Research Article

Effect of Farm Yard Manure and Compost Application on Transgenic BT Cotton Varieties

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Abstract | In Pakistan, the research work on cotton since started from the independence and many of the cultivars were introduced and evolved. But the fiber quality and seed cotton yield up to now till is poor in quality as compared to other developed countries. A judicious combination of manures and fertilizers depending upon the availability, the type of the soil and crops to be grown would not only maximize the crop production and improve the quality of agricultural products but would also maintain the fertility, productivity and overall health of the soil for posterity. So, keeping in view the beneficial effects of organic sources i-e compost and farm yard manure (FYM), a field experiment was planned with the objectives to study the comparative effect of organic sources on cotton growth and yield and to evaluate the comparative performance of different BT cotton variety. The treatments were T_0: Control T_1: FYM @10 tons ha^{-1}, T_2: Compost @10 tons ha^{-1} and T_3: FYM @10 tons ha^{-1}+ Compost @10 tons ha^{-1}. Three BT cotton varieties (BT-142, Lala zar and BT-786) were tested against the organic sources applications impacts. The application of compost and FYM in combined increased the physical parameters number of bolls per plant, plant height, sympodial branches, monopodial and seed cotton yield as compared to compost and FYM individual application. Among the all varieties, Lalazar performed better by producing maximum monopodial and sympodial branches, plant height, bolls per plant and seed cotton yield as compared to BT-142 and BT-786 while minimum performance was observed in BT-142.

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Keywords | BT Cotton, Soil properties, Organic amendment, Pod yield

Introduction

Current estimates for world production are about 25 million tonnes or 110 million bales annually, accounting for 2.5% of the world's arable land. Cotton is one of the most important commercial fibers produced and is one of the most important commodity imported and exported all over the world due to their uses in textile industry, mattress and bedding industry. The annual world production of cotton is staggering 25 million tons, accounting for 2.5% of the world's arable land. Cultivation of cotton balls is a difficult task in itself and requires a lot of effort and labor. Invention of Cotton ginning process and mechanisation has helped the producers to decrease labor and boost the production (Gudeta and Egziabher, 2019).

In Pakistan economy of foreign exchange, cotton accounts for 1.5 percent in GDP and 7.1 percent in agriculture value addition and production was 9861 thousand bales. During July-March 2014-15, textile industry fetched foreign exchange of US$ 10.22 billion (GOP, 2019). Pakistani soils are organic matter deficient because of arid and semi arid climate while the continuous cropping without concerning the organic sources of fertilizers is also an alarming issue. Soil organic matter improve the soil structure, aeration, porosity, water holding and nutrient holding capacity. FYM application improve the soil fertility as well as crop production (Weil and Magdoff, 2004; Jamal et al., 2019).

The important crops (wheat, rice, sugarcane maize and cotton) account 21.90 percent in the value addition of agriculture sector and 4.06 percent in GDP. The other crops account 11.21 percent in the value addition of agriculture sector and 2.08 percent in GDP. The production of cotton was 9861 thousand bales (Pakistan Bureau of Statistics, 2018-19).

Compost applications have a great role in sustainability of agriculture. The proper use and its management have many advantages especially by adding the nutrients (Tejada et al., 2001), increasing soil organic matter, improving physical properties like soil aggregation, bulk density, penetration resistance and water holding capacity. All these factor act as a supplier for nutrient supply and improves the plant growth (Wells et al., 2000; Togun and Akanbi, 2003; Sarwar et al., 2008). The sources of organic fertilizers have got a great importance because of their source of multiple nutrients and soil physical and chemical characteristics especially low input of organic material. The application of organic sources like manure application improved the soil physical properties especially soil texture, availability of nutrients like N, P and S as well as the micronutrients and also lower down the soil temperature and conserve the moisture (Ouedraogo et al., 2001; Palm et al., 2001; Soumare et al., 2003).

Pakistan already facing the challenges like food and energy crisis. The utilization of inorganic fertilizers is also industrial dependent which is the reason of their higher cost and also harmful for environment if they are applied in higher dose. Another hand by using organic fertilizers pollution can be controlled as well as the produce quality will be improved. For these investigations survey should be carried for comprehensive technology and production package for efficient utilization of all available sources on farm Ahmad et al. (2008). The daily boost up prices as well as energy crisis in Pakistan are the main constraints to purchase the inorganic fertilizers. Formers utilizing organic sources of fertilizers like FYM and compost as they are the cheapest sources and easily available (Zahir et al., 2007; Sial et al., 2007).

Keeping in view the importance of organic sources effect on cotton growth, a field experiment was conducted to study the comparative effect of organic sources on cotton growth and yield and to evaluate the comparative performance of different BT cotton varieties

Materials and Methods

Location and experimental layout

The field experiment was conducted at Mouza Nari Dhumrya, Tehsil Kot Chutta, Dera Ghazi Khan (33° 38′ N, 73° 05′). This is part of the core area for cotton production in Punjab. Soil samples were taken from the depth of 0-15 and 15-30 cm to check the fertility status of soil and processed in the laboratory after air drying and grinding. After determination of soil texture, samples were analyzed to determine soil ECe, pH, soluble cations and anions as according the given method of US Salinity Lab. Staff (1954) (Table 1). The plots in the field were designed randomized complete block design with repetition of each block in four times. The compost was purchased from Syngenta company. Bouyoucous hydrometer method was used for soil texture determination (Bouyoucos, 1962). Soil had pHs 7.93 and ECe of 1.79 dS m^{-1} with 0.85% organic matter (Nelson and Sommers, 1982). Three BT cotton varieties BT Cotton verities BT 142, Lala Zar and BT 786 were used as plant material. The concentration of nitrogen, phosphorus and potassium was measured from compost and farm yard manure. Keeping in view the original concentration of nitrogen, phosphorus and potassium in farm yard manure and compost the treatments were finalized (Table 2). There were four treatments i-e T_0: Control, T_1: FYM @10 tons ha^{-1}, T_2: Compost @10 tons ha^{-1} and T_3: FYM @10 tons ha^{-1}+ Compost @10 tons ha^{-1}. The half-recommended dose of NPK @100-75-50 kg ha^{-1} were applied in the form of Urea, Di-ammonium phosphate and potassium sulphate. The calculated rate of compost and FYM was applied

before the sowing of crop.

Measurements and calculations

The planting was made with combine cotton drilling machine. The experiment was thinned and hoed two times by hand and three times with machine and only once herbicides were applied just before sowing. Insects were monitored throughout the experiment and decided that no insect control was necessary during growing season.

All plots were irrigated seven times through furrow irrigation.

For the analysis of physical parameters like monopodial, sympodial branches, plant height, number of bolls per plant, seed cotton yield (g), lint percentage, lint yield and seed cotton weight per boll were recorded. The lint obtained from each sample was weighed and lint percentage was calculated by following formula.

$$\text{Lint Percentage} = \frac{\text{Weight of lint obtained in sample}}{\text{Weight of seed cotton in sample}} \times 100$$

For the analysis of ionic parameters plant samples were oven dried at 75°C for 48 hours. The plant samples were wet digested by using di-acid (HNO_3:$HClO_4$ ratio of 2:1) mixture (Jones and Case, 1990) while nitrate- nitrogen concentration in leaf was determined by the method of (McGill and Figueiredo, 1993).

Statistical analysis

To measure the difference among the means of treatments, data was subjected to statistical analysis in RCBD 2 factorial arrangement (Steel et al., 1997) by using Statistics 8.1 software.

Results and Discussion

Sympodial and monopodial branches per plant

Application of both organic sources in combine or individual increased the sympodial and monopodial branches per plant of all the varieties as compared to the controlled conditions. Maximum sympodial branches per plant (18) and monopodial branches per plant (7.00) were observed in lala zar cotton varieties while minimum sympodial (4.66) and monopodial branches per plant (4.66) was observed in BT-142 varieties (Figure 1).

Organic sources application creates a significant (P<0.05) difference in case of monopodial and sympodial branches per plant of all the varieties. Comparatively, Lala zar varieties produced maximum sympodial branches (18.33) through combined application FYM and compost while minimum sympodial branches (16.00) was observed in BT-142 varieties.

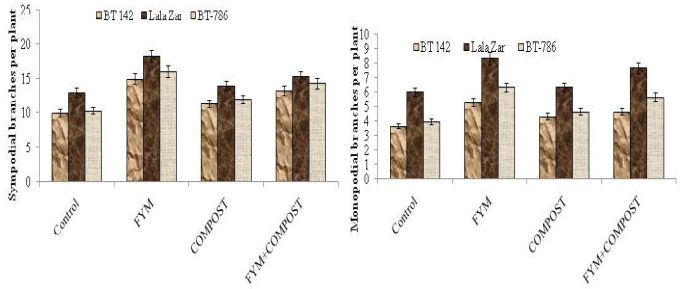

Figure 1: *Effect of FYM, compost and combined effect of FYM and compost on sympodial and Monopodial branches per plant of cotton genotypes.*

Bolls per plant and lint percentage (%)

The bolls plant^{-1} of all the varieties increased by organic sources application into the soil. The maximum bolls plant^{-1} (60.66) and percent of lint (40.66%) was observed in lala zar and BT-786 while minimum bolls plant^{-1} (43.33) and lint percent (36%) was observed in BT-142 varieties (Figure 2).

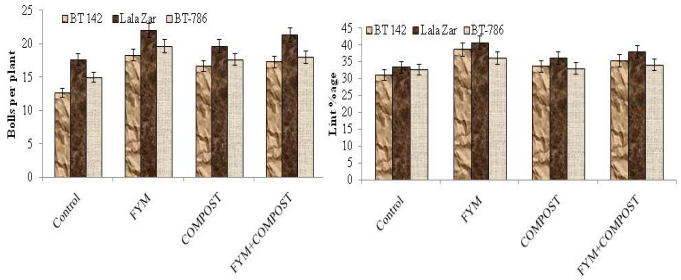

Figure 2: *Effect of FYM, compost and the combined effect of FYM and compost on boll per plant and lint percentage of cotton genotypes.*

Application of organic sources significantly (P<0.05) increased bolls plant^{-1} (60.66) and lint percent of all cotton varieties. In case of combined application of both organic sources, maximum bolls plant^{-1} (21.33) and lint percent (40) was observed in Lala zar varieties while minimum bolls plant^{-1} (17.33) and lint percent (37) was observed in BT-142 varieties.

Seed cotton yield (kg ha^{-1}) and lint yield

The application of organic sources increased the seed cotton yield of all cotton varieties. The maximum seed cotton yield (2088.7) and lint yield (913 kg ha^{-1}) was observed in lala zar and while minimum seed cotton yield (1590 kg ha^{-1}) and lint yield (490 kg ha^{-1}) was observed in BT-142 varieties (Figure 3).

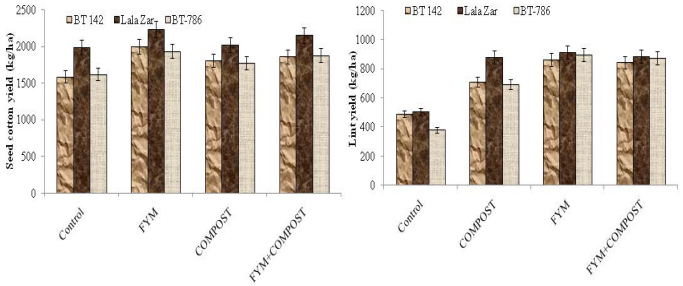

Figure 3: *Effect of FYM, Compost and the combined effect of FYM and Compost on seed cotton and lint yield of cotton genotypes.*

A significant difference (P< 0.05) was observed between the treatments on seed cotton yield and lint yield by applying organic sources. In case of combined application of both organic sources, maximum seed cotton yield (2353.3 kg ha^{-1}) and seed cotton yield (880 kg ha^{-1}) was observed in Lala zar varieties while minimum seed cotton yield (1963.3 kg ha^{-1}) and minimum lint yield (843 kg ha^{-1}) was observed in BT-142 varieties.

Plant height (cm) and seed cotton weight per boll

The organic sources application improved the plant growth and increased the plant height per plant of all the varieties. Maximum plant height per plant (90.66) and seed cotton weight per boll (1.40 g boll^{-1}) was observed in lala zar cotton varieties while minimum plant height per plant (66.33 cm) and cotton weight per bolls (1.15 g boll^{-1}) was observed in BT-786 varieties (Figure 4). Application of both the organic sources significantly increased the plant height and seed cotton weight per boll of all the cotton BT varieties. In case of combined application of both organic sources, maximum plant height per plant (94 cm) and seed cotton weight per boll (1.36 g boll^{-1}) was observed in Lala zar varieties while minimum plant height per plant (79.33 cm) and minimum Seed cotton weight per boll (1.33 g boll^{-1}) was observed in BT-142 varieties.

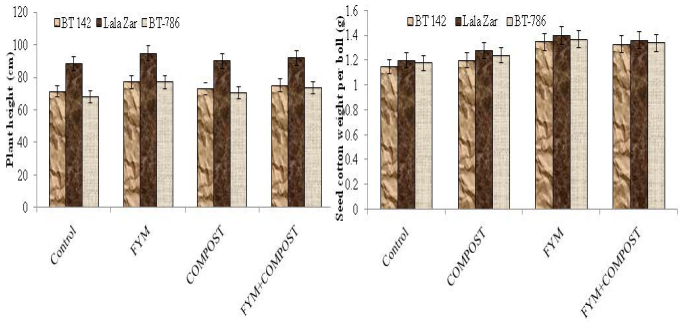

Figure 4: *Effect of FYM, Compost and the combined effect of FYM and Compost on plant height and seed cotton weight per boll of cotton genotypes.*

Leaf N and P concentration

The effect of treatments on N content was significant at (P< 0.05).

FYM application significantly increased the N content of all the varieties. The maximum N content (30.05 g kg^{-1}N) and P content (2.98 g kg^{-1}P) was observed in Lala zar varieties while minimum N content (20.00 g kg^{-1}N) and P content (2.66 g kg^{-1}P) was observed in BT-142 varieties (Figure 5).

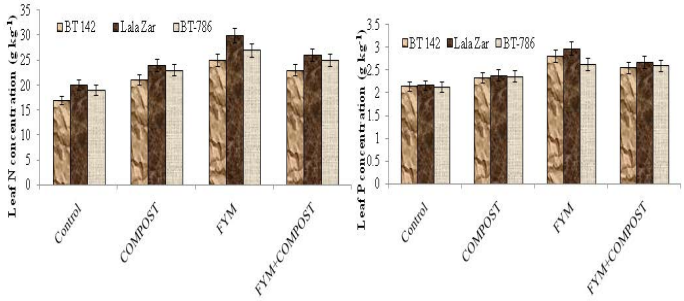

Figure 5: *Effect of FYM, Compost and the combined effect of FYM and Compost on leaf N (g kg^{-1}) and P concentration (g kg^{-1}) of cotton genotypes.*

In case of Compost application, compost application significantly (P<0.05) increased the N content of all the varieties. The maximum N content (24.00 g kg^{-1}N) and P content (2.34 g kg^{-1}P) was observed in Lala zar varieties while minimum N content (21.00 g kg^{-1}N) and P content (2.39 g kg^{-1}P) was observed in BT-142 varieties. In case of combined application, maximum P content (2.67 g kg^{-1}P) was observed in Lala zar varieties while minimum P content (2.56 g kg^{-1}P) was observed in BT-142 varieties.

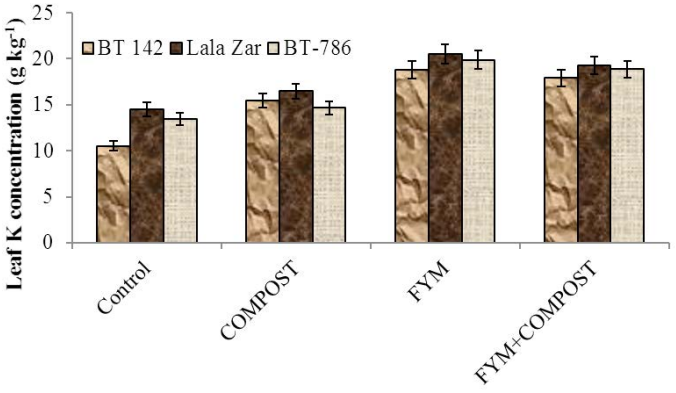

Figure 6: *Effect of FYM, Compost and the combined effect of FYM and Compost on leaf K concentration (g kg^{-1}) of cotton genotypes.*

Leaf K concentration

The effect of treatments on K content was significant at (P< 0.05). In case of FYM application, FYM application significantly (P<0.05) increased the K content of all the varieties. The maximum K content

(20.52 g kg^{-1}K) was observed in Lala zar varieties while minimum K content (18.78 g kg^{-1}K) was observed in BT-142 varieties (Figure 6). In case of Compost application, maximum K content (16.50 g kg^{-1}K) was observed in Lala zar varieties while minimum K content (14.67 g kg^{-1}K) was observed in BT-786 varieties. By applying FYM and compost combined, maximum K content (19.30g kg^{-1}K) was observed in Lala zar varieties while minimum K content (17.90 g kg^{-1}K) was observed in BT-142 varieties.

Table 1: *Physicochemical properties of soil used for experiment.*

Soil characteristics	Values
Saturation percentage (%)	56
Texture	Clayey soil
pH_s	7.50
SAR (mmol $L^{-1})^{1/2}$	3.38
EC_e (dS m^{-1})	1.85
Total N (%)	0.047
Extractable P (mg kg^{-1})	7.4
Extractable K (mg kg^{-1})	85
Organic matter (%)	0.60

Table 2: *Nutrient concentration of FYM and compost used for experiment.*

NUTRIENT (%)	FYM	COMPOST
N	1.86	1.20
P	0.94	1.76
K	0.76	1.26

Organic sources are the composed of plants and animals waste material as they are the main source of essential elements beside of this they have a key role in water and nutrient holding capacity and also increased the cation exchange capacity (CEC) of soil. Positive effect of compost and FYM application on plant height and seed yield of cotton was due to enhanced carbon sequestration in soil and other improved soil properties. Application of FYM and compost could have boosted cotton growth and yield (Nazarov and Boltaev, 2010). Application of N fertilizer at the later stages caused the accumulation of more N which was found beneficial Yang et al. (2013).

A clear difference was observed through FYM application then compost application in case of boll bearing branches. Similar findings were also observed by other researchers especially in case of boll bearing branches and plant height through FYM application (Sawan et al., 2000; Kassem et al., 2009; Gebaly, 2011). These results are in agreement with the findings of with those stated by Al-Kahal et al. (2007) in case of number of open bolls $plant^{-1}$, monopodial and sympodial branches by Attia et al. (2008) and Gebaly (2011) and boll weight and seed index by Abdel Aal et al. (2011).

Beneficial effects of combined application of organic manures with inorganic fertilizers to cotton in respect of nutrient uptake are supported by observations of Badole and More (2001) and Peshin et al. (2007). The application of organic sources increased the cotton yield and yield components (Ali et al., 2011). Among the organic sources FYM application is mostly common and have a beneficial effect on plant growth by improving the soil physical properties and have a role in nutrient availability (Clement-Bailey and Gwathmey, 2007; Sawan et al., 2008). Some other studies have reported that the application of organic sources increased the number of bolls by improving the plant growth (Dong et al., 2010; Boquet, 2005; Rinehardt et al., 2004). Our results indicate that the application of FYM increased the plant growth as compared to compost application which is also reported by Singh et al. (2013).

Application of organic manure showed a significant effect on the size of cotton boll. This result is in line with that of (Adeli et al., 2005) who reported larger boll size in poultry manure amended soil compared with non- applied plot. Larger boll produced more lint's and seed than the small size boll. Similar results have been reported by (Tewolde et al., 2007) on cotton lint yield. The highest boll weight of 6.57 g obtained in this study is close to and even higher than the boll weight of 5.30 g obtained by (Islam et al., 2014) from using 100% N from urea, and boll weight of 4.75 g obtained by (Gnanasekaran and Padmavathi, 2013) in India.

Phenotypic and genotypic correlation and showed that lint yield was the major contributor to yield, and it was followed by lint percentage and boll weight (Afiah and Ghoneim, 2000). However, other traits were found to have minor contributions towards the variations in seed cotton yield. The genetic variances were found greater than environmental variances and the heritability was also high with desired genetic gain and in presence of positive correlation, authenticated

that the cultivars have the potential to enhance the lint %. Meena et al. (2007) studied the stability and adaptability of *G. hirsutum* and observed varied values for lint percentage. Khan et al. (2009) confirmed through study of upland that bolls per plant had the most important effect on lint yield. The inconsistent findings and different views of past researchers about the said trait might be due to genotypic and environmental differences.

The yield components such as number of boll per plant and boll weight strongly influence the cottonseed yield (Sattar et al., 2017). The high lint and seed yields obtained in this study is in agreement with that of (Tewolde et al., 2009) who reported that lint and seed yields per boll were relatively higher under the application of poultry manure. In this study, seed yield increased relatively more than the lint yield contradicting (Tewolde et al., 2009) report that lint yield increased relatively more than seed yield.

Similarly, Gwarazimba (2009) also observed that the application of organic sources like FYM, compost, press mud and poultry manure application improve the physical conditions of soil and results into the enhancement in seed and lint yield of cotton crop. An enhancement in lint yield were also find by Beedy et al. (2010) through the application of farm yard manure. Application of organic fertilizers like farm yard manure and compost alone or in combination significantly increased the N, P and K content in cotton. Organic materials alone increased N contents of plants over control which might be due to organic sources decomposition which enhances the process of mineralization of organic matter (Lal et al., 2009), releasing more nutrients into the soil–plant system (Dube et al., 2009).

The highest N concentration was observed in Lala zar varieties where the FYM source was applied while the application of compost not increased the recovery and uptake of N. A positive interaction between organic (biological nutrients) and mineral fertilizers also reported by Ahmad et al. (2008) and Yaduvanshi (2003) as they argued that organic fertilizer application increased the nutrient efficiency and reduced their loss to environment.

The application of organic sources increased the P availability by releasing the organic acids and making complex with immobile nutrients (Eghball et al., 2004; Loecke et al., 2004). Potassium is the only element which is absorbed by the plant in the elemental form and remained same but having the main role in the enzymatic activities for the plant growth. Some other researchers (Muneshwar et al., 2001; Ahmad et al., 2008; Zahir et al., 2007; Rashid et al., 2016) also observed that the application of FYM and compost increased the growth of maize and wheat crop. An advantage associated with organic manures was their potential to supply nutrients over a longer period of time compared to chemical fertilizers which led to higher nutrient use efficiency and ultimately maize yield along with net returns were doubled (Ali et al., 2015; Akram et al., 2019; Ahmad et al., 2019).

Conclusions and Recommendations

It was concluded that the combined application of FYM and compost application increased the all morphological and chemical attributes as compared to their individual source application. Comparing the sources the application of FYM was beneficial as compared to compost application.

Outcome of current study reveals that the application of organic sources especially the combined application remained beneficial. Furthermore, the results from this research depict that organic sources application improved the cotton growth and the combination of these organic sources fertilizer increase the crop growth and reduce the fertilizer cost if some one adopt the mixed strategy.

Author's Contribution

Muhammad Jan conceived different research idea and conducted experiment Safdar Hussain participated in article overall management Anwar ul Haq improved the language Javed Iqbal conducted data analysis Ilyas Ahmad prepared first draft Muhammad Aslam provided technical input Aiman Faiz helped out to improve manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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