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Effect of organic and inorganic sources of nutrients on nutrient content and uptake of direct seeded rice in *Inceptisols* of Bastar plateau zone

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Abstract
A field experiment was carried out at S.G. College of Agriculture and Research Station, Jagdalpur, Chhattisgarh during *Kharif* 2016 to study the effect of organic and inorganic sources of nutrients on soil chemical properties and nutrient availabilities under direct seeded rice in *Inceptisols* of Bastar plateau zone. The experiment was conducted in randomized block design with twelve treatments and four replications. The 100% NPK i.e. recommended dose of fertilizers were 100:60:40 kg N: P_2O_5: K_2O/ ha for rice crop. Soil samples were collected from the top soil surface (0-15 cm) of all the four replications before and after *Kharif* 2016 and analyzed fornutrient content and uptake of rice crop.

Keywords: Organic and inorganic sources, chemical properties and nutrient availability.

1. Introduction
Rice (*Oryza sativa* L.) occupies a pride place among the food crops cultivated in India which has the largest areaamong rice growing countries and stands second in the production. In India, during the past three decades, intensive agriculture involving high yielding varieties of rice has led to heavy withdrawal of nutrients from thesoil. Use of organic manures in present agriculture is increasing day by day. Its utility has not only improved the physical, chemical and biological properties of soil but also maintained the good soil health. So, it is time to look for measures to stimulate sustainability in production ofrice on long- term basis. Organic manures like FYM, poultry manure, vermicompost and neemcake deservespriority for sustained production and better utilization in organic rice production. Application of organic manures improves the availability of macronutrients. Hence, an experiment was conducted to study the differentsources and time of application of organic manures on productivity and residual soil fertility status after harvest ofrice (*Oryza sativa* L.) (Sujatha *et al*, 2014) [9].
Long-term experiment has shown that crop residues incorporation, farm yard manures and green manures increased soil organic carbon and nutrient availability as compared to the nitrogenous fertilizers alone (Lado *et al.*, 2004). The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior to the use of each component separately (Palaniappan and Annadurai 2007) [6].

2. Materials and methods
The field experiment was conducted in midland field under long term fertilizer experiment, AICRIP-Dryland Agriculture at SG College of Agriculture and Research Station, Kumhrawand, Jagdalpur (C.G.) during *Kharif* 2016.The experiment was conducted with twelve treatments namely T_1(control), T_2(100% NPK i.e. 100:60:40 kg/ha N: P_2O_5: K_2O), T_3(100% PK), T_4(100% NK), T_5(100% NP), T_6(100% NPK+5 t FYM), T_7(100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1}), T_8(100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1} + Lime 3 q ha^{-1}), T_9(50% NPK), T_{10}(50% NPK + 5 t FYM), T_{11}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}) and T_{12}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}). The experiment was laid out in randomized block design (RBD) with four replications. disease.

2.1. Plant Analysis
Plant and grain sample dried at 55^0 C in an oven for 24 hours and weregrinded and used for analysis.

2.1.1. Digestion
The 0.5g of oven dried grain and straw samples were digested in 10 ml of concentrated H_2SO_4 and 1g of salt mixture (5:1 K_2SO_4: $CuSO_4$) in Kjeldahl digestion unit and determined N content.

0.5g of oven dried grain and straw samples were digested by 10 ml of diacid mixture HNO_3: $HClO_4$ (Chapman and Pratt, 1961) using Kjeldahl unit. Volume of digested grain and straw samples made up to 100ml for the estimation of phosphorus and potassium content.

2.1.2. Nitrogen content
Nitrogen content in digested grain and straw samples were determined by Kjeldahl distillation unit (Chapman and Pratt, 1961).

2.1.3. Phosphorus content
Phosphorus content of digested grain and straw samples was estimated by development of Vando-molybdophosphoric acid yellow color method (Jackson, 1973) using UV-visible double beam spectrophotometer at 420 nm.

2.1.4. Potassium content
Potassium content in the digested grain and straw samples was analyzed estimated by Flame photo-meter (Black, 1968).

2.1.5. Nutrient Uptake
The nutrient uptake was calculated by multiplying percent concentration of a particular nutrient with grain and straw yields. The uptake of the nutrients obtained in respect of grain and straw was summed up to compute the amount of total nutrient removed by the crop.
Nutrient uptake (kg/ha) = Nutrient content (%) × yield (q/ha)

3. Results and discussion
3.1. Nitrogen content and uptake
3.1.1. Nitrogen content in grain
The nitrogen content in grain was non-significantly influenced with the different levels of fertilizers and manures application (Table 4.4.1 and Fig. 4.4.1). The higher levels of nitrogen concentrations (1.04%) in grain were recorded in100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) which is the combined application of fertilizer and manure compared to the chemical fertilizer alone. While the lowest value of nitrogen content (0.96) in grain was found in 100% PK (T_3) treatment. Similar results were also found by Singh *et al.* (2001) [7].

3.1.2 Nitrogen content in straw
The effect of different treatments on nitrogen content in straw was found to be significant (Table 4.4.1. and Fig. 4.4.1). The higher level of nitrogen concentration (0.57%) recorded in 100% NPK which was found significantly higher than control (0.53%) but remind at par with 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8), 100% NPK +5 t FYM (T_6) and 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_{11}) which have 0.56% nitrogen content in straw. The lower concentration in straw in control plot may be a result of mining of nutrient with Continuous cropping without incorporation of nutrient over a long period of time.

3.1.3 Nitrogen uptake
Nitrogen uptake by both grain and straw of rice was significantly affected by the different treatments under study. The nitrogen uptake by grain varied from 24.6 to 47.8 Kg /ha. The highest nitrogen uptake (47.8 kg/ ha) by grain was recorded in the treatment100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) which was significant over all other treatments which was followed by the treatments100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha with nitrogen uptake of 45.9 kg/ ha. The lowest nitrogen uptake (24.6kg/ ha) by grain was obtained in control. The inorganic fertilizers and combined renew application of organic fertilizers was found encouraging nitrogen uptake as compared to inorganics alone. In straw, the nitrogen uptake ranged from 19.9 to 28.8 kg/ ha. The highest nitrogen uptake (28.8 kg ha^{-1}) by straw was recorded in the treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) which was significantly different from the rest of the treatments under study. The lowest nitrogen uptake (19.9 Kg ha^{-1}) was observed in the treatment control. The continuous application of inorganic fertilizers alone and in different combinations with organic sources of nutrients showed a significant increase in nitrogen uptake by straw. The highest nitrogen uptake (76.65 kg/ ha) was found in the plots which received 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8)followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (73.79 kg ha-1)and lowest nitrogen uptake was found in control (44.54 kg/ ha).
The total nitrogen uptake was significantly affected by different treatments (Table 4.4.1 and Fig. 4.4.1). Among the treatments, highest total nitrogen uptake (76.65 kg/ha) was observed in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) which was at par with 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) Total nitrogen uptake in these two treatments had significantly higher values as compared to those of others like 100% PK, 100% NK, 100% PK, 50% NPK and control which have 46.31, 51.82, 56.56 and 59.14 kg/ha nitrogen uptake, respectively. Sathish *et al.* (2011) [8] reported that treatments which received combination of organic and inorganic fertilizer showed higher uptake values by rice crop of all the three nutrients NPK.

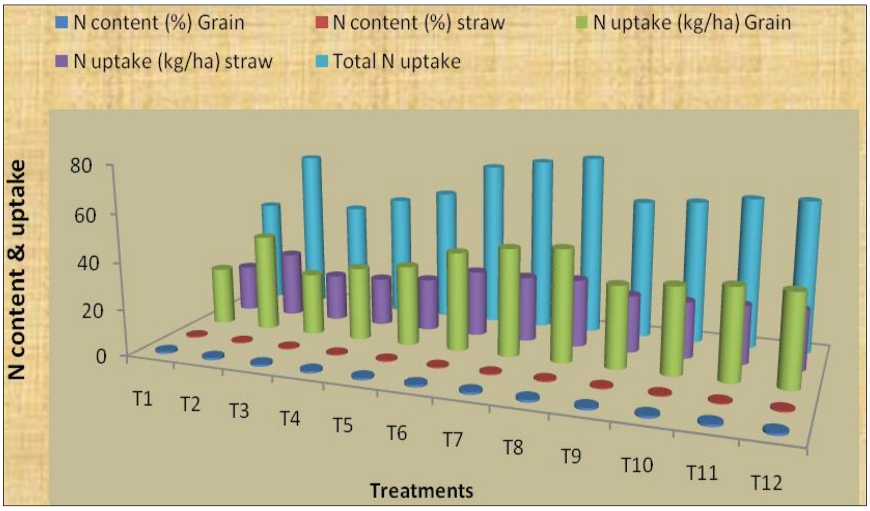

Fig. 3.1: Effect of treatments on nitrogen content and uptake

3.2. Phosphorus content and uptake

3.2.1. Phosphorus content in grain

Phosphorus content in grain of rice under different treatment combination is given in table 4.3.2.The highest P content (0.28%) in grain was recorded in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8), 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) and 50% NPK followed by 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_{11}) 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12})and lowest (0.21%) in 100% NK. The higher levels of phosphorus concentrations in grain were recorded in the combined application of fertilizers and manures compared to the chemical fertilizer alone. Similar results were also found by Singh *et al.* (2001) [7].

3.2.2. Phosphorus content in straw

The effect of different treatments on phosphorus content in straw was found to be non significant (Table 4.4.2. and Fig. 4.4.2). The higher level of phosphorus concentration (0.14%) recorded in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) and 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) which were found significantly higher than control (0.10%) but remind at par with 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{11}), 100% NPK (T_2) and 50% NPK (T_9) which have 0.13% phosphorus content in straw. The lower concentration in straw in control plot may be a result of mining of nutrient with continuous cropping without incorporation of nutrient over a long period of time.

3.2.3. Phosphorus uptake

The phosphorus uptake in both grain and straw of rice was significantly influenced due to various treatments used in the experiment. The phosphorus uptake by grain was varied from 5.4 to 13.1 kg ha^{-1}. The maximum phosphorus uptake by grain was observed in the 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) (13.1 kg ha^{-1}) followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (12.9kg/ ha). The phosphorus uptake by straw was also influenced significantly by different treatments. It was the highest (7.4 kg ha^{-1}) under 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha+ lime 3 q/ha (T_8) treatment followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (7 kg ha^{-1}) treatment. The total uptake was the highest in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) (20.5 kg ha^{-1}) treatment. Hasan *et al.* (2009) stated that total phosphorus uptake increased with the increasing levels of phosphorus.

The effect of different treatments on total phosphorus uptake was found to be significant (Table 4.4.2 and Fig. 4.4.2). The treatments 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8), 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) and 100% NPK +5 t FYM (T_6) were statistically at par and significantly higher than 100% NPK, 50% NPK, 100% NK, 50% NPK + 5 t FYM, and control. Application of 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) produced higher phosphorus uptake (20.5 kg/ ha) followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (19.9 kg/ ha) and lowest in control (9.4 kg/ ha).

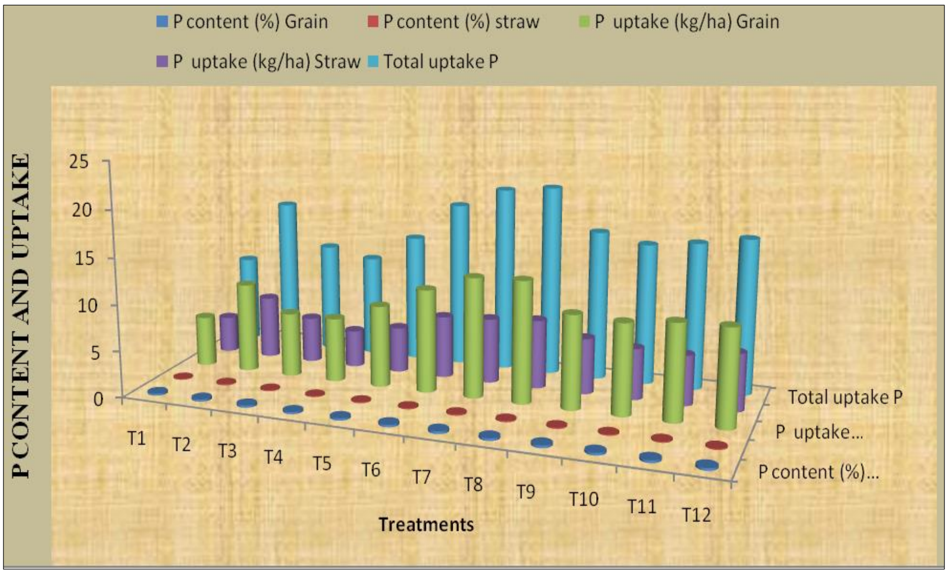

Fig 3.2: Effect of treatments on phosphorus content and uptake

3.3. Potassium content and uptake

3.3.1 Potassium content in grain

Potassium content in grain was ranged from 0.32 to 0.26 percent in different treatments. The higher (0.32%) potassium content in grain was recorded in 100% NPK (T_2) and 100% PK followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8), 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7), 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12}) and 100% NPK +5 t FYM (T_6), 50% NPK +5 t FYM (T_{10}) and 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_{11}) which have 0.31 and 0.30 percent potassium content in grain and lowest concentration (0.26%) was found in control.

3.3.2 Potassium content in straw

The effect of different treatments on potassium content in straw was found to be significant. The higher level (1.27%) of potassium concentrations was recorded in 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12}) and 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_{11}) lower values (1.15%) of potassium concentration in straw was recorded in control. This was indicate that when we applied even half of the RDF with organic manures it sustain nutrient content.

3.3.3 Potassium uptake

The K uptake by both grain and straw of rice was significantly influenced by various treatments under study (Table.4.4.3 and Fig. 4.4.3). The K uptake by grain was varied from 6.5 to 14.4 kg/ ha. The maximum K uptake (14.4 kg ha^{-1}) by grain was observed in the treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8), which was significantly higher from all other treatments. This was followed by the treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (14.1 kg/ ha). The minimum K uptake by grain was recorded 6.5 kg/ ha due to the control.

The K uptake by rice straw was ranged from 43.1 to 64.1 kg/ ha. The highest K uptake (64.1 kg/ ha) was observed in the treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8). This was followed by treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (62.4 kg/ ha). Like k uptake by grain, the lowest K uptake (43.1 kg/ ha) was recorded in the treatment control which was statistically different from all the treatments under study.

The effect of continuous application of organic and inorganic fertilizers on total uptake of potassium was found significant. The total uptake of potassium was significantly higher with 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) treatment over other treatments like 100% NPK, 100% NK, 100% NP, 100% PK, 50% NPK, 50% NPK +5 t FYM and Control. Although the treatments like 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7), 100% NPK + 5 t FYM were also statistically at par in total uptake of potassium with that of T_8 treatment. 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) treatment recorded significantly higher total potassium uptake (78.5 kg/ ha) followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (76.5 kg/ ha) which were highly significant higher over control (49.6 kg/ ha).The results are in agreement with the findings of Das *et al.* (2013) [5], showed that FYM application @ 15 t ha^{-1} along with 100% NPK fertilizers produced maximum yields, nutrients uptake and improve in soil properties.

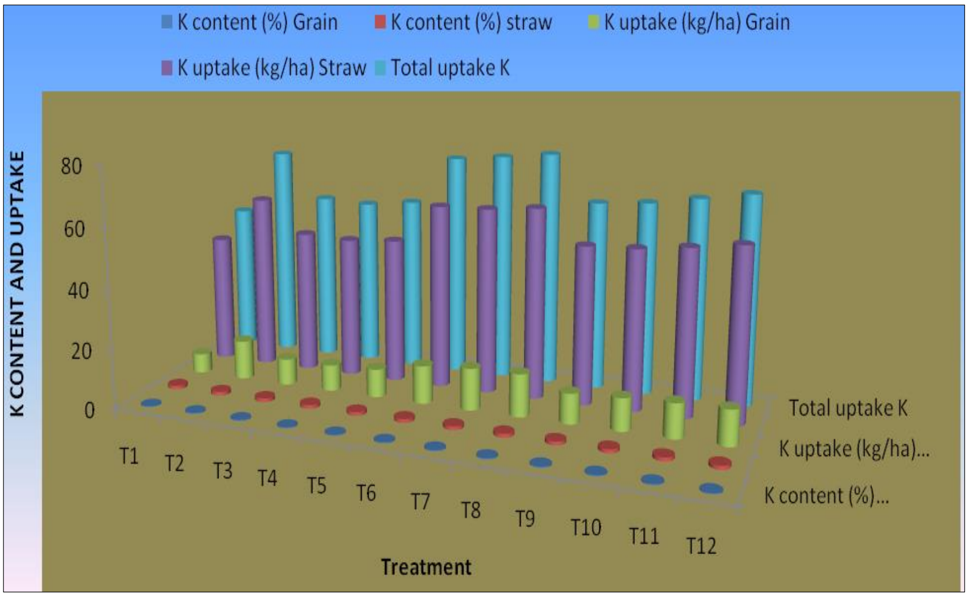

Fig 3.3: Effect of treatments on potassium content and uptake

3.4 Sulphur content and uptake

3.4.1 Sulphur content in grain

Sulphur content in grain of rice under different treatment combination is given in table 4.3.4.The highest S content (0.24%) in grain was recorded in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) and 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12}) followed by 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_{11}) and the lowest sulphur concentration (0.16%) was recorded in control. The higher levels of sulphur concentrations in grain were recorded in the combined application of fertilizers and manures compared to the chemical fertilizer alone.

3.4.2 Sulphur content in straw

The effect of different treatments on sulphur content in straw was found to be non-significant (Table 4.4.4. and Fig. 4.4.4). The higher level of sulphur concentration (0.18%) T_7, T_8, T_{10}, T_{11} and T_{12} which was found significantly higher than control (0.15%) but remind at par with 100% NPK and 50% NPK which have 0.17% sulphur content in straw. The lower concentration in straw in control plot may be a result of mining of nutrient with Continuous cropping without incorporation of nutrient over a long period of time.

3.4.3 Sulphur uptake

The Sulphur uptake in both grain and straw of rice was significantly influenced due to various treatments used in the experiment (Table 4.4.4 and Fig. 4.4.4). The sulphur uptake by grain was varied from 4.0 to 11.3 kg ha^{-1}. The maximum Sulphur uptake by grain was observed in the 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) (11.3 kg ha^{-1}) treatment followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (10.1 kg/ ha). The sulphur uptake by straw was also influenced significantly by different treatments. It was the highest (9.6 kg ha^{-1}) under 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha+ lime 3 q/ha (T_8) followed by 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) (9.4 kg ha^{-1}).

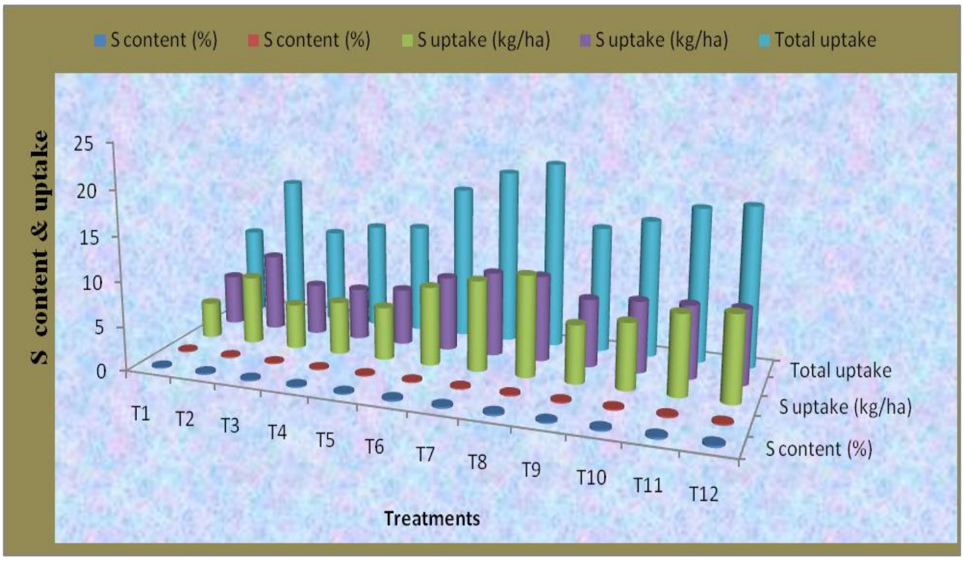

Fig 3. 4: Effect of treatments on sulphur content and uptake

4. Conclusion

High productivity of cereal cannot be sustained unless the declining trend in soil fertility resulting from the nutrient mining by these crops is replenished. Although, use of chemical and /or inorganic fertilizers is the fastest way of replenishing the nutrient depletion, but ever increasing energy cost, limited input availability and rising fertilizer prices deter the farmers from using these inputs to required level. So, the only alternative is the integrated nutrient management aimed at reducing the use of chemicals by integrating organics. Integrated nutrient management has now assumed significance because of intensive farming. Use of organics not only helps to sustain crop yields but also plays a key role by exhibiting both direct as well as indirect influence on nutrient availability in soil by improving the physical, chemical, biological properties and also improves the use efficiency of applied apparent nutrients. It also plays a vital role on sustaining crop productivity, profitability and soil fertility on long-term basis. Continuous application of inorganic fertilizers and manures influences various fractions of N, P and K in soil as well as plant. Higher response was observed in integrated use of organic along with inorganic fertilizer for the nutrient supply of rice grain and straw respectively.

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