Journal of Integrative Agriculture 2016, 15(3): 678–683

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RESEARCH ARTICLE

Impact of temperature on yield and related traits in cotton genotypes

Kalim Ullah[1], Niamatullah Khan[1], Zahid Usman[1], Rehmat Ullah[2], Fazal Yazdan Saleem[3], Syed Asif Imran Shah[1], Muhammad Salman[1]

[1] Pakistan Central Cotton Committee, Cotton Research Station, Dera Ismail Khan 29050, Pakistan
[2] Department of Agricultural Extension, Education & Communication, The University of Agriculture, Peshawar 25000, Pakistan
[3] Oil Seed Programme, National Agriculture Research Center, Islamabad 44000, Pakistan

Abstract

Cotton growth and development is influenced by various uncontrollable environmental conditions. Temperature variations in the field can be created by planting at different dates. The objective of the present study was to evaluate the effect of planting dates and thermal temperatures (growing degree days) on yield of 4 cotton genotypes, *viz*., CIM-598, CIM-599, CIM-602 and Ali Akbar-703. Plants were subjected to 6 planting dates during 2013 and 2014 in a trial conducted in randomized complete block design with four replications. For boll number, boll weight and seed cotton yield, cotton genotypes exhibited significant differences, CIM-599 produced the highest seed cotton yield of 2 062 kg ha^{-1} on account of maximum boll number and boll weight. The highest seed cotton yield was recorded in planting dates from 15th April to 1st May whereas early and delayed planting reduced the yield due to less accumulation of heat units. Regression analysis revealed that increase of one unit (15 days) from early to optimum date (15th March to 15th April) increased yield by 93.58 kg ha^{-1}. Delay in planting also decreased the seed cotton yield with the same ratio. Thus it is concluded that cotton must be sown from 15th April to 1st May to have good productivity in this kind of environment.

Keywords: *Gossypium hirsutum*, planting dates, growing degree days, genotypes

1. Introduction

Cotton growth, yield, composition and quality are influenced by various factors such as genotype, environment and agronomic practices. Environmental factors are classified into predictable and unpredictable variables (Allard and Bradshaw 1964). Sowing time is among one of the predictable factors, it is under human control and can be slightly changed as per requirements, therefore it is decleared as predictable factor. Planting time is a major agronomic factor that affect growth and yield (Gecgel *et al.* 2007). Therefore, determination of optimum sowing time and selection of suitable cultivar for specific growing areas are of utmost importance for high yield and quality cotton.

Environmental factors determine the good growing season for a specific crop. It also reveals the adoptive potential of a genotype. Temperature is a major environmental factor which reveals the growth, development and yield. All over the world, an increase in global warming increases heat stress which is a serious threat to crop productivity. Documented rise in global temperature that has been forecasted by several climatic models, have direct effect on plant growth, yield and quality. This type of temperature variation in the field can be created by cultivating the crops at dif-

Received 6 February, 2015 Accepted 6 May, 2015
Correspondence Kalim Ullah, E-mail: kalimpbgian@yahoo.com

doi: 10.1016/S2095-3119(15)61088-7

ferent sowing times and the crop will thus grow at different temperatures and relative humidities.

Cotton genotypes that have wide range of adoptability need different total numbers of cumulative heat units (CHUs) or growing degree days (GDDs) for their growth, development, yield and maturity. The CHUs or GDDs are the most common indexs used to estimate the development of a plant. CHUs accumulation determines the crop maturity along with the fiber quality of cotton crop.

In terms of quality and quantity of the product, the genotype-environment interaction is a key factor in the performance assessment of a crop cultivar. All the environmental factors such as temperature, sunshine, humidity and rainfall affect differently the growth and development of a crop. As the rate of plant growth is mainly driven by temperature (Ritche and Ne Smith 1991), the gap between the actual and potential yield needs to be closed *via* modeling the impact of temperature variation on yield and quality of genotypes.

In this context, the objectives of the study were to (i) evaluate the impact of planting dates on seed cotton yield and (ii) modeling the association between heat unit accumulation and yield-related traits of cotton genotypes planted at different times.

2. Results and discussion

2.1. Combined analysis of variance

The analysis of variance revealed significant differences ($P \leq 0.01$) among genotypes (G) and planting dates (D) for the tested parameters (Table 1), indicating the presence of variability among genotypes as well as environments. It further suggests that some of the genotypes were superior to others in these traits. The interaction of G×D for number of bolls per plant was also significant, showing that different genotypes performed differently in different environments (Table 1). Significant mean squares of genotypes also indicate higher degree of genetic variability among the material used in the study. This significant variation was observed in all the studied traits which are valuable sources used in future research for several breeding purposes. The G×D was also significant for number of bolls per plant indicating significant G×environment (E) interaction. It is thus depicted that environmental effect in understanding plant growth must be considered due to its importance in cotton breeding programme. These results are in complete analogy with the Machado *et al.* (2002), who also observed significant genotype×year and genotype×year×location interaction. In different environments, the genotypes performed differently and revealed significant genotype×environment interaction in upland cotton genotypes (Unay *et al.* 2004; Satish *et al.* 2009). Similarly, mean squares due to G, E and G×E interaction were highly significant for different morphological traits in upland cotton (Khan *et al.* 2008; Gul 2013).

2.2. Cotton development and crop phenology

Environmental factors, particularly temperature, are the key components that affect the plant growth and development. Significant differences for GDDs/CHUs in various genotypes depicted that these genotypes have varying maturity periods. However, higher GDDs/CHUs accumulated in the crop that planted on 15th April and 1st May in 2013–2014 reflected that these planting dates are optimum planting dates to have good output.

2.3. Number of bolls per plant

Bolls per plant is the major independent yield component and plays a major role in managing the variations in seed cotton yield. Hence selection for larger number of bolls per plant must receive emphasis on cotton improvement. Statistical analysis of the data revealed that planting dates significantly influenced number of bolls per plant (Table 2). Number of bolls per plant enhanced with delay in planting date, maximum number of bolls per plant (26.50) was recorded in the crop planted on 15th April, whereas further delay in planting dates reduced the number of bolls per plant and thus minimum bolls per plant was recorded in the crop planted either very early (19.50) on 1st March or delayed planting (17.42) on

Table 1 Combined analysis of variance of studied crop phenology and yield components of 4 cotton genotypes evaluated for 2 years and 6 planting dates

Source of variability	*df*	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yield (kg ha^{-1})
Years (Y)	1	324**	0.0386*	495 030
Planting dates (D)	5	249.45**	1.6550**	1 889 354**
Y×D	5	0.0086	0.0510**	101 291**
Genotypes (G)	3	229.06**	0.2710**	879 197**
Y×G	3	0.0013	0.0184	27 275
D×G	15	1.51**	0.0138	23 543
Y×D×G	15	0.0012	0.0061	16 530
Error (R×Y×D×G)	80	0.331	0.0112	21 459

* and **, significance at 5 and 1% level of probability respectively using the *F* test.