Research Article

Effect of Different Levels of Organic Matter and Genotypes on Seed Yield and Fiber Quality in Cotton (*Gossypium hirsutum* L)

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Abstract | The addition of organic matter improves yield, fiber quality and seed germination of cotton. The present studies were conducted at Cotton Research Station Vehari, Punjab, Pakistan during 2016 to find out the impact of organic matter on growth and yield of cotton. Farm yard manure and green manuring of berseem was done for consecutive four years to improve soil organic matter from initial organic matter of 0.7% and improved to 1.0 % after two years and after repeated use, it improved to 1.5 % during fourth year. Three levels of organic matter i.e., <0.5%, 1% and 1.5% were studied. It was found that by increasing organic matter significant increase was observed in all studied traits (Number of bolls per plant, boll weight, boll retention %, seed germination %, seed index and fiber characteristics). However, T3 (organic matter (1.5%) showed maximum increase in all characteristics. In T2 (organic matter 1%) varieties showed 15.8 to 19% increase in bolls per plant and 33.3 to 36.8% in T3. In treatment with organic matter (0.5%) the boll weight was (2.46gm), number of bolls (19.0), boll retention (38.0%), Ginning Out Turn (GOT) (37.7%), fiber strength (30.7), staple length (28.0mm), fiber fineness (4.3), seed germination (64.7%) and seed index (6.67%) respectively. In treatment with organic matter (1.5%) boll weight was (5.3gm), number of bolls (28.3), boll retention (66.3%), GOT (40.3%), fiber strength (35.4), staple length (29.4mm), fiber fineness (4.6), seed germination (88.7%) and seed index (9.7%) respectively. FH-Lalazar responded better to organic matter and its yield was more as compared with MNH-886 and VH-311. It is suggested that farming community should focus on enhancement of organic matter and varieties highly responsive to it for better productivity in future.

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Introduction

Cotton is a major cash crop of southern Punjab; it plays a vital role in agriculturally based economy of Pakistan. Poor soil fertility is a major cause of low productivity. That is why average yields in Pakistan are low among top cotton producing countries. There is a need to improve quantitative

and qualitative characteristics of soil by improving soil organic matter. Organic matter is life of soil that enables it to perform efficiently. So, goes a pristine proverb (translated from the Telugu Language) a soil without manure is as barren as is a cow without calf. Pakistani farmers are also well aware about the value of sustaining productivity through liberal dressings of organic manure. We understand that soil organic matter is the central elements of soil fertility, productivity and quality of the produce also. Prevalence of warm temperature along with abundant moisture, accelerates organic matter decomposition and loss. Consequently, soils with depleted organic matter content are observed in poor physical health, loss of favorable biology and occurrence of several nutrient deficiencies. Abiotic and biotic factors influencing soil health and/or soil degradation. Soil health, 145-161 (Kumar and Karthika, 2020). In fact, soil organic matter is the basic resource of several elements for normal growth of plants. Normally 95% of N and S as well as almost 70% of Zn and Cu in soil occurs in organic form (Yasmeen *et al*., 2022). The proportion of phosphorus associated with soil organic matter is variable. According to Zhao and Nehar (2013) 60-80% of soil phosphorus is of organic origin.

Organic matter also indirectly influences nutrient availability e.g., by increased availability of trace elements through complexation by organic ligands or decrease in toxicity, acceleration in availability of Fe and Mn on sub-mergence and fall in ammonia volatilization (Ali *et al*., 2023). Similarly, Agbede (2021) showed that for each 1% increase in soil organic matter, the availability/ water holding capacity in the soil was increased by 3.7%. One of the factors causing low yield in cotton is low quantity of organic matter in soil. Most of soils of Punjab have less than 1% organic matter (Mumshad *et al*., 2021). It is difficult to raise organic matter beyond 4.5%. Biovita (sea weed) is a rich source of organic matter that has significant impact on yield components and seed cotton yield but has not much significant impact on quality of cotton i.e., GOT%, staple length, fineness and fiber strength (Elayan, 2008; Abdallah and Mohamed, 2013). Studies suggested that application of farm yard manure improves fiber yield by way of improved GOT (Desouza *et al*., 2023).

Sprunger *et al*. (2023) concluded that cotton genotypes affected yield of cotton significantly in changing climate. Qamar *et al*. (2016) told that cotton genotypes have significant effect on seed cotton yield and fiber quality of cotton under agro-ecological conditions of Sakrand, Pakistan. Yasir (2023) determined that Genotypes, environment, and year significantly alter seed cotton yield and fiber quality. Genotypes play an important role in enhancing the yield of cotton.

Among causes of low yield of cotton, low organic matter content of soil is one of them. By adding organic matter in soil, yield components and yield of cotton can be increased. The objective of this study was to determine the impact of addition of organic matter on yield components and fiber quality of cotton. So, these studies were carried out to observe and calculate the impact of organic matter on bolls per plant, boll weight, boll retention percentage, seed index, seed germination and fiber quality traits i.e., GOT%, staple length, fiber fineness and strength of cotton.

Materials and Methods

Three approved cotton cultivars viz., MNH-886, FH-Lalazar and VH-311 were utilized to observe the impact of organic matter on quantity and quality traits of cotton at Vehari located between 29.360N, 71.440E and 30.220 N 72.530 E and at an altitude of 135 m. Climatic conditions of the selected location during the crop season is mentioned in Table 1. Seed of these varieties was obtained from Punjab Seed Corporation, Peerowal, Khanewal. The cultivars were sown during the first week of May 2016, following three repeats under split plot arrangement. The organic matter was kept in main plot and varieties in subplot. Before start of experimentation, organic matter in soil was 0.7 %, T1 was kept as control there was no addition of organic matter for four years except normal agronomic practices required for cotton and it get reduced to 0.5% organic matter, in T2 farm yard manure and green manuring of berseem was done for consecutive two years, during 4th year organic matter was improved to (1%) and in T3 farm yard manure and green manuring both were practiced for consecutive 4 years and organic matter was increased to (1.5%). During the 4th year, cotton was cultivated in all three plots of T1, T2 and T3 having 0.5, 1.0 and 1.5 % respectively. Farm yard manure is mixture of dung, urine, cereal and legume crop residues and farm wastes contained on an average 0.6% N, 0.22% P and 0.57% K. All other agronomic practices were kept same in all treatments. Each plot (126 m^2)

comprised of 15 rows of 12 m length and row to row distance was maintained at 0.75 m with plant to plant distance of 0.3 m. 10 central rows with consecutive 20 plants in the middle were used for collection of data. Observations recorded are given below:

Table 1: *Weather data of vehari during cotton season 2016.*

Month	Temperature (°C)		Humidity (%)	Rain fall (mm)
	Maximum	Minimum		
Apr-16	35.4	23.5	66.6	3.0
May-16	37.6	25.9	61.2	0.0
Jun-16	40.2	30.4	51.2	0.0
Jul-16	39.6	29	53.6	14.0
Aug-16	40.2	29.4	57.0	22.0
Sep-16	37.1	26.4	72.6	6.0
Oct-16	37.5	27	76.0	0.0
Nov-16	28.1	12.96	80.71	0.0

Boll number and boll weight (g)
In each treatment/repeat of each variety bolls per plant were counted from 20 marked plants and boll weight was calculated by dividing seed cotton from picked from 20 plants by number of bolls.

Boll retention percentage
Fresh flowers of all plants in each treatment/ variety were recorded on daily basis. At the termination of crop, total mature bolls counted and boll retention percentage was calculated by using following formula:

$$\text{Boll retention \% age} = \frac{\text{Total bolls matured per plant}}{\text{Total number of fruiting sites}} \times 100$$

Seed index: It is the weight of 100 seed in grams. It was calculated by using 1000 seeds in each treatment to decrease the error.

Seed germination % age: it was determined by placing 100 seeds of each treatment/ variety in three repeats in germinator and then dividing number of germinated seeds by total number of seeds multiplied by 100.

Fiber traits: GOT % age was calculated by using formula:

$$\text{GOT \% age} = \frac{\text{Lint (gm)}}{\text{Seed Cotton}} \times 100$$

All other fiber parameters were determined on High Volume Instrument (HVI). Cotton fiber properties were measured by using Uster® HVI- SPECTRUM I. Sample weight ranged in 10.1 gm to 11.5g. HVI fiber testing instrument is capable of measuring many cotton fiber properties including fiber length, fiber strength, finesses/micronaire, maturity, uniformity index etc.

Results and Discussion

The detailed results pertaining to the present studies are:

Yield attributes and seed germination
The yield attributes such as number of bolls, boll weight, boll retention, seed index and seed germination were significantly affected by different doses of organic matter. By increasing organic matter, significant improvement was observed in all traits However, T_3 (organic matter= 1.5%) showed maximum increase in all characteristics i.e., Number of bolls, boll weight, boll retention %, seed germination %, seed index, ginning out turn % and staple length ranged from 19to 38, 2.4 to 5.3, 38 to 66.3, 64.7 to 86.6,7.0 to 9.7, 37.7 to40.3 28.0 to 29.4 respectively. In fact, soil organic matter is the basic resource of several nutrients for plants (You et al., 1999; Sauvé et al., 1997; Wang and Mulligun, 2006; Leiros *et al.*, 1999) and a fall in organic matter represents a serious suppression in nutrient availability (Stangel, 1991). Seed index was recorded 9.5, 7.8 and 7.6; Boll weight 4.2, 3.7, 2.8; mike 4.4, 4.7, 5.0 for FH-Lalazar, MNH-886 and VH-311, respectively (Table 2).

Number of bolls per plant
In T_2 (organic matter 1.0%) varieties showed 15.8 to 19% increase in bolls per plant and 33.3 to 36.8% in T3 (Table 2). So, by adding or increasing organic matter, production of seed cotton yield may be increased from 15.8 to 36.8% by increasing bolls per plant. In general, 1/3 of produce may be enhanced by getting organic matter at 1.5% level. In Pakistan, average number of bolls per plant is 20. So, it may be increased to 27 by adding organic matter (Kumar and Prasad, 2007).

Boll weight (gm)
In T_2, 9.0 to 16.0% and in T_3 18.4 to 36.0% more boll weight was achieved. In Pakistan average boll weight is 3.0 gm therefore it may be improved to more than 4.0 gm (Table 2).

Table 2: *Interactive effect of organic matter and selected cultivars on yield and qualitative parameters of cotton.*

Variety	Treatment	Boll weight (g)	No. of bolls	Boll retention (%)	GOT (%)	Fiber strength (g/tex)	Staple length (mm)	Fiber fineness (micronaire)	Seed germination (%)	Seed index
FH-Lalazar	0.5	4.4 ^{c}	19.0 ^{d}	38.0 ^{h}	39.0 ^{c}	30.7 ^{e}	28.3 ^{bc}	4.8 ^{bc}	71.0 ^{cd}	8.3 ^{c}
FH-Lalazar	1.0	4.8 ^{b}	22.3 ^{cd}	42.66^{fg}	39.8 ^{ab}	32.5 ^{cd}	28.9 ^{ab}	4.7 ^{bc}	77.0 ^{b}	8.7 ^{b}
FH-Lalazar	1.5	5.3 ^{a}	25.6 ^{b}	48.0 ^{de}	39.7 ^{ab}	34 ^{abc}	29.4 ^{a}	4.3 ^{d}	86.6 ^{a}	9.7 ^{a}
MNH-886	0.5	3.06 ^{f}	21.3 ^{cd}	51.3 ^{cd}	39.4 ^{bc}	30.0 ^{e}	28.1 ^{bc}	4.9 ^{ab}	64.7 ^{e}	7.1 ^{f}
MNH-886	1.0	3.43 ^{e}	25.3 ^{bc}	57.0 ^{b}	39.3 ^{bc}	31.7 ^{de}	28.3 ^{bc}	4.7 ^{bc}	68.3 ^{d}	7.3 ^{ef}
MNH-886	1.5	3.76 ^{d}	28.3 ^{b}	66.3 ^{a}	40.3 ^{a}	33.2 ^{bcd}	28.6 ^{abc}	4.6 ^{c}	79.0 ^{b}	7.8 ^{d}
VH-311	0.5	2.46 ^{g}	28.3 ^{b}	40.0 ^{gh}	37.7 ^{d}	34.7 ^{ab}	28.0 ^{c}	5.06 ^{a}	72.6 ^{c}	7.5 ^{de}
VH-311	1.0	2.86 ^{f}	34.6 ^{a}	53.0 ^{c}	37.9 ^{d}	35.7 ^{a}	28.5 ^{bc}	4.9 ^{ab}	78.0 ^{b}	7.0 ^{f}
VH-311	1.5	3.4 ^{e}	38.0 ^{a}	45.3 ^{ef}	37.7 ^{d}	35.4 ^{a}	28.9 ^{ab}	4.6 ^{c}	88.7 ^{a}	6.67 ^{g}
LSD α (0.05)		0.26	4.25	4.27	0.69	1.77	0.74	0.17	2.97	0.29
*P-Value**		0.001	0.000	0.002	0.005	0.002	0.001	0.000	0.003	0.000

**Letters differing from each other indicate that means are significantly different from each other in respective parameter column.*

Boll retention %

In Pakistan, due to bollworms, high temperature, humidity as well as blind use of pesticides results in more than 50% bolls shedding. Due to enhanced organic matter content, boll retention was increased up to 11.8 to 13.2 % in T_2 and26.3 to 32.5% in T_3. So, produce may be increased 25.0 to 32.5% by maintaining organic matter in soil. On overall basis keeping in view above three factors seed cotton yield may be increased from 40.0 to 100.0 %. FH-Lalazar responded better to organic matter and its yield was more as compared with MNH-886 and VH-311 (Table 2).

Seed germination (%) and seed index (gm)

Seed index was also increased significantly from 2.8 to 4.8% in T_2 and 9.9 to 16.9% in T_3 (Figure 1). It also ultimately increased the seed cotton yield due to healthy and vigorous seed. Healthy seed resulted in high seed germination. Germination percentage of cotton seed in T_2 and T_3 was increased up to 5.6 to 8.5 % and 22.0 %, respectively (Figure 2).

Fiber traits

In T_2 (organic matter 1.0%) varieties showed 15.8 to 19% increase in bolls per plant and 33.3 to 36.8% in T3 (Table 2). So, by adding or increasing organic matter, production of seed cotton yield may be increased from 15.8 to 36.8% by increasing bolls per plant. In general, 1/3 of produce may be enhanced by

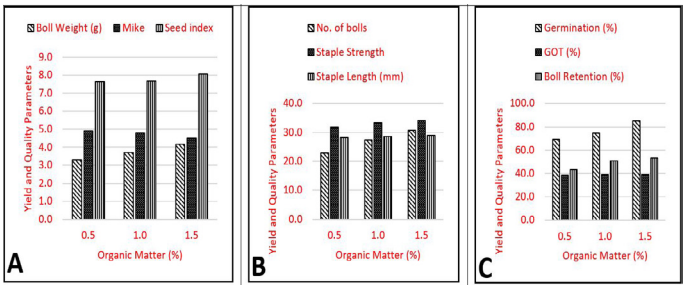

Figure 1: *Graphical presentation regarding comparative effect of organic matter on yield and quality parameters in the cotton.*

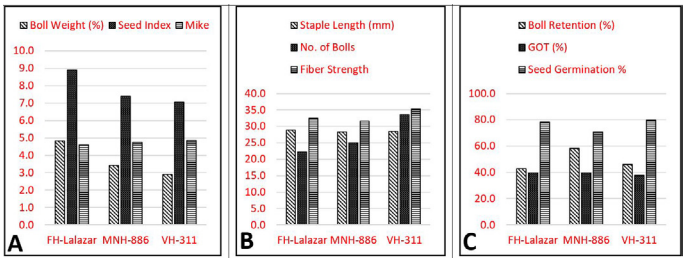

Figure 2: *Graphical presentation regarding comparative response of cultivars to yield and quality parameters of the cotton.*

Table 3: *Individual effect of organic matter on yield and quality parameter of cotton.*

O.M	B.W (g)	Mike	S.I	B.N	Staple strength	S.L. (mm)	Germination (%)	GOT (%)	B.R. (%)
0.5	3.3±0.27	4.9±0.04	7.6±0.17	22.9±1.32	31.8±0.69	28.1±0.04	69.4±1.14	38.7±0.24	43.1±1.95
1.0	3.7±0.25	4.8±0.03	7.7±0.25	27.4±1.75	33.3±0.58	28.6±0.08	74.4±1.45	39.0±0.27	50.9±2.01
1.5	4.2±0.26	4.5±0.05	8.1±0.42	30.6±1.77	34.2±0.30	29.0±0.11	84.8±1.39	39.2±0.37	53.2±3.11

O.M= Organic matter; B.W= Boll Weight; S.I= Seed Index; B.N= Boll number; S.L= Staple length; B.R= Boll retention.

getting organic matter at 1.5% level. In Pakistan, average number of bolls per plant is 20. So, it may be increased to 27 by adding organic matter (Kumar and Prasad, 2007).

Table 4: *Principal component analysis of selected traits.*

Eigen value	PC1	PC2	PC3
	4.55	3.40	1.56
Proportion	0.45	0.34	0.15
Cumulative	0.45	0.796	0.95

Table 5: *Correlation matrix and principal component analysis between yield and qualitative parameters in cotton.*

Correlation matrix		PC1	PC2	PC3
Organic matter		0.403	-0.195	-0.268
Boll weight	0.385 (0.30)	0.360	0.309	0.194
No. of bolls	0.547 (0.128)	0.088	-0.529	-0.078
Bolls retention	0.503 (0.168)	0.089	-0.048	-0.77
GOT	0.236 (0.540)	0.194	0.413	-0.37
Fiber strength	0.516 (0.155)	0.152	-0.470	0.153
Staple length	0.803 (0.009)	0.454	-0.029	0.124
Mike	-0.801 (0.009)	-0.442	-0.076	0.091
Germination	0.806 (0.009)	0.380	-0.281	0.169
Seed index	0.179 (0.646)	0.292	0.328	0.28

Results further revealed that with increase in organic matter level there was an enhancement of all yield and fiber quality parameters in cotton (Table 2). Principal component analysis amongst the studied traits with Eigen value 4.55, 3.40 and 1.56 depicted that PC1 with 45% variation contributed significantly as compared with PC2 (34% and PC3 (15%), respectively Table 4. Organic Matter and PC1 had positive correlative with the selected traits except mike.

Conclusions and Recommendations

On the basis of results of this study, it was concluded that addition of organic matter in soil enhanced number of bolls per plant 15.8 to 36.8 %, Boll weight 9 to 36% and Boll retention percentage 11.8 to 32.5 %resulting in increase of seed cotton yield from 40 to 100 % in different varieties. Seed Index was also improved from 2.8 to 16.9 % in different varieties ultimately enhancing germination percentage of cotton seed of those varieties from 5.6 to 22 %. Fiber fineness and fiber strength were also improved by increasing organic matter content of soil. Findings of this study suggests that by improving the organic matter content of soil up to 1.5 %, seed cotton yield can be increased up to 40 to 100 % in recommended varieties of cotton. However, among varieties, FH-Lalazar produced maximum seed cotton yield.

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Novelty Statement

There is no sufficient data on the impact of addition of organic matter on the yield of cotton. This study will help in the possibility of improving number of bolls per plant, boll weight and fiber characteristics of cotton.

Author's Contribution

Saeed Ahmad: Designed the experiment and collected data.
Muhammad Iqbal: Supervised of writing the manuscript.
Muhammad Akram: Helped in collection of data.
Muhammad Rafiq Shahid: Helped in writing paper.
Muhammad Shahid: Statistical analysis of data and helped in writing paper.
Taj Muhammad: Tabulated the data.
Muhammad Ihsan Ullah: Collected fiber traits and weather data.
Zunera Saeed: Helped in collection of data.
Mazhar Ali: Helped in writing of manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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