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Use of organic fertilizer improves growth and yield of *Triticum aestivum* irrigated with textile wastewater

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ABSTRACT

Water scarcity is one of those issues. Reuse of wastewater from textile industries is a very common strategy to cope with water scarcity. Continuous use of effluent water for agricultural purposes results in negative impacts on physicochemical properties of soil and plant. Organic fertilizers are considered beneficial for soil and crop quality. To exploit the strategies to use this effluent water safely for crop production a pot experiment was conducted with different combinations of organic and inorganic fertilizers viz. T_1= Control (tap water + Recommended dose of NPK (130, 95 and 65 kg ha^{-1}), T_2=Wastewater + Recommended dose of NPK, T_3=Wastewater + Organic fertilizer (200 kg ha^{-1}) + Remaining NPK from inorganic fertilizer, T_4=Wastewater + Organic fertilizer (400 kg ha^{-1}) + Remaining NPK from inorganic fertilizer, T_5 =Wastewater + Organic fertilizer (600 kg ha^{-1}) + Remaining NPK from inorganic fertilizer and T_6=Wastewater + Organic fertilizer (800 kg ha^{-1}) + Remaining NPK from inorganic fertilizer. It was observed that integrated use of organic and inorganic fertilizer (800 kg ha^{-1} organic and remaining of recommended dose from inorganic fertilizer + effluent water) enhanced the growth and yield of wheat crop. In a study found that the use of organic fertilizer could help mitigate the negative impact of textile effluent water on wheat growth.

INTRODUCTION

Water is a primary component in plants, which carries many processes like photosynthesis, movement of salts, maintenance of turgor pressure, regulation of the stomatal opening and acts as a medium for biochemical reactions. Approximately 34% of the world total depends on irrigated agriculture, which is 17% of the total land. This occupies about 30% of cultivated area in arid regions of the world which accounts for 75% of agricultural production.

The water crisis is inevitable. Challenges can be largely avoided by adjusting with water demands and supplies . The scope for water management to contribute effectively to basic human needs and livelihoods is now well documented.

The population of Pakistan is increasing at a rate of 2.6% per annum. One of the best options is use of organic fertilizer along with inorganic fertilizer as an effective tool to fulfil food demands.

Pakistan is an agricultural country and wheat *(Triticum aestivum* L.*)* is the staple crop. Pakistan is facing the severe issue of water scarcity i-e water availability below 1000 m^3. It is assumed that these issues will increase in future. Water is the most important and its timely and adequate availability to crop is essential for crop growth and production.

So, to meet the water crises use of industrial wastewater is the best alternative because it is produced in larger quantity and contains 5% nutrients (EPA 1996). Total wastewater emission is 962.4 billion gallons from all cities of Pakistan of which 674 billion gallons of wastewater from municipal and 288.3 billion gallons from industries (PWSS, 2002).

In many areas wastewater is used for irrigation purpose and has many environmental and human concerns. Some small lands in dry areas are irrigated with wastewater to cope with water requirements for crop growth (Shah, 1996). Wastewater contains many types of pollutants (heavy metals, dyes, chemicals) and many others. Heavy metals, pollutants and pollution factors in wastewater defined in term of chemical oxygen demand (COD), biological oxygen demand (BOD), total dissolved substances (TDS) and Total suspended solids (TSS). Wastewater discharges from textile industries containing inorganic (Pb, Zn, Hg, Cd and Cr) and organic compounds (detergents, disinfectants dyes etc.) . These effluents also contain reactive or non-reactive soluble and insoluble dyes which are carcinogenic and recalcitrant and cause constraints in normal growth and production of crops because of the toxic substances and heavy metals . Irrigation with local textile wastewater alters the soil chemistry also changes the bacterial population in addition to enhancing the intrinsic endurance of these microbes to different metal ions present in their microenvironment . Due to side effects of wastewater on crops, soil and microbial properties certain amendments are required to reduce toxic effects. So, keeping in view all these facts, combine the use of organic fertilizers with wastewater is a better strategy. Organic sources have a significant impact on crop yield and quality . In organic farming composts, organic manures and their extracts are used for improving soil fertility and in combating pests and diseases.

MATERIALS AND METHODS

Experimental site and design

To investigate the role of organic fertilizer to minimize the hazardous effects of textile effluents on growth and yield of wheat (*Triticum aestivum* L.) a pot experiment was conducted in the Glasshouse of Department of Agronomy, Bahauddin Zakariya University, Multan. The experiment was laid out in a Completely Randomized Design with three replicates.

Experimental material

Seeds of the wheat cultivar "Galaxy" obtained from Punjab Seed Corporation, Khanewal were used as experimental material. Textile wastewater containing natural effluents was sampled from the outlet of Fazal Textile Mills (Pvt.) Ltd. Khanewal Road, Multan. The collected sample was analyzed for different soluble effluents such as COD, BOD, TSS and TDS. Wastewater was applied frequently to keep the pots at the moist condition.

Experimental details

Seeds of wheat cultivar Galaxy were sown on November 10, 2017, in earthen pots (30 cm × 28 cm) filled with air dried and sieved through a sieve of 2mm. Pots were filled with 8 kg of soil. The physico-chemical analysis was carried out and is given in Table 01. Before the time of sowing, simple water was applied to saturate the soil-filled pots. Seeds of the wheat cultivar "Galaxy" were soaked in Hoagland solution for germination. After the germination seeds were transplanted to pots. The soil was irrigated with natural textile wastewater. But the control was irrigated with simple water. Organic fertilizer was applied in combination with inorganic fertilizer to alleviate the adverse effects of textile effluents. Physicochemical analysis of experimental soil and the textile wastewater is given in table 3.1 and Table 3.2 respectively. The date regarding textile wastewater is shown in the table. Wastewater was applied to the pots once a week interval till the completion of vegetative growth. Data regarding various attributes were recorded at maturity. Experimental treatments comprised of different combinations of organic and inorganic fertilizers viz. T_1= Control (tap water + Recommended dose of NPK (130, 95 and 65 kg ha^{-1}), T_2=Wastewater + Recommended dose of NPK, T_3=Wastewater + Organic fertilizer (200 kg ha^{-1}) + Remaining NPK from inorganic fertilizer, T_4=Wastewater + Organic fertilizer (400 kg ha^{-1}) + Remaining NPK from inorganic fertilizer, T_5 =Wastewater + Organic fertilizer (600 kg ha^{-1}) + Remaining NPK from inorganic fertilizer and T_6=Wastewater + Organic fertilizer (800 kg ha^{-1}) + Remaining NPK from inorganic fertilizer.

Wastewater analysis

Wastewater was collected from Fazal Textile Mills (Pvt.) Ltd. Khanewal Road, Multan. The water sample was collected from the site and immediately cooled to maintain its properties and was tested for pH, COD, BOD, TSS and TDS. Typical characteristics of textile wastewater vary from industry to industry. Physicochemical characteristics of woven, dyeing, printing and knitwear processing industry are given in the table.

Table Typical characteristics of textile industry wastewater.

Parameters	Dyeing	NEQS(Into inland waters)
pH (mg/l)	8.3-11.7	6-9
BOD (mg/l)	200-570	80
COD (mg/l)	640-1200	150
TSS (mg/l)	320-940	200
TDS (mg/l)	1280-540	3500

RESULTS AND DISCUSSION

Plant height

Data regarding plant height showed that various treatments differed significantly. It was observed that tallest plants were found in control than the other treatments. In contrast, the second treatment which comprises of effluent water and recommended dose of fertilizer showed the lowest plant height. Whereas remaining treatments showed an increasing trend for plant height as the effluent water and organic fertilizer application increased. In the treatments an increasing trend of 200 for each treatment was applied which showed a significant difference when compared with control as 23, 14, 9, 4 and 0 percent respectively. In conclusion, an increase in organic fertilizer increased plant height. However, very little difference was observed between the treatments containing organic fertilizer and effluent water. In this contest, treatment using tab water (T1) and effluent water + a recommended dose of fertilizer (T2) showed a higher difference for plant height in the graph.

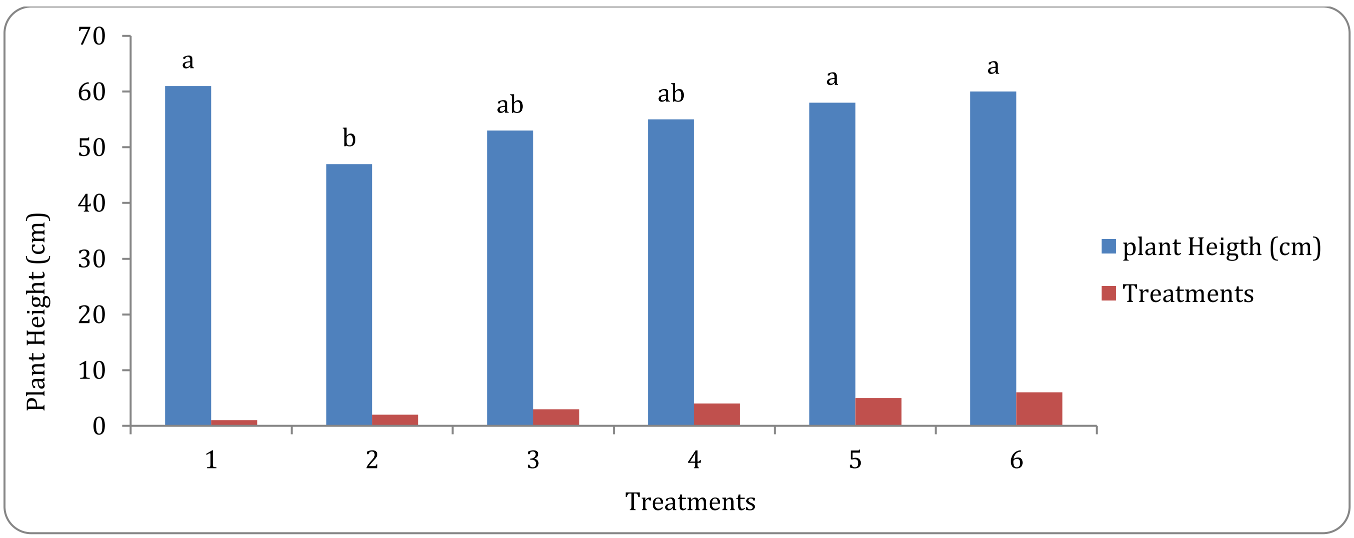

Figure 1. Effect of different treatments on plant height.

Spike length (cm)

Different treatments significantly differed for spike length. Among various treatments, maximum spike length was measured from control where tap water + recommended dose of NPK were applied. Likewise, control and treatment using wastewater and recommended dose of NPK (T2) showed more difference than the other treatments. In this regard, wastewater decreased the spike length by 23% as compared with control. It was interestingly observed that increase in organic fertilizer in rest of the treatments i.e. T3, T4, T5 and T6 instead decreased the spike length by 45, 35, 29, 19 and 10& respectively which showed the negative impact of wastewater. However, very little difference was observed among T3, T4, T5 and T6 with each other but an increasing trend for spike length was observed among them in the graph.

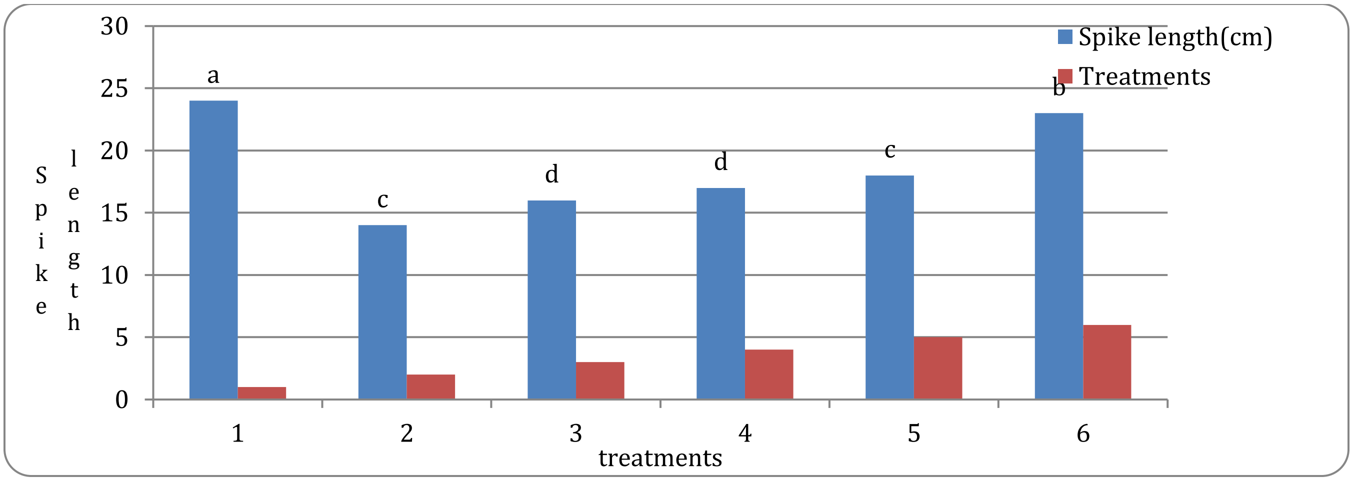

Figure 2. Effect of different treatments on spike length.

Shoot Fresh Weight (g)

The Results of shoot biomass data showed variable positive potential for different treatments for the wheat crop. It was observed that all the treatments showed statistically significant results from control (tap water). Maximum shoot biomass was observed in control. While effluent water showed 52%, decrease from control while other treatments with increasing trend of shoot biomass with 38, 29, 19 and 10% difference from control. Minor differences were observed in an increasing trend of shoot biomass in which different levels of organic fertilizer were used. It was interesting that increasing trend of organic fertilizer increased shoot biomass of wheat crop in the presence of textile effluent water. It is concluded that organic fertilizer has the potential to increase shoot biomass in presence of wheat crop. However, the highest difference was between the treatments T_1 (tap water) and T_2 (effluent water) irrigation.

Overall it is concluded from the data that organic fertilizer had a positive inhibitive effect on shoot biomass and soil physical and chemical properties.

Shoot Dry Weight (g)

Different levels of organic fertilizer have great potential for dry shoot biomass of wheat plant. Results of data clearly showed that all the treatments were significantly different as compared to control. However, maximum dry shoot biomass was obtained from control (tap water) irrigation. Minimum dry shoot biomass was observed with effluent water irrigation with chemical fertilizer. All other treatments T3, T4, T5 and T6 with organic fertilizer at 200, 400, 600 and 800 kg ha^{-1} showed an increase in dry shoot biomass length as compared to control. Dry shoot biomass significantly increased in the treatments in which different levels of organic fertilizer were used. It was concluded from the data that organic fertilizer had a positive effect on dry shoot biomass of wheat crop. Treatment means of root biomass data revealed 34, 62, 79 and 110% difference from treatment T_2. The highest mean difference was between tap water and effluent water with recommended doses of chemical NPK. All the treatments showed statistically significant results.

However, it was also clear from the data that treatment T_1 (tap water + recommended dose of chemical fertilizer) and treatment T_6 (effluent water + 800 kg ha^{-1} organic fertilizer) had almost the same results.

Number of Grains per Spike

Data regarding no. of grains/spike showed that different levels of organic fertilizers under effluent water irrigation have a significant effect on grains. It is clear from the results that control (tap water) irrigation with a recommended dose of chemical fertilizer showed maximum activity for no. of grains/spike. Effluent water with chemical fertilizer showed minimum no. of grains. All other treatment T_3, T_4, T_5 and $T_6$with organic fertilizer at 200, 400, 600 and 800 kg ha^{-1} showed that increase in organic fertilizer significantly increased no. of grains. Treatments showed 18, 13, 9, 4 and 1% difference from control respectively. Treatments in which organic fertilizer was used showed minor differences among them. The highest mean difference between treatments T_1 (tap water) and T_2 (effluent water) was observed. It was concluded from the data that organic fertilizer had a positive inhibitive effect on no. of grains/spike of wheat crop. However, it was noted that treatment T_5 (600 kg ha^{-1} organic fertilizer) and treatment T_6 (800 kg ha^{-1} organic fertilizer) showed almost the same results for no. of grains/spike in the graph.

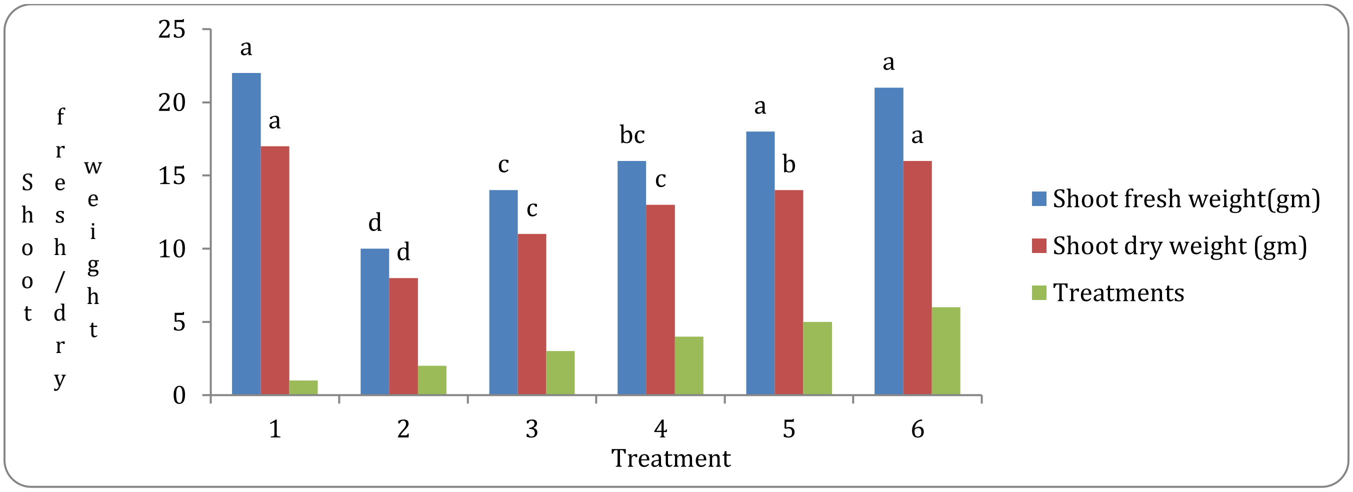

Figure 3. Effect of different treatments on fresh and dry shoot weight.

1000 grain weight

Data regarding 1000 grain weight showed that different levels of organic fertilizers under effluent water irrigation have a significant effect on 1000 grain weight. It is clear from the results that control (tap water) irrigation with the recommended dose of chemical fertilizer showed maximum activity for 1000 grain weight. While treatment T_2 (effluent water) in combination with chemical fertilizer resulted in the lowest 1000 grain weight. All other treatment T_3, T_4, T_5 and $T_6$with organic fertilizer at 200, 400, 600 and 800 kg ha^{-1} showed that increase in organic fertilizer significantly increased 1000 grain weight. Treatments T_6 (effluent water + organic fertilizer at 800 kg ha^{-1} and remaining from chemical fertilizer of recommended dose) and T_1 (tap water + recommended dose of chemical fertilizer) almost showed the same results as compared to other treatments with different levels of organic fertilizer. Treatments in which organic fertilizer was used showed minor differences among them. The highest mean difference between treatments T_1 (tap water) and T_2 (effluent water) was observed. It was concluded from the data that integrated use of organic and inorganic fertilizers had a positive inhibitive effect on 1000 grain weight in presence of wheat crop graph.

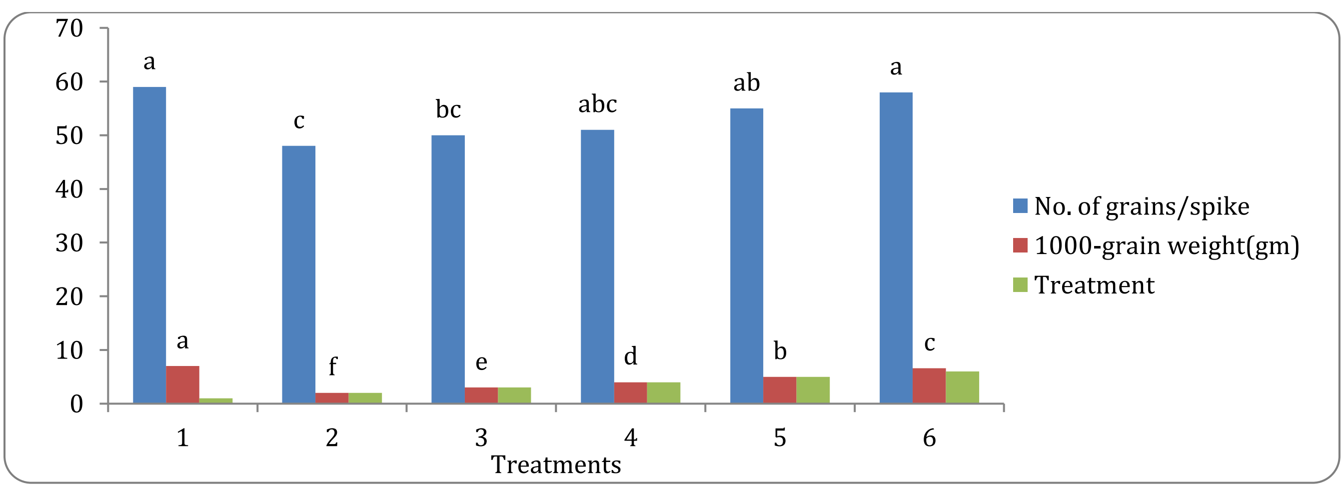

Figure 4. Effect of different treatments on no. of grains/ spike and 1000 grain weight

Nitrogen in straw (%)

Different levels of organic fertilizer have great potential for straw nitrogen (%) of the wheat plant. Results of data clearly showed that all the treatments were significantly different as compared to control. However, maximum straw nitrogen was obtained from control (tap water) irrigation. Minimum straw nitrogen was observed with effluent water irrigation with chemical fertilizer. All other treatments T_3, T_4, T_5 and T_6 with organic fertilizer at 200, 400, 600 and 800 kg ha^{-1} showed an increase in straw nitrogen as compared to treatment T2 (effluent water). Straw nitrogen significantly increased in the treatments in which different levels of organic fertilizer were used. It was concluded from the data that organic fertilizer had a positive effect on straw nitrogen of wheat crop. Treatment means of straw nitrogen data revealed 31, 110, 141 and 192% increase in straw nitrogen from treatment T_1 (effluent water). The highest yield was observed in treatment T_1 (tap water) with recommended doses of chemical NPK. Overall, it was observed that straw nitrogen was increased in the presence of organic fertilizer and textile effluent water in case of wheat crop.

Nitrogen in grain (%)

The Results of Nitrogen in grain (%) data showed variable positive potential for different treatments for the wheat crop. It was observed that all the treatments showed statistically significant results as compared to control (tap water). Maximum nitrogen in grain was observed in control. While treatment T_2 (effluent water + recommended dose of chemical fertilizer) showed a 23% decrease from control. Other treatments T_3, T_4, T_5 and T_6 showed an increasing trend of grain nitrogen 11, 21, 29, and 45% as compared to treatment T_2 (tap water). These treatments T_3, T_4, T_5 and T_6 had organic fertilizer at 200, 400, 600 and 800 kg ha^{-1}. Difference between the treatments in which organic fertilizer used was minor but in increasing trend. Overall, it was observed that increasing trend of organic fertilizer increased grain nitrogen of wheat crop in the presence of textile effluent water. Overall, it was concluded from the data that organic fertilizer with textile water irrigation had a positive inhibitive effect on grain nitrogen in the presence of wheat crop.

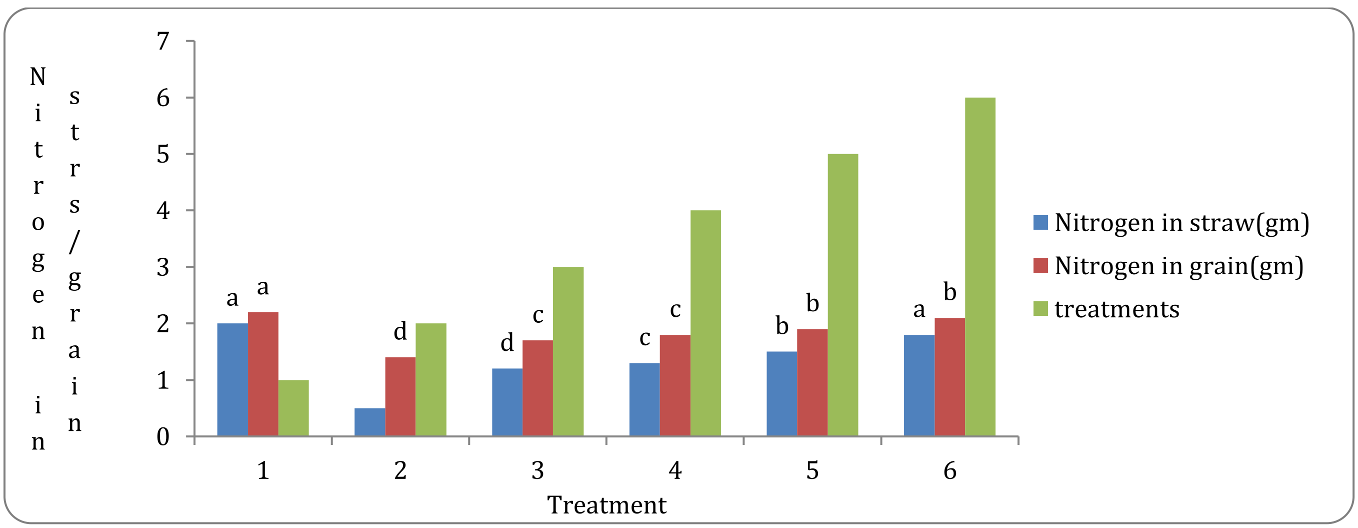

Figure 5. Effect of different treatments on nitrogen in straw and grains.

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