Research Article

Genotypic Variation in Yield and Fiber Quality Traits of Cotton Grown from Seeds Packed in Different Packaging Materials

M. Abdus Salam[1], M. Moynul Haque[2], Md. Obaidul Islam[3], M. Nasir Uddin[4] and Md. Nazmul Haque[3]*

[1]Cotton Development Board, Zonal office, Chuadanga, Bangladesh; [2]Department of Agronomy, Faculty of Agriculture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur-1706, Bangladesh; [3]Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; [4]Genetic Resources and Seed Division, Bangladesh Jute Research Institute, Dhaka-1207, Bangladesh.

Abstract | Five cotton genotypes *viz.*, CB-08, SR-08, BC-0125, BC-0236 and BC-0252 were used to determine the effects of seeds of different storage containers on growth, yield and quality of cotton genotypes. The experiment was conducted between July, 2010 to February, 2011 at Cotton Research, Training and Seed Multiplication Farm, Sreepur, Gazipur, Bangladesh. Significant variations related to genotypes and seed sources were observed for stand establishment, branch development, phenology, yield components, yield and fiber quality attributes of cotton. Yield and quality of cotton were significantly higher when crop was grown from seeds stored in polythene bag as compared to cloth bag. Interaction of genotypes and seed sources indicated that highest sympodial branches plant^{-1} (19.11), days to 50% flowering and boll splitting (72.00 and 156.33, respectively), number of bolls plant^{-1} (20.33), boll weight (4.60 g), seed cotton and lint yield (2305.30 and 832.49 kg ha^{-1}, respectively), ginning out turn (36.04%) and lint index (6.28 g) were recorded for genotype BC-0125 grown from seed stored in polythene bag. Regarding fiber quality, the genotype SR-08 grown from seeds stored in polythene bag had the highest staple length (3.15 cm) and fiber strength (86.65 P.S.I). Therefore, effective breeding program with these two genotypes may lead to development of new genotype that will give higher yield consistent with higher fiber quality.

Received | January 26, 2017; **Accepted** | May 18, 2017; **Published** | June 01, 2017
***Correspondence** | Md. Nazmul Haque, Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh; **E-mail:** sumon2539@gmail.com
Citation | Salam, M.A., M.M. Haque, M.O. Islam[3], M. N. Uddin and M.N. Haque. 2017. Genotypic variation in yield and fiber quality traits of cotton grown from seeds packed in different packaging materials. *Sarhad Journal of Agriculture,* 33(2): 255-262.
DOI | http://dx.doi.org/10.17582/journal.sja/2017/33.2.255.262
Keywords | Cotton, Fiber quality, Genotypic variation, Packaging materials, Yield

Introuction

Cotton (*Gossypium hirsutum.* L) is the main fiber crop and important industrial raw materials in the world. It is cultivated in more than 80 countries of the world, which represents 2.5% of all cultivated land. In Bangladesh, it provides raw materials to domestic cotton industries of spinning, weaving, handlooms, knitting and garment sectors. However, supply of raw cotton to domestic industry is not sufficient as it accounts only 1.19% of the yearly requirement. One of the reasons of such small supply of raw cotton is lower productivity of cotton in Bangladesh. Further, current productivity of cotton in Bangladesh is about 1.5 t ha^{-1} which is very low as compared to average yield (~5t ha^{-1}) of other cotton growing countries. Cotton yield is a polygenic complex, depends on several contributing characters coupled with varying environmental conditions (Khan, 2003; Khan et al., 2009). The yield has been stagnant for the last two decades and very low compared to other cotton growing countries of the world (Khan and Hassan, 2011).

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The yield of cotton can be improved by selecting appropriate genotype specially suited to local ecological condition (Abbas et al., 2008) with high quality seed which remains inherently vigour throughout the storing period.

Seeds are packed with different packing materials before storing for maintaining its viability. But loss of seed viability is not possible to stop totally although it can be minimized through maintaining proper storage condition and seed having inherent high vigour quality. Maintaining the viability of seeds by storing them under controlled environmental conditions has been one of the most important lines of research in seeds of a great number of species. Salam et al. (2017) found significant genotypic variation in all physiological traits of stored cotton seeds. They also reported better physiological quality of cotton seeds were achieved by storing in hermetically sealed polythene bag instead of cloth bag.

The better yield and quality of the fiber produced from cotton plant is primarily dependent on the growth and reproductive efficiency of the mother crop. The growth performance and productivity of the mother crop naturally depends on the vigor of the initial seed used for sowing and subsequently emerged seedlings that could only be possible from a healthy and viable seed (Rathinavel, 2014). Research works on genotypic variation in stand establishment, yield and fiber quality of cotton grown from seeds of different packaging materials in Bangladesh are limited and preliminary in nature but very little critical work has been done. Considering the above situation, the present study was undertaken to investigate the growth, yield and fiber quality of cotton genotypes grown from seeds stored with different packaging materials.

Materials and Methods

Description of the experimental site

The study was carried out between July, 2010 to February, 2011 at Cotton Research, Training and Seed Multiplication Farm, Sreepur, Gazipur, Bangladesh. The site was located in the centre of Madhupur Tract (24.09°N latitude and 90.26° E longitude) with an elevation of 8.4 meter above the sea level. The soils of the experimental field belong to the Salna series and characterized by heavy clays within 15 cm from the surface and are poor in chemical properties. It is red in color and acidic in nature. The weather of the experimental site was subtropical having hot and dry summer, chilly winter and heavy rainfall during the monsoon that generally commenced from June and continued up to September. Temperature gradually falls from the month of October and starts rising from February and continued up to September.

Experimental materials

Five cotton genotypes *viz.,* CB-8, SR-08, BC-0125, BC-0236 and BC-0252 were used in the experiment. The seeds of five cotton genotypes were stored for 14 months using two packaging materials i.e. hermetically sealed polythene bag (thickness 8μ) and cloth bag under ambient environment. Seeds of five cotton genotypes were sown in a randomized complete block design with three replications. Plant population of each genotype was 10 in each plot with planting configuration of 90 cm x 45 cm. Block to block distance was maintained as 1.5 m and plot to plot distance was 0.90 m for easy management of the crop. The genotypes were assigned randomly and afresh randomization was done in each replication.

Crop management

Cotton seed was sown by dibbling in line on 21 July, 2010. Ten water soaked seeds hill^{-1} were sown to ensure uniform stand, although seedlings were thinned to one plant hill^{-1}. Recommended dose of fertilizer (N_2, P_20_5, K_2O, S, Zn, B and Mg @ 296.4, 444.6, 494, 123.5, 14.82, 18.53 and 14.82 kg ha^{-1}, respectively) was applied during experimentation. The experimental field was kept weed free up to 65 days after sowing of seed with three times weeding. Besides, three times hand picking of bollworm larvae, five times insecticides spraying and molasses traps were used to keep the field free from pest. Other managements required in cotton field were ensured according to needed throughout the growing season.

Data collection

Ginning out turn of each genotype was measured as the weight of lint ginned from the seed cotton and expressed as a percent of the seed cotton weight. Seed index was calculated as weight of 100 ginned seeds.

$$\text{Lint index} = \frac{\text{Weight of lint}}{\text{Weight of seed}} \times SeedIndex$$

Staple length was measured by Fibrograph instrument and it indicates average length of individual fiber. The micronaire value represents the fiber diameter. Micronaire value was determined by Micronaire testing instrument. There are two instruments used to measure fiber strength; the Pressly and the Stelometer.

Table 1: *Effect of genotype and seed source on branch development and phenology of cotton*

Genotype	Storage container	Branch development		Phenology	
		Monopodial branches plant^{-1}	Sympodial branches plant^{-1}	Days to 50 % flowering	Days to 50 % boll splitting
CB-8	Cloth bag seed	2.78 ab	10.89 d	66.67 bc	149.33 c
SR-08		2.22 c-e	10.78 d	60.33 fg	143.33 d-f
BC-0125		2.44 b-d	12.11 cd	68.67 b	152.67 b
BC-0236		3.11 a	14.33 bc	63.67 de	144.67 de
BC-0252		2.56 b-d	14.11 c	59.33 g	141.33 f
CB-8	Polythene bag seed	2.67 a-c	14.78 bc	68.67 b	152.00 bc
SR-08		1.89 e	17.11 ab	62.33 ef	144.67 de
BC-0125		2.11 de	19.11 a	72.00 a	156.33 a
BC-0236		2.78 ab	17.78 a	65.67 cd	145.00 d
BC-0252		2.44 b-d	19.44 a	61.33 e-g	142.00 ef
$LSD_{(0.05)}$		0.471	2.916	2.728	2.766
CV (%)		10.98	11.30	2.45	1.10

In both instruments, the strength is measured by spading a bundle of parallel fiber across two clamps. Forced is applied to clamps and gradually increased until the bundle breaks.

Statistical analysis

The data obtained from the experiments on different parameters were analyzed statistically following analysis of variance (ANOVA) technique. Microsoft EXCEL and MSTATC software programs were used whenever appropriate. Means were separated using least significant difference (LSD) test at a significance level of 0.05 (Gomez and Gomez, 1984). Functional relationships among the parameters were established through regression analyses.

Results and Discussion

Stand establishment

Stand establishment differences were detected among the seeds of five cotton genotypes stored for 14 months in cloth and polythene bag (Figure 1). Among the genotypes, the genotype BC-0252 showed the highest emergence percentage while the lowest was observed in the genotype CB-08. Such genotypic variations in seedling emergence of old seeds were also detected by Pettigrew and Meredith (2009) which implies genetic variability in stand establishment. Stand establishment of cotton seeds stored in cloth bag was lower as compared to polythene bag. These results are in accordance with the findings of Patil and Shelar (1993) in brinjal. Similar results were also observed by Saxena et al. (1987) who stored the seeds of onion, cabbage, radish, cauliflower, okra and peas in impervious and pervious container at room temperature for 24 months and observed lower emergence of seeds in stored with cloth bag.

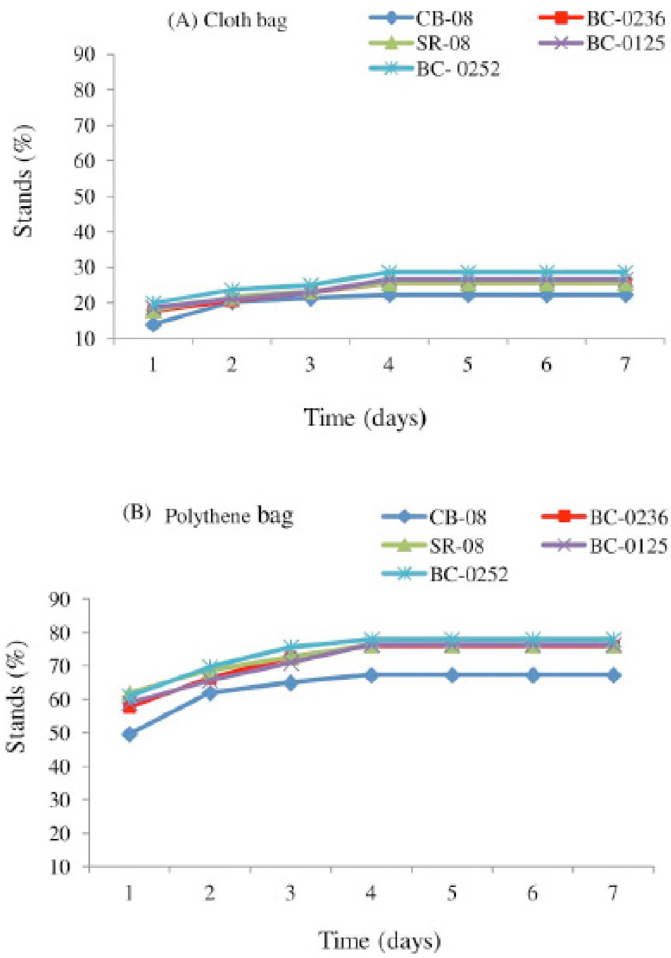

Figure 1: *Effects of seeds of (A) cloth bag (B) polythene bag on field stand establishment of cotton genotypes*

Branch development

Cotton has two kinds of branches *viz.*, monopodi-

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al and sympodial branches. Monopodial branch do not bear flowers directly, but they sometimes produce secondary fruiting branches. Number of monopodial branches differed significantly due to genotypes and seed stored for 14 months in different storage containers (Table 1). In general, minimum number of monopodia was found in the plant obtained from the seeds stored with polythene bag as compared to cloth bag. The interaction result further showed that maximum number of monopodia (3.11) was produced in BC-0236 genotype from the seeds of cloth bag which was similar to the genotype CB-08 where the seeds were stored in same container. The lowest number of monopodia (1.89) was noted in SR-08 genotype which was similar to genotype BC-0125 when seeds were stored in polythene bag. Variation in number of monopodial branches plant^{-1} of different cotton genotypes were also observed in previous studies (Abbas et al., 2008; Latif et al., 2014).

Number of sympodial branches plant^{-1} is one of the most important factors of yield contributing characters of cotton genotypes. Significant differences in the number of sympodial branches were also noticed due to storing of seeds of cotton genotypes in different containers for 14 months storage under ambient condition (Table 1). Minimum number of sympodia was recorded in the plant obtained from the seeds stored in the cloth bag as compared to polythene bag. The number of sympodial branches plant^{-1} differed from 14.78 to 19.44 and 10.78 to 14.33 in polythene and cloth bag, respectively. The genotype SR-08 produced the minimum number of sympodial branches plant^{-1} from the seeds stored in cloth bag while the maximum number of sympodial branches was recorded in the genotype BC-0252 in case of seeds stored in polythene bag. Such differences in number of sympodial branches plant^{-1} of different cotton genotypes were also observed in different cotton growing environments (Abbas et al., 2008; Ali et al., 2009).

Phenology

Days to flowering and boll split are important attributes of cotton as it depicts the earliness of the crop. Sometimes, environmental and other agronomic factors controlled the time of flowering and boll split, although these are inherent characters (Sawan et al., 1999). In present study, minimum days to flowering and boll split were recorded in the plants obtained from the seeds stored in the cloth bag compared to polythene bag (Table 1). Considering genotype, seeds of the cotton genotype BC-0252 stored in cloth bag required the minimum time (59.33 days) to flowering which was identical to the genotype SR-08. In contrast, the longest time (72 days) required by the genotype BC-0125 to flowering where seeds stored with polythene bag. Likewise flowering, the genotype BC-0125 required the maximum time (156.33 days) to boll split and while the shortest time (141.33 days) required to boll split was found in the genotype BC-0252. These results agree with the past findings as they observed the earliness in terms of flowering and boll split in some genotypes of cotton (Rauf et al., 2005; Ahmad et al., 2008).

Boll number

Number of bolls plant^{-1} is the key component of seed cotton yield. A significant difference in the number of bolls plant^{-1} was observed due to genotypes and types of containers used for storing of seeds for 14 months under ambient condition (Table 2). The results showed that the plant obtained from the seeds stored with the cloth bag showed minimum number of bolls plant^{-1}. Among genotypes, BC-0125 genotype stored with polythene bag produced the highest number of bolls plant^{-1} (20.33). Conversely, the lowest number of bolls plant^{-1} (12.11) was observed from the seeds of the genotype CB-8 stored with cloth bag. The lower number of bolls plant^{-1} of CB-8 from stored seed of cloth bag was attributed to its lower number of sympodial branch. Such differences among all the genotypes were highly significant for number of bolls plant^{-1} of cotton (Iqbal et al., 2011; Latif et al., 2014).

Boll weight

Individual boll weight is another important component of cotton yield. The boll weight significantly differed over the genotypes and storage containers (Table 2). Irrespective of genotypes, single boll weight was higher in plant obtained from seed of polythene bag and lower in cloth bag. Genotypic variation revealed that the highest single boll weight (4.77 g) was observed in the genotype SR-08 with seeds stored in polythene bag and the genotype CB-8 with seeds stored in cloth bag showed the lowest single boll weight (3.36 g). The seeds stored in cloth bag might lose vigour, resulted weak plants which in turn reduced the single boll weight considerably. Previous studies showed differences in cotton boll weight in different cotton genotypes (Abbas et al., 2008; Iqbal et al., 2011, Latif et al., 2014).

Seed cotton yield

Seed cotton yield is the function of number of bolls plant^{-1} and single boll weight. Seed cotton yield was

Table 2: *Effect of genotype and seed source on yield components, yield and ginning out turn of cotton*

Genotype	Storage container	Bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})	Lint yield (kg ha^{-1})	Ginning out turn (%)
CB-8	Cloth bag seed	12.11 d	3.36 e	1002.3 e	331.08 g	32.99 b
SR-08		12.22 d	3.87 cd	1167.9 e	380.23 fg	32.54 bc
BC-0125		15.44 bc	4.09 b-d	1552.0 d	537.73 de	34.68 ab
BC-0236		16.78 b	3.70 de	1526.9 d	469.43 ef	30.70 cd
BC-0252		12.78 cd	3.92 cd	1241.2 e	372.43 fg	30.07 d
CB-8	Polythene bag seed	16.11 b	4.13 bc	1636.1 d	601.23 cd	36.77 a
SR-08		16.78 b	4.77 a	1969.2 bc	682.39 bc	34.65 ab
BC-0125		20.33 a	4.60 a	2305.3 a	832.49 a	36.04 a
BC-0236		20.11 a	4.43 ab	2200.8 ab	713.71 b	32.42 bc
BC-0252		17.00 b	4.20 bc	1767.3 cd	581.46 cd	33.01 b
$LSD_{(0.05)}$		3.046	0.398	267.30	104.32	2.287
CV (%)		11.12	5.66	9.52	11.05	3.99

Table 3: *Effect of genotype and seed source on lint and seed index and fiber quality of cotton*

Genotype	Storage container	Lint index (g)	Seed index (g)	Staple length (cm)	Fiber strength (P.S.I)	Micronaire value
CB-8	Cloth bag seed	5.39 cd	10.92 c-f	2.74 c-e	81.03 de	4.70 a
SR-08		5.94 a-c	12.32 a	2.82 b-d	80.97 de	4.20 d
BC-0125		6.37 a	11.96 ab	2.72 c-e	80.27 e	4.40 bc
BC-0236		5.16 cd	11.65 a-c	2.64 e	80.95 de	4.40 bc
BC-0252		4.85 d	11.27 b-d	2.77 b-e	81.97 cd	4.50 b
CB-8	Polythene bag seed	5.93 a-c	10.16 f	2.82 b-d	82.17 cd	4.50 b
SR-08		5.48 b-d	10.31 ef	3.15 a	86.65 a	4.00 e
BC-0125		6.28 ab	11.11 c-e	2.87 bc	84.41 b	4.30 cd
BC-0236		5.43 b-d	11.32 b-d	2.69 de	83.30 bc	4.20 d
BC-0252		5.20 cd	10.56 d-f	2.90 b	83.14 bc	4.40 bc
$LSD_{(0.05)}$		0.855	0.826	0.154	1.372	0.195
CV (%)		8.89	4.31	3.19	0.97	2.60

significantly influenced by the genotypes and different storage containers (Table 2). In generally, seed cotton yield was higher from the seeds stored in polythene bag as compared to cloth bag. Interaction of genotypes and seeds of different storage containers indicated that the highest seed cotton yield (2305.30 kg ha^{-1}) was recorded in BC-0125 stored with polythene bag and the lowest seed cotton yield (1002.30 kg ha^{-1}) was observed in the genotype CB-8 when seeds were stored with cloth bag. The higher yield of BC-0125 can be attributed to superior yield components of the genotype. The existence of variation was found for seed cotton yield in cotton genotypes has been reported previously (Bibi et al., 2011; Iqbal et al., 2011; Shakeel et al., 2011; Latif et al., 2014). Seed cotton yield is positively correlated with the number of bolls plant^{-1} and single boll weight (Figure 2). Similar relationship was also found by Bibi et al. (2011) who reported that cotton yield is positively contributed by number of bolls plant^{-1} and single boll weight.

Lint yield

Like seed cotton yield, higher lint yield was observed from the seeds stored in polythene bag than that of seeds of cloth bag (Table 2). Thus highest lint yield (832.49 kg ha^{-1}) was found from the seeds of genotype BC-0125 stored with polythene bag. The genotype CB-8 produced the lowest lint yield (331.08 kg ha^{-1}) which was statistically at par with SR-08 and BC-0252. Variability in lint yield of cotton might be due to hereditarily effect of the genotypes and which was further influenced by variation of seed vigor resulted from different storage containers (Abbas et al., 2008; Ali and Awan, 2009; Iqbal et al., 2011).

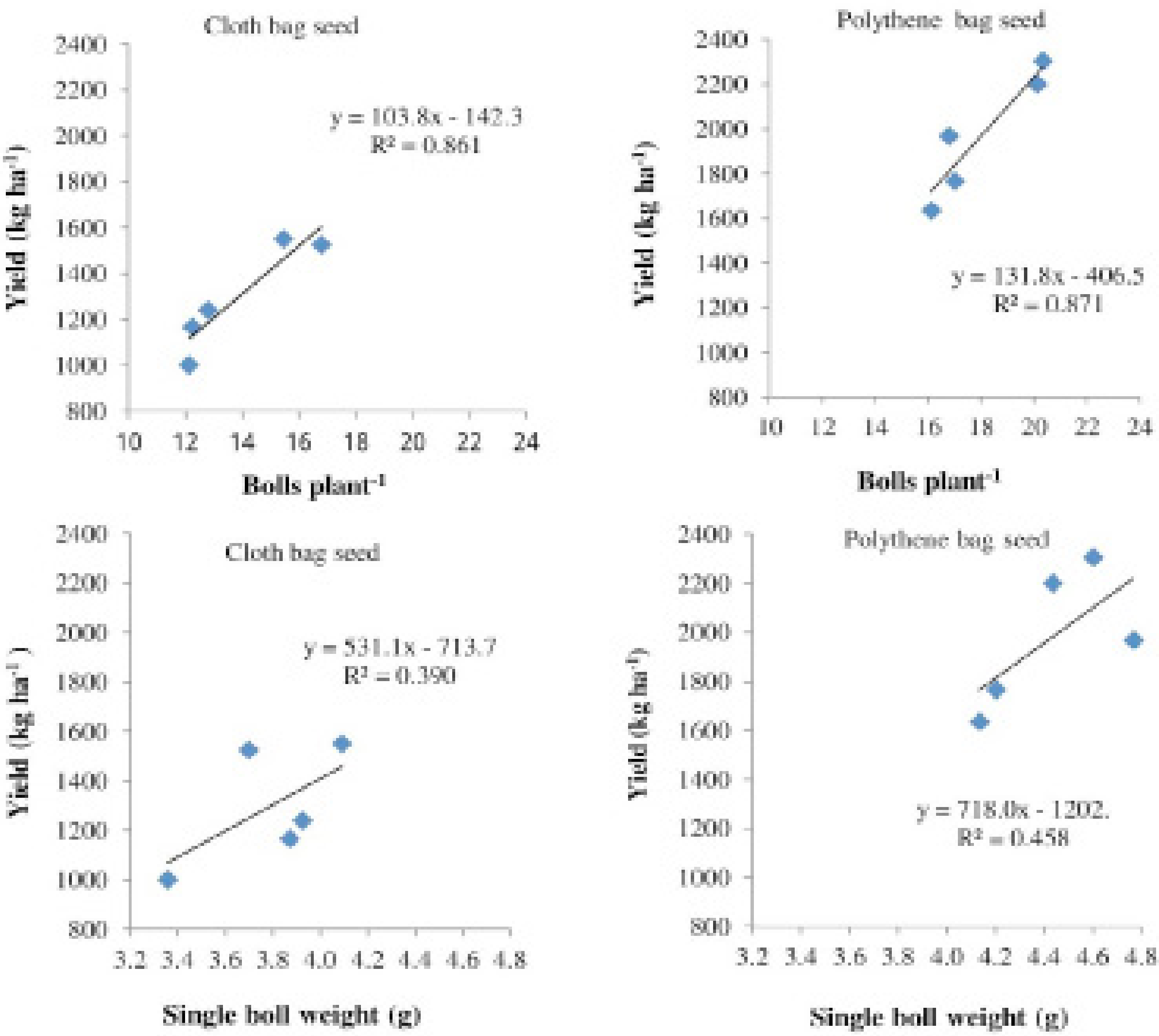

Figure 2: *Relationship among bolls plant^{-1}, single boll weight and seed cotton yield from seeds of different storage contaioners*

Ginning out turn

Ginning out turn was markedly affected by genotypes and storage containers used for storing of seed for 14 months under ambient condition (Table 2). Ginning out turn was higher from the plants of seeds stored with polythene bag compared to that of cloth bag. Besides, a great variation was recorded among the cotton genotypes with respect to ginning out turn. The maximum ginning out turn (36.77%) was counted in CB-8 when seeds were stored with polythene bag. Seeds of the genotype BC-0252 stored in cloth bag showed the lowest (30.07%) ginning out turn which was statistically identical to that of BC-0236. Similar findings were also observed in previous studies and they observed differences in lint % in different cotton genotypes (Clawson et al., 2006; Iqbal et al., 2011).

Lint index

Lint index is an important consideration in cotton production where genotypes and storage containers influenced greatly the lint index of cotton (Table 3). The highest lint index (6.37 g) was noticed in plants obtained from the seeds of BC-0125 while the lowest lint index (4.85 g) was found in seeds of BC-252 stored in cloth bag and it was statistically similar to seeds of BC-0236 and CB-8 stored in the same condition. Such differences in lint index in different cotton genotypes is occurred mostly due to number and size of seeds present in the boll (Clawson et al., 2006; Ali and Awan, 2009).

Seed index

Seed index in cotton is another important parameter that affects the lint yield. Significant differences in seed index were observed due to genotypes and storage containers used for seed preservation (Table 3). Seed index is reversal of lint index and thus the genotypes that showed greater lint index correspondingly resulted the lower seed index. The highest seed index (12.32 g) was recorded from seeds of genotype SR-08 stored in cloth bag which was statistically identical to seeds of genotype BC-0125 and BC-0236 stored in the same condition. The lowest seed index (10.16 g) was observed from the seeds of genotype CB-8 stored in polythene bag that was statistically similar to seeds of SR-08 and BC-0252 genotypes stored with polythene bag. Ali and Awan (2009) found similar seed index results for different cotton genotypes.

Staple length

Fine thread is produced from cotton fiber that contained longer staple length. Therefore, staple length is very important consideration for quality cotton production. Staple length varied significantly because of genotypes and storage containers that were used for storing seeds for a period of 14 months (Table 3). The highest staple length was recorded in the genotype SR-08 stored with polythene bag while the staple length of BC-0236 grown from the seed stored with cloth bag was the lowest. Such variation in staple length of different cotton genotypes agrees with the past findings as mentioned genotypic differences for fiber length of cotton genotypes (Nichols et al., 2004; Abbas et al., 2008).

Fiber strength

The inherent strength of individual cotton fiber is essential for high speed of spinning which affected significantly with respect to genotypes and storage containers (Table 3). The pressly strength index measurement for fiber strength differed from 80.27 to 86.65 where the highest fiber strength was recorded in the genotype SR-08 grown from the seeds stored with polythene bag. The lowest fiber strength was observed in BC-0125 grown from seeds of cloth bag. Such genotypic variability in fiber strength is very important as the genotypes with higher strength provide fewer break points in the lint (Jordan, 2001; Abbas et al., 2008; Iqbal et al., 2011).

Micronaire value

The fineness of fiber is one of the evaluation methods of cotton fiber quality. Fineness of cotton can be measured through smoothness of fiber which is associated with fiber diameter and fiber wall thickness. Micronaire value represents the fiber diameter. The results showed that micronaire value was higher in cotton fiber obtained from the seeds stored with cloth bag compared to that of seeds stored with polythene bag and it was very close to each other in both the containers. Among the genotypes, SR-08 contained the lowest micronaire value (4.00) in polythene bag while CB-8 genotype resulted the maximum value (4.70) in cloth bag. Similar results of difference in fibre fineness was also observed by Abbas et al. (2008).

Conclusion

Our study demonstrates great variability among the genotypes in respect of stand establishment, phenology, fiber yield and fiber quality attributes. Better fiber yield and better quality of cotton were achieved by seeds storing in hermetically sealed polythene bag instead of cloth bag. Among the genotypes, the genotype BC-0125 was identified as high yielding and the genotype SR-08 producing high quality fiber relating the highest staple length, fiber strength and lowest micronaire value. Therefore, effective breeding programme with these characters can be synthesized to develop new genotypes that will give high yield consistent with high fiber quality.

Acknowledgements

The authors are thankful to the authority of Central Cotton Research, Training and Seed Multiplication Farm, Sreepur, Gazipur, Bangladesh for their helpful cooperation, kind assistance and keen supervision during the period of research. The financial support from the Bangabandhu Sheikh Mujibur Rahman Agricultural University is gratefully acknowledged.

Author's Contribution

Research work presented in this paper, is part of Ph.D. dissertation of Dr. M. Abdus Salam. Prof. Dr. M. Moynul Haque was the research supervisor. Dr. Md. Obaidul Islam and Dr. M. Nasir Uddin contributed during writing up and editing of manuscript. Md. Nazmul Haque helped to critically revise the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this article.

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