PERFORMANCE OF COTTON HYBRID AND INBRED VARIETIES UNDER DIFFERENT NUTRIENT LEVELS

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TO

MY BELOVED PARENTS

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CERTIFICATE

This is to certify that the thesis entitled "**Performance of Cotton Hybrid and Inbred varieties under different nutrient levels** " submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRONOMY**, embodies the result of a piece of bona fide research work carried out by Md. Mominul Islam, Registration number: 11-04675 under my supervision and guideline. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of the investigation has duly been acknowledged.

Dated:
Dhaka, Bangladesh

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PERFORMANCE OF COTTON HYBRID AND INBRED VARIETIES AT DIFFERENT NUTRIENT LEVELS

ABSTRACT

A field study was conducted at Cotton Research Training and Seed Multiplication Farm, Sreepur, Gazipur from July 2011 to February, 2012 to investigate the influence of different levels of fertilizer on a number of hybrid and inbred varieties of cotton in respect of growth, yield components and yield, and fibre quality attributes. The experiment comprised three cotton genotypes (i) HSC-4 (hybrid), (ii) DM-2 (hybrid) and (iii) CB-12 (inbred) variety and five levels of fertilizers (i) Control (without fertilizer), (ii) 25% less than recommended dose, (iii) Recommended dose (RDF: 120, 52, 131,27:N,P,K,S kgha^{-1}), (iv) 25% higher than recommended dose and (v) 50% higher than recommended dose. The experiment was laid out in a Randomized Complete Block Design (factorial) with three replications. The results revealed that seed cotton yield, bolls plant^{-1}, ginning out turn differed among the varieties. The highest seed cotton yield and ginning out turn were obtained in hybrid HSC-4 and that of the lowest received from CB-12 variety. Increasing levels of fertilizer maintained higher values of all the parameters except days to first flowering, lint index and ginning out turn. The tallest plant (111cm) and maximum days to boll opening (129.3), number of no. of bolls plant^{-1} (27.08), seed cotton yield (2174 kg ha^{-1}), lint yield (953kgha^{-1}), seed index (9.49), staple length (1.2inch), micronaire value (4.3), fibre strength (83.70 psi), uniformity ratio (48%) were observed in the plot where 50% higher than RDF was applied. Plant height, bolls plant^{-1}, individual boll weight, lint yield and ginning out turn showed higher value with the interaction of HSC-4 x 50% higher than RDF. The highest seed cotton yield (2406 kg ha^{-1}) Gross return (144360 tk ha^{-1}) Gross margin (75358tk ha^{-1}), BCR (2.09) and seed index were obtained with the combination effect of CB-12 x 50% higher fertilizer than RDF. For economic point of view, the results indicate that CB-12 inbred variety x 50% higher fertilizer than RDF was more profitable than any of the other treatment combinations.

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LIST OF ABBREVIATION

ABBREVIATION	FULL NAME
AEZ	Agro-Ecological Zone
et. al.	and others
BBS	Bangladesh Bureau of Statistics
BTMA	Bangladesh Textile Mills Association
cm	Centimeter
° C	Degree Celsius
CDB	Cotton Development Board
DAP	Date After Planting
etc	Etcetera
FAO	Food and Agriculture Organization
ha	Hactare
kg	Kilogram
m	Meter
mm	millimeter
MOP	Muriate of Potash
No.	Number
OP	Open Pollinated
%	Percent
RDF	Recommended Dose of Fertilizer
RCBD	Randomized Complete Block Design
m^2	Square meter
TSP	Triple Super Phosphate

Chapter 1
Introduction

CHAPTER I

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important fibre yielding crop of global importance and important industrial raw materials belonging to the family Malvaceae. It is grown in tropical and subtropical regions of more than 80 countries of the world. Among these countries, China, USA, Russia, India, Brazil, Pakistan, Turkey, Egypt, Mexico and Sudan are accounted for 85-90% of the total cotton production. Cotton refers to those species of the genus *Gossypium* which bear spinnable seed coat fibres.

There are about 42 species of the genus *Gossypium* out of these only four species, viz. *Gossypium arboreum, G. herbaceum, G. hirsutum and G. barbadense* are cultivated and the rest are wild. The first two species are diploid (2n = 2x = 26) and are native of Old world. Diploid cultivated species are also known as Desi cottons or Asiatic cottons because they are cultivated in Asian region. The last two of the above mentioned cultivated species are tetraploid (2n = 4x = 52) and are referred to as New world cottons. The *G. hirsutum* is known as American cotton or upland cotton and *G. barbadense i*s also referred to as Sea Island cotton or Egyptian cotton or Tanguish cotton. The *G. hirsutum* is the predominant species, which alone contributes about 90% to the global production.

Cotton is the major textile fibre used by man in the world and it plays a key role in economic and social welfare (Munro, 1994). Although it is grown primarily as a fibre crop, but after the lint, the long twisted unicellular hairs are removed by ginning, the seed can be crushed to extract vegetable oil and protein rich animal food (Mathews, 1989). Cottonseed cake, an industrial byproduct of cotton, is a valuable source of protein for ruminant cattle.

In Bangladesh, cotton is the most important fibre crop and it provides raw materials to domestic cotton industry containing 380 spinning mills, 1623 weaving mills, more than 3 laks of handlooms, 2822 knitting and 4500 garment industries (BTMA, 2002). Current domestic requirement of cotton is about 4.3 m bales against production of 128,365 bales which accounts only 3 % of the yearly requirement (Anon., 2008). Therefore, cotton industries of Bangladesh predominantly depend upon import where nearly 98% of the requirement is fulfilled by importing raw cotton from different foreign countries. In this context, it is imperative to increase cotton production in Bangladesh to feed the cotton industry, to save the hard earned foreign exchange and to attain self sufficiency in raw cotton. Cotton production in Bangladesh may be increased either by horizontally or vertically or by both the ways. But in fact, it is almost impossible to increase cotton production horizontally because of severe competition to other crops in limited land. Yield enhancement of cotton by alternate may be possible because the productivity of cotton in Bangladesh is only 450 kg lint ha^{-1} against world average yield of 556 kg lint ha^{-1}. Higher yield of cotton may be achieved by selecting appropriate variety specifically suited to local ecological condition.

Besides lint yield, fibre quality such as fibre length, strength, elongation, uniformity index and micronaire are important as it add value to the raw cotton. The extended fruiting period of the cotton plant and the subsequent development cycle forces each boll to develop under different environmental conditions than other bolls on the same plant. Fibers from a single plant, single boll, and even a single seed will vary in length, strength and micronaire value. Plant genetics and environment provide the platform for both higher lint yields and fiber quality.

The primary reasons for the low productivity of cotton in Bangladesh are; cultivation of crops predominantly under rainfed condition, use of less efficient cultivars, predominance of pests on the crop and inadequate supply of nutrients, besides other reasons the important issue that needs to be addressed in crop productions is nutrient usase. Cotton, particularly hybrids being exhaustive, draw plenty of soil nutrients and thus under continuous cropping pattern nutrient management assumes importance.

Nutrient recommendation varies with crop response, soil condition and hence targeted yield. Now a day hybrid cotton are being popularized among the cotton growers because of protection from bollworm menace at reduce cost besides being environmental safe. Hybrid cotton is an exhaustive crop and needs heavy fertilization to get higher yield. Further, nutrient recommendation varies with crop response, soil condition, genotype and climatic conditions (Patil *et al.*, 2009). Introduced hybrid cotton (HSC-4 and DM-2) needs optimization of its fertilizer dose for higher yield.

Different varieties respond differently to varying different doses of fertilizer. In the content of yield potential some improved varieties are comparable to hybrids. The seed cost of hybrids which can not be affordable to marginal farmers. Variety CB-12 developed by Cotton Research Farm, Jadishpur, Jessere during 2010 which has maximum yield potential (2.5-3.0 ton ha^{-1}) and better ginning percentage (40-42). Newly developed variety CB-12 also needs optimization of its fertilizer dose for higher yield.

Nutrient Management which advocates need based supply of nutrients ensures application of nutrients at right time in desired quantities by the crop for obtaining target yields. The crop yields under average management and the crop has the potential to produce still higher yield levels under improved management situation. Therefore, the present investigation was planned to study the performance of cotton hybrid and inbred variety as influenced by nutrient management approach to realize maximum yield during the growing season of 2011-12 with the following objectives:

1. To evaluate the performance of cotton hybrids and inbred variety in central Madhupur Tract of Bangladesh under rain fed condition
2. To determine the optimum doses of fertilizer of hybrid and inbred variety and
3. To find out the response of cotton hybrids and inbred varieties to nutrient management for higher yield and yield attributes.

Chapter 2
Review of Literature

CHAPTER II

REVIEW OF LITERATURE

A field experiment was carried out on Performance of cotton hybrids and inbred varieties at different nutrient levels at the Central Cotton Research Farm, Sreepur, Gazipur during the 2011-12 cotton growing season. The relevant information available on the subject are reviewed in this chapter.

2.1 Variety

2.1.1 Growth characteristics

Cotton is botanically a perennial herb with an indeterminate growth habit, it that has been adapted for commercially as an annual crop. In the cultivated varieties of these species, the annual nature of cropping is imposed but these varieties still retain their perennial character to some extent. Variation in growth habit among the cotton genotypes has led to the grouping of cultivars into "determinate" and "indeterminate" classes (Eaton, 1955). Determinate cultivars are generally classed as early or short-season varieties, and indeterminate cultivars are referred to as late or full-season varieties.

2.1.2 Genotype selection

Genotype selection is a key management component in any cropping system. The yield and fiber quality potential of cotton at harvest begin with selection of genotype. Tuteja *et al*. (2006) reported wide differences existed in productivity potential and plant type of cotton. Generally, high yield potential is a predominant consideration but maturity, plant size and fibre properties are also important factors for genotype selection. Less vigorous genotypes are more susceptible to stresses caused by inadequate moisture, cool or high temperature, thrips feeding, seedling diseases, nematodes and other pests. Kudachikar and Janagoudar (2001) reported that high-yielding genotypes were characterized by having low leaf area and high total dry matter content, leaf efficiency, harvest index, and boll number.

Cotton producers are currently faced with rising cost of production and static or declining return for their commodity. To combat these challenges, producers are continually searching for new alternatives to optimize their profit. Selection of Bt transgenic cotton varieties may be a favourable choice for them. Because Bt cotton provides a fairly high degree of resistance to lepidopterous pest (Gore *et al.,* 2000, Perlak *et al.*, 2001) and is thus widely adopted in both developed and developing countries. Sarker and Hossain (2001) reported that 50% of the total production was damaged by the lepidopterous (Bollworm) insect. A series of studies conducted in the USA and South Africa which indicated that the yield of Bt cotton was significantly higher than local non Bt cotton varieties, and contributed to nearly 60% reduction in pesticides (Traxler and Falck-Zepeda, 1999; Bennett, 2000).

Most of the cotton cultivars which were grown commercially possess the normal leaf type. Leaf shapes of okra-leaf cultivars can greatly alter canopy structure and light interception characteristics. Okra leaf cultivars are characterized by moderately cleft leaves and relatively small leaf area. They typically have less vegetative growth, early maturity, greater flower production ability, and less boll rot than normal leaf cotton (Wells and Meredith, 1986). But a major disadvantage of okra leaf cotton is lower leaf area index in the early stages of development (Wells and Meredith, 1986).

In cotton shorter plant height, higher number of bolls per plant and boll weight, lower number of days to flowering and boll split are desirable (Alam and Mondol 1996). Adarsha *et al*. (2004) suggested that cotton genotypes should possess the following morphophysiological characters for getting higher yield: (i) medium duration (160-170 days), (ii) medium number of monopodial branches (1.27) and higher number of sympodial branches (at least 21.0) and (iii) higher number of bolls per plant, boll weight and harvest index

2.1.3 Hybrid cotton variety

Hybrid cotton varieties may be another choice because it is more tolerant to stress factors than non-hybrid cotton. Some authors indicated that yield advantage of hybrid is partly because of its high photosynthetic rate (Pn) and photosynthate allocation (Bhardwaj and Weaver, 1984; Wells and Meredith, 1986; Chen *et al.*, 1999). The relative high Pn without mid-day depression probably contributed to enhanced yield of hybrid cotton, compared with non-hybrid. Mid-day depression of Pn may be attributed to photo-inhibition (Powels1984), carbohydrate feedback inhibition (Peet and Kramer, 1980), high temperature stress (Perry *et al.*, 1983), water stress.

Generally hybrid variety exhibits high yield performance over HYV. High yield and quality were obtained by the optimum combination of boll weight and boll number (Tan,1993). Boll size, boll wt. and fiber properties were positively correlated with flowering date and boll retention (Fan *et al*, 1989).

Ali *et al. (*2012) studied the performance of some introduced hybrid cotton (*Gossypium hirsutum*) varieties in Bangladesh at the Regional Cotton Research Farm, Jagadishpur, Jessore during 2009-10 to evaluate six cotton varieties. Among them, four were hybrid cotton varieties and another two were inbred taken as control. Yield and ginning out turn of hybrid varieties found significantly higher than OP varieties. Hybrid variety SSC-3 performed well in terms of seed cotton yield (3570.33 kg/ha), lint yield (1404 kg ha^{-1}) and ginning out turn (GOT) percentage (43.83%). The highest 2.5% span length (31.44 mm) was found in hybrid HSC-4 and the lowest micronaire value of 3.87 mµ was found in hybrid SSC-2.

In Guntur district of Andhra Pradesh, Chandrasekhar Reddy and Satianayayana (2005) observed that overall average yield of Bollgard hybrid MECH-12 Bt and MECH-184 Bt (1231 kg $acre^{-1}$) was higher than the commercial checks (1149 kg $acre^{-1}$). This indicated a gain of 7.31 percent in favour of Bollgard hybrid.

In India at least 40% of cotton production is from intra-specific hybrid of *G. hirsutum* and 8% of its production is from *G. hirsutum* × *G. barbadense* hybrids (Chaudhry, 1977). The yield increase of hybrid over the better parents or best commercial varieties due to sufficient magnitude of heterosis.

2.1.4 Flower and boll formation

Cotton genotypes differed significantly for flower and boll production, and earliness in crop maturity (Cook and El-Zik, 1993). Although it is an inherent character of the genotype, but sometimes it also depends on other factors. Evaporation, humidity, light and temperature are the principal climatic factors that governed cotton flower and boll production (Sawan *et al.*, 1999). Harland (1917) stated that the Sea Island cotton in St Vincent "always flowers within a few days of two months". Fifty to fifty-five days may be taken as average for most areas where American uplands cotton is grown. First flowering indicates the earliness of the genotype. Similar study (Reddy *et al.*, 1993) revealed that modern cultivars developed squares faster than 20-30 years older ones, when grown at the same temperature. Fan *et al.* (1989) found that boll size; boll weight and fibre properties were positively correlated with flowering date and boll retention.

2.1.5 Yield components and yield

Variability in yield and yield attributes among genotypes are common in cotton. Seed cotton yield per unit area is the function of yield of individual plant and population densities. Lint yield of upland cotton is determined by a number of individual components (Worley *et al*., 1976). Yield components such as the plant height, number of sympodia plant^{-1}, node of first fruiting branch, days to first flowering, number of bolls per plant, boll weight, days to 50% boll split, and seed index differed significantly in the cotton genotypes. Rao and Mary (1996) and Meena *et al.*(2007) evaluated different upland cotton cultivars for yield and other economic traits and observed significant variations.

Khan *et al*. (2009) mentioned that genetic variances were found almost greater than the environmental variances and correlation of seed cotton yield with other different traits was found significantly positive for majority traits. Plant height, sympodia per plant, staple length, and staple strength exhibited high narrow sense heritability due to the presence of additive gene action whereas, monopodia per plant, number of bolls, lint percentage and seed cotton yield possessed low narrow sense heritability which was due to presence of dominant gene effects (Ahmad *et al*., 2003; Haq and Azhar, 2004). This genetic analysis suggested that plant height, sympodia per plant, staple length and fibre strength could be improved through individual plant selection, while exploitation of heterosis would be necessary to attain the genetic advancement in monopodia plant^{-1}, number of bolls, lint percentage and seed cotton yield.

Plant height of cotton cultivars differed significantly. It was positively correlated with bolls and seed cotton yield (Khan, 2003; Khan *et al*. 2009b; Batool *et al*., 2010, Taohua and Haipeng 2006). Khan *et al.,* (2009b) reported that the genetic variability for plant height among different upland cotton cultivars was present and mentioned that plant height was positively correlated with bolls and seed cotton yield if lodging did not occur. Some scientist (Murthy, 1999; Batool *et al*., 2010) reported that positive correlation between plant height and yield and noted that plant height contributed 70% of the total variability for seed cotton yield.

Among the yield components bolls per plant is the key independent component and play prime role in managing seed cotton yield. Number of open bolls had the highest direct effect on lint yield plant^{-1} (Zeina and El-Aal 1998). Rao and Mary (1996) evaluated different *hirsutum* cultivars for yield and other economic traits and observed significant variations for bolls number and observed direct positive impact on yield. Other authors (Abouzaid *et al*., 1997; Ganapathy *et al.,* 2006 and Khan *et al*., 2009b) also reported variable number of bolls per plant in upland cotton genotypes and exhibited very high positive correlation with seed cotton yield.

Boll weight is second major yield component after bolls per plant and have a greater contribution in enhancement of yield. A significant positive correlation was observed between the average number of bolls per plant, mean boll weight and seed cotton yield per plant (Zende *et al*., 2003). Similarly, several scientists (Ivanova and Stovanova, 1996; Terziv *et al.*, 1996; Abouzaid et al., 1997; Khan *et al*., 2009b) obtained the similar result for boll weight and seed cotton yield in different cotton genotypes. Others (Rao and Mary, 1996; Afiah and Ghoneim, 2000; Badr, 2003; Khan, 2003; Soomro *et al.*, 2008) also observed significant variations for boll weight and revealed highly positive effect on yield.

Seeds locule^{-1}were significant and positively associated with seed cotton yield and contributed 70% of the total variability for seed cotton yield (Khan *et al.*, 2010; Iqbal *et al.*2003). Murthy (1999) and Wang *et al.* (2004) derived information on genetic variability and observed positive yield correlation with seeds per locule and other yield traits. Genetic variability and positive correlation between seeds per bolls and seed cotton yield was derived in *G. hirsutum* and reported by many authors (Iqbal *et al*., 2003; Wang et al. 2004). Likewise, other authors (Rao and Mary 1996; Khan *et al.*, 2010) also found high genetic variability for seeds per boll and seed cotton yield.

Cotton plants grow with a monopodial vegetative, main stem and lateral monopodial and sympodial fruiting branches. Short duration genotypes were characterized by minimum spreading of their vegetative branches. Reduced number of lateral monopodial branches that are formed before sympodial fruiting branches, resulting in an earlier onset of flowering Kohel and Benedict (1987). Number of sympodial branches plant^{-1} is one of the important factors of yield contributing characters of cotton. Higher number of sympodial branches plant^{-1} and boll weight had the highest positive direct effect on yield. On the other hand, number of monopodial branches plant^{-1} and ginning out tern had a negative effect on yield (Muhammad *et al.*, 2003).

2.1.6 Genotype and fibre quality

Physiological and morphological differences were observed among cotton cultivars in relation to fibre quality. It was found that growing cotton under non-irrigated conditions resulted in the production of shorter and weaker fibre with reduced micronaire. They also mentioned that the fibre properties of cultivars were inconsistently affected by non-irrigated and irrigated conditions indicating variability inherent in cotton fibre (Mert *et al*., 2005).

Fibre elongation and fibre dry weight were closely associated with species and varietal differences. The rate of elongation was not uniform over the entire elongation period. The dry weight (secondary thickening) started only after elongation ceased and continued to increase until bolls opened (Mishra *et al.*, 2005). Naveed *et al.* (2004) determined the genetic variation in 8 upland cotton cultivars for fibre strength and staple length. They revealed that the gene action governing fibre strength and staple length in cotton. Additive dominance effects controlled fibre strength, whereas epistatic effects controlled staple length in cotton.

The phenotypic coefficient of variation and genotypic coefficient of variation were high for seed cotton yield per plant. Phenotypic variation was higher than genotypic variation for all the characters. Reddy and Satyanarayana (2005) reported that genotypic and phenotypic ratio was high for 2.5% span length and bundle strength, indicating that these traits were not much influenced by the environment. Heritability estimates were high for ginning percentage, span length, bundle strength and seed cotton yield, indicating the amenability of these traits in the selection process. High heritability coupled with high genetic advance for ginning percentage, span length, bundle strength and seed cotton yield indicates the operation of additive gene action in the inheritance of these traits.

A number of studies have reported on the association of lint yield in upland cotton and fibre quality (Culp and Harrell, 1976; Green and Culp, 1990; Kerr, 1966; Miller,1965; Scholl, and Miller, 1976; Simongulyan and Kosba, 1975; Stewart and Kerr, 1974; Worley *et al.,* 1976). Most of these studies reported a negative association between lint yield per unit land area and fibre quality, especially between yield and fibre bundle strength.

Several authors (Miller, 1965; Scholl and Miller, 1976) demonstrated strong negative association between total lint yield and fibre quality, while positive association was noted for total lint yield and lint percentage, bolls per plant, micronaire, and fiber elongation. Negative correlations were reported for total lint yield and boll weight, seed index, fiber length and fibre strength.

2.2. Fertilizer management

Cotton, particularly the hybrids are soil exhaustive crops and therefore require heavy nutrient supplementation. Nutrient requirement however, varies with cultivars, growing conditions and management practices. Sound nutrition is one of the ingredients of high yields in cotton. Nutrition affects the yields of cotton to a greater extent than its quality. Fruiting efficiency (ratio of weight of bolls to dry weight of stems) is one of the important yield parameters influenced by the nutrients. In the country, all cotton growing areas are very poor in organic carbon and N, soils are also very poor in available P and medium to high in available K. Hence, adequate fertilization based on crop requirement and soil supply capacity needs emphasis for profitable and sustained production.

Nutrient uptake is related to yield. Of all the elements, N, P and K are removed in greatest amounts. Berger (1996) reported that cotton removes 40, 7 and 14 kg ha^{-1} to produce 2.5 bales ha^{-1}, 62, 11 and 22 kg ha^{-1} to produce 3.75 bales ha^{-1}, and 125, 21 and 43 kg ha^{-1} to produce 7.5 bales ha^{-1} of N, P_2O_5 and K_2O respectively. Nearly 260 percent of N and P and 470 percent of K removed should be there in soil for adequate growth i.e. to obtain a minimum yield of 2.5 bales, the soil should have nearly 100kg N, 50 kg , P_2O_5 . In India, under rain fed condition to produce one quintal of economic product cotton uses 4.45 kg N, 0.83 kg , P_2O_5 and 7.47 kg K_2O (Das *et al*., 1991). Hybrid cotton has been found to use 5.81 kg N, 1.97 kg, P_2O_5 and 6.59 kg K_2O per quintal of seed cotton (Pundarikak shudu.1985).

It is widely recognized that nitrogen supply exerts a marked influence on vegetative and reproductive growth. In recent years, there has been tendency among some cotton growers to increase maximum yield potentials by applying higher amount than that recommended nitrogen rates. Several authors (Boquet *et al*., 1994; Soomro *et al.*, 1997) have found that increasing of nitrogen rate increased plant height and the number of flowers and bolls, but do not increased seed cotton yields because of increased shedding of lower bolls. Moreover, they added that excessive nitrogen fertilization does not improve the yield potential or profitability of cotton production. Cotton requires large amounts of N, particularly under irrigated cropping system.

Hunsagi (1973) found that the two hybrids and two varieties used in the study responded positively for increased nitrogen with respect to the leaf area and leaf area index and application of 90 kg ha^{-1} N was found optimum.

Halevy *et al.* (1987) reported that the uptake by cotton was 267 and 332 N kg ha-1, 46 and 44 , P_2O_5 kg ha-1, 208 and 251 K_2O, kg ha^{-1} at 120 and 180 N kg ha^{-1} applications respectively.

Angadi *et al.* (1989) revealed that under rainfed conditions nitrogen application up to 100 kg ha-1 to hybrid cotton increased number of bolls, yield per plant and seed cotton yield per hectare.

Hybrid cotton NHB-12 responded significantly for plant height, dry matter production per plant and number of sympodial branches to application of 160 kg N

ha^{-1} and significantly better performance over all lower doses in per plant and per hectare yield of seed cotton (Patil and Malewar, 1994).

Seed cotton yield and its components were affected (Waheed Sultan Khan and Munir Ahmed, 1996) positively with increase in the dose of N, beyond 100 kg N ha^{-1}, the response in the seed cotton yield was non significant.

At Dharwad, Karnataka under rainfed conditions uptake of N by hybrid cotton increased with N application up to 150 kg ha^{-1} (Angadi, 1985). In another experiment Gomase and Patil (1987) noticed that hybrid cotton (H-4) responded significantly to addition of N up to 100 kg ha^{-1}. Response per kg N at 50 and 100 kg N per hectare was 9.72 and 8.82 kg seed cotton kg^{-1} N applied respectively.

Several factors, including soil type, affect cotton response to P. The critical level of P is a function of actual concentration of the labile pool that in turn determines the available P at a given time during the growth of cotton. Several variables, including early P accumulation, biomass, and lint yields, positively responded to P fertilization in calcareous soils. Some positive and notable P effects on lint yield and fibre quality factors. Stewart *et al.* (2005) evaluated different methods of P fertilizer application to cotton and found P fertilizer significantly increased seed cotton yield.

Kharche *et al.* (1990) obtained significantly higher seed cotton yield with the application of 62.5 kg ha^{-1} phosphorus (2023 kg ha^{-1}) over control (1449 kg ha^{-1}) and 50 kg ha-1 phosphorus (1913 kg ha-1) and 25 kg ha^{-1} phosphorus (1721 kg ha^{1}). Increased leaf area index with higher N application rates was attributed to better leaf area development and photosynthetic efficiency. Lower N application resulted in decline in main stem nodes, leaf area and LAI (Jackson and Gerik, 1990).

Potassium is considered as an important element in cotton plant for normal functioning of metabolic process and higher yield. It is particularly a vital element for the fruiting phase of the crop. From flowering to the early boll filling, potassium is required in large amounts. Deficiencies during this time will have detrimental effect on the both yield and fibre quality of cotton. Potassium is also important for cotton lint yield and quality. Potassium is required throughout the growing season, but the demand is highest during the boll set and development stage. The boll size and boll weight increased significantly with increasing application of potash levels (Aneela *et a*l. 2003). Gormus (2002) found that application of K at early boll development increased yields, boll weight and lint turnouts and fibre quality.

Basal application of potassium is being commonly used practice to cultivate cotton in our country. But many scientists suggested (Ping *et al.*, 2003; Krishnan *et al.*, 1997 and Gormus, 2002) suggested split application of potassium in soil as it is more efficient than the basal application. Pervez *et al.*, (2005) conducted a field experiment in Multan, Pakistan to assess the effectiveness of fruiting positions along sympodia under varying levels of K fertilizer on cotton. Plant mapping data showed that the total number of fruiting positions, number of intact fruit on sympodia or monopodia and percent of bolls per position on sympodia differed greatly under different K fertilizer rates. K fertilizer application stimulated the cotton crop in lengthening sympodial branches and retaining more fruits on the first three positions and also at the bottom of the plant during the early reproductive phase.

Cassman *et al.* (1990) conducted a field experiment on a Grangeville Sandy loam soil in King's county, California to know the potassium nutrition effects on lint yield and fibre quality of Acala cotton. Single cultivar (1985) and two cultivar (1986 and 1987) were grown with 0,120, 240 and 480 kg ha^{-1}. They reported that, there was a significant seed cotton yield response to applied K in each year. Lint yield, however, increased relatively more than seed yield, resulting in greater lint percentage as plant K supply increased. Further, they concluded that K supply to cotton fruit is important from fibre quality under field condition.

Dastur and Dabir (1961) reported that, Buri-147 gave higher yield of seed cotton than Buri-0394 though it bears less number of bolls per plant. Application on N (40lb N), P (50lb P_2O_5) and K (50lb K_2O) significantly increased the yield of kapas. Combined application of N, P and K increased the yield of kapas over individual application.

At Agricultural Research Station Surat, Gujarat Sharma *et al.* (1979) observed increased yield of cotton with application of fertilizers up to 320:160:160 kg ha^{-1} NPK. However, optimum dose of fertilizer was found to be 280 kg N, 140 kg P_2O_5 and 140 kg K_2O ha^{-1} for maximum production of seed cotton. Kummur (1981) reported increased plant height in early stage with higher dose of N (250 kg ha^{-1}), but at later stages the plant height, main stem nodes and vegetative branches did not differ significantly due to differential N addition under irrigation. Fibre length of hybrid cotton (DCH-32) was reduced with application of N beyond 225 kg ha^{-1}. Other properties like fibre strength, fineness and maturity co-efficient were not affected by N increments. Further increase in number of boll per plant and seed cotton yield was very less with increase in N application up to 225 kg ha^{-1}. Both the parameters decreased significantly with further increase in N addition up to 300 kg ha^{-1}.

Vyakarnahal *et al.* (1987) found that the application of 240 kg N, 100 kg , P_2O_5 and 160 kg K_2O ha^{-1} recorded the maximum seed cotton yield as compared to application of 168:80:80 and 80:40:40 kg ha^{-1} NPK in hybrid cotton.

Nehra *et a.,l* (2006) reported that. Application of 100 per cent R.D.F. significantly increased seed cotton yield over 75 per cent R.D.F. but remained statistically *at par* with 125 per cent R.D.F. It gave 17.58 per cent higher seed cotton yield over R.D.F.

From the review it is found that there is a great variability in phenology, growth, yield and fibre quality in cotton which are influenced by genotype and fertilizer. Yield target can be fixed by looking into the genetic potential of the crop/variety and other factors. Soil testing and soil fertility management are of great importance to any country for sustained cotton production.

Chapter 3

Methodology

CHAPTER III

MATERIALS AND METHODS

3.1. Experimental site

The experiment was carried out at the Central Cotton Research Farm, Sreepur, Gazipur during the period of July, 2011 to February, 2012. The site was located in the centre of Madhupur Tract (24.09 ^{0} N latitude and 90.26 ^{0} E longitude) with an elevation of 8.4 meter above the sea level.

3.2 Climatic conditions

The experimental site is situated in the subtropical climatic zone characterized by hot and dry summer, cold winter and heavy rainfall during the monsoon. The monsoon generally commences from June and continues up to September. Temperature gradually falls from the month of October. The monthly average maximum and minimum temperature, relative humidity and rainfall during the study period were recorded (Appendix I).

3.3 Soil and its characters:

The soil of the experimental site belongs to the Salna series and has been classified as Shallow Red-Brown Terrace type which falls under the order Inceptisols of soil taxonomy (Brammer, 1980; FAO, 1988). The soils are characterized by heavy clays within 15 cm from the surface and are poor in chemical properties. The soil is acidic in nature and red in colour. The detailed information of the basic soil properties are presented in the (Appendix 2).

3.4 Previous crops in the experimental area

Sunhum crop was taken during kharif-1, 2011

3.5 Experimental details

Treatments

There were 15 treatment combinations comprising three genotypes (two hybrids and one inbred cotton variety) and five fertilizer levels for maximum yield as shown below.

Factor -1: Variety

V_1- HSC-4 (hybrid)

V_2- DM-2 (hybrid)

V_3- CB-12 (inbred)

Factor -2: Fertilizer dose

F_0 - 00 : 00 : 00 : 00 : NPKS kg^{-1} (Control)

F_1 - 90 : 34 : 98 : 20 : NPKS kg^{-1} (25% less than recommended dose)

F_2 - 120 : 45 : 131 : 27 : NPKS kg^{-1} (Recommended dose of fertilizer)

F_3 - 150 : 56 : 164 : 34 : NPKS kg^{-1} (25% higher than RDF)

F_4 - 180 : 67 : 196 : 40 : NPKS kg^{-1} (50% higher than RDF)

3.6 Source of seeds:

V_1- HSC-4 (Chinese hybrid supplied by Supreme Seed Ltd)

V_2- DM-2 (Chinese hybrid supplied by Lal Teer Seed Ltd)

V_3- CB-12 (Cotton Development Board)

3.7 Design and layout :

The experiment was laid out in randomized complete block design with three replications.

3.8 Plot size: Unit plot was 4.5 m x 2.7 m.

3.9 Spacing

Row to row distance and plant distance were 90cm and 45 cm respectively. Block to block and plot to plot distance was maintained as 1 m for easy management of the crop.

3.10 Crop establishment and management

Cotton seeds were planted on 17th July 2011 by dibbling, three water soaked seeds per hill to ensure uniform stand, later thinned to one plant per hill. Gap filling was done immediately after emergence of seedling. Thinning and ear thing up were completed by 20 days after emergence. In case of first thinning, two seedlings per hill were kept after 10 days of emergence. Second thinning was done 20 days after emergence keeping one seedling per hill.

N, P, K, S was fertilized according to the treatments in the form of urea, triple super phosphate, muriate of potash, gypsum and other micro nutrient Zn, Mg, and B @ 3.3- 1.5 -1.5 kg ha^{-1}, in the form of zinc sulphate, magnesium sulphate and boric acid, respectively. Total amount of triple super phosphate, gypsum, zinc sulphate, magnesium sulphate, boric acid, one fourth of urea and half of the muriate of potash were applied in the furrows during the final land preparation as basal dose. The rest amount of urea was applied in three equal splits at 20, 40 and 60 days after sowing as top dressing. Similarly, the rest muriate of potash was applied at the time of second and third split of nitrogen application.

The experimental field was kept weed free up to 60 days after emergence of seedling by hand weeding. Mulching between two rows was done by power tiller. At the third week of November and first week of December irrigation were given due to draught situation. First spraying of volume flaxy was done at 30 days after emergence against sucking pest like Jassid and Aphid. Other three spray of Aktara in combine with Volume flaxy were applied to control sucking and chewing (bollworms) pests. In all cases, scouting based spray was followed. Hand picking, light trapping and zollaghur (molasses) traps were also used to kill moths and adults of the insects. As a result insect reproduction was more or less stopped which encouraged friendly eco-system to some extent. To protect fungal diseases, Bavestine were sprayed at 10 days after emergence as precautionary measure.

3.11 Sampling and harvesting

Ten plants were selected randomly from each plot and tagged for taking data. Harvesting of seed cotton from the net plot and border were done in three number of picking at 15 December 2011, 20 January 2012 and 16 February 2012.

3.12 Data collection

The following data were recorded during the experimentation.

A. Growth Data

1. Plant height (at harvest)
2. Number of monopodium branch plant^{-1}
3. Number of sympodium branch plant^{-1}

B. Phenology data

1. Days to first flowering
2. Days to first boll opening

C. Yield and yield component

1. Number of bolls plant^{-1}
2. Individual boll weight
3. Seed cotton yield
4. Lint yield

D. Ginning data

1. Ginning out turn
2. Lint index
3. Seed index

E. Fibre quality data

1. Staple length
2. Micronaire value
3. Fibre strength
4. Uniformity ratio

Growth Data

Plant height

Plant height was measured on main shoot from the ground level up to the base of the node which the first fully opened leaf from the top was born at final picking.

Number of monopodial branch plant^{-1}

The monopodium branches at least one functional sympodial branch were counted separately in ten tagged plants and average value was recorded as the number of monopodium branch plant^{-1}

Number of sympodial branch plant^{-1}

Sympod is generally called fruiting branches. Fruiting branches develop in succession from the first fruiting branch and upward. The sympodial type of growth with a flower bud at each node tends to give a zigzag appearance of these branches where the lower fruiting branches are longer than the upper ones. Number of sympodial branch per plant is one of the most important factors of yield contributing characters of cotton. The fruiting branches arising on the main stem were counted separately in the ten tagged plants and average value was recorded.

B. Phenology data

Days to first flowering

Days required from seedling emergence to 50% plant of the total plot began to flowering

Days to first boll opening

Days required from seedling emergence to 50% plant of the total plot began boll splitting.

C. Yield and yield component

Number of boll plant^{-1}

Total number of boll were recorded counted separately in ten tagged plants and average value was recorded as the number of boll plant^{-1}

Individual boll weight

Fifty (50) bolls of each plot were weighted. Total weight was divided by 50 and the average weight was recorded as Individual boll weigh**.**

Seed cotton yield

The total seed cotton picked from net plot of each treatment in different pickings was used for working out seed cotton yield per hectare.

Lint yield

The total seed cotton picked from net plot of each treatment in different pickings was ginned by ginning machine. After separate seed lint was weighted and convert plot wise yield into kg ha^{-1}.

D. Ginning data

Ginning out turn:

Ginning percentage of each genotype was measured as the weight of lint ginned from the of seed cotton and expressed as a percent of the seed cotton weight. Therefore ginning out turn (GOT) can be expressed as:

$$\textbf{GOT (\%)} = \frac{\text{Weight of lint}}{\text{Weight of seed}} \times 100$$

Seed index:

Seed index was measured as the weight of 100 ginned seeds.

Lint index:

Lint index was computed by the formula:

$$\text{Lint index} = \frac{\text{Seed index} \times \text{ginning percentage}}{100 - \text{ginning percentage}}$$

$$\text{Or,}\quad \text{Lint index} = \frac{\text{Weight of lint}}{\text{Weight of seed}} \times \text{seed index}$$

E. Fibre quality data

Staple length: Staple length was measured by Fibrograph instrument.

Micronaire value: Fineness of cotton can be measured through smoothness of fibre. It is associated with fibre diameter and fiber wall thickness. The micronaire value represents the fibre diameter. Micronaire value was determined by Micronaire testing instrument.

Fibre strength: The inherent strength of individual cotton fibre is an important factor in the strength of the thread. It determines the yarn strength and is essential for high speed of spinning. There are two instruments used to measure fibre strength; the Pressly and the Stelometer in both of these the strength is measure by spading a bundle of parallel fibre across two clamps. Forced is applied to clamps and gradually increased until the bundle breaks.

3.13 Chemical analysis of soil

Soil samples from 0-30 cm soil depth after harvest of the crop were collected from each treatment in all the three replications. The soil samples were analyzed from SRDI.

3.14 Statistical analysis of the data

The data obtained from the experiment on different parameters were analyzed statistically following the analysis of variance (ANOVA) technique with the help of computer package, MSTAT C. Means were separated using Duncan's multiple range test at a significance level of 0.05 (Gomez and Gomez, 1984).

Chapter 4

Results and Discussion

CHAPTER IV
RESULTS AND DISCUSSION

Results were obtained from the present study regarding cotton hybrid varieties and fertilizer doses on the growth, yield, lint characters, nutrient availability and economy of hybrid cotton variety and their interaction effect of the crop characters of the hybrid cotton variety that have been presented and discussed parameter wise in this chapter. The results of the study have been presented in Tables 1 to 17 and Figures 1 to 32.

4.1 Plant height at harvest

4.1.1 Effect of genotype

Plant height of different hybrid varieties was measured at harvest time (Fig.1). The highest plant height was observed in hybrid variety HSC-4 (98.41cm) which was significantly higher than other varieties. The lowest plant height was observed in CB-12 variety (82.28cm). The results are in agreement with Ali *et al*. (2012) who reported that hybrid cotton responded significantly for plant height.

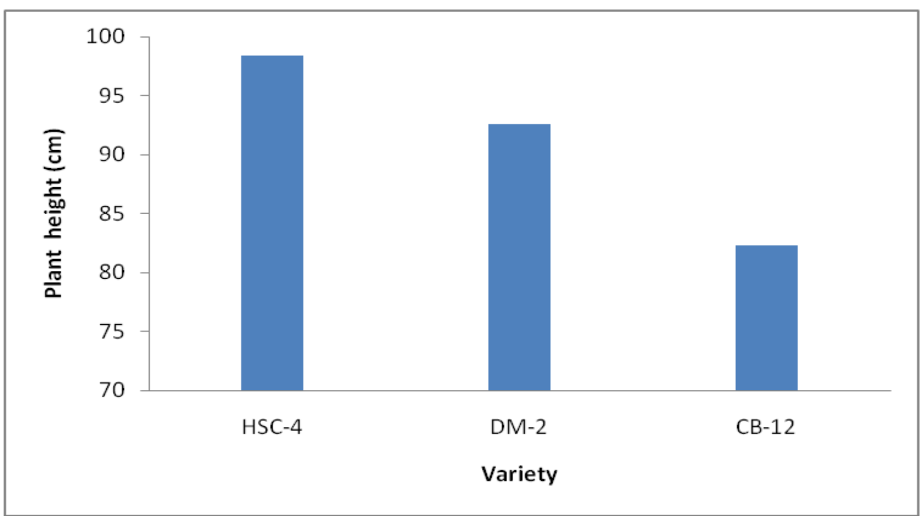

Fig.1 Effect of cotton genotypes on plant height ($S\bar{x}$ =1.001)

4.1.2 Effect of fertilizer

Plant height of cotton genotypes due to application of different levels of fertilizer were varied significantly at harvest (Fig.2). Plant height increased with the increase dose of fertilizer. The tallest plant height (111.00 cm) was recorded in the highest dose of fertilizer. The lowest plant height (59.90 cm) was observed in control treatment. Plant height at harvest with recommended dose (98.88 cm) and 25% higher fertilizer than recommended doses (99.19cm) were statistically similar. The increase in plant height due to application of fertilizer might be associated with fertilizer application with stimulating effect on various physiological process including cell division and cell elongation of the plant. The results are in agreement with Patill and Malewar (1994), who reported that hybrid cotton responded significantly for plant height, dry matter production per plant and number of sympodial branches to application of N 160kg ha^{1} and significantly better performance over all lower doses in per plant and per hectare yield of seed cotton.

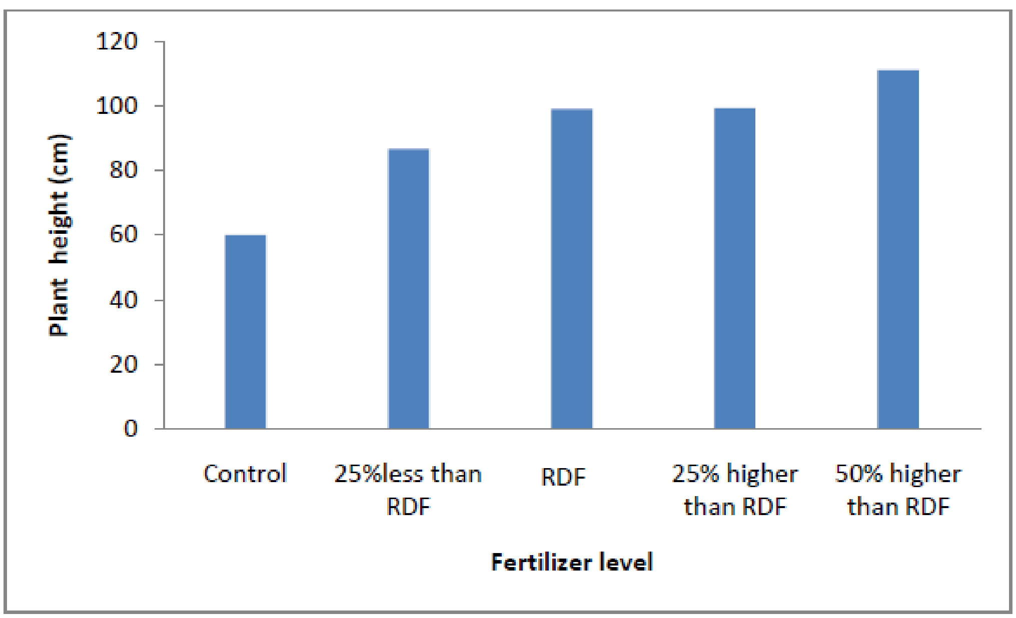

Fig. 2 Effect of fertilizer levels on plant height of cotton ($S\bar{x}$ =1.293)

4.1.3 Interaction effect of variety and fertilizer

There observed a significant difference in plant height due to interaction effect of variety and fertilizer (Table1). The result showed that the plant height increased gradually with the application of increasing fertilizer doses. The tallest plant (119.6cm) was found in the interaction of HSC-4 and 50% higher fertilizer than RDF which was significantly highest than other interaction at harvest. The lowest plant height (55.97cm) was observed in CB-12 x control treatment.

Table1. Interaction effect of variety and fertilizer levels on plant height

Interaction (Variety × fertilizer)	Plant height(cm)
HSC-4 × Control	68.70 g
× 25%less than RDF	95.40 de
× RDF	104.40 c
× 25% higher than RDF	103.90 c
× 50% higher than RDF	119.60 a
DM-2 × Control	104.40 c
× 25%less than RDF	103.90 c
× RDF	119.60 a
× 25% higher than RDF	55.03 h
× 50% higher than RDF	89.37 ef
CB-12 × Control	55.97 h
× 25%less than RDF	74.73 g
× RDF	88.20 f
× 25% higher than RDF	92.10 ef
× 50% higher than RDF	100.40 cd
$S\bar{x}$	2.24
CV (%)	4.26

4.2 Number monopodium branches plant^{-1}

4.2.1 Effect of genotype

The results showed a non significant difference in number of monopodial branches of cotton genotypes (Fig.3). However the maximum number of monopod (1.5) was noted in CB-12 genotype which was statistically similar to the genotypes DM-2 and HSC-4. The lowest number of monopod (1.10) was recorded in HSC-4. These results are similar to those reported by Iqbal *et al.* (2003), who observed the highest number of monopodial branches present in conventional genotypes of cotton.

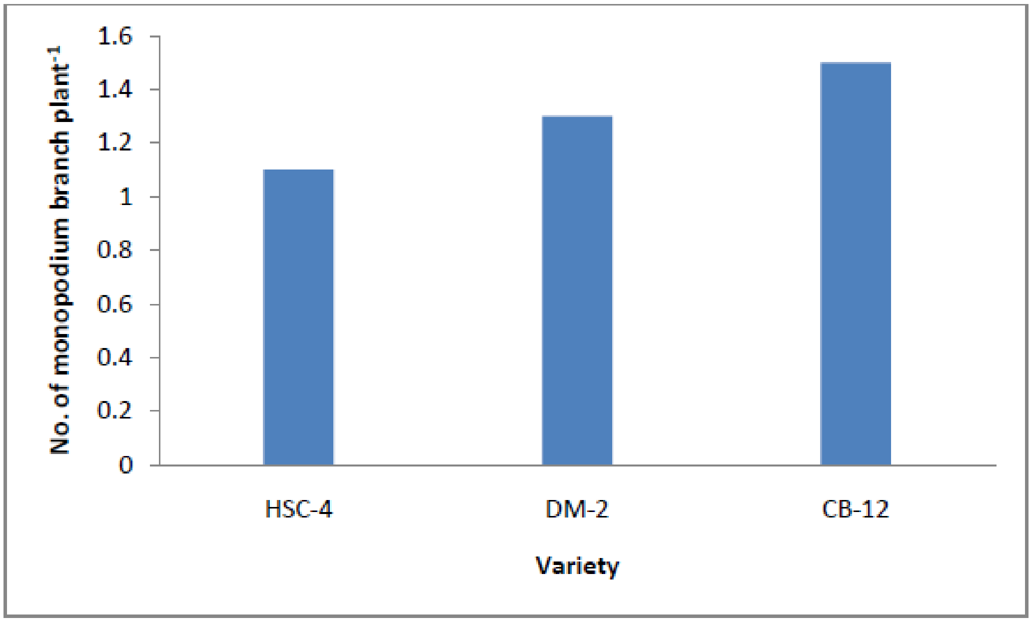

Fig .3 Effect of cotton genotype on number of monopodium branch plant^{1}

(Sx^{-} = 0.2049)

4.2.2 Effect of fertilizer

Fertilizer doses exerted significant effect on the number of monopodium branches plant^{-1} (Fig. 4). The result showed that number of monopodium branches plant^{-1} increased gradually up to 25% higher than RDF. The highest monopodia produced (1.89) which was statistically similar with recommended dose of fertilizer and

50% higher than RDF. The lowest monopodia produced by control treatment. The results are similar to Khalequzzaman *et al.* (2012) who reported fertilizer levels increased the number of monopodium branches plant^{-1}.

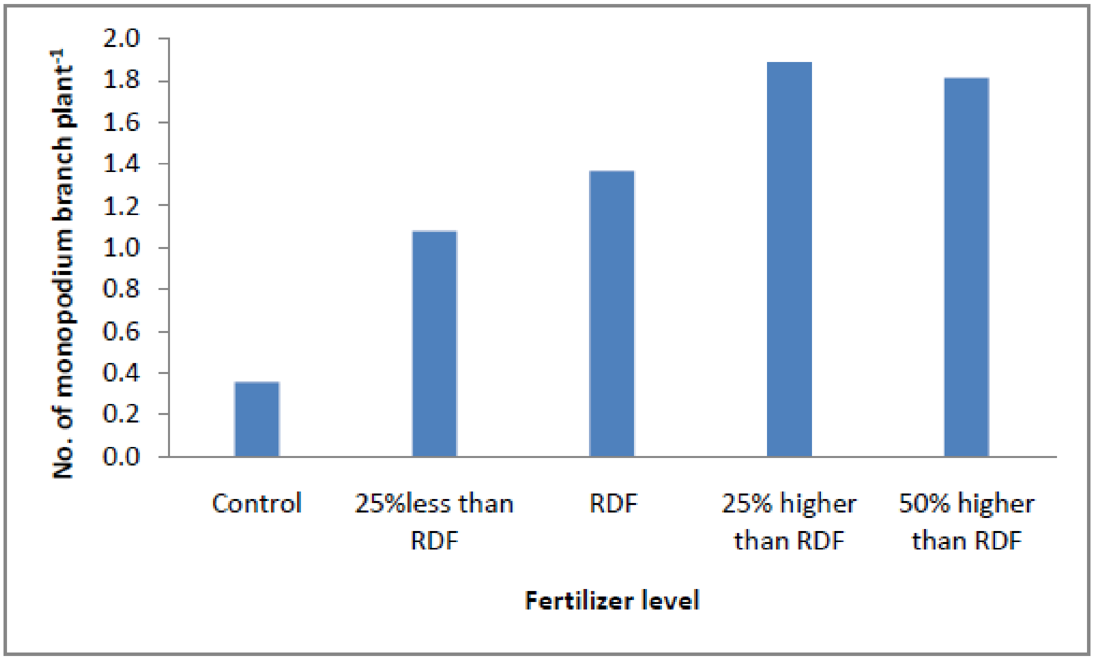

Fig. 4 Effect of fertilizer levels on number of monopodium branches plant^{-1}
($S\bar{x}$ = 0.2049)

4.2.3 Interaction effect of variety and fertilizer

Significant difference was observed in monopodium branches plant^{-1} due to interaction effect of fertilizer and variety (Table 2). The highest monopodium branches plant^{-1} (2.23) was found in the interaction of CB-12 and 50% and 25% higher than RDF which was significantly highest than other interaction at harvest. The lowest monopodium branches(0.23) was observed in HSC-4 and control interaction.

Table 2. Interaction effect of variety and Fertilizer levels on monopodium Branches plant^{-1}

Interaction (Variety × fertilizer)	Monopodium branches plant^{-1}
HSC-4 × Control	0.23 c
× 25%less than RDF	1.13 a-c
× RDF	1.06 a-c
× 25% higher than RDF	1.43 a-c
× 50% higher than RDF	1.63 a-c
DM-2 × Control	0.50 bc
× 25%less than RDF	1.13 a-c
× RDF	1.30a-c
× 25% higher than RDF	2.00 ab
× 50% higher than RDF	1.56 a-c
CB-12 × Control	0.33 c
× 25%less than RDF	0.96 a-c
× RDF	1.73 a-c
× 25% higher than RDF	2.23a
× 50% higher than RDF	2.23 a
$S\bar{x}$	0.2049
CV (%)	11.94

4.2 Number sympodium branches plant^{1}

4.3.1 Effect of genotype

The cotton genotypes showed a non significant variation in number of fruiting branches per plant (Fig.5). The number of fruiting branches per plant varied from 12.03 to 12.81 in cotton genotypes. The genotype DM-2 produced the maximum number (12.81) of fruiting branches per plant. On the other hand, minimum number (12.03) of primary fruiting branches per plant was noted in CB-12 genotype. Such differences in number of sympodial branch per plant of cotton genotypes were also reported by Nichols *et al.* (2004) in different cotton growing environments.

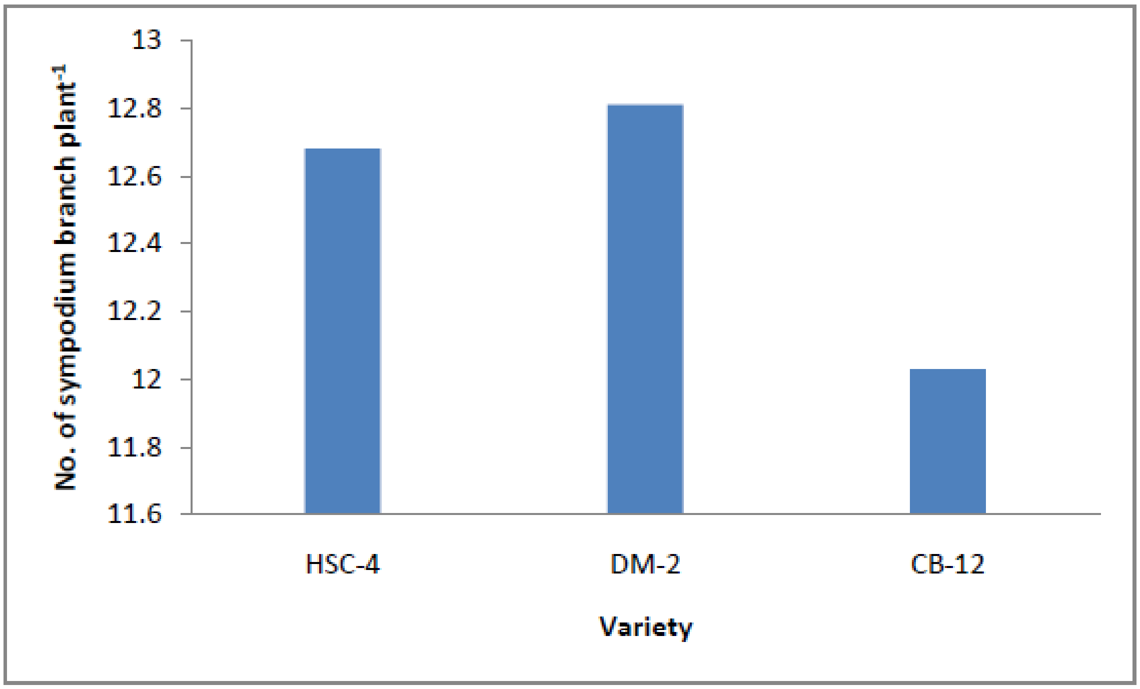

Fig.5 Effect of cotton genotype on sympodium branches plant^{-1} (Sx^{-} =0.2902)

4.3.2 Effect of fertilizer

Fertilizer doses exerted significant effect on the number of sympodium branches plant^{-1} (Fig .6). The result showed that number of sympodium branches plant^{1} increased gradually up to 25% higher than RDF. The highest sympodia produced (13.73) which was statistically similar with recommended dose of fertilizer and 50% higher than RDF. The lowest sympopodia (10.02) produced by control treatment. The results are similar to Khalequzzaman *et al*. (2012) who reported increasing fertilizer levels increased the number of sympopodium branches plant^{-1}. The result is consistent with the findings of Patil and Malewer (1994)

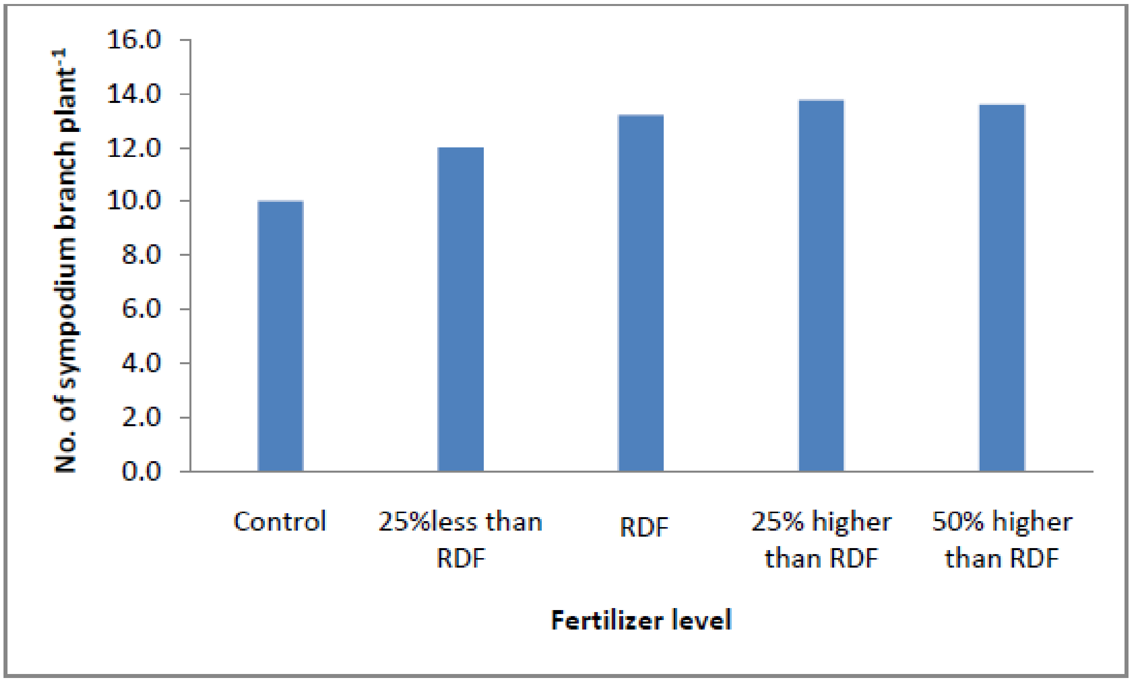

Fig.6 Effect of fertilizer levels on sympodium branches plant^{-1} ($S\bar{x}$ =0.3746)

4.3.3 Interaction effect of variety and fertilizer

There observed a significant difference in sympodium branches plant^{-1} due to interaction effect of variety and fertilizer (Table 3). The highest sympodium branches plant^{-1} (15.53) was found in the interaction of DM-2 and 25% higher than RDF which was higher than other interaction. This treatment also showed similar level of sympodium branches plant^{-1} with HSC-4 x 50% higher than RDF, DM-2 x 50% higher than RDF and DM-2 x RDF interaction treatments. The lowest sympodium branches (9.37) was observed in DM-2 and control interaction.

Table 3. Interaction effect of variety and fertilizer levels on sympodium branches plant^{-1}

Interaction (Variety × fertilizer)	Sympodium branches plant^{-1}
HSC-4 × Control	11.07 de
× 25%less than RDF	11.97 cd
× RDF	13.10 b-d
× 25% higher than RDF	13.00 b-d
× 50% higher than RDF	14.27 ab
DM-2 × Control	9.37 e
× 25%less than RDF	12.03 cd
× RDF	13.50 a-c
× 25% higher than RDF	15.53 a
× 50% higher than RDF	13.60 a-c
CB-12 × Control	9.63 e
× 25%less than RDF	12.00 cd
× RDF	13.00 b-d
× 25% higher than RDF	12.67 b-d
× 50% higher than RDF	12.87 b-d
Sx^{-}	10.65
CV (%)	8.98

4.4 Days to blooming/1st flowering

4.4.1 Effect of genotype

Blooming of each cotton genotype expressed in days after planting were summarized in Fig.7. There existed significant difference in days from planting to blooming. From planting, the cotton genotypes took 57.20 to 58.20 days to blooming. The genotype HSC-4 required the shortest time to blooming which was differed from other genotype. The longest time required by the genotype CB-12 to blooming which was similar to that of the genotype DM-2.

Days required to blooming to boll opening are important characters of cotton as it indicates the earliness of the crop. Although these are inherent characters but sometimes environmental factors also governed the time of blooming and boll opening (Sawan *et al.*, 1999).

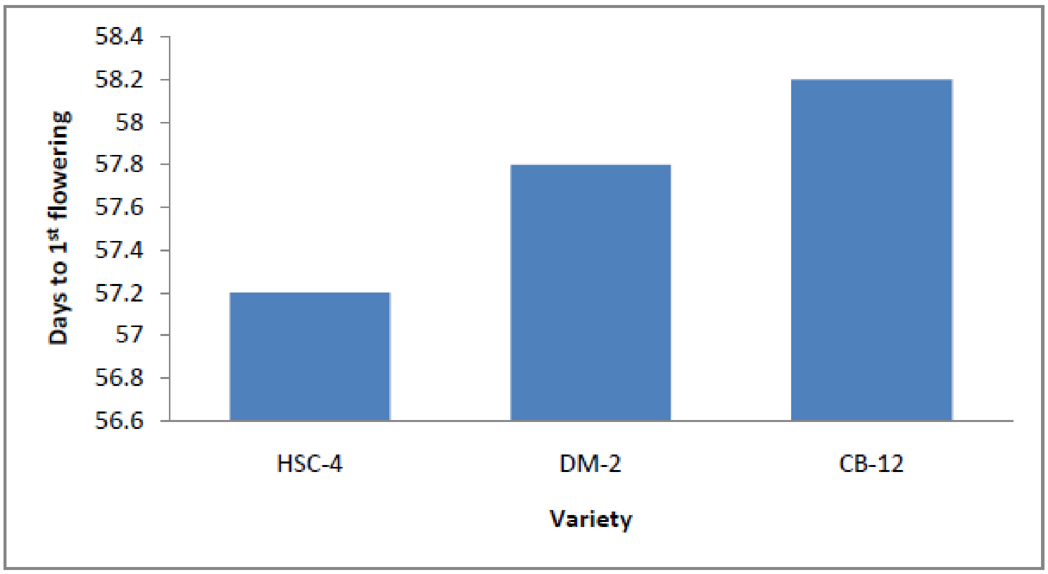

Fig. 7 Effect of cotton genotype on days to1st flowering ($S\bar{x}$ =0.3055)

4.4.2 Effect of fertilizer

Number of days to 1st flowering significantly affected by fertilizer doses (Fig.8). The result showed that time needed for 1st flowering decreased gradually upto 25% higher than RDF. The longest time needed for 1st flowering (62.89) days in control treatment which was not statistically similar with other dose of fertilizer. The shortest time (55.78) needed for1st flowering in the treatment 25% and 50% higher than RDF.

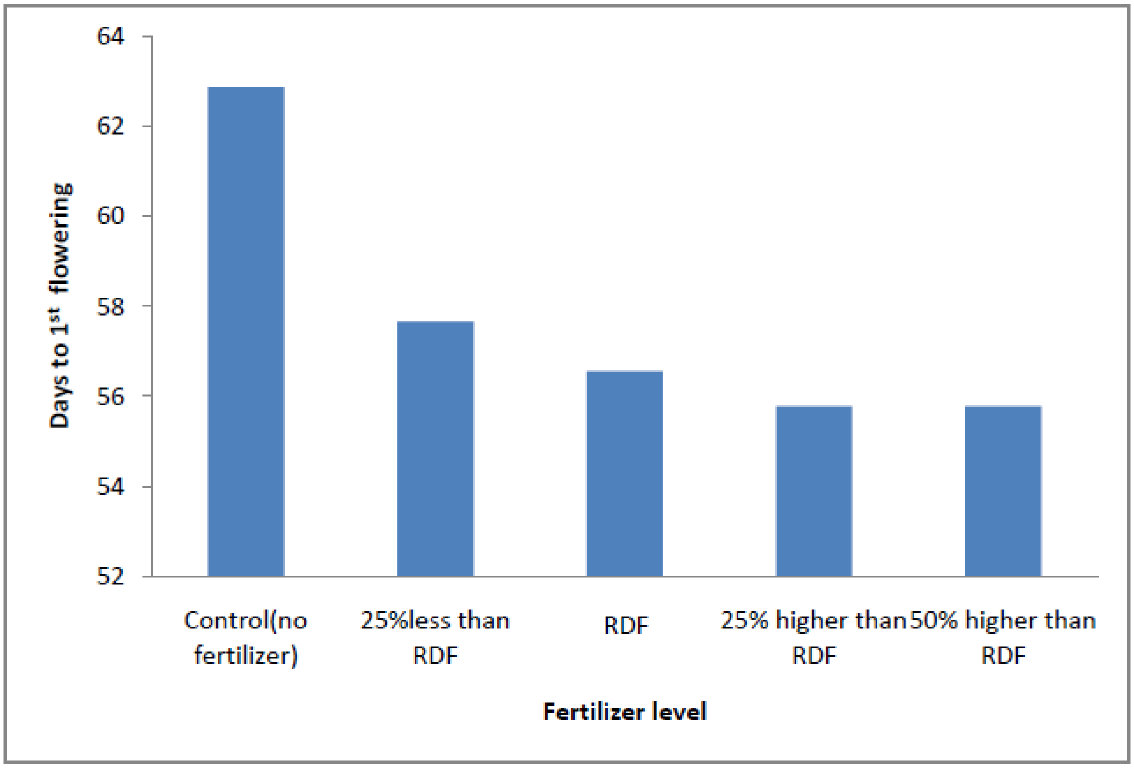

Fig.8 Effect of fertilizer levels on days to1st flowering ($S\bar{x}$ =0.3944)

4.4.3 Interaction effect of variety and fertilizer

There observed a significant difference in days to 1st flowering due to interaction effect of fertilizer and variety (Table 4). The result showed that time needed to 1st flowering reduced gradually with the application of increasing fertilizer doses. The shortest time (54.67days) was found in the interaction of HSC-4 x 25% higher than RDF which was lower than other interaction. The longest flowering time (64 days) was observed in CB-12 x control interaction.

Table 4. Interaction effect of variety and Fertilizer levels on days to 1st flowering

Interaction (Variety × fertilizer)	Days to 1st flowering
HSC-4 × Control	62.33 a
× 25%less than RDF	56.67 b-d
× RDF	56.67 b-d
× 25% higher than RDF	54.67 d
× 50% higher than RDF	55.67 cd
DM-2 × Control	62.33 a
× 25%less than RDF	57.67 bc
× RDF	56.33 cd
× 25% higher than RDF	56.33 cd
× 50% higher than RDF	56.33 cd
CB-12 × Control	64.00 a
× 25%less than RDF	58.67 b
× RDF	56.67 b-d
× 25% higher than RDF	56.33 cd
× 50% higher than RDF	55.33 d
$S\bar{x}$	0.68
CV (%)	2.05

4.5 Days to 1st boll opening

4.5.1 Effect of genotype

The genotype DM-2 and HSC-4 required the maximum time (128 days) to boll opening (Fig. 9). The shortest time (126 days) to boll opening was recorded in the genotype CB-12 and it was not statistically similar with HSC-4 and DM-2. Days required to blooming to boll opening are important characters of cotton as it indicates the earliness of the crop. Although these are inherent characters but sometimes environmental factors also governed the time of blooming and boll opening (Sawan *et al.,* 1999). In present study, earliness was observed in the genotypes CB-12.

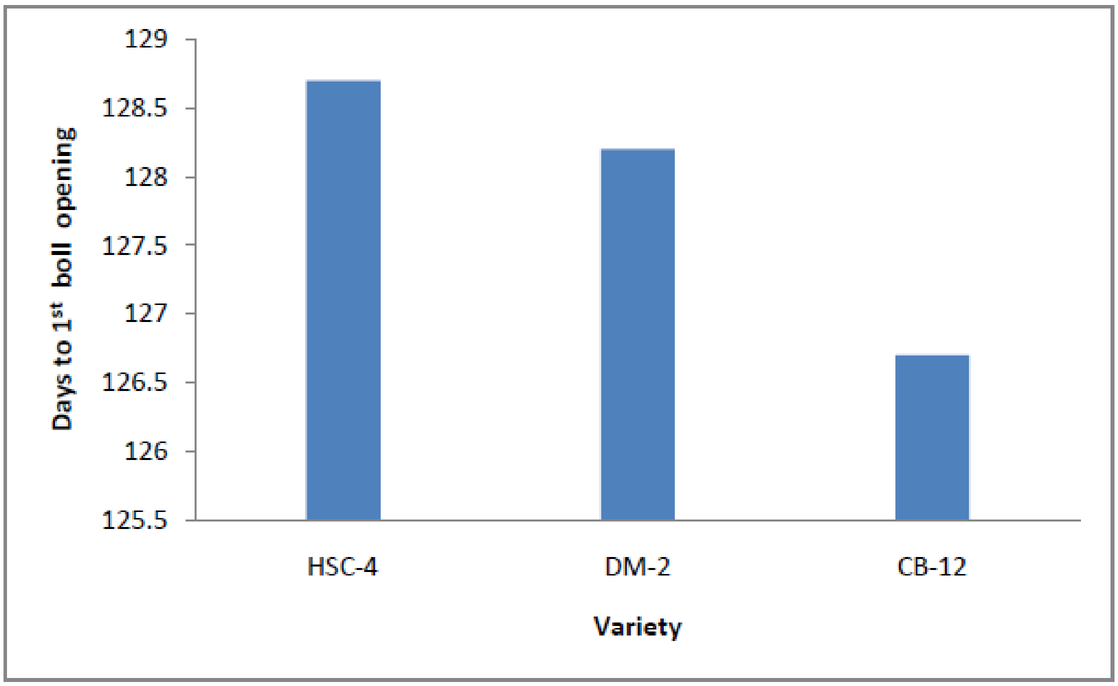

Fig. 9 Effect of cotton genotypes on days to 1st boll opening (Sx^{-} =0.6741)

4.5.2 Effect of fertilizer

Fertilizer doses showed significant effect on the number of days needed for 1st boll opening (Fig.10). The result showed that time needed for 1st boll opening increased gradually up to RDF. The longest time need to 1st boll opening (129.3) in 50% higher than RDF treatment which was statistically similar with RDF and 25% higher than RDF. The shortest time (124.7) needed for 1st boll opening in control treatment. The result indicated that higher fertilizer dose extended the duration of crop.

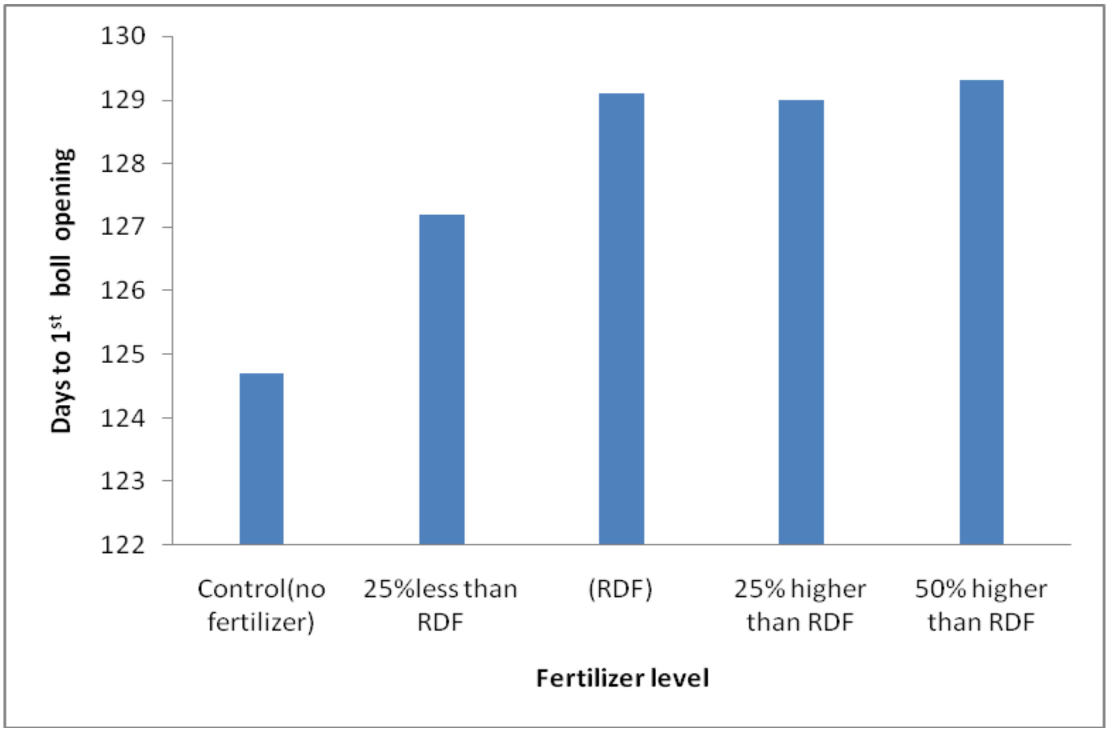

Fig .10 Effect of fertilizer levels on days to 1st boll opening ($S\bar{x}$ =0.6146)

4.5.3 Interaction effect of variety and fertilizer

There observed a significant difference in days to 1st boll opening due to interaction effect of fertilizer and variety (Table.5) The result showed that time needed to 1st boll opening increased gradually with the application of increasing fertilizer doses . The longest time (130.30 days) was found in the interaction of DM-2 x 25% higher than RDF. The shortest boll opening time (123.3 days) was observed in DM-2 x control interaction.

Table 5. Interaction effect 0f variety and Fertilizer levels on days to1st boll Opening

Interaction (Variety × fertilizer)	Days to 1st bull opening
HSC-4 × Control	125.7 c-e
× 25%less than RDF	127.7 bc
× RDF	130.00 ab
× 25% higher than RDF	130.00 ab
× 50% higher than RDF	129.30 ab
DM-2 × Control	123.30 e
× 25%less than RDF	128.00 a-d
× RDF	129.30 ab
× 25% higher than RDF	130.30 a
× 50% higher than RDF	130.00 ab
CB-12 × Control	125.00 de
× 25%less than RDF	125.00 de
× RDF	128.00 a-d
× 25% higher than RDF	126.70 b-e
× 50% higher than RDF	128.70 a-c
$S\bar{x}$	1.065
CV (%)	1.44

Yield components and yield

4.6 Boll number

4.6.1 Effect of genotype

A significant difference in number of bolls plant^{-1} among the cotton hybrid was observed (Fig.11). Among the hybrids, the number of bolls plant^{-1} varied from 18.47 to 21.27. The inbred CB-12 produced the maximum number (21.27) of bolls plant^{-1} which was statistically similar with hybrid HSC-4.The lowest number (18.47) of bolls plant^{-1} was recorded in DM-2 genotype. Number of bolls plant^{-1} is influenced by number of sympodial branch (Adarsha *et al.* 2004) and it was confirmed in this study.

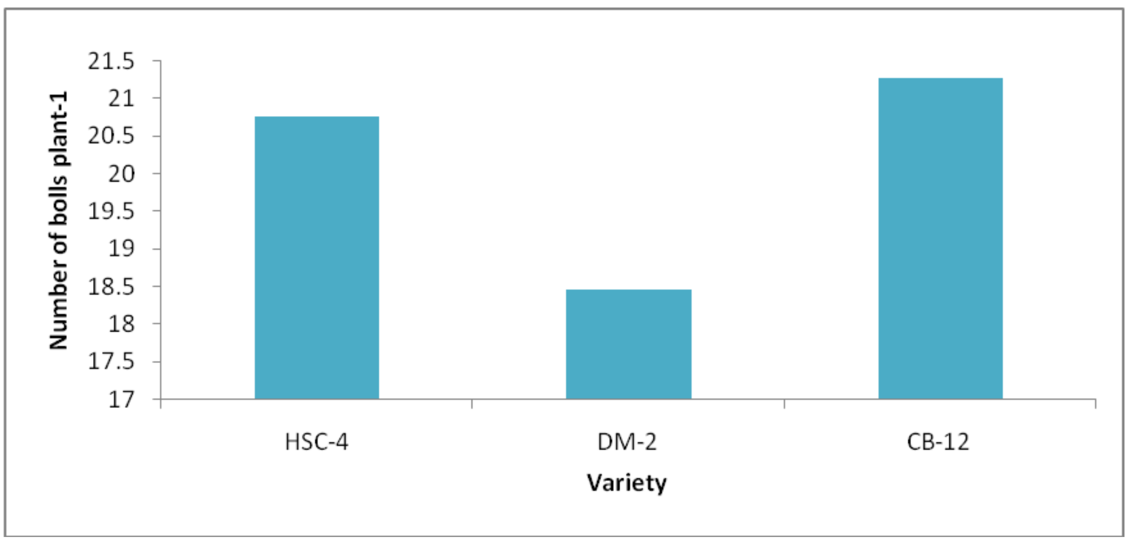

Fig .11 Effect of cotton genotype on bolls plant^{-1} ($S\bar{x}$ = 0.5665)

4.6.2 Effect on fertilizer

The result showed that number of bolls plant^{-1} increased gradually with the increase of fertilizer dose (Fig.12).The highest bolls plant^{-1} produced (27.08) at 50% higher than RDF which was statistically higher than all other doses. Recommended dose of fertilizer produced (23.86) bolls plant^{-1} which was statistically similar with the dose of 25% higher than RDF. The lowest bolls plant^{-1} (9.14) produced by control treatment. The results are similar to Parmer *et al.* (2010) who reported that fertilizer increased levels increased the number of boll plant^{-1} of hybrid cotton. The result is consistent with the findings of Angadi *et al.* (1989).

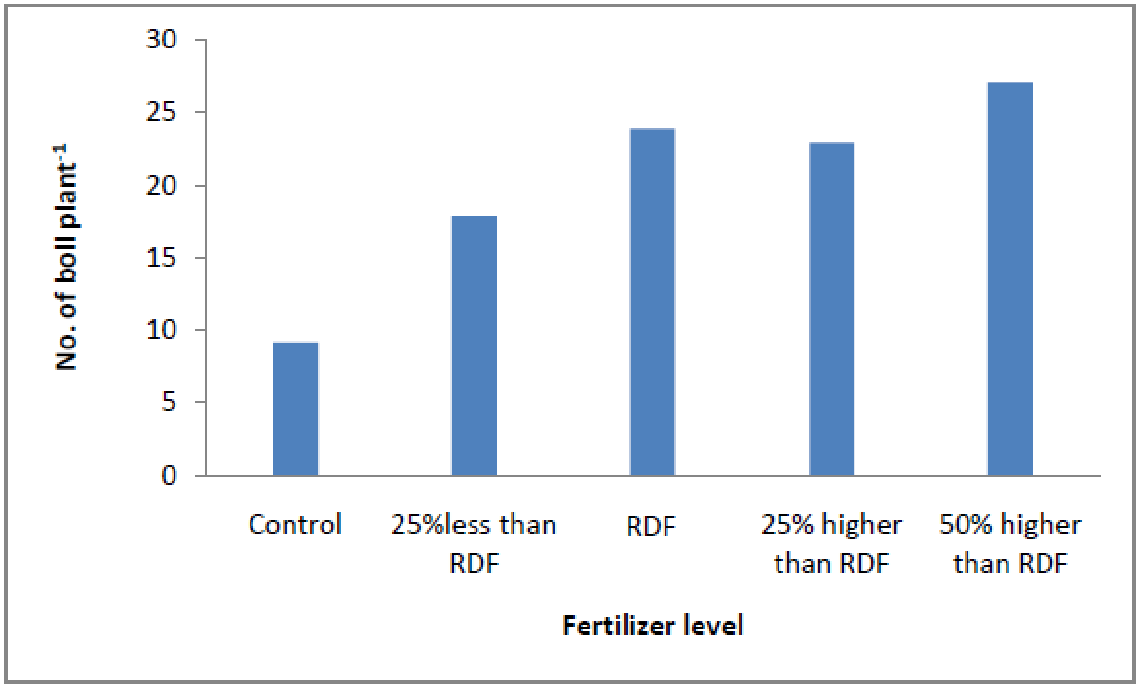

Fig .12 Effect of fertilizer levels on bolls plant^{-1} ($S\bar{x}$ = 0.7313)

4.6.3 Interaction effect of variety and fertilizer

It was found a significant difference in bolls plant^{-1} due to interaction effect of variety and fertilizer (Table 6). The result showed that the bolls plant^{-1} increased gradually with the application of increasing fertilizer dose. The highest bolls plant^{-1} (28.20) was found in the interaction of HSC-4 x 50% higher than RDF which was significantly similar with the interaction of DM-2 x 25% higher than RDF and DM-2 x 50% higher than RDF (26.90 and 27.40). The lowest bolls plant^{-1} (8.50) was observed in CB-12 x control interaction.

Table.6 Interaction effect of variety and fertilizer levels on bolls $plant^{-1}$

Interaction (Variety × fertilizer)	Bolls $plant^{-1}$
HSC-4 × Control	10.23 e
× 25%less than RDF	19.37 cd
× RDF	24.40 ab
× 25% higher than RDF	21.67 bc
× 50% higher than RDF	28.20 a
DM-2 × Control	8.50 e
× 25%less than RDF	16.13 d
× RDF	21.87 bc
× 25% higher than RDF	20.23 e
× 50% higher than RDF	25.63 ab
CB-12 × Control	8.70 e
× 25%less than RDF	18.03 cd
× RDF	25.30 ab
× 25% higher than RDF	26.90 a
× 50% higher than RDF	27.40 a
Sx^{-}	1.27
CV (%)	10.88

4.7 Boll weight

4.7.1 Effect of genotype

Individual boll weight is an important component of the yield and found significant difference among the different genotypes of cotton (Fig.13). The single boll weight among the hybrid varied from 4.84g to 5.53g. The highest single boll weight (5.53 g) was recorded in hybrid HSC-4 which was statistically higher than DM-2 and CB-12 genotypes. The lowest single boll weight (4.84 g) was observed in the CB-12 genotype. These results are similar to those reported by Ali *et al.*(2012) who observed that hybrid variety produced larger boll than conventional variety.

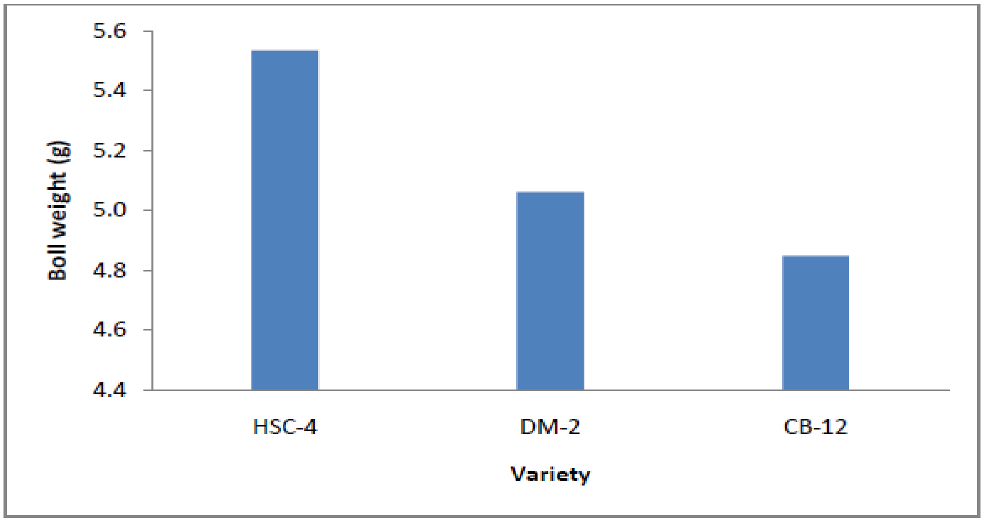

Fig.13 Effect of cotton genotype on individual boll weight ($S\bar{x}$ =1.52)

4.7.2 Effect on fertilizer

Fertilizer doses exerted significant effect on the number of boll weight (Fig.14). The highest boll weight produced (5.56g) in 25% higher than RDF which was statistically similar with other doses. The lowest boll weight (4.16g) produced from control treatment. The results are similar to Khalequzzaman *et al.* (2012) who reported increased fertilizer levels increased the with boll weight of cotton.

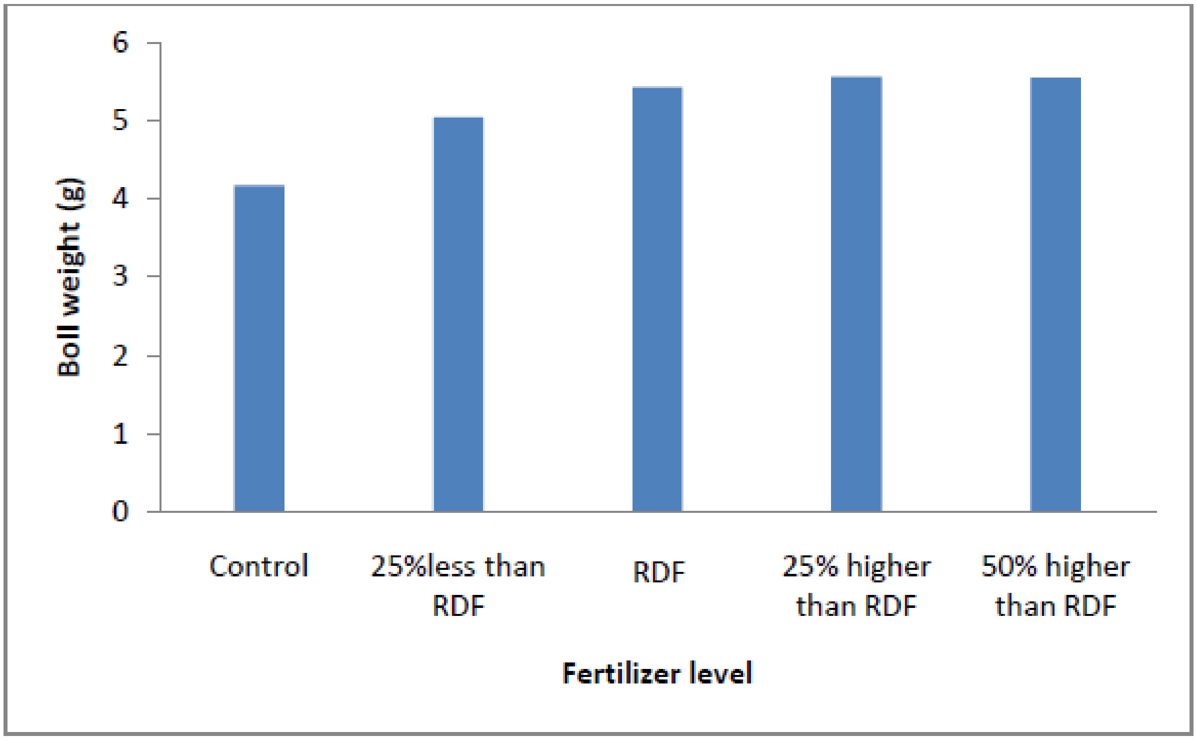

Fig .14 Effect of fertilizer levels on individual boll weight ($S\bar{x}$ = 1.96)

4.7.3 Interaction effect of variety and fertilizer

There observed a significant difference in boll weight due to interaction effect of variety and fertilizer (Table 7). The highest boll weight (5.87g) was found in the interaction of HSC-4 x 50% higher than RDF. The lowest boll weight (3.70) was observed in the interaction of DM-2 x control treatment.

Table 7 Interaction effect of variety and fertilizer levels on individual boll weight

Interaction (Variety × fertilizer)	Boll weight (g)
HSC-4 × Control	4.33 ef
× 25%less than RDF	5.83 ab
× RDF	5.77 ab
× 25% higher than RDF	5.87 a
× 50% higher than RDF	5.87 a
DM-2 × Control	3.70 f
× 25%less than RDF	4.83 b-e
× RDF	5.87 a
× 25% higher than RDF	5.50 a-e
× 50% higher than RDF	5.40 a-d
CB-12 × Control	4.47 d-f
× 25%less than RDF	4.47 d-f
× RDF	4.63 c-f
× 25% higher than RDF	5.30 a-e
× 50% higher than RDF	5.37 a-d
$S\bar{x}$	3.395
CV (%)	1.93

4.8 Seed cotton yield

4.8.1 Effect of genotype

Seed cotton yield was significantly influenced by different genotypes of cotton Fig.15). Among the genotypes, the yield of seed cotton ranged from 1415 to 1598 kg ha^{-1}. The highest seed cotton yield was recorded in HSC-4 which was statistically similar with CB-12. The lowest seed cotton yield was recorded in DM-2 hybrid. The highest seed cotton yield of HSC-4 was associated with its better yield components like number of bolls per plant and individual boll weight. The findings confirmed with the results of Tan (1993); Dhanda *et al.*(1984) who observed that seed cotton yield is positively correlated with number of bolls per plant and individual boll weight.

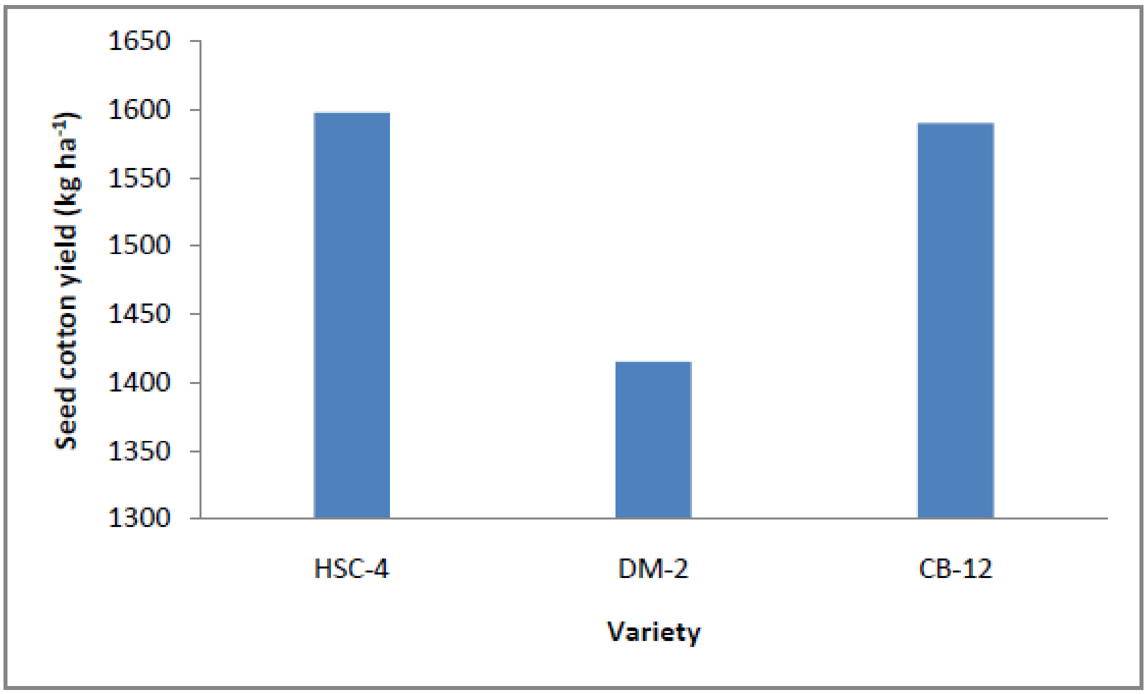

Fig.15 Effect of cotton genotype on seed cotton yield ($S\bar{x}$ =27.13)

4.8.2 Effect of fertilizer

Fertilizer doses showed significant influence on seed cotton yield (Fig.16). The results indicated that seed cotton yield showed an increasing trend with increases of fertilizer dose. The highest seed cotton yield (2174 kg ha^{-1}) observed in 50% higher than RDF which was statistically higher than other doses. The lowest seed cotton yield produced in control treatment (378 kg ha^{-1}). The highest seed cotton yield in 50% higher than RDF application might be due to the highest number of boll $plant^{-1}$, highest individual boll weight and highest number of sympodium branch $plant^{-1}$. The results was in agreement with the findings of Sharma *et al.*

(1979) who reported yield of cotton with application of fertilizers up to 320:160: 160 kg ha^{-1} NPK. However, optimum dose of fertilizer was found to be 280:140:140 kg ha^{-1} NPK for maximum production of seed cotton. The results are similar to Parmer *et al.* (2010) and Angadi *et al.* (1989) who reported fertilizer levels increase yield of hybrid cotton.

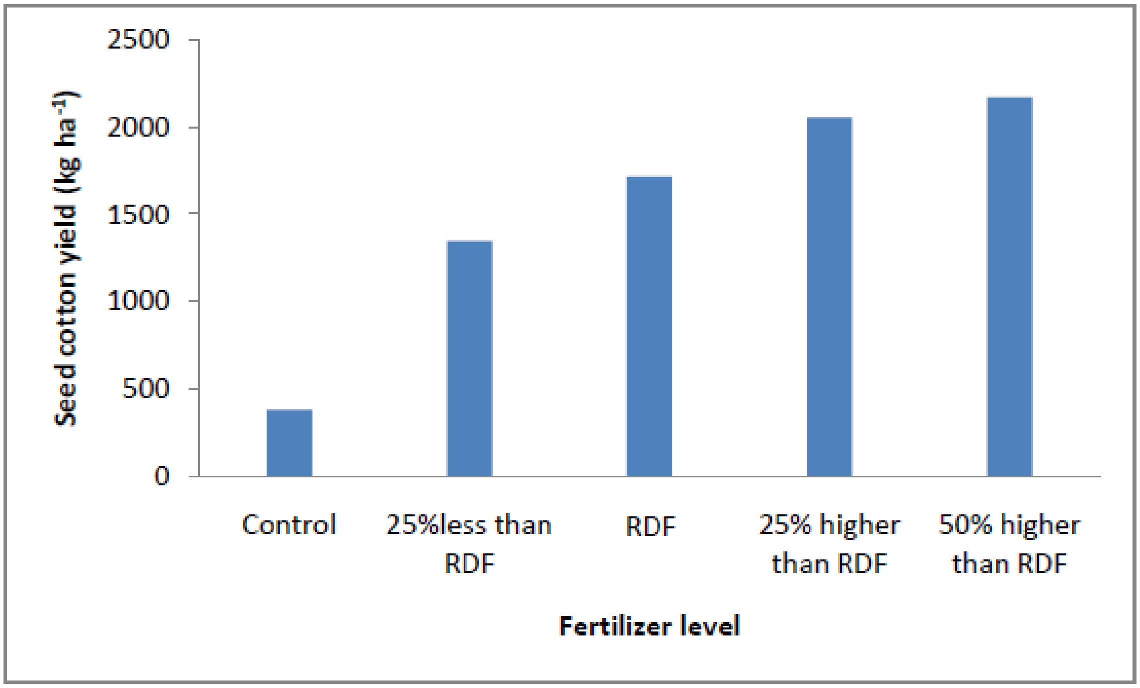

Fig. 16 Effect of fertilizer levels on seed cotton yield ($S\bar{x}$ =35.02)

4.8.3 Interaction effect of variety and fertilizer

Interaction of variety and fertilizer exerted significant effect in seed cotton yield (Table 8). The result showed that seed cotton yield increased gradually with the application of increasing fertilizer doses irrespective of variety. The highest seed cotton yield (2406 kg ha^{-1}) was found in the interaction of CB-12 x 50% higher than RDF which was statistically higher than all other variety x fertilizer interactions. The lowest seed cotton yield (299 kg ha^{-1}) was observed in DM-2 x control treatment.

Table .8 Interaction effect of variety and Fertilizer levels on seed cotton yield

Interaction (Variety × fertilizer)	Seed cotton yield (kg ha^{-1})
HSC-4 × Control	468 h
× 25%less than RDF	1522 ef
× RDF	1722 d
× 25% higher than RDF	2144 b
× 50% higher than RDF	2132 b
DM-2 × Control	299 h
× 25%less than RDF	1173 g
× RDF	1686 de
× 25% higher than RDF	1933 c
× 50% higher than RDF	1983 bc
CB-12 × Control	357 h
× 25%less than RDF	1349 f
× RDF	1738 d
× 25% higher than RDF	2088 bc
× 50% higher than RDF	2406 a
Sx^{-}	35.02
CV (%)	6.85

4.9 Lint yield

4.9.1 Effect of genotype

Lint yields were significantly different among cotton genotypes (Fig. 17). The highest lint yield (738 kg ha^{-1}) was observed for the hybrid HSC-4 which was significantly higher than other genotypes. The lowest lint yield (609 kg ha^{-1}) was obtained from DM-2 hybrid. Such great variability in lint yield might be due to gene effect as genotypic variation in yield of any crop is primarily governed by genetically characters. The result corresponds well to that of Nichols *et al*. (2004) who observed similar large variability in lint yields of different cotton genotypes.

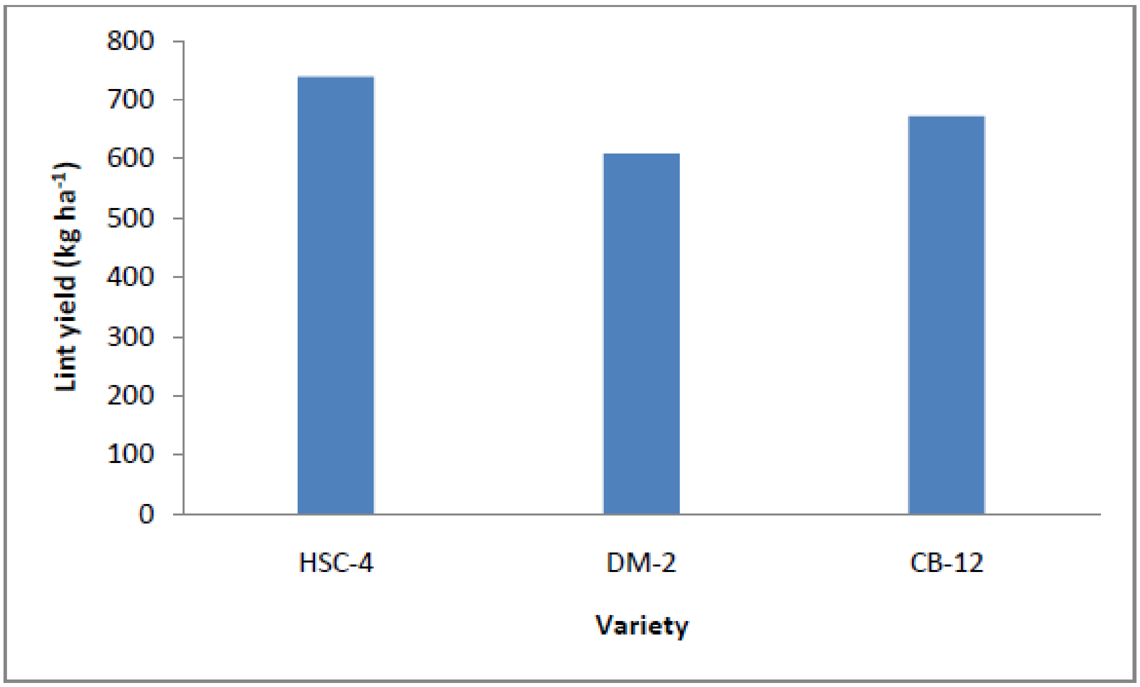

Fig.17 Effect of cotton genotype on lint yield ($S\bar{x}$ =16.31)

4.9.2 Effect of fertilizer

Fertilizer doses exerted significant effect on lint yield (Fig.18). The result showed that lint yield gradually increased with the increases of fertilizer dose. The highest lint yield (953 kg ha^{-1})) in dose of 50% higher than RDF which is statistically similar with 25% higher than RDF. The lowest lint yield (158 kg ha^{-1}) produced in control treatment. Higher lint yield in 50% and 25% higher than RDF might be due to higher ginning out turn and higher boll weight.

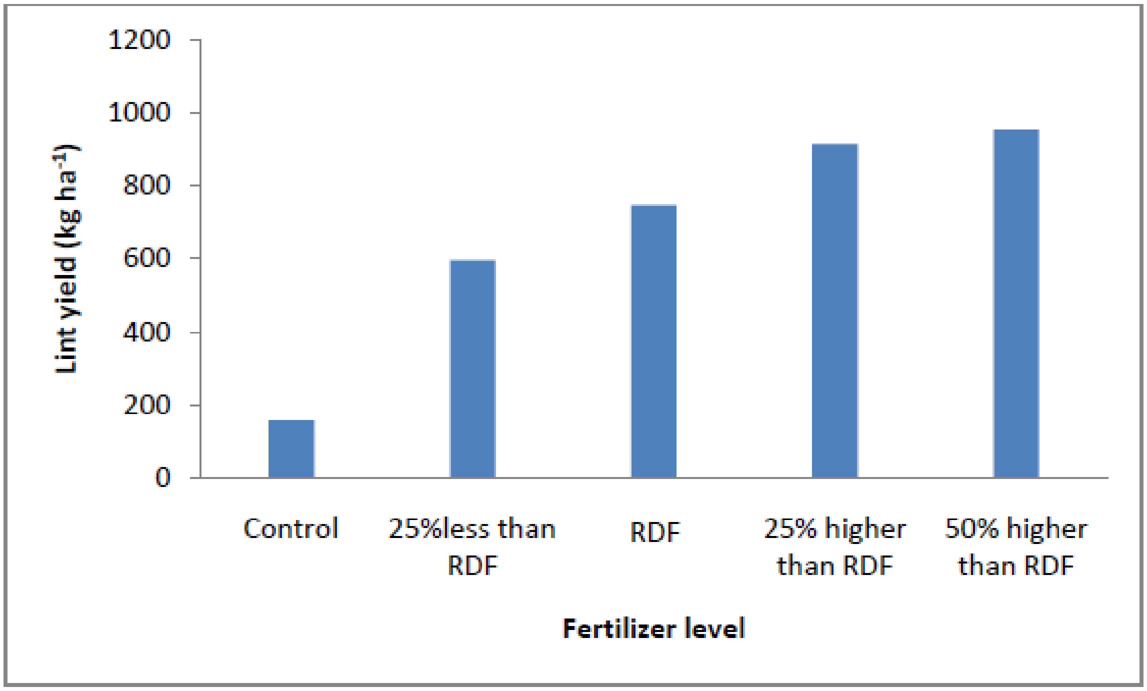

Fig.18 Effect of fertilizer levels on lint yield ($S\bar{x}$ =21.06)

4.9.3 Interaction effect of variety and fertilizer

There observed a significant difference in lint yield due to interaction effect of variety and fertilizer (Table 9). The result showed that seed cotton yield increased gradually with the application of increasing fertilizer doses. The highest lint yield (1011 kg ha^{-1}) was found in the interaction of HSC-4 x 50% higher than RDF which was statistically similar with HSC-4 x 25% higher RD, CB-12 x 25% higher RDF and CB-12 x 50% higher RDF interactions. The lowest lint yield (123kg ha^{-1}) was observed in DM-2 x control interaction.

Table 9. Interaction effect of variety and fertilizer levels on lint yield

Interaction (Variety × fertilizer)	Lint yield (kg ha^{-1})
HSC-4 × Control	200 g
× 25%less than RDF	704 e
× RDF	805 c-e
× 25% higher than RDF	974 ab
× 50% higher than RDF	1011 a
DM-2 × Control	123 g
× 25%less than RDF	514 f
× RDF	711 e
× 25% higher than RDF	826 cd
× 50% higher than RDF	873 bc
CB-12 × Control	153 g
× 25%less than RDF	569 f
× RDF	723 de
× 25% higher than RDF	942 ab
× 50% higher than RDF	978 ab
Sx^-	36.47
CV (%)	9.38

4.10 Ginning out turn

4.10.1 Effect of genotype

Ginning out turn was influenced significantly by different genotypes of cotton (Fig.19). The maximum ginning out turn was (45.29 %) noted in HSC-4 hybrid which was significantly higher than other genotypes. Ginning out turn obtained in hybrid DM-2 (42.80%) and inbred CB-12 (42.17%) were statistically similar.

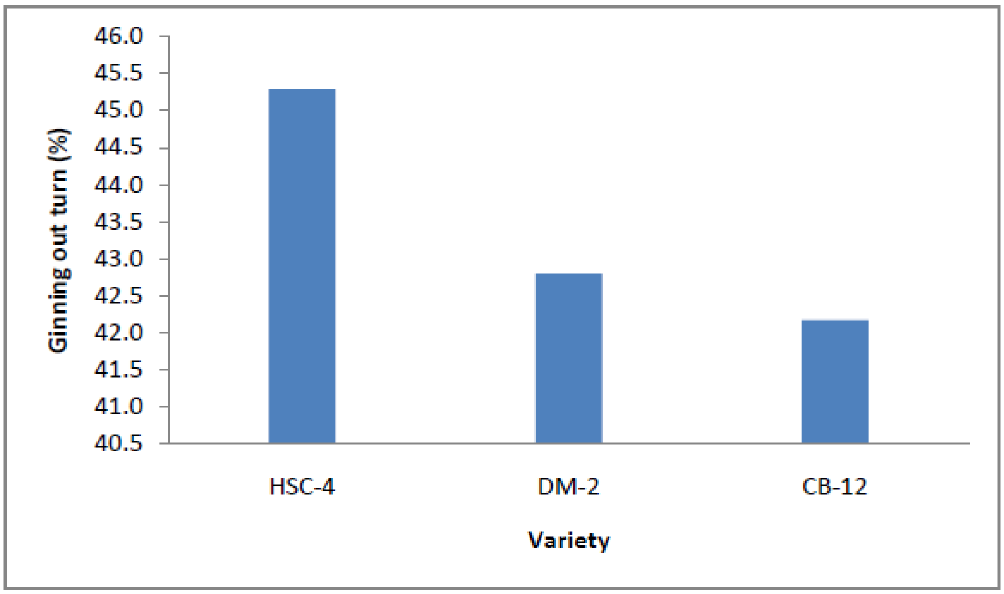

Fig.19 Effect of cotton genotype on ginning out turn ($S\bar{x}$ =0.3972)

4.10.2 Effect of fertilizer

Fertilizer doses differed significantly on ginning out turn (Fig.20). The result showed that ginning out turn gradually increased with the of fertilizer dose increase up to 25% higher than RDF. The highest ginning out turn (44.51%) in of 25% higher than RDF which was statistically similar with other doses except control. The lowest ginning out turn (41.85%) in control treatment.

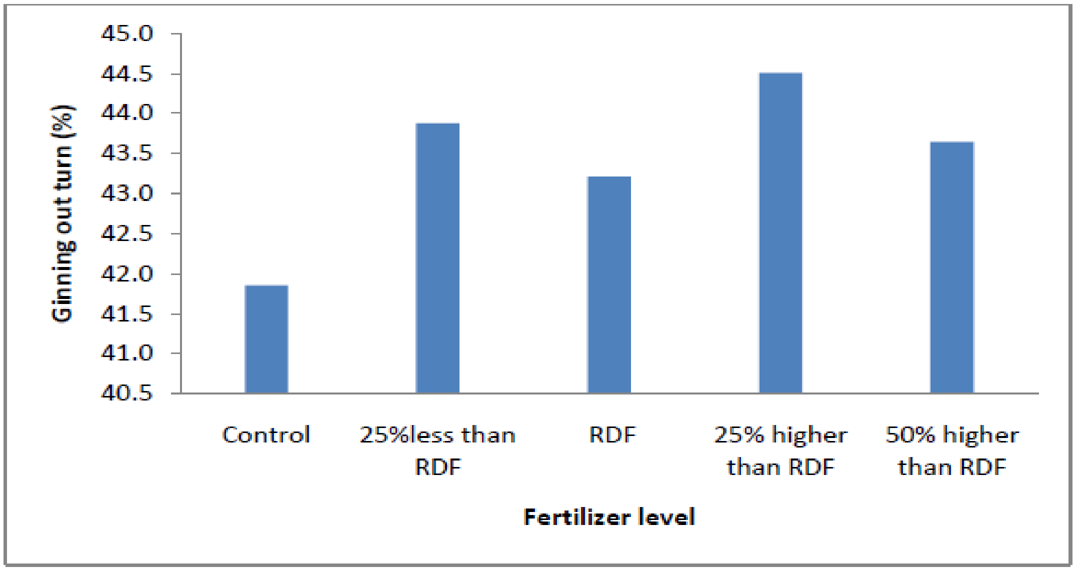

Fig. 20 Effect of fertilizer levels on ginning out turn ($S\bar{x}$ =0.5127)

4.10.3 Interaction effect of variety and fertilizer

Combination of different variety and fertilizer doses exerted significant effect on ginning out turn (Table 10). It was observed that interaction of control fertilizer with three genotypes showed lower ginning out turn. The highest ginning out turn (46.33%) was found in the interaction of HSC-4 x 50% higher than RDF which was statistically similar with HSC-4 x 25% higher RD, HSC-4 x RDF, HSC-4 x 25% lower RDF and CB-12 x 25% higher RDF fertilizer dose interactions. The lowest ginning out turn (40.60%) was observed in CB-12 x 50% higher RDF.

Table10. Interaction effect of variety and fertilizer levels on ginning out turn of cotton

Interaction (Variety × fertilizer)	Ginning out turn (%)
HSC-4 × Control	42.93 b-e
× 25%less than RDF	45.63 ab
× RDF	45.81 ab
× 25% higher than RDF	45.73 ab
× 50% higher than RDF	46.33 a
DM-2 × Control	41.30 de
× 25%less than RDF	43.80 a-d
× RDF	42.21 c-e
× 25% higher than RDF	42.70 c-e
× 50% higher than RDF	44.00 a-d
CB-12 × Control	41.33 de
× 25%less than RDF	42.21 c-e
× RDF	41.60 de
× 25% higher than RDF	45.10 a-c
× 50% higher than RDF	40.60 e
$S\bar{x}$	0.89
CV (%)	3.54

4.11. Seed index

4.11.1 Effect of genotype

Seed index of cotton is an important parameter which affects the lint yield and it significantly varied due to different genotypes of cotton (Fig.21). Seed index is reversal of lint index and thus the genotypes which showed greater lint index correspondingly indicated the lower seed index. Therefore, the maximum seed index (9.30g) was recorded in CB-12 genotype which was statistically similar to HSC-4 hybrid. The lowest seed index (9.04g) was recorded in DM-2 hybrid. The differences in seed index in different cotton genotypes is occurred mostly due to number and size of seeds present in the boll.

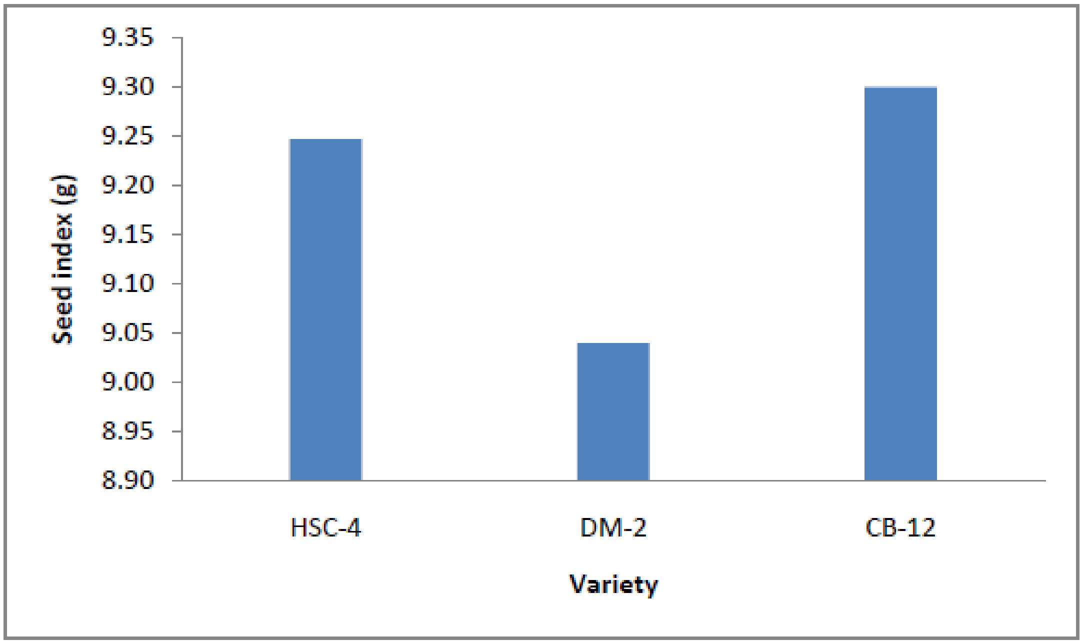

Fig .21 Effect of cotton genotype on seed index ($S\bar{x}$ =0.075)

4.11.2 Effect on fertilizer

Seed index was significantly affected due to fertilizer doses (Fig.22). It was observed that seed index gradually increased with the increases of fertilizer dose. The highest seed index (9.49g) in 50% higher than RDF which was statistically higher than other doses. Seed index of other doses were statistically similar. The lowest seed index (9.00g) was found in control treatment.

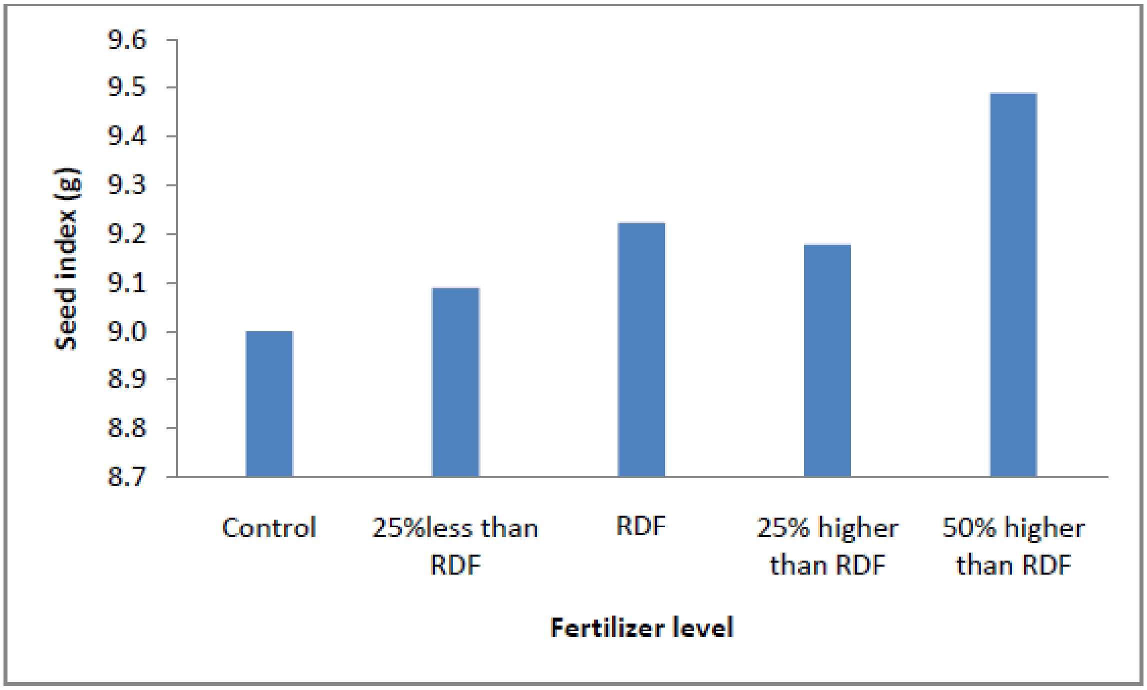

Fig.22 Effect of fertilizer levels on seed index ($S\bar{x}$ =0.097)

4.11.3 Interaction effect of variety and fertilizer

There observed a significant difference in seed index due to interaction effect of variety and fertilizer (Table 11). The highest seed index (9.83g) was observed in the interaction of variety CB-12 x 50% higher than RDF interaction which was statistically similar with HSC-4 x 50% higher dose, CB-12 x 25% higher RDF and HSC-4 x RDF interaction. Interaction of control fertilizer with the three genotypes showed the lowest seed index.

Table 11 Interaction effect of variety and fertilizer levels on seed index

Interaction (Variety × fertilizer)	Seed index (g)
HSC-4 × Control	9.00 d
× 25%less than RDF	9.00d
× RDF	9.60 a-e
× 25% higher than RDF	9.00d
× 50% higher than RDF	9.63 ab
DM-2 × Control	9.00d
× 25%less than RDF	9.13b-d
× RDF	9.07cd
× 25% higher than RDF	9.00d
× 50% higher than RDF	9.00d
CB-12 × Control	9.00d
× 25%less than RDF	9.13b-d
× RDF	9.00d
× 25% higher than RDF	9.53a-d
× 50% higher than RDF	9.83 a
Sx^{-}	0.169
CV (%)	3.17

4.12. Lint index

4.12.1 Effect of genotype

A great variation was observed among the cotton hybrids in respect of lint index (Fig.23). The lint index among the genotype varied in the range of 6.88g to 7.5g. The maximum lint index was noted (7.52g) in HSC-4 genotype which was statistically higher than other genotypes. The lowest lint index (6.88g) was recorded in CB-12. The differences in lint index in different cotton genotypes was occurred mostly due to number and size of seeds present in the boll.

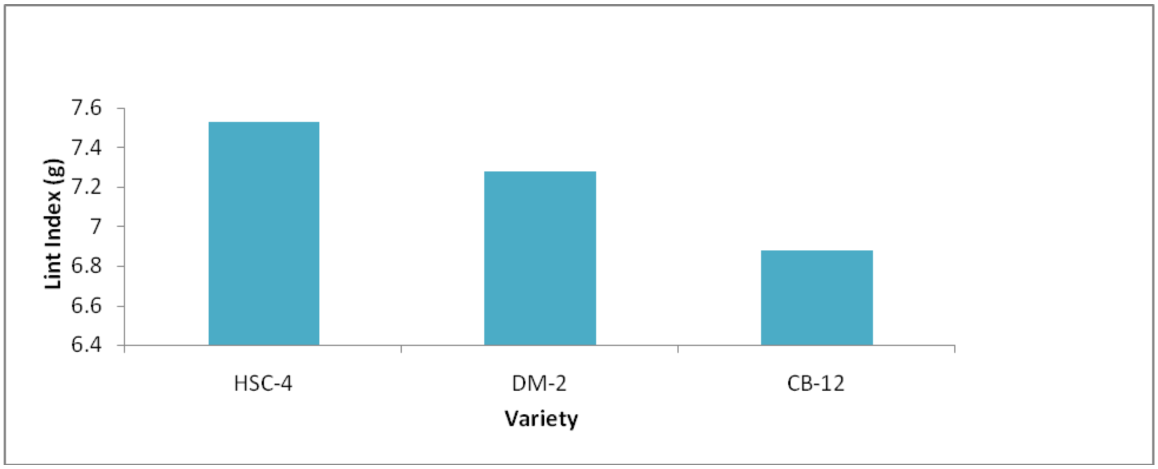

Fig. 23 Effect of cotton genotype on lint index (Sx̄ =0.046)

4.12.2 Effect of fertilizer

Lint index was significant effect due to fertilizer doses (Fig.24). The highest lint index (7.85g)) observed in 25% higher than RDF which was statistically higher than other doses .The lowest lint index (6.83g) in control treatment due to higher seed index. Seed index is reversal of lint index and thus the genotypes which showed greater lint index correspondingly indicated the lower seed index.

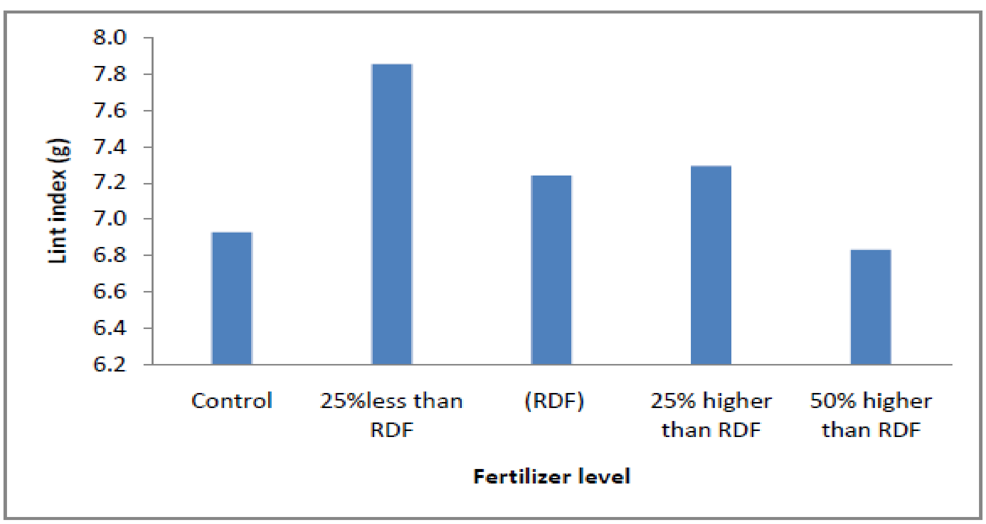

Fig.24 Effect of fertilizer levels on lint index (Sx̄ =0.096)

4.11.3 Interaction effect of variety and fertilizer

A significant difference was observed on lint index due to interaction effect of variety and fertilizer (Table12). The highest lint index (8.55g) was observed in hybrid DM-2 x 25% less than RDF interaction. Interaction of control fertilizer with DM-2 showed the lowest lint index (6.38g).

Table 12. Interaction effect of variety and fertilizer levels on lint index

Interaction (Variety × fertilizer)	**Lint index (g)**
HSC-4 × Control	8.00 be
× 25%less than RDF	7.91c
× RDF	8.27ab
× 25% higher than RDF	7.043e
× 50% higher than RDF	6.42f
DM-2 × Control	6.38f
× 25%less than RDF	8.55a
× RDF	7.04e
× 25% higher than RDF	7.83c
× 50% higher than RDF	6.61f
CB-12 × Control	6.39f
× 25%less than RDF	7.11e
× RDF	6.41f
× 25% higher than RDF	7.01e
× 50% higher than RDF	7.46d
Sx⁻	0.1033
CV (%)	2.47

4.13. Staple length

4.13.1 Effect of genotype

Staple length was significantly different among cotton genotypes (Fig.25). Fibre length of cotton genotypes varied from 1.06 inch to 1.30 inch. The genotype DM-2 had the longest fibre length (1.13inch), while fibre length of CB-12 was the shortest (1.06 inch). There was no significant difference of staple length between HSC-2 and CB-12. The results was consisted with the findings of Nichols *et al.*(2004) who reported that there was genotypic variation for staple length of cotton.

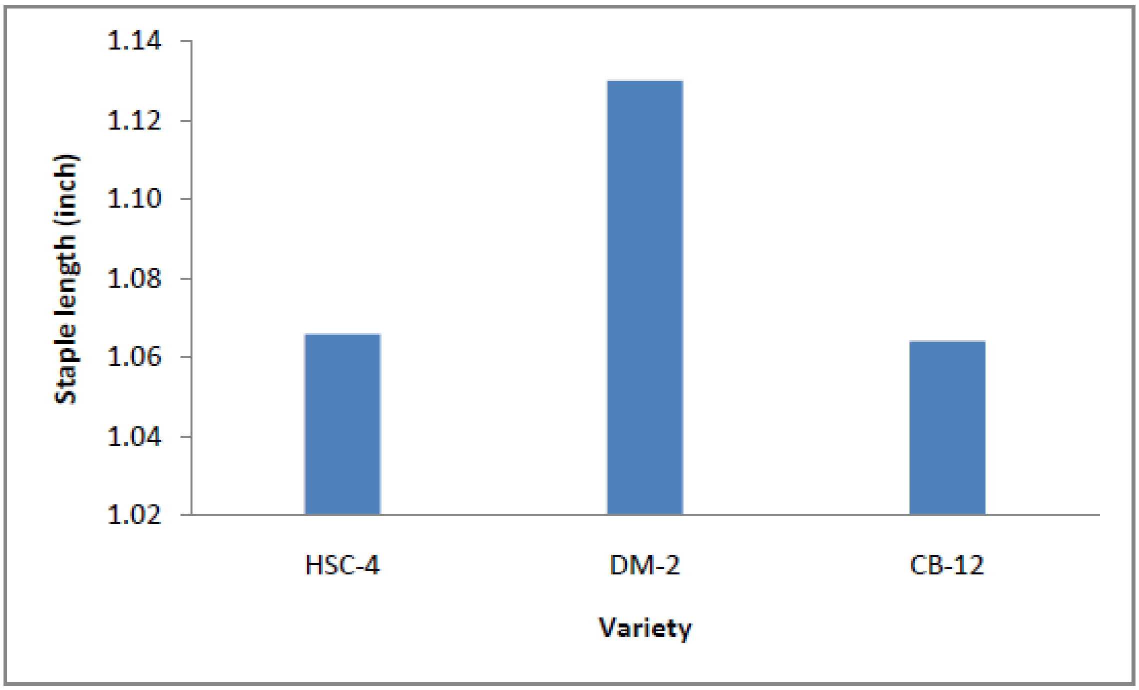

Fig.25 Effect of cotton genotype on staple length of cotton fibre ($S\bar{x}$ =0.1155)

4.13.2 Effect of fertilizer

Fertilizer doses exerted significant effect on staple length (Fig. 26). The result indicated that staple length showed gradual increasing trend with the increases of fertilizer dose. The highest staple length (1.2 inch) observed in 50% higher than RDF which was statistically higher than other doses. The lowest staple length (1.06 inch) in control treatment which was statistically similar with 25% less than

RDF. These results was similar to those of Li *et al*. (2010) who reported that fibre length and specific fibre strength increase in N fertilization treatment over the control. This result was also in agreement with the findings of Goa. Yuan *et al* (2008) who reported potassium fertilization may improve fibre quality of long-fibre cotton.

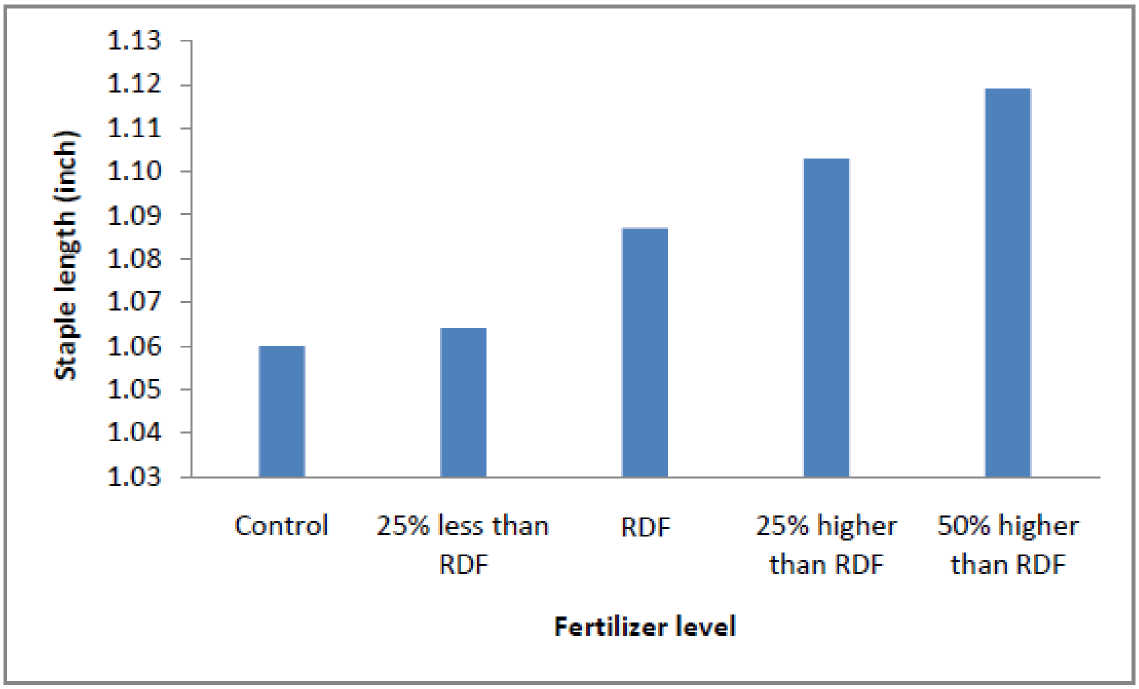

Fig.26 Effect of fertilizer levels on staple length of cotton fibre ($S\bar{x}$ =0.0143)

4.13.3 Interaction effect of variety and fertilizer

There observed a significant difference in staple length due to interaction effect of fertilizer and variety (Table13). The significantly highest staple length (1.16 inch) was observed in hybrid DM-2 x 50% higher than RDF interaction. Interaction of HSC-4 x control fertilizer showed the lowest staple length (1.03 inch).

Table13. Interaction effect of variety and fertilizer levels on staple length of cotton fibre

Interaction (Variety × fertilizer)	Staple length (inch)
HSC-4 × Control	1.03e
× 25%less than RDF	1.04de
× RDF	1.06c-e
× 25% higher than RDF	1.07b-e
× 50% higher than RDF	1.13a-d
DM-2 × Control	1.09a-e
× 25%less than RDF	1.12a-c
× RDF	1.13a-c
× 25% higher than RDF	1.15ab
× 50% higher than RDF	1.16a
CB-12 × Control	1.04d-e
× 25%less than RDF	1.05c-e
× RDF	1.07b-e
× 25% higher than RDF	1.08a-e
× 50% higher than RDF	1.08a-e
$S\bar{x}$	0.026
CV (%)	4.29

4.14. Micronaire value

4.14.1 Effect of genotype

The fineness of fibre is an important aspect of cotton lint. The finer the thread, the greater the length produces from a pound of cotton. It is one of the evaluation methods of cotton quality. Fineness of cotton can be measured through smoothness of fibre. It is associated with fibre diameter and fiber wall thickness while the micronaire value represents the fibre diameter.

There were significant differences of fineness of fibre produced by different genotypes of cotton (Fig.27). Among the cotton genotypes, DM-2 was resulted the lowest micronaire value (4.02 mµ) and it attained maximum (4.36 mµ) in HSC-4. Under the current marketing system, high micronaire cotton (micronaire of 5.0 mµ or greater) is discounted because it produces lower-strength yarns. Therefore, the cotton genotype which contains micronaire value greater than 5.0 mµ should not consider in selection process of variety development.

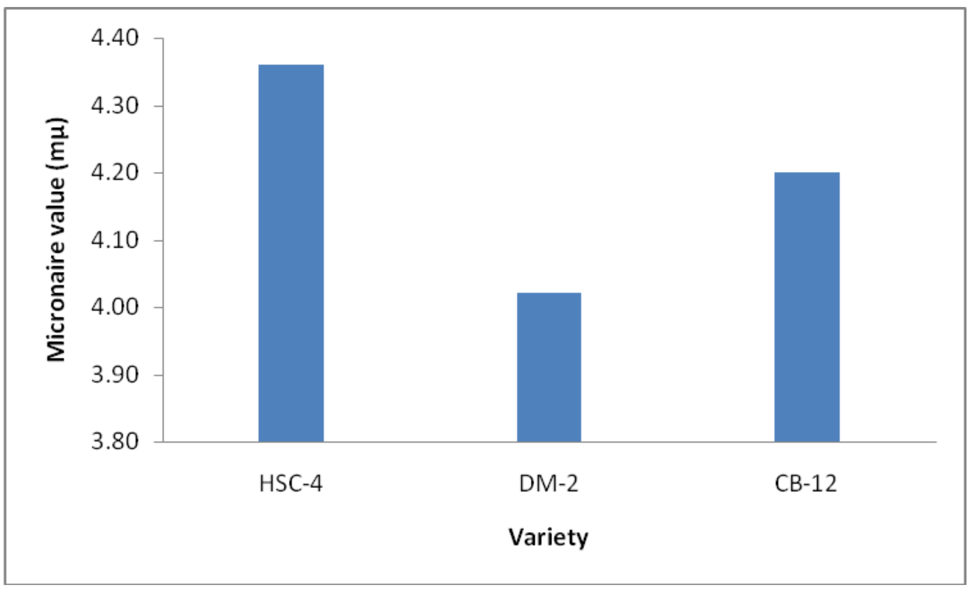

Fig.27 Effect of cotton genotype on micronaire value of cotton fibre (Sx^{-} =0.0408)

4.14.2 Effect of fertilizer

Fertilizer doses affect significantly on staple micronaire value (Fig.28). The highest micronaire value (4.3 mµ)) in 50% higher than RDF which was statistically higher than other doses .The lowest micronaire value (4.13 mµ) in control treatment which was statistically similar with RDF. This result was in agreement with the findings of Gao .Yuan *et al.* (2008) who reported that potassium fertilization may improve fibre quality of long-fibre cotton, among which the intensity, macron, maturity and spinning coefficient value of cotton fibre were all increased.

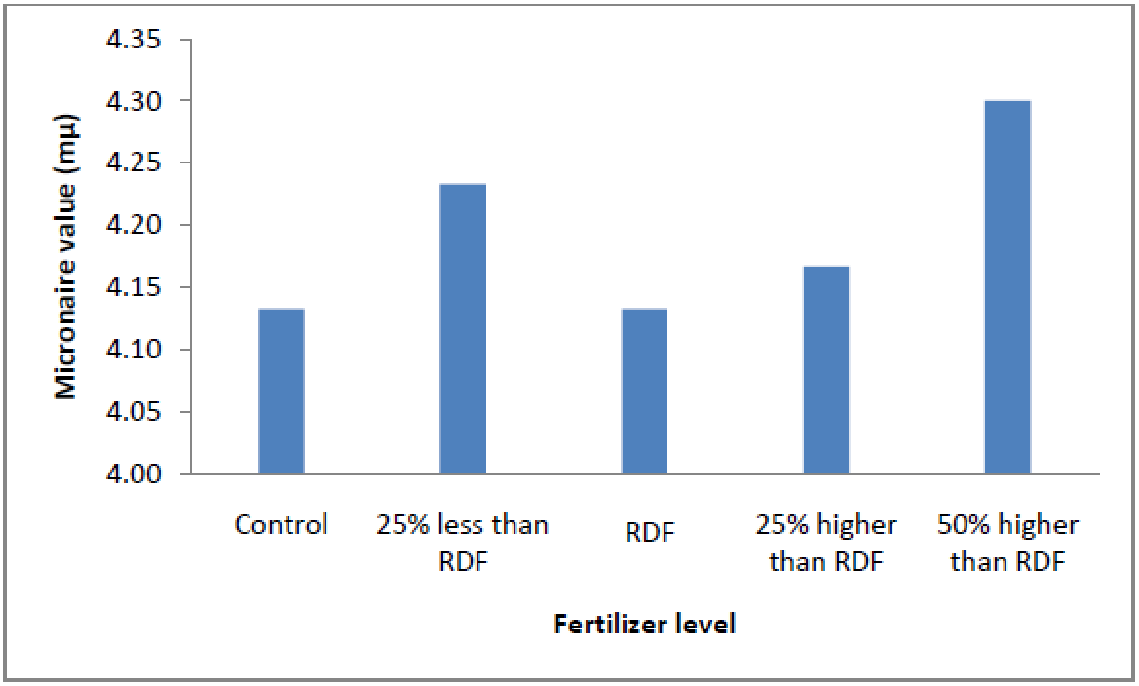

Fig.28 Effect of fertilizer levels on mcroniare value of cotton fibre ($S\bar{x}$ =0.0527)

4.14.3 Interaction effect of variety and fertilizer

Micronaire value affect significantly due to interaction effect of variety and fertilizer (Table 14). The significantly highest micronaire value (4.6 mμ) was observed in hybrid HSC-4 x 50% higher than RDF interaction which was significantly similar with HSC-4 x RDF and HSC-4 x 25% less than RDF interaction. Interaction of control fertilizer x DM-2 showed the lowest micronaire value (4 .00 mμ).

Table14. Interaction effect of variety and Fertilizer levels on mcronaire value of cotton fibre

Interaction (Variety × fertilizer)	**Micronaire value (mµ)**
HSC-4 × Control	4.10 c-e
× 25%less than RDF	4.40 a-c
× RDF	4.50 ab
× 25% higher than RDF	4.20 b-e
× 50% higher than RDF	4.60 a
DM-2 × Control	4.00 de
× 25%less than RDF	4.10 c-e
× RDF	3.90 e
× 25% higher than RDF	4.00 de
× 50% higher than RDF	4.10 c-e
CB-12 × Control	4.30 b-d
× 25%less than RDF	4.20 b-e
× RDF	4.00de
× 25% higher than RDF	4.30 b-d
× 50% higher than RDF	4.20 c-e
$S\bar{x}$	0.091
CV (%)	3.77

4.15. Fibre strength (P.S.I)

4.15.1 Effect of genotype

Fibre strength of different cotton genotypes was significant (Fig.29). The highest fibre strength (83.52PSI) was observed in DM-2 hybrid. The lowest fibre strength (82.07PSI) was found in hybrid HSC-4. Such differences in genotypes contributing to fibre strength is very important as the genotypes with the highest strength tend to produce longer cellulose molecules, thus providing fewer break points in the lint and greater cross linkage between fibres.

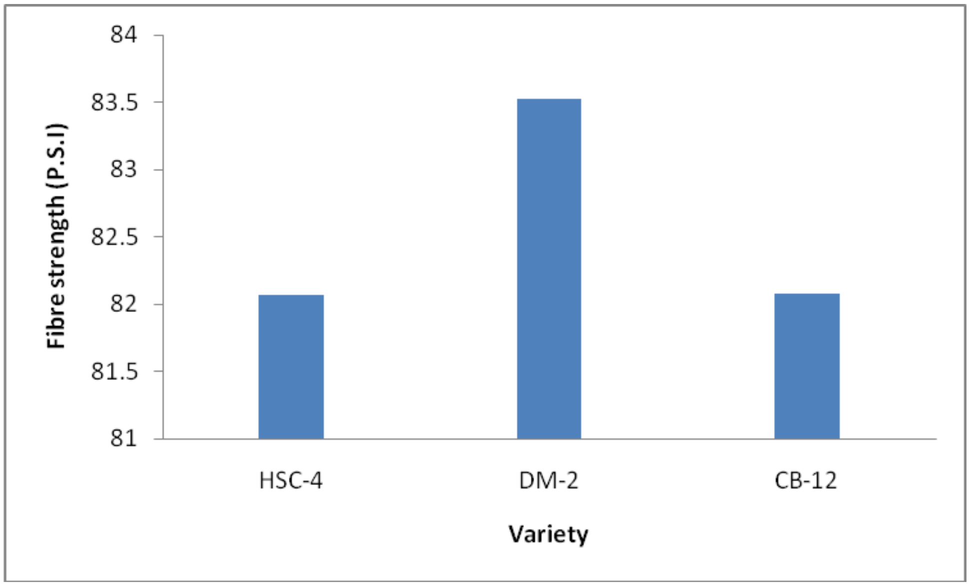

Fig.29 Effect of cotton genotype on fibre streangth (Sx^{-} =0.3844)

4.15.2 Effect of fertilizer

Fertilizer doses exerted significant effect on fibre strength P.S.I (Fig.30). Fibre strength showed an increasing trend with the increases of fertilize dose. The highest fibre strength (83.70 P.S.I) was found in 50% higher than RDF which was statistically similar with RDF and 25% higher than RDF treatments. The lowest fibre strength (80.69 P.S.I) in control treatment which was statistically similar with 25% lower than RDF. This result was in agreement with the findings of Li. *et al.*, (2010) who reported that fibre length and specific fibre strength increase in N fertilization treatment over the control.

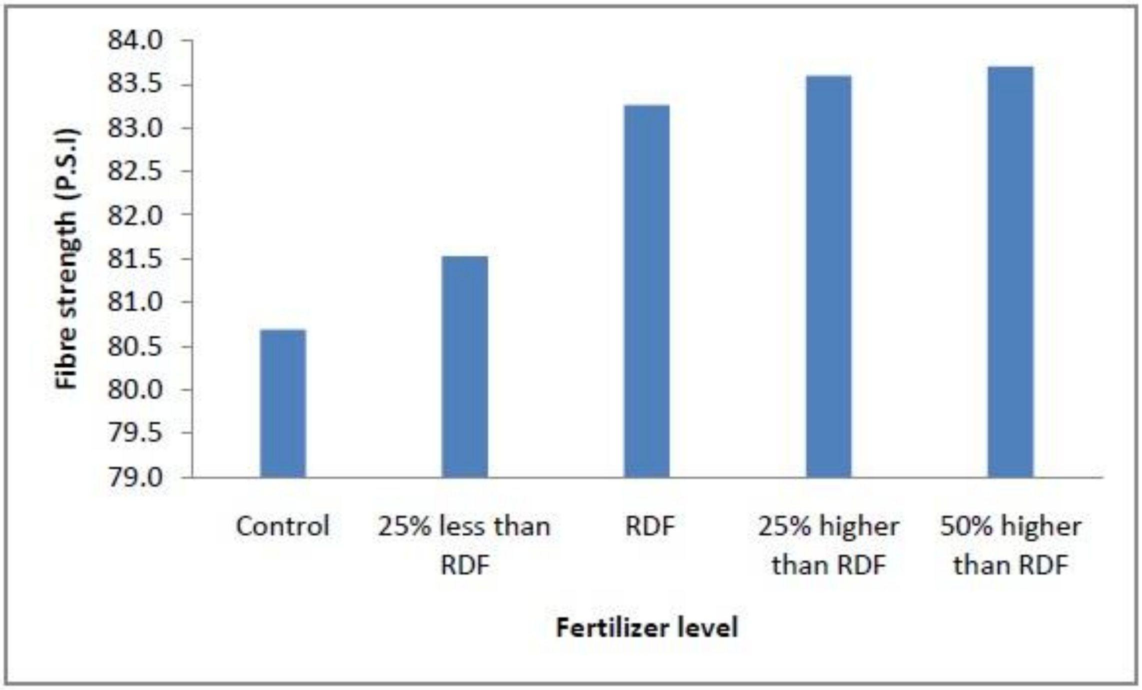

Fig.30 Effect of fertilizer levels on fibre streangth ($S\bar{x}$ =0.4962)

4.15.3 Interaction effect of variety and fertilizer

Interaction of cotton variety with fertilizer doses exerted significant effect on fibre strength (Table15). The result showed that fibre strength increased with the application of fertilizer irrespective of varieties.

Interaction of DM-2 × 25% higher than RDF and DM-2 × 50% higher than RDF showed the highest level of fibre strength which were statistically similar with DM-2 x RDF, HSC-4 × 50% higher than RDF, HSC-4 x 25% higher than RDF, CB-12 x RDF and CB-12 x 50% higher than RDF interactions. However, irrespective of varieties control treatment showed the lowest level of fibre strength.

Table15. Interaction effect of variety and fertilizer levels on cotton fibre Strength

Interaction (Variety × fertilizer)	Fibre strength (P.S.I)
HSC-4 × Control	80.03 b-d
× 25%less than RDF	80.38 d
× RDF	82.01 bd
× 25% higher than RDF	83.20 a-d
× 50% higher than RDF	82.74 a-d
DM-2 × Control	81.10 cd
× 25%less than RDF	81.54 cd
× RDF	84.16 ab
× 25% higher than RDF	85.52 a
× 50% higher than RDF	85.26 a
CB-12 × Control	80.59 d
× 25%less than RDF	81.01 cd
× RDF	83.62 a-c
× 25% higher than RDF	82.07 b-d
× 50% higher than RDF	83.10 a-d
$S\bar{x}$	0.90
CV (%)	1.80

4.16. Uniformity ratio

4.16.1 Effect of genotype

Length uniformity is now part of the premium /discount valuation of cotton. Short fibre within a process mix of cotton cannot warp around each other and contribute little or nothing to yarn strength. Short fibres indirectly cause product defaults and directly contribute to higher waste and lower manufacturing efficiency. Since short fibre content and length uniformity are devised from length, they are influenced by the same factor as length. Crop management practices that influence where bolls are located on the plant can impact short fibre content levels. Uniform fruit retention patterns encarage beller length uniformity.

Uniformity ratio of different cotton genotypes was not significant (Fig.31). The highest uniformity ratio (47.60) was observed in HSC-4 hybrid. The lowest uniformity ratio (46.00) was found in hybrid DM-2 and CB-12

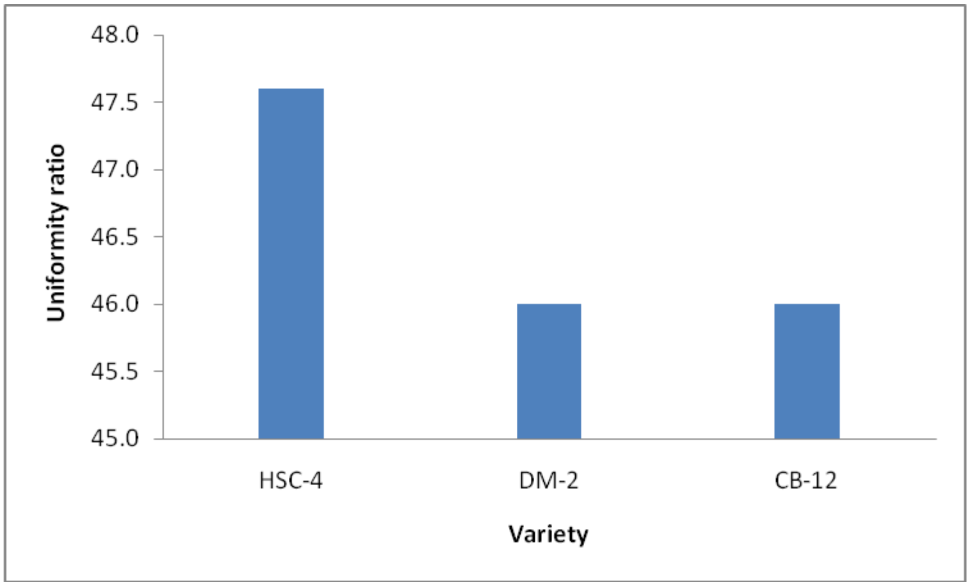

Fig.31 Effect of cotton genotype on uniformity ratio of cotton fibre ($S\bar{x}$ =0.5649)

4.16.2 Effect of fertilizer

Uniformity ratio was significantly affected due to fertilizer doses (Fig.32). Uniformity ratio increased gradually with the increase of fertilizer dose. The significantly highest uniformity ratio (48.00)) was found in 50% higher than RDF. The lowest uniformity ratio (45.33) was in control treatment. This result was in agreement with the findings of Bauer and Roof (2004) who observed lower lint quality, including fibre length, length uniformity, and fibre strength, in no N fertilization.

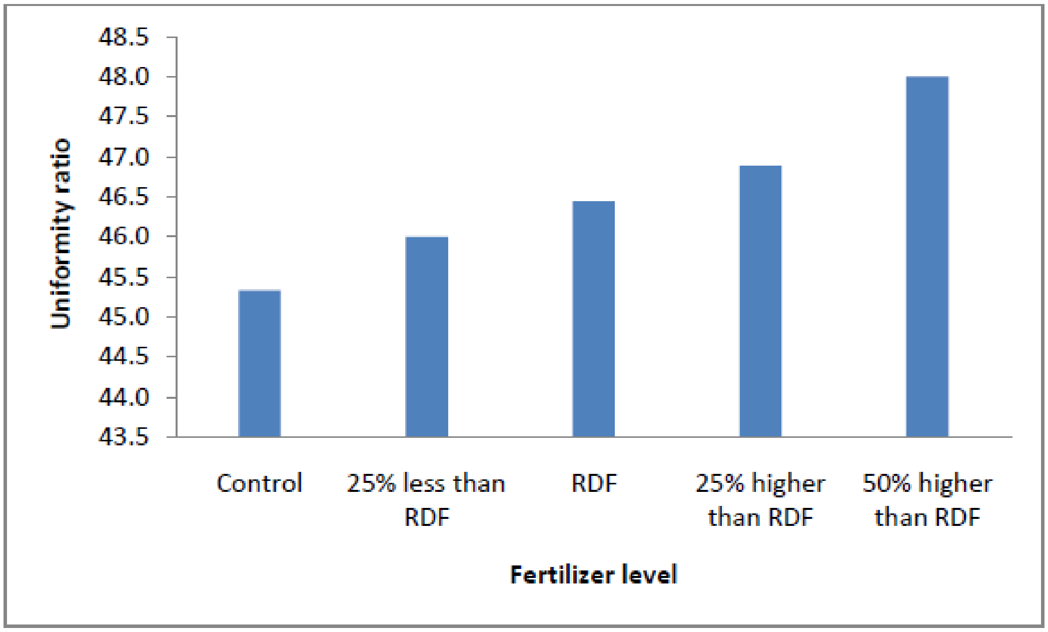

Fig.32 Effect of fertilizer levels on uniformity ratio of cotton fibre ($S\bar{x}$ =0.7293)

4.16.3 Interaction effect of variety and fertilizer

Uniformity ratio showed significant difference due to interaction effect of variety and fertilizer (Table.16). The result showed that uniformity ratio increased with the increase of fertilizer doses irrespective to variety. The significantly highest uniformity ratio (50.00) was observed in CB-12 x50% higher than RDF interaction which was statistically similar with HSC-4 x50% higher than RDF and DM-2 x 50% higher than RDF interaction. Interaction of control fertilizer with CB-12 showed the lowest uniformity ratio (43.00).

Table16. Interaction effect of variety and Fertilizer levels on uniformity ratio of cotton fibre

Interaction (Variety × fertilizer)	Uniformity ratio
HSC-4 × Control	46.00 a-d
× 25%less than RDF	47.00 a-d
× RDF	48.00 a-c
× 25% higher than RDF	48.00 a-c
× 50% higher than RDF	49.00 ab
DM-2 × Control	44.00 cd
× 25%less than RDF	44.00 cd
× RDF	46.00 a-d
× 25% higher than RDF	47.00 a-d
× 50% higher than RDF	49.00 ab
CB-12 × Control	43.00 d
× 25%less than RDF	45.33 b-d
× RDF	45.67 b-d
× 25% higher than RDF	46.00 a-d
× 50% higher than RDF	50.00 a
$S\bar{x}$	0.73
CV (%)	4.70

4.21 Economic analysis

Economic analysis was done with a view to observing the comparative cost and benefit under different treatment combinations of variety and fertilizer levels. For this purpose, the inputs cost for land preparation, cotton seed, manure and fertilizer, pesticide, intercultural operation, harvesting and post harvesting cost and manpower required for all the operations including seed cotton were recorded against each treatment, which were then enumerated into cost per hectare.

Variation in cost of production was noted due to the cost of cotton seed and different fertilizer levels (Table 22). The total cost of production ranged between 32320Tk $ha^{-1}$to 80762Tkha^{-1}. The cultivation cost increased with increasing fertilizer dose. The highest cost of production was involved when used 50% higher than RDF dose and hybrid variety (80762 Tk ha^{-1}). The lowest cost of production was involved when used no fertilizer and CB-12 variety (32320Tk ha^{-1}). The highest gross return was found when used CB-12 variety and 50% higher than RDF dose treatment combination (144360Tk ha^{-1}). The lowest gross return was found (17940Tk ha^{-1}) when used DM-2 variety and no fertilizer treatment combination. The highest gross margin was found when used CB-12 variety and 50% higher than RDF dose treatment combination (75358 Tk ha^{-1}). The lowest gross margin was found when used DM-2 variety and no fertilizer (-26140 Tk ha^{-1}) treatment combination. The maximum benefit cost ratio (BCR) was involved when used CB-12 variety and 50% higher than RDF dose treatment combination (2.09). The minimum benefit cost ratio was found when used DM-2 variety and no fertilizer treatment combination (0.41). For economic point of view, results indicate that CB-12 inbred variety with 50% higher than RDF level was more profitable than the other treatment combination.

Table17. Economic analysis in cotton production as influenced by cotton variety and fertilizer levels

Treatments		Seed cotton yield (kgha^{-1})	Gross return (tkha^{-1})	Total variable cost (tkha^{-1})	Gross margin (tkha^{-1})	BCR
Variety	fertilizer					
HSC -4 ×	Control(no fertilizer)	469	28140	44080	-15940	.64
×	25%less than RDF	1522	91320	67148	24172	1.36
×	RDF	1722	103320	71686	31634	1.44
×	25% higher than RDF	2144	128640	76224	52416	1.69
×	50% higher than RDF	2132	127920	80762	47158	1.58
DM -2 ×	Control(no fertilizer)	299	17940	44080	-26140	0.41
×	25%less than RDF	1173	70380	67148	3232	1.05
×	RDF	1686	101160	71686	29474	1.41
×	25% higher than RDF	1933	115980	76224	39756	1.52
×	50% higher than RDF	1983	118980	80762	38218	1.47
CB -12 ×	Control(no fertilizer)	367	22020	32320	-10300	0.68
×	25%less than RDF	1349	80940	55388	25552	1.46
×	RDF	1738	104280	59926	44354	1.74
×	25% higher than RDF	2088	125280	64464	60816	1.94
×	50% higher than RDF	2406	144360	69002	75358	2.09

Note:

Urea = 22tk kg^{-1}

TSP = 24 tk kg^{-1}

MOP = 17 tk kg^{-1}

Gypsum = 10 tk kg^{-1}

Hybrid seed = 2400 tk kg^{-1}

CB-12 seed = 20 tk kg^{-1}

Price of seed cotton =60tk kg^{-1}

Chapter 5

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

A field study was conducted at Cotton Research Training and Seed Multiplication Farm, Sreepur, Gazipur during the period of July 2011 to February, 2012 with a view to investigate the performance of different levels of fertilizer on some hybrid and inbred varieties of cotton genotypes in respect of phenology, growth, yield components and yield, and fibre quality attributes. The experiment comprised of (i) three cotton genotypes viz. HSC-4 (hybrid), DM-2 (hybrid) and CB-12 (inbred) variety and (ii) five levels of fertilizer viz Control, 25% less than recommended dose, recommended dose, 25% higher than recommended dose and 50% higher than recommended dose of fertilizer. Fibre quality also determined at the end of the crop harvest.

The soil of the experimental site belongs to the Salna series representing the shallow red brown terrace type under the order Inceptions of soil taxonomy. The experiment was laid out in a randomized complete block design (factorial) with three replications.

Phenological data such as days to first blooming and boll splitting time were recorded. Growth data consisted of plant height and branches plant^{-1}. Plant height, number of monopodial and sympodial branch plant^{-1} was recorded at the time of harvest. Yield parameters consisted of number of bolls plant^{-1} and boll size (weight). Plots were harvested by hand and seed cotton yield was converted into kgha^{-1}.

Ginning and lint characteristics of cotton were determined by ginning out turn (%), lint index, seed index, staple length, micronaire value and fibre strength (PSI) and uniformity ratio.

A significant variation was observed among the three cotton genotypes in majority of the observed parameters. The tallest plant (98.41 cm) was found in the genotype HSC-4 at harvest. Conversely, the shortest plant (82.28 cm) was recorded in CB-

12 variety. The cotton genotypes showed no significant variation in number of monopodial and sympodial fruiting branches plant^{-1} among the genotypes.

The genotypes HSC-4 required the shortest time from planting to blooming and the genotype CB-12 required the longest time from planting to flowering. On the other hand, genotype HSC-4 required the longest time to boll opening and the genotype CB-12 required the shortest time from planting to boll opening.

The tallest plant (98.41 cm) was found in the genotype HSC-4. Conversely, the shortest plant (82.28 cm) was recorded in CB-12 variety. The cotton genotypes showed no significant variation in number of monopodial and sympodial fruiting branches per plant among the genotypes. The highest seed cotton yield (1598 kgha^{-1}), lint yield (738 kgha^{-1}) and individual boll weight (5.53g) was recorded in genotype HSC-4. However, the lowest seed cotton yield (1415 kgha^{-1}), lint yield (609 kgha^{-1}) and individual boll weight (5.06g) was recorded in genotype DM-2. The maximum number of bolls plant^{-1}(21.27) was recorded CB-12 inbred and the lowest number of bolls per plant (18.47) was observed in the DM-2 genotype.

Ginning out turn, lint index and seed index were markedly influenced by different genotypes of cotton. The maximum ginning out turn (45.29 %) and lint index (7.53) were noted in HSC-4 hybrid and the minimum ginning out turn (42.17) and lint index (6.88) were noted in CB-12. The maximum seed index was noted in CB-12 genotype and the lowest lint index was recorded in DM-2 hybrid.

The maximum fibre length and strength of cotton genotypes were recorded in hybrid DM-2 and the minimum length and strength of cotton genotypes were recorded in CB-12 variety. The maximum micromere value cotton genotypes were recorded in hybrid HSC-4 and the minimum micromere value of cotton genotypes were recorded in DM-2 hybrid.

Result showed that different levels of fertilizer had significant effect on all the studied parameters. The result relevant that increasing the levels of fertilizer increase most of the parameters except days to first flowering, lint index and ginning out turn. The tallest plant (111cm), maximum days to boll opening, maximum number of bolls plant^{-1} (27.08), maximum seed cotton yield (2174 kg ha^{-1}) maximum lint yield (953kg ha^{-1}) maximum seed index (9.49), maximum staple length(1.2inch) maximum micronaire value (4.3) fibre strength (83.70P.S.I), maximum uniformity ratio (48%) were observed in the treatment where 50% higher than RDF fertilizer dose applied. The maximum monopodial branch plant^{-1}(1.9), the maximum sympodial branches plant^{-1}(13.73), the maximum boll weight (5.57) were recorded in the treatment where 25% higher than RDF fertilizer applied. The 25% less than RDF dose obtained the highest lint index (7.86). Control treatment showed the lowest performance on all the studied parameters except days to 1st flowering.

The combined effect of different genotypes and fertilizer levels on all the studies parameters such as phenological, growth, yield and yield attributes, and lint characters in the experiment were significant. The highest seed cotton yield and lint yield were obtained in the treatment combination of CB-12 with 50% higher than RDF treatment.

Variation in cost of production was noticed due to the varied cost of cotton seed and different levels of fertilizers. The total cost of production range between 32320 tk ha^{-1} to 80762tk ha^{-1}. The highest gross return was found in 50% higher than RDF and CB-12 treatment combination (144360Tk ha^{-1}). The lowest gross return was found when used no fertilizer (17940Tk ha^{-1}) and DM-2 treatment combination. However, the highest gross margin was found when used 50% higher than RDF and CB-12 treatment combination (75358 tk ha^{-1}). The lowest gross margin was found when used DM-2 and no fertilizer treatment combination.

The maximum benefit cost ratio (2.09) was involved when used 50% higher than RDF dose and CB-12 treatment combination. The minimum benefit cost was (0.41) was found DM-2 and no fertilizer treatment combination. From economic point of view, the results indicated that CB-12 inbred variety with 50% higher than RDF was more profitable than any of the other treatment combinations.

Based on the experimental results, it may be concluded that-

i) The effect of the cotton genotypes and fertilizer levels had positive impact on phenological, growth characters, yield and yield attributes, lint characters and nutrient status post harvest of soil ; and
ii) The inbred variety CB-12 with 50% higher than the recommended dose of fertilizer seems to be more suitable for achieving higher seed cotton yield which reflected better in economic analysis.

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Appendices

APPENDICES

Appendix I. Mean monthly temperature, relative humidity and monthly rainfall from June 2011 to March 2012

Month	**Air Temperature (^oC)			**Humidity (%)	*Rain Fall (mm)
	Max.	Min.	Ave.		
June/11	32.56	28.96	30.76	88.66	344.62
July/11	32.32	27.67	30.00	83.45	269.13
August/11	32.0	25.90	28.95	85.58	138.65
September/11	30.38	26.53	28.45	89.46	212.65
October/11	30.67	27.06	28.87	87.41	187.01
November/11	27.76	23.76	25.76	85.66	00.0
December/11	24.80	16.58	20.69	90.70	55.19
January/12	19.48	9.76	14.62	90.16	00.00
February/12	27.00	15.35	21.17	88.42	00.00
March/12	31.32	24.80	28.06	86.00	105.18

*Monthly total, **Monthly average

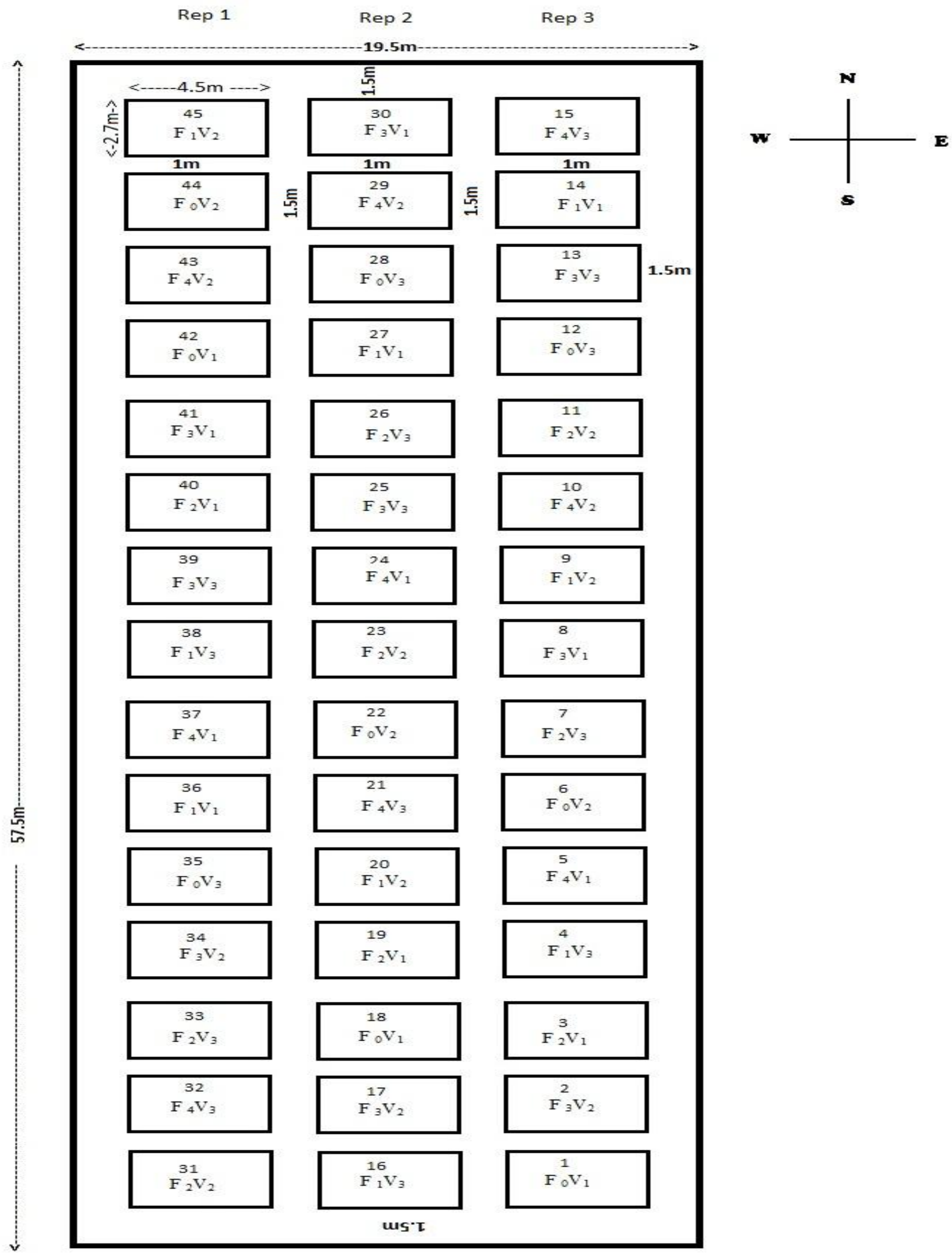
Sourc : Department of Agricultural Engineering, **:** BSMRAU, Salna, Gazipur

Appendix2. Physical and chemical properties of the experimental soil (0-30 cm depth)

Soil properties	Content
Organic matter	0.81%
P^h	5.2
Total N	0.080%
Available P	6.9 microgram/g soil
Exchangeable K	0.21 me/100 g soil
Available Zn	3.14 microgram/g soil
Available S	3.56 microgram/g soil
Available B	0.69 microgram/g soil
Exchangeable Ca	4.4 me/100 g soil
Exchangeable Mg	1.9 me/100 g soil
Texture	Clay loam

Source: SRDI, Dhaka (2011)

Appendix3. Layout of experimental field



Appendix4. Cotton Production Area in Bangladesh

(Red Box) Indicate the place of the research field.

Appendix5. Soil test value after cotton harvest

Treatment	P^h	O. M	Total N	K	Ca	Mg	P	S	B	Zn
		%		me/100 g soil			microgram/g soil			
V_1xF_0	6.4	2.22	0.120	0.25	6.73	3.17	5.2	5.0	0.22	2.53
V_1xF_1	6.5	1.20	0.070	0.26	5.38	1.88	7.0	5.1	0.29	2.61
V_1xF_2	6.0	2.08	0.110	0.28	5.00	1.50	5.2	6.3	0.24	2.23
V_1xF_3	6.1	1.34	0.068	0.31	6.83	1.50	10.7	5.2	0.12	3.3
V_1xF_4	5.9	1.75	0.090	0.26	4.60	1.33	10.7	13.7	0.19	1.98
V_2xF_0	6.2	1.68	0.085	0.29	6.83	2.42	6.4	16.9	0.11	1.82
V_2xF1	6.6	1.55	0.078	0.25	5.18	2.08	8.3	4.8	0.37	1.89
V_2xF_2	6.4	2.49	0.145	0.23	4.60	1.25	4.7	5.0	0.15	2.22
V_2xF_3	6.7	0.67	0.034	0.23	6.05	2.46	4.9	12.5	0.14	1.59
V_2xF_4	6.6	0.87	0.045	0.27	5.28	1.63	6.7	5.8	0.21	2.43
V_3xF_0	6.5	0.47	0.030	0.33	5.58	1.96	8.6	8.1	0.23	2.65
V_3xF_1	6.5	1.01	0.051	0.32	9.15	3.75	6.3	4.8	0.20	2.61
V_3xF_2	6.3	0.47	0.024	0.31	4.70	1.79	4.7	10.3	0.21	1.63
V_3xF_3	6.2	0.94	0.047	0.26	4.90	1.21	7.1	12.7	0.24	2.06
V_3xF_4	6.6	1.08	0.054	0.45	5.28	1.46	16.4	3.5	0.26	3.66