

NUTRIENTS STATUS OF SOIL UNDER LONG-TERM APPLICATION OF FERTILIZERS AND MANURES IN PERMANENT PLOT TECHNIQUE OF RICE-RICE CROPPING SYSTEM

*¹SURESH, M.; ¹JAYASREE, G.; ¹SRILATHA, M.; ²MALLA REDDY, M. AND
³NARENDER REDDY, S.

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL
UNIVERSITY
RAJENDRANAGAR, HYDERABAD-500 030, TELANGANA

*E-MAIL: manchikunta.suresh5@gmail.com

¹Dept. of Soil Science & Agricultural Chemistry, College of Agriculture, PJTSAU, Hyderabad-500 030

²Dept. of Agronomy, College of Agriculture, PJTSAU, Hyderabad-500 030

³Dept. of Crop physiology, College of Agriculture, PJTSAU, Hyderabad-500 030

ABSTRACT

A long-term experiment was conducted with the objective of assessing the effect of integrated use of organic and inorganic sources of nutrients on properties of soil quality and yield sustainability under rice –rice crop rotation. A field experiment was conducted during rabi 2014-15 and kharif 2015-16 at Regional Agricultural Research Station, Jagtial (India) on an ongoing long term (16 years) experiment which was initiated in kharif 2000. Twelve treatments were laid out in randomized block design with four replications. The twelve treatments were 50 % NPK (T₁), 100 % NPK (T₂), 150 % NPK (T₃), 100 % NPK + HW (T₄), 100 % NPK + ZnSO₄ (T₅), 100 % NP (T₆), 100 % N (T₇), 100 % NPK + FYM (10 t FYM /ha in kharif) (T₈), 100 % NPK – S (T₉), FYM (10 t FYM /ha in kharif and rabi) (T₁₀), Control (T₁₁) and Fallow (T₁₂). Results showed that application of 150% NPK recorded highest yield which was on par with 100% NPK+FYM treatment. The soil pH and EC did not change but markedly changed the organic carbon and available nutrient contents of the soil. The available N, P and K were gradually depleted in all the treatments but the magnitude of depletion was less in the treatments which received N, P and K, respectively. Thus, the combined use of organic and inorganic source of plant nutrients necessary for sustainable soil fertility option for optimizing the yield of rice.

KEY WORDS: Fertilizers, Cropping system, Manures, Rice

INTRODUCTION

Soil is a key natural resource and soil quality is the integrated effect of management on most soil properties that determine crop productivity and sustainability. Good soil quality not only produces good crop yield, but also maintains environmental quality and consequently plant, animal and human health. With the advancement of intensive agriculture, soils

are being degraded at an alarming rate by wind and water erosion, desertification and salinization, because of exploitative total farming practices for short term gains. Growing of crops without due consideration to total nutrient requirement has resulted in decline in soil fertility (Ghosh *et al.*, 2003). Soil quality assessment has been suggested as a tool for evaluating sustainability of soil

and crop management practices (Hussain *et al.*, 1999).

Rice (*Oryza sativa* L.) is the principal food crop of the world, contributes to about 60 per cent of the world's food. India ranks second in rice production with 104.80 million tonnes and productivity 2.39 t/ha from an area of 43.86 million hectares (Anonymous, 2015-16). During 2013-14, Telangana rice production is about 66.22 lakh tonnes with a productivity of 3.31 t/ha from an area of 20.00 lakh ha (Raji Reddy, 2017).

Higher production requirements for the future to meet the demands of growing population need to be achieved, maintaining the soil quality and sustainability of the productivity at the same time. Increase in cropping intensity with optimum use of production inputs like seed, water and fertilizers and effective plant production measures are the key for sustained crop yields.

In long term experiments, the treatments are applied for a long time sufficient to assess their impact on the resource base. Overall trends and cumulative impact of management systems are best studied through long term experiments. Long term experiments provide a reliable means to study the effect of continuous application of organic manures and inorganic fertilizers on the crop yields and productivity of the soil (Manna *et al.*, 2005). The importance of long term fertilizer experiments in studying the effect of continuous cropping and fertilizer or manure application on soil quality and sustainability of crop production is widely recognized.

MATERIALS AND METHODS

The field experiment was conducted at Regional Agricultural Research Station, Polasa, Jagtial district of Telangana. The farm is geographically situated at 78°45' E to 79°0' E Longitude and 18°45' N to 19°0' N Latitude. The climate of polasa,

Jagtial was classified as sub-tropical. The southwest monsoon usually sets in during June-October giving 40-50 rainy days per year. Winter was generally milder at Jagtial and temperature begins to rise from January and reach it peak by May. The present experiment is a part of All India Coordinated Research Project on long term fertilizer experiment initiated in *kharif* 2000-01. The present study was taken up in 2014-15 and 2015-16 (both in *rabi* and *kharif* seasons respectively) with a view to study the effect of long term fertilizer management on soil quality. Twelve treatments were laid out in randomized block design with four replications. The twelve treatments were 50 % NPK (T₁), 100 % NPK (T₂), 150 % NPK (T₃), 100 % NPK + HW (T₄), 100 % NPK + ZnSO₄ (T₅), 100 % NP (T₆), 100 % N (T₇), 100 % NPK + FYM (10 t FYM /ha in *kharif*) (T₈), 100 % NP –S (T₉), FYM (10 t FYM /ha in *kharif* and *rabi*) (T₁₀), Control (T₁₁) and Fallow (T₁₂). The experimental site was a typical clayey soil. The properties of the soil before the initiation of experiment (sample collected at the initiation of the experiment *i.e.*, before *kharif* 2000-01). The physico chemical properties revealed that the soil was alkaline (8.22 pH) in reaction, non saline (0.47 dS/m) in nature and medium in organic carbon (0.79 g/kg). The soil under study was low in available nitrogen (107.6 kg N/ha), medium in available phosphorus (19.6 kg P₂O₅ /ha) and high in available potassium (364 kg K₂O/ha) at the initiation.

Soil sampling and analysis

Soil samples were collected during *rabi* and *kharif* from the plough layer (0.0–0.15 m depth) from both the experimental sites after the harvest of (2014-15 *rabi* and 2015-16 *kharif*) crop. These samples were partitioned and passed through standard prescribed sieves for further use in a different kind of analysis. Soil samples that passed through the 8-mm sieve and were

retained on the 4.75-mm sieve were used for aggregate analysis, while the sample that passed through the 0.2-mm sieve was used for estimating organic carbon (OC) and rest of the soil quality parameters such as pH, electrical conductivity (EC), available N, available P, available K.

RESULTS AND DISCUSSION

The physico-chemical properties of soil

Soil pH

The physico-chemical properties of soil samples after harvest of 15th cropping cycle (*Rabi* 2014-15) and 16th cropping cycle (*Kharif* 2015-16) and the analysis values of these two years are presented in Table 1. The initial pH (1:2) of the soil i.e., the pH of the soil at the initiation of the experiment was 8.22. Continuous application of chemical fertilizers led to a change in soil reaction. The pH decreased slightly in the treatments receiving 100% N, control and FYM, while the increase in level of fertilizer dose from 50% to 150% NPK caused a significant increase in pH (Table 1). This increase could be due to the continuous addition of soluble salts in the form of fertilizers. The addition of 100% NPK + FYM registered a non significant decrease in soil reaction, which could be due to the buffering action of FYM and the application of FYM is ascribed to the beneficial effects associated with buffering action. The non-significant effect of application of organic manures along with recommended dose of inorganic fertilizers on pH have been reported by several workers (Subehia *et al.*, 2005; Stalin *et al.*, 2006; Khadka *et al.*, 2008) and the possible reason is that the added FYM was not sufficient enough to bring about changes in soil pH.

Electrical conductivity

The measure of electrical conductivity indicates the total soluble salt concentration of a soil. The initial soluble salts content of the soil was 0.47 dS/m. The

results presented in Table 1 indicated that compared to the initial value, the soluble salt content reduced at the end of the 15th and 16th cropping cycle. The treatments receiving through 50% NPK (T₁) or 100% NP (T₆) had positive influence on EC and showed higher values (0.45 and 0.44 dS/m, respectively) over control in *rabi* season. The treatments receiving organics either through 100% NPK+ HW (T₄) or 100% N (T₇) and control (T₁₁) had positive influence on EC and showed higher values (0.413 and 0.415 dS/m, respectively) over other treatments in *Kharif* season. However, from the above results, it could be observed that only marginal changes occurred in pH and EC which could be due to the fact that the buffering capacity of soil resulting from the production of humic substances (Thakur and Sawarkar, 2009) due to the decomposition of incorporated root matter and crop stubbles might have resisted considerable changes in soil pH and EC.

Organic carbon (%)

The soil samples collected after harvest of *rabi* rice were analysed for organic carbon. The data on organic carbon content in soil as influenced by different treatments are presented in Table 1 and Figure 1. The mean organic carbon content after 15th and 16th cropping cycles ranged from 0.77 to 1.09 % in *rabi* season and 0.7 to 1.10 in *kharif* season. There was a significant and appreciable build up in organic carbon in treatments receiving 100% NPK, 150% NPK, 100% NPK + FYM and only FYM. There was an increase in organic carbon from initial status (0.79 %) in all the treatments. There was an increase of 21.5 and 39.2 per cent in organic carbon (Figure 1) in T₈ (100 % NPK+FYM) and T₁₀ (FYM), respectively over initial value (0.79 %). This could be due to the direct addition of organic matter and partly through better root growth and addition of more biomass in these particular treatments. The increase in

organic carbon content due to the continuous use of fertilizers can also be attributed to higher contribution of biomass to soil in the form of stubbles and crop residues. Further, as pointed out by Katkar *et al.* (2011), that this increase could be attributed to addition of FYM which stimulates the growth and activity of microorganisms and better root growth. It also indicates that balanced fertilizer application and integrated use of fertilizers and manures resulted in substantial improvement in soil health (Subehia *et al.*, 2005; Bajpai *et al.*, 2006; Kumar *et al.*, 2008; Thakur *et al.*, 2011). Addition of organic manures increases microbial activity leading to greater decomposition of raw organic manures (Sharma *et al.*, 2009). Similar results were also reported by Laxminarayana (2006) and Reddy *et al.* (2006). In Inceptisols of Ludhiana, Raipur, New Delhi, Coimbatore and Junagarh, increase in soil organic carbon (SOC) was recorded under balanced application of nutrients. But, the imbalanced use of nutrients or application of nutrients in 100% N, 100% NP, 50% NPK resulted in decline in SOC. Incorporation of crop residue in less quantity as a result of low productivity under imbalanced nutrient application is the main reason for decline in SOC under imbalanced fertilization (Anonymous, 2006).

Available nitrogen

The data on available nitrogen in soil are presented in Table 2. Close perusal of data indicated that available nitrogen content increased over the initial level (107.6 kg/ha). Among the treatments, after 15th cropping cycle (*rabi* 2014-15), higher values of available nitrogen content were recorded with application of 100 % NPK + FYM (203 kg/ha), 150% NPK (195 kg/ha), and 100 % NPK (183 kg/ha) which were statistically on par with each other. Increase in the available nitrogen content in soil over initial value with the application of 100 % NPK + FYM,

150% NPK and 100% NPK was to a tune of 47.1, 41.3 and 32.6 per cent, respectively over control. Among the treatments, 16th cropping cycle (*khariif* 2015-16) higher values of available nitrogen content were recorded with application of 100 % NPK + FYM (217 kg/ha), 150% NPK (212 kg/ha), and 100 % NPK+HW (202 kg/ha), which were statistically on par with each other. Increase in the available nitrogen content in soil over initial value with the application of 100 % NPK + FYM, 150% NPK and 100% NPK+HW was to a tune of 51.7, 48.25 and 41.25 per cent, respectively over control. Walia *et al.* (2010) reported that integrated use of organic manures with chemical fertilizers improved the available nitrogen status in soil in comparison to inorganic fertilizers alone. Similar results were also reported by Verma *et al.* (2012) in maize – wheat intensive cropping system.

There was an increase of 10.9 per cent in available nitrogen with the treatment receiving 100% NPK + FYM over 100% NPK in *rabi* and 10.7 per cent in *khariif*. This may be attributed to continuous addition of nutrients through FYM and their retention by enhanced level of organic matter. Jamwal (2005), Sharma *et al.* (2007), Selvi *et al.* (2005), Subehia *et al.* (2005) and Thakur *et al.* (2011) also reported similar results. This increase in available nitrogen content can be attributed to the mineralisation of soil nitrogen leading to build up of available nitrogen (Swarup and Yaduvanshi, 2000 and Kumar *et al.* 2012).

The results also showed that the increase in the dose of fertiliser resulted in increase in mineralised N. At the same level of nutrient application, the magnitude of increase in soil mineralisable nitrogen was higher with the balanced nutrient application (100% NPK), while the application of phosphorus along with nitrogen also (100% NP) improved the mineralisable nitrogen

status of the soil in comparison to the application of nitrogen alone (100% N).

Available phosphorus

The available phosphorus content of soil data are presented in Table 2. The available phosphorus content of soil was significantly influenced by different treatments under study. The data on available P indicated a build up in available phosphorus in treatments where phosphorus fertilizers and organic manures were applied. This phosphorus build up in soil was due to continuous application of fertilizers and/or organic manure. Available phosphorus increased from medium initial level of 19.6 kg P/ha to a significantly high available P status with application of 100% NPK+FYM (35.9 kg P/ha⁻¹) and 150% NPK (33.2 kg P/ha⁻¹) in *rabi* season. Among the treatments, higher values of available phosphorus content were recorded with application of 150% NPK (45.4 kg/ha), 100 % NPK + FYM (43.4 kg/ha⁻¹) which were statistically on par with each other. Increase in the available phosphorus content in soil over initial value with the application of 150% NPK and 100 % NPK + FYM was to a tune of 51.7, 48.25 and 41.25 per cent, respectively over control in *Kharif* season.

At the same level of phosphorus application (100% P), the magnitude of increase in the available P was higher with balanced nutrient application (100% NPK). The application of phosphorus along with nitrogen (100% NP) also improved the available P content of the soil (by 41.9%) in comparison to the application of nitrogen alone (100% N). The lowest value of available phosphorus content was observed in treatment receiving imbalanced nutrition *i.e.*, 100% N (19.2 kg/ha). This could be due to the removal of nutrient by the crop with continuous cropping without addition of phosphorus from external sources. Similar results were reported by Bharadwaj *et al.* (1994).

Among the fertilizer treatments, available phosphorous content in soil increased with increased NPK levels. Available phosphorus content increased by 48%, 54% and 110% over control with 50%, 100% and 150% NPK, respectively. Verma *et al.* (2012) opined that the increase in available P with increase in levels of fertilizer might be due to the addition of P at higher rates.

Available potassium

The results on available potassium content of soil are presented in Table 2. As it could be seen from the data that a decrease in the available potassium content was recorded in the treatments as compared to the initial value of 364 kg K/ha at the beginning of the experiment. Decrease in available potassium with continuous cropping was also reported by Subehia *et al.* (2005) and Yaduvanshi and Swarup (2006).

Among the treatments, higher values of available K content were recorded with application of 150% NPK (384 kg/ha) followed by 100% NPK+FYM (375 kg/ha), which were statistically on par with each other. Lower available potassium content was recorded with imbalanced nutrition *i.e.*, in treatment receiving 100% N (288 kg ha⁻¹) in *rabi* season.

Higher values of available K content were recorded with application of 150% NPK (386 kg/ha) followed by 100% NPK+FYM (381 kg/ha), which were statistically on par with each other. Lower available potassium content was recorded with imbalanced nutrition *i.e.*, in treatment receiving 100% N (295 kg ha⁻¹) in *kharif* season. Similar results were reported by Kumar *et al.* (2008) and Urkurkar *et al.* (2010)

Effect of long term fertilizer and manure application on rice yield

The data pertaining to grain yield of rice during 2014-15 and 2015-16 are presented in Table 3 and Figure 2. The grain

yield of rice ranged from 21.84 to 63.82 q/ha in *rabi* and 24.15 to 60.90 q/ha in *kharif*. Application of 100% NPK along with FYM @ 10 t/ha resulted in 59.36 and 58.24 q/ha in *rabi* and *kharif*, but slightly lower grain yield over 150% NPK (63.82 and 60.90 q/ha in *rabi* and *kharif*, respectively). As FYM directly adds appreciable amounts of macro and micro nutrients and FYM had a significant positive role in improving the soil environment. Similar results were also reported by Selvi *et al.* (2005). The application of graded levels of NPK fertilizers significantly increased the grain yield. Application of optimum dose of NPK (120-60-40 kg/ha) exhibited beneficial effects. An additional increase of NPK resulted in further increase in yield. Among the fertilizer treatments, grain yield increased by 108.43 and 79.50%, with 50% NPK, 136.72 and 128.12% with 100% RDF, 192.22 and 152.17% with 150% RDF over control during *rabi* and *kharif*, respectively.

CONCLUSION

The results suggests that the contribution of important soil quality attributes like organic carbon, available nitrogen, phosphorus and potassium is governing the soil quality indicators of soil. Integrated use of inorganic fertilizer and organic manure resulted in maximum yield of rice. There was a buildup in organic carbon and available nitrogen, phosphorus and potassium status of soil under combined application of organic and inorganic sources of plant nutrients. Thus, the combined use of organic and inorganic source of plant nutrients could be a sustainable option for optimizing the yield of rice.

REFERENCES

Anonymous (2015-16). Annual Report – 2015-16. Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi.

Anonymous (2006). Annual Report of All India Coordinated Research Project on Long Term Fertilizer Experiments, Indian Institute of Soil Science, Bhopal.

Bajpai, R. K.; Chitake, S.; Upadhyay, S. K and Urukurkar, J. S. (2006). Long term studies on soil physico chemical properties and productivity of rice–wheat system as influenced by integrated nutrient management in Inceptisol of Chattisgarh. *J. Indian Soc. Soil Sci.*, **54**(1): 24-29.

Bharadwaj, V.; Bansal, S. K.; Maheshwari, S. C and Omanwar, P. K. (1994). Long term effect of continuous rotational cropping and fertilization on crop yield and soil properties –III. Changes in the fractions of N, P and K of the soil. *J. Indian Soc. Soil Sci.*, **42**(3): 392-397.

Ghosh, B. N.; Vedprakash; Kundu, S.; Singh, R. D and Gupta, H. S. (2003). Distribution and build up of oxidizable and non-oxidizable soil organic carbon in soil profiles under long term fertilizer trial in the Mid-hills of N-W Himalayas. *J. Indian Soc. Soil Sci.*, **51**(3) :298-301.

Hussain, I.; Olson, K. R.; Wander, M. M and Karlen, D. L. (1999). Adaptation of soil quality indices and application to three tillage systems in southern Illinois. *Soil Till. Res.*, **50**: 237-249.

Jamwal, J. S. (2005). Productivity and economics of maize (*Zea mays*) – wheat cropping system under integrated nutrient supply system in rainfed areas of Jammu. *Indian J. Agron.*, **50**: 110 -112.

Katkar, R. N.; Sonune, B. A. and Kadu, P. R. (2011). Long term effect of fertilization on soil chemical and biological characteristics and productivity under sorghum

- (*Sorghum bicolor*) – wheat (*Triticum aestivum*) system in vertisol. *Indian J. Agril. Sci.*, **81**(8): 734-739.
- Khadka, Y. G.; Rai, S. K. and Raut, S. (2008). Long term effects of organic and inorganic fertilizers on rice–wheat cropping sequence. *Nepal J. Sci. Technol.*, **9**: 7-13.
- Kumar, B.; Gupta, R. K and Bhandari, A. L. (2008). Soil fertility changes after long term application of organic manures and crop residues under rice-wheat system. *J. Indian Soc. Soil Sci.*, **56**(1): 80-85.
- Kumar, M.; Yaduvanshi, N. P. S. and Singh, Y. V. (2012). Effects of integrated nutrient management on rice yield, nutrient uptake and soil fertility status in reclaimed sodic soils. *J. Indian Soc. Soil Sci.*, **60**(2): 132 - 137.
- Laxminarayana, K. (2006). Effect of integrated use of inorganic and organic manures on soil properties, yield and nutrient uptake of rice in ultisols of Mizoram. *J. Indian Soc. Soil Sci.*, **54**(1): 120-123.
- Manna, M. C.; Swarup, A.; Wanjari, R. H., Ravankar, H. N.; Mishra, B.; Saha, M. N.; Singh, Y. V.; Sahi, D. K. and Sarap, P. A. (2005). Long term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under sub humid and semi arid tropical India. *Field Crop Res.*, **93**: 264-280.
- Raji Reddy, D. (2017). Agriculture in Telangana
http://niti.gov.in/writereaddata/files/Telangana_Presentation_1.pdf.
- Reddy, M. D.; Rama Laxmi, Ch. S.; Rao, C. N.; Rao, K. V., Sitaramayya; Padmaja, G and Ramalakshmi, T. (2006). Effect of long –term integrated nutrient supply on soil chemical properties, nutrient uptake and yield of rice. *Indian J. Ferti.*, **2**(2): 25-28.
- Selvi, D.; Santhy, P and Dakshinamoorthy, M. (2005). Effect of inorganics alone and in combination with farm yard manure on physical properties and productivity of Vertic haplstepts under long – term fertilization. *J. Indian Soc. Soil Sci.*, **53**(3): 302-307.
- Sharma, A.; Jalali, V. K., Arya, V. M and Rai, P. (2009). Distribution of various forms of potassium in soils representing intermediate zone of Jammu region. *J. Indian Soc. Soil Sci.*, **57**(2): 205 – 207.
- Sharma, M.; Mishra, B. and Singh, R. (2007). Log – term effects of fertilizers and manure on physical and chemical properties of Mollisol. *J. Indian Soc. Soil Sci.*, **55**: 523-524.
- Stalin, P.; Ramanathan, S.; Nagarajan, P. and Natrajan, K. (2006). Long term effect of continuous manorial practices on grain yield and some soil chemical properties in rice–based cropping system. *J. Indian Soc. Soil Sci.*, **54**(1): 30-37.
- Subehia, S. K.; Verma, S and Sharma, S. P. (2005). Effect of long – term use of chemical fertilizers with and without organics on forms of soil acidity, phosphorous adsorption and crop yields in an acid soil. *J. Indian Soc. Soil Sci.*, **53**(3): 308-314.
- Swarup, A and Yaduvanshi, N. P. S. (2000). Effects of integrated nutrient management on soil properties and yield of rice in alkali soils. *J. Indian Soc. Soil Sci.*, **48**: 279 -282.
- Thakur, R. and Sawarkar, S. D. (2009). Influence of long term continuous application of nutrients and spatial distribution of Sulphur on soybean – wheat cropping sequence. *J. Soil Crops*, **19**(2): 225-228.

- Thakur, R.; Sawarkar, S. D.; Vaishya, U. K and Singh, M. (2011). Impact of continuous use of inorganic fertilizers and organic manures on soil properties and productivity under soybean – wheat intensive cropping of a vertisol. *J. Indian Soc. Soil Sci.*, **59**(1): 74 -81.
- Urkurkar, J. S.; Tiwari, A.; Chitale, S. and Bajpai, R. K. (2010). Influence of long term use of inorganic and organic manures on soil fertility and sustainable productivity of rice (*Oryza sativa*) and wheat (*Triticum aestivum*) in Inceptisols. *J. Indian Soc. Soil Sci.*, **80**(3): 208-212.
- Verma, G.; Mathure, A. K and Verma, A. (2012). Effect of continuous use of organics and inorganics on nutrient status of soil and yield under maize – wheat intensive cropping system in an Inceptisol. *J. Soils Crops*, **22**(2): 280 -286.
- Walia, M. K.; Walia, S. S. and Dhaliwal, S. S. (2010). Long – term effect of integrated nutrient management on properties of Typic Ustochrept after 23 cycles of an irrigated rice (*oryza sativa* L.) – wheat system. *J. Sustain. Agric.*, **34**: 724 -743.
- Yaduvanshi, N. P. S and Swarup, A. (2006). Effect of long term fertilization and manuring on potassium balance and non-exchangeable K release in a reclaimed sodic soil. *J. Indian Soc. Soil Sci.*, **54**(2): 203-207.

Table 1: Effect of long term fertilizer and manure application on physico-chemical properties of post-harvest soils of rice

Treatments	pH		EC (dS/m)		OC (%)	
	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>
50% NPK	8.20	8.22	0.453	0.365	0.79	0.81
100% NPK	8.18	8.26	0.383	0.383	0.84	0.82
150% NPK	8.09	8.34	0.408	0.398	0.86	0.88
100% NPK + HW	8.09	8.27	0.433	0.413	0.82	0.84
100% NPK + Zn	8.14	8.23	0.395	0.360	0.84	0.82
100% NP	8.22	8.21	0.438	0.358	0.82	0.82
100% N	8.08	8.16	0.413	0.413	0.85	0.82
100% NPK + FYM	8.14	8.14	0.425	0.375	0.96	1.06
100% NPK - S	7.90	8.26	0.423	0.398	0.81	0.84
FYM	8.18	8.16	0.425	0.400	1.09	1.10
Control	8.06	8.11	0.415	0.415	0.77	0.77
Fallow	8.08	8.18	0.415	0.415	0.83	0.81
S. Em. +	0.28	0.247	0.015	0.012	0.03	0.03
CD (0.05)	NS	NS	NS	0.036	0.10	0.10
Initial	8.2		0.47		0.79	

Table 2: Effect of long term fertilizer and manure application on available soil nutrients of post-harvest soils of rice 2014-15

Treatments	Available Nitrogen (kg/ha)		Available Phosphorous (kg/ha)		Available Potassium (kg/ha)	
	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>	<i>Rabi</i>	<i>Kharif</i>
50% NPK	159	184	21.8	30.3	331	321
100% NPK	183	196	25.7	31.4	364	371
150% NPK	195	212	33.2	45.4	384	386
100% NPK + HW	175	202	24.8	31.2	339	249
100% NPK + Zn	174	199	24.4	30.7	341	341
100% NP	155	193	22.0	24.5	324	326
100% N	141	175	15.5	19.5	288	295
100% NPK + FYM	203	217	35.9	43.4	375	381
100% NPK - S	168	192	24.6	30.9	351	357
FYM	160	191	24.3	31.3	337	334
Control	138	143	21.9	21.7	347	348
Fallow	153	161	24.1	29.0	372	375
S. Em. +	9.45	9.18	1.76	2.29	20.2	20.0
CD (0.05)	27.31	26.55	5.08	6.63	NS	57.8
Initial	107.6		19.6		364	

Table 3: Effect of long term fertilizer and manure application on rice grain yield and straw yield (q/ha)

Treatment	Grain yield(q/ha)	
	<i>Rabi</i>	<i>Kharif</i>
50% NPK	45.52	43.35
100% NPK	51.70	55.09
150% NPK	63.82	60.90
100% NPK + HW	55.48	57.78
100% NPK + Zn	54.80	57.61
100% NP	53.34	53.46
100% N	31.75	39.06
100% NPK + FYM	59.36	58.24
100% NPK - S	51.83	54.41
FYM	39.42	47.22
Control	21.84	24.15
S. Em. $\pm$	2.85	2.24
CD (5%)	8.27	6.51

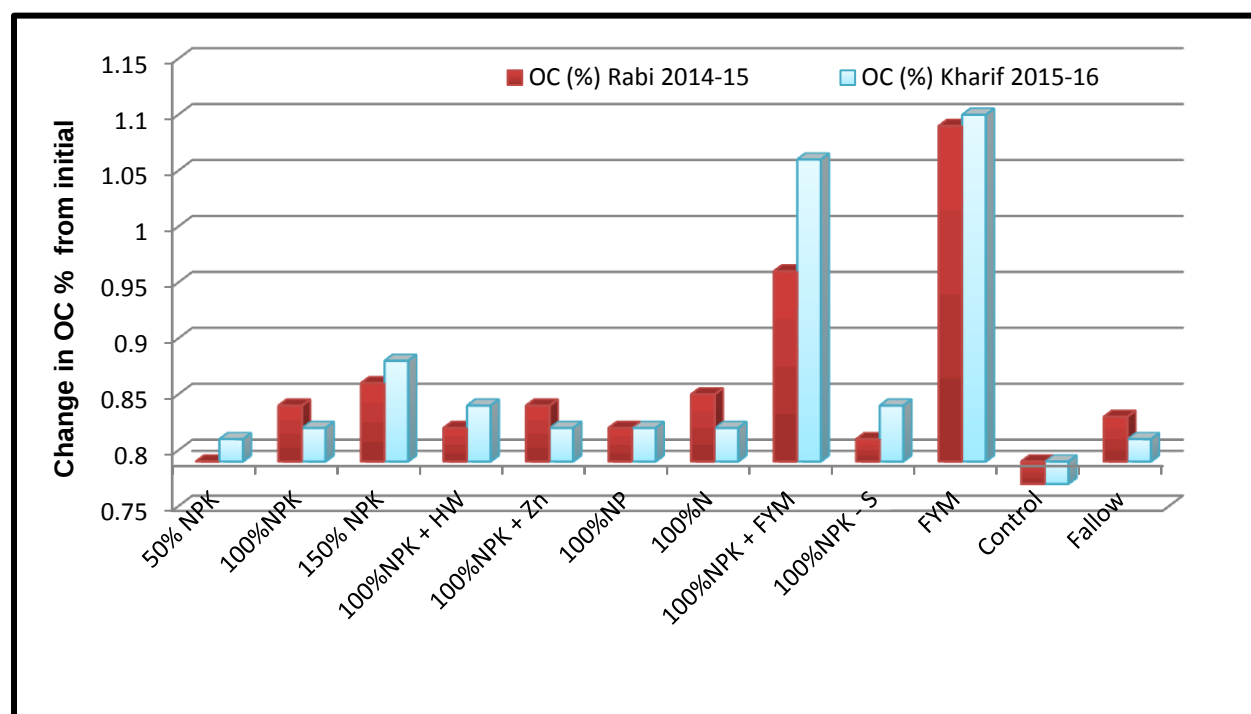


Fig. 1: Effect of long term fertilizer and manure application on organic carbon content in post-harvest soils of rabi rice

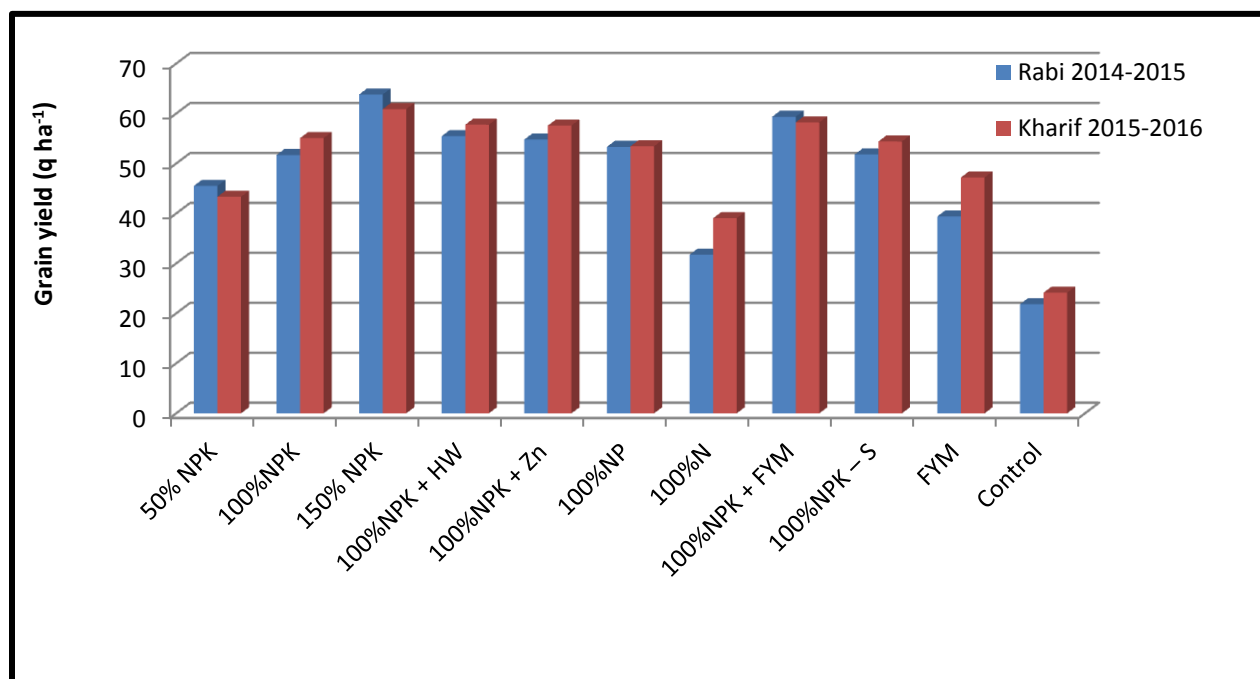


Fig. 2: Effect of long term fertilizer and manure application on rice grain yield (q/ha)