“Genetic Analysis in Bread Wheat under different Environments”

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In

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By

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2015

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This is to certify that the thesis entitled, ***"Genetic Analysis in Bread Wheat under different Environments"*** *submitted in partial fulfillment of the requirement for the degree of* ***MASTER OF SCIENCE (Ag.)*** *in* ***Plant Breeding and Genetics*** *of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by* ***Mr. Pankaj Bisen*** *under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.*

All the assistance and help received during the course of the investigation has been acknowledged by him.

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Place: Jabalpur

Date: ***(Pankaj Bisen)***

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LIST OF ABBREVIATIONS

E_1	First environment
E_2	Second environment
E_3	Third environment
Pooled	Pooled data over all environments
Fig.	Figure
GCV	Genotypic Coefficient of Variation
HCl	Hydrochloric Acid
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
No.	Number
PCV	Phenotypic Coefficient of Variation

SYMBOLS

%	Percentage
±	Plus or Minus
∑	Summation
^oC	Degree Celsius
cm	Centimeter
ddH_2O	Double distil water
e.g.	For example
et al.,	And others
i.e.,	That is
g	Gram
hrs	Hours
ml	Milli litre
PM	Prime Meridian
v/v	Volume by volume
viz.,	Namely

INTRODUCTION

Bread Wheat (*Triticum aestivum* L.) is the world's second most important staple food crop for more than 35 percent of world's population next to the rice. It produces about 20% food resources of the world, high productivity and the prominent position.

India is the second largest wheat producer in the world with a production level of 95.91milion tones (FAO, 2014) second ranked largest wheat producing country in the world next to China. Madhya Pradesh is the third largest producer state of wheat with area, production and productivity are 54.59 lakh hectare 161.25 lakh tones and 2.959 tones respectively with the ratio of cultivated *T. aestivum* and *T. durum* is 80:20. (Anonymous, 2014).

It is cultivated in India as well as in M.P. in various growing situations *viz.*, rainfed sown, irrigated timely sown and late sown. Due to high cropping intensity particularly in Kaymore Plateau and Satpura Hills the farmers used to cultivate the wheat in month of December as well as January after harvesting of rice and potato. In such condition they need early genotypes tolerant to heat with average production. However many varieties of bread wheat but there is unavailability of variety for very late sown condition.

Currently irregularity in monsoon, distribution of rainfall and global warming creates great problem in form of drought and heat stress at the time of wheat production. Global warming is predicted to increase the frequency and severity of heat stress leading to drastic reduction in the food production (Talukder et al. 2014). Wheat is sensitive to high temperature and temperature has emerged as a major constraint for the successful wheat production worldwide (Hays et al. 2007; Kumar et al. 2012a, b,

Slafer and Satorre, 1999). It is predominantly consumed in tropical and subtropical regions of the world. In subtropical regions wheat is cultivated in winter season but it exposed to high temperature stress at the end of the season i.e. at grain filling stage. Heat stress is anticipated to become more important in future with climate changes, monsoon irregularities and rice-wheat cropping system which has compelled wheat crop to be subjected to rapidly ascending temperature coupled with hot dry winds.

The crop season of wheat ranges from 110 to 145 days for normally planted crop in India. The two most important phases of crop growth are pre-anthesis and post-anthesis. The pre-anthesis phase that determines the yield potential of the crop includes: (i) germination to seedling emergence; (ii) canopy development and conversion of the vegetative meristem to reproductive meristem and spike initiation; (iii) spikelet development – first spikelet initiation to the formation of the terminal spikelet; and (iv) ear emergence and anthesis. The period from anthesis to maturity is the grain formation process which is termed as post anthesis periods/grain filling period (GFP).

In India, breeding for specific situation in wheat is becoming important because of fast growing area under delayed planting due to rice-wheat crop rotation, where crop is exposed to high temperature stress at the post anthesis phase. Hence, now breeding for heat tolerance has become an integral component of wheat improvement at both National and International level.

Information about phenotypic stability is useful for the selection of varieties as well as for breeding programme. Understanding of environment and genotypic causes leading to G x E interaction are important at all stages of the plant breeding including ideotype design, parental selection, selection based on traits and on yield. This understanding can be used to establish

breeding objectives, identify ideal test conditions and finely recommendation for areas of optimal cultivable conditions.

At present, breeding of wheat for such specific situation including identification of potential genotypes and related attributes and studies on variability, association value. There is great scope to increase wheat production in very late sown conditions by breeding more efficient plant types adaptable to hot weather conditions.

Since, the estimation of genetic parameters like variability, heritability, genetic advance, phenotypic coefficient of variation, genotypic coefficient of variation, character correlation and simultaneous inheritance of characters that help to decide breeding strategies may vary with environmental conditions and set up of experimental genotypes. Hence, it is essential to conduct studies in different environment with diverse available genotypes.

Looking to the above facts a study has planned to study effects of heat stress on wheat crop during vegetative, reproductive and grain filling stages. Morphological and physiological response to heat stress and defense mechanism will be emphasized and different methods for evaluation and breeding for heat tolerance will be elucidated with the following objectives.

Objectives:-

1. To estimate genetic variability of characters under study in various growing situations.
2. To assess the extent of association among yield and yield contributing traits.
3. To identify stable wheat genotypes for different growing situations.

****

REVIEW OF LITERATURE

The present investigation was conducted to estimate the coefficient of variation, heritability, genetic advance, correlation coefficient and stability parameters for high temperature tolerance and yield contributing characters in bread wheat (*Triticum aestivum* L.). The information related to present investigation has been reviewed under the following heads:

2.1. Study on Coefficient of variation

2.2. Study on Heritability

2.3. Genetic Advance

2.4. Study on Correlation coefficient

2.5. Study on Path coefficient

2.6. Study on Stability analysis

2.1 Coefficient of variation

Babar et al.2006, studied 15 widely adapted and unrelated CIMMYT wheat genotypes, and 25 and 36 RILs from two different crosses. The globally adapted genotypes expressed high variation for morphological traits such as green leaf area duration, height, plant type, heading and maturity dates, and yield potential.

Ali et al. 2008, they were observed significant genotypic differences observed for all the traits studied i.e. plant height, number of productive tillers per plant, number of spikelets per spike, spike length, number of grains per spike, fertility %, 1000 grain weight and yield per plant, indicated considerable amount of variation among genotypes for each character. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for yield per plant, number of productive tillers per plant and number of grains per spike.

Majumder et al. 2008, were studied on twenty wheat divers genotype both genotypic and phenotypic variances were highly significant in all the traits with little higher phenotypic variations as usual. Similarly, the low differences between the phenotypic and genotypic coefficients of variations indicated low environmental influences on the expression of these characters.

Eid 2009, was found mean average for plant height, spike length, number of spikes per plant, number of grains per spike, 50% heading date and 1000 grain-weight revealed highly significant differences among genotypes and crosses under irrigated and drought sown.

Kahrizi et al. 2010, they were estimate genetic variability parameters in 18 experimental durum wheat and two checks under rainfed condition Analysis of variance showed a significantly variation among genotypes for the characters plant height, no. of productive tillers, peduncle length, flag length, leaf dry weight, stem dry weight, spike dry weight, spike height, leaf area ratio and net assimilation rate.

Soleman Mohamed Al-Otayk 2010, combined analysis of variance showed that plant height, spike length, number of kernels per spike, harvest index and grain yield were significantly influenced by years, sowing dates, and genotypes. The results showed that sowing at the first date increased plant height, grain yield, and harvest index. Highly significant genotype differences were recorded for all characters.

Ali and Shakor 2011, they found high genetic variation for plant height, number of spikes, 1000 grain weight, biological yield and grain yield in durum wheat.

Al-Tabbal and Al-Fraihat 2012, were studied on twenty tree promising wheat genotype. Analysis of variance revealed significant differences among the genotypes for all the characters. The estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were high for

grain yield per plant, plant height, biological yield and kernel weight and number of kernel per main spike.

Savii and Nedelea 2012, was found that high phenotypic correlations between spike yield and other traits, positive correlations exist between the studied traits in wheat genotypes, high plant size is first of all associated with higher spike length and number of spikelet's, and subsequent with high levels of grain number and spike yield. The relationship between the grains number and spike yield is affected in a small and insignificant measure and correlation between plant height and grain weight/spike is real and significant.

Talebi and Fayyaz 2012, studied on 24 Iranian bread wheat cultivars under two constructing water regimes. PCV ranged from 0.359% for harvest index to 35.9% for number of seeds per spike and in drought stress condition this value ranged from 0.113% for harvest index to 21.57 for plant grain yield. The GCV values were the lowest (<2%) for harvest index and highest (12%) for plant height, number of seeds per spike and plant grain yield. 1000-seeds weight and plant biomass as well as number of seeds per m2, also showed relatively low GCV values (3.8-8.8%).

Baloch et al. 2013, were studied on eight wheat diverse genotype showed mean squares from analysis of variance revealed significant differences among the genotypes for all the traits studied. The variety TD-1 produced maximum tillers plant^{-1}, more spikelets spike^{-1}, gave higher grain yield plant^{-1} (g), more seed index (g) and harvest index (%). Sarsabz produced longer spike length, more spikelets and grains spike^{-1}, however Sundar recorded taller plants.

Ghafoor et al. 2013, observed 20 wheat genotypes, among the genotypes were highly significant for plant height and significant for days to maturity and spikelet spike^{-1} while non-significant for grains spike^{-1}, spike weight, and grain yield plant^{-1}.

Mean values for genotypes ranged between 65.07 to 88.93 cm for plant height, 166.3 to 171.0 for days to maturity, 53.3 to 70.4 for grains spike^{-1}, 2.89 to 4.42 g for spike weight, 18.7 to 21.9 for spikelet spike^{-1} and 8.23 to 18.93 g for grain yield plant^{-1}.

Nukasani et al. 2013, were studied on one hundred fourteen pre-breeding lines of wheat showed high values of GCV and PCV were recorded for tillers meter-1 and grain yield meter-1, whereas moderate values for rest of the traits.

Singh and Upadhyay 2013, observed in 27 diverse genotype of wheat that analysis of variance for significant differences was among the all characters except, number of effective tillers per plant and spike length. A broad range of variation was observed for grain yield per ha^{-1}, plant height at maturity and number of grain per spike. Phenotypic variance value for most characters was closer than the corresponding genotypic variance value showing little environment effect on the expression of these characters.

Hamam 2013, evaluated wheat genotypes of diverse origins for three sowing date treatments during three seasons, to assess the heat stress tolerance of these genotypes under nine environmental conditions. Analysis of variance revealed that all of these traits i.e. plant height, days to heading, spikes per plant, 1000-kernel weight, and grain yield, were significantly affected by genotypes, under heat stress treatments.

Shukla and Moitra 2013, they found phenotypic and genotypic coefficient of variance to be higher for number of tillers per plant, spike density, number of ears par plant and high PCV% for grain yield per plant and high GCV% for number of grains per spike, grain yield per plant and harvest index.

Shukla and Moitra 2013, comprised 75 elite wheat diverse lines received from CIMMYT with six check varieties. They studied PCV, GCV for 14 characters revealed highly significance

differences for all the characters. They found phenotypic and genotypic coefficient of variance to be higher for number of tillers per plant, spike density, number of ears par plant and high PCV% for grain yield. per plant. They had reported high GCV% for number of grains per spike, grain yield per plant and harvest index.

Bala et al. 2014, studied on three wheat genotypes C 273 (heat tolerant) and PBW 343, PBW 550 (susceptible) under normal and heat stress (late sowing) conditions. Grain yield, no of grain per kernel, plant height, grain filling duration, peduncle length, peduncle weight and 1000 kernels weight were measured. High temperature significantly decreased all traits specially grain yield (26% and 54.2%), 1000-kernel weight (24% and 31%) and grain filling duration (3% and 9%) in tolerant and susceptible genotypes, respectively. Grain yield (54%) was most affected and grain filling duration (9%) was least affected by heat stress.

Kumar et al. 2014, observed phenotypic coefficient of variation higher than genotypic coefficient of variation, which indicates less effect of environment on the expression of characters studied. Highest estimates of GCV and PCV were observed for grain yield per plant followed by biological yield and harvest index (GCV 22.87 and PCV 23.03).

Tesfaye et al. 2014, were studied on 14 wheat genotypes under 8 environments showed that analysis of variance for the grain yield, days to heading, days to maturity, plant height, thousand seed weight highly significant difference among the genotypes and environment accounted for the highest percentage of variation.

Dharmendra and Singh 2015, studied on 20 wheat genotypes under various environments showed on pooled over environments high estimates of PCV and GCV for grain per spike, grain yield per plant, plant height followed by 1000-grain weight and little variability in days to 50 % heading and days to maturity.

2.2. Study on Heritability

Kashif and Khaliq 2004, Moderate to very high broad sense heritability was estimated for all the morphological characters except fertile tillers per plant. Plant height exhibited highest heritability value of 92.08% while fertile tillers per plant showed minimum value of 40.71%.

Shukla and Singh 2004, evaluated twenty-five genotypes of bread wheat for various traits associated with tolerance of high temperature and moisture stress under 2 dates of sowing, number of grains per spike, grain yield per plant, total biomass per plant, straw weight per plant, and spike weight per plant exhibited high heritability

Ali et al. 2008, were observed moderate heritability for number of productive tillers per plant and fertility %. High heritability estimates were recorded for plant height, number of spikelets per spike, spike length, number of grains per spike, 1000 grain weight and yield per plant.

Majumder et al. 2008, found high heritability coupled with high genetic advance were obtained with plant height, grains per spike, 100-grain weight, harvest index and grain yield.

Eid 2009, was found low, medium and high heritability was found in different yield traits under study. High heritability was observed for spike length and 1000 grain-weight and low heritability was for plant height and number of grains per spike. However, the heritability was generally found to be lower under drought stress conditions.

Ali and Shakor 2011, they found high heritability for plant height, number of spikes, 1000 grain weight, biological yield and grain yield in durum wheat.

Khan and Naqvi 2011, was studied on 13 advance wheat lines showed spike length exhibited highest heritability value of 0.89, 0.84 and 0.87 under irrigated, tillering and grain filling

stress whereas grain yield had highest heritability value of 0.76 under anthesis stress.

Shukla et al. 2011, reported that kernel weight and spike length had high heritability in very late sown condition.

Talebi and Fayyaz 2012, studied on 24 Iranian bread wheat cultivars under two constructing water regimes. Broad sense heritability estimates was very high under both control and water stress conditions, for plant height and number of seeds per spike, while broad sense heritability significantly decreased under water stress conditions for harvest index, 1000 grain weight and number of seeds per plant.

Baloch et al. 2013, were studied on eight wheat diverse genotype showed that heritability (broad sense) high for plant height, tillers plant^{-1}, spike length, spikeletes spike^{-1}, grains spike^{-1}, grain yield plant^{-1}, seed index and harvest index.

Nukasani et al. 2013, were studied on one hundred fourteen pre-breeding lines of wheat showed high heritability were recorded for traits plant height, tillers m^{-1}, grain yield m^{-1}, grain wt spike^{-1} and spike length.

Shukla and Moitra 2013, comprised 75 elite wheat diverse lines received from CIMMYT with six check varieties. They estimated high heritability for numbers of ears per plant and spike density.

Singh and Upadhyay 2013, studied on 27 diverse genotype of wheat showed that high heritability was observed for grain yield ha^{-1}, plant height at maturity, number of grain per spike and days to maturity.

Baloch et al. 2014, were observed high heritability for seed index, total biomass, grains per spike and plant height.

Kumar et al. 2014, heritability estimates revealed that characters like biological yield per plant exhibited highest heritability followed by test weight and flag leaf length.

Ram et al. 2014, evaluated 54 wheat cultivars was screened for terminal heat stress ten cultivars. They were found h^2 for CTD and CMS estimate was high.

Tesfaye et al. 2014, were studied on 14 wheat genotypes showed thousands seed weight had high heritability, while grain yield, days to heading and plant height had medium heritability and days to maturity had low heritability.

Dharmendra and Singh 2015, studied on 20 wheat genotypes showed high heritability for grain per spike, grain yield per plant, plant height, medium for 1000-grain weight and low for days to 50 % heading and days to maturity.

Kumar et al. 2015, were studied on 10 parents and their 45 F1's, estimates of h^2 were found highly significant for number of productive tillers per plant, flag leaf area, spike length, spikelets per spike, biological yield per plant, grain yield per plant, harvest index, ash content and gluten content.

2.3. Study on Genetic advance

Ali et al. 2008, were observed high genetic advance for number of productive tillers per plant, plant height, number of spikelets per spike, spike length, number of grains per spike, 1000 grain weight and yield per plant.

Eid 2009, high genetic advance was observed for spike length and 1000 grain-weight and low genetic advance was for plant height and number of grains per spike.

Kahrizi et al. 2010, high genetic advance were observed for YLD, NT, PL, LDW, STW, SPW, LAR and NAR**.**

Ali and Shakor 2011, they found high genetic advance for plant height, number of spikes, 1000 grain weight, biological yield and grain yield in durum wheat.

Nukasani et al. 2013, were studied on one hundred fourteen pre-breeding lines of wheat showed high genetic advance were

recorded for traits plant height, tillers m^{-1}, grain yield m^{-1}, grain wt $spike^{-1}$ and spike length.

Singh and Upadhyay 2013, studied on 27 diverse genotype of wheat showed that high genetic advance as per mean was observed for grain yield ha^{-1}, plant height at maturity, number of grain per spike and days to maturity.

Kumar et al. 2014, Genetic advance revealed was high for plant height, biological yield per plant 1000 seed weight and moderate estimates were exhibited by harvest index, test weight and low genetic advance was observed for flag leaf width, days to 50% flowering, spike length and flag leaf length.

Dharmendra and Singh 2015, studied on 20 wheat genotypes showed high genetic advance for grain per spike, grain yield per plant, plant height, medium for 1000-grain weight and low for days to 50 % heading and days to maturity.

2.4. Study on Correlation coefficient

Kashif and Khaliq 2004, was studied in wheat showed that genotypically plant height, spike length, spikelets per spike, grains per spike and 1000-grain weight were positively and significantly correlated with grain yield while highly significantly associated phenotypically whereas, fertile tillers per plant was negatively and non-significantly correlated with grain yield.

Ali et al. 2008, were observed grain yield per plant showed highly significant positive correlation with number of productive tillers per plant, number of spikelets per spike and number of grains per spike and significant positive correlation with spike length.

Majumder et al. 2008, found genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients in most of the traits. Spikes per plant, grains per spike, spike length, 100-grain weight and harvest index

were the most important characters which possessed positive association with grain yield.

Kahrizi et al. 2010, high correlations were found among the plant height, leaf dry weight, stem dry weight, spike dry weight, leaf area ratio and net assimilation ratio.

Khokhar et al. 2010, were correlation coefficients were determined in fifteen wheat genotypes. The result revealed that grain yield per plant was positively and highly significantly correlated with days to maturity but negatively and highly significantly associated with plant height.

Ali and Shakor 2011, they found grain yield was correlated genetically positive and significantly with 1000 grain weight, biological yield and harvest index in durum wheat, while showed genetically positive and significant correlation with all traits in bread wheat.

Deyong .2011, was studied on spring wheat, revealed that 1000 Grain Weight and Unit Weight correlated positively with yield, while No. of Valid Ear and non-pregnancy spike number of main ear (NSME) correlated less positively with yield. grain number of main ear, spike no. of main ear(SNME) ,flag leaf area, plant height, were negatively correlated with yield. SNME and NSNME were positively correlated with plant height, while No. of valid ear was negatively correlated with plant height, spike number of main ear was positively correlated with grain number of main ear, while it was negatively correlated with No. of valid ear. Length of main ear and flag leaf area were positively correlated.

Mohibullah et. al. 2011, studied on 100 wheat diverse genotype. They were found spike length showed positive significant correlation with number of spikelets per spike and grain yield per plant. While positive correlation was observed from spike length and 1000-grain weight. Number of spikelets per spike had highly significant correlation with grain yield per plant.

High significantly positive correlation was depicted from grain yield per plant and grain yield while, 1000-grain weight had positive highly significant correlation with grain yield.

Al-Tabbal and Al-Fraihat 2012, studied in wheat grain yield per plant showed highly significant positive genetic and phenotypic correlation with kernel weight, number of kernels per main spike and number of spikelet's per main spike. The total variability calculated through multiple correlation in the population for yield improvement accounted by fertile tiller number and kernel weight of main spike was 78.6% compared to 82.4% accounted by the all characters. It is concluded that more fertile tiller number and kernel weight of main spike are major yield contributing factors in selecting high yielding wheat cultivars.

Talebi and Fayyaz 2012, was found positive and significant correlation between harvest index and number of grains per spike with yield at both genotypic and phenotypic level in both environments among 24 Iranian bread wheat cultivars.

Abderrahmane et al. 2013, they were studied on fifteen hybrids and theirs six parents. Grain yield per plant was significantly and positively correlated with above ground biomass, straw yield, number of spikes per plant and number of grains per spike.

Baloch et al. 2013, studied on eight diverse wheat genotypes showed tillers plant^{-1}, spike length, spikelets spike^{-1}, number of grains spike^{-1}, seed index and harvest index were significantly and positively correlated with grain yield plant^{-1} .

Bilge et al. 2013, studied on 8 wheat genotype showed that canopy temperature depression was positively correlated with grain yield, spike yield, and grain numbers per spike.

Ghafoor et al. 2013, observed 20 wheat genotypes these showed that grain yield pant-1 was positive and highly significantly correlated with plant height, spike weight and grains

spike^{-1} while negative and highly significantly correlated with days to maturity.

Nukasani et al. 2013, studied in wheat correlation revealed that, three characters, tiller number m^{-1}, grain weight spike^{-1} and number of grains spike^{-1} in that order are the most important characters as these exhibited positive and strong association.

Sharma et al.2013, studied on six generation of wheat from backcross showed significant estimates of correlation of grain yield with days to heading, days to anthesis and days to maturity were recorded in late sown condition during first year. While under timely sown condition spike length has high estimate correlation with grain yield in first year itself. Significant estimated were recorded for tillers per plant in both the environments in second year.

Singh and Upadhyay 2013, studied on 27 diverse genotype of wheat showed that Grain yield ha^{-1} showed significant positive genotypic and phenotypic correlation with grain yield per plant (r_g=0.454, r_p= 0.442) and spike length (r_g=0.536).

Zafarnaderi et al. 2013, were found significant positive relationships between grain yield and harvest index as well as peduncle length in eight recombinant inbreed line of wheat.

Baloch et al. 2014, were observed in 20 advance bread wheat cultivars that grain yield per plant made positive and significant association with productive tillers per plant, spike length, spikelets per spike, grains per spike, seed index, total biomass and harvest index. Significant and negative correlation was revealed by plant height with productive tillers per plant, spike length, spikelets per spike and seed index.

Chhibber and Jain 2014, studied on currently cultivated three bread wheat genotypes in Haryana, namely, HD 2932, HD 2967 and HD 2851 showed that the grain yield depicts significant positive correlation with shoot height, tiller number, vegetative

dry matter content, and reproductive dry matter content and biological yield.

Khan et al. 2014, were studied on 25 genotype to evaluated the effect of heat tolerant traits on grain yield and their association were studied in late sowing environment. Biomass and grain filling rate were found positively correlated (0.652**) with each other and also with grain yield (0.919** and 0.800**). The significant positive correlation of ground coverage with grain yield (0.478*) suggests that higher ground coverage at early stage will lead to increase in yield.

Suleiman et al. 2014, were found simple correlation between the grain yield with leaf area index and days to maturity were positive but non – significant, positive and highly significant with number of tillers, number of grains per spike and 1000-grains weight. Negative but non-significant with plant height and days to 50% heading, association of grain yield with number of grains per spike, positive and highly significant with number of tillers and positive significant with 1000 - grain weight and negative but not significant with leaf area index, days to 50% heading and days to maturity.

Dharmendra and Singh 2015, studied on 20 wheat genotypes, estimates of correlation coefficient indicated that days to maturity, plant height, spike length, spikelets per spike, tillers per plant, grains per spike and 100-grain weight were positively correlated with grain yield.

2.5. Study on Path Analysis

Khokhar et. al. 2009, observed that the highest positive direct effect on yield were exhibited by days to maturity (1.05) followed by days to heading (0.6741).

Mollasadeghi et. al. 2011, were studied on path analysis results showed that the grain yield has a direct and positive effect

(0.527) over harvest index, while the straw yield has a direct and negative effect over it(-0.366). Effective traits to grain yield, four traits including number of grain per spike (0.212), grain weight (0.408), 1000 grain weight (0.093) and biological yield (0.853) had the most direct and positive effect on grain yield. Three traits including spike length, spike weight and biological yield had the most direct effect to straw yield (respectively with 0.029,-0.191 and 0.891).

Kashif et al. 2012, were found that Plant height, flag leaf area, spike length and grains per spike had positive direct effects on grain yield. While fertile tillers per plant, spikelets per spike and 1000-grain weight exhibited negative direct effects on grain yield. The traits having positive direct effects on grain yield are considered to be suitable selection criteria for evolving high yielding genotypes.

Hannachi et al. 2013, were found that above ground biomass and harvest index exerted positive direct effect on grain yield (1.365 and 0.235, respectively), whereas straw yield had a negative direct effect on grain yield (-0.713). The highest indirect effects on grain yield were observed with straw yield (1.220), spikes number per plant (1.128), plant height (0.647), and thousand-kernel weight (0.463) through above ground biomass and with harvest index via straw yield (0.453). However, plant height, spikes number per plant, number of grains per spike and thousand-kernel weight exerted insignificant effects on grain yield.

Khan et. al. 2013, were studied on path coefficient revealed that maturity days, number of spikes/m^2 and 1000-grain weight had significant positive direct effects on grain yield. Number of grains/spike had also direct positive effect, but in low magnitude. The indirect effect of heading days and plant height on grain yield was found mainly through maturity days and 1000-grain weight. It can be concluded that emphasis should be given on heading days

and plant height along with 1000-grain weight, number of spikes/m^2 and number of grains/spike for selection of durum wheat genotypes.

Nukasani et al. 2013, were found tiller number m^{-1} > grain weight $spike^{-1}$ > number of grains $spike^{-1}$ in that order are the most important characters as these exhibited maximum positive direct effects on grain yield.

Singh and Upadhyay 2013, observed that grain yield ha^{-1} (0.938, 0.502) had highest positive direct effect on grain yield per plant followed by 1000 grain weight (0.490, 0.336). It is suggested that these characters can be considered as selection criteria in improving the grain yield.

Ata et. Al. 2014, were found that path analysis revealed in both environments that number of grains per spike and spike length could be used for direct selection for the yield. Plant height, 1000-grian weight and relative water contents also contributed for the grain yield in positive way. Canopy temperature could also be used as differentiating trait for the selection of best surviving genotype under drought conditions. Path analysis under normal condition exhibited that Plant height have negative direct effect on yield, but this negativity was countered by its positive indirect through spike length, relative water contents and lea area.

2.6. Study on Stability Analysis

Acura et al. 2005, were studied coefficient of determination for genotype 10 was as high as 0.98, confirming its stability. In contrast, wheat genotypes 2, 7, 8, 11, 12 and 13 showed regression coefficients greater than 1.0, indicating sensitivity to environmental changes for grain yield. Among the genotypes, the highest grain yield was obtained from genotypes 12 and13 (3.49 t ha^{-1} and 3.38 t ha^{-1}) across environments. These genotypes (12 and 13) had deviations from regression values around zero,

suggesting that they were responsive to changing environments and could be recommended for favorable environments.

Kabir et al. 2009, studied on eight different date of sowing for popular wheat varieties. Stability analyses of variance showed highly significant ($P<0.01$) differences for environments, genotypes and environment (linear). Variety Sourav and Shatabdi have regression coefficient values close to unity (0.9 and 0.93, respectively) with small deviation from regression and above average yield and thus possessed fair stability and wider adaptation over different environment. Variety Prodip and line BAW 1064 had regression coefficients greater than unity for grain yields with at per or above mean grain yield. Therefore, these genotypes are sensitive to environmental changes and can be recommended for cultivation under favorable conditions. According to the stability analysis, variety Sourav was the most stable for grain yield. The regression coefficient for Sourav was almost unity and had one of the lowest deviations from regressions.

Feiziasl et al. 2010, were studied on adaptation of commonly grown winter wheat varieties showed that ‘Sardari’ is more suitable for regions with cold winters and cool springs along with spring precipitation; ‘Sabalan’ variety is adapted to cold winters and relatively temperate spring with abundant spring precipitation; and ‘Azar-2’ cultivar is suitable for cold falls and temperate springs along with fall-spring precipitation and minimum winter precipitation.

Soleman Mohamed Al-Otayk 2010, studied on the heat tolerance of twelve wheat genotypes under four environmental conditions two sowing dates and two years. The genotypes YR-19 and YR-20 produced the highest grain yield in both seasons, while, local cultivar ’Sama’ produced the lowest grain yield. On the other hand, YR-2 and YR-3 showed below-average stability.

Arain et al. 2011, were observed genotype MSH-14 produced the highest mean yield (5090 kg/ha) in all environments averaged for two years, and had regression coefficient (b) close to unity (0.86) and S^2d close to zero (0.7923). This indicated wide adaptation and stability of performance of MSH-14 in all environments. Other high yielding genotypes MSH-03 and MSH-05 ranked 2^{nd} and 3^{rd} showing regression coefficient (b=0.78 and 0.69 respectively) and deviation from regression (S2d= 1.076 and 1.29 respectively) indicating specific adaptability of these genotypes to harsh (unfavorable) environments.

Almeselmani and Deshmukh 2012, evaluated seeds of eight irrigated wheat genotypes recommended for irrigated conditions and twelve rainfed genotypes recommended for rainfed conditions were sown in three situations i.e. normal, late and very late sowing. Significant reductions in all the parameters at all growth stages were recorded in all genotypes. Yield and yield components were also adversely affected under late and very late planting. Genotypes recommended for irrigated conditions showed more reductions in chlorophyll content, relative water content, yield and yield components than the genotypes recommended for rainfed conditions

Birla et al. 2012, evaluate the various recommended wheat genotypes for the zones using stability analysis for their suitability for yield performance under late and very late conditions of wheat sowing. Stability analysis indicated that the genotype GW 366, GW 322, GW 273, LOK 1, JW 3269 and JW 3211 were found promising for normal date of sowing whereas genotypes LOK1, HD 2864, HD 2932, JW 3269 and LOK 1, HD 2864, MP 4010, HD 2932 and JW 3269 were emerging genotype for late and very late sown condition.

Mondal et al. 2013, reported that high temperatures are a primary concern for wheat production in South Asia. A trial was

conducted to evaluate the grain yield performance of high yielding, early maturing heat tolerant CIMMYT wheat lines, developed recently in Mexico for adaptation to high temperature stresses in South Asia. The early maturing CIMMYT check ‘Baj’ performed well across all locations. In the Mexico location, CT was associated with GY, thereby suggesting that cooler canopies may contribute to higher GY under normal as well as high temperature stress condition. Our results suggest that the early maturing, high yielding, and high heat tolerant wheat lines developed in Mexico can adopt to diverse heat stressed areas of South Asia.

Khan et al. 2014, were studied on heat stress in wheat under timely sown and late sown situation. They found low grain yield under late sowing condition. G-12, G-13, G-14, G-18, and G-19 were identified as heat tolerant genotypes based on their relative performance in yield components, grain yield and heat susceptibility indices. Present genotypes are found to be ideal candidates to be used in developing heat tolerant wheat varieties.

Patel et al. 2014, were studied in bread wheat eight advance lines and four check varieties *viz.,* GW 322, GW 366, GW 496 and LOK-1 were evaluated at three locations to estimate stability parameters for seed yield. Both linear and non-linear (pooled deviation) components of G x E variance were significant; however, linear component was of greater magnitude.

Ram et al. 2014, evaluated 54 wheat cultivars was screened for terminal heat stress ten cultivars classified as highly tolerant, tolerant, moderately tolerant and susceptible to heat stress. They were matted in diallele fashion generated 45 f1 hybrid. They were evaluated in both normal and heat stress condition parents HUW-234 followed by PBW-175, HD-2888 and DBW-14 in both normal and stress environment with high performance for canopy temperature depression and cell membrane thermo stability.

MATERIAL AND METHODS

The present investigation entitled **"Genetic Analysis in Bread Wheat under different Environments"** was carried out during the *rabi* season of 2014-15. The techniques followed and materials used during the course of investigation are presented under following subheads.

3.1 Experimental site

The experiment was carried out under Wheat Improvement Project Department of Plant Breeding and Genetics at Seed Breeding Farm, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur (M.P.) under rainfed sown, restricted irrigated and timely sown conditions. The experimental area occupied was quite uniform in respect of topography and fertility.

3.2 Climate and weather

Jabalpur is situated at 23.90° N latitude and 79.58° E longitudes at an attitude of 411.87 M above the mean sea level. This region has subtropical, semi-arid climate. The main features are hot and dry summer and cold winter with occasional showers. The average rainfall is about 1300-1400 mm, which is received mostly during July to September. Temperature varies from 4.9°C being minimum in December to 39.2°C being maximum in April. The 77.2 mm precipitations received at grain filling stage in the last week of February and first fortnight of March help wheat crops and save one irrigation. The crop was grown under normal crop season. The meteorological data of crop season is presented in Table 3.1.

Table 3.1: Weekly meteorological data during the cropping season (2014-2015)

Month/date	Weeks	Temperature (^{o}C)		Rainfall (mm)	Relative Humidity (%)		Rainy days
		Min	Max.		Min	Max.	
Oct 01-Oct 07	40	33.40	21.05	0.83	84.83	46.83	1
Oct 08-Oct 14	41	32.14	20.31	1.60	87.29	57.71	1
Oct 15-Oct 21	42	30.26	19.47	3.63	91.00	48.43	1
Oct 22-Oct 28	43	29.89	16.91	0.00	77.29	37.14	0
Oct29-Nov04	44	30.70	14.60	0.00	87.86	30.00	0
Nov05-Nov11	45	30.96	13.14	0.00	87.00	27.29	0
Nov12-Nov18	46	30.64	15.93	0.00	81.43	29.00	0
19 to 25 Nov.	47	28.51	8.64	0.00	82.71	19.43	0
26 to 2 Dec.	48	29.34	10.03	0.00	85.00	24.43	0
3 to 9 Dec.	49	27.24	8.39	0.00	88.14	23.14	0
10 to 16 Dec.	50	25.64	11.99	0.69	87.00	49.14	1
17 to 23 Dec.	51	21.69	5.61	0.00	87.71	37.29	0
24 to 30 Dec.	52	23.61	4.59	0.00	88.29	24.86	0
31 to 6 Jan.	1	20.71	11.11	5.39	88.29	67.71	3
7 to 13 Jan.	2	22.87	6.46	0.00	87.43	33.14	0
14 to 20 Jan.	3	21.19	4.63	0.00	90.86	41.00	0
21 to 27 Jan.	4	22.20	10.09	1.46	89.43	58.71	2
28 to 3 Feb.	5	20.11	9.23	1.54	88.43	56.86	2
4 to 10 Feb.	6	26.11	10.54	2.06	85.86	48.43	1
11 to 17 Feb.	7	25.07	10.01	0.89	88.14	46.29	1
18 to 24 Feb.	8	29.84	11.73	0.00	86.29	33.29	0
25 to 3March	9	27.90	14.31	5.89	84.57	50.71	1
4 to 10 March	10	26.83	11.79	3.37	85.57	38.29	1
11 to 17March	11	26.79	14.74	3.37	86.14	57.43	3
18 to 24March	12	30.19	13.67	0.00	82.43	32.14	0
25 to 31March	13	35.61	17.01	0.37	79.57	24.71	0
1 to 7 April	14	31.1	18.7	0	79	16	0
8 to 14 April	15	33.1	18.5	1.6	71.3	36.3	3
15 to 21 April	16	39.2	21.3	0.9	54.3	15.4	1
22 to 28 April	17	38.9	21.7	0.0	43.1	17.6	0

3.3 Experimental material

Source: Experimental material consists of 100 genotypes comprising 89 test entries and 11 checks obtained from Wheat Improvement Project, Department of Plant Breeding and Genetics, JNKVV, Jabalpur during *Rabi*, 2014-15. The experiment was conducted in three replications under randomized complete block design. The experiment was conducted in three replications under Randomized Complete Block design. Each plot consists of six rows of 2.5 m length and 22.5 cm apart in three environments. (Table 3.2)

Table 3.2: Genotypes of wheat used as experimental material

G.No.	Pedigree	G.No.	Pedigree
G-1	DBW 16 (C)	G-26	35IBWSN 159/DBW 17
G-2	DBW 17 (C)	G-27	35IBWSN 159/DBW 17
G-3	HD 2967 (C)	G-28	35IBWSN 159/DBW 17
G-4	CBW 38 (C)	G-29	35IBWSN 159/DBW 17
G-5	DBW 14 (C)	G-30	35IBWSN 249/DBW 17
G-6	K307 (C)	G-31	35IBWSN 249/DBW 17
G-7	GW322 (C)	G-32	35IBWSN 249/DBW 17
G-8	NIAW 34 (C)	G-33	35IBWSN 249/DBW 17
G-9	NIAW 917 (C)	G-34	BABAX/*2PRL//PBW502
G-10	DBW 71 (C)	G-35	BABAX/*2PRL//DBW 16
G-11	HD 3086 (C)	G-36	BABAX/*2PRL//DBW 16
G-12	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-37	BOW/BUC//WEAVER/3/STAR/4/PBW 502
G-13	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-38	STY45/CELTA//PALS/3/SW2005
G-14	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-39	SW2005/DBW 17
G-15	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-40	SW2005/DBW 17
G-16	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-41	SW2005/DBW 17
G-17	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-42	MS1900/WKLDN151
G-18	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-43	5EGPSN83/DBW 17
G-19	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-44	5EGPSN83/DBW 17
G-20	CHEN/Ae.sq(Taus)//BCN/3/KAUZ/4/DBW17	G-45	DBW 17/PBW 343
G-21	35IBWSN159/3/ALTAR84/Ae.sq(229)//SERI	G-46	DBW 17/PBW 343
G-22	35IBWSN159/3/ALTAR84/Ae.sq(229)//SERI	G-47	DBW 17/PBW 343
G-23	35IBWSN159/3/ALTAR84/Ae.sq(229)//SERI	G-48	DBW 17/PBW 343
G-24	35IBWSN 159/DBW 17	G-49	DBW 17/PBW 343
G-25	35IBWSN 159/DBW 17	G-50	BCN//Croc_1/Ae.sq (662)/3/WH542

Cont….

G.No.	Pedigree	G.No.	Pedigree
G-51	BCN//Croc_1/Ae.sq (662)/ 3/WH542	G-76	Croc_1/Ae.sq (224)//OPATA/3/UP2425
G-52	ALTAR 84/Ae.sq (229)//SERI/ 3/DBW17	G-77	ALTAR84/Ae.sq(219)//SERI/3/BCN//Croc_1/Ae.sq(662)
G-53	CHEN/Ae.sq(Taus)//FCT/3/3.../4/UP2425	G-78	ALTAR 84/Ae.sq (219)//SERI/4/ALTAR84/Ae.sq(229)//2*LOXIA /3/KAUZ
G-54	CHEN/Ae.sq(Taus)//FCT/3/3.../4/DBW17	G-79	ALTAR 84/Ae.sq (229)//2*LOXIA /3/KAUZ/4/DBW17
G-55	CHEN/Ae.sq(Taus)//FCT/3/3.../4/DBW17	G-80	CHEN/Ae.sq (Taus)//FCT/3/PBW343
G-56	15KBSN96/DBW16	G-81	ALTAR 84/Ae.sq (219)//FCT /3/5EGPSN83
G-57	TURACO/CHIL//CHIL/BUC/ 3/DBW 16	G-82	ALTAR 84/Ae.sq (219)//FCT /3/5EGPSN83
G-58	TURACO/CHIL//CHIL/BUC/ 3/DBW 16	G-83	HD2189/DBW16
G-59	WKLDN151/3 EGPSN 82	G-84	HD2189/DBW16
G-60	WKLDN151/3 EGPSN 82	G-85	CMH83.2517/4EGPSN6
G-61	WKLDN151/3 EGPSN 82	G-86	20SAWSN48/4/CHOIT/STAR/ /WEAVER/3/STAR
G-62	15KBSN98/UP2425	G-87	BABAX/*2PRL//R9946/R9883
G-63	15KBSN98/UP2425	G-88	BABAX/*2PRL//R9946/R9883
G-64	15KBSN98/UP2425	G-89	BABAX/*2PRL//R9946/R9883
G-65	MS1770/MS1900	G-90	BABAX/*2PRL//R9946/R9883
G-66	MS1770/MS1900	G-91	20SAWSN23/10SAWYT27
G-67	MS1770/MS1900	G-92	20SAWSN23/10SAWYT27
G-68	MS1770/MS1900	G-93	SGH7/PBW502
G-69	4EGPSN109/4EGPSN83	G-94	SGH7/PBW502
G-70	AGA/2*CMH79A.582//RAJ3777/3/PBW502	G-95	SGH7/PBW502
G-71	AGA/2*CMH79A.582//RAJ3777/3/PBW502	G-96	R9819/R9883//18SAWSN131
G-72	MINYANG30//R9819/R9893	G-97	BCN//Croc_1/Ae.sq (662)/3/DBW17
G-73	CHEN/Ae.sq (Taus)/ /FCT/3/DBW 17	G-98	PR846/R9883//PBW502
G-74	Croc_1/Ae.sq (224)//OPATA /3/DBW17	G-99	K9107/UP2425
G-75	Croc_1/Ae.sq (224)//OPATA /3/DBW17	G-100	K9107/UP2425

3.4. Observations recorded

The observations were recorded on five randomly selected plants from each plot and from each replication for the following characters and per plant data was obtained by averaging the values.

3.4.1 Morphological traits and yield components:

Plant height (cm): Plant height of sampled plants was measured in centimeters from ground level to tip of the tallest spike (excluding awns) at the time of maturity

Number of effective tillers per plant: It was recorded by counting the number of productive tillers of the plant excluding non-productive tillers.

Number of ears per plant: Number of ears were counted in each plant of the sampled plants and averaged to find average number of ears per plant.

Number of spikelets/spike: Number of spikelets were counted in each spike of the sampled plants and averaged to find average number of spikelets per spike.

Ear length (cm): The length of the spike was recorded in cm from base to tip of spike excluding awns.

Spike density: it is estimated by following formulas:

$$\text{Spike density} = \frac{\text{No. of spikelets per ear}}{\text{Ear length(cm)}} \text{ X } 100$$

No. of grains per ear: Total number of grains in the main spike of sampled plants was counted after harvesting.

1000-grain weight (g): The weight of 1000 randomly selected grains from the seed mixture of plants of each replication was recorded.

Grain yield/plant (g): The grains obtained from each plant were weighed in grams and average over 10 plants per replication.

Biological yield/plant (g): Each of the selected plants was harvested at maturity and weight recorded in grams after complete sun drying excluding roots.

Harvest index %: The harvest index was calculated by using the following formula and expressed in percentage.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield per plant(g)}}{\text{Biological yield per plant (g)}} \text{ X } 100$$

3.4.2 Phenological development

Days to full stem elongation: The number of days required from sowing to emergence of flag leaf that's indicates end of vegetative phase of wheat plant.

Days to 50% flowering (days): The number of days required from sowing to ear head emergence for 50% flowering was recorded.

Days to stay green: The number of days required from sowing to senescence of flag leaf.

Days to maturity (days): The number of days required to achieve physiological maturity was recorded.

3.4.3 Physiological traits

Relative water content of flag leaf: RWC was measured from flag leaves at anthesis. Immediately after cutting at the base of lamina, leaves were sealed within plastic bags and transferred to the laboratory. Fresh weight (FW) was measured after excision and the full turgid weight (TW) after the dehydration of the leaves by placing them in a test tube containing 100 ml distilled water for 24 hrs at room temperature (about 21^0C). After soaking, leaves were carefully blotted dried with tissue paper. Dry weight (DW) was measured after oven drying at 70^0C for 72 hrs. The RWC was calculated from the equation given by Schonfeld et al. (1988) as:

$$RWC\ (\%) = \frac{(FW\text{-}DW)}{(TW\text{-}DW)} \times 100$$

Where

FW = Fresh weight of the flag leaf

TW = Turgid weight of the flag leaf

DW = Dry weight of the flag leaf

RWC = Relative Water Content of flag leaf

Chlorophyll content: Chlorophyll content of leaf was measured by chlorophyll content meter (CCM200) at tillering stage and after 50% flowering. The chlorophyll content of leaf obtains from average.

Leaf canopy temperature (^{o}C): Leaf canopy temperature was measured using Infrared thermometer at the grain filling stage in the day time of minimum humidity, high temperature, full sunshine and least wind velocity *i.e.* at 2 to 4 PM.

Membrane thermo stability (%): It was determined by the method of Almeselmani et. al., (2006) and letter by Yildirim et al. (2009). Membrane thermo stability was determined by recording the electrical conductivity of leaf leakages in double distilled water at 40^{o}C and 100^{o}C. Leaf samples (0.1 g) were cut into discs of uniform size and taken in test tubes containing 10 ml of double distilled water in two sets. One set was keep at 40^{o}C for 30 minutes and another set at 100^{o}C in boiling water bath for 15 minutes and their respective electric conductivities C_1 and C_2 were measured by Conductivity meter (Century Instruments, Chandigarh, India).

$$\text{Membrane thermo-stability (\%)} = \left\{1 - \left[\frac{C_1}{C_2}\right] \times 100\right\}$$

Where,

C_1 = Electrical conductivity of controls

C_1 = Electrical conductivity of treatment

3.5. Statistical analysis for field characters

Table 3.3: The skeleton of analysis of variance table is given below:

S.no.	S.V.	d.f.	S.S.	M.S.S	$F_{(cal)}$
1	replication	(r-1)= 2	SSr	RSS	RSS/ ESS
2	treatment	(t-1)=99	SSt	TSS	TSS/ ESS
3	error	(r-1)×(t-1) =198	SSe	ESS	
	Total	(rt-1)=299			

Where,

r = no. of replications

t = no. of genotypes

RSS = Replication sum of square

EMS = Error mean sum of square

TSS = Treatment sum of square

A significant value of F-test indicates that the test entries differ significantly among themselves, which requires computing the critical difference (CD).

$$\text{Coefficient of variation (CV\%)} = \frac{\sqrt{EMS}}{GM} \text{ X } 100$$

$$\text{Standard error of difference } (SE_d) = \frac{\sqrt{EMS}}{r}$$

$$\text{Critical Difference (CD} = t_{(0.01)} \text{ X } SE_d$$

Where,

G.M. = General mean

$t_{(0.01)}$ = t-value at 1% probability level

r = number of replication

3.3 Parameters of Genetic variability

3.5.i Mean - The mean was calculated by conventional method as

$$\text{Mean } (\bar{X}) = \frac{\sum \bar{X}}{N}$$

Where,

$\sum xi$ = sum of i^{th} character

N = total no. of observations

ii. Range - the range for each character was determined by taking the lowest and highest value of each character.

iii. Coefficient of variation (CV)

Genotypic and phenotypic coefficient of variation was computed, using formula given by Burton (1952).

$$\text{Genotypic coefficient of variation (GCV\%)} = \frac{\sqrt{\sigma_g^2}}{\bar{X}} \text{ X } 100$$

$$\text{Phenotypic coefficient of variation (PCV\%)} = \frac{\sqrt{\sigma_p^2}}{\bar{X}} \text{ X } 100$$

Where,

$\sqrt{\sigma_g^2}$ = Genotypic standard deviation

$\sqrt{\sigma_p^2}$ = Phenotypic standard deviation

$\bar{X}$ = General mean of particular character

iv. Heritability (h^2 bs)

Heritability in broad sense was calculated by the method proposed byAllard (1960) and Hanson *et al.* (1957).

$$\text{Heritability } (h^2 bs\%) = \frac{\sigma^2 g}{\sigma^2 p} \text{ X } 100$$

Where,

h^2 (bs%) = Heritability in broad sense

$\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

v. Genetic advance

The estimation of genotypic and phenotypic variances and heritability were used to determine the expected genetic advance as suggested by Johnson *et al.* (1955) and expressed as-

$$GA = K \times \sigma_p \times h^2$$

Where,

K = Selection intensity (2.06 at 5% level)

σ_p = Phenotypic standard deviation

h^2 = Heritability (bs) in fraction

vi. Genetic advance as percentage of mean

This was expressed by following formula

$$\text{GA as a \% of mean} = \frac{GA}{\bar{X}} \times 100$$

Where,

$\bar{X}$ = General mean of particular character

GA = Genetic advance

3.4 Association analysis

3.6.i Correlation coefficient

All correlation coefficients were calculated at genotypic and phenotypic levels using the formula suggested by Miller et al., (1958).

$$rX_iX_j = \frac{CovX_iX_j}{\sqrt{(VarX_i)(VarX_j)}} \times 100$$

Where,

$r\ x_i x_j$ = Coefficient of correlation between characters X_i and X_j

$Cov\ (X_i X_j)$ = Covariance between characters X_i and X_j

$Var\ (X_i)$ = Variance of character X_i

$Var\ (X_j)$ = Variance of character X_j

Genotypic and phenotypic correlation coefficients were compared by substituting the corresponding variance and covariance for all the observed characteristics.

$$\text{Genotypic cor.} X_i X_j = \frac{\text{Genotypiccov } X_i X_j}{\sqrt{\sigma_g^2(X_i)\sigma_g^2(X_j)}} \text{ X 100}$$

$$\text{Phenotypic cor. } X_i X_j = \frac{\text{Phenotypiccov } X_i X_j}{\sqrt{\sigma_p^2(X_i)\sigma_p^2(X_j)}} \text{ X 100}$$

Where,

$\sigma^2 g\ (X_i)$ = Genotypic variance of character X_i

$\sigma^2 g\ (X_j)$ = Genotypic variance of character X_j

$\sigma^2 p\ (X_i)$ = Phenotypic variance of character X_i

$\sigma^2 p\ (X_j)$ = Phenotypic variance of character X_j

Testing of correlation coefficient for significance: To test the significance of correlation coefficient, t-value was computed and compared with the tabulated value of ‘t’ at (n-2) degree of freedom at 5% and 1% level of probability.

$$t_c = \frac{r}{\sqrt{1 - r^2}} \text{ x } \sqrt{n - 2}$$

Where,

t_c = Calculated value of t

r = Estimated value of correlation coefficient

n = Number of paired observations

3.6.ii Path coefficient analysis:

It is a simple standardized partial coefficient method to detect the direct and indirect effects of the independent variable on dependent variable. It permits separation of correlation into components of direct and indirect effects. The method of path coefficient was developed by Wright (1921) and modified by Dewey and Lu, (1959). The following set of simultaneous equations were formed and used for estimation of direct and indirect effects on seed vigour.

R1y = p1y+r12p2y+r13p3y+……+r1yp1y

R2y = r2yp1y+p2y+r23p3y+……+r21p1y

rky = rki+rkip2y+r13p3y+……..+r2iypiy

rxky = rxkipiy+rzk2p2y+rxk3p3y+…….+pky

where,

Rxky = Coefficient of correlation between the independent character

Piy to pky = Direct effects of character 1 to k on dependent character Y

Direct effect: The direct effects were calculated as follows-

$$P_{ky} = \sum_{i=1}^{k} C_{ki}\, r_{ky}$$

Indirect effect: Indirect effect of any independent traits on the dependent one *via.* others independent traits was computed by multiplying the direct effect (P_{ky}) of that independent variable with the corresponding correlation coefficient as follows:

K^{th} trait via (n-1) = rk (n-1) P(n-1) Y

Residual effect: Residual effect was obtained as per formula given below:

$$R = \sqrt{1 - E_{di} r_{ji}}$$

Where,

d_i = Direct effect of character

r_{ij}= Correlation coefficient of i^{th} character with j^{th} character

table: scale for path coefficient (Lenka and Mishra, 1973)

Value of direct or indirect effect	**Rate or Scale**
0.00 to 0.09	Negligible
0.10 to 0.19	Low
0.20 to 0.29	Moderate
0.30 to 0.99	High
More than 1.00	Very high

3.7 ESTIMATION OF STABILITY PARAMETERS

Prior to the pooled analysis variance, the error variances for each environment (years) are subjected to test the homogeneity of variance as per the Bartlett's test of homogeneity.

Stability analysis was carried out as per the Eberhart and Russell (1996) model. The model stated as –

$$Y_{ij} = m + B_i I_j + \delta^2_{ij} \qquad (i=1,2,3,\ldots\ldots\ldots t)$$

$$(j=1,2,\ldots\ldots\ldots\ldots s)$$

Where,

Y_{ij} = mean of the ith variety in jth environment.

M = Mean of all the varieties over all the environments.

B_i = the regression coefficient of the i^{th} variety on the Environmental index, which measure the response of this variety to varying environments.

I_j = the environment index which is defined as the deviation of the mean of all the varieties at a given location from the overall mean

δ^2_{ij} = the deviation from regression of the i^{th} variety at j^{th} environment.

Eberhert and Russell (1996) proposed the following three stability parameters.

1. Mean performance: This parameter is used for recognizing the performance of genotypes over year/locations etc.
2. Regression coefficient: It is measured as the regression of the performance of each variety under different environments or locations on the environmental or location means. A stable genotype was considered it expressed as they should not be significantly different from variety.
3. Deviation from regression coefficient: Deviation from regression should be not significantly different from Zero ($S^2_d = 0$).

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RESULTS

The experimental findings of the present study have been reported here in under the following heads:

4.1 Analysis of variance and performance of genotypes.

4.2 Estimates of parameters of genetic variability

4.3 Heritability and Genetic advance

4.4 Correlation and Path analysis

4.5 Stability analysis

4.1 Analysis of variance and performance of genotypes.

The results from the analysis of variance of all characters under the study have been given in table 4.1. It was observed that estimated variance due to varieties for all phenological, physiological, morphological and yield contributing traits were highly significant which indicate the existence of considerable variability for all concerned characters over 3 environments i.e., irrigated timely sown (E_1), restricted irrigated sown (E_2) and rainfed sown (E_3).

The results obtained from the analysis of variance of all characters under pooled data have been given in table 4.2. It was observed that estimated variance due to varieties for all phenological, physiological and yield contributing traits were highly significant

First environment (E_1)

The mean sum of square based on analysis of variance of 100 genotypes of wheat for 19 characters as observed in first environment have been presented in table 4.1 The coefficient of variation (CV) ranged from 7.93 percent (number of ears per plant) to 0.28 percent (1000-grain weight) for various characters (table 4.4).

Table 4.1: Analysis of variance for phenological, physiological and yield contributing traits of different genotypes of wheat under three environments.

S.V.	d.f.	Env.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}
Rpl.	2	E1	145.2**	939.5**	828.99**	453.7**	1.47	578.7**	0.45	2.38	1257.5**	0.60	3.51**	0.11	0.05	0.006	0.10	21.15**	30.90**	500.5**	1012.9**
		E2	23.43**	606.7**	2.73	62.23**	71.85**	71.85**	0.02	1.53	1701.1**	0.33	4.89**	103.3**	0.05	0.003	108.3**	410.5**	26.15**	398.24**	84.90**
		E3	38.6**	139.8**	78.64**	478.5**	67.70**	67.70**	0.23	0.39	1853.8**	0.80**	48.43**	19.68**	0.04	0.02	0.10	0.20	208.09**	400.8**	85.10**
Gen.	99	E1	79.9**	94.63**	51.50**	53.55**	4.50**	98.11**	2.36**	373.6**	138.15**	3.42**	3.32**	16.27**	4.51**	0.25*	400.7**	154.5**	28.07**	38.70**	105.8**
		E2	75.5**	76.94**	47.35**	17.95**	88.05**	88.05**	1.35**	373.6**	140.8**	2.71**	2.91**	14.70**	4.53**	0.19*	402.6**	186.01**	5.15**	28.81**	127.6**
		E3	78.87**	95.56**	61.57**	50.45**	99.50**	112.7**	1.74**	377.0**	133.19**	2.24**	3.08**	10.73**	3.09**	0.18**	402.69**	173.35**	10.86**	27.53**	96.98**
Error	198	E1	6.668	1.567	5.37	4.39	0.554	3.267	0.334	1.68	1.060	0.064	0.112	0.073	0.175	0.010	0.131	0.014	0.469	0.490	6.85
		E2	5.85	1.94	8.19	5.94	2.66	2.65	0.210	1.39	1.229	0.042	0.095	0.211	0.175	0.003	0.143	0.168	2.13	1.636	61.77
		E3	6.53	2.17	6.23	4.66	2.94	2.94	0.48	0.41	1.29	0.04	0.14	0.24	0.052	0.018	0.03	0.064	3.59	0.623	63.97
SE (d)		E1	2.11	1.022	1.89	1.71	1.09	1.48	0.472	1.059	0.840	0.064	0.112	0.221	0.341	0.082	0.295	0.098	0.56	0.571	2.14
		E2	1.97	1.138	2.34	1.99	1.33	1.33	0.374	0.96	0.905	0.168	0.252	0.375	0.341	0.042	0.309	0.335	1.19	1.045	6.417
		E3	2.09	1.20	2.04	1.76	1.39	1.39	0.57	0.52	0.93	0.17	0.30	0.39	0.19	0.11	0.142	0.21	1.55	0.645	6.53
CD at 5%		E1	4.16	2.015	3.73	3.37	1.092	2.91	0.931	2.089	1.658	0.406	0.539	0.435	0.673	0.161	0.583	0.193	1.103	1.127	4.22
		E2	3.89	2.244	4.61	3.92	2.63	2.63	0.738	1.899	1.785	0.331	0.497	0.740	0.672	0.084	0.609	0.660	2.35	2.06	12.66
		E3		2.37	4.02	3.48	2.76	2.76	1.12	1.02	1.83	0.33	0.59	0.78	0.37	0.21	0.28	0.41	3.05	1.27	12.88

X_1 Days to full stem elongation
X_2 Days to 50% flowering
X_3 Days to stay green
X_4 Days to maturity
X_5 RWC of flag leaf
X_6 Chlorophyll content
X_7 Canopy temperature (^{0}C)
X_8 Membrane thermo-stability (%)
X_9 Plant height (cm)
X_{10} No. of effective tillers plant^{-1}
X_{11} No. of ears plant^{-1}
X_{12} No. of spikelets ear^{-1}
X_{13} Length of ear (cm)
X_{14} Spike density
X_{15} No. of grains ear^{-1}
X_{16} 1000-grain weight (g)
X_{17} Yield plant^{-1} (g)
X_{18} Biological yield plant^{-1} (g)
X_{19} Harvest index (%)
** Significant at 1% level
* Significant at 5% level

Table 4.2: Analysis of variance for phenological, physiological and yield contributing traits of different genotypes of wheat for pooled data.

S.V.	d.f.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}
Rlp.	2	30.52**	251.6**	82.6**	42.15**	268.9**	28.48**	0.031	3.74	216.17**	1.55	39.94*	73.95**	0.05	0.018	38.18**	199.9**	91.33*	120.5**	28.53**
Env.	2	0.18	7.46*	3.29	0.33	1.94	0.92	0.31	2.99	0.913	0 .14**	0.082	0.13	0.05	0.02	0.105	0.64	5.88**	0.32	40.45**
Int.	4	0.55	1.69	9.65	4.331	2.94	1.77	0.56	0.052	0.472	0 .012	0.148	0.07	0.03	0.008	0.055	0.031	1.61*	0.29	25.18**
Pooled	8	259.2**	631.7*	213.1**	107.6**	674.3**	713.1**	0.37	1.71*	540.89**	0 .43	10.08	18.55**	0.04	0.012	9.59**	50.17**	25.11**	30.36**	236.1**
Gen.	99	212.5**	209.2**	190.5**	93.66**	406.5**	197.7**	10.56**	108.7**	151.41**	4.84**	4.56	30.35**	8.61	0.28	485.14**	228.4**	23.31**	95.86**	141.6**
Error	792	23.38	21.79	18.35	13.45	29.65	29.22	0.54	67.45	41.92	0 .71	0.81	3.15	0.94	0.046	97.25	39.65	6.63	10.82	78.92
SE (d)		2.27	2.21	2.02	1.72	2.56	2.54	0.34	3.87	3.05	0.39	0.42	0.83	0.45	0.101	4.65	2.97	1.25	1.55	4.19
CD at 5%		1.61	1.55	1.42	1.22	1.81	1.80	0.24	2.73	5.99	0.78	0.83	1.64	0.89	0.19	9.12	5.82	0.85	3.04	8.22

X_1 Days to full stem elongation
X_2 Days to 50% flowering
X_3 Days to stay green
X_4 Days to maturity
X_5 RWC of flag leaf
X_6 Chlorophyll content
X_7 Canopy temperature (^oC)
X_8 Membrane thermo-stability (%)
X_9 Plant height (cm)
X_{10} No. of effective tillers plant^{-1}
X_{11} No. of ears plant^{-1}
X_{12} No. of spikelets ear^{-1}
X_{13} Length of ear (cm)
X_{14} Spike density
X_{15} No. of grains ear^{-1}
X_{16} 1000-grain weight (g)
X_{17} Yield plant^{-1} (g)
X_{18} Biological yield plant^{-1} (g)
X_{19} Harvest index (%)
** Significant at 1% level
* Significant at 5% level

Second environment (E_2)

The mean sum of square based on analysis of variance of 100 genotypes of wheat for 19 characters as observed in second environment have been presented in table 4.1. The coefficient of variation (CV) ranged from 18.92 percent (yield per plant) to 0.79 percent (number of grains per ear) for various characters (table 4.4).

Third environment (E_3)

The mean sum of square based on analysis of variance of 100 genotypes of wheat for 19 characters as found in third environment have been presented in table 4.1 The coefficient of variation (CV) ranged from 21.34 percent (yield per plant) to 0.37(number of grains per ear) percent for various characters (table 4.4).

Pooled

The mean sum of square based on analysis of variance of 100 genotypes of wheat for 19 characters as observed in pooled environment have been given in table 4.2. The coefficient of variation (CV%) ranged from 29.39 percent (grain yield per plant) to 3.56 percent (canopy temperature) for various characters (table 4.5).

4.2.1 Estimates of parameters of genetic variability

The mean sum of square based on analysis of variance of 100 genotypes of wheat for 19 characters *viz;* days to full stem elongation, days to 50% flowering, days to stay green, days to maturity, relative water content of flag leaf, chlorophyll content, canopy temperature, membrane thermo-stability, plant height, number of effective tillers, number of ears per plant, number of spiklets per ear, length of ear, spike density, number of grains per ear, 1000- grain weight, yield per plant, biological yield per plant and harvest index have been presented in table 4.1.

Table 4.3: Parameters of genetic variability for phenological, physiological and yield contributing traits of different genotypes of Wheat under three environments.

Characters	Mean			Rang						CV (%)		
				Minimum			Maximum					
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
Days to full stem elongation	68.12	52.49	60.57	56.00	47.67	48.67	77.30	69.70	72.33	4.44	4.61	4.22
Days to 50% flowering	79.10	67.69	72.03	75.00	59.00	64	86.67	74.67	79.67	1.69	2.06	1.96
Days to stay green	109.06	95.23	103.01	103.30	90.00	100.33	114.26	104.66	110.33	2.27	3.07	2.52
Days to maturity	122.06	107.74	112.09	115.69	101.31	107.34	125.16	115.82	119.67	1.87	2.26	1.93
RWC of flag leaf (%)	71.46	77.67	66.39	63.05	62.54	50.96	91.44	89.11	78.67	0.95	2.09	2.58
Chlorophyll content	33.70	32.67	28.15	18.05	17.54	15.82	46.44	44.11	43.43	5.36	4.99	6.09
Canopy temperature (^oC)	19.59	20.82	21.81	15.67	18.33	19.60	21.77	20.72	21.81	2.95	2.21	3.19
Membrane thermo-stability	50.99	36.36	34.46	18.90	11.40	8.99	60.95	53.48	53.45	2.54	3.24	1.85
Plant height(cm)	93.12	91.35	90.09	77.7	75.73	74.00	112.7	110.10	108.3	1.11	1.21	1.26
No. of effective tillers plant^{-1}	4.34	3.94	3.25	2.40	2.37	2.07	7.57	6.10	5.18	5.81	5.21	6.22
No. of ears plant^{-1}	4.22	3.92	3.51	2.33	1.95	1.80	7.40	6.05	5.10	7.93	8.79	9.39
No. of spikelets ear^{-1}	19.74	17.54	17.14	16.7	13.87	13.43	23.6	21.40	20.11	1.37	2.62	2.84
Length of ear (cm)	9.53	8.53	8.10	7.03	6.03	5.40	12.53	11.53	10.10	4.38	4.89	2.81
Spike density	2.12	2.07	2.04	1.49	1.56	1.38	2.85	2.78	2.97	4.71	2.51	6.54
No. of grains ear^{-1}	52.67	48.13	46.40	23.58	19.43	17.71	89.58	85.48	83.71	0.69	0.79	0.37
1000-grain weight (g)	42.88	42.15	38.94	25.37	23.42	21.25	59.03	62.93	59.88	0.28	0.97	0.65
Grain yield plant^{-1} (g)	9.71	7.71	8.87	5.71	5.49	4.49	23.82	12.20	14.18	7.06	18.92	21.34
Biological yield plant^{-1} (g)	23.40	17.64	18.56	18.01	12.67	13.58	40.91	33.66	29.17	2.99	7.25	4.26
Harvest index (%)	47.66	43.86	44.07	31.87	22.04	31.05	63.53	64.18	63.18	5.49	17.92	18.15

Table 4.4: Parameters of genetic variability for phenological, physiological and yield contributing traits of different genotypes of Wheat under three environments.

Characters	GCV (%)			PCV (%)			h^2(bs) %			GA as a % of mean		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
Days to full stem elongation	8.50	9.18	8.10	9.59	10.27	9.14	78.55	79.87	78.70	15.52	16.89	14.82
Days to 50% flowering	7.52	7.39	7.44	7.70	7.67	7.69	95.19	92.79	93.48	15.12	14.66	14.81
Days to stay green	3.48	3.88	4.34	4.46	4.94	5.02	74.10	61.44	74.74	6.81	6.26	7.73
Days to maturity	3.61	1.85	3.49	4.07	2.93	3.99	78.85	40.29	76.62	6.61	2.43	6.29
RWC of flag leaf (%)	1.62	6.87	8.54	1.88	7.18	8.93	74.57	91.46	91.64	2.89	13.53	16.85
Chlorophyll content	16.68	16.33	21.49	17.53	17.09	22.34	90.64	91.46	92.57	32.72	32.18	42.59
Canopy temperature (^oC)	4.19	2.98	2.97	5.13	3.71	4.36	66.92	64.41	46.54	7.07	4.92	4.18
Membrane thermo-stability	21.84	30.64	32.51	21.98	30.81	32.56	98.66	98.89	99.69	44.68	62.77	66.86
Plant height(cm)	7.26	7.47	7.36	7.34	7.56	7.45	97.73	97.43	97.15	14.78	15.18	14.94
No. of effective tillers plant^{-1}	24.37	23.95	26.39	25.05	24.51	27.11	94.62	95.48	94.75	48.83	48.21	52.92
No. of ears plant^{-1}	24.49	27.62	25.27	25.74	28.98	26.97	90.52	90.80	87.85	48.01	54.21	48.80
No. of spikelets ear^{-1}	11.77	12.53	10.91	11.85	12.80	11.27	98.67	95.81	93.66	24.09	25.26	21.76
Length of ear (cm)	12.61	14.09	12.42	13.36	14.92	12.74	89.23	89.23	95.13	24.55	27.43	24.97
Spike density	12.02	12.24	11.63	12.91	12.49	13.35	86.69	95.95	75.97	23.06	24.69	20.89
No. of grains ear^{-1}	22.11	24.06	24.96	22.12	24.08	24.97	99.90	99.89	99.98	45.52	49.55	51.43
1000-grain weight (g)	16.72	18.67	19.52	16.74	18.69	19.53	99.97	99.73	99.89	34.47	38.41	40.18
Grain yield plant^{-1} (g)	31.24	13.03	17.56	32.03	22.97	27.64	95.14	32.16	40.36	62.77	15.22	22.98
Biological yield plant^{-1} (g)	15.25	17.06	16.14	15.54	18.56	16.69	96.30	84.70	93.50	30.84	32.34	32.15
Harvest index (%)	12.06	10.68	7.53	13.25	20.88	19.65	82.81	26.21	24.68	22.60	11.26	5.94

Analysis of variance revealed that, all the genotypes were significant at 1% level. The coefficient of variation (CV%) ranged from 7.93 percent (number of ears per plant) to 0.28 percent (1000-grain weight) for various characters (table 4.2).

The mean performance of genotypes for all the 16 characters studied in the present investigation has been discussed as under (appendix-I, II, III, IV):

Days to full stem elongation

E_1- The perusal of data revealed that days to full stem elongation of different genotypes ranged from 56.00 to 77.30 days with a mean value of 68.12 days. The earliest flag leaf initiation was observed in G-73 (56.00), G-53 (57.67), G-36, G-63 (58.67), G-56, G-37 (59.00), and G-51 (61.67). The latest being in the G-91 (77.3), G-96, G-39 (77), G-34, G-52, G-89 (76.7) and G-26 (75).

E_2- The period of days to full stem elongation for different genotypes ranged between 47.67 to 69.70 days with average value of 52.49 days. The earliest flag leaf initiation was observed in G-73 (47.67), G-53 (48.00), G-63 (49.00) and G-36 (48.7), G-56 (51.67).The latest being the G-76 (69.70), G-67 (68), G-91 (67.3) G-39, G-96 (67.00).

E_3- Days to full stem elongation observed for different genotypes ranged as of 48.67 to 72.33 days with a mean value of 60.57 days. The earliest flag leaf initiation was observed in G-73 (48.67), G-58 (48.00), G-53 (49.00) and G-33 (51.67). The latest being the G-67 (72.33), G-47 (68), G-91 (67.3), G-39, G-96 (67.00).

Pooled- The perusal of data revealed that days to full stem elongation of different genotypes ranged flanked by 44.33 to 68.89 days with a mean value of 57.06 days. The earliest flag leaf initiation was observed in G-46 (44.33), G-58 (46.00), G-55 (47.00) and G-52 (47.56).The latest being the G-97 (68.89), G-78

(66.00), G-83 (66.89).

Days to 50% flowering

E_1- Days to 50% flower initiation of different genotypes ranged from 75.00 to 86.67 days with a mean value of 79.10 days. The earliest flowering was found in G-63 (75.00) G-17, G-53, G-58 (75.00), G-10, G-37 (76.00) and G-5 (76.7).The latest being in the G-91 (86.7), G-67 (85.7) and G-35 (84.6).

E_2- The perusal of data observed that days to 50% flower initiation of different genotypes varied between 59.00 to 74.67 days with a mean value of 67.69 days. The earliest flowering was recorded in G-58, G-53, G-17 (59.00), G-10, G-37 (60.00) and G-51 (61.00).The latest being the G-35, G-59, G-89 (74.67), G-100 (74) and G-52 (73.70).

E_3- The period days to 50% flower initiation observed for different genotypes ranged flanked by 64.00 to 79.67 days with an average value of 72.03 days. The earliest flowering was observed in G-63 (64.00), G-17 (66.00), G-37 (67.00) and G-5 (67.7).The latest was in G-91 (86.7), G-67 (85.7) and G-35 (84.6).

Pooled- The results revealed that days to 50% flower initiation of different genotypes ranged as of 61.33 to 85.22 days with a mean value of 72.27 days. The earliest flowering was observed in G-46 (61.33), G-61 (63.00), G-57 (63.67) and G-59 (63.70).The latest was in G-97 (85.22), G-78 (81.22) and G-14 (80.44).

Days to stay green

E_1- The period of stay green of genotypes ranged flanked by 103.30 to 114.26 days with a mean value of 109.06 days. The earliest senescence of flag leaf was observed in G-17 (103.30), G-37 (104.34), G-36, G-51 (105.39) and G-12, G-56, G-72, G-8, G-99 (106.44). The latest being the G-39, G-4, G-67 (114.3), G-42 (110.07) and G-91 (109).

E_2- Days to stay green of genotypes ranged as of 90.30 to

104.66 days with an average value of 95.23 days. The earliest senescence of flag leaf was found in G-17, G-63 (90.30) G-12 (93.70), G-31, G-53 (94.00) and G-5, G-11, G-18, G-44 (94.7). The latest being the G-20 (104.66), G-59, G-52, G-67 (104.00), and G-40 (103.3).

E_3- The period of stay green of genotypes varied as of 100.33 to 110.33 days with a mean value of 103.01 days. The earliest senescence of flag leaf was observed in G-17, G-53 (100.33) G-10, G-37 (101.30), G-36, G-51, G-8 (102.3) and G-12, G-56, G-72 (104.00).The latest being the G-67 (110.33), G-91 (110.00) and G-59 (109).

Pooled- Days to stay green of genotypes ranged between 88.78 to 108.11 days with a mean value of 98.10 days. The earliest senescence of flag leaf was observed in G-38 (88.78), G-37 (89.33), G-52 (89.78) and G-46 (90.33). The latest being the G-14 (108.11), G-97 (107.44) and G-29 (106.67).

Days to maturity

E_1- Days to maturity varied as of 115.7 to 125.16 days, with a mean value of 122.06 days. The earliest maturity was found in G-64 (115.7) followed by G-17 (116.3), G-73 (116.5). The genotypes G-67 (125.16) was latest in maturity followed by G-59, G-39 (125.00), and G-100 (124.00).

E_2- The period of Days to maturity ranged between 101.31 to 115.82 days, with a mean value of 107.74 days. The earliest maturity was observed in G-17 (101.31) followed by G-5 (101.40), G-59 (102.00). The genotypes G-67 (115.82) was latest in maturity followed by G-59 (115.7), G-39 (115.3).

E_3- Days to maturity ranged from 107.34 to 119.67 days, with a mean value of 112.09 days. The earliest maturity was observed in G-63 (107.34) followed by G-10, G-37 (107.8), G-8, G-36 (108.67). The genotypes G-90 (119.67) was found latest in maturity followed by G-26 (119.33), and G-91 (118.67).

Pooled- Days to maturity varied as of 104.44 to 118.67 days, with a mean value of 110.63 days. The earliest maturity was observed in G-57 (104.44) followed by G-35 (104.89), G-52 (105.33). The genotypes G-97 (118.67) was latest in maturity followed by G-16, G-17 (116.33), G-78 (116.00).

Relative water content of flag leaf (RWC %)

E_1- The relative water content varied from 63.05% to 91.44% with an average value of 71.46%.The maximum RWC was noted in G-33 (91.44%) followed by G-25 (90.99%), G-43 (89.47), G-51 (89.52%) and minimum was in G-77 (69.90), G-48 (68.72), G-1(68.28%), G-87 (68.72%), G-83 (66.45%) and G-19 (63.05%).

E_2- Relative water content for different genotypes ranged between 62.54% to 89.11% with a mean value of 77.67%.The maximum RWC was found in G-7 (89.11%) followed by G-5, G-33 (88.88%), G-94, G-25 (88.35%) and minimum was in G-19 (62.54%), G-81 (66.38%) G-77 (67.23) and G-6 (67.91%).

E_3- The different genotypes revealed that, the relative water content ranged flanked by 50.96% to 78.67% with a mean value of 66.39%.The maximum RWC was observed in G-33 (78.67%) followed by G-25 (77.90%), G-94 (77.83%), G-93 (77.28%), G-43 (76.46%), and minimum was in G-1 (50.90%), G-19 (52.01%), and G-6 (52.04%).

Pooled- The relative water content of flag leaf ranged from 87.41% to 57.66% with a mean value of 74.27%.The maximum RWC was recorded by G-15 (87.41%) followed by G-11 (86.64.90%), G-9 (86.00%), G-42 (85.07%) and minimum in G-68 (57.66%), G-93 (59.34%) and G-83 (60.73%).

Chlorophyll content

E_1- Chlorophyll content of different genotypes varied from 46.44 to 18.05 with a mean value of 37.70.The maximum chlorophyll content was noted in G-33 (46.44) followed by G-25 (45.99), G-43 (44.52), G-94 (44.47) and minimum in G-19 (18.05),

G-6 (21.45), G-87 (21.70), G-1 (23.28), G-48 (23.78) and G-77 (24.97).

E_2- Chlorophyll content of different genotypes ranged from 44.11 to 17.54 with a mean value of 77.67. The higher chlorophyll content was found in G-7 (44.11) followed by G-5, 33 (43.88), G-25 (43.43), G-94 (43.36), and lower was in G-19 (17.54), G-87 (21.38), G-77 (22.63) and G-6 (22.91).

E_3- The chlorophyll content varied from 43.43 to 15.82 with a mean value of 77.67. The maximum chlorophyll content was noted in G-25 (43.43) followed by G-17(41.03), G-32 (41.01), G-26 (40.90), G-33 (38.32), and minimum in G-87 (15.82), G-1 (16.49) and 77 (17.07).

Pooled- The chlorophyll content ranged between 42.86 to 19.31 with a mean value of 31.50. The maximum chlorophyll content was noted in G-11 (42.86) followed by G-15 (41.03), G-9 (41.01), G-42 (40.90) and minimum in G-96 (19.31), G-83 (20.70) and 93 (21.75).

Canopy temperature (^oC)

E_1- Canopy temperature for different genotypes ranged from 21.67 to 15.77 with a mean value of 19.59. The maximum canopy temperature was found in G-37 (21.67) followed by G-12 (21.23), G-10, G-56 (20.97), G-22 (20.93) and minimum in G-7 (15.77), G-6 (16.63), G-3 (17.76), G-5 (18.03), and G-91 (18.37).

E_2- The canopy temperature varied between 22.37 to 18.83 with a mean value of 20.82.The maximum canopy temperature was recorded in G-35 (22.37) followed by G-25 (22.00), G-37, G-22 (21.97), G-28 (21.78) and minimum in G-91 (18.83), G-5 (19.00), G-90 (19.43), G-53 (19.53), and G-70 (19.57).

E_3- The canopy temperature ranged between 23.40 to 19.60 with a mean value of 21.81. The maximum canopy temperature was noted in G-35 (23.40) followed by G-56, 44 (22.90), G-96 (22.87), G-53 (22.80), and minimum in G-5 (19.60), G-6 (19.80)

and 69 (20.23).

Pooled- The canopy temperature varied from 22.54 to 17.96 with a mean value of 20.71. The maximum canopy temperature was noted under G-86 (22.54) followed by G- 82 (22.52), G-83 (22.42), G-79 (22.41), and minimum under G-2 (17.96), G-3 (18.57) and G-32 (18.80).

Membrane thermo-stability (%)

E_1- The membrane thermo-stability ranged from 60.95 to 18.91 with a mean value of 50.99. The maximum membrane thermo-stability was noted in G-46 (60.95) followed by G-38 (60.81), G-50 (58.87), G-78 (57.06) and minimum in G-32 (18.91), G-31 (18.93), G-59 (18.98) and G-55 (21.27).

E_2- The membrane thermo-stability varied from 53.45 to 11.4 with an average value of 36.36 .The maximum membrane thermo-stability was observed in G-46 (53.45) followed by G-38 (53.30), G-50 (50.37), G-78 (49.56) and minimum was in G-32 (11.4), G-31 (11.43), G-59 (11.48) and G-55 (13.57).

E_3- The membrane thermo-stability ranged from 53.45 to 8.29 with a mean value of 34.46 .The maximum membrane thermo-stability was noted in G-46 (53.45) followed by G-38 (53.32), G-50 (50.30), G-78 (49.50) and minimum in G-47 (8.29), G-39 (8.39), G-32 (11.40) and G-59 (11.48).

Pooled- The membrane thermo-stability ranged from 66.07 to 20.20 with a mean value of 40.60 .The maximum membrane thermo-stability was found in G-22 (66.07) followed by G-1 (65.52), G-14 (63.28), G-18 (62.00) and minimum in G-87 (20.20), G-78 (21.40), G-44 (22.43) and G-76 (23.06).

Plant height (cm)

E_1- The plant height ranged from 77.70 to 112.68 cm with a mean value of 93.12 cm. The maximum plant height was observed by G-39 (112.68) followed by G-92, G-89, G-100 (112.50), G-26 (110.70) and minimum by G-7 (77.70), G-30 (80.11), G-50

(80.41), G-12 (80.51), and G-60 (82.58).

E_2- The plant height varied from 75.73 to 110.47 cm with a mean value of 91.35 cm. The maximum plant height was noted by G-92 (110.47) followed by G-39 (110.30), G-100 (109.93), G-89 (108.37) and minimum in G-42 (75.73), G-12 (77.53), G-30 (78.43), G-50 (78.27), and G-30 (78.43).

E_3- The plant height of different genotypes ranged between 108.6 to 74.60 cm with a mean value of 90.09 cm. The maximum plant height was noted in G-39 (108.6) followed by G-17 (41.03), G-100 (107.37), G-92 (107.33), G-89 (106.53), and minimum in G-42 (74.60), G-12 (75.57) and G-30 (75.60).

Pooled- The plant height ranged between 102.40 to 82.67 cm with a mean value of 91.52 cm. The maximum plant height was noted G-13 in (102.40) followed by G-31 (99.28), G-3 (99.17), G-80 (99.12) and minimum in G-77 (82.67), G-81 (83.42) and G-54 (83.88).

Number of effective tillers per plant

E_1- The number of effective tillers per plant ranged from 2.40 to 7.57 with a mean value between of 4.34. The maximum number of effective tillers per plant was found in G-84 (7.57) followed by G-80 (7.40), G-35, 37 (6.5), G-31, 43 (6.40) and minimum in G-4, G-24 (2.40), G-22 (2.6) and G-89, G-25 (2.8).

E_2- The number of effective tillers per plant varied from 6.10 to 2.37 with a mean value of 3.94. The maximum number of effective tillers per plant was noted in G-31 (6.10) followed by G-35 (6.07), G-37 (5.93), G-15 (5.87) and minimum in G-4 (2.37), G-24 (2.40), G-83 (2.47), and G-83 (2.63).

E_3- The number of effective tillers per plant ranged from 5.18 to 2.07 with a mean value of 3.25. The maximum number of effective tillers per plant was observed by G-80 (5.38) followed by G-43 (5.11), 30 (5.05), 70 (4.93) and minimum in G-4 (2.07), G-24 (2.11) and 83 (2.25).

Pooled- The number of effective tillers per plant ranged from 5.93 to 2.24 with a mean value of 3.85. The maximum number of effective tillers per plant was noted in G-27 (5.93) followed by G-28 (5.92), 31 (5.73), 15 (5.44) and minimum in G-70 (2.24), G-68 (2.57) and G-71 (2.58).

Number of ears per plant

E_1- The number of ears per plant varied from 7.40 to 2.33 with a mean value of 4.22. The maximum number of ears per plant was observed by G-84 (7.40) followed by G-80 (7.27), G-35 (6.40), G-31 (6.33) and minimum in G-24 (2.33), G-22 (2.53), G-4 (2.57), and G-11 (2.60).

E_2- The number of ears per plant ranged between 6.05 to 1.95 with a mean value of 3.92.The maximum number of ears per plant was noted in G-80 (6.05) followed by G-35 (5.68), G-31, G-43 (5.61), and minimum in G-24 (1.95), G-22 (2.00), G-4 (2.08), and G-11 (2.15).

E_3- The number of ears per plant ranged from 5.10 to 1.80 with a mean value of 3.51.The maximum number of ears per plant was found in G-84 (5.10) followed by G-80 (5.00), 35 (4.95), G-31 (4.90), and minimum in G-8 (1.80), G-24 (2.37) and 89 (2.40).

Pooled- The number of ears per plant varied between 5.87 to 2.28 with a mean value of 3.89. The maximum number of ears per plant was noted in G-28 (5.87) followed by G-27 (5.81), G-31 (5.62), and minimum in G-42 (2.28), G-37 (2.30) and G- 41 (2.63).

Number of spikelets per ear

E_1- The number of spikelets per ear ranged between 23.60 to 16.10 with a mean value of 19.70. The maximum number of spikelets per ear was noted in G-80 (23.60) followed by G-66 (21.20), G-35 (21.10), G-16, 54, 65, 26 (21.00) and minimum in G-37, 40 (16.10), G-53 (16.20) and G- (16.30).

E_2- The number of spikelets per ear ranged from 21.40 to 13.87 with a mean value of 17.54. The maximum number of

spikelets per ear was observed in G-80 (21.40) followed by G-66 (23.40), G-35 (23.30), G-16 (23.2) and minimum in G-37, 40 (13.87), G-53 (14.03), G- 4 (14.07), and G-41 (14.10).

E_3- The number of spikelets per ear ranged from 20.11 to 13.43 with a mean value of 17.14. The maximum number of spikelets per ear was noted in G-80 (20.11) followed by G-66 (19.99), G-35 (19.93), G-34 (19.79) and minimum in G-37 (13.43), 40 (13.47), G-41 (14.57), G- 55 (13.57), and G-72 (14.00).

Pooled- The number of spikelets per ear varied from 23.17 to 14.03 with a mean value of 18.14. The maximum number of spikelets per ear was recorded in G-27 (23.17) followed by G-22 (23.06), G-30 (22.67) and minimum in G-47 (14.03), 80 (14.38) and G-86 (14.56).

Length of ear (cm)

E_1- The length of ear ranged from 12.53 to 7.07 with a mean value of 9.53. The maximum length of ear was observed in G-19, G-44 (12.53) followed by G-3 (12.33), G-26 (12.03) and minimum in G-4 (7.07), G-23 (7.33), G-37 (7.43) and G-40 (7.55).

E_2- The length of ear varied between 11.50 to 6.03 with a mean value of 8.53. The maximum length of ear was noted in G-19, G-44 (11.50) followed by G-3 (11.30), G-26 (11.00) and minimum in G-4 (6.03), G-23 (6.3), G-37 (6.4) and G-40 (6.5).

E_3- The length of ear ranged from 10.10 to 5.40 with a mean value of 8.10.The maximum length of ear was found in G-20 (10.10) followed by G-54, G-81, G-83 (9.80), G-88 (9.70), 100 (9.60), G-34 (9.50), and minimum in G-45 (5.40), G-4 (5.80) and G-23 (6.1).

Pooled - The length of ear varied from 11.10 to 7.00 with a mean value of 8.72.The maximum length of ear was noted in G-27 (11.10) followed by G-G-28 (11.10), G-7 (10.73), G-30 (10.53), and minimum in G-46 (7.00), G-41 (7.03) and G-75 (7.10).

Spike density

E_1- The spike density varied between 2.85 to 1.49 with a mean value of 19.59. The maximum spike density was noted in G-92 (2.85) followed by G-63 (2.84), G-96 (2.73), G-64 (2.66) and minimum in G-55 (1.49), G-47 (1.61), G-44 (1.64), and G-12 (1.65).

E_2- The spike density ranged from 2.78 to 1.56 with a mean value of 2.07. The maximum spike density was found in G-45 (2.78) followed by G-61 (2.58), G-64 (2.70), G-59 (2.60) and minimum in G-47 (1.56), G-44 (1.59), G-12, G-100 (1.60), and G-55 (1.63).

E_3- The spike density ranged from 2.97 to 1.38 with a mean value of 2.04. The maximum spike density was recorded in G-45 (2.97) followed by G-61 (2.58), G-64 (2.56), G-77 (2.52), G-21 (2.48), and minimum in G-15 (1.38), G-47 (1.52) and G-100 (1.56).

Pooled- The spike density varied from 2.60 to 1.68 with a mean value of 2.07. The maximum spike density was noted in G-21 (2.60) followed by G-22 (2.58), G-54 (2.43) and minimum in G-85 (1.68), G-87 (1.71) and G-38 (1.76).

Number of grains per ear

E_1- The number of grains per ear ranged between 89.58 to 23.58 with a mean value of 19.59. The maximum number of grains per ear was found in G-16 (89.58) followed by G-82 (75.60), G-66 (72.60), G-26 (7.06) and minimum in G-55 (23.58), G-8 (26.70), G-5 (32.60), and G-86 (35.60).

E_2- The number of grains per ear ranged from 85.48 to 19.43 with a mean value of 48.13. The maximum number of grains per ear was observed in G-16 (85.48) followed by G-82 (71.40), G-66 (68.40), G-26 (66.40) and minimum in G-55 (19.43), G-8 (23.40), G-5 (28.40), and G-86 (30.40).

E_3- The number of grains per ear varied between 83.71 to

17.71 with a mean value of 46.40. The maximum number of grains per ear was found in G-16 (83.71) followed by G-82 (69.70), G-66 (66.70), G-26 (64.70) and minimum in G-55 (17.71), G-8 (21.70), G-5 (26.70), and G-86 (28.70).

Pooled- The number of grains per ear ranged from 67.27 to 29.37 with a mean value of 48.93. The maximum number of grains per ear was noted in G-28 (67.27) followed by G-6 (66.60), G-22 (65.93) and minimum in G-70 (29.37), G-47 (35.10), G-37 (35.43).

1000-grain weight (g)

E_1- The 1000-grain weight ranged between 59.03 to 25.37 g with a mean value of 42.88 g. The maximum 1000-grain weight was recorded in G-55 (59.03) followed by G-71 (57.73), G-58 (56.53), G-81 (55.63) and minimum in G-3 (25.37), G-87 (26.20), G-41 (29.10), and G-63 (29.53).

E_2- The 1000-grain weight varied from 62.93 to 23.42 g with a mean value of 42.15 g. The maximum 1000-grain weight was noted in G-8 (62.93) followed by G-94 (60.18), G-55 (59.10), G-71 (57.71) and minimum in G-3 (23.42), G-87 (24.52), G-41 (27.36), and G-63 (28.09).

E_3- The 1000-grain weight ranged from 59.88 to 21.25 g with a mean value of 38.94 g. The maximum 1000-grain weight was found in G-8 (59.88) followed by G-53 (58.57), G-94 (55.85), G-55 (54.91) and minimum in G-3 (21.25), G-87 (22.09), G-41 (24.98), and G-63 (25.42).

Pooled- The 1000-grain weight varied between 56.27 to 29.95 g with a mean value of 41.32 g. The maximum 1000-grain weight was recorded in G-19 (56.27) followed by G-53 (52.51), G-52 (51.63) and minimum in G-68 (29.95), G-1 (31.27), G-63 (32.61).

Grain Yield per plant (g)

E_1- The grain yield per plant was ranged from 23.89 to 5.71 g with a mean value of 9.71 g. The maximum grain yield per plant

was noted G-84 (23.89) followed by G-80 (17.70), G-82 (17.52), G-79 (15.67) and minimum in G-24 (5.71), G-8 (5.65), G-19 (5.80), and G-25 (5.84).

E_2- The grain yield per plant ranged between 12.20 to 5.49 g with a mean value of 7.71 g. The maximum grain yield per plant was recorded in G-15 (12.20) followed by G-8 (11.80), G-31 (10.9), G-43 (10.5) and minimum in G-74 (5.49), G-1 (5.87), G-25 (5.88), and G-22 (5.90).

E_3- The grain yield per plant ranged from 14.18 to 4.49 g with a mean value of 8.87 g. The maximum grain yield per plant was observed in G-43 (14.18) followed by G-79, G-70 (13.20), G-20 (13.10) and minimum in G-41 (4.49), G-9 (5.80), G-8 (5.87), and G-51 (5.96).

Pooled - The grain yield per plant varied from 16.71 to 6.38 g with a mean value of 8.76 g. The maximum grain yield per plant was noted G-28 (16.71) followed by G-27 (14.14), G-31 (12.48) and minimum in G-70 (6.38), G-51 (6.41), G-58 (6.43).

Biological yield per plant (g)

E_1- The biological yield per plant varied between 40.91 to 18.01g with a mean value of 23.40 g. The maximum biological yield per plant was noted in G-84 (40.91) followed by G-80 (35.37), G-82 (33.80), G-35 (30.77) and minimum in G-24 (18.01), G-4 (18.89), G-19 (19.03), and G-18 (19.05).

E_2- The biological yield per plant ranged from 33.66 to 12.67 g with a mean value of 17.64 g. The maximum biological yield per plant was found in G-84 (33.66) followed by G-82 (27.28), G-80 (26.67), G-57 (24.07) and minimum in G-4 (12.67), G-19 (13.38), G-51 (13.55), and G-41 (13.77).

E_3- The biological yield per plant ranged between 29.17 to 13.58 g with a mean value of 18.56 g. The maximum biological yield per plant was recorded in G-82 (29.17) followed by G-80 (28.69), G-57 (24.93), G-15 (24.18) and minimum in G-4 (13.58),

G-24 (13.75), G-8 (13.89), and G-41 (14.35).

Pooled- The biological yield per plant ranged between 32.18 to 14.15 g with a mean value of 19.87 g. The maximum biological yield per plant was noted in G-68 (32.18) followed by G-28 (28.03), G-27 (26.14) and minimum in G-37 (14.15), G-47 (14.72), G-35 (15.09).

Harvest index (%)

E_1- The harvest index varied from 63.53% to 31.87% with a mean value of 47.66%. The maximum harvest index was noted in G-79 (63.53%) followed by G-80 (62.95%), G-92 (59.53%), G-88 (58.83%) and minimum in G-24 (31.87%), G-8 (35.25%), G-19 (37.30%), and G-97 (37.67%).

E_2- The harvest index ranged between 64.18% to 22.04% with a mean value of 43.86%. The maximum harvest index was recorded in G-19 (64.18%) followed by G-31 (57.00%), G-15 (56.70%), G-89 (56.6%) and minimum in G-84 (22.04%), G-29 (28.10%), G-57 (28.90%), and G-16 (30.70%).

E_3- The harvest index ranged from 63.18% to 31.05% with a mean value of 44.07%. The maximum harvest index was found in G-37 (63.18%) followed by G-43 (60.12%), G-70 (58.80%), G-79 (53.00%) and minimum in G-29 (31.05%), G-48 (33.83%), G-82 (34.00%), and G-100 (34.93%).

Pooled- The harvest index ranged between 57.64% to 33.89% with a mean value of 45.20%. The maximum harvest index was recorded in G-27 (63.18%) followed by G-31 (56.11%), G-28 (55.12%) and minimum in G-62 (33.89%), G-70 (37.51%), G-73 (38.10%).

4.2.2 Phenotypic and genotypic coefficient of variation (%)

E_1- In general, the value of phenotypic coefficients of variation was found higher than that of the genotypic coefficients of variation for all the characters. The phenotypic coefficient of variation was estimated to be high for yield per plant (32.03%) followed by no. of ears per plant (25.74%), no. of effective tillers

Table 4.5: Parameters of genetic variability for phenological, physiological and yield contributing traits of different genotypes of Wheat for pooled data.

Characters	Mean	Range		CV (%)	GCV (%)	PCV (%)	h^2(bs)%	GA as a % of mean
		Minimum	Maximum					
Days to full stem elongation	57.06	44.33	68.89	8.47	8.04	11.68	47.30	11.39
Days to 50% flowering	72.27	61.33	85.22	6.46	6.31	9.03	48.90	9.09
Days to stay green	98.10	88.78	108.11	4.37	4.46	6.24	51.10	6.56
Days to maturity	110.63	104.44	118.67	3.32	2.70	4.28	39.90	3.51
RWC of flag leaf (%)	74.27	56.66	87.41	7.33	8.71	11.39	58.50	13.73
Chlorophyll content	31.50	19.31	42.86	17.16	13.74	21.98	39.10	17.69
Canopy temperature(^oC)	20.71	17.96	22.54	3.56	5.10	6.22	67.20	8.60
Membrane thermo-stability	40.60	20.20	66.07	20.23	26.22	33.12	6270	42.76
Plant height(cm)	91.52	82.67	102.40	7.08	3.81	8.04	22.50	3.72
No. of effective tillers plant^{-1}	3.85	2.24	5.93	21.92	17.63	28.13	39.30	22.76
No. of ears plant^{-1}	3.89	2.28	5.87	23.29	16.60	28.60	33.70	19.84
No. of spikelets ear^{-1}	18.14	14.03	23.17	9.80	9.58	13.70	48.90	13.81
Length of ear (cm)	8.72	7.00	11.10	11.14	10.58	15.36	47.40	15.01
Spike density	2.07	1.68	2.60	10.34	7.93	13.03	37.00	9.94
No. of grains ear^{-1}	48.93	29.37	67.27	20.15	13.42	24.21	30.70	15.32
1000 grain weight (g)	41.32	29.95	56.27	15.24	11.08	18.84	34.60	13.43
Grain yield plant^{-1} (g)	8.76	6.38	16.71	29.39	15.54	33.25	43.80	14.95
Biological yield plant^{-1}	19.87	14.15	32.18	16.56	15.47	22.66	46.60	21.77
Harvest index (%)	45.20	33.89	57.64	19.65	5.84	20.50	28.10	3.43

per plant (25.05%), no. of grains per ear (22.12%), membrane thermo-stability (21.98%), chlorophyll content (17.53%), 1000-grain weight (16.74%), biological yield (15.54%), length of ear (13.36%), harvest index (13.25%), spike density (12.91%), no. of spikelets per ear (11.85%), days to full stem elongation (9.59%), days to 50% flowering (7.70%), plant height (7.34%), canopy temperature (5.13%), days to stay green (4.46%), days to maturity (4.07%), and RWC of flag leaf (1.88%).

Genotypic coefficient of variation also showed the similar trend for all the traits under studied and was observed to be high for yield per plant (31.24%) followed by no. of ears per plant (24.49%), no. of effective tillers per plant (24.37%), no. of grains per ear (22.11%), membrane thermo-stability (21.84%), 1000-grain weight (16.72%), chlorophyll content (16.68%), biological yield (15.25%), length of ear (12.61%), harvest index (12.06%), spike density (12.02%), no. of spikelets per ear (11.77%), days to full stem elongation (8.50%), days to 50% flowering (7.52%), plant height (7.26%), canopy temperature (4.19%), days to maturity (3.61%), days to stay green (3.48%), and RWC of flag leaf (1.62%).

E_2- The phenotypic coefficient of variation was estimated to be high for membrane thermo-stability (30.81%), no. of ears per plant (28.98%), no. of effective tillers per plant (24.51%), no. of grains per ear (24.08%), yield per plant (22.97%), harvest index (10.88%), 1000-grain weight (18.69%), biological yield (18.56%), chlorophyll content (17.09%), length of ear (14.92%), no. of spikelets per ear (12.80%), spike density (12.49%), days to full stem elongation (10.27%), days to 50% flowering (7.67%), plant height (7.56%), RWC of flag leaf (7.18%). days to stay green (4.94%), canopy temperature (3.71%), and days to maturity (2.93%).

Genotypic coefficient of variation was estimated to be high for membrane thermo-stability (30.64%), no. of ears per plant

(27.62%), no. of grains per ear (24.06%), no. of effective tillers per plant (23.95%),1000-grain weight (18.67%), biological yield (17.06%), chlorophyll content (16.33%), length of ear (14.09%), yield per plant (13.03%), no. of spikelets per ear (12.53%), spike density (12.24%), harvest index (10.68), days to full stem elongation(9.18%), plant height (7.47%), days to 50% flowering (7.39%), RWC of flag leaf (6.87%). days to stay green(3.88%), canopy temperature (2.98%), and days to maturity (1.85%).

E_3- The phenotypic coefficient of variation was estimated to be high for membrane thermo-stability (32.56%), yield per plant (27.64%), no. of effective tillers per plant (27.11%), no. of ears per plant (26.97%), no. of grains per ear (25.97%), chlorophyll content (22.34%), harvest index (19.65%),1000-grain weight (19.53%), biological yield (16.69%), spike density (13.35%), length of ear (12.74%), no. of spikelets per ear (11.27%) and low days to full stem elongation (9.14%), RWC of flag leaf (8.93%), days to 50% flowering (7.69%), plant height (7.45%), days to stay green (5.02%), canopy temperature (4.36%), and days to maturity (3.99%).

Genotypic coefficient of variation was estimated to be higher for membrane thermo-stability (32.51%) followed by no. of effective tillers per plant (26.36%), no. of ears per plant (25.27%), no. of grains per ear (25.96%), chlorophyll content (21.49%), 1000-grain weight (19.52%), yield per plant (17.56%), biological yield (16.14%), length of ear (12.42%), spike density (11.63%), no. of spikelets per ear (10.91%) and lower for RWC of flag leaf (8.54%), days to full stem elongation (8.10%), harvest index (7.53%), days to 50% flowering (7.44%), plant height (7.36%), days to stay green (4.34%), days to maturity (3.49%) and canopy temperature (2.97%).

Pooled- In general, the values of phenotypic coefficient of variations was higher than that of the genotypic coefficient of variation for all the characters. The phenotypic coefficient of

variation was estimated to be higher for biological yield per plant (33.25%) followed by membrane thermo-stability (33.12%), no. of ears per plant (28.6%), no. of effective tillers per plant (28.13%), no. of grains per ear (24.21%), harvest index (22.66%), chlorophyll content (21.98%), grain yield per plant (20.5%), 1000-grain weight (18.84%), length of ear (15.36%), no. of spikelets per ear (13.7%), spike density (13.03%), days to full stem elongation (11.68%), relative water content of flag leaf (11.39%) and lower for days to 50% flowering (9.03%), plant height (8.04%), days to stay green (6.24%), canopy temperature (6.22%) and days to maturity (4.28%),

Genotypic coefficient of variation was estimated to be higher for membrane thermo-stability (26.22%), followed by no. of effective tillers per plant (17.63%), no. of ears per plant (16.6%), biological yield per plant (15.54%), harvest index (15.47%), chlorophyll content (13.74%), no. of grains per ear (13.42%), 1000-grain weight (11.08%), length of ear (10.58%) whereas, lower for no. of spikelets per ear (9.58%), relative water content of flag leaf (8.71%), days to full stem elongation (8.04%), spike density (7.93%), days to 50% flowering (6.31%), grain yield per plant (5.84%), canopy temperature (5.1%), days to stay green (4.46%), plant height (3.81%), and days to maturity (2.7%),

4.3.1 Heritability (h^2 bs%)

In the present investigation broad sense heritability, which is the ratio of total genotypic variance to total phenotypic variance, have been estimated and classified in categories- high (>70%), medium (50-70%) and low (<50%). Knowledge of heritability of characters is important for any breeding programmers. The heritability estimates for different characters were presented in table 4.3.

E_1- Heritability estimates was exhibited higher for 1000-grain weight (99.97%) followed by no. of grains per ear

(99.90%), no. of spikelets per ear (98.67%), membrane thermo-stability (98.66%), plant height (97.73%), biological yield per plant (96.30%), days to 50% flowering (95.19%), yield per plant (95.14%), number of effective tillers per plant (94.62%), chlorophyll content (90.64%) no. of ears plant^{-1}(90.52%), length of ear (89.23%), spike density, 86.69, harvest index (82.81%), days to maturity (78.85%), days to full stem elongation (78.55%), RWC of flag leaf (74.57%), days to stay green (74.1%), while moderate for canopy temperature (66.92%).

E_2-.Heritability estimates was found high for no. of grains per ear (99.89%), followed by 1000-grain weight (99.73%), membrane thermo-stability (98.89%), plant height (97.43%), spike density (95.95%), no. of spikelets per ear (95.81%), no. of effective tillers per plant (95.48%), days to 50% flowering (92.79%), chlorophyll content (91.46%), RWC of flag leaf (91.46%), no. of ears per plant (90.8%), length of ear (89.23%), biological yield per plant (84.7%), days to full stem elongation (79.87%), whereas, it was moderate for canopy temperature (64.41%), days to stay green (61.44%) and low for days to maturity (40.29%), grain yield per plant (32.16%), and harvest index (26.21%).

E_3- Heritability estimates was exhibited higher for no. of grains per ear (99.98%) followed by 1000-grain weight (99.89%), membrane thermo-stability (99.69%), plant height (97.15%), length of ear (95.13%), no. of effective tillers per plant (94.75%), no. of spikelets ear (93.66%), biological yield per plant (93.5%), days to 50% flowering (93.48%), chlorophyll content (92.57%), RWC of flag leaf (91.64%), no. of ears per plant (87.85%), days to full stem elongation (78.7%), days to maturity (76.62%), spike density (75.97%), days to stay green (74.74%) and lower heritability for canopy temperature (46.54%), yield per plant (40.36) and harvest index (24.68%).

Pooled- In the present investigation the heritability estimates was noted moderate in canopy temperature (67.2%), membrane thermo-stability (62.7%), relative water content of flag leaf (58.5%), days to stay green (51.1%) and lower heritability for days to 50% flowering (48.9%), no. of spikelets per ear (48.9%), length of ear (47.4%), days to full stem elongation (47.3%), harvest index (46.6%), biological yield per plant (43.8%), days to maturity (39.9%), no. of effective tillers per plant (39.3%), chlorophyll content (39.1%), spike density (37.0%), 1000-grain weight (34.6%), no. of ears per plant (33.7%), no. of grains per ear (30.7%), grain yield per plant (28.1%) and plant height (22.5%).

4.3.2 Genetic advance as a % of mean

E_1- The higher estimate of genetic advance as a percent of mean was exhibited for yield per plant (62.77%), followed by no. of effective tillers per plant (48.83%), no. of ears per plant (48.01%), no. of grains per ear (45.52%), membrane thermo-stability (44.68%), while it was moderate for 1000-grain weight (34.47%), chlorophyll content (32.72%), biological yield per plant (30.84%) and lower for length of ear (24.55%), no. of spikelets per ear (24.09%), spike density (23.06%), harvest index (22.6%), days to full stem elongation (15.52%), days to 50% flowering (15.12%), plant height (14.78%), canopy temperature (7.07%), days to stay green (6.81%), days to maturity (6.61%) and RWC of flag leaf (2.89%).

E_2- The higher estimate of genetic advance as a percent of mean was showed for membrane thermo-stability (62.77%) followed by no. of ears per plant (54.21%), no. of grains per ear (49.55%), no. of effective tillers per plant (48.21%), 1000-grain weight (38.41%) and moderate for biological yield per plant (32.34%), chlorophyll content (32.18%), length of ear (27.43%), no. of spikelets per ear (25.26%) and lower for spike density

(24.69%), days to full stem elongation (16.89%), yield per plant (15.22%), plant height (15.18%), days to 50% flowering (14.66%), RWC of flag leaf (13.53%), harvest index (11.26%), days to stay green (6.26%), canopy temperature (4.92%) and days to maturity (2.43%).

E_3- The higher estimate of genetic advance as a percent of mean was exhibited for membrane thermo-stability (66.86%) followed by no. of effective tillers per plant (52.92%), no. of grains per ear (51.43%), no. of ears per plant (48.8%), chlorophyll content (42.59%), 1000-grain weight (40.18%) and moderate for biological yield per plant (32.15%), length of ear (24.97%), while, it was lower for yield per plant (22.98%), no. of spikelets per ear (21.76%), spike density (20.89%), RWC of flag leaf (16.85%), plant height (14.94%), days to full stem elongation (14.82%), days to 50% flowering (14.81%), days to stay green (7.73%), days to maturity (6.29%), harvest index (5.94%), canopy temperature (4.18%).

Pooled- The higher estimate of genetic advance as a percent of mean was exhibited for membrane thermo-stability (42.76%) and lower for no. of effective tillers per plant (22.76%), harvest index (21.77%), no. of ears per plant (19.84%), chlorophyll content (17.69%), no. of grains per ear (15.32%), length of ear (15.01%), biological yield per plant (14.95%), no. of spikelets per ear (13.81%), relative water content of flag leaf (13.73%),1000-grain weight (13.43%), days to full stem elongation (11.39%), spike density (9.94%), days to 50% flowering (9.09%), canopy temperature (8.6%), days to stay green (6.56%), plant height (3.72%), days to maturity (3.51%) and grain yield per plant (3.43%).

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4.4 Association Analysis

4.4.1 Correlation coefficient between characters

First environment (E_1)

The phenotypic and genotypic correlation coefficient for different pairs of characters was studied and results presented in table 4.6 (a) and table 4.6 (b). The phonotypic correlation coefficient for grain yield per plant were significant positively associated with biological yield per plant (0.954), no. of effective tillers per plant (0.789), no. of ears per plant (0.785), harvest index (0.762), no. of grains per ear (0.302), no. of spikelets per ear (0.270) and length of ear (0.258). Whereas, canopy temperature (-0.127) and plant height (-0.121) reported significant negative association with grain yield per plant.

The results obtain from phenotypic correlation coefficients for different pairs of characters in first environment presented character wise. (Table 4.6 a)

Days to full stem elongation

Days to full stem elongation was highly significant and positively associated with days to 50% heading (0.797) followed by days to stay green (0.685), days to maturity (0.606), no. of grains per ear (0.219), no. of spikelets per ear (0.197) and spike density (0.114) but It was significant negatively associated with 1000-grain weight (-0.300), and canopy temperature (-0.205).

Days to 50% heading

Days to 50% heading was noted significant positively associated with days to stay green (0.827) followed by days to maturity (0.713), spike density (0.121), no. of grains per ear (0.218) and no. of spikelests per ear (0.206), While, It was significant negatively correlated with RWC of flag leaf (-0.136), chlorophyll content (-0.145), canopy temperature (-0.216), membrane thermo-stability (-0.101).

Table 4.6 (a):- Phenotypic correlation among phenological, physiological and yield constituting traits (E_1)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.797**	1																
Days to stay green	0.685**	0.827**	1															
Days to maturity	0.606**	0.713**	0.596**	1														
RWC of flag leaf (%)	-0.080	-0.136*	-0.165**	-0.080	1													
Chlorophyll content	-0.086	-0.145*	-0.174**	-0.081	0.976**	1												
Canopy temperature (^oC)	-0.205**	-0.216**	-0.183**	-0.038	0.051	0.056	1											
Membrane thermo-stability	-0.081	-0.101	-0.044	-0.113	-0.063	-0.067	-0.128*	1										
Plant height(cm)	0.043	0.108	0.024	0.100	-0.023	-0.037	-0.007	-0.106	1									
No. of effective tillers plant^{-1}	-0.001	0.107	0.038	0.029	0.010	0.005	-0.161**	0.021	-0.066	1								
No. of ears plant^{-1}	-0.001	0.108	0.042	0.030	0.011	0.005	-0.175**	-0.004	-0.058	0.975**	1							
No. of spikelets ear^{-1}	0.197**	0.206**	0.091	-0.041	-0.072	-0.081	-0.125*	0.070	-0.033	0.142*	0.140*	1						
Length of ear (cm)	0.055	0.056	-0.040	0.012	-0.126*	-0.144*	-0.105	-0.030	0.153**	0.156**	0.160**	0.555**	1					
Spike density	0.114*	0.121*	0.155**	-0.025	-0.009	0.002	-0.051	0.087	-0.033	0.022	0.004	0.296**	-0.460**	1				
No. of grains ear^{-1}	0.219**	0.218**	0.084	0.022	-0.084	-0.103	-0.184**	0.155**	-0.104	0.153**	0.150**	0.812**	0.552**	0.152**	1			
1000-grain weight (g)	-0.300**	-0.313**	-0.266**	-0.193**	0.123*	0.120*	0.259**	-0.138*	0.007	-0.072	-0.073	-0.208**	-0.133*	-0.097**	-0.290**	1		
Biological yield plant^{-1} (g)	-0.025	0.063	0.016	-0.035	0.070	0.056	-0.128*	-0.018	-0.163**	0.797**	0.797**	0.294**	0.257**	0.040	0.307**	0.03 8	1	
Harvest index (%)	-0.026	0.048	-0.017	-0.020	-0.026	-0.034	-0.232**	0.004	-0.008	0.619**	0.597**	0.261**	0.203**	0.153**	0.335**	0.017	0.646**	1
Grain yield plant^{-1} (g)	-0.008	0.077	0.013	-0.004	0.050	0.034	-0.127*	-0.047	-0.121*	0.789**	0.785**	0.270**	0.258**	0.043	0.302**	0.031	0.954**	0.762**

Table 4.6 (b):- Genotypic correlation among phenological, physiological and yield constituting traits (E_1)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.903**	1																
Days to stay green	0.925**	0.970**	1															
Days to maturity	0.739**	0.824**	0.826**	1														
RWC of flag leaf (%)	-0.110	-0.149**	-0.199**	-0.096	1													
Chlorophyll content	-0.120*	-0.157**	-0.203**	-0.098	0.924**	1												
Canopy temperature (^oC)	-0.272**	-0.256**	-0.291**	-0.075	0.080	0.060	1											
Membrane thermo-stability	-0.094	-0.105	-0.049	-0.124*	-0.070	-0.075	-0.156**	1										
Plant height(cm)	0.041	0.113	0.033	0.114*	-0.031	-0.045	-0.021	-0.110	1									
No. of effective tillers plant^{-1}	-0.002	0.108	0.033	0.035	0.013	0.009	-0.194**	0.017	-0.066	1								
No. of ears plant^{-1}	-0.003	0.108	0.035	0.020	0.015	0.012	-0.209**	-0.011	-0.058	0.943**	1							
No. of spikelets ear^{-1}	0.220**	0.212**	0.106	-0.046	-0.080	-0.085	-0.154**	0.072	-0.032	0.146*	0.146*	1						
Length of ear (cm)	0.080	0.057	-0.035	-0.002	-0.119*	-0.128*	-0.143*	-0.035	0.166**	0.171**	0.177**	0.589**	1					
Spike density	0.102	0.132*	0.194**	-0.022	-0.034	-0.026	-0.055	0.097	-0.043	0.017	0.007**	0.312**	-0.424**	1				
No. of grains ear^{-1}	0.246**	0.223**	0.098	0.022	-0.090	-0.109	-0.228**	0.156**	-0.105	0.157**	0.158**	0.818**	0.583**	0.164**	1			
1000-grain weight (g)	-0.340**	-0.321**	-0.309**	-0.218**	0.132*	0.127*	0.316**	-0.139*	0.007	-0.074	-0.077	-0.209**	-0.142*	-0.104	-0.290**	1		
Biological yield plant^{-1} (g)	-0.016	0.069	0.038	-0.034	0.076	0.058	-0.150**	-0.020	-0.164**	0.835**	0.858**	0.302**	0.278**	0.045	0.313**	0.039	1	
Harvest index (%)	-0.062	0.062	-0.015	-0.021	-0.031	-0.045	-0.289**	0.005	-0.014	0.727**	0.762**	0.291**	0.252**	0.157**	0.370**	0.018	0.729**	1
Grain yield plant^{-1} (g)	-0.011	0.086	0.036	0.006	0.049	0.031	-0.148*	-0.046	-0.121*	0.843**	0.872**	0.280**	0.282**	0.046	0.310**	0.031	0.967**	0.829**

Days to stay green

Days to stay green was found significant positively associated with days to maturity (0.596) and no. of spikelets per ear (0.155), whereas it noticed significant negatively correlation with canopy temperature (-0.183) followed by chlorophyll content (-0.174) and RWC of flag leaf (-0.165).

Days to maturity

Days to maturity exhibited significantly negative association with 1000-grain weight (-0.193). Whereas, positively correlated with plant height (0.100). However, It was negatively correlated with membrane thermo-stability (-0.113).

Relative water content of flag leaf (RWC %)

RWC of flag leaf was found significant positively associated with chlorophyll content (0.976), but significant negatively correlated with length of ear (-0.126).

Chlorophyll content

Chlorophyll content observed significant positively correlated only with 1000-grain weight (0.120) and negatively correlated with length of ear (-0.144).

Canopy temperature (^{o}C)

Canopy temperature was exhibited significant positive correlation only with 1000-grain weight (0.259) but significant negatively correlated with harvest index (-0.232), no. of ears per plant (-0.175), no. of effective tillers per plant (-0.161), membrane thermo-stability (-0.128), grain yield per plant (-0.127) and no. of spikelets per ear (-0.125).

Membrane thermo-stability

Membrane thermo-stability was found significant positively associated only with no. of grains per ear (0.155) while significant negative correlation with 1000-grain weight (-0.138).

Plant height (cm)

Plant height was noticed significant positively associated only with length of ear (0.153) but significant negatively correlated with biological yield per plant (-0.163) and grain yield per plant (-0.121).

Number of Effective tillers per plant

Effective tillers per plant was significant, positively associated with no. of ears per plant (0.975), no. of spikelets per ear (0.142), no. of grains per ear (0.153), biological yield per plant (0.797), harvest index (0.619), grain yield per plant (0.789), and length of ear (0.156).

Number of Ears per plant

No. of ears per plant showed significant positive association with biological yield per plant (0.797) followed by grain yield per plant (0.785), harvest index (0.597), length of ear (0.160), no. of grains per ear (0.150), no. of spikelets per ear (0.140).

Number of Spikelets per ear

Spikelets per ear was observed significant positively associated with no. of grains per ear (0.812) followed by length of ear (0.555), spike density (0.296), biological yield per plant (0.294), harvest index (0.261), grain yield per plant (0.270) but significant negatively associated with 1000-grain weight (-0.208).

Ear length (cm)

Ear length found significant positively associated with no. of grains per ear (0.552), biological yield per plant (0.257), harvest index (0.203), grain yield per plant (0.258). Whereas, it was significant negatively associated with spike density (-0.460) and 1000-grain weight (-0.133).

Spike density

Spike density was significant, positively associated with no.

of grains per ear (0.152), harvest index (0.153) and negatively correlated with 1000-grain weight (-0.097).

Number of grains per ear

No. of grains per ear was exhibited significant positive association with biological yield per plant (0.307), harvest index (0.335) and grain yield per plant (0.302), but It was significant negatively associated with 1000-grain weight (-0.290).

1000-grain weight (g)

1000-grain weight found positive association with biological yield per plant (0.038) and grain yield per plant (0.031).

Biological yield per plant (g)

Biological yield per plant showed significant positive association with harvest index (0.646) and grain yield per plant (0.954).

Harvest index (%)

Harvest index revealed significant positive association with grain yield per plant (0.762).

Second environment (E_2)

The phenotypic and genotypic correlation coefficient for different pairs of characters was studied and results presented in table 4.7 (a) and table 4.7 (b).

The phonotypic correlation coefficient for grain yield per plant was significant positively associated with harvest index (0.604) followed by no. of effective tillers per plant (0.433), biological yield per plant (0.419) no. of ears per plant (0.413), length of ear (0.263) no. of spikelets per ear (0.163) and no. of grains per ear (0.122). Whereas, spike density (-0.156) and membrane thermo-stability (-0.134) was found significant negative correlation with grain yield per plant.

The results obtain from phenotypic correlation coefficients

for different pairs of characters in second environment presented character wise. (Table 4.7.a)

Days to full stem elongation

Days to full stem elongation was found significant positively associated with days to 50% heading (0.765) followed by days to stay green (0.486), days to maturity (0.285), no. of spikelets per ear (0.247), no. of grains per ear (0.233) and spike density (0.155). Whereas, significant negatively associated with 1000-grain weight (-0.260) followed by RWC of flag leaf (-0.129), chlorophyll content (-0.129).

Days to 50% heading

Days to 50% heading was observed significant positively associated with days to stay green (0.640) followed by days to maturity (0.365), no. of spikelets per ear (0.208), no. of grains per ear (0.191), spike density (0.159) and no. of effective tillers per plant (0.152), but It was significant negatively associated with 1000-grain weight (-0.319), RWC of flag leaf (-0.171), chlorophyll content (-0.171). However, it noticed non-significant positively associated with plant height (0.106).

Days to stay green

Days to stay green was found significant positive associated with days to maturity (0.337) followed by no. of effective tillers per plant (0.186), no. of ears per plant (0.186), no. of grains per ear (0.185), no. of spikelets per ear (0.172), biological yield per plant (0.152). Whereas, it was significant negatively associated with 1000-grain weight (-0.313) followed by RWC of flag leaf (-0.114), chlorophyll content (-0.114).

Days to maturity

Days to maturity was significant positively associated with no. of grains per ear (0.141), but it was non-significant positively associated with spike density (0.109).

Table 4.7 (a):- Phenotypic correlation among phenological, physiological and yield constituting traits (E_2)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (°C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.765**	1																
Days to stay green	0.486**	0.640**	1															
Days to maturity	0.285**	0.365**	0.337**	1														
RWC of flag leaf (%)	-0.129*	-0.171**	-0.114*	-0.072	1													
Chlorophyll content	-0.129*	-0.171**	-0.114*	-0.072	0.913**	1												
Canopy temperature (°C)	-0.067	0.020	-0.009	0.051	-0.038	-0.038	1											
Membrane thermo-stability	-0.108	-0.089	-0.001	-0.051	-0.058	-0.058	-0.070	1										
Plant height(cm)	0.026	0.106	0.111	0.078	0.011	0.011	-0.067	-0.087	1									
No. of effective tillers plant^{-1}	0.080	0.152**	0.186**	-0.030	0.006	0.006	0.053	0.043	-0.031	1								
No. of ears plant^{-1}	0.032	0.082	0.186**	-0.006	-0.020	-0.020	-0.003	-0.004	-0.011	0.893**	1							
No. of spikelets ear^{-1}	0.247**	0.208**	0.172**	0.101	-0.128*	-0.128*	0.003	0.054	-0.045	0.019	0.095	1						
Length of ear (cm)	0.086	0.043	0.109	-0.027	-0.098	-0.098	-0.024	-0.034	0.153**	0.106	0.133*	0.561**	1					
Spike density	0.155**	0.159**	0.069	0.109	-0.007	-0.007	0.048	0.090	-0.235**	-0.124*	-0.089	0.313**	-0.519**	1				
No. of grains ear^{-1}	0.233**	0.191**	0.185**	0.141*	-0.121*	-0.121*	-0.037	0.154**	-0.110	0.079**	0.123*	0.800**	0.555**	0.140*	1			
1000-grain weight (g)	-0.260**	-0.319**	-0.313**	-0.048	0.114*	0.114*	0.042	-0.148*	0.024	-0.122*	-0.086	-0.197**	-0.132*	-0.065	-0.303**	1		
Biological yield plant^{-1} (g)	0.019	0.087	0.152**	0.019	0.015	0.015	-0.003	-0.031	-0.096	0.660**	0.656**	0.248**	0.285**	-0.116*	0.299**	0.044	1	
Harvest index (%)	0.072	0.008	0.002	0.004	0.004	0.004	0.047	-0.097	0.105	-0.091	-0.089	0.015	0.076	-0.059	-0.079	-0.072	0.308**	1
Grain yield plant^{-1} (g)	0.071	0.069	0.100	0.014	0.040	0.040	0.079	-0.134*	0.005	0.433**	0.413**	0.163**	0.265**	-0.156**	0.122*	-0.079	0.419**	0.604**

Table 4.7 (b):- Genotypic correlation among phenological, physiological and yield constituting traits (E_2)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.885**	1																
Days to stay green	0.761**	0.809**	1															
Days to maturity	0.569**	0.617**	0.704**	1														
RWC of flag leaf (%)	-0.155**	-0.184**	-0.178**	-0.067	1													
Chlorophyll content	-0.155**	-0.184**	-0.178**	-0.067	0.935**	1												
Canopy temperature (^oC)	-0.109	0.035	-0.048	0.045	-0.049	-0.049	1											
Membrane thermo-stability	-0.122*	-0.093	0.002	-0.082	-0.061	-0.061	-0.083	1										
Plant height(cm)	0.035	0.107	0.133*	0.073	0.010	0.010	-0.077	-0.088	1									
No. of effective tillers plant^{-1}	0.098	0.163**	0.246**	-0.016	0.008	0.008	0.061	0.044	-0.032	1								
No. of ears plant^{-1}	0.018	0.093	0.269**	0.008	-0.018	-0.018	0.014	-0.011	-0.016	0.943**	1							
No. of spikelets ear^{-1}	0.268**	0.216**	0.236**	0.157**	-0.140*	-0.140*	-0.008	0.055	-0.047	0.025	0.098	1						
Length of ear (cm)	0.096	0.049	0.103	-0.021	-0.137*	-0.137*	-0.066	-0.033	0.163**	0.117*	0.152**	0.605**	1					
Spike density	0.172**	0.166**	0.082	0.153**	-0.014	-0.014	0.060	0.094	-0.245**	-0.125*	-0.093**	0.318**	-0.592**	1				
No. of grains ear^{-1}	0.263**	0.199**	0.232**	0.220**	-0.128*	-0.128*	-0.045	0.155**	-0.111	0.081	0.129*	0.818**	0.587**	0.144*	1			
1000-grain weight (g)	-0.294**	-0.332**	-0.398**	-0.064	0.120*	0.120*	0.056	-0.148*	0.025	-0.125*	-0.090	-0.201**	-0.139*	-0.066	-0.303**	1		
Biological yield plant^{-1} (g)	0.030	0.093	0.198**	0.010	0.037	0.037	0.011	-0.031	-0.134*	0.729**	0.754**	0.273**	0.335**	-0.127*	0.325**	0.046	1	
Harvest index (%)	0.073	0.024	0.021	0.122*	-0.004	-0.004	0.023	-0.191**	0.217**	-0.162**	-0.147*	-0.012	0.123*	-0.107	-0.154**	-0.135*	-0.562**	1
Grain yield plant^{-1} (g)	0.093	0.134*	0.275**	0.228**	0.079	0.079	0.066	-0.234**	0.014	0.775**	0.809**	0.266**	0.474**	-0.255**	0.215**	-0.137*	0.668**	0.248**

Relative water content of flag leaf (RWC %)

RWC of flag leaf was found significant positively associated with chlorophyll content (0.913) followed by 1000-grain weight (0.114). Whereas, it was significant negatively associated with no. of spikelets per ear (-0.128) followed by no. of grains per ear (-0.121).

Chlorophyll Content

Chlorophyll Content was noticed significant positive association with 1000-grain weight (0.114). Whereas it was significant negatively associated with no. of spikelets per ear (-0.128) and no. of grains per ear (-0.121).

Canopy temperature

Canopy temperature was positively associated with grain yield per plant (0.079) followed by no. of effective tillers per plant (0.053).

Membrane thermo-stability

Membrane thermo-stability was significant positively associated with no. of grains per ear (0.154), It was significant negatively associated with 1000-grain weight (-0.148), grain yield per plant (-0.134).

Plant height (cm)

Plant height was significant positively associated with length of ear (0.153) and significant negatively correlated with spike density (-0.235). While, it was reported non-significant positively associated with harvest index (0.105).

Number of effective tillers per plant

No. of effective tillers per plant was noticed significant positively associated with no. of ears per plant (0.893) followed by biological yield per plant (0.660), grain yield per plant (0.433). Whereas, it was significant negatively correlated with spike

density (-0.124), 1000-grain weight (-0.122). However, it was recorded non-significant positively associated with length of ear (0.106).

Number of ears per plant

No. of ears per plant was exhibited significant positive association with biological yield per plant (0.656) followed by grain yield per plant (0.413) length of ear (0.133), no. of grains per ear (0.123).

Number of spikelets per ear

No. of spikelets per ear was observed significant positively associated with no. of grains per ear (0.800) followed by length of ear (0.561), spike density (0.313), biological yield per plant (0.248), grain yield per plant (0.163), but significant negatively correlated with 1000-grain weight (-0.197).

Length of ear (cm)

Length of ear was significant positively associated with no. of grains per ear (0.555), biological yield per plant (0.285), grain yield per plant (0.265), where it was significant negatively correlated with spike density (-0.519), 1000-grain weight (-0.132).

Spike density

Spike density was significant positively associated with no. of grains per ear (0.140) while it was found significant negatively correlated with grain yield per plant (-0.156) and biological yield per plant (-0.116).

Number of grains per ear

No. of grains per ear was significant positively associated with biological yield per plant (0.299), grain yield per plant (0.122) but significant negatively correlated with 1000-grain weight (-0.303).

1000-grain weight (g)

1000-grain weight was non-significant positively associated with grain yield per plant (0.079) and harvest index (0.072).

Biological yield per plant (g)

Biological yield per plant was significant positively associated with grain yield per plant (0.419) but negatively correlated with harvest index (-0.308).

Third environment (E_3)

The phenotypic and genotypic correlation coefficient for different pairs of characters was studied and results presented in table 4.8 (a) and table 4.8 (b). The phenotypic correlation coefficient for grain yield per plant was significant and positively associated with harvest index (0.634) followed by no. of effective tillers per plant (0.609), no. of ears per plant (0.582), biological yield per plant (0.430),length of ear (0.274), no. of grains per ear (0.216), no. of spikelets per ear (0.144). Whereas, spike density (-0.174) was observed significant negatively associated with grain yield per plant.

The results obtain from phenotypic correlation coefficients for different pair of characters in third environment presented character wise. (Table 4.8.a)

Days to full stem elongation

Days to full stem elongation was found significant and positively associated with days to 50% heading (0.808), days to stay green (0.688), days to maturity (0.622), no. of spikelets per ear (0.247), no. of grains per ear (0.225), but it was significant negatively correlated with 1000-grain weight (-0.303), biological yield per plant (-0.166), RWC of flag leaf (-0.131).

Days to 50% heading

Days to 50% heading was found significant positive association with days to stay green (0.835), days to maturity

Table 4.8 (a):- Phenotypic correlation among phenological, physiological and yield constituting traits (E_3)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (°C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.808**	1																
Days to stay green	0.688**	0.835**	1															
Days to maturity	0.622**	0.778**	0.707**	1														
RWC of flag leaf (%)	-0.131*	-0.135*	-0.138*	-0.156**	1													
Chlorophyll content	-0.094	-0.120*	-0.124*	-0.136*	0.911**	1												
Canopy temperature (°C)	-0.022	0.092	0.011	0.214**	0.005	-0.054	1											
Membrane thermo-stability	-0.104	-0.109	-0.079	-0.107	-0.040	-0.133*	-0.003	1										
Plant height(cm)	0.024	0.098	0.048	0.064	-0.017	-0.026	-0.052	-0.138*	1									
No. of effective tillers plant^{-1}	0.075	0.173**	0.126*	0.173**	0.054	-0.017	0.126*	0.070	-0.053	1								
No. of ears plant^{-1}	0.030	0.108	0.063	0.136*	0.062	-0.063	0.106	0.017	-0.075	0.847**	1							
No. of spikelets ear^{-1}	0.247**	0.201**	0.175**	0.196**	-0.054	-0.072	0.025	0.070	-0.022	0.018**	0.088	1						
Length of ear (cm)	0.087	0.089	0.016	0.119*	-0.084	-0.106	0.115*	-0.091	0.106	0.127**	0.158**	0.520**	1					
Spike density	0.103	0.096	0.159**	0.049	0.062	0.069	-0.074	0.133*	-0.119*	-0.123*	-0.081	0.258**	-0.629**	1				
No. of grains ear^{-1}	0.225**	0.207**	0.195**	0.205**	-0.081	-0.127*	0.050	0.183**	-0.089	0.078	0.155**	0.779**	0.495**	0.129*	1			
1000-grain weight (g)	-0.303**	-0.320**	-0.284**	-0.206**	0.213**	0.181**	-0.032	-0.074	0.014	-0.132*	-0.068	-0.218**	-0.085**	-0.098	-0.313**	1		
Biological yield plant^{-1} (g)	-0.166**	-0.087	-0.121*	-0.010	0.159**	0.068	0.056	-0.076	-0.089	0.434**	0.510**	0.163**	0.148*	0.024	0.177**	0.096	1	
Harvest index (%)	-0.041	-0.055	-0.054	-0.052	-0.004	-0.047	-0.104	0.090	-0.060	0.176**	0.182**	0.002	0.077	-0.109	0.088	0.011	0.013	1
Grain yield plant^{-1} (g)	-0.015	0.048	0.021	0.078	0.086	0.058	0.002	0.015	-0.059	0.609**	0.582**	0.144*	0.274**	-0.174**	0.216**	0.018	0.430**	0.634**

Table 4.8 (b):- Genotypic correlation among phenological, physiological and yield constituting traits (E_3)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1																	
Days to 5% heading	0.944**	1																
Days to stay green	0.940**	0.996**	1															
Days to maturity	0.807**	0.912**	0.907**	1														
RWC of flag leaf (%)	-0.157**	-0.152**	-0.153**	-0.169**	1													
Chlorophyll content	-0.113	-0.134*	-0.137*	-0.145*	0.903**	1												
Canopy temperature (^oC)	-0.009	0.130*	0.106	0.273**	-0.016	-0.105	1											
Membrane thermo-stability	-0.118*	-0.113	-0.088	-0.123*	-0.042	-0.139*	-0.007	1										
Plant height(cm)	0.038	0.104	0.054	0.072	-0.018	-0.028	-0.084	-0.139*	1									
No. of effective tillers plant^{-1}	0.093	0.188**	0.159**	0.207**	0.062	-0.014	0.157**	0.072	-0.054	1								
No. of ears plant^{-1}	0.034	0.126*	0.091	0.152**	0.063	-0.076	0.171**	0.021	-0.065	0.941**	1							
No. of spikelets ear^{-1}	0.256**	0.216**	0.223**	0.237**	-0.063	-0.082	0.035	0.072	-0.021	0.015	0.101	1						
Length of ear (cm)	0.095	0.091	0.034	0.122*	-0.081	-0.105	0.162**	-0.093	0.112	0.126*	0.176**	0.556**	1					
Spike density	0.149**	0.117*	0.177**	0.092	0.052	0.062	-0.111	0.152**	-0.139*	-0.126*	-0.105	0.305**	-0.620**	1				
No. of grains ear^{-1}	0.252**	0.214**	0.227**	0.234**	-0.085	-0.132*	0.073	0.183**	-0.090	0.080	0.165**	0.805**	0.508**	0.149**	1			
1000-grain weight (g)	-0.342**	-0.331**	-0.331**	-0.236**	0.224**	0.188**	-0.045	-0.074	0.015	-0.135*	-0.073	-0.226**	-0.087	-0.112	-0.313**	1		
Biological yield plant^{-1} (g)	-0.182**	-0.093	-0.152**	-0.028	0.165**	0.067	0.055	-0.079	-0.110	0.458**	0.577**	0.181**	0.157**	0.033	0.183**	0.099	1	
Harvest index (%)	-0.148*	-0.136*	-0.118*	-0.271**	0.160**	0.033	-0.207**	0.249**	-0.174**	0.402**	0.446**	0.026	0.134*	-0.175**	0.226**	-0.013	0.009	1
Grain yield plant^{-1} (g)	-0.019	0.075	0.043	0.061	0.206**	0.155**	0.020	0.030	-0.096	0.942**	0.981**	0.233**	0.385**	-0.194**	0.339**	0.023	0.636**	0.230**

(0.778), no. of grains per ear (0.207), no. of spikelets per ear (0.201) and no. of effective tillers per plant (0.173), but it was significant negatively correlated with 1000-grain weight (-0.320), RWC of flag leaf (-0.135), chlorophyll content (-0.120).

Days to stay green

Days to stay green was found significant positive association with days to maturity (0.707), no. of grains per ear (0.195), no. of spikelets per ear (0.175), spike density (0.159) and no. of effective tillers per plant (0.126). While, it was noticed significant negative correlation with 1000-grain weight (-0.284), RWC of flag leaf (-0.138), chlorophyll content (-0.124), biological yield per plant (-0.121).

Days to maturity

Days to maturity was significant and positively associated with canopy temperature (0.214), no. of grains per ear (0.205), no. of spikelets per ear(0.196), no. of effective tillers per plant (0.173), no. of ears per plant (0.136), length of ear (0.119). Where it found significant negatively associated with 1000-grain weight (-0.206), RWC of flag leaf (-0.156), chlorophyll content (-0.136).

Relative Water Content of flag leaf (RWC %)

RWC of flag leaf was recorded significant positively correlated with chlorophyll content (0.911), 1000-grain weight (0.213) and biological yield per plant (0.159).

Chlorophyll content

Chlorophyll content was exhibited significant positive correlation with 1000-grain weight (0.181) while significant negatively correlated with membrane thermo-stability (-0.133), no. of grains per ear (-0.127).

Canopy temperature (^{o}C)

Canopy temperature was revealed significant positive

association with no. of effective tillers per plant (0.126) and length of ear (0.115), but it was non-significant positive correlated with no. of ears per plant (0.106).

Membrane thermo-stability

Membrane thermo-stability was observed significant positively associated with no. of grains per ear (0.183) and spike density (0.133), but it was significant negatively associated with plant height (-0.138).

Plant height (g)

Plant height was found significant negatively association with spike density (-0.119).

No. of effective tillers per plant

No. of effective tillers per plant was significant positively associated with no. of ears per plant(0.847), grain yield per plant (0.609), biological yield per plant (0.434), harvest index (0.176), length of ear (0.127), and significant negatively associated with spike density (-0.123).

No. of ears per plant

No. of ears per plant was exhibited significant positive association with grain yield per plant (0.582), biological yield per plant (0.510), harvest index (0.182), length of ear (0.158), no. of grains per ear (0.155).

No. of spikelets per ear

No. of spikelets per ear was noticed significant positively associated with no. of grains per ear (0.779), length of ear (0.520), spike density (0.258), biological yield per plant (0.163), grain yield per plant (0.144).

Length of ear (g)

Length of ear was found significant and positive association with no. of grains per ear (0.495), grain yield per plant (0.274), biological yield per plant (0.148).While, it was showed significant

negative association with spike density (-0.629).

Spike density

Spike density exhibited significant positive association with no. of grains per ear (0.129) but significant negatively associated with grain yield per plant (-0.174). Non-significant negative association was found with harvest index (-0.109).

No. of grains per ear

No. of grains per ear was notice significant positively associated with grain yield per plant (0.216) and biological yield per plant (0.177), while significant negatively associated with 1000-grain weight (-0.313).

1000-grain weight (g)

1000-grain weight was observed non-significant positively associated biological yield per plant (0.096).

Biological yield per plant (g)

Biological yield per plant was exhibited significant positive association with grain yield per plant (0.430).

Harvest index (%)

Harvest index showed positive and significant association with grain yield per plant (0.634).

Pooled

The phenotypic and genotypic correlation coefficient for different pairs of characters was studied and results presented in table 4.7 (a) and table 4.7 (b). The phenotypic correlation coefficient for grain yield per plant was recorded significant positive associated with biological yield per plant (0.675), harvest index (0.666), no. of ears per plant (0.542), no. of effective tillers per plant (0.529), length of ear (0.280), no. of grains per ear (0.219), no. of spikelets per ear (0.213). While, it was significant negatively associated with canopy temperature (-0.120).

The results obtain from phenotypic correlation coefficients for different pair of characters presented character wise. (Table 4.9.a)

Days to full stem elongation

Days to full stem elongation was noticed significant positive associated with days to 50% heading (0.804), days to stay green(0.618), days to maturity (0.578), no. of spikelets per ear (0.193), no. of grains per ear (0.180). Whereas, it was recorded significant negatively correlated with RWC of flag leaf (-0.269).

Days to 50% heading

Days to 50% heading was recorded significant positively associated with days to stay green (0.785), days to maturity (0.720), no. of ears per plant (0.217), no. of spikelets per ear (0.211), no. of grains per ear (0.182), biological yield per plant (0.127), spike density (0.106) but It was observed significant negatively correlated with 1000-grain weight (-0.311), RWC of flag leaf (-0.25), chlorophyll content (-0.168).

Days to stay green

Days to stay green was recorded significant positively associated with days to maturity (0.612), biological yield per plant (0.317), no. of spikelets per ear (0.265), no. of ears per plant (0.2314), membrane thermo-stability (0.202), no. of grains per ear (0.182), length of ear (0.164), spike density (0.138), no. of effective tillers per plant (0.130), plant height (0.142). It was significant negatively correlated with 1000-grain weight (-0.209), canopy temperature (-0.187).

Days to maturity

Days to maturity was noticed significant positive association with no. of ears per plant (0.191), no. of spikelets per ear (0.143), no. of grains per ear (0.1210), but it was found significant negative correlated with 1000-grain weight (-0.161).

Table 4.9 (a):- Phenotypic correlation among phenological, physiological and yield constituting traits (Pooled)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1.000																	
Days to 5% heading	0.804 **	1.000																
Days to stay green	0.618 **	0.785**	1.000															
Days to maturity	0.578**	0.72 **	0.61 **	1.000														
RWC of flag leaf (%)	-0.269**	-0.25**	-0.07*	-0.216**	1.000													
Chlorophyll content	-0.14 **	-0.168**	-0.042	-0.162**	0.908**	1.000												
Canopy temperature (^{o}C)	0.045	0.016	-0.187**	0.050	-0.41**	-0.231**	1.000											
Membrane thermo-stability	-0.034	0.012	0.202**	0.029	0.20**	0.0765*	-0.397**	1.000										
Plant height(cm)	0.007	0.065*	0.142**	0.018	0.145**	0.109**	-0.147**	0.003	1.000									
No. of effective tillers plant^{-1}	-0.059	0.054	0.130**	0.020	0.278**	0.149**	-0.299**	0.227**	0.029	1.000								
No. of ears plant^{-1}	0.099**	0.217**	0.2314**	0.1910**	0.003	-0.023	-0.095**	0.112**	-0.048	0.814**	1.000							
No. of spikelets ear^{-1}	0.193**	0.211**	0.265**	0.143**	0.130**	0.017	-0.328**	0.301**	0.034	0.221**	0.181**	1.000						
Length of ear (cm)	0.039	0.0707 *	0.164**	0.068*	0.167**	0.041	-0.317**	0.206**	0.190**	0.280**	0.197**	0.634**	1.000					
Spike density	0.090 **	0.1068*	0.138**	0.036	0.089**	0.068*	-0.113**	0.154**	-0.088*	-0.009	-0.032	0.307**	-0.409**	1.000				
No. of grains ear^{-1}	0.180 **	0.1815**	0.182**	0.1210**	0.041	-0.041	-0.185**	0.246**	-0.057	0.174**	0.164**	0.781**	0.560**	0.162**	1.000			
1000-grain weight (g)	-0.30**	-0.311**	-0.209**	-0.161**	0.238 **	0.184**	-0.082*	-0.009	0.061	-0.002	-0.064	-0.091*	-0.020	-0.057	-0.246**	1.000		
Biological yield plant^{-1} (g)	0.020	0.127**	0.317 **	0.085 **	0.194 **	0.119**	-0.340**	0.275**	0.044	0.6010"*	0.567**	0.383**	0.388**	0.051	0.292**	0.102**	1.000	
Harvest index (%)	0.065	0.016	0.030	-0.020	0.094**	0.063	-0.175 **	0.101*	0.0015	0.2112**	0.1681**	0.118**	0.169**	0.0015	0.110**	-0.033	0.186**	1.000
Grain yield plant^{-1} (g)	0.091	0.132	0.172	0.074	0.031	0.039	-0.120**	0.084	-0.044	0.529**	0.542**	0.213**	0.280**	-0.048	0.219**	-0.025	0.675**	0.666**

Table 4.9 (b):- Genotypic correlation among phenological, physiological and yield constituting traits (Pooled)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	1.000																	
Days to 5% heading	0.967	1.000																
Days to stay green	0.814	0.874	1.000															
Days to maturity	0.865	0.885	0.855	1.000														
RWC of flag leaf (%)	-0.469	-0.372	-0.124	-0.284	1.000													
Chlorophyll content	-0.292	-0.237	-0.076	-0.156	0.865	1.000												
Canopy temperature (^oC)	0.166	0.094	-0.253	0.094	-0.628	-0.429	1.000											
Membrane thermo-stability	-0.058	-0.008	0.335	0.077	0.362	0.177	-0.604	1.000										
Plant height(cm)	-0.113	-0.049	0.057	-0.035	0.224	0.122	-0.372	0.149	1.000									
No. of effective tillers plant^{-1}	-0.189	-0.085	0.081	-0.013	0.602	0.424	-0.492	0.408	0.083	1.000								
No. of ears plant^{-1}	0.216	0.253	0.334	0.302	0.048	0.025	-0.102	0.241	0.008	0.709	1.000							
No. of spikelets ear^{-1}	0.093	0.163	0.407	0.208	0.355	0.215	-0.550	0.390	0.036	0.468	0.371	1.000						
Length of ear (cm)	-0.017	0.026	0.264	0.124	0.375	0.195	-0.497	0.370	0.268	0.522	0.373	0.747	1.000					
Spike density	0.023	0.081	0.158	0.002	0.200	0.183	-0.294	0.154	-0.232	0.079	-0.035	0.407	-0.269	1.000				
No. of grains ear^{-1}	0.082	0.062	0.211	0.133	0.277	0.162	-0.360	0.248	-0.078	0.400	0.378	0.852	0.695	0.209	1.000			
1000-grain weight (g)	-0.563	-0.489	-0.325	-0.369	0.363	0.267	-0.160	0.144	0.193	0.294	0.133	0.106	0.200	-0.049	0.003	1.000		
Biological yield plant^{-1} (g)	0.153	0.245	0.484	0.310	0.322	0.221	-0.528	0.484	0.142	0.634	0.717	0.763	0.743	0.089	0.599	0.352	1.000	
Harvest index (%)	-0.020	0.141	0.372	0.118	0.371	0.290	-0.503	0.470	0.216	0.641	0.604	0.681	0.574	0.209	0.572	0.114	0.711	1.000
Grain yield plant^{-1} (g)	0.244	0.309	0.411	0.344	0.052	0.116	-0.169	0.223	0.020	0.591	0.853	0.611	0.591	-0.011	0.539	0.206	0.816	0.720

Relative Water Content of flag leaf (%)

RWC of flag leaf (%) was found significant positively associated with chlorophyll content (0.908), no. of effective tillers per plant (0.278), 1000-grain weight (0.238), biological yield per plant (0.194), length of ear (0.167), plant height (0.145).

Chlorophyll content

Chlorophyll content was recorded significantly positive correlated with no. of effective tillers per plant (0.149), 1000-grain weight (0.184), biological yield per plant (0.119), plant height (0.109) but it was significant negatively correlated with canopy temperature (-0.231).

Canopy temperature (^{O}C)

Canopy temperature was observed significant negative association with membrane thermo-stability (-0.397), biological yield per plant (-0.340), no. of spikelets per ear (-0.328), length of ear (-0.317), no. of effective tillers per plant (-0.299), no. of grains per ear (-0.185), harvest index (-0.175), plant height (-0.147) and spike density (-0.113).

Membrane thermo-stability

Membrane thermo-stability was exhibited significant positive association with no. of spikelets per ear (0.301), biological yield per plant (0.275), no. of grains per ear (0.246), no. of effective tillers per plant (0.227), length of ear (0.206), spike density (0.154), no. of ears per plant (0.112), harvest index (0.101).

Plant height (cm)

Plant height was recorded significant positive association with length of ear (0.190).

Number of effective tillers per plant

No. of effective tillers per was recorded significant positive association with plant no. of ears per plant (0.814), biological

yield per plant (0.6010), length of ear (0.280), no. of spikelets per ear (0.221), harvest index (0.211) and no. of grains per ear (0.174).

Number of ears per plant

No. of ears per plant was exhibited significant positive association with biological yield per plant (0.567), length of ear (0.197), no. of spikelets per ear (0.181), harvest index (0.168) and no. of grains per ear (0.164).

Number of spikelets per ear

No. of spikelets per ear was observed significant positively associated with no. of grains per ear (0.781), length of ear (0.634), biological yield per plant (0.383), spike density (0.307) and harvest index (0.118).

Length of ear (cm)

Length of ear was found significant positive association with no. of grains per ear (0.560), biological yield per plant (0.388) and harvest index (0.169), but it was significant negatively associated with spike density (-0.409).

Spike density

Spike density was showed significant positively associated with no. of grains per ear (0.162).

Number of grains per ear

No. of grains per ear was found significant positively associated with biological yield per plant (0.292), harvest index (0.110) while significant negatively associated with 1000-grain weight (-0.246).

1000-grain weight (g)

1000-grain weight was exhibited significant positive association with grain yield per plant (0.675) and biological yield

per plant (0.102).

Biological yield per plant (g)

Biological yield per plant was significant positively associated with grain yield per plant (0.675) and harvest index (0.186).

Harvest index (%)

Harvest index showed significant positive association with grain yield per plant (0.666).

4.4.2 Path analysis

It is a standardized partial regression coefficient, which splits the correlation coefficients into the measures of direct and indirect effects. It measures the direct and indirect contribution of various independent characters on a dependent character. It is three types for replicated data viz., phenotypic, genotypic and environmental path coefficient.

First environment (E_1)

The phenotypic and genotypic path coefficients for different pairs of characters had studied and results presented in table 4.10 (a) and table 4.10 (b). Path coefficients has worked out from all possible genotypic correlation coefficients of all the various characters under study constitute the genotypic path coefficients. The estimates of genotypic path coefficients for yield and yield attributing traits on grain yield furnished in table 4.10 (b). The result obtained from present investigation for direct and indirect effects presented character wise as:

Direct effect

This direct effect of character under studied on grain yield per plant. Higher positive direct effect on grain yield was biological yield per plant (0.7251) followed by harvest index

(0.3281), days to stay green (0.2560). The high negative direct effect observed by days to 50% heading (-0.2300).

Indirect effect

Days to full stem elongation was showed negative indirect effect viadays to 50% heading (-0.0141), days to full stem elongation (-0.0138), harvest index (-0.0138).

Days to 50% heading was recorded positive indirect effect on grain yield per plant via 1000-grain weight (0.0739) but it was noticed negative indirect effect via days to stay green (-0.2231), days to full stem elongation (-0.2077), days to maturity (-0.1895). Days to stay green was observed positive indirect effect on grain yield per plant via days to 50% heading (0.2483), days to full stem elongation (0.2367), days to maturity (0.2114).

Days to maturity was exhibited positive indirect effect on grain yield per plant via days to 50% heading (0.0162), days to stay green (0.0162) and days to full stem elongation (0.0145).

Canopy temperature was found positive indirect effect on grain yield per plant via1000-grain weight (0.0245)

Membrane thermo-stability was reported positive indirect effect on grain yield per plant via canopy temperature (0.0051).

Number of effective tillers per plant exhibited positive indirect effect on grain yield per plant via no. of ears per plant (0.0347).

Number of spikelets per ear was reported positive indirect effect on grain yield per plant via no. of grains per ear (0.0376).

Length of ear was observed positive indirect effect on grain yield per plant via spike density (0.0224).

Spike density was reported positive indirect effect on grain yield per plant via length of ear (0.0372). Whereas, it was exhibited negative indirect effect via no. of spikelets per ear (-0.0274).

Number of grains per ear was exhibited positive indirect

Table 4.10 (a):- Phenotypic path among phenological, physiological and yield constituting traits (E_1)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**0.0246**	0.0196	0.0168	0.0149	0.0008	-0.0021	-0.0050	-0.0020	0.0011	0.0000	0.0000	0.0049	0.0013	0.0028	0.0054	-0.0074	-0.0006	-0.0006
Days to 5% heading	0.0225	**0.0283**	0.0234	0.0201	0.0000	-0.0041	-0.0061	-0.0029	0.0031	0.0030	0.0031	0.0058	0.0016	0.0034	0.0062	-0.0089	0.0018	0.0013
Days to stay green	-0.0227	-0.0275	**-0.0332**	-0.0198	-0.0009	0.0058	0.0061	0.0015	-0.0008	-0.0013	-0.0014	-0.0030	0.0013	-0.0051	-0.0028	0.0088	-0.0005	0.0006
Days to maturity	0.0054	0.0063	0.0053	**0.0089**	-00001	-0.0007	-0.0003	-0.0010	0.0009	0.0003	0.0003	-0.0004	0.0001	-0.0002	0.0002	-0.0017	-0.0003	-0.0002
RWC of flag leaf (%)	0.0006	0.0000	0.0005	-0.0002	**0.0181**	0.0008	-0.0023	0.0014	-0.0005	-0.0012	-0.0010	-0.0016	-0.0007	-0.0008	-0.0001	-0.0022	-0.0014	-0.0004
Chlorophyll content	0.0003	0.0005	0.0007	0.0003	-0.0002	**-0.0037**	-0.0002	0.0003	0.0001	0.0000	0.0000	0.0003	0.0005	0.0000	0.0004	-0.0004	-0.0002	0.0001
Canopy temperature (^oC)	-0.0085	-0.0090	-0.0076	-0.0016	-0.0052	0.0023	**0.0417**	-0.0053	-0.0003	-0.0067	-0.0073	-0.0052	-0.0044	-0.0021	-0.0077	0.0108	-0.0053	-0.0097
Membrane thermo-stability	0.0016	0.0020	0.0009	0.0023	-0.0015	0.0013	0.0026	**-0.0200**	0.0021	-0.0004	0.0001	-0.0014	0.0006	-0.0018	-0.0031	0.0028	0.0004	-0.0001
Plant height(cm)	-0.0001	-0.0002	0.0000	-0.0002	0.0000	0.0001	0.0000	0.0002	**-0.0015**	0.0001	0.0001	0.0001	-0.0002	0.0000	0.0002	0.0000	0.0002	0.0000
No. of effective tillers plant^{-1}	0.0000	-0.0043	-0.0015	-0.0012	0.0027	-0.0002	0.0065	-0.0008	0.0026	**-0.0400**	-0.0390	-0.0057	-0.0062	-0.0009	-0.0061	0.0029	-0.0319	-0.0248
No. of ears plant^{-1}	0.0000	0.0033	0.0013	0.0009	-0.0016	0.0001	-0.0054	-0.0001	-0.0018	0.0301	**0.0309**	0.0043	0.0049	0.0001	0.0046	-0.0023	0.0246	0.0184
No. of spikelets ear^{-1}	-0.0058	-0.0060	-0.0027	0.0012	0.0025	0.0024	0.0037	-0.0021	0.0010	-0.0042	-0.0041	**-0.0293**	-0.0163	-0.0087	-0.0238	0.0061	-0.0086	-0.0076
Length of ear (cm)	0.0014	0.0014	-0.0010	0.0003	-0.0010	-0.0037	-0.0027	-0.0008	0.0039	0.0040	0.0041	0.0142	**0.0255**	-0.0117	0.0141	-0.0034	0.0065	0.0052
Spike density	-0.0003	-0.0003	-0.0004	0.0001	0.0001	0.0000	0.0001	-0.0002	0.0001	-0.0001	0.0000	-0.0008	0.0013	**-0.0028**	-0.0004	0.0003	-0.0001	-0.0004
No. of grains ear^{-1}	-0.0061	-0.0060	-0.0023	-0.0006	0.0002	0.0028	0.0051	-0.0043	0.0029	-0.0042	-0.0041	-0.0224	-0.0152	-0.0042	**-0.0276**	0.0080	-0.0085	-0.0092
1000-grain weight (g)	0.0055	0.0057	0.0049	0.0035	0.0022	-0.0022	-0.0047	0.0025	-0.0001	0.0013	0.0013	0.0038	0.0024	0.0018	0.0053	**-0.0183**	-0.0007	-0.0003
Biological yield plant^{-1} (g)	-0.0198	0.0506	0.0127	-0.0280	-0.0611	0.0448	-0.1024	-0.0148	-0.1312	0.6399	0.6405	0.2361	0.2063	0.0322	0.2467	0.0309	**0.8032**	0.5186
Harvest index (%)	-0.0071	0.0129	-0.0046	-0.0054	-0.0065	-0.0094	-0.0631	0.0012	-0.0021	0.1680	0.1618	0.0708	0.0549	0.0415	0.0909	0.0045	0.1751	**0.2712**
Grain yield plant^{-1} (g)	-0.0085	0.0775	0.0130	-0.0044	-0.0514	0.0343	-0.1266	-0.0474	-0.1205	0.7886	0.7851	0.2705	0.2579	0.0434	0.3022	0.0305	0.9537	0.7619

Table 4.10 (b):- Genotypic path among phenological, physiological and yield constituting traits (E_1)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (°C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**-0.0153**	-0.0138	-0.0141	-0.0113	-0.0020	0.0018	0.0042	0.0014	-0.0006	0.0000	0.0000	-0.0034	-00012	-0.0016	-0.0037	0.0052	0.0002	0.0009
Days to 5% heading	-0.2077	**-0.2300**	-0.2231	-0.1895	0.0002	0.0361	0.0589	0.0242	-0.0260	-0.0248	-0.0248	-0.0488	-0.0131	-0.0305	-0.0514	0.0739	-0.0158	-0.0142
Days to stay green	0.2367	0.2483	**0.2560**	0.2114	0.0096	-0.0519	-0.0744	-0.0125	0.0085	0.0085	0.0089	0.0272	-0.0089	0.0496	0.0250	-0.0791	0.0096	-0.0039
Days to maturity	0.0145	0.0162	0.0162	**0.0196**	-0.0009	-0.0019	-0.0015	-0.0024	0.0022	0.0007	0.0004	-0.0009	0.0000	-0.0004	0.0004	-0.0043	-0.0007	-0.0004
RWC of flag leaf (%)	0.0020	0.0000	0.0006	-0.0007	**0.0154**	0.0007	-0.0020	0.0014	-0.0003	-0 0011	-0.0011	-0.0015	-0.0009	-0.0007	-0.0001	-0.0022	-0.0017	-0.0002
Chlorophyll content	-0.0016	-0.0021	-0.0027	-0.0013	0.0006	**0.0134**	0.0008	-0.0010	-0.0006	0.0001	0.0002	-0.0011	-0.0017	-0.0003	-0.0015	0.0017	0.0008	-0.0006
Canopy temperature (°C)	-0.0211	-0.0198	-0.0225	-0.0058	-0.0100	0.0046	**0.0775**	-0.0121	-0.0016	-0.0150	-0.0162	-0.0120	-0.0111	-0.0042	-0 0177	0.0245	-0.0116	-0.0224
Membrane thermo-stability	0.0031	0.0034	0.0016	0.0040	-0.0030	0.0024	0.0051	**-0.0323**	0.0035	-0.0005	0.0004	-0.0023	0.0011	-0-0031	-0.0050	0.0045	0.0007	-0.0002
Plant height(cm)	0.0011	0.0031	0.0009	0.0031	-0.0006	-0.0012	-0.0006	-0.0030	**0.0274**	-0.0018	-0.0016	-0.0009	0.0046	-00012	-0.0029	0.0002	-0.0045	-0.0004
No. of effective tillers plant^{-1}	-0.0001	0.0037	0.0012	0.0012	-0.0025	0.0003	-0.0067	0.0006	-0.0023	**0.0347**	0.0347	0.0051	0.0059	0.0006	0.0054	-0.0026	0.0290	0.0252
No. of ears plant^{-1}	0.0000	-0.0002	-0.0001	0.0000	0.0001	0.0000	0.0004	0.0000	0.0001	-0.0019	**-0.0019**	-0.0003	-0.0003	0.0000	-0.0003	0.0001	-0.0016	-0.0015
No. of spikelets ear^{-1}	0.0101	0.0098	0.0049	-0.0021	-0.0044	-0.0039	-0.0071	0.0033	-0.0015	0.0067	0.0067	**0.0460**	0.0271	0.0144	0.0376	-0.0096	0.0139	0.0134
Length of ear (cm)	-0.0042	-0.0030	0.0018	0.0001	0.0030	0.0067	0.0076	0.0018	-0.0088	-0.0090	-0.0094	-0.0311	**-0.0528**	0.0224	-0.0308	0.0075	-0.0147	-0.0133
Spike density	-0.0090	-0.0116	-0.0170	0.0020	0.0038	0.0023	0.0048	-0.0085	0.0038	-0.0015	-0.0006	-0.0274	0.0372	**-0.0877**	-0.0144	0.0092	-0.0039	-0.0138
No. of grains ear^{-1}	0.0032	0.0029	0.0013	0.0003	-0.0001	-0.0014	-0.0029	0.0020	-0.0014	0.0020	0.0020	0.0105	0.0075	0.0021	**0.0129**	-0.0037	0.0040	0.0048
1000-grain weight (g)	0.0096	0.0091	0.0088	0.0062	0.0040	-0.0036	-0.0090	0.0039	-0.0002	0.0021	0.0022	0.0059	0.0040	0.0030	0.0082	**-0.0284**	-0.0011	-0.0005
Biological yield plant^{-1} (g)	-0.0118	0.0498	0.0273	-0.0245	-0.0785	0.0419	-0.1085	-0.0148	-0.1186	0.6053	0.6218	0.2192	0.2018	0.0323	0.2268	0.0286	**0.7251**	0.5282
Harvest index (%)	-0.0202	0.0202	-0.0050	-0.0068	-0.0048	-0.0149	-0.0948	0.0015	-0.0047	0.2385	0.2502	0.0954	0.0828	0.0516	0.1213	0.0060	0.2391	**0.3281**
Grain yield plant^{-1} (g)	-0.0107	0.0859	0.0359	0.0059	-0.0701	0.0314	-0.1484	-0.0463	-0.1210	0.8430	0.8719	0.2797	0.2820	0.0463	0.3098	0.0315	0.9668	0.8293

effect on grain yield per plant via no. of spikelets per ear (0.0105).

Biological yield per plant reported positive indirect effect on grain yield per plant via no. of ears per plant (0.6218) followed by no. of effective tillers per plant (0.6053), length of ear (0.2018), harvest index (0.5282), no. of grains per ear (0.2268), no. of spikelets per ear (0.2192), but it found negative indirect effect via plant height (-0.1186) followed by canopy temperature (-0.1085).

Harvest index recorded positive indirect effect on grain yield per plant via no. of ears per plant (0.2502) followed by biological yield per plant (0.2391), no. of effective tillers per plant (0.2385), no. of grains per ear (0.1213).

Rest of above characters showed negligible indirect effect on grain yield per plant.

Second environment (E_2)

The phenotypic and genotypic path coefficients for different pairs of characters were studied and results are presented in table 4.11 (a) and table 4.11 (b).

Path coefficients that had worked out from all possible genotypic correlation coefficients of all the various characters under study constitute the genotypic path coefficients. In general, the genotypic direct as well as indirect effects were higher in magnitude as compared to the phenotypic direct and indirect effects. The estimates of path coefficients for yield and yield attributing traits on grain yield was furnished in table 4.11 (b). The result obtained from present investigation for direct and indirect effects presented character wise as:

Direct effect

This direct effect of character under studied on grain yield. Positive direct effect on grain yield was reported biological yield per plant (0.8558) followed by harvest index (0.6586), days to full

stem elongation (0.0639), days to maturity (0.4090), no. of spikelets per ear (0.3213), no. of ears per plant (0.1816), no. of effective tillers per plant (0.1505). Whereas, it was noticed negative direct effect observed by days to stay green (-0.3089), no. of grains per ear (-0.2413), 1000-grain weight (-0.2148), spike density (-0.2127), days to 50% heading (-0.1097).

Indirect effect

Days to 50% heading was showed positive indirect effect on grain yield per plant via 1000-grain weight (0.0364). Whereas, it had negative indirect effect via days to full stem elongation (-0.0970) followed by days to stay green (-0.0887).

Days to stay green positive was reported indirect effect on grain yield per plant via 1000-grain weight (0.1229) followed by no. of ears per plant (-0.0831). However, it had negative indirect effect via days to 50% heading (-0.2499) followed by days to full stem elongation (-0.2350) and days to maturity (-0.2174).

Days to maturity was noticed positive indirect effect on grain yield per plant via days to stay green (0.2879) followed by days to 50% heading (0.2524), days to full stem elongation (0.2327) and no. of grains per ear (0.0901).

Number of effective tillers per plant was exhibited positive indirect effect on grain yield via no. of ears per plant (0.1420) followed by biological yield per plant (0.1098).

Number of ears per plant recorded positive indirect effect on grain yield per plant via no. of effective tillers per plant (0.1713) followed by biological yield per plant (0.1370).

Number of spikelets per ear was reported positive indirect effect on grain yield per plant via no. of grains per ear (0.2627) followed by length of ear (0.1943), spike density (0.1020), biological yield per plant (0.0878).

Table 4.11 (a):- Phenotypic path among phenological, physiological and yield constituting traits (E_2)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**-0.0064**	-0.0049	-0.0031	-0.0018	0.0008	0.0008	0.0004	0.0007	-0.0002	-0.0005	-0.0002	-0.0016	-0.0006	-0.0010	-0.0015	0.0017	-0.0001	-0.0005
Days to 5% heading	-0.0062	**-0.0081**	-0.0052	-0.0030	0.0014	0.0014	-0.0002	0.0007	-0.0009	-0.0012	-0.0007	-0.0017	-0.0003	-0.0013	-0.0015	0.0026	-0.0007	-0.0001
Days to stay green	-0.0087	-0.0115	**-0.0179**	-0.0061	0.0020	0.0020	0.0002	0.0000	-0.0020	-0.0033	-0.0033	-0.0031	-0.0019	-0.0012	-0.0033	0.0056	-0.0027	0.0000
Days to maturity	0.0047	0.0060	0.0056	**0.0165**	-0.0012	-0.0012	0.0008	-0.0008	0.0013	-0.0005	-0.0001	0.0017	-0.0004	0.0018	0.0023	-0.0008	0.0003	0.0001
RWC of flag leaf (%)	-0.0040	-0.0053	-0.0035	-0.0022	**0.0309**	0.0309	-0.0012	-0.0018	0.0003	0.0002	-0.0006	-0.0040	-0.0030	-0.0002	-0.0037	0.0035	0.0005	0.0001
Chlorophyll content	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Canopy temperature (^oC)	-0.0023	0.0007	-0.0003	0.0018	-0.0013	-0.0013	**0.0342**	-0.0024	-0.0023	0.0018	-0.0001	0.0001	-0.0008	0.0016	-0.0013	0.0014	-0.0001	0.0016
Membrane thermo-stability	0.0051	0.0042	0.0000	0.0024	0.0027	0.0027	0.0033	**-0.0473**	0.0041	-0.0020	0.0002	-0.0026	0.0016	-0.0043	-0.0073	0.0070	0.0015	0.0046
Plant height(cm)	-0.0007	-0.0029	-0.0030	-0.0021	-0.0003	-0.0003	0.0018	0.0024	**-0.0273**	0.0008	0.0003	0.0012	-0.0042	0.0064	0.0030	-0.0007	0.0026	-0.0029
No. of effective tillers plant^{-1}	0.0114	0.0217	0.0265	-0.0043	0.0008	0.0008	0.0075	0.0062	-0.0044	**0.1425**	0.1272	0.0027	0.0151	-0.0176	0.0112	-0.0174	0.0940	-0.0130
No. of ears plant^{-1}	-0.0009	-0.0025	-0.0056	0.0002	0.0006	0.0006	0.0001	0.0001	0.0003	-0.0268	**-0.0300**	-0.0028	-0.0040	0.0027	-0.0037	0.0026	-0.0197	0.0027
No. of spikelets ear^{-1}	0.0096	0.0081	0.0067	0.0039	-0.0050	-0.0050	0.0001	0.0021	-0.0017	0.0008	0.0037	**0.0391**	0.0219	0.0122	0.0313	-0.0077	0.0097	0.0006
Length of ear (cm)	0.0007	0.0004	0.0009	-0.0002	-0.0008	-0.0008	-0.0002	-0.0003	0.0012	0.0009	0.0011	0.0046	**0.0082**	-0.0042	0.0045	-0.0011	0.0023	0.0006
Spike density	-0.0058	-0.0059	-0.0026	-0.0040	0.0002	0.0002	-0.0018	-0.0033	0.0087	0.0046	0.0033	-0.0116	0.0193	**-0.0371**	-0.0052	0.0024	0.0043	0.0022
No. of grains ear^{-1}	-0.0075	-0.0061	-0.0060	-0.0045	0.0039	0.0039	0.0012	-0.0050	0.0035	-0.0025	-0.0039	-0.0258	-0.0179	-0.0045	**-0.0322**	0.0098	-0.0096	0.0025
1000-grain weight (g)	0.0149	0.0183	0.0180	0.0028	-0.0066	-0.0066	-0.0024	0.0085	-0.0014	0.0070	0.0050	0.0113	0.0076	0.0037	0.0174	**-0.0575**	-0.0025	0.0041
Biological yield plant^{-1} (g)	0.0112	0.0507	0.0879	0.0112	0.0088	0.0088	-0.0017	-0.0182	-0.0560	0.3828	0.3803	0.1435	0.1651	-0.0672	0.1733	0.0255	**0.5799**	-0.1787
Harvest index (%)	0.0562	0.0062	0.0014	0.0033	0.0031	0.0031	0.0367	-0.0757	0.0817	-0.0711	-0.0690	0.0116	0.0595	-0.0459	-0.0617	-0.0559	-0.2404	**0.7802**
Grain yield plant^{-1} (g)	0.0714	0.0692	0.0999	0.0139	0.0402	0.0402	0.0789	-0.1342	0.0051	0.4332	0.4130	0.1628	0.2650	-0.1560	0.1216	-0.0790	0.4193	0.6042

Table 4.11 (b):- Genotypic path among phenological, physiological and yield constituting traits (E_2)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (°C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**0.0639**	0.0565	0.0486	0.0363	-0.0099	-0.0099	-0.0070	-0.0078	0.0022	0.0063	0.0011	0.0171	0.0062	0.0110	0.0168	-0.0187	0.0019	0.0046
Days to 5% heading	-0.0970	**-0.1097**	-0.0887	-0.0677	0.0201	0.0201	-0.0038	0.0102	-0.0117	-0.0179	-0.0102	-0.0236	-0.0054	-0.0182	-0.0218	0.0364	-0.0102	-0.0027
Days to stay green	-0.2350	-0.2499	**-0.3089**	-0.2174	0.0551	0.0551	0.0149	-0.0006	-0.0411	-0.0760	-0.0831	-0.0728	-0.0318	-0.0252	-0.0718	0.1229	-0.0612	-0.0064
Days to maturity	0.2327	0.2524	0.2879	**0.4090**	-0.0273	-0.0273	0.0183	-0.0334	0.0297	-0.0067	0.0032	0.0642	-0.0085	0.0626	0.0901	-0.0260	0.0039	0.0500
RWC of flag leaf (%)	-0.0054	-0.0064	-0.0062	-0.0023	**0.0350**	0.0350	-0.0017	-0.0021	0.0003	0.0003	-0.0006	-0.0049	-0.0048	-0.0005	-0.0045	0.0042	0.0013	-0.0001
Chlorophyll content	0.0000	0.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Canopy temperature (°C)	-0.0014	0.0005	-0.0006	0.0006	-0.0006	-0.0006	**0.0133**	-0.0011	-0.0010	0.0008	0.0002	-0.0001	-0.0009	0.0008	-0.0006	0.0007	0.0001	0.0003
Membrane thermo-stability	0.0061	0.0046	-0.0001	0.0041	0.0030	0.0030	0.0041	**-0.0497**	0.0044	-0.0022	0.0006	-0.0027	0.0016	-0.0047	-0.0077	0.0074	0.0015	0.0095
Plant height(cm)	-0.0011	-0.0034	-0.0043	-0.0023	-0.0003	-0.0003	0.0025	0.0028	**-0.0321**	0.0010	0.0005	0.0015	-0.0052	0.0079	0.0036	-0.0008	0.0043	-0.0070
No. of effective tillers plant^{-1}	0.0148	0.0246	0.0370	-0.0025	0.0012	0.0012	0.0092	0.0066	-0.0048	**0.1505**	0.1420	0.0037	0.0176	-0.0189	0.0121	-0.0189	0.1098	-0.0244
No. of ears plant^{-1}	0.0032	0.0169	0.0489	0.0014	-0.0032	-0.0032	0.0025	-0.0021	-0.0029	0.1713	**0.1816**	0.0178	0.0277	-0.0170	0.0234	-0.0163	0.1370	-0.0266
No. of spikelets ear^{-1}	0.0860	0.0693	0.0757	0.0504	-0.0451	-0.0451	-0.0026	0.0177	-0.0150	0.0079	0.0316	**0.3213**	0.1943	0.1020	0.2627	-0.0645	0.0878	-0.0039
Length of ear (cm)	-0.0095	-0.0048	-0.0101	0.0020	0.0134	0.0134	0.0065	0.0032	-0.0160	-0.0115	-0.0150	-0.0593	**-0.0981**	0.0580	-0.0576	0.0136	-0.0328	-0.0121
Spike density	-0.0366	-0.0353	-0.0173	-0.0326	0.0030	0.0030	-0.0129	-0.0200	0.0521	0.0267	0.0199	-0.0675	0.1258	**-0.2127**	-0.0305	0.0140	0.0271	0.0228
No. of grains ear^{-1}	-0.0635	-0.0480	-0.0561	-0.0532	0.0310	0.0310	0.0109	-0.0375	0.0268	-0.0194	-0.0311	-0.1972	-0.1416	-0.0346	**-0.2413**	0.0732	-0.0785	0.0371
1000-grain weight (g)	0.0630	0.0713	0.0855	0.0137	-0.0258	-0.0258	-0.0121	0.0319	-0.0053	0.0269	0.0193	0.0431	0.0299	0.0141	0.0651	**-0.2148**	-0.0100	0.0290
Biological yield plant^{-1} (g)	0.0254	0.0796	0.1695	0.0082	0.0318	0.0318	0.0092	-0.0262	-0.1148	0.6242	0.6454	0.2339	0.2864	-0.1089	0.2783	0.0398	**0.8558**	-0.4805
Harvest index (%)	0.0479	0.0160	0.0137	0.0806	-0.0028	-0.0028	0.0149	-0.1256	0.1427	-0.1069	-0.0965	-0.0080	0.0813	-0.0706	-0.1014	-0.0890	-0.3698	**0.6586**
Grain yield plant^{-1} (g)	0.0935	0.1340	0.2745	0.2283	0.0787	0.0787	0.0662	-0.2337	0.0137	0.7754	0.8088	0.2664	0.4745	-0.2548	0.2150	-0.1368	0.6681	0.2482

Spike density was exhibited positive indirect effect on grain yield per plant via length of ear (0.1258).

Number of grains per ear had positive indirect effect on grain yield per plant via 1000-grain weight (0.0732). Whereas, observed negative indirect effect via no. of spikelets per ear (-0.1972), length of ear (-0.1416).

1000-grain weight recorded positive indirect effect on grain yield per plant via days to stay green (0.0855).

Biological yield per plant was reported positive indirect effect on grain yield per plant via no. of ears per plant (0.6454) followed by no. of effective tillers per plant (0.6242), length of ear (0.2864), no. of grains per ear (0.2783), no. of spikelets per ear (0.2339) and days to stay green (0.1695). However, it was recorded negative indirect effect via harvest index (-0.4805) followed by plant height (-0.1148) and spike density (-0.1089).

Harvest index had positive indirect effect on grain yield per plant via plant height (0.1427) followed by length of ear (0.0813), days to maturity (0.0806), days to full stem elongation (0.0479) and days to 50% heading (0.0160). While, it had negative indirect effect via biological yield per plant (-0.3698) followed by membrane thermo-stability (-0.1256), no. of grains per ear (-0.1014), no. of effective tillers per plant (-0.1069) no. of ears per plant (-0.0965).

Rest of above characters showed negligible indirect effect on grain yield per plant.

Third environment (E_3)

The phenotypic and genotypic path coefficient for different pairs of characters was studied and results presented in table 4.12 (a) and table 4.12 (b). Path coefficients that are worked out from all possible genotypic correlation coefficients of all the various characters under study constitute the genotypic path

coefficients. The estimates of path coefficients for yield and yield attributing traits on grain yield had furnished in table 4.12 (b). The result obtained from present investigation for direct and indirect effects presented character wise as:

Direct effect

The direct effect of characters under studied on grain yield per plant. High positive direct effect on grain yield observed no. of spikelets per ear (18.197) followed by canopy temperature (17.354), chlorophyll content (15.070), days to stay green (12.1934), days to full stem elongation (3.7148), biological yield per plant (2.8190) direct effect was no. of effective tillers per plant (0.5555) and lower membrane thermo-stability (0.3851). High negative direct effect on grain yield was revealed length of ear (-20.761) followed by spike density (-19.232), days to 50% heading (-12.9677) days to maturity (-2.3947) and lower no. of grains per ear (-1.7285), RWC of flag leaf (-1.0771) by no. of ears per plant (-0.2019) and 1000-grain weight (-0.1053).

Indirect effect

Days to full stem elongation was exhibited positive indirect effect on grain yield per plant via days to 50% heading (3.5056), days to stay green (3.4906), days to maturity (2.9973), no. of grains per ear (0.9372). Whereas, it was showed negative indirect effect on grain yield per plant via 1000-grain weight (-1.2696) followed by RWC of flag leaf (-0.5841) and chlorophyll content (-0.4192).

Days to 50% heading was recorded positive indirect effect on grain yield per plant via 1000-grain weight (4.2984) followed by RWC of flag leaf (1.9650), biological yield per plant (1.1999), harvest index (1.7681), chlorophyll content (1.7441) and membrane thermo-stability (1.4596) but it was reported negative indirect effect on grain yield per plant via days to stay green

(-12.9123) followed by days to full stem elongation (-12.2372), days to maturity (-11.8205), no. of spikelets per ear (-2.7988) and no. of grains per ear (-2.7776).

Days to stay green recorded positive indirect effect on grain yield per plant via days to 50% heading (12.1413) followed by days to full stem elongation (11.4574), days to maturity (11.0611), no. of spikelets per ear (2.7137), no. of grains per ear (2.7623), spike density (2.1597), no. of effective tillers per plant (1.9358) and no. of ears per plant (1.1154). Whereas, it was showed negative indirect effect on grain yield per plant via 1000-grain weight (-4.0389) and RWC of flag leaf (-1.8715).

Days to maturity was exhibited positive indirect effect on grain yield per plant via biological yield per plant (0.0675) followed by harvest index (0.6491), 1000-grain weight (0.5643), RWC of flag leaf (0.4041) and chlorophyll content (0.3461). While, it was observed negative indirect effect on grain yield per plant via days to 50% heading (-2.1829) followed by days to stay green (-2.1724), days to full stem elongation (-1.9322), canopy temperature (-0.6528), no. of spikelets per ear (-0.5674), no. of grains per ear (-0.5607) and no. of effective tillers per plant (-0.4953).

RWC of flag leaf was reported positive indirect effect on grain yield per plant via days to maturity (0.1818) followed by days to full stem elongation (0.1694), days to stay green (0.1653), days to 50% heading (0.1632) and no. of grains per ear (0.0919). However, it was showed high negative indirect effect on grain yield per plant via chlorophyll content (-0.9727) followed by 1000-grain weight (-0.2409), biological yield per plant (-0.1783) and harvest index (-0.1719).

Chlorophyll content was observed positive indirect effect on grain yield per plant via RWC of flag leaf (1.3609) followed by 1000-grain weight (0.2840), biological yield per plant (0.1005) and harvest index (0.0498). Whereas, it had negative indirect

Table 4.12 (a):- Phenotypic path among phenological, physiological and yield constituting traits (E_3)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**-0.0523**	-0.0423	-0.0360	-0.0326	0.0069	0.0049	0.0011	0.0055	-0.0013	-0.0039	-0.0015	-0.0129	-0.0045	-0.0054	-0.0118	0.0159	0.0087	0.0022
Days to 5% heading	0.0314	**0.0389**	0.0325	0.0303	-0.0052	-0.0047	0.0036	-0.0042	0.0038	0.0067	0.0042	0.0078	0.0035	0.0037	0.0080	-0.0124	-0.0034	-0.0021
Days to stay green	0.0313	0.0380	**0.0455**	0.0322	-0.0063	-0.0056	0.0005	-0.0036	0.0022	0.0057	0.0029	0.0080	0.0007	0.0072	0.0089	-0.0129	-0.0055	-0.0025
Days to maturity	-0.0016	-0.0020	-0.0019	**-0.0026**	0.0004	0.0004	-0.0006	0.0003	-0.0002	-0.0005	-0.0004	-0.0005	-0.0003	-0.0001	-0.0005	0.0005	0.0000	0.0001
RWC of flag leaf (%)	0.0403	0.0414	0.0424	0.0480	**-0.3073**	-0.2798	-0.0017	0.0121	0.0053	-0.0166	-0.0190	0.0167	0.0258	-0.0189	0.0249	-0.0656	-0.0489	0.0013
Chlorophyll content	-0.0351	-0.0447	-0.0462	-0.0506	0.3394	**0.3727**	-0.0200	-0.0497	-0.0098	-0.0062	-0.0236	-0.0270	-0.0396	0.0258	-0.0473	0.0674	0.0252	-0.0175
Canopy temperature (^oC)	0.0001	-0.0003	0.0000	-0.0006	0.0000	0.0002	**-0.0030**	0.0000	0.0002	-0.0004	-0.0003	-0.0001	-0.0003	0.0002	-0.0001	0.0001	-0.0002	0.0003
Membrane thermo-stability	-0.0001	-0.0002	-0.0001	-0.0002	-0.0001	-0.0002	0.0000	**0.0014**	-0.0002	0.0001	0.0000	0.0001	-0.0001	0.0002	0.0003	-0.0001	-0.0001	0.0001
Plant height(cm)	0.0003	0.0010	0.0005	0.0007	-0.0002	-0.0003	-0.0005	-0.0014	**0.0105**	-0.0006	-0.0008	-0.0002	0.0011	-0.0012	-0.0009	0.0001	-0.0009	-0.0006
No. of effective tillers plant^{-1}	0.0259	0.0600	0.0439	0.0602	0.0188	-0.0058	0.0437	0.0244	-0.0186	**0.3477**	0.2945	0.0063	0.0441	-0.0426	0.0270	-0.0457	0.1508	0.0611
No. of ears plant^{-1}	0.0028	0.0101	0.0059	0.0127	0.0058	-0.0059	0.0099	0.0016	-0.0070	0.0792	**0.0935**	0.0082	0.0148	-0.0076	0.0145	-0.0064	0.0477	0.0170
No. of spikelets ear^{-1}	-0.0005	-0.0004	-0.0004	-0.0004	0.0001	0.0002	-0.0001	-0.0001	0.0000	0.0000	-0.0002	**-0.0021**	-0.0011	-0.0005	-0.0017	0.0005	-0.0003	0.0000
Length of ear (cm)	0.0111	0.0114	0.0020	0.0152	-0.0108	-0.0136	0.0148	-0.0117	0.0136	0.0162	0.0203	0.0666	**0.1282**	-0.0806	0.0635	-0.0108	0.0190	0.0099
Spike density	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	-0.0001	0.0002	-0.0002	-0.0002	-0.0001	0.0004	-0.0009	**0.0014**	0.0002	-0.0001	0.0000	-0.0002
No. of grains ear^{-1}	0.0166	0.0153	0.0144	0.0151	-0.0060	-0.0094	0.0037	0.0135	-0.0065	0.0057	0.0114	0.0576	0.0366	0.0095	**0.0739**	-0.0231	0.0131	0.0065
1000-grain weight (g)	-0.0274	-0.0290	-0.0257	-0.0186	0.0193	0.0164	-0.0029	-0.0067	0.0013	-0.0119	-0.0062	-0.0197	-0.0077	-0.0089	-0.0284	**0.0906**	0.0087	0.0000
Biological yield plant^{-1} (g)	-0.0346	-0.0182	-0.0253	-0.0022	0.0332	0.0141	0.0117	-0.0159	-0.0186	0.0905	0.1063	0.0340	0.0310	0.0049	0.0369	0.0201	**0.2086**	0.0027
Harvest index (%)	-0.0229	-0.0307	-0.0302	-0.0291	-0.0023	-0.0261	-0.0578	0.0497	-0.0333	0.0976	0.1010	0.0010	0.0428	-0.0607	0.0489	0.0000	0.0071	**0.5556**
Grain yield plant^{-1} (g)	-0.0148	0.0484	0.0215	0.0776	0.0859	0.0576	0.0023	0.0154	-0.0588	0.6092	0.5819	0.1442	0.2740	-0.1736	0.2162	0.0179	0.4296	0.6338

Table 4.12 (b):- Genotypic path among phenological, physiological and yield constituting traits (E_3)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**3.7148**	3.5056	3.4906	2.9973	-0.5841	-0.4192	-0.0327	-0.4376	0.1416	0.3466	0.1280	0.9501	0.3541	0.5552	0.9372	-1.2696	-0.6757	-0.5495
Days to 5% heading	-12.2372	**-12.9677**	-12.912	-11.820	1.9650	1.7441	-1.6916	1.4596	-1.3456	-2.4398	-1.6304	-2.7988	-1.1820	-1.5152	-2.7776	4.2984	1.1999	1.7681
Days to stay green	11.4574	12.1413	**12.1934**	11.0611	-1.8715	-1.6672	1.2975	-1.0750	0.6611	1.9358	1.1154	2.7137	0.4118	2.1597	2.7623	-4.0389	-1.8557	-1.4364
Days to maturity	-1.9322	-2.1829	-2.1724	**-2.3947**	0.4041	0.3461	-0.6528	0.2946	-0.1717	-0.4953	-0.3638	-0.5674	-0.2917	-0.2211	-0.5607	0.5643	0.0675	0.6491
RWC of flag leaf (%)	0.1694	0.1632	0.1653	0.1818	**-1.0771**	-0.9727	0.0174	0.0448	0.0197	-0.0666	-0.0683	0.0681	0.0872	-0.0559	0.0919	-0.2409	-0.1783	-0.1719
Chlorophyll content	-0.1700	-0.2027	-0.2061	-0.2178	1.3609	**15.070**	-0.1579	-0.2096	-0.0418	-0.0214	-0.1138	-0.1236	-0.1579	0.0934	-0.1996	0.2840	0.1005	0.0498
Canopy temperature (^oC)	-0.0153	0.2264	0.1847	0.4730	-0.0280	-0.1818	**17.354**	-0.0117	-0.1457	0.2718	0.2964	0.0608	0.2814	-0.1923	0.1264	-0.0785	0.0962	-0.3589
Membrane thermo-stability	-0.0454	-0.0434	-0.0340	-0.0474	-0.0160	-0.0536	-0.0026	**0.3851**	-0.0536	0.0279	0.0079	0.0278	-0.0359	0.0586	0.0705	-0.0284	-0.0303	0.0960
Plant height(cm)	0.0365	0.0993	0.0519	0.0686	-0.0175	-0.0265	-0.0803	-0.1332	**0.9565**	-0.0514	-0.0622	-0.0201	0.1069	-0.1331	-0.0861	0.0140	-0.1049	-0.1663
No. of effective tillers plant^{-1}	0.0518	0.1045	0.0882	0.1149	0.0344	-0.0079	0.0870	0.0402	-0.0299	**0.5555**	0.5229	0.0085	0.0699	-0.0701	0.0444	-0.0751	0.2543	0.2233
No. of ears plant^{-1}	-0.0070	-0.0254	-0.0185	-0.0307	-0.0128	0.0152	-0.0345	-0.0042	0.0131	-0.1901	**-0.2019**	-0.0204	-0.0355	0.0213	-0.0332	0.0146	-0.1165	-0.0901
No. of spikelets ear^{-1}	4.6541	3.9276	4.0500	4.3118	-1.1501	-1.4926	0.6376	1.3159	-0.3833	0.2789	1.8413	**18.1976**	10.1095	5.5431	14.6490	-4.1036	3.2913	0.4810
Length of ear (cm)	-1.9789	-1.8924	-0.7012	-2.5292	1.6811	2.1747	-3.3667	1.9374	-2.3200	-2.6145	-3.6542	-11.5340	**-20.7618**	12.8651	-10.5420	1.8154	-3.2694	-2.7858
Spike density	-2.8746	-2.2473	-3.4064	-1.7759	-0.9973	-1.1923	2.1315	-2.9271	2.6763	2.4284	2.0251	-5.8584	11.9175	**-19.2325**	-2.8571	2.1449	-0.6310	3.3603
No. of grains ear^{-1}	-0.4361	-0.3702	-0.3916	-0.4047	0.1475	0.2290	-0.1259	-0.3166	0.1555	-0.1383	-0.2844	-1.3914	-0.8776	-0.2568	**-1.7285**	0.5412	-0.3163	-0.3910
1000-grain weight (g)	0.0360	0.0349	0.0349	0.0248	-0.0235	-0.0198	0.0048	0.0078	-0.0015	0.0142	0.0076	0.0237	0.0092	0.0117	0.0330	**-0.1053**	-0.0105	0.0014
Biological yield plant^{-1} (g)	-0.5128	-0.2609	-0.4290	-0.0795	0.4665	0.1880	0.1562	-0.2218	-0.3090	1.2909	1.6265	0.5099	0.4439	0.0925	0.5159	0.2799	**2.8190**	0.0247
Harvest index (%)	0.0700	0.0646	0.0558	0.1284	-0.0756	-0.0156	0.0979	-0.1181	0.0823	-0.1903	-0.2113	-0.0125	-0.0635	0.0827	-0.1071	0.0064	-0.0042	**-0.4735**
Grain yield plant^{-1} (g)	-0.0194	0.0745	0.0433	0.0613	0.2060	0.1550	0.0203	0.0305	-0.0960	0.9420	0.9809	0.2335	0.3854	-0.1937	0.3387	0.0228	0.6362	0.2302

effect on grain yield per plant via days to maturity (-0.2178) followed by membrane thermo-stability (-0.2096) and days to stay green (-0.2061).

Canopy temperature was reported positive indirect effect on grain yield per plant via days to maturity (0.4730) followed by no. of ears per plant (0.2964), length of ear (0.2814), no. of effective tillers per plant (0.2718), days to 50% heading (0.2264) and no. of grains per ear (0.1264). While, it was observed negative indirect effect on grain yield per plant via spike density (-0.1923), chlorophyll content (-0.1818) and plant height (-0.1457).

Membrane thermo-stability was exhibited positive indirect effect on grain yield per plant via harvest index (0.0960).

Plant height was recorded positive indirect effect on grain yield per plant via length of ear (0.1069) followed by days to 50% heading (0.0993) but It was exhibited negative indirect effect on grain yield per plant via harvest index (-0.1663), membrane thermo-stability (-0.1332), spike density (-0.1331) and biological yield per plant (-0.1049).

Number of effective tillers per plant exhibited positive indirect effect on grain yield per plant via no. of ears per plant (0.5229), biological yield per plant (0.2543), harvest index (0.2233), days to maturity (0.1149), days to 50% heading (0.1045).

Number of ears per plant was reported negative indirect effect on grain yield per plant via no. of effective tillers per plant (-0.1901) and biological yield per plant (-0.1165).

Number of spikelets per ear was observed positive indirect effect on grain yield per plant via no. of grains per ear (14.649) followed by length of ear (10.1095), spike density (5.5431), days to full stem elongation (4.6541), days to maturity (4.3118), days to stay green (4.050) and days to 50% heading (3.9276).

However, it was observed negative indirect effect on grain yield per plant via RWC of flag leaf (-1.1501).

Length of ear was recorded positive indirect effect on grain yield per plant via spike density (12.8651) followed by chlorophyll content (2.1747), membrane thermo-stability (1.9374) and 1000-grain weight (1.8154). However, it was notice negative indirect effect on grain yield per plant via no. of spikelets per ear (-11.5340) followed by no. of grains per ear (-10.5420) and canopy temperature (-3.3667).

Spike density was noticed positive indirect effect on grain yield per plant via length of ear (11.9175) followed by harvest index (3.3603), plant height (2.6763), no. of effective tillers per plant (2.4284) and 1000-grain weight (2.1449). Whereas, it was observed negative indirect effect on grain yield per plant via no. of spikelets per ear (-5.8584), days to stay green (-3.4064) and membrane thermo-stability (-2.9271).

Number of grains per ear exhibited high positive indirect effect on grain yield per plant via 1000-grain weight (0.5412) followed by and plant height (0.1555) but It showed negative indirect effect on grain yield per plant via no. of spikelets per ear (-1.3914) followed by length of ear (-0.8776) and days to full stem elongation (-0.4361).

Biological yield per plant was exhibited positive indirect effect on grain yield per plant via no. of ears per plant (1.6265) followed by no. of effective tillers per plant (1.2909), no. of grains per ear (0.5159) and no. of spikelets per ear (0.5099). While, it was showed negative indirect effect on grain yield per plant via days to full stem elongation (-0.5128) followed by days to stay green (-0.4290).

Harvest index was reported positive indirect effect on grain yield per plant via days to maturity (0.1284). However, it was recorded negative indirect effect on grain yield per plant via no.

of ears per plant (-0.2113) and no. of effective tillers per plant (-0.1903).

Pooled over environments

The phenotypic and genotypic path coefficient for different pairs of characters was studied and results presented in table 4.13 (a) and table 4.13 (b). The estimates of path coefficients for yield and yield attributing traits on grain yield furnished in table 4.13 (b). The result obtained from present investigation for direct and indirect effects presented character wise as:

Direct effect

The direct effect of characters under studied on grain yield per plant. Higher positive direct effect on grain yield was observed by biological yield per plant (0.7199), no. of effective tillers per plant (0.7440), no. of spikelets per ear (0.5104), chlorophyll content (0.6625), canopy temperature (0.3983) and lower direct effect was reported harvest index (0.0839). However, it higher negative direct effect on grain yield was reported by RWC of flag leaf (-1.0533), length of ear (-0.4957), spike density (-0.3363), days to maturity (-0.3296), days to stay green (-0.3113) and lower negative direct effect 1000-grain weight (-0.0539).

Indirect effect

Days to full stem elongation was exhibited positive indirect effect on grain yield per plant via chlorophyll content (0.4937) followed by days to maturity (0.4752), biological yield per plant (0.1099).While, it was reported high negative indirect effect on grain yield per plant via days to stay green (-0.3447), RWC of flag leaf (-0.2851), no. of effective tillers per plant (-0.1405) and canopy temperature (-0.1936).

Days to 50% heading was noticed high positive indirect effect on grain yield per plant via days to maturity (0.5098) followed by chlorophyll content (0.3923) and biological yield per

plant (0.1764). However, it was observed negative indirect effect on grain yield per plant via days to stay green (-0.3564) followed by RWC of flag leaf (-0.2916) and canopy temperature (-0.1571).

Days to stay green was exhibited positive indirect effect on grain yield per plant via days to maturity (0.5836) followed by biological yield per plant (0.3485), no. of spikelets per ear (0.2076), length of ear (-0.1309) and chlorophyll content (0.1300). Whereas, It was reported negative indirect effect on grain yield per plant via RWC of flag leaf (-0.2817).

Days to maturity was recorded positive indirect effect on grain yield per plant via days to stay green (0.4990) followed by RWC of flag leaf (0.2989), biological yield per plant (0.2233) and no. of spikelets per ear (0.1062). It was noticed negative indirect effect on grain yield per plant via days to 50% heading (-0.3153).

Relative Water Content of flag leaf was observed positive indirect effect on grain yield per plant via chlorophyll content (0.5728) followed by no. of effective tillers per plant (0.4477), biological yield per plant (0.2317), no. of spikelets per ear (0.1814), days to 50% heading (0.1327). While, it was reported negative indirect effect on grain yield per plant via canopy temperature (-0.2503).

Chlorophyll content was exhibited positive indirect effect on grain yield per plant via no. of effective tillers per plant (0.3158) followed by biological yield per plant (0.1589), no. of spikelets per ear (0.1096). Whereas, it was recorded negative indirect effect on grain yield per plant via RWC of flag leaf (-0.9107) followed by canopy temperature (-0.1707).

Canopy temperature was reported positive indirect effect on grain yield per plant via RWC of flag leaf (0.6619) followed by chlorophyll content (-0.2839), length of ear (0.2465) and spike density (0.0988). While, it was noticed negative indirect effect on grain yield per plant via biological yield per plant (-0.3802)

Table 4.13 (a):- Phenotypic path among phenological, physiological and yield constituting traits (Pooled)

Character	Days to full stem elongation	Days to 50% heading	Days to staygreen	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**-0.0319**	-0.0257	-0.0197	-0.0185	0.0086	0.0048	-0.0014	0.0011	-0.0002	0.0019	-0.0032	-0.0062	-0.0012	-0.0029	-0.0058	0.0096	-0.0006	-0.0021
Days to 5% heading	0.0520	**0.0647**	0.0508	0.0470	-0.0162	-0.0109	0.0010	0.0008	0.0043	0.0035	0.0141	0.0137	0.0046	0.0069	0.0117	-0.0202	0.0083	0.0010
Days to stay green	-0.0378	-0.0480	**-0.0611**	-0.0375	0.0045	0.0025	0.0111	-0.0124	-0.0087	-0.0080	-0.0141	-0.0162	-0.0101	-0.0085	-0.0111	0.0128	-0.0194	-0.0019
Days to maturity	0.0004	0.0005	0.0004	**0.0007**	-0.0001	-0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000	0.0001	-0.0001	0.0001	0.0000
RWC of flag leaf (%)	0.1105	0.1029	0.0304	0.0888	**-0.4101**	-0.3724	0.1689	-0.0850	-0.0596	-0.1143	-0.0014	-0.0534	-0.0686	-0.0366	-0.0168	-0.0980	-0.0798	-0.0388
Chlorophyll content	-0.0481	-0.0544	-0.0135	-0.0523	0.2929	**0.3226**	-0.0751	0.0247	0.0352	0.0455	-0.0073	0.0055	0.0133	0.0220	-0.0132	0.0593	0.0384	0.0202
Canopy temperature (^{o}C)	0.0036	0.0013	-0.0144	0.0040	-0.0327	-0.0185	**0.0795**	-0.0316	-0.0117	-0.0238	-0.0076	-0.0261	-0.0252	-0.0090	-0.0148	-0.0066	-0.0271	-0.0138
Membrane thermo-stability	0.0021	-0.0007	-0.0124	-0.0018	-0.0127	-0.0047	0.0244	**-0.0614**	-0.0002	-0.0139	-0.0069	-0.0185	-0.0127	-0.0095	-0.0151	0.0006	-0.0169	-0.0062
Plant height(cm)	-0.0002	-0.0020	-0.0043	-0.0005	-0.0043	-0.0033	0.0044	-0.0001	**-0.0298**	-0.0009	0.0014	-0.0010	-0.0057	0.0026	0.0017	-0.0018	-0.0013	0.0000
No. of effective tillers plant^{-1}	-0.0104	0.0095	0.0229	0.0035	0.0489	0.0247	-0.0525	0.0398	0.0051	**0.1754**	0.1428	0.0389	0.0491	-0.0016	0.0306	-0.0003	0.1054	0.0370
No. of ears plant^{-1}	0.0008	0.0017	0.0018	0.0015	0.0000	-0.0002	-0.0007	0.0009	-0.0004	0.0063	**0.0077**	0.0014	0.0015	-0.0002	0.0013	-0.0005	0.0044	0.0013
No. of spikelets ear^{-1}	-0.0077	-0.0084	-0.0106	-0.0057	-0.0052	-0.0007	0.0131	-0.0120	-0.0013	-0.0088	-0.0072	**-0.0399**	-0.0253	-0.0123	-0.0311	0.0037	-0.0153	-0.0047
Length of ear (cm)	-0.0002	-0.0004	-0.0009	-0.0004	-0.0009	-0.0002	0.0018	-0.0012	-0.0011	-0.0016	-0.0011	-0.0036	**-0.0056**	0.0023	-0.0032	0.0001	-0.0022	-0.0010
Spike density	-0.0038	-0.0045	-0.0058	-0.0015	-0.0037	-0.0029	0.0048	-0.0065	0.0037	0.0004	0.0013	-0.0129	0.0172	**-0.0419**	-0.0068	0.0024	-0.0021	-0.0001
No. of grains ear^{-1}	0.0113	0.0114	0.0114	0.0076	0.0026	-0.0026	-0.0117	0.0155	-0.0036	0.0110	0.0103	0.0490	0.0352	0.0102	**0.0628**	-0.0155	0.0184	0.0069
1000-grain weight (g)	0.0029	0.0030	0.0020	0.0016	-0.0023	-0.0018	0.0008	0.0001	-0.0006	0.0000	0.0006	0.0009	0.0002	0.0006	0.0024	**-0.0097**	-0.0010	0.0003
Biological yield plant^{-1} (g)	0.0110	0.0717	0.1778	0.0482	0.1091	0.0667	-0.1912	0.1547	0.0246	0.3371	0.3181	0.2151	0.2176	0.0287	0.1640	0.0577	**0.5608**	0.1047
Harvest index (%)	0.0365	0.0089	0.0171	-0.0110	0.0532	0.0352	-0.0974	0.0566	0.0005	0.1188	0.0945	0.0666	0.0954	0.0007	0.0619	-0.0187	0.1050	**0.5624**
Grain yield plant^{-1} (g)	0.0909	0.1316	0.1720	0.0737	0.0314	0.0385	-0.1203	0.0841	-0.0437	0.5285	0.5421	0.2133	0.2797	-0.0484	0.2186	-0.0252	0.6749	0.6655

Table 4.13 (b):- Genotypic path among phenological, physiological and yield constituting traits (Pooled)

Character	Days to full stem elongation	Days to 50% heading	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000-grain weight (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Days to full stem elongation	**-0.0017**	0.0118	0.0312	0.0293	-0.0159	-0.0099	0.0056	-0.0020	-0.0038	-0.0064	0.0073	0.0031	-0.0006	0.0008	0.0028	-0.0191	0.0052	-0.0007
Days to 5% heading	0.0339	**0.0328**	0.0276	-0.3153	0.1327	0.0845	-0.0337	0.0029	0.0174	0.0303	-0.0901	-0.0581	-0.0092	-0.0287	-0.0221	0.1741	-0.0873	-0.0502
Days to stay green	-0.3447	-0.3564	**-0.3113**	0.4990	-0.0721	-0.0445	-0.1475	0.1957	0.0333	0.0472	0.1950	0.2374	0.1541	0.0920	0.1234	-0.1894	0.2825	0.2170
Days to maturity	0.4752	0.5098	0.5836	**-0.3296**	0.0935	0.0513	-0.0308	-0.0254	0.0115	0.0042	-0.0995	-0.0686	-0.0407	-0.0007	-0.0439	0.1216	-0.1022	-0.0389
RWC of flag leaf (%)	-0.2851	-0.2916	-0.2817	0.2989	**-1.0533**	-0.9107	0.6619	-0.3810	-0.2354	-0.6339	-0.0503	-0.3743	-0.3946	-0.2103	-0.2914	-0.3819	-0.3390	-0.3905
Chlorophyll content	0.4937	0.3923	0.1300	-0.1030	0.5728	**0.6625**	-0.2839	0.1175	0.0811	0.2812	0.0162	0.1423	0.1292	0.1213	0.1072	0.1768	0.1462	0.1918
Canopy temperature (^{o}C)	-0.1936	-0.1571	-0.0505	0.0372	-0.2503	-0.1707	**0.3983**	-0.2408	-0.1483	-0.1958	-0.0406	-0.2191	-0.1981	-0.1170	-0.1434	-0.0637	-0.2104	-0.2004
Membrane thermo-stability	0.0662	0.0376	-0.1007	-0.0071	-0.0336	-0.0165	0.0561	**-0.0928**	-0.0138	-0.0378	-0.0224	-0.0362	-0.0344	-0.0143	-0.0230	-0.0134	-0.0449	-0.0436
Plant height(cm)	-0.0173	-0.0075	0.0088	-0.0054	0.0343	0.0188	-0.0572	0.0228	**0.1537**	0.0128	0.0013	0.0055	0.0412	-0.0357	-0.0120	0.0296	0.0219	0.0332
No. of effective tillers plant^{-1}	-0.1405	-0.0633	0.0601	-0.0094	0.4477	0.3158	-0.3657	0.3034	0.0618	**0.7440**	0.5276	0.3478	0.3883	0.0589	0.2973	0.2190	0.4717	0.4770
No. of ears plant^{-1}	-0.0465	-0.0543	-0.0717	-0.0648	-0.0103	-0.0053	0.0219	-0.0518	-0.0018	-0.1523	**-0.2147**	-0.0796	-0.0800	0.0076	-0.0811	-0.0286	-0.1539	-0.1296
No. of spikelets ear^{-1}	0.0474	0.0832	0.2076	0.1062	0.1814	0.1096	-0.2807	0.1988	0.0182	0.2386	0.1893	**0.5104**	0.3813	0.2075	0.4350	0.0543	0.3891	0.3475
Length of ear (cm)	0.0085	-0.0128	-0.1309	-0.0612	-0.1857	-0.0967	0.2465	-0.1836	-0.1328	-0.2587	-0.1847	-0.3704	**-0.4957**	0.1332	-0.3445	-0.0989	-0.3685	-0.2845
Spike density	-0.0078	-0.0271	-0.0530	-0.0007	-0.0671	-0.0616	0.0988	-0.0519	0.0781	-0.0266	0.0119	-0.1368	0.0904	**-0.3363**	-0.0704	0.0164	-0.0301	-0.0702
No. of grains ear^{-1}	0.0103	0.0078	0.0265	0.0167	0.0347	0.0203	-0.0452	0.0312	-0.0098	0.0502	0.0474	0.1071	0.0873	0.0263	**0.1256**	0.0004	0.0752	0.0718
1000-grain weight (g)	0.0303	0.0263	0.0175	0.0199	-0.0195	-0.0144	0.0086	-0.0078	-0.0104	-0.0159	-0.0072	-0.0057	-0.0108	0.0026	-0.0002	**-0.0539**	-0.0189	-0.0062
Biological yield plant^{-1} (g)	0.1099	0.1764	0.3485	0.2233	0.2317	0.1589	-0.3802	0.3481	0.1025	0.4564	0.5161	0.5489	0.5351	0.0643	0.4312	0.2532	**0.7199**	0.5119
Harvest index (%)	0.0054	0.0008	-0.0311	0.0099	0.0311	0.0243	-0.0422	0.0394	0.0181	0.0538	0.0507	0.0571	0.0482	0.0175	0.0480	0.0096	0.0597	**0.0839**
Grain yield plant^{-1} (g)	0.2436	0.3087	0.4105	0.3438	0.0523	0.1159	-0.1694	0.2229	0.0196	0.5911	0.8533	0.6109	0.5910	-0.0108	0.5386	0.2060	0.8162	0.7195

followed by no. of effective tillers per plant (-0.3657), no. of spikelets per ear (-0.2807) and days to stay green (-0.1475).

Membrane thermo-stability was exhibited positive indirect effect on grain yield per plant via biological yield per plant (0.3481) followed by no. of effective tillers per plant (0.3034), no. of spikelets per ear (0.1988), days to stay green (0.1957), chlorophyll content (0.1175). However, it was reported negative indirect effect on grain yield per plant via RWC of flag leaf (-0.3810) followed by canopy temperature (-0.2408) and length of ear (-0.1836)

Plant height was noticed positive indirect effect on grain yield per plant via biological yield per plant (0.1025).While, It was reported negative indirect effect on grain yield per plant via RWC of flag leaf (-0.2354), canopy temperature (-0.1483) and length of ear (-0.1328).

Number of effective tillers per plant was recorded positive indirect effect on grain yield per plant via biological yield per plant (0.4564) followed by chlorophyll content (0.2812) and no. of spikelets per ear (0.2386). Whereas, it was noticed negative indirect effect on grain yield per plant via canopy temperature (-0.1958) and no. of ears per plant (-0.1523).

Number of ears per plant was observed positive indirect effect on grain yield per plant via no. of effective tillers per plant (0.5276) followed by biological yield per plant (0.5161), days to stay green (0.1950) and no. of spikelets per ear (0.1893). However, it was recorded negative indirect effect on grain yield per plant via length of ear (-0.1847).

Number of spikelets per ear was exhibited positive indirect effect on grain yield per plant via biological yield per plant (0.5489), no. of effective tillers per plant (0.3478) and no. of grains per ear (0.1071) but it was showed negative indirect effect on grain yield per plant via length of ear (-0.3704).

Length of ear was recorded positive indirect effect on grain

yield per plant via biological yield per plant (0.5351) followed by no. of effective tillers per plant (0.3883), days to stay green (0.1541), no. of spikelets per ear (0.3813). While, it was observed negative indirect effect on grain yield per plant via and canopy temperature (-0.1981).

Spike density was found positive indirect effect on grain yield per plant via no. of spikelets per ear (0.2075) followed by chlorophyll content (0.1213) and length of ear (0.1332). While, it was reported negative indirect effect on grain yield per plant via and canopy temperature (-0.1170).

Number of grains per ear was recorded positive indirect effect on grain yield per plant via no. of spikelets per ear (0.4350) followed by biological yield per plant (0.4312), no. of effective tillers per plant (0.2973), days to stay green (0.1234). However, it was found negative indirect effect on grain yield per plant via length of ear (-0.3445) followed by canopy temperature (-0.1434).

1000-grain weight was observed positive indirect effect on grain yield per plant via biological yield per plant (0.2532) followed by no. of effective tillers per plant (0.2190), chlorophyll content (0.1768), days to 50% heading (0.1741) and days to maturity (0.1216). Whereas, it was noticed negative indirect effect on grain yield per plant via followed by days to stay green (-0.1894).

Biological yield per plant was reported positive indirect effect on grain yield per plant via no. of effective tillers per plant (0.4717) followed by no. of spikelets per ear (0.3891), days to stay green (0.2825) and chlorophyll content (0.1462). Whereas, it was found negative indirect effect on grain yield per plant via and canopy temperature (-0.2104).

Harvest index was exhibited positive indirect effect on grain yield per plant via biological yield per plant (0.5119) followed by no. of effective tillers per plant (0.4770), no. of spikelets per ear (0.3475), days to stay green (0.2170), chlorophyll content (0.1918).

4.5 Stability analysis

The stability analysis was carried out for the characters under study as per Eberhert and Russell Model (1966). The analysis of variance for stability analysis for phenological, physiological, morphological and yield contributing traits has been presented in table (4.14) and table (4.15).

All genotype where evaluated in 3 different environments i.e. irrigated timely sown (E_1), restricted irrigated sown (E_2) and rainfed sown (E_2) situations in wheat. The differences among the environment were significant among all the characters. The genotype x environment interaction showed the significant differences for characters like days to full stem elongation, days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf, chlorophyll content, canopy temperature, Plant height, No. of effective tillers per plant, no. of spikelets per ear, spike density, no. of grains per ear, grain yield per plant.

The variation due to environment (linear) was found significant for all characters. The variation due to genotype x environment (linear) was found significant for different characters except ear length, 1000-grain weight, biological yield per plant and membrane thermo-stability. However, pooled deviation was found to be significant for no. of effective tillers per plant, No. of spikelets per ear, ear length, Spike density, No. of grains per ear, 1000-grain weight, biological yield per plant, harvest index, days to maturity chlorophyll content and canopy temperature.

Days to full stem elongation

The genotypes G-2 and G-3 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

The genotypes G-6, G-8, G-10, G-11, G-12, G-13, G-17, G-23, G-25, G-31, G-36, G-37, G-38, G-51, G-53, G-54, G-55, G-60, G-61, G-62, G-63, G-64, G-65, G-66, G-68, G-69, G-70, G-71,

Table 4.14: ANOVA of stability for different phenological, physiological and morphological characters.

Source	DF	Days to full stem elongation	Days to 50% flowering	Days to stay green	Days to maturity	RWC of flag leaf (%)	Chlorophyll content	Canopy temperature (^{0}C)	Membrane thermo-stability	Plant height (cm)
Rep within Env.	6	465.097 **	327.171 **	179.794**	110.498**	614.96**	658.6**	0.084	0.500	534.679 **
Varieties	99	77.275**	87.319**	45.013**	28.859 **	89.753**	94.18**	1.168**	369.89**	135.748**
Env.+ (Var.* Env.)	200	17.567**	16.800**	24.302 **	12.099**	49.033**	11.41**	1.547**	84.215**	3.125**
Environments	2	1716.077**	1594.390**	2011.331 **	625.954**	4675.29**	872.32**	122.4**	8180.8**	231.621 **
Var.* Env.	198	0.411 **	0.864 **	4.231 **	5.899	2.303**	2.719**	0.325*	2.432	0.817**
Environments (Lin.)	1	3432.155**	3188.781 **	4022.662**	1251.907**	9350.5**	1744.6**	244.9**	16361.5**	463.243**
Var.* Env.(Lin.)	99	0.667 **	1.507**	5.904**	6.783	3.639**	4.476**	0.424**	1.681	1 222 **
Pooled Deviation	100	0.153	0.219	2.533	4.965 **	0.957	0.952	0.225**	3.151**	0.407
Pooled Error	594	2.116	0.631	2.2	1.666	1.113	0.984	0.114	0.386	0.398
Total	299	37.337	40.149	31.16	17.649	62.515	38.821	1.422	178.805	47.037

Table 4.15: ANOVA of stability for yield and its constituting characters.

Source	DF	No. of effective tillers plant^{-1}	No. of ears plant^{-1}	No. of spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of grains ear^{-1}	1000-grain weight (g)	Yield plant^{-1} (g)	Biological yield plant^{-1} (g)	Harvest index (%)
Rep within Env.	6	0.193**	6.315**	13.689**	0.017	0.004	12.07**	48.01**	87.13**	144.39**	1150.5**
Varieties	99	2 672 **	3.057 **	13.586**	3.810**	0.15**	401.9**	169.9**	10.72**	26.13**	37.97
Env.+ (Var.* Env.)	200	0.367 **	0.152**	2.116***	0.649 **	0.020**	9.120**	5.075**	2.974 **	12.320**	40.28
Environments	2	30.500 **	12.727**	195.780**	53.480 **	0.18**	908.4**	439.7**	100.9**	957.4**	455.3**
Var.* Env.	198	0.062 **	0.025	0.159*	0.115	0.018**	0.034**	0.686	1.984**	2.77	36.09
Environments (Lin.)	1	60.999 **	25.454**	391.560**	106.960**	0.36**	1816.8**	879.3**	201.8**	1914.8**	910.6**
Var.* Env.(Lin.)	99	0.085 **	0.030*	0.206 **	0.123	0.024**	0.063**	0.731	3.376**	1.55	39.23
Pooled Deviation	100	0.039 **	0.02	0.112**	0.106**	0.011**	0.006	0.634**	0.586	3.963**	32.6**
Pooled Error	594	0.016	0.038	0.058	0.045	0.003	0.034	0.027	0.687	0.31	14.73
Total	299	1.13	1.114	5.914	1.696	0.066	139.19	59.66	5.541	16.89	39.51

G-56, G-57, G-58, G-72, G-73, G-74, G-75, G-76, G-77, G-78, G-79, G-80, G-81, G-82, G-83, G-88, G-93, G-94, G-95, G-97, G-99 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression coupled with lesser mean value to population mean (not widely adopted).

Days to 50% flowering

The genotypes G-67, G-39 and G-40 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

Regression coefficient below unity and minimum deviation from regression also with high mean value over population mean was recorded for genotype G-63 (above average stability).

The genotypes G-2, G-3, G-41, G-42, G-43, G-52, G-59, G-78, G-84, G-85, G-86, G-87, G-89, G-90, G-91, G-92, G-96, G-100, G-6, G-7, G-9, G-14, G-15, G-16, G-19, G-20, G-21, G-22, G-23, G-24, G-26, G-27, G-28, G-29, G-30, G-32, G-33, G-34, G-35, G-45, G-46, G-47, G-48, G-49, G-50 had regression coefficient close to unity and maximum deviation from regression coupled with high mean value to population mean (unpredictable exploitation of this character).

Regression coefficient equal to unity (or close to unity) minimum deviation from regression with lesser mean value to population mean were recorded for the genotypes G-1, G-4, G-5, G-8, G-10, G-11, G-12, G-13,G-17, G-18, G-25, G-31, G-36, G-37, G-38, G-44, G-51, G-53, G-54, G-55, G-56, G-57, G-58, G-60, G-61, G-62, G-64, G-65, G-66, G-68, G-69, G-70, G-71, G-72, G-73, G-74, G-75, G-76, G-77, G-79, G-80, G-81, G-82, G-83, G-88, G-93, G-94, G-95,G-97, G-98, G-99 (not widely adopted).

Days to stay green

The genotypes G-14, G-15, G-16, G-19, G-21, G-22, G-33, G-41, G-42, G-43, G-47, G-48, G-87, G-89, G-90, G-91, G-92,

Table 4.16: Stability parameters for phenological traits.

Sno.	Genotype	Days to full stem elongation			Days to 50% flowering			Days to stay green		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	59.00	1.00	-1.63	71.22	0.93	-3.78	98.67	0.78	-1.04
2	G-02	59.11	1.89	-0.03	72.33	0.95	-3.89	99.67	0.78	-1.04
3	G-03	60.56	1.31	-0.07	73.33	0.95	-3.89	99.78	0.89	-3.45
4	G-04	54.56	1.45	-0.03	70.33	0.95	-3.89	98.00	0.44	-0.93
5	G-05	57.00	1.27	-0.07	65.11	0.90	-3.88	94.44	1.37	-3.83
6	G-06	54.00	1.00	-0.63	76.33	0.95	-3.89	101.56	0.89	-3.35
7	G-07	58.00	1.00	-1.63	74.33	0.95	-3.89	99.56	0.89	-3.35
8	G-08	55.33	1.00	-0.63	65.56	1.00	-3.89	92.67	0.90	-1.91
9	G-09	57.67	1.00	-0.66	72.33	0.95	-3.89	97.78	1.25	-3.97
10	G-10	54.00	1.00	-9.63	64.33	0.95	-3.89	93.89	1.34	18.08
11	G-11	56.67	1.00	-0.63	69.33	0.95	-3.89	94.44	1.37	-3.83
12	G-12	54.00	1.00	-0.03	66.33	0.95	-3.89	92.56	1.23	-3.79
13	G-13	51.67	1.00	-0.06	67.56	1.00	-3.89	93.89	1.26	-3.22
14	G-14	58.33	1.00	-2.63	73.56	1.00	-3.89	98.67	1.44	-3.98
15	G-15	59.67	1.00	-1.60	76.33	0.95	-3.89	100.89	1.13	-2.17
16	G-16	62.00	1.00	-2.55	78.56	1.00	-3.89	101.78	1.44	3.84
17	G-17	50.67	1.00	-3.02	63.33	0.95	-3.89	89.67	0.90	-3.94
18	G-18	57.67	1.00	-1.73	69.56	1.00	-3.89	94.44	1.37	-3.83
19	G-19	59.67	1.00	-6.63	74.56	1.00	-3.89	99.33	1.41	-3.75
20	G-20	61.67	1.00	-1.63	79.89	1.14	-3.90	103.67	0.27	-2.69
21	G-21	58.00	1.00	-0.42	74.56	1.00	-3.89	99.78	1.25	-3.97
22	G-22	58.00	1.00	-0.61	75.56	1.00	-3.89	100.00	1.53	-3.41
23	G-23	57.00	1.00	-0.67	75.33	0.95	-3.89	101.00	1.17	-3.97
24	G-24	59.33	1.00	-2.60	75.33	0.95	-3.89	100.00	1.53	-3.41
25	G-25	53.67	1.00	-1.06	70.56	1.00	-3.89	96.11	1.13	-3.95
26	G-26	63.67	1.00	-2.63	78.56	1.00	-3.89	102.22	0.91	4.09
27	G-27	58.00	1.00	-6.63	73.33	0.95	-3.89	98.78	1.25	-3.97
28	G-28	59.67	1.00	-6.63	73.56	1.00	-3.89	98.78	1.25	-3.97
29	G-29	60.00	1.00	-1.82	75.56	1.00	-3.89	100.67	1.29	-3.94
30	G-30	60.33	1.00	-0.60	76.33	0.95	-3.89	99.89	1.50	0.76
31	G-31	55.00	1.00	-2.03	68.56	1.00	-3.89	93.67	1.34	-3.66
32	G-32	61.33	1.00	-2.63	76.56	1.00	-3.89	101.56	0.96	-3.48
33	G-33	60.78	0.98	-0.71	75.33	0.95	-3.89	101.11	1.13	-3.95
34	G-34	65.44	0.98	-0.73	81.67	1.81	-3.67	103.89	0.73	1.52
35	G-35	64.44	0.98	-0.65	82.78	1.04	-3.90	105.00	0.80	-1.47
36	G-36	47.78	0.98	-0.07	65.33	0.95	-3.89	92.56	0.58	-3.11
37	G-37	48.11	0.98	-0.01	64.33	0.95	-3.89	92.00	0.42	-2.28
38	G-38	50.44	0.98	-0.01	67.33	0.95	-3.89	94.11	0.74	-3.66
39	G-39	66.11	0.98	-0.23	81.44	1.76	-3.70	104.44	0.64	-3.98
40	G-40	62.78	0.98	-0.78	79.78	1.33	-3.87	104.00	0.64	-1.58
41	G-41	60.44	0.98	-0.58	76.11	0.90	-3.88	102.11	1.13	-3.95
42	G-42	63.78	0.98	-0.53	79.56	1.00	-3.89	104.33	1.60	-3.53
43	G-43	60.11	0.98	-6.71	74.56	1.00	-3.89	99.00	1.53	-3.41
44	G-44	57.44	0.98	-6.71	68.56	1.00	-3.89	93.89	1.26	-3.84
45	G-45	61.44	0.98	-0.43	79.33	0.95	-3.89	102.44	0.81	-3.61
46	G-46	64.11	0.98	-0.37	79.78	1.04	-3.90	101.78	1.05	-2.63
47	G-47	59.78	0.98	-0.89	73.33	0.95	-3.89	98.78	1.25	-3.97
48	G-48	63.44	0.98	-0.52	76.56	1.00	-3.89	100.44	1.22	-0.75
49	G-49	63.78	0.98	-0.64	76.56	1.00	-3.89	100.11	1.34	0.33
50	G-50	60.44	0.98	-0.47	74.33	0.95	-3.89	100.11	1.13	-3.95

Cont…

Sno.	Genotype	Days to full stem elongation			Days to 50% flowering			Days to stay green		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	50.78	0.98	-6.63	65.33	0.95	-3.89	92.22	0.70	-3.55
52	G-52	65.78	0.98	-2.93	81.22	1.00	-3.89	105.33	0.68	-3.97
53	G-53	46.78	0.98	-5.93	63.33	0.95	-3.89	91.33	1.03	1.82
54	G-54	54.78	0.98	-5.43	69.78	1.04	-3.90	95.44	1.01	-3.78
55	G-55	53.11	0.98	-0.07	69.11	0.90	-3.88	95.11	1.13	-3.95
56	G-56	48.11	0.98	-0.63	66.33	0.95	-3.89	92.89	0.82	-3.84
57	G-57	54.11	0.98	-0.63	70.56	1.00	-3.89	96.22	1.09	-3.91
58	G-58	47.22	0.14	-6.63	63.33	0.95	-3.89	94.33	1.10	-3.98
59	G-59	68.78	0.98	-0.66	82.56	1.00	-3.89	105.67	0.73	-3.80
60	G-60	55.11	0.98	-6.63	70.56	1.00	-3.89	96.89	1.13	-2.17
61	G-61	55.44	0.98	-6.63	71.56	1.00	-3.89	97.11	1.27	-3.15
62	G-62	53.44	0.98	-0.03	69.56	1.00	-3.89	97.11	1.42	-0.01
63	G-63	47.44	0.98	-0.06	63.67	-0.06	-3.34	96.00	0.66	-0.01
64	G-64	52.78	0.98	-6.63	68.56	1.00	-3.89	96.56	1.01	8.70
65	G-65	54.11	0.98	-0.6	68.78	1.04	-3.90	95.78	1.00	0.21
66	G-66	55.78	0.98	-1.55	71.22	0.90	-2.76	98.22	0.92	-3.86
67	G-67	67.11	0.98	-0.02	81.11	2.19	-3.37	108.89	1.40	-3.93
68	G-68	54.78	0.98	-0.73	70.56	1.00	-3.89	96.22	1.09	-3.91
69	G-69	54.11	0.98	-6.63	69.56	1.00	-3.89	94.89	1.21	-3.98
70	G-70	53.78	0.98	-0.63	67.33	0.95	-3.89	94.67	0.54	-2.93
71	G-71	52.78	0.98	-0.42	67.33	0.95	-3.89	95.56	0.45	-3.97
72	G-72	52.44	0.98	-0.61	66.33	0.95	-3.89	94.11	0.90	2.64
73	G-73	45.11	0.98	-0.67	71.33	0.42	14.68	95.67	1.06	12.81
74	G-74	53.78	0.98	-0.6	69.33	0.95	-3.89	95.89	0.61	2.89
75	G-75	53.44	0.98	-0.06	70.33	0.95	-3.89	97.44	0.93	-3.20
76	G-76	54.11	0.98	-2.63	66.56	1.00	-3.89	93.89	0.46	-2.52
77	G-77	55.11	0.98	-6.63	67.78	1.04	-3.90	95.56	0.22	-0.87
78	G-78	56.78	0.98	-6.63	72.56	1.00	-3.89	97.22	0.64	26.92
79	G-79	49.78	0.98	-0.82	66.78	1.04	-3.90	96.11	0.32	-0.03
80	G-80	51.44	0.98	-0.6	66.78	1.04	-3.90	95.44	0.11	3.60
81	G-81	55.11	0.98	-0.03	67.56	1.00	-3.89	94.89	0.65	-3.92
82	G-82	54.11	0.98	-0.63	68.78	1.04	-3.90	98.56	-0.44	8.36
83	G-83	53.11	0.98	-0.71	66.56	1.00	-3.89	93.67	0.54	-2.93
84	G-84	59.44	0.98	-0.73	73.56	1.00	-3.89	99.56	1.26	-3.22
85	G-85	59.11	0.98	-0.65	76.33	0.95	-3.89	99.78	1.88	-2.87
86	G-86	58.44	0.98	-0.71	76.33	0.95	-3.89	100.78	1.66	-2.29
87	G-87	60.44	0.98	-0.71	76.56	1.00	-3.89	101.44	1.47	-2.75
88	G-88	51.78	0.98	-6.71	67.78	1.04	-3.90	96.22	0.40	-3.12
89	G-89	65.78	0.98	-0.23	82.56	1.00	-3.89	104.56	1.18	4.74
90	G-90	63.78	0.98	-0.78	79.78	1.04	-3.90	101.44	1.27	0.68
91	G-91	66.44	0.98	-0.58	83.67	1.52	-3.82	105.78	1.31	10.20
92	G-92	58.44	0.98	-0.53	74.33	0.95	-3.89	99.78	1.25	-3.97
93	G-93	53.78	0.98	-6.71	69.56	1.00	-3.89	94.89	0.84	-3.79
94	G-94	55.78	0.98	-6.71	68.33	0.95	-3.89	94.56	1.11	-3.68
95	G-95	53.44	0.98	-0.43	66.56	1.00	-3.89	95.33	0.75	-3.98
96	G-96	66.11	0.98	-0.37	80.56	1.00	-3.89	102.89	1.28	-2.25
97	G-97	54.11	0.98	-0.89	67.33	0.95	-3.89	96.44	1.40	-2.27
98	G-98	59.11	0.98	-0.52	67.56	1.00	-3.89	95.56	0.80	-2.59
99	G-99	56.78	0.98	-0.64	68.56	1.00	-3.89	94.67	0.68	-2.27
100	G-100	57.11	0.98	-0.47	81.33	0.95	-3.89	103.56	0.67	-3.93
Population mean		57.06			72.27			98.10		

G-96, G-23, G-24, G-27, G-28, G-29, G-30, G-49, G-50, G-67, G-84, G-85, G-86 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

The genotypes G-1, G-35, G-100, G-3, G-40, G-6, G-52, G-34, G-2, G-39, G-20, G-4, G-45, G-7, G-59, G-82 had regression coefficient below unity and minimum deviation from regression coupled with high mean value over population mean (above average stability). The genotypes G-46, G-66 and G-26 had regression coefficient close to unity and high mean value to population mean with maximum deviation from regression (unpredictable exploitation of character).

The genotypes G-64, G-65, G-72, G-73, G-53, G-54, G-55, G-68, G-57, G-8, G-17 had regression coefficient equal to unity (or close to unity) minimum deviation from regression with lesser mean value to population mean revealed (not widely adopted).

Days to maturity

Regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean were noticed for the genotypes G-6, G-7, G-15, G-20, G-21, G-22, G-23, G-24, G-26, G-27, G-29, G-30, G-32, G-33, G-34, G-35, G-39, G-40, G-41, G-45, G-46, G-47, G-48, G-49, G-50, G-52, G-53, G-59, G-67, G-84, G-85, G-86, G-87, G-89, G-90, G-91, G-92, G-100, G-43 (below average stability).

The genotypes G-9, G-42, G-56, G-58, G-80 were showed regression coefficient below unity and minimum deviation from regression coupled with high mean value over population mean (above average stability). The genotypes G-96 and G-16 was exhibited regression coefficient equal to unity, high mean value to population mean with maximum deviation from regression (unpredictable expression of character).

Table 4.17: Stability parameters for phenological and physiological traits

Sno.	Genotype	Days to maturity			RWC of flag leaf			Chlorophyll content		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	109.11	1.77	-0.63	63.26	1.54	0.45	21.77	1.46	-0.24
2	G-02	109.44	1.54	-2.75	74.12	1.81	-5.80	32.64	2.12	-5.62
3	G-03	110.33	1.50	-1.45	69.36	2.05	5.41	27.88	2.63	8.16
4	G-04	108.78	0.62	-2.75	70.0	1.61	1.48	28.60	1.62	1.15
5	G-05	104.56	1.00	-0.69	81.52	1.65	-1.65	40.02	1.73	-1.79
6	G-06	112.78	1.20	1.63	62.14	1.26	-3.27	20.64	0.84	-4.78
7	G-07	111.11	1.31	-0.84	81.66	1.64	-0.87	40.18	1.70	-1.06
8	G-08	106.78	-0.31	2.77	74.35	1.17	-6.72	32.86	0.67	-7.46
9	G-09	111.44	0.04	-2.70	76.88	0.91	-7.14	35.39	0.07	-7.46
10	G-10	105.56	-0.04	3.96	74.70	0.94	-7.23	33.21	0.15	-7.00
11	G-11	108.78	0.84	-0.70	73.47	0.94	-7.23	31.99	0.15	-7.01
12	G-12	108.67	0.91	35.07	78.16	0.94	-7.22	36.68	0.16	-6.95
13	G-13	109.89	0.64	32.15	77.98	0.92	-7.22	36.49	0.10	-7.33
14	G-14	110.44	1.42	-2.30	77.13	0.91	-7.14	35.65	0.07	-7.46
15	G-15	113.11	1.31	-0.84	81.02	1.09	-2.38	38.45	0.13	-7.14
16	G-16	114.44	1.08	5.10	74.14	1.07	-3.09	31.54	0.09	-7.37
17	G-17	106.22	0.89	-0.10	82.25	0.80	-4.11	41.51	0.08	-7.42
18	G-18	108.00	1.38	-0.66	71.29	1.08	-3.03	28.67	0.08	-7.39
19	G-19	110.56	1.70	-0.87	59.00	0.91	-7.14	17.71	0.06	-7.46
20	G-20	112.78	1.54	-2.75	67.04	0.90	-7.07	25.60	0.05	-7.51
21	G-21	111.56	1.47	2.64	74.258	0.92	-7.21	32.77	0.09	-7.36
22	G-22	112.22	1.35	6.44	67.751	0.99	-6.48	26.26	0.29	-5.49
23	G-23	112.22	1.35	6.44	72.158	0.99	-6.41	30.67	0.30	-5.38
24	G-24	112.56	1.47	2.64	78.173	1.00	-6.30	36.68	0.31	-5.22
25	G-25	108.89	0.54	2.74	85.774	1.00	-6.16	44.28	0.32	-5.01
26	G-26	115.56	1.47	2.64	83.229	1.00	-6.21	41.74	0.32	-5.09
27	G-27	110.89	1.58	-0.15	73.507	1.00	-6.39	32.02	0.30	-5.35
28	G-28	110.44	1.42	-2.30	72.931	1.00	-6.4	31.44	0.30	-5.36
29	G-29	112.44	1.42	-2.30	80.252	1.05	-6.26	38.76	0.31	-5.17
30	G-30	113.44	1.42	-2.30	68.531	0.99	-6.47	27.04	0.29	-5.47
31	G-31	107.78	0.50	-2.24	78.47	1.00	-6.30	36.98	0.31	-5.22
32	G-32	113.44	1.42	-2.30	83.336	1.00	-6.21	41.85	0.32	-5.09
33	G-33	113.11	1.65	-2.20	85.003	0.83	-5.23	42.88	1.39	-6.91
34	G-34	114.44	2.11	-2.18	69.29	0.88	-6.73	25.95	1.06	-6.86
35	G-35	115.11	1.66	-2.31	76.708	1.00	-6.33	33.36	1.38	-7.04
36	G-36	108.56	-0.05	26.62	82.378	1.00	-6.23	39.03	1.39	-6.97
37	G-37	105.89	0.07	8.15	73.906	1.00	-6.38	30.56	1.37	-7.07
38	G-38	109.11	-0.20	6.61	79.883	1.00	-6.27	36.54	1.38	-7.00
39	G-39	116.44	2.46	5.58	69.199	0.91	-7.19	25.86	1.15	-7.41
40	G-40	115.11	2.00	-2.75	73.436	0.90	-7.21	30.09	1.16	-7.44
41	G-41	113.44	1.42	-2.30	70.348	0.85	-6.94	27.00	1.09	-7.10
42	G-42	114.89	0.89	-2.71	68.067	0.99	-6.47	24.72	1.36	-7.14
43	G-43	112.22	1.69	-1.94	84.324	1.00	-6.18	40.98	1.39	-6.94
44	G-44	107.22	1.92	-0.62	83.48	1.00	-6.20	40.14	1.39	-6.95
45	G-45	114.11	1.42	-2.71	78.901	1.00	-6.29	35.56	1.38	-7.01
46	G-46	114.67	1.62	-2.75	74.627	1.00	-6.36	31.28	1.37	-7.06
47	G-47	111.89	1.92	-2.49	66.46	0.89	-6.98	23.12	1.10	-7.14
48	G-48	114.11	1.65	-2.20	64.98	0.90	-7.05	21.64	1.11	-7.23
49	G-49	114.11	1.65	-2.20	72.142	0.90	-7.11	28.80	1.13	-7.30
50	G-50	111.22	2.27	-2.18	66.361	0.99	-6.50	23.02	1.36	-7.16

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Sno.	Genotype	Days to maturity			RWC of flag leaf			Chlorophyll content		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	110.33	2.31	-0.60	74.24	0.92	-7.21	30.90	1.16	-7.44
52	G-52	114.56	2.27	1.98	75.34	0.92	-7.21	32.00	1.16	-7.45
53	G-53	112.22	1.22	9.57	74.45	0.92	-7.21	31.11	1.16	-7.44
54	G-54	106.56	1.00	-0.82	69.77	0.94	-7.24	26.42	1.21	-7.55
55	G-55	106.56	1.00	-0.82	71.93	0.94	-7.23	28.59	1.22	-7.56
56	G-56	110.78	0.74	3.88	76.81	0.95	-7.18	33.47	1.25	-7.56
57	G-57	107.44	1.20	6.46	69.48	0.91	-7.09	26.14	1.12	-7.27
58	G-58	111.22	0.42	7.39	73.24	0.92	-7.21	29.89	1.16	-7.44
59	G-59	117.56	1.34	9.97	75.14	0.96	-7.16	31.79	1.25	-7.55
60	G-60	107.56	1.00	-0.82	76.06	0.92	-7.22	32.72	1.16	-7.45
61	G-61	108.00	1.04	1.64	73.53	0.93	-7.25	30.18	1.19	-7.52
62	G-62	108.33	0.12	-2.26	72.87	0.91	-7.11	29.53	1.13	-7.30
63	G-63	106.33	-0.93	2.70	74.16	0.91	-7.12	30.82	1.13	-7.31
64	G-64	107.00	-0.23	-0.74	73.87	0.90	-6.98	30.53	1.10	-7.14
65	G-65	107.00	0.12	-2.26	78.82	0.94	-7.25	35.48	1.20	-7.54
66	G-66	109.33	-0.11	1.76	75.26	0.97	-7.03	31.92	1.28	-7.49
67	G-67	118.00	1.15	11.67	77.88	0.95	-7.22	34.54	1.23	-7.56
68	G-68	108.67	0.23	-0.77	72.12	0.90	-6.96	28.78	1.10	-7.12
69	G-69	106.89	1.12	-2.29	74.38	0.98	-6.87	31.04	1.31	-7.40
70	G-70	106.44	0.50	-2.24	80.35	0.91	-7.16	37.01	1.14	-7.37
71	G-71	106.56	0.65	-2.23	82.18	0.94	-7.25	38.83	1.20	-7.54
72	G-72	106.33	0.23	-0.74	73.80	0.90	-6.98	30.46	1.10	-7.14
73	G-73	108.00	0.35	-2.24	75.96	0.97	-7.03	32.61	1.28	-7.49
74	G-74	107.67	0.58	-2.27	69.41	0.92	-7.19	26.06	1.15	-7.41
75	G-75	108.56	0.66	-2.28	73.96	1.00	-6.37	30.62	1.37	-7.07
76	G-76	109.11	0.51	9.66	72.31	0.89	-6.76	28.97	1.07	-6.90
77	G-77	107.44	-0.19	-2.26	64.88	1.00	-6.53	21.53	1.36	-7.17
78	G-78	109.78	0.85	-0.81	74.46	1.00	-6.37	31.11	1.37	-7.06
79	G-79	109.89	0.55	24.00	68.68	0.89	-6.92	25.34	1.09	-7.08
80	G-80	111.22	0.66	13.18	75.36	0.93	-7.25	32.02	1.19	-7.53
81	G-81	109.67	0.35	9.69	74.87	0.93	-7.25	31.53	1.19	-7.52
82	G-82	107.78	0.62	-1.89	76.90	0.95	-7.22	33.56	1.23	-7.56
83	G-83	110.00	0.57	0.01	71.91	0.91	-7.11	28.57	1.13	-7.30
84	G-84	111.44	1.42	-2.21	70.47	0.98	-6.91	27.12	1.31	-7.42
85	G-85	112.78	1.54	-0.86	67.37	0.91	-7.07	24.03	1.12	-7.25
86	G-86	112.78	1.20	1.63	66.29	0.95	-7.20	22.95	1.24	-7.56
87	G-87	113.11	1.31	-0.84	62.98	0.90	-7.04	19.63	1.11	-7.21
88	G-88	109.11	0.39	-2.54	70.65	0.93	-7.24	27.31	1.18	-7.51
89	G-89	115.33	2.42	0.16	75.68	0.93	-7.25	32.34	1.19	-7.53
90	G-90	114.89	2.39	0.59	70.77	0.91	-7.10	27.43	1.12	-7.28
91	G-91	116.56	1.92	-1.78	77.76	0.95	-7.22	34.42	1.23	-7.56
92	G-92	111.00	1.50	-2.71	71.89	0.92	-7.20	28.55	1.16	-7.43
93	G-93	107.67	0.58	-2.27	84.67	0.94	-7.24	41.32	1.21	-7.55
94	G-94	108.33	0.58	1.69	85.22	0.94	-7.24	41.88	1.21	-7.55
95	G-95	109.22	-0.04	-0.03	74.85	0.93	-7.25	31.50	1.19	-7.52
96	G-96	115.22	0.99	19.69	73.72	0.90	-6.98	30.37	1.10	-7.14
97	G-97	108.00	0.00	-2.75	75.40	0.96	-7.16	32.05	1.25	-7.55
98	G-98	108.67	-0.81	-2.69	75.73	1.00	-6.34	32.38	1.37	-7.05
99	G-99	109.89	-0.39	-2.75	73.24	0.94	-7.23	29.90	1.22	-7.56
100	G-100	116.22	1.22	15.49	77.91	0.89	-6.83	34.57	1.08	-6.98
Population mean		110.629			74.267			31.504		

The genotypes G-12, G-13, G-97, G-61, G-63, G-17, G-25, G-31, G-5, G-54, G-55, G-60 had regression coefficient equal to unity (or close to unity) and deviation from regression equal to zero (closed to zero) with lesser mean value to population mean (widely adopted).

Relative Water Conant of flag leaf (RWC %)

The genotypes G-5, G-7, G-8, G-15, G-16 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability). The genotypes G-100, G-33, G-17 had regression coefficient below unity and minimum deviation from regression coupled with high mean value over population mean greater (above average stability).

The genotypes G-9, G-10, G-12, G-13, G-14, G-24, G-25, G-26, G-29, G-31, G-32, G-35, G-36, G-37, G-38, G-45, G-46, G-52, G-53, G-56, G-59, G-60, G-65, G-66, G-67, G-69, G-70, G-71, G-73, G-78, G-80, G-81, G-82, G-93, G-94, G-95, G-97, G-98 had high mean value to population mean and regression coefficient equal to unity with maximum deviation from regression (unpredictable exploitation of this character).

The genotypes G-11, G-21, G-19, G-20, G-22, G-23, G-27, G-28, G-39, G-40, G-42, G-48, G-49, G-50, G-51, G-54, G-55, G-57, G-58, G-61, G-62, G-63, G-30, G-74, G-75, G-77, G-83, G-84, G-85, G-86, G-87, G-88, G-89, G-90, G-91, G-92, G-99 had regression coefficient equal to unity (or close to unity) so that the genotypes not widely adopted for this character.

Chlorophyll content

Regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean was observed for the genotypes G-2, G-5, G-7, G-38, G-43, G-44, G-45, G-52, G-56, G-59, G-60, G-65, G-66, G-67, G-70, G-71, G-73, G-80, G-81, G-82, G-89, G-100, G-97

G-98, G-91, G-93, G-94, G-33, G-35, G-36 (below average stability). The genotypes G-8, G-9, G-10, G-11, G-12, G-13, G-14, G-15, G-16, G-17, G-21, G-24, G-25, G-26, G-27, G-29, G-31, G-32 had regression coefficient below unity and minimum deviation from regression coupled with high mean value over population mean (above average stability).

The genotypes G-34, G-76 had regression coefficient equal to unity (or close to unity) minimum deviation from regression coupled with lesser mean value to population mean revealed that the genotype not widely adopted for this character.

Canopy temperature

The genotypes G-34, G-35, G-41, G-44, G-45, G-46, G-47, G-42, G-49, G-53, G-54, G-55, G-73, G-74 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability). Regression coefficient below unity and minimum deviation from regression coupled with high mean value over population mean was recorded for the genotypes G-9, G-10, G-11, G-12, G-14, G-15, G-16, G-17, G-21, G-22, G-24, G-25, G-26, G-27, G-28, G-29, G-30, G-31, G-36, G-37, G-38, G-59, G-80, G-81, G-100 (above average stability).

The genotypes G-32, G-40, G-56, G-57, G-51 were showed high mean value to population mean with maximum deviation from regression (unpredictable expression of the character). The genotypes G-98, G-87, G-88, G-82, G-79, G-39, G-33 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression coupled with lesser mean value to population mean revealed that the genotype not widely adopted for this character.

The genotypes G-4, G-83, G-63, G-64, G-60, G-99, G-58 and G-75 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation

Table 4.18: Stability parameters for physiological traits

Sno.	Genotype	Canopy temperature			Membrane thermo-stability		
		mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	21.16	1.05	-0.10	54.94	1.29	6.25
2	G-02	19.88	0.36	-0.11	47.44	1.42	5.82
3	G-03	20.26	1.89	1.77	53.31	1.38	4.53
4	G-04	20.52	1.00	0.09	34.32	1.19	1.17
5	G-05	18.88	0.71	-0.09	32.97	1.17	8.37
6	G-06	18.67	1.44	1.05	37.23	1.31	2.57
7	G-07	18.64	2.07	1.91	48.58	1.27	2.90
8	G-08	20.16	0.42	-0.10	35.93	1.16	7.11
9	G-09	20.71	0.53	-0.08	31.99	1.12	3.93
10	G-10	20.76	0.03	0.25	57.54	0.97	-0.07
11	G-11	20.76	0.50	-0.05	52.52	0.97	-0.07
12	G-12	21.54	0.38	-0.04	35.44	0.97	-0.07
13	G-13	20.54	0.70	0.00	54.30	0.97	-0.07
14	G-14	20.70	1.09	0.29	35.42	0.97	-0.07
15	G-15	20.81	0.74	-0.04	37.26	0.97	-0.07
16	G-16	21.14	0.92	-0.11	54.09	0.97	-0.07
17	G-17	20.73	0.34	-0.03	35.43	0.97	-0.07
18	G-18	20.60	0.54	-0.05	25.42	0.97	-0.07
19	G-19	20.68	0.78	0.82	33.24	0.97	-0.07
20	G-20	20.41	1.04	0.35	33.28	0.97	-0.07
21	G-21	21.49	0.69	-0.03	28.27	0.97	-0.07
22	G-22	21.82	0.77	-0.11	33.34	0.97	-0.07
23	G-23	20.54	1.51	0.22	47.14	0.97	-0.07
24	G-24	21.26	0.39	-0.11	35.42	0.97	-0.07
25	G-25	21.77	0.89	-0.04	33.18	0.97	-0.07
26	G-26	21.48	0.83	-0.10	29.34	0.97	-0.07
27	G-27	21.43	0.78	-0.09	27.19	0.97	-0.07
28	G-28	21.58	0.66	-0.08	29.34	0.97	-0.07
29	G-29	21.32	0.66	-0.11	31.56	0.97	-0.07
30	G-30	21.40	0.66	-0.09	38.31	0.97	-0.07
31	G-31	21.40	0.57	-0.11	21.30	0.97	-0.07
32	G-32	21.00	1.08	-0.05	21.27	0.97	-0.07
33	G-33	20.29	0.92	-0.05	29.49	0.97	-0.07
34	G-34	20.93	1.63	0.28	30.15	0.97	-0.07
35	G-35	21.63	1.93	0.64	27.25	0.97	-0.07
36	G-36	21.51	0.56	-0.10	34.15	0.97	-0.07
37	G-37	21.77	0.00	-0.05	40.36	0.97	-0.07
38	G-38	21.36	0.81	1.10	63.17	0.97	-0.07
39	G-39	20.24	1.02	0.04	24.93	1.34	36.11
40	G-40	21.17	1.07	0.07	55.06	0.97	-0.07
41	G-41	21.27	1.29	-0.10	48.36	0.97	-0.07
42	G-42	20.81	1.28	0.09	56.12	0.97	-0.07
43	G-43	20.54	1.36	-0.11	49.13	0.97	-0.07
44	G-44	20.99	1.67	-0.08	47.33	0.97	-0.07
45	G-45	21.17	1.40	0.01	49.21	0.97	-0.07
46	G-46	20.81	1.33	0.06	63.32	0.97	-0.07
47	G-47	20.72	1.45	-0.11	34.95	1.33	33.45
48	G-48	20.66	1.38	-0.07	43.43	0.97	-0.07
49	G-49	20.97	1.40	0.11	46.50	0.97	-0.07
50	G-50	20.67	1.37	0.11	61.24	0.97	-0.07

Cont..

Sno.	Genotype	Canopy temperature			Membrane thermo-stability		
		mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	21.11	0.96	0.67	41.33	0.97	-0.07
52	G-52	20.50	1.34	0.04	54.49	0.97	-0.07
53	G-53	21.34	1.19	0.02	48.79	0.97	-0.07
54	G-54	21.10	1.13	0.01	52.41	0.97	-0.07
55	G-55	21.11	1.19	0.18	23.64	0.97	-0.07
56	G-56	21.68	0.90	0.41	49.54	0.97	-0.07
57	G-57	21.01	0.99	-0.11	55.66	0.97	-0.07
58	G-58	21.22	1.01	-0.07	23.38	0.97	-0.07
59	G-59	20.81	0.40	0.73	21.35	0.97	-0.07
60	G-60	20.11	0.91	-0.05	26.50	0.97	-0.07
61	G-61	20.46	1.76	-0.05	29.46	0.97	-0.07
62	G-62	20.66	1.40	0.06	52.25	0.97	-0.07
63	G-63	20.50	1.01	0.07	53.72	0.97	-0.07
64	G-64	20.31	1.03	-0.08	55.09	0.97	-0.07
65	G-65	20.18	0.79	0.00	55.34	0.97	-0.07
66	G-66	19.74	0.76	0.00	57.48	0.97	-0.07
67	G-67	19.47	0.81	-0.11	44.48	0.97	-0.07
68	G-68	20.17	0.58	0.20	48.40	0.97	-0.07
69	G-69	19.92	0.44	0.06	49.39	0.97	-0.07
70	G-70	19.49	0.80	-0.11	53.28	0.97	-0.07
71	G-71	20.33	0.35	-0.04	46.37	0.97	-0.07
72	G-72	20.78	0.59	-0.09	28.52	0.97	-0.07
73	G-73	21.24	1.31	-0.10	34.38	0.97	-0.07
74	G-74	21.03	1.22	0.15	42.11	0.97	-0.07
75	G-75	21.19	1.00	0.03	53.22	0.97	-0.07
76	G-76	20.53	0.62	0.61	29.30	0.97	-0.07
77	G-77	20.52	0.65	-0.11	43.24	0.97	-0.07
78	G-78	20.58	0.74	-0.11	59.43	0.97	-0.07
79	G-79	21.29	1.06	-0.10	54.24	0.97	-0.07
80	G-80	21.43	0.77	-0.10	36.25	0.97	-0.07
81	G-81	20.76	0.72	-0.10	54.19	0.97	-0.07
82	G-82	20.62	1.52	0.44	39.37	0.97	-0.07
83	G-83	20.82	1.01	0.00	35.01	0.97	-0.07
84	G-84	20.66	1.27	-0.10	43.09	0.97	-0.07
85	G-85	20.79	1.61	-0.02	41.21	0.97	-0.07
86	G-86	20.52	1.36	1.21	30.79	0.84	7.26
87	G-87	20.60	1.05	0.34	32.46	0.97	-0.07
88	G-88	20.31	1.01	-0.10	33.38	0.97	-0.07
89	G-89	20.58	0.53	-0.11	37.12	0.97	-0.07
90	G-90	19.74	1.08	0.05	25.41	0.97	-0.07
91	G-91	19.60	1.46	0.81	50.20	0.97	-0.07
92	G-92	20.77	1.13	0.10	34.72	0.97	-0.07
93	G-93	20.46	1.59	0.03	33.49	0.97	-0.07
94	G-94	20.11	1.20	0.12	26.36	0.97	-0.07
95	G-95	20.07	1.35	-0.04	34.52	0.97	-0.07
96	G-96	20.69	1.85	0.00	28.34	0.97	-0.07
97	G-97	20.78	1.14	-0.06	41.61	0.97	-0.07
98	G-98	20.24	0.98	-0.11	32.56	0.97	-0.07
99	G-99	20.40	1.04	-0.08	40.33	0.97	-0.07
100	G-100	20.71	0.92	-0.11	32.45	0.97	-0.07
Population mean		20.706			40.602		

from regression was equal to zero (or close to zero) revealed that the genotype had wider adoption for this character.

Membrane thermo-stability

The genotypes G-1, G-2, G-3, G-73 were showed regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

Regression coefficient equal to unity (or close to unity) and minimum deviation from regression coupled with lesser mean value to population mean were observed for the genotypes G-55, G-58, G-59, G-60, G-61, G-12, G-14, G-15, G-17, G-18, G-19, G-20, G-21, G-22, G-24, G-25, G-26, G-27, G-28, G-29, G-30, G-31, G-32, G-33, G-34, G-35, G-36, G-37, G-87, G-88, G-89, G-90, G-92, G-93, G-94, G-95, G-96, G-98, G-99, G-100, G-72, G-73, G-76, G-80, G-82, G-83 (the genotype not widely adopted for this trait).

The genotypes G-10, G-11, G-13, G-16, G-23, G-38, G-40, G-41, G-42, G-43, G-44, G-45, G-46, G-48, G-49, G-50, G-51, G-52, G-53, G-54, G-56, G-62, G-63, G-64, G-65, G-66, G-67, G-68, G-70, G-71, G-74, G-75, G-91, G-77, G-78, G-79, G-81, G-84, G-85, G-97 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted for this character.

Plant height (cm)

The genotypes G-8, G-9, G-57, G-38, G-39, G-59, G-85, G-87, G-89, G-92, G-93, G-19, G-44, G-27, G-14, G-18, G-25, G-31, G-35, G-53, G-55, G-103 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

Regression coefficient below unity and minimum deviation from regression coupled with high mean value over population

Table 4.19: Stability parameters for morphological and yield contributing traits

Sno.	Genotype	Plant height(cm)			No. of effective tillers plant^{-1}			No. of ears plant^{-1}		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	86.16	1.08	-5.31	2.98	0.89	-0.02	2.67	0.96	-0.07
2	G-02	83.79	0.09	-5.73	3.53	0.95	-0.02	3.41	0.98	-0.09
3	G-03	99.42	0.74	-5.74	3.84	0.81	-0.01	3.74	0.98	-0.09
4	G-04	98.12	0.19	-5.55	1.96	0.92	-0.02	2.43	0.75	-0.03
5	G-05	83.21	1.17	-5.74	3.66	0.82	0.00	3.58	0.98	-0.09
6	G-06	100.86	0.77	-5.61	4.77	0.93	-0.02	4.88	0.98	-0.09
7	G-07	93.76	0.97	-5.62	3.62	0.93	0.05	3.28	0.98	-0.09
8	G-08	101.41	1.44	-5.72	2.47	0.79	-0.01	2.46	0.26	-0.08
9	G-09	96.59	1.21	-5.58	2.78	0.89	-0.02	2.98	0.98	-0.09
10	G-10	98.99	0.99	-5.34	2.98	0.65	0.02	2.77	1.00	-0.09
11	G-11	96.66	0.60	-5.44	2.72	0.60	0.04	2.34	1.02	-0.06
12	G-12	78.17	1.60	-5.29	2.76	0.68	0.02	2.71	1.03	-0.04
13	G-13	88.46	1.94	-5.67	3.60	0.66	0.05	3.31	0.98	-0.09
14	G-14	93.27	1.25	-5.74	3.29	0.76	0.00	3.16	1.02	-0.05
15	G-15	94.27	1.04	-5.71	5.47	1.05	0.02	5.31	0.98	-0.09
16	G-16	91.17	0.63	-5.70	3.44	0.73	0.00	3.28	0.98	-0.09
17	G-17	85.51	1.77	-5.19	2.78	0.65	0.02	2.69	1.02	-0.05
18	G-18	99.42	1.73	-4.87	3.61	0.73	0.00	3.43	0.97	-0.09
19	G-19	99.90	1.75	-5.66	2.87	0.79	-0.01	2.79	0.98	-0.10
20	G-20	86.53	1.14	-5.19	5.09	0.80	0.01	4.91	0.98	-0.09
21	G-21	93.03	0.96	-5.00	2.89	0.51	0.06	2.67	1.01	-0.07
22	G-22	81.07	2.02	-5.39	2.47	0.50	0.04	2.28	1.02	-0.06
23	G-23	86.29	1.45	-5.54	4.42	0.60	0.04	4.18	0.98	-0.09
24	G-24	87.61	0.82	-5.68	2.51	-0.33	-0.01	2.12	1.04	-0.01
25	G-25	91.58	1.73	-5.74	2.56	0.68	0.02	2.49	1.02	-0.05
26	G-26	103.73	0.94	-5.73	3.51	0.73	0.00	3.51	0.98	-0.09
27	G-27	94.14	1.16	-5.58	4.66	0.54	0.04	4.38	0.98	-0.09
28	G-28	88.21	1.37	-4.94	3.13	0.70	0.01	2.99	0.98	-0.10
29	G-29	84.42	1.32	-5.73	4.31	0.73	0.00	4.12	0.98	-0.10
30	G-30	77.79	1.44	-5.74	5.53	0.95	0.01	5.38	0.98	-0.09
31	G-31	91.88	1.54	-5.71	5.77	1.51	0.04	6.02	0.99	-0.09
32	G-32	92.08	0.48	-5.54	2.87	1.03	-0.02	2.98	1.00	-0.09
33	G-33	89.30	1.47	-5.67	4.13	1.00	0.00	4.31	0.98	-0.09
34	G-34	84.51	1.35	-5.73	3.20	0.87	-0.01	3.18	0.98	-0.09
35	G-35	94.50	1.09	-5.55	5.79	1.59	0.01	6.09	0.99	-0.09
36	G-36	85.02	1.60	-4.88	2.78	0.89	-0.02	2.83	1.00	-0.09
37	G-37	91.33	1.23	-5.73	5.62	1.02	0.01	5.51	-0.49	0.06
38	G-38	99.46	1.24	-5.21	3.20	0.87	-0.01	3.13	0.98	-0.10
39	G-39	110.52	1.34	-5.74	4.91	0.84	0.05	4.78	0.98	-0.09
40	G-40	92.44	0.60	-5.64	4.31	0.98	-0.02	4.38	0.98	-0.09
41	G-41	90.78	1.37	-4.94	3.33	0.97	0.01	3.11	0.98	-0.09
42	G-42	76.00	1.02	-5.73	4.27	1.03	-0.02	4.07	1.13	0.55
43	G-43	88.50	1.06	-5.39	5.78	1.04	-0.01	5.98	0.98	-0.09
44	G-44	98.49	1.32	-5.74	5.02	0.84	-0.01	4.91	0.98	-0.09
45	G-45	93.29	0.53	-5.66	4.09	0.92	-0.02	4.12	1.01	-0.08
46	G-46	89.48	1.29	-5.69	3.93	0.95	-0.02	3.99	1.01	-0.08
47	G-47	83.53	1.02	-5.71	3.80	0.87	-0.01	3.78	0.98	-0.09
48	G-48	84.19	0.82	-5.52	4.11	0.98	-0.02	4.12	0.98	-0.10
49	G-49	94.93	0.89	-5.72	2.98	0.73	0.00	2.63	1.00	-0.09
50	G-50	78.69	0.94	-5.64	4.42	1.09	-0.01	4.58	0.98	-0.09

Cont..

Sno.	Genotype	Plant height(cm)			No. of effective tillers plant^{-1}			No. of ears plant^{-1}		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	92.00	0.96	-5.57	3.07	0.79	-0.01	2.99	0.98	-0.10
52	G-52	89.48	0.61	-5.68	4.67	0.79	-0.01	4.58	0.98	-0.09
53	G-53	93.38	1.35	-5.47	3.51	0.73	0.00	3.31	0.98	-0.09
54	G-54	91.76	0.96	-5.69	4.29	1.05	0.01	4.58	0.98	-0.09
55	G-55	93.79	1.11	-5.74	3.33	0.95	-0.02	3.38	0.98	-0.09
56	G-56	88.67	1.04	-5.73	3.56	0.92	-0.02	3.58	0.98	-0.09
57	G-57	101.78	1.74	-5.70	4.62	0.92	-0.02	4.64	0.98	-0.09
58	G-58	87.19	1.03	-5.70	3.78	0.89	-0.02	3.78	0.98	-0.09
59	G-59	91.79	1.08	-5.68	2.87	1.03	-0.02	2.99	0.98	-0.10
60	G-60	84.07	-1.96	17.76	4.02	0.84	-0.01	4.01	0.99	-0.10
61	G-61	85.29	0.64	-5.44	4.38	1.04	-0.01	4.58	0.98	-0.09
62	G-62	87.11	1.42	-5.46	3.07	0.79	-0.01	2.92	0.98	-0.10
63	G-63	93.72	0.86	-5.74	3.36	0.92	-0.02	3.38	0.98	-0.09
64	G-64	90.71	1.21	-5.73	3.42	0.84	-0.01	3.31	0.98	-0.09
65	G-65	86.82	1.46	-5.73	3.56	0.92	-0.02	3.51	0.98	-0.09
66	G-66	90.89	1.10	-5.68	3.44	1.06	-0.02	3.41	0.99	-0.10
67	G-67	91.86	0.71	-5.70	3.69	1.00	0.01	3.61	0.98	-0.09
68	G-68	85.23	0.42	-5.70	3.76	1.41	0.06	4.16	0.99	-0.09
69	G-69	90.77	1.05	-5.72	3.53	0.95	-0.02	3.41	0.98	-0.09
70	G-70	86.31	0.38	-5.67	5.51	0.98	-0.02	5.44	0.98	-0.09
71	G-71	91.48	0.62	-5.64	3.64	1.30	0.03	3.91	0.98	-0.09
72	G-72	91.41	0.52	-5.70	3.44	1.06	-0.02	3.58	0.98	-0.09
73	G-73	92.12	0.09	-5.73	3.67	1.77	0.23	4.38	0.98	-0.09
74	G-74	94.46	0.70	-5.70	4.04	1.00	0.03	4.31	0.98	-0.09
75	G-75	90.24	0.95	-5.73	3.93	0.95	-0.02	2.99	0.98	-0.10
76	G-76	95.51	0.41	-5.74	3.42	1.58	0.13	3.98	0.98	-0.09
77	G-77	93.17	0.74	-5.72	3.53	1.44	0.07	3.91	0.98	-0.09
78	G-78	94.90	0.27	-5.48	4.18	0.89	-0.02	4.12	0.98	-0.10
79	G-79	94.06	1.00	-5.62	5.40	1.01	-0.01	5.51	0.98	-0.09
80	G-80	83.58	0.46	-5.74	6.16	1.90	0.32	6.91	0.98	-0.09
81	G-81	89.87	0.13	-5.73	3.42	1.58	0.13	3.94	0.98	-0.09
82	G-82	89.40	0.59	-5.74	5.33	1.44	0.07	5.62	1.66	-0.09
83	G-83	100.82	0.90	-5.70	2.87	1.77	0.23	3.51	0.98	-0.09
84	G-84	80.99	1.46	-5.25	6.00	2.65	0.21	6.76	3.34	0.26
85	G-85	100.53	1.52	-5.58	4.58	0.89	-0.02	4.58	0.98	-0.09
86	G-86	92.27	1.02	-5.73	2.77	1.15	0.24	3.38	0.98	-0.09
87	G-87	94.58	1.28	-5.73	3.40	1.11	-0.01	3.58	0.98	-0.09
88	G-88	93.16	0.94	-5.53	4.04	1.55	0.11	4.51	0.98	-0.09
89	G-89	108.47	1.30	-5.72	2.49	0.76	0.00	2.58	0.07	-0.08
90	G-90	90.44	1.14	-5.73	3.38	1.14	-0.01	3.51	0.98	-0.09
91	G-91	89.33	1.21	-5.69	4.36	1.41	0.06	4.71	0.98	-0.09
92	G-92	110.10	1.67	-5.09	5.22	1.03	0.03	5.26	2.13	-0.05
93	G-93	92.67	1.14	-4.61	5.24	1.00	0.01	5.39	1.81	-0.08
94	G-94	93.99	0.50	-5.63	3.31	1.47	0.08	3.78	0.98	-0.09
95	G-95	93.48	0.69	-5.72	3.48	0.89	-0.02	3.51	0.98	-0.09
96	G-96	89.33	0.74	-5.54	4.33	1.01	-0.01	4.11	0.98	-0.09
97	G-97	83.43	0.47	-5.74	4.11	0.73	0.00	4.01	0.98	-0.09
98	G-98	88.61	0.92	-5.72	3.71	1.22	0.01	3.91	0.98	-0.09
99	G-99	85.64	1.15	-5.72	3.20	0.87	-0.01	3.12	0.98	-0.10
100	G-100	109.11	0.83	-4.33	5.33	0.98	0.01	4.91	0.98	-0.09
Population mean		91.52			3.84			3.88		

mean were observed for the genotypes G-3, G-4, G-100, G-6, G-63, G-67, G-73, G-76, G-77, G-78, G-74, G-94, G-95, G-83, G-11, G-32, G-45, G-49, G-40 (above average stability). The genotype G-86 had high mean value to population mean with maximum deviation from regression (unpredictable exploration of the character).

The genotype G-98, G-75, G-69, G-50, G-51, G-54, G-56, G-58, G-42, G-43, G-47, G-15 had regression coefficient equal to unity (or close to unity) with lesser mean value to population mean revealed that the genotype not widely adopted.

Number of effective tillers per plant

Regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean were recorded for The genotypes G-31, G-35, G-88, G-80, G-82, G-91, G-84 (below average stability).

The genotypes G-20, G-23, G-27, G-29, G-39, G-40, G-44, G-52, G-60, G-97, G-78, G-85 was revealed regression coefficient below unity and minimum deviation from regression also with high mean value over population mean (above average stability).

The genotypes G-63, G-65, G-32, G-55, G-56, G-59, G-69 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression with lesser mean value to population mean (the genotypes not widely adopted).

The genotypes G-30, G-41, G-7, G-2, G-75, G-15, G-42, G-6, G-92, G-93, G-96, G-79, G-43, G-50, G-54, G-37, G-74, G-61, G-33,G-100, G-57, G-70, G-45, G-46, G-48 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted for this trait.

Number of ears per plant

The genotypes G-42, G-92, G-93, G-84, G-82 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean

(below average stability).

The genotypes G-1, G-2, G-3, G-4, G-5, G-7, G-8, G-9, G-10, G-11, G-12, G-13, G-14, G-16, G-17, G-18, G-19, G-20, G-21, G-22, G-24, G-25, G-26, G-27, G-28, G-32, G-34, G-36, G-38, G-41, G-47, G-49, G-51, G-53, G-55, G-56, G-58, G-59, G-62, G-63, G-64, G-65, G-66, G-67, G-69, G-72, G-75, G-83, G-86, G-87, G-89, G-90, G-94, G-95 had regression coefficient equal to unity (or close to unity) with lesser mean value to population mean and minimum deviation from regression (the genotypes not widely adopted for this trait).

Regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression equal to zero were reported for the genotypes G-6, G-15, G-23, G-29, G-30, G-31, G-33, G-35, G-39, G-40, G-43, G-44, G-45, G-46, G-48, G-50, G-52, G-54, G-57, G-60, G-61, G-77, G-78, G-79, G-80, G-81, G-85, G-88, G-91, G-96, G-97, G-98, G-99, G-100 had (or close to zero) revealed that the genotypes widely adopted for this trait.

Number of spikelets per ear

The genotypes G-35, G-42, G-46, G-54, G-64, G-65, G-60, G-66, G-77, G-78, G-79, G-80, G-81, G-82, G-83, G-88, G-89, G-90, G-91, G-59- had regression coefficient higher than unity coupled and minimum deviation from regression with mean value high to population mean (below average stability). The genotypes G-13, G-16, G-18, G-19, G-20, G-22, G-31, G-32, G-34, G-48, G-49, G-68, G-73, G-76, G-87, G-95, G-96, G-99 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability)

The genotypes G- 69, G-62, G-63, G-53, G-33, G-30, G-25, G-27, G-23 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression with lesser mean value to population mean (the genotypes not widely adopted for this trait).

Table 4.20: Stability parameters for morphological and yield contributing traits

Sno.	Genotype	No. of spikelets ear^{-1}			Length of ear (cm)			Spike density		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	16.87	0.86	-0.17	9.09	0.89	-0.03	16.87	0.86	-0.17
2	G-02	15.79	0.85	-0.17	7.79	0.89	-0.03	15.79	0.85	-0.17
3	G-03	20.10	0.99	-0.16	11.02	1.87	0.67	20.10	0.99	-0.16
4	G-04	14.78	0.89	-0.14	6.29	0.89	-0.03	14.78	0.89	-0.14
5	G-05	16.10	0.86	-0.17	7.79	0.89	-0.03	16.10	0.86	-0.17
6	G-06	17.00	0.85	-0.18	8.79	0.89	-0.03	17.00	0.85	-0.18
7	G-07	16.89	0.87	-0.16	8.99	0.89	-0.03	16.89	0.87	-0.16
8	G-08	18.06	0.87	-0.14	8.19	0.89	-0.03	18.06	0.87	-0.14
9	G-09	15.89	0.87	-0.16	6.99	0.89	-0.03	15.89	0.87	-0.16
10	G-10	16.78	0.89	-0.14	7.69	0.89	-0.03	16.78	0.89	-0.14
11	G-11	15.86	0.89	-0.13	7.99	0.89	-0.03	15.86	0.89	-0.13
12	G-12	15.78	0.89	-0.14	9.69	0.89	-0.03	15.78	0.89	-0.14
13	G-13	18.92	0.87	-0.18	10.29	1.93	0.76	18.92	0.87	-0.18
14	G-14	17.90	0.88	-0.16	8.99	0.89	-0.03	17.90	0.88	-0.16
15	G-15	15.87	0.90	-0.13	8.59	0.89	-0.03	15.87	0.90	-0.13
16	G-16	20.74	0.86	0.84	9.79	0.89	-0.03	20.74	0.86	0.84
17	G-17	18.00	0.85	-0.18	8.99	0.89	-0.03	18.00	0.85	-0.18
18	G-18	18.78	0.88	-0.15	8.89	0.89	-0.03	18.78	0.88	-0.15
19	G-19	21.00	1.02	-0.09	11.13	2.02	0.94	21.00	1.02	-0.09
20	G-20	19.01	0.88	-0.17	10.59	0.89	-0.03	19.01	0.88	-0.17
21	G-21	18.90	0.99	-0.17	7.59	0.89	-0.03	18.90	0.99	-0.17
22	G-22	18.94	0.86	-0.19	7.69	0.89	-0.03	18.94	0.86	-0.19
23	G-23	15.96	0.90	-0.11	6.59	0.89	-0.03	15.96	0.90	-0.11
24	G-24	17.97	0.86	-0.16	7.99	0.89	-0.03	17.97	0.86	-0.16
25	G-25	17.98	1.00	-0.16	8.19	0.89	-0.03	17.98	1.00	-0.16
26	G-26	21.06	0.97	0.23	10.51	2.23	1.39	21.06	0.97	0.23
27	G-27	16.88	0.99	-0.08	8.99	0.89	-0.03	16.88	0.99	-0.08
28	G-28	21.01	0.99	0.06	9.49	0.89	-0.03	21.01	0.99	0.06
29	G-29	18.89	0.99	-0.15	8.49	0.89	-0.03	18.89	0.99	-0.15
30	G-30	15.07	0.98	-0.14	7.09	0.89	-0.03	15.07	0.98	-0.14
31	G-31	18.28	0.86	-0.16	8.19	0.89	-0.03	18.28	0.86	-0.16
32	G-32	19.99	0.89	-0.15	8.79	0.89	-0.03	19.99	0.89	-0.15
33	G-33	15.89	1.00	-0.17	6.89	0.89	-0.03	15.89	1.00	-0.17
34	G-34	20.61	0.60	-0.05	9.99	0.89	-0.03	20.61	0.60	-0.05
35	G-35	21.59	1.36	0.03	8.79	0.89	-0.03	21.59	1.36	0.03
36	G-36	14.86	0.89	-0.13	7.39	0.89	-0.03	14.86	0.89	-0.13
37	G-37	14.31	0.81	-0.18	6.69	0.89	-0.03	14.31	0.81	-0.18
38	G-38	16.28	0.86	-0.16	7.69	0.89	-0.03	16.28	0.86	-0.16
39	G-39	14.84	0.87	-0.13	8.49	0.89	-0.03	14.84	0.87	-0.13
40	G-40	14.26	0.74	-0.19	6.79	0.89	-0.03	14.26	0.74	-0.19
41	G-41	14.39	0.71	-0.16	7.39	0.89	-0.03	14.39	0.71	-0.16
42	G-42	20.60	1.26	0.28	9.19	0.89	-0.03	20.60	1.26	0.28
43	G-43	17.84	0.87	-0.13	9.19	0.89	-0.03	17.84	0.87	-0.13
44	G-44	19.10	0.88	-0.16	11.19	1.93	0.76	19.10	0.88	-0.16
45	G-45	16.53	1.33	-0.19	6.89	1.75	0.49	16.53	1.33	-0.19
46	G-46	20.42	1.36	0.12	8.89	0.89	-0.03	20.42	1.36	0.12
47	G-47	15.28	0.86	-0.16	9.59	0.89	-0.03	15.28	0.86	-0.16
48	G-48	18.78	0.89	-0.14	8.59	0.89	-0.03	18.78	0.89	-0.14
49	G-49	20.01	0.88	-0.17	9.09	0.89	-0.03	20.01	0.88	-0.17
50	G-50	17.28	0.86	-0.16	7.19	0.89	-0.03	17.28	0.86	-0.16

Cont…

Sno.	Genotype	No. of spikelets ear^{-1}			Length of ear (cm)			Spike density		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	15.90	0.88	-0.16	7.39	0.89	-0.03	15.90	0.88	-0.16
52	G-52	20.80	1.01	-0.07	9.89	0.89	-0.03	20.80	1.01	-0.07
53	G-53	14.84	1.02	-0.12	7.39	0.89	-0.03	14.84	1.02	-0.12
54	G-54	21.04	1.74	1.53	10.29	0.89	-0.03	21.04	1.74	1.53
55	G-55	14.54	0.48	-0.03	9.49	0.89	-0.03	14.54	0.48	-0.03
56	G-56	15.97	0.86	-0.16	8.79	0.89	-0.03	15.97	0.86	-0.16
57	G-57	19.93	1.02	-0.09	9.09	0.89	-0.03	19.93	1.02	-0.09
58	G-58	15.90	0.88	-0.16	8.89	0.89	-0.03	15.90	0.88	-0.16
59	G-59	19.54	1.05	-0.15	7.69	0.89	-0.03	19.54	1.05	-0.15
60	G-60	20.57	1.25	0.16	9.29	0.89	-0.03	20.57	1.25	0.16
61	G-61	20.56	1.03	-0.13	7.59	0.89	-0.03	20.56	1.03	-0.13
62	G-62	17.92	0.99	-0.13	7.69	0.89	-0.03	17.92	0.99	-0.13
63	G-63	17.06	1.00	-0.18	8.59	0.89	-0.03	17.06	1.00	-0.18
64	G-64	19.78	1.18	-0.10	7.39	0.89	-0.03	19.78	1.18	-0.10
65	G-65	21.51	1.45	0.02	8.69	0.89	-0.03	21.51	1.45	0.02
66	G-66	21.63	1.37	0.02	8.49	0.89	-0.03	21.63	1.37	0.02
67	G-67	17.29	0.87	-0.16	7.99	0.89	-0.03	17.29	0.87	-0.16
68	G-68	19.89	0.87	-0.16	8.09	0.89	-0.03	19.89	0.87	-0.16
69	G-69	17.90	0.94	-0.12	8.09	0.89	-0.03	17.90	0.94	-0.12
70	G-70	16.84	0.87	-0.13	7.79	0.89	-0.03	16.84	0.87	-0.13
71	G-71	15.94	0.86	-0.19	6.89	0.89	-0.03	15.94	0.86	-0.19
72	G-72	14.97	1.09	-0.16	7.29	0.89	-0.03	14.97	1.09	-0.16
73	G-73	18.89	0.87	-0.16	9.79	0.89	-0.03	18.89	0.87	-0.16
74	G-74	17.06	0.82	-0.10	8.99	0.89	-0.03	17.06	0.82	-0.10
75	G-75	16.60	1.16	0.01	7.99	0.89	-0.03	16.60	1.16	0.01
76	G-76	18.02	0.88	-0.10	8.79	0.89	-0.03	18.02	0.88	-0.10
77	G-77	21.23	1.46	-0.14	9.82	2.56	2.24	21.23	1.46	-0.14
78	G-78	20.59	1.16	0.25	9.59	0.89	-0.03	20.59	1.16	0.25
79	G-79	21.11	1.51	-0.17	10.46	2.16	1.21	21.11	1.51	-0.17
80	G-80	21.63	1.15	0.17	9.59	0.89	-0.03	21.63	1.15	0.17
81	G-81	20.62	1.29	0.33	10.29	0.89	-0.03	20.62	1.29	0.33
82	G-82	20.52	1.89	-0.15	10.78	1.60	0.29	20.52	1.89	-0.15
83	G-83	20.57	1.22	0.29	10.41	1.02	-0.04	20.57	1.22	0.29
84	G-84	18.96	1.03	-0.12	9.39	0.89	-0.03	18.96	1.03	-0.12
85	G-85	16.84	0.87	-0.13	7.99	0.89	-0.03	16.84	0.87	-0.13
86	G-86	16.06	0.87	-0.14	9.19	0.89	-0.03	16.06	0.87	-0.14
87	G-87	19.07	0.88	-0.14	7.99	0.89	-0.03	19.07	0.88	-0.14
88	G-88	20.87	1.21	-0.11	10.19	0.89	-0.03	20.87	1.21	-0.11
89	G-89	20.24	1.29	-0.19	9.69	0.89	-0.03	20.24	1.29	-0.19
90	G-90	20.78	1.36	-0.19	9.49	0.89	-0.03	20.78	1.36	-0.19
91	G-91	20.88	1.64	-0.19	8.89	0.89	-0.03	20.88	1.64	-0.19
92	G-92	15.98	0.88	-0.15	8.89	0.89	-0.03	15.98	0.88	-0.15
93	G-93	17.62	1.37	-0.19	8.69	0.89	-0.03	17.62	1.37	-0.19
94	G-94	17.03	0.90	-0.10	9.49	0.89	-0.03	17.03	0.90	-0.10
95	G-95	18.99	0.89	-0.15	8.99	0.89	-0.03	18.99	0.89	-0.15
96	G-96	19.10	0.88	-0.16	9.29	0.89	-0.03	19.10	0.88	-0.16
97	G-97	17.12	0.87	-0.18	8.99	0.89	-0.03	17.12	0.87	-0.18
98	G-98	18.29	0.96	-0.17	8.79	0.89	-0.03	18.29	0.96	-0.17
99	G-99	18.20	0.79	-0.19	10.01	1.72	0.44	18.20	0.79	-0.19
100	G-100	16.82	1.22	-0.12	10.09	0.89	-0.03	16.82	1.22	-0.12
Population mean		18.13			8.73			2.07		

The genotypes G-3, G-21, G-26, G-28, G-29, G-84, G-61, G-44, G-52, G-57 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotypes widely adopted for this trait.

Length of ear (cm)

The genotypes G-3, G-13, G-19, G-44, G-26, G-79, G-77, G-82, G-99 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability). The genotypes G-1, G-6, G-7, G-12, G-16, G-17, G-18, G-20, G-28, G-27, G-32, G-34, G-35, G-42, G-43, G-46, G-47, G-49, G-52, G-54, G-55, G-56, G-57, G-58, G-60, G-73, G-74, G-76, G-78, G-80, G-81, G-84, G-86, G-88, G-89, G-90, G-91, G-92, G-93, G-94, G-95, G-96, G-97, G-98, G-100 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability).

The genotype G-83 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted for this trat.

Spike density

The genotypes G-16, G-28, G-35, G-42, G-45, G-46, G-57, G-52, G-60, G-63, G-77, G-78, G-85, G-89, G-90, G-91, G-92, G-80,G-96, G-65, G-66 had regression coefficient higher than unity minimum deviation from regression coupled with mean value high to population mean (below average stability). The genotypes G-2, G-4, G-5, G-8, G-9, G-10, G-11, G-18, G-21, G-22, G-23, G-24, G-25, G-29, G-30, G-31, G-32, G-33, G-34, G-37, G-38, G-40, G-48, G-49, G-61, G-62, G-67, G-68, G-69, G-70, G-71, G-72, G-75, G-76, G-79, G-87, G-95, G-98 had regression coefficient below unity and minimum deviation from regression

with high mean value over population mean (above average stability).

The genotypes G-55, G-56, G-58 had regression coefficient equal to unity (or close to unity) with lesser mean value to population mean (the genotypes not widely adopted for this trait). The genotypes G-59 and G-64 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted for this trait.

Number of Grains per ear

The genotypes G-1, G-2, G-3, G-4, G-5, G-8, G-9, G-10, G-11, G-14, G-15, G-21, G-23, G-24, G-30, G-31, G-33, G-36, G-37, G-38, G-39, G-40, G-41, G-45, G-47, G-50, G-51, G-53, G-55, G-56, G-58, G-63, G-67, G-70, G-71, G-72, G-74, G-75, G-86, G-87, G-89, G-92, G-93, G-94, G-97, G-100 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability).

The genotypes G-6, G-7, G-12, G-13, G-16, G-17, G-18, G-19, G-20, G-22, G-25, G-26, G-27, G-28, G-29, G-32, G-34, G-35, G-42, G-43, G-44, G-46, G-48, G-49, G-52, G-54, G-57, G-59, G-60, G-61, G-62, G-64, G-65, G-66, G-68, G-69, G-73, G-76, G-77, G-78, G-79, G-80, G-81, G-82, G-83, G-84, G-85, G-98, G-99, G-90, G-91, G-95, G-96 had high mean value to population mean with maximum deviation from regression (unpredictable exploitation of this traits).

1000-grain weight (g)

The genotypes G-5, G-11, G-14, G-12, G-10, G-15, G-16, G-17, G-21, G-22, G-27, G-30, G-36, G-37, G-49, G-42, G-55, G-56, G-57, G-58, G-59, G-62, G-63, G-64, G-67, G-70, G-71, G-76, G-79, G-81, G-84, G-85, G-86, G-90, G-93, G-95 had regression coefficient higher than unity and minimum deviation

Table 4.21: Stability parameters for yield and its contributing traits

Sno.	Genotype	No. of grains ear^{-1}			1000-grain weight (g)			Yield plant^{-1}(g)		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	45.24	1.01	-0.15	28.78	0.96	-0.05	45.24	1.01	-0.15
2	G-02	44.13	0.95	-0.15	35.95	1.00	-0.37	44.13	0.95	-0.15
3	G-03	66.06	0.90	-0.14	23.34	0.93	0.33	66.06	0.90	-0.14
4	G-04	35.36	1.07	-0.15	37.34	1.01	-0.41	35.36	1.07	-0.15
5	G-05	29.26	1.01	-0.15	48.88	1.07	-0.48	29.26	1.01	-0.15
6	G-06	49.24	1.01	-0.15	28.87	0.94	-0.16	49.24	1.01	-0.15
7	G-07	49.24	1.01	-0.15	34.21	0.99	-0.30	49.24	1.01	-0.15
8	G-08	24.24	1.01	-0.15	59.10	-0.66	32.03	24.24	1.01	-0.15
9	G-09	40.24	1.01	-0.15	42.71	1.04	-0.50	40.24	1.01	-0.15
10	G-10	31.24	1.01	-0.15	47.64	1.06	-0.49	31.24	1.01	-0.15
11	G-11	37.24	1.01	-0.15	50.26	1.68	-0.43	37.24	1.01	-0.15
12	G-12	54.24	1.01	-0.15	41.81	1.06	-0.50	54.24	1.01	-0.15
13	G-13	53.24	1.01	-0.15	35.21	1.14	-0.08	53.24	1.01	-0.15
14	G-14	43.24	1.01	-0.15	45.75	1.08	-0.44	43.24	1.01	-0.15
15	G-15	36.24	1.01	-0.15	45.92	1.08	-0.44	36.24	1.01	-0.15
16	G-16	86.24	1.01	-0.15	41.78	1.06	-0.50	86.24	1.01	-0.15
17	G-17	51.24	1.01	-0.15	42.86	1.06	-0.49	51.24	1.01	-0.15
18	G-18	52.24	1.01	-0.15	38.40	1.16	-0.23	52.24	1.01	-0.15
19	G-19	61.24	1.01	-0.15	38.37	1.22	0.03	61.24	1.01	-0.15
20	G-20	52.24	1.01	-0.15	37.57	1.03	-0.50	52.24	1.01	-0.15
21	G-21	38.24	1.01	-0.15	42.23	1.08	-0.48	38.24	1.01	-0.15
22	G-22	49.24	1.01	-0.15	47.77	1.07	-0.46	49.24	1.01	-0.15
23	G-23	37.24	1.01	-0.15	36.62	1.01	-0.43	37.24	1.01	-0.15
24	G-24	38.24	1.01	-0.15	41.51	1.04	-0.50	38.24	1.01	-0.15
25	G-25	45.24	1.01	-0.15	36.80	1.01	-0.44	45.24	1.01	-0.15
26	G-26	67.24	1.01	-0.15	36.86	1.01	-0.44	67.24	1.01	-0.15
27	G-27	46.24	1.01	-0.15	44.57	1.06	-0.50	46.24	1.01	-0.15
28	G-28	49.24	1.01	-0.15	41.20	1.17	-0.19	49.24	1.01	-0.15
29	G-29	51.24	1.01	-0.15	40.90	1.04	-0.50	51.24	1.01	-0.15
30	G-30	36.24	1.01	-0.15	47.93	1.07	-0.46	36.24	1.01	-0.15
31	G-31	47.24	1.01	-0.15	40.72	1.04	-0.51	47.24	1.01	-0.15
32	G-32	53.24	1.01	-0.15	44.43	1.06	-0.49	53.24	1.01	-0.15
33	G-33	38.24	1.01	-0.15	39.78	1.04	-0.50	38.24	1.01	-0.15
34	G-34	60.24	1.01	-0.15	35.70	1.02	-0.45	60.24	1.01	-0.15
35	G-35	64.24	1.01	-0.15	32.91	1.00	-0.37	64.24	1.01	-0.15
36	G-36	37.24	1.01	-0.15	47.51	1.08	-0.44	37.24	1.01	-0.15
37	G-37	35.24	1.01	-0.15	47.05	1.07	-0.44	35.24	1.01	-0.15
38	G-38	43.24	1.01	-0.15	38.67	1.03	-0.50	43.24	1.01	-0.15
39	G-39	39.24	1.01	-0.15	39.84	1.04	-0.50	39.24	1.01	-0.15
40	G-40	35.24	1.01	-0.15	34.47	1.01	-0.42	35.24	1.01	-0.15
41	G-41	33.24	1.01	-0.15	27.15	0.95	0.06	33.24	1.01	-0.15
42	G-42	63.24	1.01	-0.15	47.96	1.07	-0.49	63.24	1.01	-0.15
43	G-43	50.24	1.01	-0.15	38.94	1.01	-0.45	50.24	1.01	-0.15
44	G-44	54.24	1.01	-0.15	30.11	0.97	-0.13	54.24	1.01	-0.15
45	G-45	40.24	1.01	-0.15	42.53	1.04	-0.50	40.24	1.01	-0.15
46	G-46	64.24	1.01	-0.15	35.13	1.00	-0.34	64.24	1.01	-0.15
47	G-47	39.24	1.01	-0.15	34.15	0.99	-0.31	39.24	1.01	-0.15
48	G-48	52.24	1.01	-0.15	41.74	1.03	-0.49	52.24	1.01	-0.15
49	G-49	52.24	1.01	-0.15	47.08	1.06	-0.50	52.24	1.01	-0.15
50	G-50	45.24	1.01	-0.15	31.20	0.97	-0.18	45.24	1.01	-0.15

Cont.

Sno.	Genotype	No. of grains ear^{-1}			1000-grain weight (g)			Yield plant^{-1}(g)		
		mean	Bi	S^2di	mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	37.24	1.01	-0.15	39.63	1.03	-0.48	37.24	1.01	-0.15
52	G-52	58.24	1.01	-0.15	38.29	1.02	-0.47	58.24	1.01	-0.15
53	G-53	32.24	1.01	-0.15	56.29	-0.89	0.59	32.24	1.01	-0.15
54	G-54	67.24	1.01	-0.15	40.57	1.03	-0.50	67.24	1.01	-0.15
55	G-55	20.24	1.01	-0.15	57.68	1.13	-0.11	20.24	1.01	-0.15
56	G-56	41.24	1.01	-0.15	53.30	1.10	-0.30	41.24	1.01	-0.15
57	G-57	59.24	1.01	-0.15	53.60	1.10	-0.30	59.24	1.01	-0.15
58	G-58	41.24	1.01	-0.15	55.12	1.11	-0.24	41.24	1.01	-0.15
59	G-59	56.24	1.01	-0.15	45.28	1.06	-0.50	56.24	1.01	-0.15
60	G-60	53.24	1.01	-0.15	38.36	1.02	-0.47	53.24	1.01	-0.15
61	G-61	54.24	1.01	-0.15	38.67	1.04	-0.50	54.24	1.01	-0.15
62	G-62	52.24	1.01	-0.15	45.13	1.08	-0.46	52.24	1.01	-0.15
63	G-63	41.24	1.01	-0.15	43.41	1.06	-0.48	41.24	1.01	-0.15
64	G-64	59.24	1.01	-0.15	43.53	1.07	-0.49	59.24	1.01	-0.15
65	G-65	59.24	1.01	-0.15	40.32	1.05	-0.51	59.24	1.01	-0.15
66	G-66	69.24	1.01	-0.15	27.68	0.98	-0.23	69.24	1.01	-0.15
67	G-67	46.24	1.01	-0.15	44.39	1.07	-0.47	46.24	1.01	-0.15
68	G-68	53.24	1.01	-0.15	38.91	1.04	-0.50	53.24	1.01	-0.15
69	G-69	59.24	1.01	-0.15	37.04	1.03	-0.49	59.24	1.01	-0.15
70	G-70	41.24	1.01	-0.15	47.86	1.09	-0.39	41.24	1.01	-0.15
71	G-71	33.24	1.01	-0.15	56.37	1.11	-0.22	33.24	1.01	-0.15
72	G-72	39.24	1.01	-0.15	33.78	1.00	-0.31	39.24	1.01	-0.15
73	G-73	50.24	1.01	-0.15	44.27	1.05	-0.51	50.24	1.01	-0.15
74	G-74	40.24	1.01	-0.15	37.70	1.01	-0.44	40.24	1.01	-0.15
75	G-75	45.24	1.01	-0.15	37.08	1.01	-0.42	45.24	1.01	-0.15
76	G-76	53.24	1.01	-0.15	51.90	1.09	-0.38	53.24	1.01	-0.15
77	G-77	66.24	1.01	-0.15	40.78	1.03	-0.49	66.24	1.01	-0.15
78	G-78	52.24	1.01	-0.15	41.84	1.03	-0.50	52.24	1.01	-0.15
79	G-79	59.24	1.01	-0.15	46.87	1.06	-0.49	59.24	1.01	-0.15
80	G-80	53.24	1.01	-0.15	34.42	1.00	-0.33	53.24	1.01	-0.15
81	G-81	60.24	1.01	-0.15	54.29	1.12	-0.18	60.24	1.01	-0.15
82	G-82	72.24	1.01	-0.15	39.00	1.04	-0.50	72.24	1.01	-0.15
83	G-83	63.24	1.01	-0.15	42.31	1.05	-0.50	63.24	1.01	-0.15
84	G-84	56.24	1.01	-0.15	47.30	1.08	-0.43	56.24	1.01	-0.15
85	G-85	49.24	1.01	-0.15	49.85	1.09	-0.35	49.24	1.01	-0.15
86	G-86	31.24	1.01	-0.15	51.27	1.10	-0.31	31.24	1.01	-0.15
87	G-87	44.24	1.01	-0.15	24.27	0.96	-0.01	44.24	1.01	-0.15
88	G-88	56.21	0.44	0.36	35.48	1.02	-0.46	56.21	0.44	0.36
89	G-89	45.24	1.01	-0.15	36.45	1.03	-0.47	45.24	1.01	-0.15
90	G-90	67.24	1.01	-0.15	46.64	1.08	-0.45	67.24	1.01	-0.15
91	G-91	66.24	1.01	-0.15	29.49	0.47	0.08	66.24	1.01	-0.15
92	G-92	40.24	1.01	-0.15	41.75	1.05	-0.51	40.24	1.01	-0.15
93	G-93	46.24	1.01	-0.15	46.46	1.08	-0.46	46.24	1.01	-0.15
94	G-94	46.24	1.01	-0.15	56.80	0.15	17.50	46.24	1.01	-0.15
95	G-95	57.24	1.01	-0.15	43.62	1.06	-0.50	57.24	1.01	-0.15
96	G-96	59.24	1.01	-0.15	27.75	0.98	-0.16	59.24	1.01	-0.15
97	G-97	41.24	1.01	-0.15	33.88	1.00	-0.41	41.24	1.01	-0.15
98	G-98	54.34	1.06	-0.15	35.71	1.01	-0.45	54.34	1.06	-0.15
99	G-99	61.24	1.01	-0.15	41.79	1.05	-0.51	61.24	1.01	-0.15
100	G-100	33.24	1.01	-0.15	40.07	1.04	-0.50	33.24	1.01	-0.15
Population mean		48.93			41.32			8.76		

from regression coupled with mean value high to population mean (below average stability). The genotypes G-8, G-53, G-94 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability).

The genotypes G-9, G-48, G-45, G-73, G-83, G-78, G-31, G-32, G-24, G-92, G-99 had high mean value to population mean with maximum deviation from regression (unpredictable expression of this trait).

The genotypesG-1, G-2, G-3, G-4, G-6, G-7, G-20, G-23, G-25, G-26, G-29, G-33, G-34, G-35, G-38, G-39, G-40, G-41, G-44, G-46, G-47, G-50, G-51, G-52, G-54, G-60, G-61, G-65, G-66, G-68, G-69, G-72, G-74, G-75, G-77, G-80, G-82, G-87, G-88, G-89, G-96, G-97, G-98, G-100 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression with lesser mean value to population mean (the genotypes not widely adopted for this traits).

Yield plant per plant (g)

The genotypesG-20, G-15, G-12, G-16, G-18, G-29, G-44, G-35, G-33, G-52, G-54, G-57, G-61, G-63, G-68, G-70, G-69, G-76, G-79, G-85, G-88, G-90, G-91, G-92, G-93, G-96, G-98, G-99, G-73 had regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean (below average stability). The genotypes G-13, G-31, G-26, G-34 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability).

The genotypes G-27, G-4, G-36, G-37, G-6, G-30, G-87, G-7, G-100, G-43 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted.

Biological yield per plant (g)

Regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean were observed for the genotypes G-16, G-20, G-29, G-30, G-31, G-35, G-43, G-44, G-52, G-60, G-61, G-68, G-56, G-70, G-79, G-80, G-82, G-84, G-98, G-100, G-54 (below average stability). The genotypes G-13, G-32, G-33, G-37, G-45 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability).

The genotypes G-71, G-72, G-74, G-75, G-77, G-81, G-86, G-87, G-94, G-64, G-65, G-66, G-67, G-63, G-58, G-59, G-51, G-53, G-55, G-38, G-39, G-9, G-11, G-19, G-21, G-1 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression with lesser mean value to population mean (the genotypes not widely adopted). The genotypes G-57, G-69, G-73, G-76, G-78, G-85, G-88, G-90, G-91, G-92, G-93, G-96, G-6, G-15, G-18, G-7 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotypes widely adopted.

Harvest Index (%)

Regression coefficient higher than unity and minimum deviation from regression coupled with mean value high to population mean were recorded for the genotypes G-5, G-27, G-44, G-30, G-52, G-58, G-63, G-68, G-79, G-80, G-88, G-89, G-98, G-99, G-91, G-92, G-96, G-3, G-19 (below average stability). The genotypesG-6, G-12, G-13, G-14, G-15, G-20, G-26, G-28, G-54, G-59 had regression coefficient below unity and minimum deviation from regression with high mean value over population mean (above average stability).

Table 4.22: Stability parameters for yield and its contributing traits

Sno.	Genotype	Biological yield plant^{-1} (g)			Harvest Index (%)		
		mean	Bi	S^2di	mean	Bi	S^2di
1	G-01	16.56	0.96	-1.61	40.17	-0.27	-2.55
2	G-02	18.20	0.88	-1.70	43.80	1.09	-0.02
3	G-03	17.25	0.87	-1.58	46.76	-1.42	-2.00
4	G-04	15.12	1.12	-1.73	48.97	-1.00	-0.02
5	G-05	19.79	1.33	-1.63	45.29	-1.42	-2.52
6	G-06	19.88	1.01	-1.74	47.22	0.78	-0.36
7	G-07	19.10	0.96	-1.69	48.47	0.98	0.04
8	G-08	15.78	0.64	0.16	38.94	-2.46	1.47
9	G-09	16.32	0.90	-1.73	38.82	-0.26	0.66
10	G-10	16.55	0.85	-0.87	43.73	-1.53	2.08
11	G-11	16.22	0.93	-1.74	42.4	-0.84	-0.10
12	G-12	18.97	0.72	-1.74	48.95	-0.54	-0.53
13	G-13	20.92	0.80	-0.46	49.45	0.33	-0.51
14	G-14	18.20	0.76	-0.57	46.12	0.35	-2.09
15	G-15	24.46	1.00	0.10	47.89	-0.61	10.77
16	G-16	21.90	1.42	2.46	42.12	3.80	5.93
17	G-17	19.26	0.29	4.56	40.21	-0.79	-1.03
18	G-18	21.52	0.68	8.82	41.86	3.90	-2.51
19	G-19	15.81	0.93	-1.41	46.46	-4.00	29.87
20	G-20	23.78	1.39	14.38	46.25	0.11	-1.99
21	G-21	17.74	0.93	-1.33	44.60	0.24	-1.67
22	G-22	19.93	0.37	34.38	40.47	0.69	-2.45
23	G-23	19.32	0.89	3.80	47.01	1.39	-2.56
24	G-24	16.36	0.48	-1.57	36.55	-1.97	-0.54
25	G-25	16.87	0.68	2.81	39.24	-0.37	-1.70
26	G-26	18.45	1.20	15.25	47.37	0.63	-2.14
27	G-27	18.86	1.32	9.93	45.96	2.71	7.81
28	G-28	18.42	0.82	-0.41	46.60	-0.77	-0.63
29	G-29	21.75	1.30	1.35	35.47	4.82	-2.40
30	G-30	20.94	1.23	9.79	51.58	1.80	-1.58
31	G-31	21.65	1.13	-1.65	47.54	0.95	21.70
32	G-32	20.07	0.68	7.03	45.99	1.00	-0.02
33	G-33	22.40	0.77	1.00	45.68	0.94	0.03
34	G-34	18.88	0.90	-1.70	50.80	-0.86	0.99
35	G-35	24.10	1.78	6.51	49.64	1.47	-2.60
36	G-36	17.32	0.72	1.10	40.73	-0.59	-1.19
37	G-37	21.75	0.57	13.07	53.81	-4.31	1.24
38	G-38	16.83	0.99	-1.68	40.56	0.73	-2.56
39	G-39	17.97	0.97	-0.61	44.85	0.57	-2.56
40	G-40	17.66	1.11	-1.70	44.40	1.02	-0.02
41	G-41	16.32	0.82	-0.34	38.76	-0.09	-2.60
42	G-42	18.87	1.30	-1.73	43.49	0.65	-0.79
43	G-43	21.44	1.87	3.58	54.88	-0.30	1.92
44	G-44	20.96	1.22	7.19	46.98	1.08	2.92
45	G-45	20.64	0.27	9.42	44.54	-0.03	9.78
46	G-46	19.56	1.10	-0.86	42.88	1.93	1.23
47	G-47	18.26	0.86	-1.58	43.82	0.59	-0.77
48	G-48	19.03	0.80	-1.60	40.37	2.72	-0.33
49	G-49	17.49	0.76	-1.53	42.34	0.09	-2.57
50	G-50	18.84	1.12	-1.66	44.10	2.53	-2.31

Cont..

Sno.	Genotype	Biological yield plant^{-1}			Harvest Index (%)		
		mean	Bi	S^2di	mean	Bi	S^2di
51	G-51	16.03	0.92	-1.27	41.21	-1.35	-1.20
52	G-52	21.38	1.38	0.60	45.53	1.86	8.18
53	G-53	19.04	0.98	-1.75	44.22	2.66	-0.24
54	G-54	20.64	1.07	-1.66	48.79	-0.33	-2.17
55	G-55	19.00	0.92	-1.75	47.78	0.79	-2.44
56	G-56	20.24	1.72	-1.74	42.11	-0.71	-0.99
57	G-57	26.29	1.01	-1.74	41.77	4.77	6.50
58	G-58	18.66	0.98	-1.73	45.52	1.69	-0.18
59	G-59	18.22	0.92	-1.67	45.97	0.18	-1.08
60	G-60	20.17	1.53	-1.53	44.43	-0.27	0.05
61	G-61	21.01	1.39	-1.73	44.75	0.38	-2.48
62	G-62	19.02	1.14	-1.53	43.72	0.31	-2.50
63	G-63	19.86	0.98	-1.59	47.24	1.76	-2.38
64	G-64	19.09	0.99	-1.63	44.52	2.03	-2.30
65	G-65	18.50	0.98	-1.61	47.15	0.08	-1.99
66	G-66	18.97	0.94	-1.74	48.24	0.93	-2.33
67	G-67	17.93	0.93	-1.70	44.70	0.12	-2.08
68	G-68	21.21	1.13	-1.64	45.29	2.31	-1.43
69	G-69	20.55	0.94	-1.71	44.74	3.17	0.51
70	G-70	22.94	1.11	-1.47	51.69	2.64	14.04
71	G-71	19.00	0.98	-1.65	43.30	2.25	-2.60
72	G-72	17.53	0.96	-1.46	42.73	0.49	-0.52
73	G-73	20.97	0.90	-1.37	45.49	3.32	0.35
74	G-74	18.20	0.98	-1.45	42.67	1.84	-1.08
75	G-75	16.87	0.93	-1.72	46.46	-0.97	0.02
76	G-76	21.61	0.95	-0.82	45.14	4.36	1.29
77	G-77	18.12	0.92	-1.63	49.17	-0.26	-2.13
78	G-78	20.15	1.00	-1.66	44.91	2.81	1.80
79	G-79	24.77	1.09	-1.69	54.83	3.58	-1.67
80	G-80	29.54	1.08	-1.20	47.28	5.14	0.75
81	G-81	19.00	0.95	-0.82	48.05	0.44	-2.17
82	G-82	30.08	1.07	-1.33	41.76	6.81	-2.60
83	G-83	18.78	0.90	-0.89	47.69	0.51	-2.43
84	G-84	32.73	2.02	70.90	42.83	6.38	2.34
85	G-85	21.26	1.00	-1.74	43.33	5.08	-2.34
86	G-86	19.03	0.90	-1.27	42.04	0.09	-1.51
87	G-87	18.37	0.97	-1.58	43.44	1.67	0.93
88	G-88	23.91	0.96	-1.39	46.52	5.06	-1.03
89	G-89	16.68	0.74	-0.77	45.24	-2.82	9.47
90	G-90	20.88	0.94	-1.50	45.12	3.33	-2.60
91	G-91	20.20	0.99	-1.60	49.17	1.57	-0.65
92	G-92	22.89	1.03	-1.69	49.58	4.09	-1.69
93	G-93	24.28	1.08	-1.24	45.17	4.42	-1.70
94	G-94	19.27	0.94	-1.43	48.35	0.55	-2.39
95	G-95	17.56	0.80	-1.35	46.90	-0.98	-1.53
96	G-96	21.06	0.99	-1.74	48.97	1.87	-2.24
97	G-97	19.42	1.51	-0.10	41.96	-1.71	-2.21
98	G-98	20.63	1.10	-1.67	46.70	2.04	-1.29
99	G-99	17.87	0.65	0.91	46.81	-1.19	0.71
100	G-100	22.60	1.09	-1.71	43.54	2.25	4.37
Population mean		19.86			45.19		

The genotypes G-31, G-66, G-95 had high mean value to population mean with maximum deviation from regression revealed (unpredictable performance of genotypes for this trait). The genotypes G-2 and G-40 had regression coefficient equal to unity (or close to unity) and minimum deviation from regression with lesser mean value to population mean, it revealed that the genotypes not widely adopted for this trait.

The genotypes G-4, G-7, G-32, G-33, G-75 had regression coefficient equal to unity (or close to unity) with greater mean value to population mean and deviation from regression was equal to zero (or close to zero) revealed that the genotype widely adopted for this trait.

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DISCUSSION

India has achieved a record food production in the recent past. It may be considered a gradual transition from chronic shortage to self-sufficiency in the important cereal crops especially in wheat. This has been achieved due to hard and painstaking work of wheat scientist by manipulating the yield components and consequent availability of right type of plant ideotype and sound production technology.

Earlier, wheat sowing was being performed in rainfed, irrigated timely sown and restricted irrigation late sown but now the irrigated wheat sowing gets more delay in different areas to long duration paddy and increasing cropping intensity. Prevalence of high temperature during post anthesis is one of the key production constraints in irrigated late sown wheat. The high temperature influences the expression of different physiological, phenological, and yield components traits, which ultimately cause reduction in economic yield.

Therefore, the present investigation was designed to estimate the genetic variability, heritability, genetic advance character association and stability of genotypes in short duration bread wheat, so that much information could be exploited for breeding high temperature tolerant (Thermo insensitive) and short duration varieties. The expected improvement will primarily depend upon the magnitude and the nature of genetic variability present in base population. Furthermore, the understanding of correlation and path coefficient among yield and its components characters is desirable to aim at rational improvement in yield through selection.

The important viz days to full stem elongation, days to 50% flowering, days to stay green, days to maturity, relative water content of flag leaf (RWC%), chlorophyll content, canopy

temperature, membrane thermo-stability, plant height, number of effective tillers per plant, number of ears per plant, number of spikelets per spike, length of ear, spike density, number of grains per ear, 1000-grain weight, grain yield per plant, biological yield per plant, harvest index, were including in this investigation.

The experimental finding of the present investigation has been discussed under the following heads.

5.1 Genetic variability

5.2 Heritability and Genetic advance expressed as a % of mean

5.3 Association analysis

5.4 Stability analysis

5.1 Genetic variability

One of the important purposes of present investigation was to find out the extent of variability present in 89 advance generation genotypes of wheat with 11 check in regards to 19 characters.

A critical survey of genetic variability is necessary for smooth and effective planning as well as evaluation and screening of desirable material in wheat. The analysis variance for three environment including pooled environment revealed highly significant differences for all the characters indicated the existence of sufficient genetic variability for the characters studies. The wide ranges of variability included of better scope for selection and utilization of important phenological, physiological, yield contributing components in wheat breeding. The larger differences noted among phenotypic and genotypic variance in first environment for number of ears per plant, harvest index, days to full stem elongation, days to stay green and canopy temperature indicated the substantial influence of environment. Whereas, spike density, chlorophyll content, grain yield per plant, length of ear, number of effective tillers per plant,

days to maturity were record moderate differences in phenotypic and genotypic variance. Biological yield per plant, RWC of flag leaf, days to 50% flowering, membrane thermo-stability, plant height, number of spikelets per ear, 1000-grain weight, number of grains per ear were observed least difference between phenotypic and genotypic variance that shows traits were little influence to environment. In second environment harvest index, grain yield per plant, biological yield per plant, number of ears per plant, days to full stem elongation, days to maturity days to stay green recorded larger differences in phenotypic and genotypic variance indicated the substantial influence of environment. In spite of this length of ear, chlorophyll content, canopy temperature, number of effective tillers per plant, RWC of flag leaf were noticed moderate differences in phenotypic and genotypic variance whereas days to 50% flowering, number of spikelets per ear, spike density, membrane thermo-stability, plant height, number of grains per ear, 1000-grain weight were observed least phenotypic and genotypic variance, it revealed that traits were little influence of environment.

In third environment harvest index, grain yield per plant, spike density, number of ears per plant, canopy temperature, days to full stem elongation showed larger differences in phenotypic and genotypic variance indicated the substantial influence of environment. Chlorophyll content, number of effective tillers per plant, days to stay green, biological yield plant, days to maturity, RWC of flag leaf, number of spikelets per ear, length of ear were exhibited moderate differences in phenotypic and genotypic variance whereas days to 50% flowering, plant height, membrane thermo-stability, 1000-grain weight, number of grains per ear were observed least phenotypic and genotypic variance, that shows traits were little influence of environment.

The average performances of genotypes pooled over environments were recorded larger differences in phenotypic and

genotypic variances. Grain yield per plant, harvest index, number of ears, per plant, number of grains per ear, number of effective tillers per plant, chlorophyll content, 1000-grain weight, biological yield per plant, membrane thermo-stability, spike density, length of ear plant height, number of spikelets per ear, days to full stem elongation indicated the substantial influence of pooled environment whereas days to 50% flowering, RWC of flag leaf, days to stay green, days to maturity, canopy temperature that shows traits were little influence of pooled environmental effect.

On the basis of performance of genotypes of advance generation for yield and its contributing traits, ranking of top ten promising genotypes on the basis of their performance under three environments given in table: 5.1. In first environment thirty five genotypes viz.,G-84 followed by G-80, G-82, G-79, G-20, G-35, G-43, G-15, G-88, G-57, G-92, G-70, G-100, G-31, G-29, G-30, G-16, G-52, G-85, G-76, G-33, G-96, G-54, G-12, G-68, G-73, G-44, G-90, G-27, G-13, G-98, G-61, G-91, G-69 observed high grain yield per plant as compare to best check (K307). While, Seventeen genotypes i.e. G-15 followed by G-80, G-31, G-43, G-99, G-79, G-20, G-35, G-37, G-45, G-13, G-34, G- 30, G-88, G-82, G-100, G-28 were noticed higher grain yield per plant than best check K307 in second environment.

In third environment twenty three genotypes i.e. G-43 followed by G-79, G-70, G-20, G-15, G-30, G-84, G-100, G-31, G-35, G-57, G-80, G-82, G-37, G-16, G-12, G-92, G-33, G-88, G-52, G-93, G-13, G-29 recorded higher grain yield per plant as compare to best check K307.

In pooled over environments twenty four genotypes i.e. G-84 followed by G-80, G-15, G-43, G-79, G-20, G-35, G-82, G-31, G-70, G-88, G-30, G-100, G-92, G-57, G-93, G-29, G-13, G-12, G-37, G-16, G-54, G-52, G-96 show superiority in grain yield per plant as compare to best check K307.

Table 5.1: Top ten promising genotypes on the basis of yield and its yield contributing traits

G.No.	No. of earsplant^{-1}			No. of spikeletsear^{-1}			No. of Grainsear^{-1}			1000 grain weight(g)			Biological yield plant^{-1}(g)			Harvest index (%)			Grain yield plant^{-1}(g)		
	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3
G-1																					
G-2																					
G-3							ix	ix	viii												
G-4																		x			
G-5																					
G-6																					
G-7																					
G-8										viii	i	i									
G-9																					
G-10																					
G-11																					
G-12																		v			
G-13																		vii			
G-14																					
G-15		x											x		iv		iii		viii	i	v
G-16				iv	vi		i	i	i					viii							
G-17																					
G-18																					
G-19				ix	ix	v											i				
G-20													vi	v	v				v	vii	iv
G-21																					
G-22																					
G-23																					
G-24																					
G-25																					
G-26				vii	vii	viii	iv	v	iv												
G-27																					
G-28				viii	viii	vii															
G-29																					
G-30		viii														ix	ii	viii			vi
G-31	iv	iii	iv												vi					iii	ix
G-32																					
G-33																					
G-34				x		iv															
G-35	iii	ii	iii	iii	iii	iii	x	x	x				iv	vii	vii				vi	ix	x
G-36																					
G-37																					
G-38																					
G-39																					
G-40																					
G-41																					
G-42																					
G-43	v	iv	v										vii					ii	vii	iv	i
G-44																		ix			
G-45																	ix			x	
G-46																					
G-47																					
G-48																					
G-49																					
G-50																					

Cont….

G.No.	No. of earsplant^{-1}			No. of spikeletsear^{-1}			No. of Grainsear^{-1}			1000 grain weight(g)			Biological yield plant^{-1}(g)			Harvest index (%)			Grain yield plant^{-1}(g)		
	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3
G-51																					
G-52						x															
G-53										v	viii	ii									
G-54				v	iv		v	iv	vi												
G-55										i	iii	iv									
G-56										vii	ix	ix									
G-57										vi	vii	viii	v	iv	iii				x		
G-58										iii	v	vi									
G-59																					
G-60																					
G-61																					
G-62																					
G-63																					
G-64																					
G-65				vi	v	vi															
G-66				ii	ii	ii	iii	iii	iii												
G-67																					
G-68																					
G-69																					
G-70	x	vii	x															iii			iii
G-71										ii	iv	v				vii					
G-72																					
G-73																					
G-74																					
G-75																	vii				
G-76										x	x	x									
G-77					x	ix	vii	vii	vii								x				
G-78																					
G-79	ix	vi	viii										viii	vi	ix	i		iv	iv	vi	ii
G-80	ii	i	ii	i	i	i							iii	iii	ii	ii			ii	ii	
G-81										iv	vi	vii									
G-82	vi	ix	vi				ii	ii	ii				ii	ii	i	iv			iii		
G-83																					
G-84	i	v	i										i	i	viii	vi			i		vii
G-85																x					
G-86																					
G-87																					
G-88														x		iv			ix		
G-89																	iv				
G-90							vi	vi	v												
G-91							viii	viii	ix												
G-92	viii		ix													iii					
G-93	vii		vii										ix	ix	x	viii					
G-94										ix	ii	iii									
G-95																					
G-96																					
G-97																					
G-98																					
G-99																	viii			v	
G-100																					viii

The results found in present investigation were in agreement with genotypic and phenotypic variances were highly significant in all the traits with little higher phenotypic variations as usual. Similarly, the low differences between the phenotypic and genotypic coefficients of variations (Majumdar et. al., 2008, Soleman Mohamed Al-Otayk 2010), green leaf area duration, height, plant type, heading and maturity dates, and yield potential. (Babar et al., 2006), plant height, number of productive tillers per plant, number of spikelets per spike, spike length, number of grains per spike, fertility %, 1000 grain weight (Ali et al., 2008, Ali and Shakor, 2011, Al-Tabbal and Al-Fraihat, 2012, Talebi and Fayyaz, 2012, Baloch et al. 2013, Singh and Upadhyay, 2013, Haman, 2013, Shukla and Moitra, 2013, Bala et al., 2014, Dharmendra and Singh, 2015).

Finding were partially agreed with genotypes were highly significant for plant height and significant for days to maturity and spikelet spike^{-1} while non-significant for grains spike^{-1}, spike weight, and grain yield plant^{-1} (Ghafoor et al. 2013, Nukasani et al. 2013, Kumar et al. 2014, Tesfaye et al. 2014).

5.2 Heritability and Genetic advance expressed as a % of mean

Heritability (broad sense) is a measure of proportion of phenotypic variation contributed by genotypic variation for a given trait. The success of improvement of a particular trait depends on the relationship between the phenotype and genotype. This relationship is very well judged through heritability estimates. If the value of heritability in broad sense is high, it indicates that though the character is least influenced by the environmental effects, the selection for improvement of such character may not be useful, because broad sense heritability is based on total genetic variance which includes both fixable (additive) and non fixable (dominance and epistatic) variances. If broad sense

heritability is low, it reveals that the character is highly influenced by environmental effects and genetic improvement through selection will be difficult due to masking effects of the environment on the genotypic effects. Genetic advance is the mean genotypic value of the selected genotypes over the base population. Genetic advance in many populations would depend upon its genetic makeup. If the value of genetic advance is high, it shows that the character is governed by additive genes and selection will be rewarding for improvement of such trait. High heritability alone does not ascertain any desirable grain from selection unless sufficient genetic advance attributable to additive gene action is present. Since estimates of heritability in broad sense include contribution from additive as well as non-additive gene effects, they are of limited importance.

High heritability accompanied with high genetic advance, It indicates that most likely the heritability is due to additive gene effects and selection may be effective. Low heritability accompanied with high genetic advance, it reveals that the character is governed by additive gene effects. The low heritability is being exhibited due to high environmental effects. Selection may be effective in such cases. Due to these reason heritability and genetic advance are important selection parameter. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability alone. However, it necessary that a character showing high heritability will also exhibit high genetic advance (Johnson et al., 1955). In the present study, broad sense heritability has been computed which indicates the degree of genetic determination i.e. extent to which individual phenotypes are determined by their genotypes.

As per value of heritability and genetic advance as per mean exhibited high for number of effective tillers per plant,

number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, biological yield per plant, harvest index, membrane thermo-stability, chlorophyll content that indicate selection of such traits in all three environments may be effective. While, grain yield revealed high heritability with high genetic advance as per mean indicated good response to selection in first environment but it recorded low heritability and high genetic advance as per mean in second and third environment, indicated that grain yield has additive gene action but more influenced by environment effects, so selection may be effective. RWC of flag leaf (%) was reported high value for heritability and genetic advance as per mean indicated good response to selection in third environment.

In pooled over environments chlorophyll content, membrane thermo-stability, number of effective tillers per plant, number of ears per plant, length of ear, number of grains per ear, grain yield per plant, biological yield per plant revealed low value of heritability and high genetic advance as per mean indicated that selection of such traits may be effective in pooled over environments.

The results found in present investigation were in agreement with number of grains per spike, grain yield per plant, total biomass per plant, straw weight per plant, and spike weight per plant exhibited high heritability with high genetic advance (Shukla and Singh 2004, Ali et al. 2008, Majumder et al., 2008, Eid 2009, Shukla et al., 2011). Heritability (broad sense) reported high for plant height, tillers plant^{-1}, spike length, spikeletes spike^{-1}, grains spike^{-1}, grain yield plant^{-1}, seed index and harvest index (Baloch et al., 2013, Nukasani et al., 2013). High heritability and genetic advance was observed for grain yield ha^{-1}, plant height at maturity, number of grain per spike and days to maturity (Singh

and Upadhyay, 2013), Baloch et al,. 2014, Ram et al., 2014, Tesfaye et al., 2014, Dharmendra and Singh, 2015).

5.3 Association analysis

5.3.1 Correlation coefficient

Correlation study provide estimates of the degree of association between the various components of yield, which in direct selection of associated character for the improvement of desirable traits. In this investigation, an attempt was made to estimate the genotypic, phenotypic and environmental correlation in all possible pairs of character combinations under study. The breeder is no doubt concerned with the genotypic correlation. Though environmental coefficients will not be of much use for the breeder but they will give an idea about the extent to which characters are influenced by environmental factor irrespective of their genetic control.

In general, the magnitudes of genotypic correlation coefficients greater than corresponding phenotypic correlation coefficients which revealed influence of environment on the genotypic expression of the characters under study.

Correlations among characters are of much interest, because the changes brought about by selection for one character may bring simultaneous changes in the other characters also. The estimates of correlation coefficients may have positive or negative values. Character pairs showing positive correlation reflects selection for one trait giving simultaneous improvement in the other, while negative correlation will check the recovery of desirable trait because selection for one trait could decrease value of the other and vice versa. The correlation coefficient between two characters was zero or insignificant, it means these two characters are independent. So only significant the correlation coefficients for major yield and yield contributing traits have been discussed and mentioned in Table: 5.2.

Table 5.2: Summery table of phenotypic correlation coefficient of yield and its constituting traits under three environments including pooled over environments.

Character	No. of Effective tillers plant^{-1}				No. of earsplant^{-1}				No. of spikeletsear^{-1}				Spike density				No. of grainsear^{-1}				1000-grain weight (g)				Biological yield plant^{-1} (g)				Harvest index (%)			
	E_1	E_2	E_3	P	E1	E2	E3	P	E1	E2	E3	P	E1	E2	E3	P	E1	E2	E3	P	E1	E2	E3	P	E1	E2	E3	P	E1	E2	E3	P
No. of ears plant^{-1}	+**	+**	+**	+**																												
No. of spikelets ear^{-1}	+*	+	+**	+**	+*	+	+	+**																								
Spike density	+	-*	-*	-	+	-	-	-	+**	+**	+**	+**																				
No. of grains ear^{-1}	+**	+**	+	+**	+**	+*	+**	+**	+**	+**	+**	+**	+**	+*	+*	+**																
1000-grain weight(g)	-	-*	-*	-	-	-	-	-	-**	-**	-**	-*	-**	-	-	-	-**	-**	-**	-**												
Biological yield plant^{-1} (g)	+**	+**	+**	+**	+**	+**	+**	**	+**	+**	+**	**	+	-*	+	+	+**	+**	+**	+**	+	+	+	+**								
Harvest index (%)	+**	-	+**	+**	+**	-	+**	+**	+**	+	+	+**	+**	-	-	+	+**	-	+	+**	+	-	+	-	+**	+**	+	+**				
Grain yield plant^{-1}(g)	+**	+**	+**	+**	+**	+**	+**	+**	+**	+**	+*	+**	+	-**	-**	-	+**	+*	+**	+**	+	-	+	-	+**	+**	+**	+**	+**	+**	+**	+**

Grain yield per plant recorded significant positive correlation with number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, number of grains per ear, biological yield per plant, harvest index in all environments including pooled over environments. However, plant height and canopy temperature was significant negative association with grain yield per plant in first environment. Spike density and 1000-grain weight had significant negative association with grain yield per plant in second environment. Whereas, spike density had significant negatively correlated with grain yield per plant in third environment, while canopy temperature noticed significant negative correlation with grain yield per plant in pooled.

Apart from this significant positive association was recorded for days to full stem elongation with days to 50% flowering, days to stay green, days to maturity, no. of spikelets per ear, no. of grains per ear. Days to 50% flowering was significant positively associated with days to stay green, days to maturity, no. of spikelests per ear, no. of grains per ear. Days to stay green found significant positive association with days to maturity. Effective tillers per plant was significant positively associated with no. of ears per plant, biological yield per. Number of ears per plant revealed significant positive correlation with length of ear, no. of grains per ear, biological yield per plant. Spikelets per ear were significant positive association with length of ear, spike density, no. of grains per ear, biological yield per plant. Ear length noticed significant positive association with no. of grains per ear, biological yield per plant. Spike density found significant positive correlation with no. of grains per ear. No. of grains per ear was significant, positively associated with biological yield per plant all three environments including pooled.

Days to full stem elongation noticed significant negative

correlation with 1000-grain weight. Days to 50% flowering exhibited significant negative correlation with RWC of flag leaf, chlorophyll content, 1000-grain weight. Days to stay green were found significant negative correlation with RWC of flag leaf, chlorophyll content, 1000-grain weight in all three environment and pooled over environments.

The results found in present investigation were in agreement with spikelets per ear was negatively associated with 1000 grain weight. Ear length was significant negatively associated with spike density 1000 grain weight. No. of grains per ear was significant negatively associated with 1000-grain weight. genotypically plant height, spike length, spikelets per spike, grains per spike and 1000-grain weight were positively and significantly correlated with grain yield (Ali et al., 2008, Khokhar et al., 2010, Abderrahmane et al., 2013, Chhibber and Jain, 2014, while highly significantly associated phenotypically whereas, fertile tillers per plant was negative and non-significantly correlated with grain yield (Kashif and Khaliq, 2004, Majumder et al., 2008, Ali and Shakor, 2011, Mohibullah et. al., 2011, Suleiman et al., 2014), The results found in present investigation were in partially agreed with positive and significant correlation between harvest index and number of grains per spike with yield at both genotypic and phenotypic level in both environments was reported by Talebi and Fayyaz (2012).

5.3.2 Path coefficient

Path coefficient measures the direct and indirect contributions of independent variables on a dependent variable. Though the correlation coefficients depict the nature of association among the characters, it is the path analysis that splits the correlation coefficients into direct and indirect effects thus specifying the relative contribution of each character. It further reveals the different ways in which a particular character

influences a dependent variable. The Path coefficient analysis has been discussed in the following paragraphs.

Canopy temperature, number of effective tillers per plant, biological yield per plant exhibited high direct effect on grain yield in all three environments including pooled. The effects of these characters were further increased by positive indirect effect of days to 50% flowering, days to stay green, chlorophyll content, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, harvest index (in first environment), RWC of flag leaf, chlorophyll content, days to 50% flowering, number of ears per plant, number of spikelets per ear, length of ear, number of grains per ear, 1000-grain weight (in second environment), days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf chlorophyll content, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, harvest index (in third environment), days to full stem elongation, days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf, chlorophyll content, membrane thermo-stability, plant height, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, harvest index (in pooled).

The results found in present investigation were in agreement with highest positive direct effect on yield were exhibited by days to maturity followed by days to heading (Khokhar et. al., 2009), grain yield has a direct and positive effect over harvest index, while the straw yield has a direct and negative effect over it. Effective traits to grain yield, four traits including number of grain per spike, grain weight, 1000 grain weight (Nukasani et al., 2013) and biological yield had the most direct and positive effect on grain yield (Singh and Upadhyay, 2013). Three traits including spike length, spike weight and

biological yield had the most direct effect to straw yield (Mollasadeghi et. al., 2011), Kashif et al., 2012, Hannachi et al., 2013).

Result was partially agreed with number of grains per spike, spike length, plant height, 1000-grain weight, relative water contents canopy temperature had positive direct effect on grain yield under drought conditions. (Ata et. al., 2014),

5.4 Stability analysis

Genotypes x environment interactions are of the major importance of the plant breeder in developing improved varieties. When varieties are compared over a series of environments to relative ranking usually differs. This causes difficulties in determining the significant superiority of any variety. This interaction in usually present whether the varieties are pure lines, single cross, double cross hybrids, top crosses or any other material with which the breeder working for reducing G x E interactions, breeder should select stable genotype that interact less with the environments in which they are to be grown, and the genotype should be evaluated by growing in more number of environments with only few stable genotypes remaining for final stable of testing, the breeder would be greatly aided in his selection of superior genotypes.

The pooled analysis of variance revealed that the difference among the genotypes were highly significant for all the characters. The genotype x environment interaction found significant differences for characters like days to full stem elongation, days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf, chlorophyll content, canopy temperature, plant height, no. of effective tillers per plant, no. of spikelets per ear, spike density, no. of grains per ear, yield per plant.

The variation due to environment (linear) was found significant for different characters. The variation due to genotype x environment (linear) recorded significant for different characters except ear length, 1000 grain weight, biological yield per plant and membrane thermo-stability. However, pooled deviation noticed to be significant for no. of effective tillers per plant, no. of spikelets per ear, ear length, spike density, no. of grains per ear, 1000 grain weight, biological yield per plant, harvest index, days to maturity chlorophyll content and canopy temperature. This indicated the differential response of the genotype to different agro climate conditions. Eberhort and Russell (1966) stated that stable variety would be one, having high mean withy near unit regression coefficient (b=1) and deviation from regression as minimum as ($S^2_d = 0$), possible.

The genotypes G-20, G-15, G-12, G-16, G-18, G-29, G-44, G-35, G-33, G-52, G-54, G-57, G-61, G-63, G-68, G-70, G-69, G-76, G-79, G-85, G-88, G-90, G-91, G-92, G-93, G-96, G-98, G-99, G-73 had regression coefficient higher than unity coupled with mean of yield per plant high to grand mean of yield per plant indicating higher sensitivity to environmental change (below average stability) and specificity of adoptability to high yielding environments.

Regression coefficient below unity and also with high mean of yield per plant over grand mean of yield per plant was reported for genotypes G-13, G-31, G-26, G-34, revealed that greater resistance to the environmental change (above average stability) and increase the specificity of adoptability to the low yielding environment.

Genotypes G-27, G-4, G-36, G-37, G-6, G-30, G-87, G-7, G-100, G-43 exhibited regression coefficient equal to unity (or close to unity) with greater mean value to grand mean and deviation from regression was equal to zero (or close to zero)

Table 5.3: Stability of genotypes for different characters

Character	(b>1, m> μ) S^2di= min. (Below average stability)	(b<1, m> μ) S^2di= min. (Above average stability)
Days to full stem elongation	G-2, 3	----------
Days to 50% flowering	G-67, 39, 40	G-63
Days to stay green	G-14, 15, 33, 41, 42, 43, 47, 48, 87, 89, 90, 91, 92, 96, 23, 24,27, 28, 29, 30, 49, 50, 67, 84, 85, 86	G-1, 35, 100, 3, 40, 6, 52, 34, 2, 39, 20, 4, 45, 7, 59, 82
Days to maturity	G-6, 7, 15, 20, 21, 22, 23, 24, 26, 27, 29, 30, 41, 45, 46, 47, 67, 84, 85, 86, 87, 89, 90, 91, 92, 100, 43	G-9, 42, 56, 58, 80
RWC of flag leaf (%)	G-5, 7, 8, 15, 16	G-100, 33, 17
Chlorophyll content	G-2, 5, 7, 38, 43, 44, 45, 52, 56, 59, 60, 65, 66, 67, 73, 80, 81, 82, 89, 100, 97, 98, 91, 93, 94, 33, 35, 36	G-8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 21, 24, 25, 26, 27, 29, 31, 32
Canopy temperature (^oC)	G-34, 35, 41, 44, 45, 46, 47, 42, 49, 53, 54, 55, 73, 74	G-9, 10, 11, 12, 14, 15, 16, 17, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 36, 37, 38, 59, 80, 81, 10
Membrane thermo-stability	G-1, 2, 3, 73	----------
Plant height(cm)	G-8, 9, 57, 38, 39, 59, 85, 87, 89, 92, 93, 19, 44, 27, 14, 18, 25, 31, 35, 53, 55, 1	G-3, 4, 100, 6, 63, 67, 73, 76, 77, 78, 74, 94, 95, 83, 11, 32, 45, 49, 40
No. of effective tillers $plant^{-1}$	G-31, 35, 88, 80, 82, 91, 84	20, 23, 27, 29, 39, 40, 44, 52, 60, 97, 78, 85
No. of ears $plant^{-1}$	G-42, 92, 93, 84, 82	G-1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 32, 34, 36, 38, 41, 47, 67, 69, 72, 75, 83, 86, 87, 89, 90, 94, 95
No. of spikelets ear^{-1}	G-35, 42, 46, 54, 64, 65, 60, 66, 77, 78, 79, 80, 81, 82, 83, 88, 89, 90, 91, 59	G-13 16, 18, 19, 20, 22, 31, 32, 34, 48, 49, 68, 73, 76, 87, 95, 96, 99
Length of ear (cm)	G-3, 13, 19, 44, 26, 79, 77, 82, 99	G-1, 6, 7, 12, 16, 17, 60, 73, 74, 76, 78, 80, 81, 91, 92, 93, 94, 95, 96, 97, 98, 100
Spike density	G-16, 28, 35, 42, 45, 46, 57, 52, 60, 63, 77, 78, 85, 89, 90, 91, 92, 80, 96, 65, 66	G-2, 4, 5, 8, 9, 10, 11, 18, 21, 22, 23, 24, 25, 29, 30, 31, 32, , 38, 40, 48, 49, 61, 62, 67, 68, 69, 70, 71, 72, 75, 76, 79, 87, 95, 98
No. of grains ear^{-1}	G-1, 2, 3, 4, 5, 8, 9, 10, 11, 14, 15, 21, 23, 24, 58, 63, 67, 70, 71, 72, 74, 75, 86, 87, 89, 92, 93, 94, 97,100	----------
1000 grain weight (g)	G-5, 11, 14, 12, 10, 15, 16, 17, 21, 22, 27, 30, 64, 67, 70, 71, 76, 79, 81, 84, 85, 86, 90, 93, 95	G-8, 53, 94
Biological yield $plant^{-1}$ (g)	G-16, 20, 29, 30, 31, 35, 43, 44, 52, 60, 61, 68, 56, 70, 79, 80, 82, 84, 98, 100, 54	G-13, 32, 33, 37, 45
Harvest index (%)	G-5, 27, 44, 30, 52, 58, 63, 68, 79, 80, 88, 89, 98, 99, 91, 92, 96, 3, 19	G-6, 12, 13, 14, 15, 20, 26, 28, 54, 59
Grain yield $plant^{-1}$ (g)	G-20, 15, 12, 16, 18, 29, 44, 35, 33, 52, 54, 57, 61, 63, 68, 70, 69, 76, 79, 85, 88, 90, 91, 92, 93, 96, 98, 99, 73	G-13, 31, 26, 34

Cont...

Character	(b=1, m<M) $S^2di=0$ (No wider adoption)	(B=1, m>M, $S^2di=0$) (Wider adoption)
Days to full stem elongation	G-6, 8, 10, 11, 12, 13, 17, 23, 25, 31, 36, 37, 38, 51, 53,77, 78, 79, 80, 81, 82, 83, 88, 93, 94, 95, 97, 99	----------
Days to 50% flowering	G-1, 4, 5, 8, 10, 11, 12, 13, 17, 18, 25, 3180, 81, 82, 83, 88, 93, 94, 95, 97, 98, 99	----------
Days to stay green	G-64, 65, 72, 73, 53, 54, 55, 68, 57, 8, 17	----------
Days to maturity	G-12, 13, 97, 61, 63, 17, 25, 31, 5, 54, 55, 60	----------
RWC of flag leaf (%)	G-11, 21, 19, 20, 22, 23, 27, 28, 39, 40, 4283, 84, 85, 86, 87, 88, 89, 90, 91, 92, 99	----------
Chlorophyll content	G-34, 76	----------
Canopy temperature (^oC)	G-98, 87, 88, 82, 79, 39, 33	G-4, 83, 63, 64, 60, 99, 58 and 75
Membrane thermo-stability	G- 36, 37, 87, 88, 89, 90, 92, 93, 94	G-79, 81, 84, 85, 9710, 11, 13, 16, 23, 38, 40
Plant height(cm)	G-98, 75, 69, 50, 51, 54, 56, 58, 42, 43, 47, 15	----------
No. of effective tillers plant^{-1}	G-63, 65, 32, 55, 56, 59, 69	G-30, 41, 7, 2, 75, 15, 42, 6, 92, 93, 96, 79, 43, 50, 54, 37, 61, 33 100, 57, 70, 45, 46, 48
No. of ears plant^{-1}	----------	G-6, 15, 23, 29, 30, 31, 33, 35, 39, 40, 43, 44, 45, 46, 48, 50,61, 68, 70, 71, 73, 74, 76, 77, 78, 79, 80, 81, 85, 88, 91, 96, 97, 98, 99, 100
No. of spikelets ear^{-1}	G-69, 62, 63, 53, 33, 30, 25, 27, 23	G-3, 21, 26, 28, 29, 84, 61, 44, 52, 57
Length of ear (cm)	----------	G-83
Spike density	G-55, 56, 58	G-59 ,64
No. of grains ear^{-1}	----------	----------
1000 grain weight (g)	G-1, 2, 3, 4, 6, 7, 20, 23, 25,26, 29, 33, 34, 35, 38, 39, , 50, 51, 52, 54, 60, 61, 65, 66, 68, 69, 72, 74, 75, 77, 80, 82, 87, 88, 89, 96, 97, 98, 100	----------
Biological yield plant^{-1} (g)	G-71, 72, 74, 75, 77, 81, 86, 87, 94, 64, 65, 66, 67, 63, 58, 59, 51, 53, 55, 38, 39, 9, 11, 19, 21, 1	G-57, 69, 73, 76, 78, 85, 88, 90, 91, 92, 93, 96, 6, 15, 18, 7
Harvest index (%)	G-2, 40	G-4, 7, 32, 33, 75
Grain yield plant^{-1} (g)	----------	G-27, 4, 36, 37, 6, 30, 87, 7, 100, 43

that the genotype widely adopted (stable genotype). Most of the genotypes showed varying degree of stability for different character those are presenting in table: 5.3.

The finding supported by Acura et al. (2005), Kabir et al. (2009), Feiziasl et al. (2010), Soleman Mohamed Al-Otayk (2010), Arain et al. (2011), Almeselmani and Deshmukh (2012), Birla et al. (2012), Mondal et al. (2013), Khan et al. (2014), Patel et al. (2014), Ram et al. (2014), suggested that wheat genotypes had regression coefficient higher than unity coupled with mean value high to grand mean, are higher sensitivity to environmental change (below average stability) and could be recommended for high yielding environments. The genotypes had regression coefficient below unity and also with high mean value over grand mean greater resistance to the environmental change (above average stability) and could be recommended for the low yielding environment. The genotypes had regression coefficient equal to unity (or close to unity) with lesser mean value to grand mean and reveled that the genotype not widely adopted. The genotypes had regression coefficient equal to unity (or close to unity) with greater mean value to grand mean and deviation from regression was equal to zero (or close to zero) reveled that the genotype widely adopted.(Kabir et. al., 2009, Arain et. al., 2011).

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Summary, Conclusion and Suggestion for Further Work

6.1. Summary

The present investigation entitled “Genetic Analysis in Bread Wheat under different Environments” was carried out during the *rabi* season of 2014-15. The techniques followed and materials used during the course of investigation are presented under following subheads. The experiment was carried out under Wheat Improvement Project Department of Plant Breeding and Genetics at Seed Breeding Farm, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur (M.P.) under rainfed sown, irrigated timely sown and late sown conditions.

The experimental material consists of 89 uniform wheat lines of advance generation including 11 checks viz. DBW 16, DBW 17, HD 2967, CBW 38, DBW 14, K307, GW322, NIAW 34, NIAW 917, DBW 71, HD 3086. The experiment was conducted in three replications under Randomized Complete Block design. Each plot consists of six rows of 2.5 m length and 20 cm apart in three environments. The sowing was done on 30/10/2014 (rainfed sowing), 05/11/2014 (restricted irrigated) and 17/11/2014 (irrigated timely sown) by dibbling of seed in rows. The recommended cultural packages practices were followed to raise that healthy crop.

The present studies included estimation of genetic variability, heritability (broad sense), genetic advance as percentage of mean, correlation analysis (genotypic and phenotypic) and path coefficient analysis.

The analysis variance for three environment including pooled environment revealed highly significant differences larger differences in phenotypic and genotypic variances grain yield per plant, harvest index, number of ears, per plant, number of grains per ear, number of effective tillers per plant, chlorophyll content,

1000-grain weight, biological yield per plant, membrane thermo-stability, spike density, length of ear plant height, number of spikelets per ear, days to full stem elongation indicated the substantial influence of pooled environment whereas days to 50% flowering, RWC of flag leaf, days to stay green, days to maturity, canopy temperature.

On the basis of performance of different genotypes of advance generation, out of 89 genotypes twelve (G-13, G-15, G-20, G-30, G-31, G-35, G-43, G-79, G-80, G-82, G-88, G-100) were recorded high grain yield as compare to best check K307 under all three environments.

Heritability and genetic advance as per mean exhibited high for number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, biological yield per plant, harvest index, membrane thermo-stability, chlorophyll content that indicate selection of such traits in all tree environments may be effective. While, grain yield revealed high heritability with high genetic advance as per mean indicated good response to selection in first environment but it recorded low heritability and high genetic advance as per mean in second and third environment, indicated that grain yield has additive gene action but more influenced by environment effects, so selection may be effective. RWC of flag leaf was reported high value for heritability and genetic advance as per mean indicated good response to selection in third environment.

Grain yield per plant recorded significant positive correlation with number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, number of grains per ear, biological yield per plant, harvest index in both environment including pooled environment. However, plant height and canopy temperature was significant negative association with

grain yield per plant in first environment. Spike density and 1000-grain weight had significant negative association with grain yield per plant in second environment. Whereas, spike density was observed significant negatively correlated with grain yield per plant in third environment, while canopy temperature noticed significant negative correlation with grain yield per plant in pooled environment.

Path efficient analysis revealed that canopy temperature, number of effective tillers per plant, biological yield per plant exhibited high direct effect on grain yield in all three environments including pooled environment. The effects of these characters were further increased by positive indirect effect days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf, chlorophyll content, membrane thermo-stability, plant height, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, harvest index.

The genotypes G-20, G-15, G-12, G-16, G-18, G-29, G-44, G-35, G-33, G-52, G-54, G-57, G-61, G-63, G-68, G-70, G-69, G-76, G-79, G-85, G-88, G-90, G-91, G-92, G-93, G-96, G-98, G-99, G-73 had regression coefficient higher than unity coupled with mean of yield per plant high to grand mean of yield per plant revealed that genotypes recommended for irrigated timely sown.

Regression coefficient below unity and also with high mean of yield per plant over grand mean of yield per plant was reported for genotypes G-13, G-31, G-26, G-34, revealed that genotypes suitable for rainfed sown and late sown situations.

Genotypes G-27, G-4, G-36, G-37, G-6, G-30, G-87, G-7, G-100, G-43 exhibited regression coefficient equal to unity (or close to unity) with greater mean value to grand mean and deviation from regression was equal to zero (or close to zero), revealed that the genotype give stable performance in all situations.

6.2 Conclusion

1. Among the traits for number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, biological yield per plant, harvest index, membrane thermo-stability, chlorophyll content had heritability and genetic advance as per mean in all tree environments indicated importance of additive genetic variance in the expression of these traits.
2. Based on the studies of correlation and path analysis, it may be concluded that number of effective tillers per plant, number of ears per plant, number of spikelets per ear, number of grains per ear, biological yield per plant and harvest index showed positive direct effect with positive correlation need attention of wheat breeders for breeding suitable cultivars of wheat for different growing situation.
3. Genotypes G-20, G-15, G-12, G-16, and G-18 for irrigated timely sowing, genotypes G-13, G-31, G-26 and G-34, were suitable for late and rainfed sown condition of wheat respectively. While, Genotypes G-27, G-4, G-36, G-37, G-6, G-30 were suitable for all three situations. The above findings indicates that due consideration should be given to above varieties for better yield potential at the time of formation of sowing programme of wheat.

6.3 Suggestion for further work

1. As evident from phenotypic and genotypic coefficients of variation, heritability, genetic advance, correlation coefficient, path analysis the characters viz harvest index, biological yield per plant, and 1000 grain weight might be utilized in designing high yielding plant ideotype.

2. The experiment conducted to Screening of genotypes for heat tolerance under controlled environmental condition or sowing of crop in off season.
3. Present investigation done in one cropping season. It may be included in more than two year programme for better results.
4. Physiological traits or relationship i.e. stem reverse remobilization, root-shoot relationship, pollen fertility, those are related to survival of crop plant under adverse condition will be included in future work.
5. Screening of genotypes at molecular level using real time PCR.

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Appendix-I

Mean value of phenological, physiological and yield contributing traits (First environment)

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-1	70.3	77.7	107.7	122.9	68.28	23.28	20.03	55.46	88.11	3.40
G-2	72.7	79.0	108.7	121.9	81.42	36.42	19.47	49.08	86.65	4.00
G-3	72.7	80.0	108.8	121.9	76.16	31.16	17.60	54.61	99.95	4.20
G-4	67.0	77.0	114.6	119.5	75.31	30.31	19.23	33.95	98.58	2.40
G-5	69.0	76.7	104.6	116.8	87.31	42.31	18.03	32.38	80.08	4.00
G-6	65.3	83.0	109.8	123.0	66.45	21.45	16.63	37.86	102.21	5.20
G-7	69.3	81.0	107.8	122.0	87.31	42.31	15.77	48.88	95.45	3.80
G-8	66.7	72.3	102.0	118.2	79.14	34.14	19.73	35.23	103.66	2.80
G-9	69.0	79.0	107.7	121.6	80.73	35.73	20.20	30.95	98.41	3.20
G-10	65.3	76.0	106.7	117.6	79.02	34.02	20.97	55.17	100.38	3.20
G-11	68.0	76.0	104.6	120.8	77.78	32.78	20.10	50.15	97.45	2.90
G-12	65.3	73.0	106.4	122.0	82.51	37.51	21.23	33.07	80.51	3.00
G-13	63.0	74.3	106.5	125.0	82.00	37.00	19.63	51.93	91.48	3.80
G-14	69.7	80.3	108.8	122.0	80.99	35.99	19.23	33.05	95.28	3.60
G-15	71.0	83.0	109.8	124.0	84.14	39.14	20.10	34.89	96.01	5.80
G-16	73.3	85.3	111.0	124.0	77.01	32.01	20.13	51.72	91.91	3.73
G-17	62.0	75.0	103.3	116.3	86.90	41.90	20.47	33.06	88.61	3.00
G-18	69.0	76.3	104.6	120.8	74.11	29.11	20.10	23.06	102.51	3.90
G-19	71.0	81.3	109.8	122.0	63.05	18.05	20.20	30.88	102.81	3.20
G-20	73.0	87.0	110.3	125.0	70.86	25.86	19.53	30.91	88.61	5.40
G-21	69.3	81.3	109.8	122.0	78.24	33.24	20.83	25.90	94.88	3.00
G-22	69.3	82.3	110.9	122.0	72.80	27.80	20.93	30.97	84.51	2.60
G-23	68.3	82.0	110.9	122.0	77.24	32.24	18.63	44.78	88.48	4.60
G-24	70.7	82.0	110.9	123.0	83.31	38.31	20.80	33.06	89.01	2.40
G-25	65.0	77.3	105.6	117.8	90.99	45.99	20.67	30.82	94.38	2.80
G-26	75.0	85.3	109.3	126.0	88.42	43.42	20.60	26.98	105.21	3.80
G-27	69.3	80.0	108.8	122.0	78.61	33.61	20.50	24.83	95.88	4.80
G-28	71.0	80.3	108.8	122.0	78.03	33.03	20.77	26.97	90.11	3.40
G-29	71.3	82.3	110.9	124.0	85.41	40.41	20.60	29.19	86.51	4.60
G-30	71.7	83.0	111.9	125.0	73.58	28.58	20.60	35.95	80.11	5.80
G-31	66.3	75.3	103.5	118.8	83.61	38.61	20.77	18.93	94.41	6.40
G-32	72.7	83.3	110.2	125.0	88.52	43.52	19.90	18.91	93.01	3.40
G-33	71.7	82.0	110.9	126.0	91.44	46.44	19.17	27.12	91.58	4.80
G-34	76.7	84.3	113.0	128.0	72.75	27.75	18.87	27.78	86.65	3.60
G-35	75.3	80.7	112.3	127.0	81.83	36.83	19.13	24.88	96.11	6.50
G-36	58.3	76.0	105.4	121.2	87.56	42.56	20.93	31.78	87.28	3.20
G-37	59.0	76.0	104.3	119.3	79.01	34.01	21.67	37.99	93.35	6.50
G-38	61.3	77.0	107.5	121.2	85.04	40.04	20.90	60.81	101.21	3.60
G-39	77.0	80.0	114.4	132.0	73.14	28.14	19.27	25.90	109.35	5.20
G-40	73.7	87.3	111.3	128.0	77.41	32.41	19.80	52.70	93.31	4.80
G-41	71.3	82.7	111.9	125.0	73.98	28.98	19.87	45.99	92.68	3.60
G-42	74.7	86.3	110.1	126.0	73.11	28.11	19.20	53.75	77.68	4.80
G-43	71.0	81.3	109.8	124.0	89.52	44.52	19.07	46.76	90.41	6.40
G-44	68.3	75.3	103.5	120.8	88.67	43.67	19.20	44.97	100.65	5.40
G-45	72.3	86.0	110.3	126.0	84.05	39.05	19.47	46.85	94.25	4.53
G-46	75.0	86.7	110.3	127.0	79.73	34.73	19.17	60.95	91.48	4.40
G-47	70.7	80.0	108.8	125.0	70.12	25.12	19.10	35.80	85.11	4.20
G-48	74.3	83.3	109.5	127.0	68.72	23.72	19.20	41.06	85.35	4.60
G-49	74.7	83.3	109.5	127.0	75.95	30.95	19.60	44.13	96.41	3.27
G-50	71.3	81.0	109.8	125.0	71.39	26.39	19.33	58.87	83.65	5.00

Appendix-I Cont….

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (°C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-51	61.7	72.0	106.4	124.9	78.22	33.22	20.40	38.97	93.41	3.40
G-52	76.7	82.0	113.0	124.2	79.34	34.34	19.17	52.13	90.38	5.00
G-53	57.7	75.0	106.6	124.0	78.44	33.44	20.17	46.42	95.38	3.80
G-54	75.7	76.7	104.6	116.9	74.03	29.03	19.70	50.04	93.38	5.00
G-55	64.0	75.7	104.6	116.9	76.22	31.22	19.57	21.27	92.25	3.80
G-56	59.0	76.0	106.4	120.0	81.25	36.25	20.97	47.18	93.65	4.00
G-57	65.0	77.3	105.6	116.9	73.27	28.27	19.93	53.29	104.51	5.07
G-58	56.0	75.0	103.5	121.7	77.22	32.22	20.07	21.01	88.78	4.20
G-59	79.7	85.3	113.3	122.0	79.61	34.61	20.00	18.98	93.61	3.40
G-60	66.0	77.3	105.6	117.9	80.07	35.07	19.00	24.14	82.58	4.40
G-61	66.3	78.3	106.7	117.8	77.67	32.67	18.60	27.09	86.51	5.00
G-62	64.3	76.3	106.6	117.8	76.69	31.69	19.27	49.89	89.58	3.40
G-63	58.3	75.0	104.7	116.6	77.99	32.99	19.20	51.36	95.11	3.80
G-64	63.7	75.3	103.5	115.7	77.54	32.54	19.10	52.72	92.61	3.80
G-65	65.0	75.7	103.5	116.7	83.01	38.01	19.17	52.97	89.21	4.00
G-66	66.7	78.7	106.7	117.7	79.90	34.90	18.77	55.12	92.75	4.00
G-67	85.7	80.7	114.4	132.2	82.22	37.22	18.53	42.11	93.08	4.00
G-68	65.7	77.3	105.6	117.9	75.77	30.77	19.30	46.04	85.98	4.60
G-69	65.0	76.3	104.6	118.0	79.17	34.17	19.27	47.02	92.41	4.00
G-70	64.7	75.0	102.5	117.7	84.24	39.24	18.57	50.92	86.85	6.00
G-71	63.7	75.0	102.5	117.8	86.40	41.40	19.83	44.01	92.38	4.40
G-72	63.3	76.0	106.4	117.7	77.46	32.46	20.07	26.15	92.31	4.00
G-73	56.0	80.3	107.0	116.6	80.60	35.60	19.83	32.02	88.91	4.80
G-74	64.7	76.0	104.6	117.9	73.35	28.35	19.47	39.75	92.18	4.80
G-75	64.3	77.0	105.6	118.8	79.06	34.06	20.03	50.85	91.81	3.40
G-76	56.0	76.3	108.4	117.6	75.80	30.80	19.50	26.94	96.18	4.40
G-77	66.0	77.7	108.5	117.6	69.90	24.90	19.77	40.87	94.31	4.40
G-78	67.7	79.3	107.7	119.9	79.56	34.56	19.73	57.06	95.18	4.60
G-79	60.7	76.7	109.4	117.2	72.30	27.30	20.07	51.87	95.55	6.00
G-80	62.3	75.7	108.3	119.5	79.52	34.52	20.53	33.89	87.68	7.40
G-81	66.0	75.3	110.5	117.6	79.03	34.03	19.90	51.82	86.78	4.40
G-82	65.0	75.7	104.5	117.8	81.23	36.23	19.23	37.01	90.33	6.20
G-83	64.0	73.3	106.4	122.2	75.72	30.72	19.50	32.64	103.01	4.00
G-84	70.3	80.3	110.1	124.0	75.22	30.22	19.20	40.72	81.24	7.57
G-85	70.0	83.0	111.9	124.0	71.13	26.13	18.87	38.84	102.85	5.00
G-86	69.3	83.0	111.9	123.0	70.69	25.69	19.47	27.31	93.95	3.60
G-87	71.3	83.3	111.9	124.0	66.70	21.70	19.70	30.10	96.68	4.00
G-88	62.7	74.7	106.5	119.4	74.76	29.76	19.23	31.01	94.51	5.00
G-89	76.7	89.3	112.7	130.0	79.84	34.84	19.97	34.76	109.83	2.80
G-90	74.7	86.7	110.3	127.0	74.57	29.57	18.70	23.05	92.25	4.00
G-91	77.3	91.7	109.0	130.0	82.10	37.10	18.37	47.84	95.21	5.20
G-92	69.3	81.0	109.8	123.0	75.86	30.86	19.70	32.35	110.50	6.00
G-93	64.7	76.3	105.0	117.9	88.91	43.91	18.83	31.13	92.48	6.00
G-94	66.7	75.0	103.5	117.7	89.47	44.47	18.97	23.99	94.58	4.20
G-95	64.3	75.3	107.4	118.1	79.00	34.00	18.67	32.16	91.88	3.90
G-96	77.0	87.3	113.7	130.0	77.38	32.38	18.77	25.97	92.71	4.93
G-97	65.0	75.0	107.8	117.8	79.87	34.87	19.60	39.24	81.88	4.40
G-98	70.0	74.3	104.5	117.4	80.85	35.85	19.13	30.19	90.05	4.40
G-99	67.7	75.3	101.7	119.6	77.54	32.54	19.27	37.96	87.55	3.60
G-100	68.0	88.0	111.3	131.0	81.45	36.45	19.70	30.08	109.38	5.73

Appendix-I Cont….

G.No.	No. of earsplant^{-1}	No. of spikeletsear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-1	3.07	18.43	9.83	1.86	48.58	30.70	19.92	39.53	6.34
G-2	3.77	17.37	8.53	2.01	47.25	37.73	21.35	46.47	8.14
G-3	4.10	21.57	12.33	1.73	69.03	25.37	20.41	43.37	7.19
G-4	2.57	16.27	7.03	2.31	38.94	39.10	19.12	46.47	8.37
G-5	3.93	17.67	8.53	2.05	32.61	50.43	24.56	41.83	8.94
G-6	5.23	18.60	9.53	2.14	52.58	30.70	23.48	48.97	10.25
G-7	3.63	18.43	9.73	1.88	52.58	36.03	22.55	49.63	9.23
G-8	2.60	19.57	8.93	2.18	27.58	54.50	18.23	33.13	4.75
G-9	3.33	17.43	7.73	2.24	43.58	44.37	19.49	38.40	6.02
G-10	3.07	18.27	8.43	2.16	34.58	49.20	19.45	40.23	6.24
G-11	2.60	17.33	8.73	2.22	40.58	53.05	19.54	40.60	6.31
G-12	2.93	17.27	10.43	1.65	57.58	43.40	21.51	47.43	11.04
G-13	3.67	20.50	11.63	1.75	56.58	37.40	23.91	50.10	10.62
G-14	3.40	19.43	9.73	1.98	46.58	47.27	21.05	46.90	8.01
G-15	5.67	17.33	9.33	1.86	39.58	47.43	27.85	46.83	14.50
G-16	3.63	23.20	10.53	2.13	89.58	43.37	27.53	51.13	12.06
G-17	2.93	19.60	9.73	1.99	54.58	44.43	19.47	38.40	5.98
G-18	3.80	20.30	9.63	2.10	55.58	40.53	23.55	51.43	10.09
G-19	3.13	22.83	12.53	1.80	64.58	40.73	19.03	37.30	5.65
G-20	5.27	20.57	11.33	1.80	55.58	39.23	29.18	46.43	15.67
G-21	2.93	20.40	8.33	2.46	41.58	44.00	21.13	45.33	7.79
G-22	2.53	20.57	8.43	2.41	52.58	49.30	20.52	42.13	6.97
G-23	4.53	17.40	7.33	2.38	40.58	38.37	22.77	50.47	9.54
G-24	2.33	19.50	8.73	2.22	41.58	43.17	18.01	31.87	4.49
G-25	2.73	19.43	8.93	2.19	48.58	38.53	19.04	38.43	5.80
G-26	3.87	23.17	12.03	1.87	70.58	38.60	23.20	48.87	9.45
G-27	4.73	18.23	9.73	1.90	49.58	46.17	23.94	53.03	10.64
G-28	3.33	23.00	10.23	2.20	52.58	43.37	21.19	44.87	7.76
G-29	4.47	20.33	9.23	2.22	54.58	42.57	26.57	47.30	12.34
G-30	5.73	16.50	7.83	2.10	39.58	49.47	25.70	55.90	12.23
G-31	6.33	19.83	8.93	2.20	50.58	42.37	25.63	50.50	12.49
G-32	3.27	21.50	9.53	2.25	56.58	46.00	22.12	48.47	8.81
G-33	4.67	17.37	7.63	2.29	41.58	41.43	24.72	47.57	11.21
G-34	3.53	22.73	10.73	2.00	63.58	37.43	22.05	48.90	8.86
G-35	6.40	23.33	9.53	2.48	67.58	34.70	30.77	53.27	15.63
G-36	3.13	16.33	8.13	2.08	40.58	49.03	19.68	39.43	6.22
G-37	5.53	16.10	7.43	2.10	38.58	48.57	23.31	42.97	8.94
G-38	3.47	17.83	8.43	2.09	46.58	40.33	20.37	42.33	6.97
G-39	5.13	16.33	9.23	1.76	42.58	41.50	21.27	46.23	8.10
G-40	4.73	16.07	7.53	2.05	38.58	36.23	21.63	46.87	8.36
G-41	3.47	16.30	8.13	1.90	36.58	29.10	19.11	38.53	5.87
G-42	4.07	22.57	9.93	2.27	66.58	49.53	23.49	44.93	8.77
G-43	6.33	19.33	9.93	1.94	53.58	40.67	28.83	53.87	14.57
G-44	5.27	20.63	12.53	1.64	57.58	32.00	25.67	49.37	10.77
G-45	4.40	17.90	8.13	2.14	43.58	44.20	21.22	44.90	7.81
G-46	4.27	22.23	9.63	2.34	67.58	36.93	23.36	47.90	9.33
G-47	4.13	16.83	10.33	1.61	42.58	35.97	21.37	45.47	7.97
G-48	4.47	20.27	9.33	2.17	55.58	43.43	21.85	47.27	8.51
G-49	2.93	21.57	9.83	2.18	55.58	48.67	20.15	42.60	6.91
G-50	4.93	18.83	7.93	2.35	48.58	33.07	22.85	50.27	9.56

Appendix-I Cont….

G.No.	No. of earsplant^{-1}	No. of Spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-51	3.33	17.43	8.13	2.13	40.58	41.33	19.20	38.03	5.84
G-52	4.93	22.67	10.63	2.10	61.58	40.00	26.42	49.70	11.89
G-53	3.67	16.23	8.13	2.03	35.58	55.56	22.51	50.57	9.38
G-54	4.93	23.20	11.03	2.14	70.58	42.23	24.39	47.90	11.06
G-55	3.73	16.77	10.23	1.49	23.58	59.03	22.25	49.67	9.10
G-56	3.93	17.50	9.53	1.82	44.58	54.73	26.31	40.20	9.03
G-57	5.00	21.77	9.83	2.19	62.58	55.03	29.86	53.13	13.80
G-58	4.13	17.43	9.63	1.80	44.58	56.53	22.13	49.50	9.03
G-59	3.33	21.27	8.43	2.51	59.58	46.87	21.45	46.57	8.16
G-60	4.33	22.47	10.03	2.24	56.58	40.07	25.65	43.57	9.48
G-61	4.93	22.33	8.33	2.66	57.58	40.33	25.93	45.63	10.58
G-62	3.27	19.33	8.43	2.31	55.58	46.67	23.11	44.43	8.50
G-63	3.73	18.57	9.33	2.84	44.58	44.97	23.28	51.50	9.96
G-64	3.67	21.50	8.13	2.66	62.58	45.10	22.53	49.43	9.19
G-65	3.87	23.20	9.43	2.52	62.58	41.93	21.93	47.43	8.55
G-66	3.73	23.37	9.23	2.57	72.58	29.53	22.28	50.33	9.21
G-67	3.97	18.83	8.73	2.14	49.58	45.93	21.18	45.10	7.81
G-68	4.47	21.43	8.83	2.41	56.58	40.57	25.16	50.83	10.90
G-69	3.77	19.33	8.83	2.19	62.58	38.73	23.85	52.33	10.41
G-70	5.80	18.33	8.53	2.14	44.58	49.33	26.79	57.70	13.22
G-71	4.27	17.57	7.63	2.27	36.58	57.77	22.48	48.83	9.08
G-72	3.93	16.37	8.03	2.05	42.58	35.60	20.85	44.13	7.50
G-73	4.73	20.43	10.53	1.93	53.58	45.90	24.09	53.47	10.81
G-74	4.67	18.53	9.73	1.89	43.58	39.43	21.59	47.07	8.36
G-75	3.33	17.77	8.73	2.12	48.58	38.83	20.15	44.37	7.20
G-76	4.33	19.47	9.53	2.04	56.58	53.37	24.86	55.63	11.65
G-77	4.27	22.73	11.53	2.04	69.58	42.47	21.31	48.60	8.46
G-78	4.47	22.60	10.33	2.16	55.58	43.50	23.65	51.57	10.19
G-79	5.87	22.53	11.93	2.11	62.58	48.43	28.59	63.53	15.67
G-80	7.27	23.60	10.33	2.37	56.58	36.23	33.26	60.17	17.70
G-81	4.30	22.60	11.03	2.05	63.58	55.67	22.25	49.23	9.04
G-82	6.13	21.43	11.93	1.97	75.58	40.67	33.80	58.53	17.52
G-83	3.87	22.57	11.23	2.00	66.58	43.90	21.85	49.00	8.78
G-84	7.60	20.33	10.13	2.03	59.58	48.80	40.91	57.83	23.82
G-85	4.93	18.33	8.73	2.25	52.58	51.30	24.79	55.77	11.66
G-86	3.73	17.57	9.93	1.76	34.58	52.70	22.14	42.40	8.65
G-87	3.93	20.57	8.73	2.35	47.58	26.20	21.75	47.80	8.76
G-88	4.87	22.57	10.93	2.08	57.49	37.20	27.24	58.83	14.09
G-89	2.67	21.67	10.43	2.23	48.58	38.17	19.39	38.73	5.86
G-90	3.87	22.23	10.23	2.28	70.58	48.17	24.13	53.33	10.77
G-91	5.07	22.13	9.63	2.44	69.58	30.70	23.66	52.87	10.47
G-92	5.87	17.50	9.63	2.85	43.58	43.37	26.49	59.53	13.47
G-93	5.93	19.03	9.43	1.95	49.58	48.00	28.01	55.93	13.52
G-94	4.13	18.47	10.23	1.81	49.58	54.37	22.53	49.77	9.28
G-95	3.87	20.50	9.73	2.10	60.58	45.20	20.47	44.60	7.40
G-96	4.47	20.63	10.03	2.73	62.58	29.63	24.55	53.50	11.06
G-97	4.37	18.70	9.73	1.90	44.58	35.63	24.91	37.67	7.62
G-98	4.27	19.80	9.53	2.05	57.90	37.43	24.47	51.60	10.60
G-99	3.47	19.90	11.23	1.73	64.58	43.40	20.37	44.10	7.25
G-100	5.27	16.30	10.83	1.79	36.58	41.73	26.43	49.40	12.60

Appendix-II

Mean value of phenological, physiological and yield contributing traits (Second environment)

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-1	54.33	67.00	92.33	104.20	70.55	25.55	21.07	47.96	85.43	3.10
G-2	50.00	68.00	93.33	105.20	81.17	36.17	19.90	41.57	83.70	3.63
G-3	54.33	69.00	92.67	106.20	78.98	33.98	21.40	47.11	100.97	4.00
G-4	47.67	66.00	93.33	106.80	77.75	32.75	20.90	26.45	97.73	2.07
G-5	51.00	61.00	84.67	101.44	88.88	43.88	19.00	24.88	83.07	3.83
G-6	49.33	72.00	94.00	109.32	67.91	22.91	19.57	30.36	100.43	4.90
G-7	53.33	70.00	92.00	107.32	89.11	44.11	19.83	41.38	93.30	3.90
G-8	50.67	61.00	85.67	107.89	78.89	33.89	20.07	27.73	101.27	2.63
G-9	53.00	68.00	88.67	111.56	80.22	35.22	20.57	23.45	96.70	2.90
G-10	49.33	60.00	85.67	105.93	77.81	32.81	20.27	47.67	99.33	3.20
G-11	52.00	65.00	84.67	106.15	76.59	31.59	20.97	42.65	97.00	2.97
G-12	49.33	62.00	83.67	106.02	81.26	36.26	21.33	25.56	85.10	2.97
G-13	47.00	63.00	85.00	107.98	81.24	36.24	20.83	44.43	88.33	3.87
G-14	53.67	69.00	88.67	106.32	80.48	35.48	21.23	25.55	93.07	3.47
G-15	55.00	72.00	92.00	109.32	83.11	38.11	20.60	27.39	93.93	5.87
G-16	57.33	74.00	91.00	111.32	76.31	31.31	21.13	44.22	90.90	3.63
G-17	46.00	59.00	82.33	101.31	86.31	41.31	20.50	25.56	84.60	3.00
G-18	53.00	65.00	84.67	105.44	73.45	28.45	20.40	15.55	98.37	3.80
G-19	55.00	70.00	89.33	107.32	62.54	17.54	19.90	23.37	99.37	3.03
G-20	57.00	74.67	99.67	108.33	70.48	25.48	19.87	23.40	85.73	5.30
G-21	53.33	70.00	90.67	107.32	77.53	32.53	21.27	18.40	92.17	3.17
G-22	53.33	71.00	89.33	108.32	70.49	25.49	21.90	23.47	80.23	2.70
G-23	52.33	71.00	92.33	108.32	74.88	29.88	21.03	37.28	86.40	4.67
G-24	54.67	71.00	89.33	108.32	80.87	35.87	21.30	25.55	87.27	2.40
G-25	49.00	66.00	87.67	107.15	88.43	43.43	22.00	23.31	91.23	2.77
G-26	59.00	74.00	94.00	111.32	85.90	40.90	21.40	19.47	103.67	3.70
G-27	53.33	69.00	89.67	106.32	76.22	31.22	21.57	17.32	91.27	4.90
G-28	55.00	69.00	89.67	106.32	75.65	30.65	21.73	19.47	88.70	3.33
G-29	55.33	71.00	91.33	108.32	82.94	37.94	21.30	21.69	84.27	4.50
G-30	55.67	72.00	89.00	109.32	71.27	26.27	21.53	28.44	77.53	5.73
G-31	50.33	64.00	84.00	106.10	81.16	36.16	21.40	11.43	91.47	6.10
G-32	56.67	72.00	93.67	109.32	86.01	41.01	20.80	11.40	91.63	2.93
G-33	56.33	71.00	92.67	108.32	88.88	43.88	20.50	19.61	89.27	4.13
G-34	61.00	73.33	98.00	108.33	72.82	27.82	21.47	20.28	84.37	3.33
G-35	60.00	78.00	97.67	110.33	79.41	34.41	22.37	17.38	94.67	6.07
G-36	43.33	61.00	87.00	108.85	85.05	40.05	21.43	24.27	85.50	2.90
G-37	43.67	60.00	87.33	105.93	76.62	31.62	21.97	30.49	91.03	5.93
G-38	46.00	63.00	87.67	109.89	82.57	37.57	20.47	53.30	99.83	3.33
G-39	61.67	73.33	98.33	109.33	72.49	27.49	19.93	18.39	110.30	5.20
G-40	58.33	73.67	98.33	109.33	76.71	31.71	21.53	45.19	92.60	4.40
G-41	56.00	72.00	93.67	109.33	73.80	28.80	21.20	38.49	91.27	3.53
G-42	59.33	75.00	93.33	112.32	70.81	25.81	21.20	46.25	75.73	4.33
G-43	55.67	70.00	88.33	107.32	86.99	41.99	20.50	39.25	87.83	5.80
G-44	53.00	64.00	84.67	109.81	86.15	41.15	20.87	37.46	98.20	5.17
G-45	57.00	75.00	95.33	112.32	81.59	36.59	21.47	39.34	92.97	4.20
G-46	59.67	75.00	93.33	112.32	77.34	32.34	21.17	53.45	89.43	4.03
G-47	55.33	69.00	89.67	106.32	69.89	24.89	20.77	28.29	83.50	3.93
G-48	59.00	72.00	91.00	109.32	68.37	23.37	20.50	33.55	84.43	4.20
G-49	59.33	72.00	90.00	109.32	75.50	30.50	20.60	36.63	94.67	3.17
G-50	56.00	70.00	91.67	107.32	69.11	24.11	20.30	51.37	78.27	4.47

Appendix-II Cont….

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (°C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-51	46.33	61.00	86.00	109.50	77.51	32.51	20.40	31.46	92.17	3.23
G-52	61.33	76.67	99.00	114.47	78.61	33.61	20.20	44.62	89.57	4.83
G-53	42.33	59.00	84.00	115.67	77.72	32.72	21.07	38.92	93.57	3.70
G-54	50.33	65.00	87.67	103.57	72.90	27.90	21.40	42.54	91.40	4.27
G-55	48.67	65.00	86.67	103.57	75.05	30.05	21.57	13.77	93.60	3.43
G-56	43.67	62.00	86.00	108.89	79.86	34.86	21.10	39.67	88.57	3.67
G-57	49.67	66.00	88.00	103.94	72.86	27.86	20.97	45.79	101.63	4.73
G-58	47.00	59.00	86.00	110.00	76.51	31.51	21.07	13.51	87.17	3.90
G-59	64.33	78.00	99.00	115.32	78.16	33.16	21.57	11.48	91.40	2.93
G-60	50.67	66.00	88.00	104.57	79.33	34.33	20.33	16.63	80.47	4.17
G-61	51.00	67.00	87.67	106.81	76.72	31.72	20.27	19.59	88.07	4.40
G-62	49.00	65.00	86.67	105.44	76.23	31.23	20.33	42.38	86.43	3.23
G-63	43.00	64.00	82.00	109.63	77.52	32.52	20.87	43.85	93.57	3.47
G-64	48.33	64.00	87.67	105.69	77.31	32.31	20.47	45.22	90.60	3.57
G-65	49.67	64.00	87.33	105.06	81.99	36.99	20.47	45.47	86.47	3.67
G-66	51.33	67.00	90.67	108.69	78.21	33.21	20.03	47.61	90.50	3.50
G-67	62.67	71.00	99.00	115.82	80.98	35.98	19.53	34.60	91.57	3.27
G-68	50.33	66.00	88.00	105.19	75.56	30.56	20.63	38.53	85.00	3.67
G-69	49.67	65.00	86.00	102.32	77.25	32.25	20.27	39.52	90.70	3.63
G-70	49.33	63.00	87.33	106.06	83.68	38.68	19.57	43.41	86.47	5.60
G-71	48.33	63.00	88.33	104.15	85.33	40.33	20.57	36.50	91.63	3.60
G-72	48.00	62.00	86.00	106.02	77.23	32.23	20.90	18.65	91.17	3.50
G-73	40.67	69.00	88.67	107.55	78.90	33.90	21.17	24.51	92.20	3.43
G-74	49.33	65.00	89.33	105.19	72.70	27.70	21.47	32.24	94.50	4.00
G-75	49.00	66.00	89.67	107.15	76.68	31.68	20.90	43.35	90.00	3.03
G-76	49.67	62.00	86.33	107.93	75.83	30.83	21.23	19.43	95.43	3.27
G-77	50.67	63.00	88.67	107.98	67.63	22.63	20.60	33.36	93.17	3.43
G-78	52.33	68.00	91.00	107.23	77.17	32.17	20.63	49.56	95.27	4.30
G-79	45.33	62.00	87.33	108.89	72.14	27.14	21.40	44.37	94.17	5.43
G-80	47.00	62.00	89.00	109.85	78.55	33.55	21.53	26.38	83.47	5.87
G-81	50.67	63.00	88.67	107.98	78.06	33.06	20.87	44.32	89.77	3.27
G-82	49.67	64.00	90.67	105.15	80.00	35.00	20.03	29.50	86.00	5.23
G-83	48.67	62.00	88.33	109.85	75.27	30.27	20.57	25.14	100.50	2.63
G-84	55.00	69.00	90.67	106.32	73.36	28.36	20.77	33.22	78.83	5.87
G-85	54.67	72.00	87.33	109.32	70.75	25.75	21.07	31.34	100.60	4.70
G-86	54.00	72.00	89.33	109.32	69.36	24.36	19.60	19.80	92.00	2.47
G-87	56.00	72.00	91.00	109.32	66.38	21.38	20.07	22.59	94.27	3.43
G-88	47.33	63.00	89.00	107.02	73.86	28.86	20.23	23.51	93.37	3.90
G-89	61.33	78.00	95.00	107.00	78.86	33.86	20.63	27.25	108.37	2.67
G-90	59.33	75.00	91.67	109.43	74.14	29.14	19.43	15.54	90.33	3.40
G-91	62.00	76.67	95.33	110.77	80.86	35.86	18.83	40.33	89.30	4.27
G-92	54.00	70.00	90.67	107.32	75.17	30.17	20.40	24.85	108.13	5.17
G-93	49.33	65.00	87.67	105.19	87.81	42.81	20.17	23.62	96.67	5.20
G-94	51.33	64.00	86.00	107.06	88.36	43.36	19.73	16.49	93.63	3.20
G-95	49.00	62.00	88.67	110.80	78.04	33.04	19.87	24.65	93.47	3.60
G-96	61.67	76.00	94.00	113.32	77.15	32.15	20.43	18.47	90.57	4.37
G-97	49.67	63.00	87.00	105.10	78.42	33.42	20.60	31.73	86.63	4.30
G-98	54.67	63.00	89.00	113.72	78.43	33.43	20.30	22.69	88.57	3.70
G-99	52.33	64.00	88.00	109.93	76.36	31.36	20.27	30.46	87.67	3.33
G-100	52.67	77.00	97.33	114.32	81.41	36.41	20.70	22.58	108.60	5.57

Appendix-II Cont….

G.No.	No. of earsplant^{-1}	No. of spikeletsear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-1	2.34	16.23	8.83	1.84	44.43	29.06	14.20	41.07	5.87
G-2	3.04	15.17	7.53	2.09	43.43	36.49	16.37	41.61	6.83
G-3	3.38	19.37	11.33	1.71	65.43	23.42	15.55	50.35	7.90
G-4	1.84	14.07	6.03	2.37	34.43	37.93	12.67	49.44	6.27
G-5	3.21	15.47	7.53	2.06	28.43	49.91	17.04	47.81	8.10
G-6	4.51	16.40	8.53	1.92	48.43	29.20	17.63	42.93	7.60
G-7	2.91	16.23	8.73	1.86	48.43	34.69	17.10	47.37	8.03
G-8	2.37	17.37	7.93	2.21	23.43	62.93	15.24	46.61	7.27
G-9	2.61	15.23	6.73	2.28	39.43	43.50	14.24	43.11	6.03
G-10	2.34	16.07	7.43	2.18	30.43	48.62	14.07	50.48	7.00
G-11	1.88	15.13	7.73	1.98	36.43	51.44	14.15	47.04	6.67
G-12	2.21	15.07	9.43	1.60	53.43	42.75	17.33	46.55	8.23
G-13	2.94	18.30	10.63	1.71	52.43	35.66	19.85	45.86	9.33
G-14	2.68	17.23	8.73	1.98	42.43	46.83	17.19	44.10	7.83
G-15	4.94	15.13	8.33	1.83	35.43	47.01	21.36	56.66	12.20
G-16	2.91	21.00	9.53	2.22	85.43	42.71	21.81	30.71	6.80
G-17	2.21	17.40	8.73	1.99	50.43	43.83	14.15	44.00	6.27
G-18	3.08	18.10	8.63	2.11	51.43	38.96	17.93	35.98	7.60
G-19	2.41	20.63	11.53	1.78	60.43	38.82	13.38	64.18	8.60
G-20	4.54	18.37	10.33	1.78	51.43	38.36	23.26	44.39	10.23
G-21	2.21	18.20	7.33	2.44	37.43	43.01	16.08	46.37	7.37
G-22	1.81	18.37	7.43	2.43	48.43	48.82	15.27	38.71	5.90
G-23	3.81	15.20	6.33	2.40	36.43	37.26	18.85	45.62	8.53
G-24	1.61	17.30	7.73	2.26	37.43	42.32	15.03	42.31	6.50
G-25	2.01	17.23	7.93	2.14	44.43	37.45	13.99	41.82	5.88
G-26	3.14	20.97	11.03	1.89	66.43	37.50	18.41	45.05	8.50
G-27	4.01	16.03	8.73	1.80	45.43	45.49	18.11	49.36	8.60
G-28	2.61	20.80	9.23	2.26	48.43	41.74	15.87	50.69	8.63
G-29	3.74	18.13	8.23	2.17	50.43	41.70	19.98	28.06	8.27
G-30	5.01	14.30	6.83	2.11	35.43	48.98	20.38	46.98	9.17
G-31	5.61	17.63	7.93	2.24	46.43	41.56	18.94	56.99	10.87
G-32	2.54	19.30	8.53	2.24	52.43	45.41	16.67	44.87	7.43
G-33	3.94	15.17	6.63	2.24	37.43	40.59	18.50	36.74	6.60
G-34	2.81	20.53	9.73	2.15	59.43	36.36	16.73	56.08	9.23
G-35	5.68	21.13	8.53	2.44	63.43	33.46	21.97	47.54	10.13
G-36	2.41	14.13	7.13	1.96	36.43	48.60	14.63	44.14	6.40
G-37	4.81	13.90	6.43	2.17	34.43	48.14	18.03	55.30	10.13
G-38	2.74	15.63	7.43	2.11	42.43	39.44	14.79	44.21	6.40
G-39	4.41	14.13	8.23	1.68	38.43	40.64	15.13	49.67	7.17
G-40	4.01	13.87	6.53	2.15	34.43	35.08	15.31	48.49	7.43
G-41	2.74	14.10	7.13	1.99	32.43	27.36	13.73	45.46	6.17
G-42	3.34	20.37	8.93	2.30	62.43	48.95	16.03	39.70	6.30
G-43	5.61	17.13	8.93	1.94	49.43	39.60	21.17	50.66	10.50
G-44	4.54	18.43	11.53	1.59	53.43	30.44	20.15	40.43	8.27
G-45	3.68	15.70	7.13	2.17	39.43	43.31	17.90	52.23	9.60
G-46	3.54	20.03	8.63	2.31	63.43	35.64	16.51	44.56	7.17
G-47	3.41	14.63	9.33	1.56	38.43	34.63	16.59	45.97	7.60
G-48	3.74	18.07	8.33	2.19	51.43	42.50	17.00	40.01	6.77
G-49	2.21	19.37	8.83	2.18	51.43	48.04	15.50	42.65	6.70
G-50	4.21	16.63	6.93	2.42	44.43	31.57	16.53	39.55	6.37

Appendix-II Cont….

G.No.	No. of earsplant^{-1}	No. of Spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-51	2.61	15.23	7.13	2.12	36.43	40.38	13.55	45.58	6.10
G-52	4.21	20.47	9.63	2.09	57.43	38.99	19.30	35.92	6.90
G-53	2.94	14.03	7.13	1.93	31.43	54.74	16.85	37.34	6.23
G-54	4.21	21.00	10.03	2.06	66.43	41.36	18.07	47.79	8.47
G-55	3.01	14.57	9.23	1.63	19.43	59.10	16.93	45.84	7.77
G-56	3.21	15.30	8.53	1.75	40.43	54.56	16.46	40.31	6.60
G-57	4.28	19.57	8.83	2.22	58.43	54.87	24.07	28.86	6.90
G-58	3.41	15.23	8.63	1.73	40.43	56.44	16.41	39.89	6.53
G-59	2.61	19.07	7.43	2.60	55.43	46.23	15.99	48.41	7.63
G-60	3.61	20.27	9.03	2.22	52.43	39.06	17.06	41.24	7.00
G-61	4.21	20.13	7.33	2.78	53.43	39.49	18.01	43.48	7.57
G-62	2.54	17.13	7.43	2.29	51.43	46.19	16.79	42.62	7.13
G-63	3.01	16.37	8.33	1.91	40.43	44.40	17.43	43.88	7.53
G-64	2.94	19.30	7.13	2.70	58.43	44.53	16.68	40.62	6.63
G-65	3.14	21.00	8.43	2.46	58.43	41.20	16.07	48.75	7.67
G-66	3.01	21.17	8.23	2.55	68.43	28.09	16.83	48.27	8.03
G-67	3.24	16.63	7.73	2.16	45.43	45.42	15.73	46.11	7.17
G-68	3.74	19.23	7.83	2.48	52.43	39.74	18.49	39.86	7.23
G-69	3.04	17.13	7.83	2.21	58.43	37.80	18.33	36.67	6.63
G-70	5.08	16.13	7.53	2.16	40.43	49.02	20.13	39.30	7.77
G-71	3.54	15.37	6.63	2.26	32.43	57.71	17.03	40.19	6.80
G-72	3.21	14.17	7.03	1.96	38.43	34.26	15.06	45.21	6.67
G-73	4.01	18.23	9.53	1.92	49.43	45.15	18.57	37.35	6.87
G-74	3.94	16.33	8.73	1.90	39.43	38.34	15.67	37.53	5.77
G-75	2.61	15.57	7.73	1.93	44.43	37.70	14.69	53.19	7.70
G-76	3.61	17.27	8.53	2.05	52.43	53.07	18.87	35.04	6.50
G-77	3.54	20.53	10.53	1.90	65.43	41.52	15.86	51.01	8.07
G-78	3.74	20.40	9.33	2.15	51.43	42.63	17.73	36.60	6.37
G-79	5.14	20.33	10.93	1.81	58.43	47.84	22.20	47.96	10.30
G-80	6.54	21.40	9.33	2.26	52.43	34.93	26.67	44.40	11.83
G-81	3.58	20.40	10.03	1.99	59.43	55.66	16.27	48.88	7.83
G-82	4.97	19.23	10.93	1.64	71.43	39.80	27.28	32.74	8.80
G-83	3.14	20.37	10.23	1.96	62.43	43.24	16.19	47.93	7.77
G-84	5.32	18.13	9.13	1.96	55.43	48.42	33.67	22.05	8.27
G-85	4.21	16.13	7.73	2.07	48.43	51.06	19.00	35.44	6.53
G-86	3.01	15.37	8.93	1.73	30.43	52.53	16.58	44.18	7.23
G-87	3.21	18.37	7.73	2.40	43.43	24.52	15.96	45.30	7.10
G-88	4.14	20.37	9.93	2.01	56.43	36.15	21.39	37.04	9.17
G-89	2.61	19.47	9.43	2.01	44.43	37.16	15.67	56.55	8.13
G-90	3.14	20.03	9.23	2.16	66.43	47.73	18.47	40.58	7.40
G-91	4.34	19.93	8.63	2.23	65.43	29.29	17.74	44.04	7.63
G-92	4.40	15.30	8.63	1.77	39.43	42.64	20.44	42.05	8.37
G-93	4.64	16.83	8.43	1.94	45.43	47.51	21.43	37.21	7.67
G-94	3.41	16.27	9.23	1.78	45.43	60.18	16.81	48.61	8.10
G-95	3.14	18.30	8.73	2.11	56.43	44.57	16.18	50.47	8.20
G-96	3.74	18.43	9.03	2.05	58.43	28.10	18.80	45.15	8.37
G-97	3.64	16.50	8.73	1.88	40.43	34.47	16.88	42.88	7.23
G-98	3.54	17.60	8.53	2.06	53.43	36.37	18.02	41.49	7.40
G-99	2.74	17.70	10.23	1.75	60.43	42.67	17.45	52.35	10.33
G-100	4.54	16.30	9.83	1.60	32.43	40.89	20.04	46.26	8.77

Appendix-III

Mean value of phenological, physiological and yield contributing traits (Third environment)

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-1	62.33	74.00	98.00	110.67	50.96	16.49	22.37	39.29	84.91	2.41
G-2	64.67	75.00	99.00	111.67	59.79	25.32	20.27	29.57	83.70	2.95
G-3	64.67	76.00	100.00	113.33	52.97	18.50	21.77	36.11	98.37	3.31
G-4	59.00	73.00	97.00	109.67	57.22	22.75	21.43	20.45	98.07	1.38
G-5	61.00	67.67	96.00	105.00	68.35	33.88	19.60	19.54	78.17	3.12
G-6	57.33	79.00	103.00	116.00	52.04	17.57	19.80	21.36	99.93	4.19
G-7	61.33	77.00	101.00	114.00	68.58	34.11	20.33	33.38	92.53	3.17
G-8	58.67	68.33	92.33	104.67	65.03	30.56	20.67	22.73	99.30	1.95
G-9	61.00	75.00	99.00	111.67	69.69	35.22	21.37	19.45	94.67	2.21
G-10	57.33	67.00	91.33	103.67	67.28	32.81	21.03	47.67	97.27	2.51
G-11	60.00	72.00	96.00	109.00	66.06	31.59	21.20	42.65	95.53	2.28
G-12	57.33	69.00	93.33	105.67	70.73	36.26	22.07	25.56	75.57	2.28
G-13	55.00	70.33	94.33	106.67	70.71	36.24	21.17	44.43	85.57	3.13
G-14	61.67	76.33	100.00	113.00	69.95	35.48	21.63	25.55	91.47	2.78
G-15	63.00	79.00	103.00	116.00	72.58	38.11	21.73	27.39	92.87	4.71
G-16	65.33	81.33	105.33	118.00	65.78	31.31	22.17	44.22	90.37	2.95
G-17	54.00	66.00	90.33	108.67	75.78	41.31	21.23	25.56	83.33	2.31
G-18	61.00	72.33	96.00	109.00	62.92	28.45	21.30	15.55	97.40	3.11
G-19	63.00	77.33	101.00	114.00	52.01	17.54	21.93	23.37	97.53	2.35
G-20	65.00	83.00	103.00	115.00	59.95	25.48	21.83	23.40	85.27	4.55
G-21	61.33	77.33	101.00	115.33	67.00	32.53	22.37	18.40	92.07	2.48
G-22	61.33	78.33	102.00	116.33	59.96	25.49	22.63	23.47	78.47	2.11
G-23	60.33	78.00	102.00	116.33	64.35	29.88	21.97	37.28	84.00	3.98
G-24	62.67	78.00	102.00	116.33	70.34	35.87	21.67	25.55	86.57	1.71
G-25	57.00	73.33	97.00	111.33	77.90	43.43	22.63	23.31	89.13	2.08
G-26	67.00	81.33	105.33	119.33	75.37	40.90	22.43	19.47	102.33	3.01
G-27	61.33	76.00	100.00	114.33	65.69	31.22	22.23	17.32	92.30	4.25
G-28	63.00	76.33	100.00	113.00	65.12	30.65	22.23	19.47	85.83	2.65
G-29	63.33	78.33	102.00	115.00	72.41	37.94	22.07	21.69	82.50	3.81
G-30	63.67	79.00	103.00	116.00	60.74	26.27	22.07	28.44	79.07	5.05
G-31	58.33	71.33	95.33	108.00	70.63	36.16	22.03	11.43	89.77	4.77
G-32	64.67	79.33	103.00	116.00	75.48	41.01	22.30	11.40	91.60	2.25
G-33	64.33	78.00	102.00	115.00	78.35	38.32	21.20	19.61	87.07	3.45
G-34	69.00	86.33	102.67	117.00	62.29	22.26	22.47	20.28	82.53	2.65
G-35	68.00	85.67	107.00	118.00	68.88	28.85	23.40	17.38	92.73	4.80
G-36	51.33	68.00	92.33	104.67	74.52	34.49	22.17	24.27	82.30	2.21
G-37	51.67	67.00	91.33	103.67	66.09	26.06	21.67	30.49	89.63	4.41
G-38	54.00	70.00	94.33	106.67	72.04	32.01	22.70	53.30	97.33	2.65
G-39	69.67	86.00	105.00	118.00	61.96	21.93	21.53	8.39	108.60	4.32
G-40	66.33	83.33	103.33	118.00	66.18	26.15	22.17	45.19	91.43	3.71
G-41	64.00	78.67	103.00	116.00	63.27	23.24	22.73	38.49	88.40	2.85
G-42	67.33	82.33	106.33	116.33	60.28	20.25	22.03	46.25	76.93	3.65
G-43	63.67	77.33	101.00	115.33	76.46	36.43	22.07	39.25	89.93	5.11
G-44	61.00	71.33	95.33	109.00	75.62	35.59	22.90	37.46	96.63	4.48
G-45	65.00	82.00	103.67	116.33	71.06	31.03	22.57	39.34	92.67	3.51
G-46	67.67	82.67	103.67	117.00	66.81	26.78	22.10	53.45	87.53	3.35
G-47	63.33	76.00	100.00	114.33	59.36	19.33	22.30	8.29	85.33	3.25
G-48	67.00	79.33	103.00	116.00	57.84	17.81	22.27	33.55	82.80	3.51
G-49	67.33	79.33	103.00	116.00	64.97	24.94	22.70	36.63	93.73	2.48
G-50	62.33	74.00	98.00	110.67	50.96	16.49	22.37	39.29	84.91	2.41

Appendix-III Cont….

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-51	64.00	77.00	101.00	114.00	58.58	18.55	22.37	51.37	80.83	3.78
G-52	54.33	68.00	92.33	112.67	66.98	26.95	22.53	31.46	90.43	2.55
G-53	69.33	84.00	106.00	116.33	68.08	28.05	22.13	44.62	88.50	4.15
G-54	50.33	66.00	90.33	110.00	67.19	27.16	22.80	38.92	91.20	3.01
G-55	58.33	72.67	96.00	109.00	62.37	22.34	22.20	42.54	90.50	3.58
G-56	56.67	71.67	96.00	109.00	64.52	24.49	22.20	13.77	94.20	2.75
G-57	51.67	69.00	93.33	113.67	69.33	29.30	22.97	39.67	87.13	2.98
G-58	57.67	73.33	97.00	111.33	62.33	22.30	22.13	45.79	99.20	4.05
G-59	48.67	66.00	95.33	108.67	65.98	25.95	22.53	13.51	85.63	3.21
G-60	72.33	85.33	109.33	117.00	67.63	27.60	20.87	11.48	90.37	2.25
G-61	58.67	73.33	99.00	110.00	68.80	28.77	21.00	16.63	89.17	3.48
G-62	59.00	74.33	99.00	111.00	66.19	26.16	22.50	19.59	87.97	3.71
G-63	57.00	72.33	100.00	109.00	65.70	25.67	22.37	42.38	85.33	2.55
G-64	51.00	64.00	95.00	103.33	66.99	26.96	21.43	43.85	89.17	2.78
G-65	56.33	71.33	100.33	107.67	66.78	26.75	21.37	45.22	90.60	2.88
G-66	57.67	71.67	98.33	107.67	71.46	31.43	20.90	45.47	84.80	2.98
G-67	59.33	74.67	99.33	110.67	67.68	27.65	20.43	47.61	89.43	2.81
G-68	70.67	86.67	110.33	117.00	70.45	30.42	20.33	34.60	90.93	2.58
G-69	58.33	73.33	97.00	110.00	65.03	25.00	20.57	38.53	84.73	2.98
G-70	57.67	72.33	96.00	109.00	66.72	26.69	20.23	39.52	89.20	2.95
G-71	57.33	70.00	94.33	106.67	73.15	33.12	20.33	43.41	88.97	4.91
G-72	56.33	70.00	94.33	107.00	74.80	34.77	20.60	36.50	90.43	2.91
G-73	56.00	69.00	93.33	105.67	66.70	26.67	21.37	18.65	90.77	2.81
G-74	48.67	69.67	98.00	108.00	68.37	28.34	22.73	24.51	91.93	2.75
G-75	57.33	72.00	96.00	109.00	62.17	22.14	22.17	32.24	93.37	3.31
G-76	57.00	73.00	97.00	110.00	66.15	26.12	22.63	43.35	88.93	2.35
G-77	57.67	69.33	93.33	112.33	65.30	25.27	20.87	19.43	94.93	2.58
G-78	58.67	70.67	94.33	106.67	57.10	17.07	21.20	33.36	92.03	2.75
G-79	60.33	75.33	99.00	112.00	66.64	26.61	21.37	49.56	94.27	3.61
G-80	53.33	69.67	93.33	114.33	61.61	21.58	22.40	44.37	92.47	4.75
G-81	55.00	69.67	93.33	115.00	68.02	27.99	22.23	26.38	82.93	5.18
G-82	58.67	70.33	95.67	112.67	67.53	27.50	21.50	44.32	89.73	2.58
G-83	57.67	71.67	95.33	109.33	69.47	29.44	22.60	29.50	91.87	4.55
G-84	56.67	69.33	93.33	109.67	64.74	24.71	22.40	25.14	101.16	1.95
G-85	63.00	76.33	100.00	113.00	62.83	22.80	22.00	33.22	82.57	4.53
G-86	62.67	79.00	102.33	116.00	60.22	20.19	22.43	31.34	98.17	4.01
G-87	62.00	79.00	103.33	116.00	58.83	18.80	22.50	19.80	90.87	2.21
G-88	64.00	79.33	103.67	116.00	55.85	15.82	22.04	22.59	92.80	2.75
G-89	55.33	70.67	97.33	110.00	63.33	23.30	21.47	23.51	91.60	3.21
G-90	69.33	85.33	108.00	117.67	68.33	28.30	21.13	27.25	106.53	1.98
G-91	67.33	82.67	104.33	119.67	63.61	23.58	21.10	15.54	88.77	2.71
G-92	70.00	87.67	110.00	118.67	70.33	30.30	21.60	40.33	84.17	3.58
G-93	62.00	77.00	101.00	110.67	64.64	24.61	22.20	24.85	107.33	4.48
G-94	57.33	72.33	96.00	109.00	77.28	37.25	22.37	23.62	91.87	4.51
G-95	59.33	71.00	96.00	110.67	77.83	37.80	21.63	16.49	93.43	2.51
G-96	57.00	69.33	96.00	109.67	67.51	27.48	21.67	24.65	95.77	2.91
G-97	69.67	83.33	103.00	113.33	66.62	26.59	22.87	18.47	88.07	3.68
G-98	57.67	70.00	96.67	108.00	67.89	27.86	22.13	31.73	82.80	3.61
G-99	62.67	70.33	95.33	107.67	67.90	27.87	21.30	22.69	93.90	3.01
G-100	60.33	71.33	96.33	109.33	65.83	25.80	21.67	30.46	85.73	2.65

Appendix-III Cont….

G.No.	No. of earsplant^{-1}	No. of spikeletsear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-1	2.56	16.10	8.60	1.79	42.71	26.59	15.59	39.93	6.70
G-2	3.40	15.01	7.30	1.96	41.71	33.62	16.89	43.34	7.84
G-3	3.73	19.23	9.40	1.97	63.71	21.25	15.79	46.59	7.92
G-4	2.67	14.05	5.80	2.30	32.71	34.98	13.58	51.03	7.44
G-5	3.57	15.33	7.30	2.00	26.71	46.31	17.79	46.24	9.01
G-6	4.87	16.21	8.30	1.87	46.71	26.72	18.55	49.78	10.26
G-7	3.27	16.13	8.50	1.81	46.71	31.91	17.65	48.41	8.81
G-8	2.37	17.31	7.70	2.15	21.71	59.88	13.89	37.08	5.94
G-9	2.97	15.13	6.50	2.22	37.71	40.25	15.23	34.97	5.77
G-10	2.87	16.05	7.20	2.13	28.71	45.09	16.15	40.48	7.44
G-11	2.53	15.13	7.50	1.92	34.71	46.29	14.97	39.80	6.56
G-12	2.93	15.05	9.20	1.56	51.71	39.29	18.08	52.87	10.85
G-13	3.30	18.15	8.60	2.03	50.71	32.58	19.01	52.39	10.28
G-14	3.37	17.15	8.50	1.93	40.71	43.15	16.38	47.37	7.93
G-15	5.30	15.15	8.10	1.78	33.71	43.32	24.18	40.19	12.92
G-16	3.27	19.23	9.30	1.88	83.71	39.25	23.10	44.55	10.94
G-17	2.90	17.21	8.50	1.94	48.71	40.31	15.04	38.23	6.69
G-18	3.40	18.03	8.40	2.06	49.71	35.70	18.91	38.17	9.30
G-19	2.80	19.77	9.33	1.99	58.71	35.57	16.03	37.90	7.38
G-20	4.90	18.25	10.10	1.74	49.71	35.13	24.01	47.93	13.08
G-21	2.83	18.00	7.10	2.48	35.71	39.69	16.37	42.11	7.12
G-22	2.47	18.15	7.20	2.43	46.71	45.19	16.05	40.57	6.70
G-23	4.17	15.25	6.10	2.38	34.71	34.25	17.60	44.94	8.78
G-24	2.40	17.21	7.50	2.20	35.71	39.04	13.75	35.48	6.50
G-25	2.70	17.10	7.70	2.17	42.71	34.43	14.54	37.49	6.02
G-26	3.50	19.67	8.47	2.17	64.71	34.48	18.23	48.21	9.42
G-27	4.37	16.10	8.50	1.83	43.71	42.04	18.71	35.49	9.29
G-28	3.00	19.70	9.00	2.05	46.71	38.49	16.75	44.26	7.74
G-29	4.13	18.03	8.00	2.20	48.71	38.45	20.40	31.05	10.28
G-30	5.37	14.25	6.60	2.05	33.71	45.34	21.43	51.87	12.32
G-31	6.10	17.51	7.70	2.18	44.71	38.24	24.00	35.16	11.86
G-32	3.10	19.25	8.30	2.23	50.71	41.88	17.85	44.65	8.27
G-33	4.30	15.00	6.40	2.29	35.71	37.32	19.59	52.76	10.71
G-34	3.17	19.79	9.50	1.97	57.71	33.32	17.65	47.42	8.64
G-35	6.17	19.93	8.30	2.22	61.71	30.58	23.93	48.14	11.81
G-36	2.93	14.13	6.90	1.94	34.71	44.90	15.35	38.71	6.11
G-37	5.17	13.43	6.20	2.05	32.71	44.46	17.51	63.18	10.99
G-38	3.17	15.51	7.20	2.05	40.71	36.23	16.04	40.20	6.66
G-39	4.77	14.11	8.00	1.67	36.71	37.37	16.14	44.68	7.46
G-40	4.37	13.49	6.30	1.99	32.71	32.11	17.10	44.53	7.82
G-41	3.10	13.57	6.90	1.83	30.71	24.98	14.35	39.03	5.71
G-42	4.77	18.90	8.70	1.99	60.71	45.40	17.09	45.85	8.11
G-43	5.97	17.11	8.70	1.88	47.71	36.56	22.83	60.12	14.18
G-44	4.90	18.35	9.50	1.86	51.71	27.89	18.83	51.16	9.91
G-45	4.27	15.23	5.40	2.97	37.71	40.07	16.82	36.50	7.96
G-46	4.13	18.70	8.40	2.08	61.71	32.81	18.26	36.20	8.48
G-47	3.77	14.51	9.10	1.52	36.71	31.86	16.84	40.04	7.49
G-48	4.13	18.05	8.10	2.14	49.71	39.30	17.15	33.83	7.80
G-49	2.73	19.25	8.60	2.16	49.71	44.54	15.35	41.79	7.04
G-50	4.57	16.51	6.70	2.36	42.71	28.96	18.41	42.49	8.20

Appendix-III Cont….

G.No.	No. of earsplant^{-1}	No. of Spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain weight(g)	Biological Yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-51	3.00	15.15	6.90	2.09	34.71	37.20	14.77	40.02	6.02
G-52	4.57	19.57	9.40	1.97	55.71	35.89	20.02	50.98	10.66
G-53	3.30	14.00	6.90	1.97	29.71	58.57	17.77	44.76	8.29
G-54	4.57	18.47	9.80	1.70	64.71	38.13	19.45	50.67	10.26
G-55	3.37	13.78	9.00	1.38	17.71	54.91	17.82	47.83	8.80
G-56	3.57	15.21	8.30	1.75	38.71	50.62	17.95	45.83	8.52
G-57	4.63	18.70	8.60	2.05	56.71	50.91	24.93	43.32	11.65
G-58	3.77	15.15	8.40	1.72	38.71	52.40	17.46	47.19	8.51
G-59	3.00	18.37	7.20	2.41	53.71	42.74	17.21	42.93	7.66
G-60	4.07	18.93	8.80	2.01	50.71	35.96	17.81	48.47	8.92
G-61	4.57	19.37	7.10	2.58	51.71	36.20	19.09	45.16	9.07
G-62	2.93	17.12	7.20	2.31	49.71	42.54	17.17	44.11	7.85
G-63	3.37	16.15	8.10	1.91	38.71	40.85	18.88	46.34	9.12
G-64	3.30	18.40	6.90	2.56	56.71	40.97	18.07	43.50	8.21
G-65	3.50	19.74	8.20	2.25	56.71	37.82	17.49	45.26	8.19
G-66	3.47	19.99	8.00	2.32	66.71	25.42	17.81	46.10	8.52
G-67	3.60	16.53	7.50	2.11	43.71	41.81	16.88	42.91	7.49
G-68	4.23	19.13	7.60	2.42	50.71	36.44	19.98	45.17	9.52
G-69	3.40	17.15	7.60	2.17	56.71	34.60	19.45	45.20	9.23
G-70	5.43	16.11	7.30	2.11	38.71	45.22	21.89	58.08	13.16
G-71	3.90	15.15	6.40	2.26	30.71	53.65	17.48	40.88	7.66
G-72	3.57	14.00	6.80	2.00	36.71	31.47	16.68	38.85	6.76
G-73	4.37	18.13	9.30	1.87	47.71	41.77	20.25	45.65	9.74
G-74	4.30	16.43	8.50	1.85	37.71	35.33	17.33	43.41	7.82
G-75	3.00	15.73	7.50	2.08	42.71	34.72	15.78	41.84	6.80
G-76	3.97	17.31	8.30	2.00	50.71	49.26	21.09	44.76	10.01
G-77	3.90	19.63	7.40	2.52	63.71	38.34	17.18	47.89	8.46
G-78	4.13	18.97	9.10	1.92	49.71	39.39	19.05	46.56	9.27
G-79	5.50	19.52	8.50	2.18	56.71	44.32	23.52	53.00	13.24
G-80	6.90	20.11	9.10	2.05	50.71	32.10	28.69	37.26	11.62
G-81	3.93	18.87	9.80	1.81	57.71	51.54	18.49	46.03	8.84
G-82	5.77	18.77	9.47	1.95	69.71	36.54	29.17	34.00	11.10
G-83	3.50	18.90	9.77	1.80	60.71	39.79	18.31	46.15	8.77
G-84	7.37	18.12	8.90	2.00	53.71	44.69	23.60	48.61	12.01
G-85	4.57	16.11	7.50	2.05	46.71	47.19	19.99	38.78	8.10
G-86	3.37	15.31	8.70	1.68	28.71	48.58	18.37	39.54	7.52
G-87	3.57	18.33	7.50	2.35	41.71	22.09	17.41	37.23	6.66
G-88	4.50	19.47	9.70	1.88	54.71	33.09	23.11	43.68	10.68
G-89	2.47	18.97	9.20	2.00	42.71	34.04	14.96	40.44	6.05
G-90	3.50	19.37	9.00	2.06	64.71	44.04	20.03	41.45	8.68
G-91	4.70	19.20	8.40	2.21	63.71	28.47	19.19	50.61	10.07
G-92	5.50	15.23	8.40	1.73	37.71	39.26	21.73	47.16	10.84
G-93	5.57	16.25	8.20	1.89	43.71	43.87	23.41	42.36	10.63
G-94	3.77	16.33	9.00	1.73	43.71	55.85	18.47	46.66	8.94
G-95	3.50	18.25	8.50	2.06	54.71	41.09	16.03	45.64	7.48
G-96	4.10	18.35	8.80	2.01	56.71	25.51	19.82	48.24	9.99
G-97	4.00	16.35	8.50	1.84	38.71	31.53	16.47	45.34	7.65
G-98	3.90	17.43	8.30	2.01	51.71	33.33	19.41	47.02	9.55
G-99	3.13	17.41	8.57	1.93	58.71	39.29	15.77	43.97	7.92
G-100	4.90	15.45	9.60	1.54	30.71	37.60	21.33	34.93	11.91

Appendix-IV

Mean value of phenological, physiological and yield contributing traits (Pooled)

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^oC)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-1	61.89	73.89	103.33	112.00	75.29	30.29	19.03	65.52	90.89	3.87
G-2	57.11	72.22	101.67	109.89	76.36	31.36	17.96	47.20	95.28	3.87
G-3	58.33	72.44	100.78	110.44	82.39	37.39	18.57	50.82	99.17	3.27
G-4	56.22	68.33	99.67	110.89	79.77	34.77	20.77	58.60	92.77	3.03
G-5	57.89	74.22	102.78	113.67	83.46	37.38	19.66	52.43	94.24	4.40
G-6	58.11	72.22	99.67	110.44	80.84	34.34	20.23	48.42	94.44	3.54
G-7	61.11	78.22	104.89	113.00	70.72	25.72	20.19	41.70	95.42	3.87
G-8	59.44	77.11	105.67	112.33	77.79	32.79	20.12	48.74	87.32	3.20
G-9	59.78	75.89	102.89	112.00	86.00	41.00	20.59	40.01	98.48	3.80
G-10	61.33	76.89	104.67	113.67	79.01	34.01	20.66	43.17	85.57	4.60
G-11	60.22	75.22	103.11	113.33	86.64	42.86	19.94	34.12	92.99	4.87
G-12	60.11	79.00	103.56	115.78	80.71	35.71	19.64	40.62	90.00	4.43
G-13	55.78	73.33	99.56	113.78	79.06	34.06	20.61	54.03	102.40	5.10
G-14	63.22	80.44	108.11	116.33	74.84	29.84	19.62	63.28	87.88	4.40
G-15	60.56	75.89	102.89	113.67	87.41	42.41	19.24	58.66	95.09	5.44
G-16	63.33	78.33	104.44	116.33	72.86	27.86	19.16	58.41	87.30	4.40
G-17	59.22	73.78	101.44	115.56	75.19	30.19	19.78	59.79	90.03	3.89
G-18	56.67	73.22	101.44	114.78	77.27	32.27	19.68	62.00	93.03	4.60
G-19	52.67	70.33	98.89	108.00	76.91	31.91	20.16	53.05	96.79	4.29
G-20	57.22	73.89	102.56	115.00	78.96	33.96	19.69	33.85	88.31	4.00
G-21	53.00	69.22	101.00	107.56	77.45	32.45	19.02	55.25	90.39	4.07
G-22	55.11	71.56	99.67	106.67	80.15	35.15	19.01	66.07	91.51	3.93
G-23	59.56	76.44	104.89	112.78	79.05	34.05	19.03	57.53	90.48	4.20
G-24	53.89	68.67	97.00	107.78	82.70	37.70	19.49	52.83	90.50	4.80
G-25	51.67	72.78	100.78	108.67	77.67	32.67	19.78	53.34	93.18	4.33
G-26	56.22	70.78	98.78	108.33	75.09	30.09	19.67	54.09	95.21	4.47
G-27	53.00	68.89	97.00	108.00	76.95	31.95	20.17	58.33	89.99	5.93
G-28	56.44	71.44	100.00	111.33	77.39	32.39	19.31	49.26	92.08	5.92
G-29	60.22	78.11	106.67	113.67	69.51	24.51	19.34	44.55	97.81	4.20
G-30	61.33	78.56	103.44	115.44	76.39	31.39	19.30	42.07	99.08	3.93
G-31	60.44	78.00	103.89	113.67	82.29	37.29	18.97	49.58	99.28	5.73
G-32	59.33	73.56	101.89	111.89	81.95	36.95	18.80	39.84	93.27	4.34
G-33	57.56	69.56	99.56	108.22	79.42	34.42	19.33	48.27	87.26	4.13
G-34	54.11	72.67	99.33	110.00	77.72	32.72	20.22	47.59	93.06	4.16
G-35	51.00	65.33	93.22	104.89	81.87	36.87	20.43	38.15	93.37	3.30
G-36	51.11	67.67	93.56	108.11	78.64	33.64	19.82	38.49	98.33	3.81
G-37	51.44	64.33	89.33	107.78	78.21	33.21	20.60	43.26	97.68	3.02
G-38	50.00	64.67	88.78	106.78	80.99	35.99	21.13	37.19	86.61	3.43
G-39	52.78	68.33	91.44	108.11	81.91	36.91	20.74	37.73	89.81	4.17
G-40	55.00	69.89	94.22	106.00	68.82	23.82	20.06	26.12	94.49	4.04
G-41	53.00	70.67	93.78	108.00	74.30	29.30	21.40	31.72	86.27	3.51
G-42	54.22	70.33	93.33	109.00	85.07	40.07	21.57	28.12	94.06	2.96
G-43	54.56	69.67	93.22	107.00	78.27	33.27	21.53	24.83	89.08	4.24
G-44	54.22	69.33	91.89	108.33	79.48	34.48	21.24	22.43	86.88	4.92
G-45	59.11	74.11	99.11	109.00	80.37	35.37	21.44	24.43	89.43	4.51
G-46	44.33	61.33	90.33	108.00	81.41	36.41	21.29	41.36	92.12	4.06
G-47	58.67	73.00	99.78	109.33	74.33	29.33	20.89	39.37	98.06	4.38
G-48	56.00	69.67	91.78	107.11	81.32	36.32	20.86	46.33	87.26	5.10
G-49	57.33	73.00	95.78	108.78	76.27	31.27	21.13	45.70	88.63	4.06
G-50	58.11	71.33	93.89	107.78	71.00	26.00	20.47	45.86	85.79	3.94

Appendix-IV Cont….

G.No.	Days to full stem elongation	Days to 50% flowering	Days to Stay green	Days to maturity	RWC of flag leaf (%)	Chloro-phyll content	Canopy tempe-rature (^{o}C)	Membrane thermo-stability	Plant height (cm)	No. of Effective tillers plant^{-1}
G-51	50.00	65.56	92.67	106.78	77.95	32.95	20.56	43.67	91.77	3.92
G-52	47.56	64.00	89.78	105.33	75.94	30.94	21.36	37.33	91.19	3.79
G-53	53.67	67.67	94.00	109.22	75.84	30.84	21.20	28.93	93.40	3.86
G-54	50.22	66.00	90.44	105.89	77.43	32.43	20.31	31.54	83.88	3.93
G-55	47.00	64.00	91.44	107.78	78.94	33.94	20.60	50.19	90.21	3.57
G-56	54.78	68.00	95.56	110.78	78.25	33.25	20.07	45.59	89.02	3.48
G-57	49.11	63.67	91.56	104.44	82.09	37.09	20.13	45.15	89.60	4.28
G-58	46.00	65.33	91.44	106.22	76.28	31.28	21.18	30.47	92.62	3.64
G-59	49.78	63.67	93.22	107.44	73.38	28.38	20.91	37.39	92.87	3.24
G-60	48.22	64.00	95.11	108.33	75.95	30.95	21.19	45.44	90.97	5.20
G-61	49.67	63.00	94.89	107.67	77.78	32.78	20.49	38.33	93.20	3.71
G-62	54.56	71.00	92.11	108.33	71.16	26.16	20.48	33.46	90.92	4.34
G-63	54.89	71.00	95.33	108.56	73.03	28.03	20.31	29.79	98.67	3.33
G-64	58.44	73.89	95.56	108.56	76.72	31.72	19.56	32.25	96.70	4.28
G-65	49.89	63.67	90.44	107.33	84.74	39.74	19.92	26.93	93.48	4.00
G-66	55.33	67.33	93.00	110.44	78.00	33.00	20.44	29.64	87.14	4.12
G-67	55.78	71.67	96.44	111.44	69.58	28.09	21.11	35.77	93.40	3.78
G-68	62.78	74.67	98.67	111.56	56.66	22.19	21.16	33.01	93.38	2.57
G-69	59.89	74.56	100.00	111.67	62.99	28.52	19.91	29.06	91.32	3.50
G-70	59.00	70.11	94.22	106.67	67.33	32.86	21.02	34.25	97.08	2.24
G-71	57.44	70.44	94.56	107.11	69.17	34.70	21.48	41.85	85.56	2.58
G-72	63.33	78.89	102.78	115.67	69.43	34.96	21.84	36.69	91.57	3.50
G-73	59.33	71.89	95.78	110.56	63.57	29.10	21.49	25.80	92.76	2.61
G-74	62.56	79.56	102.00	115.56	62.30	27.83	22.28	26.06	85.27	3.06
G-75	60.00	76.44	100.33	114.67	70.86	36.39	22.09	33.01	86.57	2.94
G-76	63.78	77.89	101.78	115.56	68.73	34.26	22.30	23.06	93.49	3.32
G-77	61.78	76.22	100.11	113.00	67.93	33.46	22.06	24.82	82.67	4.57
G-78	66.00	81.22	102.56	116.00	72.04	33.86	21.99	21.40	87.07	2.80
G-79	57.00	73.56	96.89	108.78	69.83	29.80	22.41	28.35	88.22	3.82
G-80	63.33	79.78	100.89	114.22	66.73	26.70	22.13	39.93	99.12	3.58
G-81	65.00	79.44	103.44	115.89	66.67	26.64	22.28	45.63	83.42	3.89
G-82	64.56	78.67	100.89	114.11	71.16	31.13	22.52	47.72	92.28	3.80
G-83	65.89	78.22	102.00	115.44	60.73	20.70	22.42	33.91	86.18	3.10
G-84	62.56	76.33	99.78	114.33	64.55	24.52	22.34	46.79	85.48	3.51
G-85	55.11	70.11	94.11	109.33	64.70	24.67	22.40	36.04	91.30	3.13
G-86	52.67	69.44	95.22	111.22	65.88	25.85	22.54	37.29	90.66	3.43
G-87	63.33	77.67	101.56	112.67	67.54	27.51	21.46	20.20	88.06	3.17
G-88	54.78	69.22	98.44	106.67	66.49	26.46	21.72	48.12	88.92	2.76
G-89	62.56	77.11	102.67	111.78	69.86	29.83	20.56	46.86	88.39	2.81
G-90	57.78	71.89	95.78	108.56	68.30	28.27	20.38	44.79	86.52	3.63
G-91	53.67	69.56	95.44	106.89	69.96	29.93	21.57	30.85	91.04	2.84
G-92	57.33	71.44	95.56	110.44	64.54	24.51	21.89	35.98	92.41	2.77
G-93	57.44	71.89	95.22	111.00	61.78	21.75	21.66	46.73	92.92	3.72
G-94	57.11	70.56	94.78	112.33	68.34	28.31	22.11	37.70	87.07	4.12
G-95	60.78	74.89	98.56	112.89	62.60	22.57	22.28	34.20	92.34	3.52
G-96	60.44	76.33	101.44	114.00	59.34	19.31	22.00	27.38	91.76	2.74
G-97	68.89	85.22	107.44	118.67	67.42	27.39	21.28	32.01	94.27	2.78
G-98	59.56	73.44	97.67	111.00	73.25	33.22	22.07	25.95	97.10	3.86
G-99	61.44	74.22	98.56	110.56	67.34	27.31	22.22	29.25	87.77	3.42
G-100	61.22	75.22	98.56	110.67	68.20	28.17	21.57	29.54	92.89	3.47

Appendix-IV Cont….

G. No.	No. of earsplant^{-1}	No. of Spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain Weight (g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-1	3.64	19.04	10.23	1.87	54.97	31.27	20.56	43.12	7.22
G-2	3.91	17.37	8.37	2.17	41.39	40.08	22.39	45.76	8.85
G-3	3.19	18.36	8.80	2.10	41.27	44.97	20.09	40.39	6.67
G-4	2.87	17.59	9.20	2.01	44.27	48.55	20.17	42.76	7.87
G-5	4.24	19.00	10.23	1.86	47.60	44.03	24.27	47.94	11.04
G-6	3.46	20.52	9.97	2.07	66.60	42.78	23.52	46.99	9.38
G-7	3.78	21.18	10.73	2.02	53.93	41.32	23.12	43.02	9.70
G-8	3.13	19.04	8.17	2.33	44.93	43.61	20.43	41.49	7.00
G-9	3.78	20.21	10.23	1.99	56.27	41.10	22.06	46.78	8.63
G-10	4.51	19.90	9.10	2.17	48.93	45.13	24.48	49.36	10.78
G-11	4.76	19.53	8.70	2.25	49.60	43.27	24.16	48.84	10.83
G-12	4.36	20.51	9.47	2.19	57.27	40.39	24.17	47.20	10.24
G-13	4.71	16.51	8.37	1.99	42.60	43.47	21.65	43.84	8.00
G-14	4.09	17.82	8.53	2.07	47.27	38.29	21.41	43.44	7.66
G-15	5.33	19.49	10.20	1.90	51.60	38.96	25.24	49.38	11.05
G-16	4.29	19.81	9.77	2.04	55.27	38.78	22.20	46.88	8.60
G-17	3.73	19.14	8.63	2.22	48.26	41.02	20.73	43.63	7.44
G-18	4.51	20.84	9.93	2.09	55.93	45.93	24.44	49.39	10.78
G-19	4.22	18.06	9.87	1.83	43.60	56.27	26.14	47.67	10.64
G-20	3.93	20.34	9.37	2.18	53.60	47.82	23.07	46.54	8.89
G-21	3.98	20.12	8.70	2.60	52.60	43.99	24.11	47.19	9.68
G-22	3.76	23.06	8.93	2.58	65.93	38.86	22.25	49.07	8.98
G-23	4.07	19.81	8.80	2.25	56.27	41.74	23.40	49.42	9.71
G-24	4.67	17.44	8.07	2.15	41.27	47.57	23.37	50.22	9.93
G-25	4.24	19.07	9.67	1.98	48.60	41.39	21.94	48.30	8.79
G-26	4.36	21.79	10.47	2.08	60.60	46.44	23.28	51.93	10.10
G-27	5.81	23.17	11.10	2.18	60.93	46.78	28.03	57.64	14.14
G-28	5.87	22.21	11.10	2.00	67.27	44.46	32.18	55.12	16.71
G-29	4.20	18.74	9.13	2.12	44.93	43.40	22.89	48.66	9.69
G-30	3.80	22.67	10.53	2.20	58.90	41.18	23.59	50.30	10.24
G-31	5.62	20.23	9.57	2.41	54.27	40.69	26.06	56.11	12.48
G-32	4.16	19.82	10.00	2.21	57.60	43.07	22.52	49.29	9.25
G-33	4.03	19.28	10.17	1.90	55.70	38.82	23.25	44.46	8.49
G-34	3.57	16.71	9.07	1.91	41.49	35.76	19.00	44.03	8.43
G-35	2.90	16.30	8.30	2.04	42.77	37.08	15.09	49.20	7.42
G-36	3.29	16.67	8.40	2.00	40.10	42.27	16.66	45.64	7.97
G-37	2.30	15.48	7.30	2.15	35.43	47.85	14.15	46.88	6.57
G-38	2.63	16.87	9.60	1.76	49.43	41.75	18.12	45.51	8.47
G-39	3.38	17.84	8.87	2.01	57.10	44.52	19.11	43.79	8.42
G-40	3.37	19.03	10.17	1.89	54.43	38.71	18.19	48.19	8.81
G-41	2.63	17.26	7.03	2.43	40.77	43.03	16.73	43.57	7.27
G-42	2.28	18.50	8.90	2.10	49.43	39.09	15.81	43.06	6.96
G-43	3.48	18.32	8.73	2.08	48.10	42.98	17.99	42.70	8.50
G-44	4.41	17.08	7.77	2.20	44.77	45.32	18.66	49.61	9.16
G-45	4.17	18.94	8.30	2.28	53.43	36.81	19.07	46.79	8.66
G-46	3.68	14.56	7.00	2.08	37.77	45.39	15.81	46.20	7.64
G-47	3.74	14.03	7.30	1.94	35.10	34.36	14.72	41.40	6.92
G-48	4.52	18.64	9.80	1.94	55.10	39.66	19.12	43.60	8.36
G-49	3.57	16.79	8.37	2.01	47.10	37.86	17.00	47.59	8.12
G-50	3.41	18.02	8.03	2.26	49.10	40.70	16.34	40.74	6.61

Appendix-IV Cont….

G.No.	No. of earsplant^{-1}	No. of Spikelets ear^{-1}	Length of ear (cm)	Spike density	No. of Grains ear^{-1}	1000 grain Weight (g)	Biological yield plant^{-1}(g)	Harvest index (%)	Grain yield plant^{-1}(g)
G-51	3.28	16.58	7.97	2.05	41.77	44.70	16.57	39.61	6.41
G-52	3.50	16.96	9.27	1.81	42.10	51.67	17.15	44.64	7.61
G-53	3.46	17.96	8.30	2.18	51.43	52.51	18.82	39.05	7.02
G-54	3.48	19.18	7.93	2.43	52.43	41.58	17.28	42.45	7.23
G-55	3.06	18.89	7.97	2.36	52.43	43.38	16.73	44.42	7.28
G-56	3.36	19.01	7.93	2.40	55.43	37.75	17.02	44.75	7.48
G-57	3.91	16.21	7.33	2.21	43.77	48.18	18.50	38.72	7.07
G-58	3.74	16.24	8.43	1.93	42.43	39.25	16.43	40.03	6.43
G-59	3.28	17.79	8.93	1.96	54.10	44.10	16.48	46.41	7.42
G-60	5.17	20.71	9.87	2.07	54.10	41.80	22.20	42.99	9.50
G-61	3.91	20.00	10.40	1.86	64.43	46.23	19.91	43.18	8.13
G-62	4.19	16.54	8.60	1.92	44.77	50.67	23.08	33.89	7.34
G-63	3.33	19.40	9.03	2.14	48.10	32.61	17.67	46.30	8.13
G-64	3.98	18.42	8.83	2.05	57.10	39.89	18.88	42.22	7.80
G-65	3.76	17.13	8.80	1.94	49.10	50.75	18.14	45.43	7.99
G-66	3.67	17.51	8.77	2.00	50.77	32.98	17.90	43.17	7.67
G-67	3.30	16.70	9.56	1.71	45.19	36.71	17.69	46.19	8.60
G-68	3.27	16.10	7.50	2.08	46.03	29.95	15.4178.	46.98	7.73
G-69	3.90	15.90	8.03	1.89	40.03	34.98	18.00	48.14	9.36
G-70	2.73	16.17	7.13	2.17	29.37	48.40	15.09	37.51	6.38
G-71	2.92	16.10	8.43	1.84	45.70	39.39	17.35	48.36	9.23
G-72	3.98	17.17	8.63	1.87	52.70	41.90	18.98	44.03	10.60
G-73	3.03	18.34	8.74	2.00	52.37	37.19	20.77	38.10	7.79
G-74	3.40	18.12	8.13	2.22	44.03	40.00	19.65	43.54	8.97
G-75	3.09	16.52	7.10	2.25	37.70	35.90	16.67	39.30	7.10
G-76	3.62	18.49	8.66	2.02	51.70	38.33	15.51	42.65	8.82
G-77	5.20	16.60	7.43	2.15	42.37	40.67	18.62	39.36	11.49
G-78	3.52	18.00	8.07	2.16	48.03	37.50	21.10	48.27	9.21
G-79	4.76	15.83	7.13	2.07	43.03	39.98	20.39	50.01	9.64
G-80	4.10	14.38	7.17	1.91	36.70	35.23	16.30	43.14	7.31
G-81	4.61	16.53	8.10	1.90	46.37	35.64	15.86	48.33	9.33
G-82	4.43	17.42	7.77	2.30	50.37	33.59	19.58	41.28	8.78
G-83	3.54	17.27	8.60	1.94	45.37	38.56	17.31	38.55	7.44
G-84	4.04	17.08	7.67	2.14	44.37	34.01	16.97	44.49	8.29
G-85	3.74	15.42	8.57	1.68	37.37	50.53	18.35	47.75	9.12
G-86	3.99	16.36	8.43	1.84	44.70	51.31	20.11	45.45	9.56
G-87	3.88	18.89	7.70	2.33	52.03	38.30	18.04	45.52	8.55
G-88	3.20	17.21	7.40	2.26	48.37	41.45	18.04	44.65	8.39
G-89	3.52	18.76	7.90	2.23	55.70	35.01	17.40	44.76	8.07
G-90	4.36	17.47	7.50	2.23	48.70	38.75	20.44	49.48	10.64
G-91	3.94	15.76	7.50	2.04	38.37	42.29	18.14	41.79	8.05
G-92	3.76	16.50	8.10	1.98	43.70	39.77	18.07	43.34	8.21
G-93	4.51	19.38	8.33	2.20	56.70	40.68	19.92	49.15	10.32
G-94	5.53	19.24	9.46	1.94	59.37	40.06	25.45	39.10	10.52
G-95	5.14	17.71	8.72	1.95	53.70	43.89	20.63	44.51	9.63
G-96	3.81	17.71	8.63	1.97	41.70	34.58	19.63	40.15	8.29
G-97	3.56	19.18	8.87	2.09	57.03	35.51	18.06	44.17	8.27
G-98	4.94	15.93	8.53	1.79	41.70	46.32	21.20	45.39	10.14
G-99	3.87	17.63	8.60	1.97	50.03	32.71	17.44	46.41	8.37
G-100	3.98	16.77	8.82	1.83	47.03	36.74	18.84	41.97	9.79

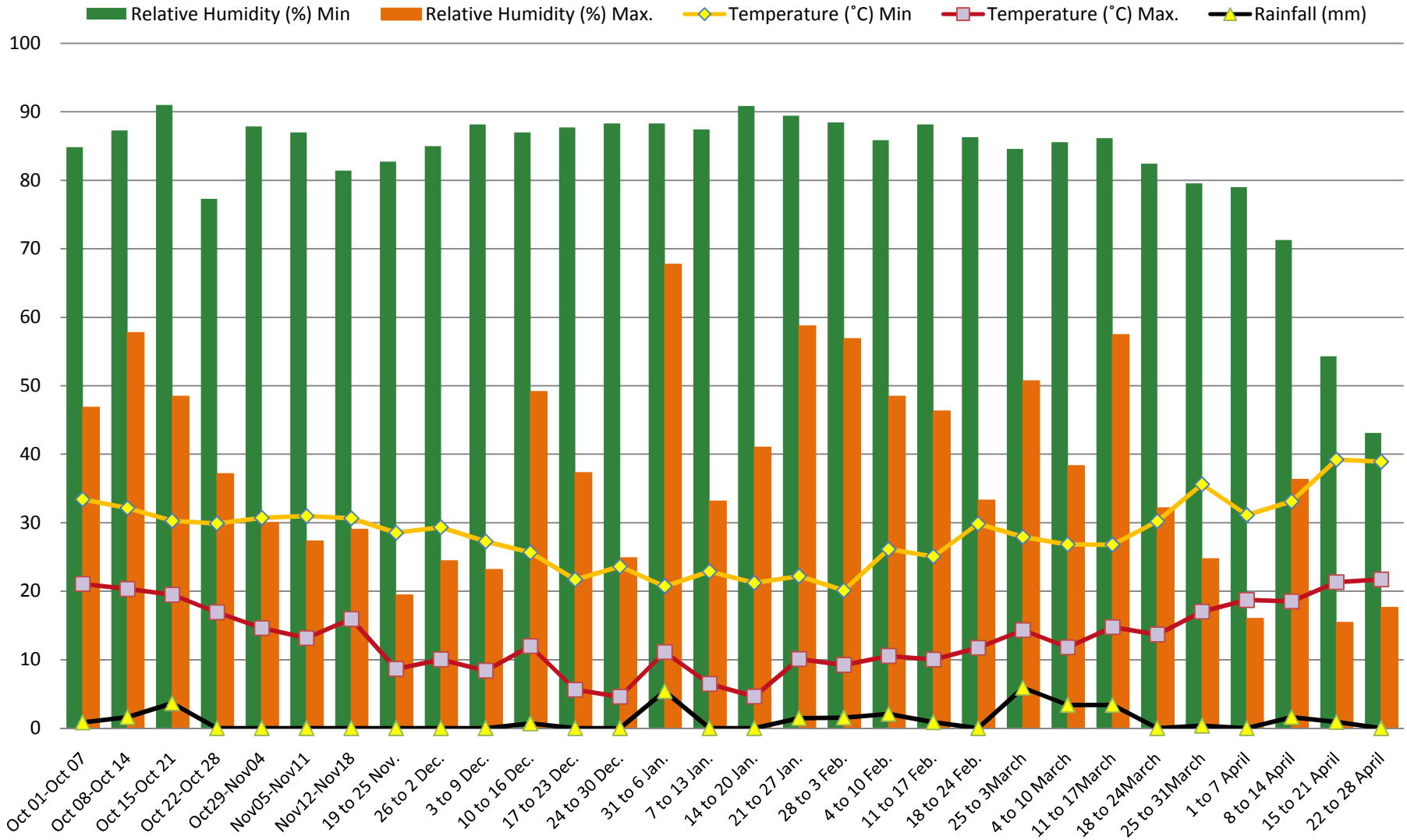


Fig. 1: Weekly meteorological data during the cropping season (2014-2015)

Fig. 5:- Genotypic and Phenotypic Path Diagram showing direct and indirect effect on grain yield via phenological, physiological and yield constituting traits (Pooled)

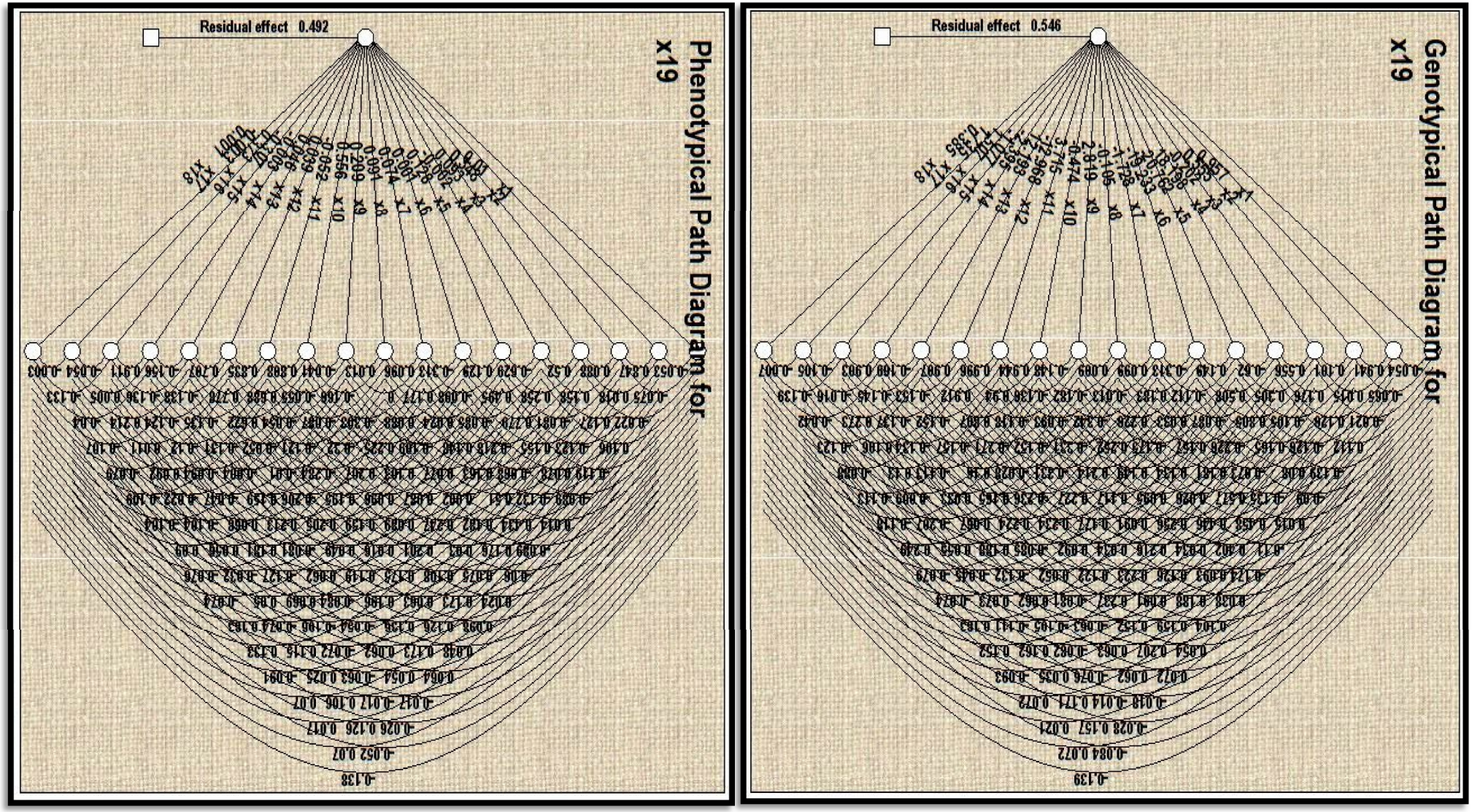


Fig. 4:- Genotypic and Phenotypic Path Diagram showing direct and indirect effect on grain yield via phenological, physiological and yield constituting traits (E_3)

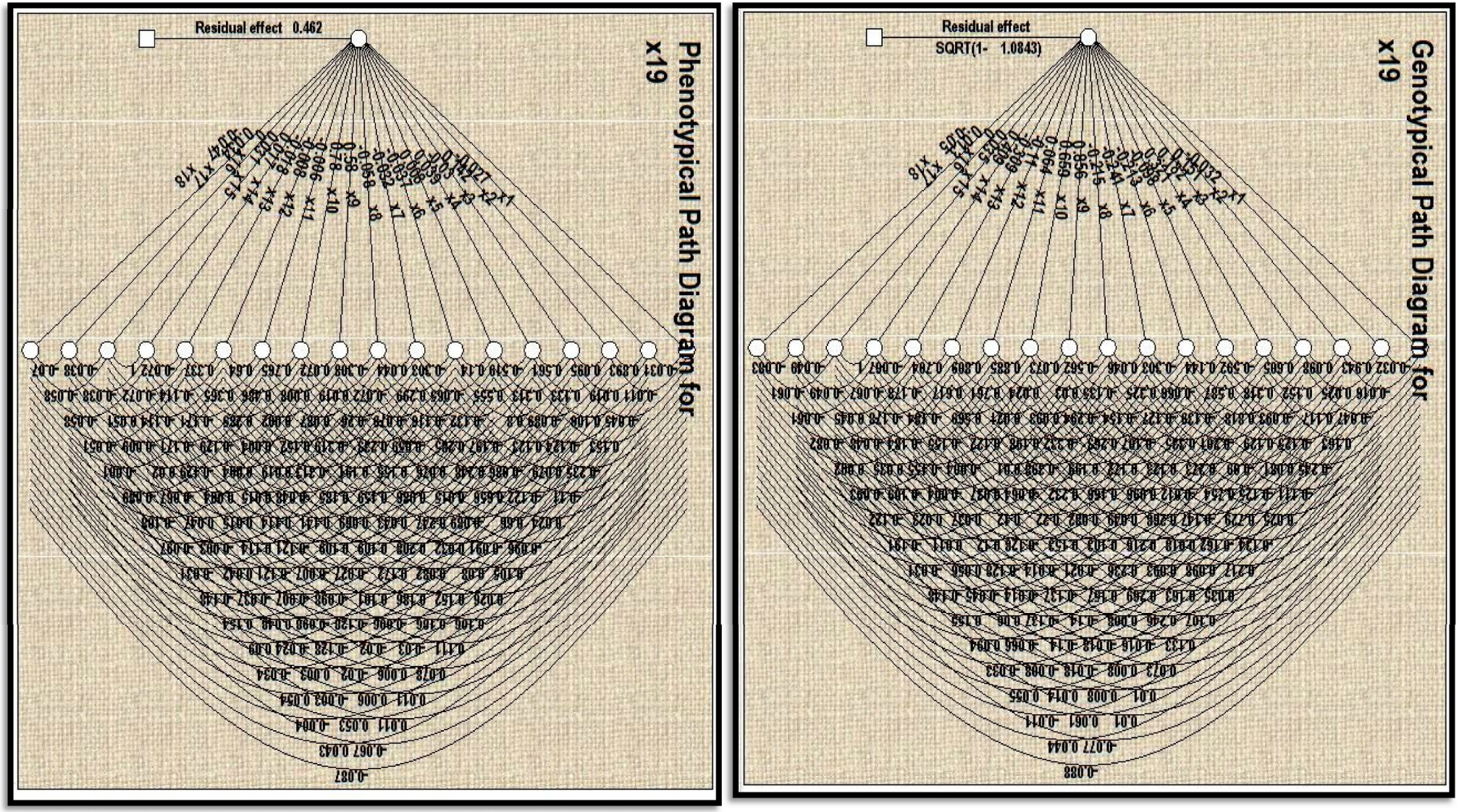


Fig. 3:- Genotypic and Phenotypic Path Diagram showing direct and indirect effect on grain yield via phenological, physiological and yield constituting traits (E_2)

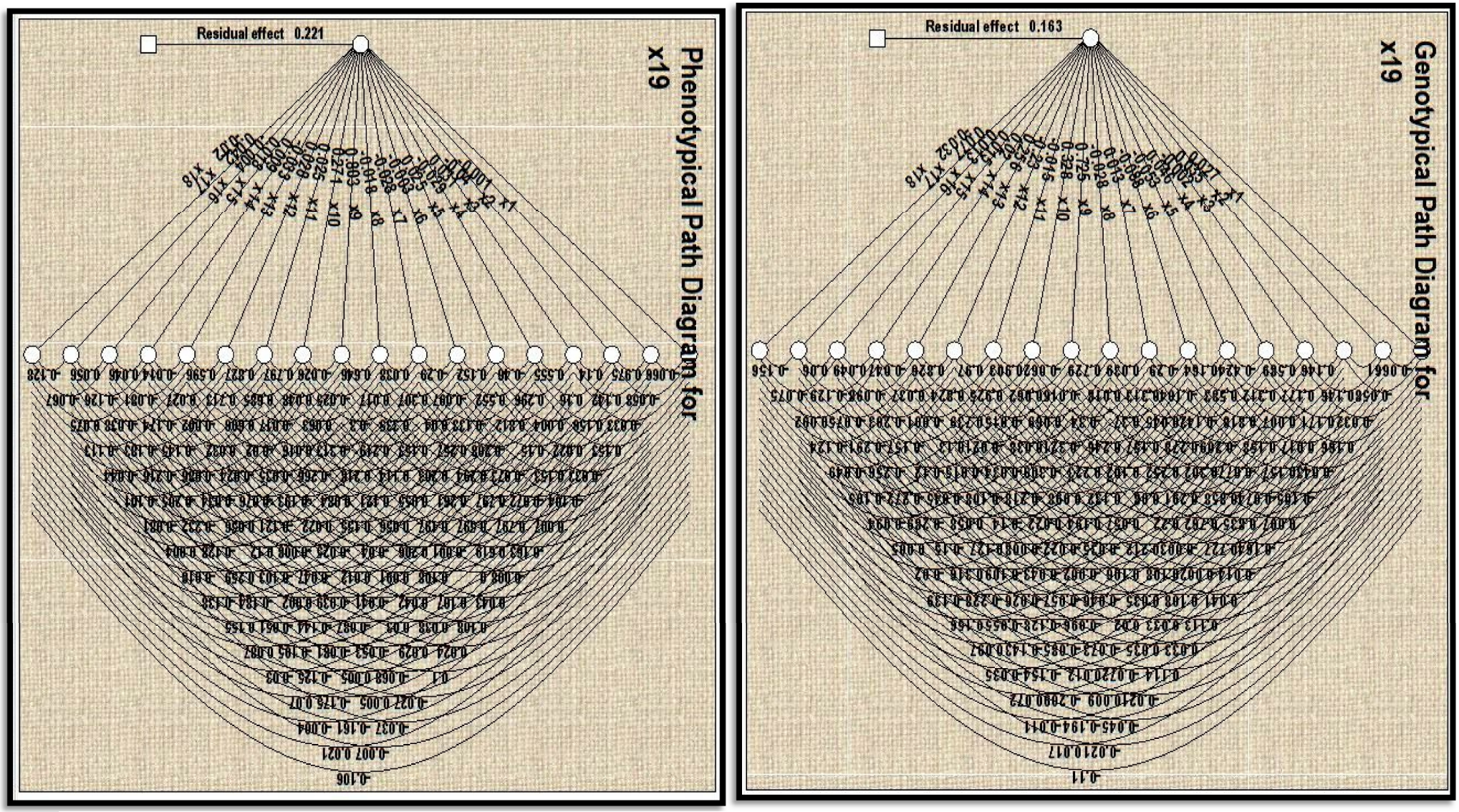


Fig. 2:- Genotypic and Phenotypic Path Diagram showing direct and indirect effect on grain yield via phenological, physiological and yield constituting traits (E_1)

ABSTRACT

Bread Wheat (*Triticum aestivum* L.) is the world's second most important staple food crop for more than 35 percent of world's population next to the rice. It produces about 20% food resources of the world, high productivity and the prominent position. Currently irregularity in monsoon, distribution of rainfall and global warming creates great problem in form of drought and heat stress at the time of wheat production. Global warming is predicted to increase the frequency and severity of heat stress leading to drastic reduction in the food production (Talukder et al. 2014).

The experiment consists of 89 uniform wheat lines of advance generation including 11 checks. The sowing was done in three environment, irrigated timely sown (E_1), restricted irrigated (E_2) and rainfed sowing (E_3). In the experiment randomized block design with three replications was used. The present studies included estimation of genetic variability, heritability (broad sense), genetic advance as percentage of mean, correlation analysis (genotypic and phenotypic) and path coefficient analysis.

The analysis variance for three environment including pooled environment revealed highly significant differences larger differences in phenotypic and genotypic variances grain yield per plant, harvest index, number of ears, per plant, number of grains per ear, number of effective tillers per plant, chlorophyll content, 1000-grain weight, biological yield per plant, membrane thermo-stability, spike density, length of ear plant height, number of spikelets per ear, days to full stem elongation indicated the substantial influence of pooled environment whereas days to 50% flowering, RWC of flag leaf, days to stay green, days to maturity, canopy temperature.

On the basis of performance of different genotypes of advance generation, out of 89 genotypes twelve (G-13, G-15, G-20, G-30, G-31, G-35, G-43, G-79, G-80, G-82, G-88, G-100) were recorded high grain yield as compare to best check K307 under all three environments.

Heritability and genetic advance as per mean exhibited high for number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight,

biological yield per plant, harvest index, membrane thermo-stability, chlorophyll content that indicate selection of such traits in all tree environments may be effective. While, grain yield revealed high heritability with high genetic advance as per mean indicated good response to selection

Grain yield per plant recorded significant positive correlation with number of effective tillers per plant, number of ears per plant, number of spikelets per ear, length of ear, number of grains per ear, biological yield per plant, harvest index in both environment including pooled environment. However, plant height and canopy temperature was significant negative association with grain yield per plant in first environment. Spike density and 1000-grain weight had significant negative association with grain yield per plant in second environment. However, spike density was observed significant negatively correlated with grain yield per plant in third environment. While canopy temperature noticed significant and negative correlation with grain yield per plant in pooled environment.

Path efficient analysis revealed that canopy temperature, number of effective tillers per plant, biological yield per plant exhibited high direct effect on grain yield in all three environments including pooled environment. The effects of these characters were further increased by positive indirect effect days to 50% flowering, days to stay green, days to maturity, RWC of flag leaf, chlorophyll content, membrane thermo-stability, plant height, number of ears per plant, number of spikelets per ear, length of ear, spike density, number of grains per ear, 1000-grain weight, harvest index.

Stability analysis for different genotypes revealed that variation due to genotype x environment (linear) was found significant for different characters except ear length, 1000-grain weight, biological yield per plant and membrane thermo-stability. Genotypes G-27, G-4, G-36, G-37, G-6, G-30, G-87, G-7, G-100, G-43 exhibited regression coefficient equal to unity (or close to unity) with greater mean value to grand mean and deviation from regression was equal to zero (or close to zero), revealed that the genotype give stable performance in all situations.

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The author of this thesis Mr. Pankaj Bisen, S/o Shri. Amirchand Bisen and Smt. Rekha Bisen was born on 25th September 1988 at Balaghat (M.P.). The author joined the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh in the year 2009 and completed the B.Sc. (Ag.) degree in the year 2013 with first division. Subsequently after graduation the author completed the M.Sc. (Ag.) degree with first division (OGPA) in the year 2014-15.

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4	10th	MP BOARD	2004

Scientific interests

a. Molecular Breeding
b. Plant Physiology
c. Research and Development

Awards

For the partial fulfilment of the master's degree programme she was allotted a research problem on **"Genetic Analysis in Bread Wheat under different Environments"** which was successfully conducted by him and being submitted in the form of the thesis.