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Quantification of weather relationship with seed vigour development and germination percentage in *desi* cotton (*Gossypium arboreum* L.)

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ABSTRACT

The present investigation was carried out during 2015 and 2016 at Research Farm of Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar to study the impact of weather parameters on seed development in *desi* cotton under varying environmental conditions. The experiment was comprised of three varieties of *desi* cotton namely, HD 123, HD 324 and HD 432 planted under three environmental conditions (early, normal and late sown).The results revealed that seed development as indicated by germination, protein content, gossypol content and seed vigour was affected significantly by delayed sowing. The seed quality parameters of April sown cotton crop were maximum except gossypol content.The cotton seed of variety HD 432 recorded the highest seed vigour and germination (54.49%) while the lowest values were observed in cotton seed of variety HD 123 (49.5%). Cotton seed vigour development was correlated with weather parameters prevailed during seed development phase pooled for both seasons. Weather factors and thermal indices had positive correlation with seed vigour protein content and germination except maximum temperature which was negatively associated whereas this response was reverse in case of gossypol content of cotton seeds.

Keywords: Seed development, seed germination(%), photothermal unit, polynomial response and weather

Cotton is the most important renewable natural fibre crop and continues to be the predominant and sustainable fibre in the Indian textile scene, despite stiff competition from the man made synthetic fibers.In India, cotton is grown in 105 lakh hectares area with production of 351 lakh bales.In Haryana area under cotton cultivation is 4.98 lakh hectares with production 20 lakh bales and productivity of 683 kg lint ha^{-1} compared to 568 kg lint ha^{-1} of India (Anonymous, 2017). Cotton is an indeterminate plant and any weather aberrations particularly continuous wet and cloudy weather during different stages of crop adversely affect the cotton yield. Cotton development rates were related to air temperature during the growing season and expressed as accumulated heat units or growing degree days (Thakur *et al*., 2017; Singh *et al.* 2007). Cotton often produces more vegetative growth than is needed for maximum boll production and yield especially when climatic conditions favours vegetative growth (Nawalkar *et al.,* 2015). Seed germination in cotton is a big problem under North Indian conditions. It remains below normal seed standards because of poor seed development. Cotton seed development is very much affected by environmental conditions. Sometimes seed germination in cotton may be reduced as low as 10 per cent due to adverse environmental conditions and exact reasons for poor seed development are still unknown. Therefore, the present investigation was carried out to study cotton seed vigour/quality in relation to weather parameters.

MATERIAL AND METHODS

The study was conducted at the research farm of Cotton Section, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Lat.$29^0 10'$ N,Long. $75^0 46'$ E and altitude 215.2 m above) with 3 varieties of *desi* cotton (HD123, HD324 and HD432) sown on three dates (early, normal and late sown) in RBD design with six replications during two *kharif* seasons, 2015 (April 10, May 15 and June 5) and 2016 (April 26, May 5 and June 2). There were eight rows of each genotype of six meter length spaced at 67.5 cm apart and plant to plant distance was kept 30 cm. All recommended packages of practices were followed to grow the healthy crop.

The plants were tagged in each plot for observation

Table 1: Influence of sowing time on seed quality of different cotton varieties (Pooled for 2015 &2016)

Treatments	Germination (%)	Protein Content (mg/100 g seed wt.)	Gossypol Content	Seed Vigour-II
Varieties				
HD123	49.51	24.58	0.41	12.76
HD324	50.98	25.07	0.44	13.76
HD432	55.49	25.42	0.37	13.86
SE(m)±	0.58	0.54	0.13	0.82
CD @ 5%	1.743	NS	NS	2.02
Sowing dates				
Early	63.43	26.55	0.35	18.11
Normal	51.27	24.87	0.430	12.84
Late	40.68	23.65	0.46	9.43
SE(m)±	0.58	0.54	0.13	0.82
CD @ 5%	1.74	1.88	NS	2.46

on flowering and boll development. As and when flowers appeared on plant, opened flowers were tagged during July to September. Flower tagged in on week were grouped together and it was named as I to X in both the seasons. The seed cotton yield of tagged flowers was picked up after their maturity in all the varieties. Seed cotton was ginned for obtaining cotton seed in all the treatments.Total nitrogen content in seed was estimated by micro-Kjeldahl method (AOAC, 1990) and protein content was calculated by multiplying with a factor of 6.25. Gossypol content was determined by the method suggested by Bell (1967).

Germination test of cotton seed was conducted using four replicates of 100 seeds each by adopting "Between paper method" as described by ISTA (Anon., 2011). The germination cabinet was maintained at 25 ± 1^{0}C temperature and 90 ± 2 per cent relative humidity. At the end of 10th day of germination test, the numbers of normal seedlings in each replication were counted and the germination was calculated and expressed in percentage as:

$$\text{Germination} = \frac{\textit{Number of normal seedlings}}{\textit{Total number of seedlings}} x\ 100$$

The seedling vigour index was computed using the formula as suggested by AbdulBaki and Anderson (1973) and expressed as whole number.Seedling vigour index-II = Standard germination (%) x Average seedling dry weight (mg).

Weekly weather data was taken from agro-meteorological observatory situated about 500m away from experimental field. During both seasons the most active seed development period was 14 to 35 days after flower opening in cotton. Therefore the weather data prevailed during the period (seed development period) were averaged. The agrometeorological indices viz. growing degree days (GDD), heliothermal unit (HTU) and photothermal unit (PTU) were computed using base temperature of 10^{o}C.

Average weather prevailed during active seed development phase *i.e.* 14 to 35 days after flower opening were correlated with cotton seed quality parameters such as seed vigour, protein and gossypol content. On the basis of test of significance of correlation coefficients, weather parameters were selected and weather-seed quality interaction was quantified for each cultivar.

RESULTS AND DISCUSSION

The seed quality parameters of cotton seed of different varieties (Table 1) revealed that the protein content was highest in cotton seeds of early sown crop and decreased with delay in sowing. A reverse trend was observed in gossypol content of cotton seeds. Seed protein content was higher in HD 432 as compared to other varieties but difference was not significant whereas gossypol content was lowest in this cultivar. Seed vigour was maximum in HD 432 followed by HD 324 and HD 123 cotton varieties. It was significantly affected by sowing time of cotton crops. Early sown cotton crop produced maximum seed vigour and it decreased about 60 per cent by delayed sowing upto first week of June. Germination of cotton seed of early sown cotton was significantly higher (63.43 %) as compared to germination

Table 2: Correlation matrix of seed quality of cotton varieties with weather parameters

	Protein Content	Gossypol Content	Seed vigour-II	Seed germination
Max. temp.	-0.453*	0.455*	-0.391*	-0.429*
Min. temp.	0.692**	-0.671**	0.663**	0.679**
RH-I	0.483*	-0.550**	0.479*	0.479*
RH-II	0.695**	-0.681**	0.473*	0.698**
Sunshine	0.364	-0.348	0.169	0.354
Rainfall	0.438*	-0.457*	0.332	0.416*
Rainy day	0.559**	-0.569**	0.355	0.540**
GDD	0.688**	-0.661**	0.509**	0.622**
HTU	0.259	-0.285	0.099	0.240
PTU	0.709**	-0.684**	0.515**	0.667**
Protein cont.	—	—	—	0.960**
Gossy. Cont.	—	—	—	-0.963**
Seed vig. II	—	—	—	0.981**

*& ** Significant at 5 and 1% confidence level, respectively ; n=26; Tmax- Maximum temperature, Tmin- Minimum temperature, RHm- Morning relative humidity, RHe- Evening relative humidity, SS- Sunshine hrs, RF- Rainfall, RD- Rainy days,GDD – growing degree days, HTU-Heliothermal unit, PTU- Photothermal unit,

Table 3: Relationship of cotton seed development for better germination with weather parameters

Variety	Weather parameters	$Y=ax^2+bx+c$	R^2
HD123	Tmin	$y=-0.090x^2+10.88x-159.6$	0.40
	RHe	$y=-0.034x^2+4.960x-115.2$	0.49
HD324	Tmin	$y=-0.340x^2+21.72x-273.7$	0.45
	RHe	$y=-0.031x^2+4.400x-94.24$	0.46
HD432	Tmin	$y=-0.441x^2+27.17x-341.9$	0.52
	RHe	$y=-0.044x^2+5.985x-135.3$	0.55

of cotton seed harvested from latter sown cotton crops (40.68%). The differences in seed germination were found significant among the cotton varieties. The seed of variety HD 432 showed highest germination (55.49%) while the lowest seed germination was recorded in HD 123 (49.51%).The seed vigour, protein content and germination of cotton seed of early sown cotton crop was maximum. These results were in the confirmity with the findings of Sarwar *et al.* (2012) and Hebbar *et al.* (2007) reported better seed development in early sown cotton crop.

The correlation coefficients of seed quality parameters of cotton with weather parameters and thermal indices prevailed during critical seed development phase (Table 2) revealed that the maximum air temperature was negatively associated with seed germination, seed vigour and protein content but 'r" values were not significant at $p\leq0.05$. Other weather parameters were directly correlated with seed quality parameters except gossypol content and 'r' values were significant at $p\leq0.05$ except in case of sunshine hours and heliothermal units.Among the weather parameters evening relative humidity was highly correlated (0.698, 0.695, -0.681 and 0.473) with seed germination, protein content, gossypol content and seed vigour followed by minimum temperature, rainy days, morning relative humidity and rainfall.Thermal indices also directly correlated with seed quality parameters except gossypol content of cotton seeds. The correlation coefficients in case of heliothermal units were not significant. Seed germination was directly correlated with protein content and seed vigour while negatively correlated with gossypol content (Table 2). The 'r' values were highly significant (i.e. at $p\leq0.01$).Photothermal units were highly correlated with seed quality parameters followed by heat units and heliothermal units. The coefficient of a determination indicates that photothermal index accounted significant variation in seed germination. This could be explained by the fact that PTU is the productive effect of both temperature and day length.

Optimum range of environmental factors for better seed development was determined using best fit weather-seed quality (germination) response functions presented in Table 3.Optimum relative humidity required for better seed vigour (germination) ranged from 60 to 70 per cent. A range

of minimum temperature 25.2 to 26 °C during reproductive phase was favourable for better seed quality (germination) in desi cotton varieties.These favourable weather ranges were observed from first week of August to first week of September during crop growing season.Which is the best period for best seed quality development, protein content, gossypol content and seed vigour therefore cotton bolls formed during this period should be picked up for cotton seed production.

The values of correlation coefficients indicate that among the weather parameters relative humidity played crucial role for better seed quality development during reproductive period followed by minimum temperature. These results were found in confirmation with earlier findings of Patil and Dighe (1985),

CONCLUSION

Cotton seed harvested from early sown desi cotton showed maximum seed vigour for germination and delayed sowing caused reduction in cotton seed vigour. The cotton seed of variety HD 432 showed highest seed vigour while the lowest seed vigour was recorded in cotton seed of HD 123.Evening time relative humidity during seed development phase played an important role in cotton seed quality parameters. The weather prevailed during first week of August to first week of September provided optimum conditions for better seed vigour development for germination in desi cotton .Therefore bolls formed during this period should be picked up for good quality cotton seeds production.

REFERENCES

A.O.A.C. (1990). Official method of analysis 15th edition, Association of Analytical Communities, Washington, D.C., U.S.A.

Abdul Baki, A.A. and Anderson, J.D. (1973). Vigour determination in cotton by multiple criteria. *Crop Sci.,* 13**:** 630-633.

Anonymous, (2011). International Rules for Seed Testing. Chapter 5: The Germination Test. International Seed Testing Association, Baserdorf, Swizerland.

Bell, A.A. (1967). Formation of gossypol in infected or chemically irritated tissues of gossypium species. *Phytopathol.,* 57:759-764.

Anonymous (2017). Status Paper of Indian Cotton. Directorate of Cotton Development, Ministry of Agriculture and Farmers Welfare, Government of India. pp 182.

Hebbar, K. B., Venugopalan. M. V., Khadi, B. M. and Agarwal, P. K. (2007). Impact from climate change on cotton production (abstracts). "National Conference on Impact of Climate Change with Particular Reference to Agriculture" organized by Agro-Climate Research Centre, Tamil Nadu Agricultural University during 22–24, August at Coimbatore.

Nawalkar, D.P., Ban, Y.G., Mote, B.M. and Kumar, V. (2015). Influence of growth regulators on thermal energy requirement at various phenophases in transgenic cotton. *J. Agrometeorol.,* 17(2):253-255.

Patil, V.N. and Dighe, R.S. (1985). Cotton seed quality related to time ofharvest and position of bolls. *Cotton Res. Devel.,* 14(4):29-32.

Sarwar, M., Farrukh Saleem, M., Ashfaq Wahid, M., Amir Shakeel and Faisal Bilal, M. (2012). Comparison of Bt and non Bt cotton (Gossypiumhirsutum L.) cultivars for earliness indicators at different sowing datesand nitrogen levels. *J. Agric. Res.,* 50(3):335-347.

Singh, Sompal, Butlar, G.S. and Singh, Sudeep (2007). Heat use efficiency of Bt cotton cultivar in the semi-arid region of Punjab. *J. Agrometeorol.,* 9(1):122-124.

Thakur, M.R., Bhole, V.M., Mote, B.M. and Wanjari, S.S. (2017). A comparative assessment of crop phenology, agrometeorological indices and yield of Bt and non-Bt. Cotton in Akola, Maharashtra. *J. Agrometeorol.,* 19(2):153-155.

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