stage of growth. *Agronomy Journal*. 1962; 54:222-229.
- Jat NK, Kumar A, Meena SR, Rana DS, Meena BP, Rana KS. Influence of integrated nutrient management on the productivity, quality and soil health of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*. 2012; 57(4):327-332.
- Jat ML, Gathala MK, Saharawat YS, Tetarwal JP, Gupta Raj, Yadvinder-Singh. Double no-till and permanent raised beds in maize–wheat rotation of northwestern Indo-Gangetic plains of India: effects on crop yields, water productivity, profitability and soil. *Field Crops Res*. 2013; 149:291-299.
- Karlen DL, Flannery RL, Sadler EJ. Aerial accumulation and partitioning of nutrients by corn. *Agronomy Journal*. 1988; 80:232-242.
- Kumari G, Thakur SK, Kumar N, Mishra B. Longterm effect of fertilizer, manure and lime on yield sustainability and soil organic carbon status under maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system in Alfisols. *Indian Journal of Agronomy*. 2013; 58(2):152-158.
- Majhi S, Thakur R, Pal SK, Upasani RR, Puran AN, Kujur AN. Long-term influence of nutrient management on productivity and profitability of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Indian Journal of Agronomy*. 2018; 63(1):14-20.
- Mumtaz MZ, Aslam M, Jamil M, Ahmad M. Effect of different phosphorus levels on growth and yield of wheat under water stress conditions. *Journal of Environment and Earth Science*. 2014; 4(19):23-30.
- Nasrollahzadeh S, Aysan H, Kolvanagh J, Shafagh S, Shaker K. Effect of nitrogen rates and weed interference on yield and yield components of corn (*Zea mays L.*). *International Journal of Agronomy and Agricultural Research*. 2015; 7:1-6.
- Porpavai S, Devasenapathy P, Siddeswaran K, Jayaraj T. Impact of various rice-based cropping system on soil fertility. *Journal of Cereals and Oilseeds*. 2011; 2(3):43-46.
- Sahay S, Singh BP. Effect of cropping and nutrient use on yield and protein content of wheat. *Journal of Research (BAU)*. 2004; 16(2):197-201.
- Sepat S, Rai RK. Effect of phosphorus levels and sources on productivity, nutrient uptake and soil fertility of maize (*Zea mays*)–wheat (*Triticum aestivum*) cropping system. *Crop Research*. 2013; 58(3):292-297.
- Sharma SK, Rana SS Subehia SK. Response of maize - wheat cropping system to NPK in low hills of Himachal Pradesh. *Himachal Journal of Agricultural Research*. 2005; 41(1):73-76.
- Singh R, Agrawal SK. Growth and yield of wheat (*Triticum aestivum*) as influenced by levels of farmyard manure and nitrogen. *Indian Journal of Agronomy*. 2001; 46(3):462-467.
- Singh M, Wanjari RH. Measures to sustain and restore declined productivity in Aifisoles under long term fertilizer experiments. *Indian Journal of Fertilisers*. 2013; 9(2):24-32.