

Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 21(3) September-December 2023]

Pantnagar Journal of Research

(Formerly International Journal of Basic and
Applied Agricultural Research ISSN : 2349-8765)



G.B. Pant University of Agriculture & Technology, Pantnagar



ADVISORYBOARD

Patron

Dr. Manmohan Singh Chauhan, Vice-Chancellor, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Members

Dr. A.S. Nain, Ph.D., Director Research, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. Jitendra Kwatra, Ph.D., Director, Extension Education, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. S.K. Kashyap, Ph.D., Dean, College of Agriculture, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. S.P. Singh, Ph.D., Dean, College of Veterinary & Animal Sciences, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. K.P. Raverkar, Ph.D., Dean, College of Post Graduate Studies, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. Sandeep Arora, Ph.D., Dean, College of Basic Sciences & Humanities, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. Alknanda Ashok, Ph.D., Dean, College of Technology, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. Alka Goel, Ph.D., Dean, College of Community Science, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. Malobica Das Trakroo, Ph.D., Dean, College of Fisheries, G.B. Pant University of Agri. & Tech., Pantnagar, India
Dr. R.S. Jadoun, Ph.D., Dean, College of Agribusiness Management, G.B. Pant University of Agri. & Tech., Pantnagar, India

EDITORIALBOARD

Members

Prof. A.K. Misra, Ph.D., Chairman, Agricultural Scientists Recruitment Board, Krishi Anusandhan Bhavan I, New Delhi, India
Dr. Anand Shukla, Director, Reefberry Foodex Pvt. Ltd., Veraval, Gujarat, India
Dr. Anil Kumar, Ph.D., Director, Education, Rani Lakshmi Bai Central Agricultural University, Jhansi, India
Dr. Ashok K. Mishra, Ph.D., Kemper and Ethel Marley Foundation Chair, W P Carey Business School, Arizona State University, U.S.A
Dr. B.B. Singh, Ph.D., Visiting Professor and Senior Fellow, Dept. of Soil and Crop Sciences and Borlaug Institute for International Agriculture, Texas A&M University, U.S.A.
Prof. Binod Kumar Kanaujia, Ph.D., Professor, School of Computational and Integrative Sciences, Jawahar Lal Nehru University, New Delhi, India
Dr. D. Ratna Kumari, Ph.D., Associate Dean, College of Community / Home Science, PJTSAU, Hyderabad, India
Dr. Deepak Pant, Ph.D., Separation and Conversion Technology, Flemish Institute for Technological Research (VITO), Belgium
Dr. Desirazu N. Rao, Ph.D., Professor, Department of Biochemistry, Indian Institute of Science, Bangalore, India
Dr. G.K. Garg, Ph.D., Dean (Retired), College of Basic Sciences & Humanities, G.B. Pant University of Agric. & Tech., Pantnagar, India
Dr. Humnath Bhandari, Ph.D., IIRRI Representative for Bangladesh, Agricultural Economist, Agrifood Policy Platform, Philippines
Dr. Indu S Sawant, Ph.D., Director, ICAR - National Research Centre for Grapes, Pune, India
Dr. Kuldeep Singh, Ph.D., Director, ICAR - National Bureau of Plant Genetic Resources, New Delhi, India
Dr. M.P. Pandey, Ph.D., Ex. Vice Chancellor, BAU, Ranchi & IGKV, Raipur and Director General, IAT, Allahabad, India
Dr. Martin Mortimer, Ph.D., Professor, The Centre of Excellence for Sustainable Food Systems, University of Liverpool, United Kingdom
Dr. Muneshwar Singh, Ph.D., Project Coordinator AICRP- LTFE, ICAR - Indian Institute of Soil Science, Bhopal, India
Prof. Omkar, Ph.D., Professor, Department of Zoology, University of Lucknow, India
Dr. P.C. Srivastav, Ph.D., Professor, Department of Soil Science, G.B. Pant University of Agriculture and Technology, Pantnagar, India
Dr. Prashant Srivastava, Ph.D., Cooperative Research Centre for Contamination Assessment and Remediation of the Environment, University of South Australia, Australia
Dr. Puneet Srivastava, Ph.D., Director, Water Resources Center, Butler-Cunningham Eminent Scholar, Professor, Biosystems Engineering, Auburn University, U.S.A.
Dr. R.C. Chaudhary, Ph.D., Chairman, Participatory Rural Development Foundation, Gorakhpur, India
Dr. R.K. Singh, Ph.D., Director & Vice Chancellor, ICAR-Indian Veterinary Research Institute, Izatnagar, U.P., India
Prof. Ramesh Kanwar, Ph.D., Charles F. Curtiss Distinguished Professor of Water Resources Engineering, Iowa State University, U.S.A.
Dr. S.N. Maurya, Ph.D., Professor (Retired), Department of Gynecology & Obstetrics, G.B. Pant University of Agric. & Tech., Pantnagar, India
Dr. Sham S. Goyal, Ph.D., Professor (Retired), Faculty of Agriculture and Environmental Sciences, University of California, Davis, U.S.A.
Prof. Umesh Varshney, Ph.D., Professor, Department of Microbiology and Cell Biology, Indian Institute of Science, Bangalore, India
Prof. V.D. Sharma, Ph.D., Dean Academics, SAI Group of Institutions, Dehradun, India
Dr. V.K. Singh, Ph.D., Head, Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi, India
Dr. Vijay P. Singh, Ph.D., Distinguished Professor, Caroline and William N. Lehrer Distinguished Chair in Water Engineering, Department of Biological Agricultural Engineering, Texas A&M University, U.S.A.
Dr. Vinay Mehrotra, Ph.D., President, Vinlax Canada Inc., Canada

Editor-in-Chief

Dr. Manoranjan Dutta, Head Crop Improvement Division (Retd.), National Bureau of Plant Genetic Resources, New Delhi, India

Managing Editor

Dr. S.N. Tiwari, Ph.D., Professor, Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Assistant Managing Editor

Dr. Jyotsna Yadav, Ph.D., Research Editor, Directorate of Research, G.B. Pant University of Agriculture and Technology, Pantnagar, India

Technical Manager

Dr. S.D. Samantray, Ph.D., Professor, Department of Computer Science and Engineering, G.B. Pant University of Agriculture and Technology, Pantnagar, India

CONTENTS

- Studies on genetic diversity and character association analysis in wheat (*Triticum aestivum* L. em. Thell)** 337-344
P. SINGH, B. PRASAD, J. P. JAISWAL and A. KUMAR
- Study of Genetic Variability for yield and yield contributing characters in Bread Wheat (*Triticum aestivum* L.)** 345-348
SHIVANI KHATRI, RAKESH SINGH NEGI and SHIVANI NAUTIYAL
- To assessment about the combining ability and heterosis studies in pea [*Pisum sativum* L. var. *hortense*]** 349-355
AKASH KUMAR, BANKEY LAL, P. K. TIWARI, PRANJAL SINGH and ASHUTOSH UPADHYAY
- Effect of integrated nutrient management on growth, yield, and quality traits in garden pea (*Pisum sativum* L.) under sub-tropical conditions of Garhwal hills** 356-364
SUMIT CHAUHAN, D. K. RANA and LAXMI RAWAT
- To study of correlation and path coefficients analysis for pod yield in garden pea [*Pisum sativum* L. var. *hortense*]** 365-370
CHANDRAMANI KUSWAHA, H. C. SINGH, BANKEY LAL, PRANJAL SINGH and ASHUTOSH UPADHYAY
- Black gram (*Vigna mungo* L.) response to plant geometry and biofertilizers in western Himalayan Agroecosystem** 371-375
SANDEEPTI RAWAT, HIMANSHU VERMA and J P SINGH
- Integrated effect of natural farming concortions, organic farming practices and different fertilizer doses on productivity and profitability of wheat in western Himalayan zones of India** 376-382
PRERNA NEGI, HIMANSHU VERMA, MOINUDDIN CHISTI, J. P. SINGH, PRIYANKA BANKOTI, ANJANA NAUTIYAL and SHALINI CHAUDHARY
- Economics of paddy cultivation in the salinity affected regions of Alappuzha district, Kerala** 383-390
NITHIN RAJ. K, T. PAUL LAZARUS, ASWATHY VIJAYAN, DURGA A. R, B. APARNA and BRIGIT JOSEPH
- Persistent toxicity of insecticides, fungicides, and their combinations against *Spodoptera litura* (Fab.) on soybean** 391-395
GUNJAN KANDPAL, R.P. SRIVASTAVA and ANKIT UNIYAL

| | |
|--|---------|
| Productive and reproductive performance of dairy animals in district Varanasi of Uttar Pradesh RISHABH SINGH , YASHESH SINGH and PUSHP RAJ SHIVAHRE | 396-400 |
| Role of nanotechnology in environmental pollution remediation A.K. UPADHYAY, ANUPRIYA MISRA, YASHOVARDHAN MISRA and ANIMESH KUMAR MISHRA | 401-408 |
| Effects of chemical industry effluents on humoral immune response in mice SEEMA AGARWAL and D.K. AGRAWAL | 409-415 |
| Correlation between sero-conversion and clinical score in Peste des petits ruminants disease in goats AMISHA NETAM, ANUJ TEWARI, RAJESH KUMAR, SAUMYA JOSHI, SURBHI BHARTI and PREETINDER SINGH | 416-419 |
| Length weight relationship and condition factor of Bengal corvina, <i>Daysciaena albida</i> (Cuvier, 1830) from Vembanad Lake KITTY FRANCIS C. and M. K. SAJEEVAN | 420-424 |
| Temporal changes in per capita consumption of meat in different countries of South East Asia region ABDUL WAHID and S. K. SRIVASTAVA | 425-431 |
| Temporal analysis of milk production and consumption in the Central Asian countries ABDUL WAHID and S. K. SRIVASTAVA | 432-436 |
| Development and quality evaluation of jackfruit rind incorporated vermicelli <i>Payasam</i> ATHIRA RAJ, SHARON, C.L., SEEJA THOMACHAN PANJIKKARAN., LAKSHMI, P.S., SUMAN, K.T., DELGI JOSEPH C. and SREELAKSHMI A. S | 437-443 |
| Optimizing pre-drying treatments of kale leaves for enhanced processing quality BINDVI ARORA, SHRUTI SETHI, ALKA JOSHI and AJAY NAROLA | 444-452 |
| Effect of training and visit (T & V) system on fish production (Aquaculture) in Ogun State, Nigeria UWANA G.U. and V.E OGBE | 453-459 |
| Use of social media by rural and urban youths: A study in Uttarakhand ANNU PARAGI and ARPITA SHARMA KANDPAL | 460-465 |
| Assessment of traditional knowledge of therapeutic potential of native crops among population of Udham Singh Nagar, Uttarakhand A. DUTTA, A. BHATT, S. SINGH and K. JOSHI | 466-472 |
| Modernizing dairy operations: A comprehensive case study of mechanization in Bhopal farms M. KUMAR | 473-477 |

Studies on genetic diversity and character association analysis in wheat (*Triticum aestivum* L. em. Thell)

P. SINGH, B. PRASAD*, J. P. JAISWAL and A. KUMAR

Department of Genetics and Plant Breeding, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar-263145 (U. S. Nagar, Uttarakhand)

**Corresponding author's email id: prasadsst@gmail.com*

ABSTRACT: The experiment was conducted in the Augmented Block Design, comprised of 90 entries, along with 3 check varieties Sonalika, HD 2967 and HI 8713. Results revealed that variance was the highest for grain yield per plot and the lowest for spike length. The coefficient of variability was the highest for grain yield and the lowest for days to 75% heading. The highest heritability was recorded for tillers per meter and the lowest for 1000- grain weight. Grain yield exhibited highest genetic advance in percent of mean and lowest for days to 75% heading. However, with respect to correlation with one or other traits, grain yield was positive and significantly correlated with days to 75% heading, plant height, tillers per meter, grain per spike, spike length and grain yield per plot. Path coefficient revealed that 1000- grain weight exerted positive effect on all characters except days to 75% heading. The genotypes were classified into 7 different clusters by Non- Hierarchical Euclidean Cluster Analysis. Cluster -I had 13 genotypes whereas cluster -II had 20 genotypes, cluster- III had 8 genotypes, cluster -IV had 12 genotypes, cluster -V had 9 genotypes, cluster-VI has 15 genotypes and cluster-VII had 16 genotypes. Inter cluster distance was found maximum between cluster -III and cluster -IV and minimum was found in cluster -I and II.

Key words: Genetic Advance, heritability, path coefficient, variability

Wheat (*Triticum aestivum* L. em. Thell), also known as Bread Wheat is an allohexaploid crop ($2n=6x=42$), belongs to family Gramineae (Poaceae). It is most important food crop for humans from the very beginning of era of agriculture. It is known as 'King of Cereals' as it is the best staple diet for the people and can be grown in variety of soils and climates than any other crop.

According to FAOSTAT (2019-20), the largest producer of wheat is European Union (153500 metric tons) followed by China (133590 metric tons), India (102190 metric tons), Russia (74500 metric tons) & USA (52258 metric tons) etc. and bread wheat has worldwide production of about 766.4 million tons. In India, wheat production has increased to a record of 101.20 million tons for the crop year 2018-19, up by 1-3% a year ago, said by Ministry of Agriculture, during 2017-2018 wheat was grown on 29.72 million hectares of area with the production of 98.61 million tons with an average productivity of about 3318 kg/ha. In India, Uttar Pradesh has registered the highest production (30.24

million tons) followed by Punjab (17.04 million tons), Madhya Pradesh (13.93 million tons), Haryana (11.80 million tons), Rajasthan (8.92 million tons) and Bihar (5.08 million tons). These six states together contributed around 90% of the total wheat production in the country (Anonymous, 2017). In Uttarakhand, the area under wheat cultivation is about 383 thousand hectares with production of 880 thousand tons and an average productivity of 2643 kg/ha (Anonymous, 2018).

A successful selection depends upon the information on the genetic variability and association of morpho-agronomic traits with grain yield. Correlation studies along with path analysis provide a better understanding of the association of different characters with grain yield. Fonseca and Peterson (1968) based on their study highlighted the significance of components approach in formulating a successful breeding programme. The correlation coefficient gives an idea about the various linkages existing between the yield components. Path

coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient (Dubey *et al.*, 1984).

Evaluation of genetic diversity among adapted, elite germplasm can provide predictive estimates of genetic variation among segregating progeny for pure line cultivar development. Knowledge about germplasm diversity and genetic relationships among breeding material could be an invaluable aid in crop improvement strategies (Mohammadi and Prasanna, 2003) and study of the genetic diversity in bread wheat is important for breeding and genetic resource conservation programs.

The experiment was done to assess the genetic diversity among the germplasm under study; to estimate the relative extent of variability for different characters among wheat germplasm; to assess the nature and magnitude of inter-character correlation; characterization of germplasm for agromorphological traits, identification of superior lines which can be used as potential donors for yield and yield contributing characters and to assess the disease reaction on the wheat germplasm.

MATERIALS AND METHODS

The present investigation was conducted at N. E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand; during the *Rabi* Season 2019-20.

The present experiment comprised of 90 germplasm lines of National Genetic Stock Nursery (NGSN), obtained from National Bureau of Plant Genetic Resources (NBPGR), New Delhi. The experiment was carried out in the Augmented Block Design with 3 blocks, each containing 30 test entries along with 3 checks (randomly allocated) namely, Sonalika, HD-2967, HI 8713.

During experiment data were recorded for days to 75% heading, plant height (cm), number of tillers per meter, spike length (cm), number of grains per spike, 1000 -grain weight and grain yield per plot.

The analysis of variance for augmented design has been calculated by using Federer (1956, 1961) and (Federer and Raghavarao, 1975) and Peterson (1985).

RESULTS AND DISCUSSION

Mean sum of squares were highly significant for all the seven characters studied. The significant differences among all the genotypes indicated handsome amount of genetic variation for all the traits studied.

Variance was found highest for grain yield per plot (302550.31), followed by number of tillers per meter (2998.68), plant height (853.28), grains per spike (247.43), days to 75% heading (143.77), 1000- grain weight (98.15) and least variance is found in spike length (11.53). All the variance was found to be significant.

Grain yield per plot (16.94) showed highest PCV followed by tiller per meter (12.12), spike length (10.81), 1000- grain weight (10.45), plant height (8.18), grain per spike (7.58) and days to 75% heading (2.36) showed lowest value for PCV.

GCV was highest for grain yield (15.85), followed by tiller per meter (11.93), spike length (8.42), plant height (7.89), 1000- grain weight (6.63), grains per spike (5.61), days to 75% heading (2.20) had the lowest value for GCV.

The findings are in accordance with earlier observation of Sidharthan *et al.* (2007), Ali *et al.* (2008), Majumder *et al.* (2008), Mohsin *et al.* (2009), Ferdous *et al.* (2010), Kotal *et al.* (2010), Kumar *et al.* (2013) and Fikre *et al.* (2015).

Kumar *et al.* (2013) and Bhushan *et al.* (2013) and Kumar *et al.* (2014) estimates high GCV and PCV observed for grain yield per plant followed by tillers per plant and harvest index.

The estimates in heritability in broad sense (h^2_b) showed considerable variation for different characters in table. The value of heritability ranges

from 40.26% (1000- grain weight) to 96.98% (tiller per meter). Higher estimates of heritability were observed for number of tillers per meter (96.98%) followed by plant height (93%), grain yield per plot (87.48%), days to 75% heading (87.20%). Moderate estimate for spike length (60.62%), grains per spike (54.63%) and low estimate for 1000- grain weight (40.26).

Differential heritability for different genotypes in wheat were reported by Saxena *et al.* (2007), Majumder *et al.* (2008), Aydin *et al.* (2010), Ullah *et al.* (2011) and Fikre *et al.* (2015)

The genetic advance in percent of mean ranged from 4.24% (days to 75% heading) to 30.53% (grain yield per plot). Highest genetic advance is of grain yield per plot (30.53%), followed by number of tillers per meter (24.21%), plant height (15.67%), spike length (13.50%), 1000- grain weight (8.66%), grains per spike (8.54%) and days to 75% heading (4.24%) had

lowest genetic advance.

Such findings were also recorded by Joshi (1984), Kumar *et al.* (1986), Sandhu and Lal (1989), Crowley *et al.* (1993), Bergale *et al.* (2002), Anwar *et al.* (2009), Pawar *et al.* (1990), Lu *et al.* (1991), Mohan *et al.* (1993), Ibrahim (1994), Paul and Ganguli (1996), Dwivedi *et al.* (2002), Mohammad *et al.* (2008), Rangare *et al.* (2010), Bhushan *et al.* (2013), Kumar *et al.* (2014) and Khan *et al.* (2010).

The positive direct effect on grain yield (dependent variable) is a function of concomitant variables (independent variables) *viz.*, days to 75% heading, plant height, tillers per meter, grains per spike, 1000-grain weight and spike length. Similar results were also observed by Hirachand *et al.* (1978), Sharma and Singh (1989), Ibrahim (1994), Dwivedi *et al.* (2002), Asif *et al.* (2004), Khaliq *et al.* (2004), Sherif *et al.* (2005), Mukherjee *et al.* (2008), Singh *et al.* (2009), Gulmezoglu *et al.* (2010), Cicfi (2012) and

Table 1: Genetic variability recorded for the characters studied

| Characters | G mean | Var (g) | Var (p) | Heritability (%) | GA (%) | GA% mean | GCV (%) | PCV (%) |
|--------------------------|--------|---------|---------|------------------|--------|----------|---------|---------|
| Days to 75% heading | 96.69 | 4.54 | 5.21 | 87.20 | 4.10 | 4.24 | 2.20 | 2.36 |
| Plant Height | 88.51 | 48.72 | 52.38 | 93.00 | 13.87 | 15.67 | 7.89 | 8.18 |
| No. of tillers per meter | 88.13 | 110.61 | 114.06 | 96.98 | 21.34 | 24.21 | 11.93 | 12.12 |
| Grains per spike | 57.62 | 10.44 | 19.10 | 54.63 | 4.92 | 8.54 | 5.61 | 7.58 |
| 1000-grain weight (g) | 35.82 | 5.64 | 14.00 | 40.26 | 3.10 | 8.66 | 6.63 | 10.45 |
| Spike length | 8.86 | 0.56 | 0.92 | 60.62 | 1.20 | 13.50 | 8.42 | 10.81 |
| Grain Yield (g/plot) | 513.03 | 6609.68 | 7555.46 | 87.48 | 156.65 | 30.53 | 15.85 | 16.94 |

G mean: Geometric Mean, Var (p): Phenotypic variance, Var (g): Genotypic Variance, GA: Genetic Advance, GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation

Correlation analysis revealed that grain yield was positively and significantly correlated with days to 75% heading, plant height, tillers per meter, grain per spikelet, spike length and grain yield per plot.

Table 2: Correlations among the characters studied

| Characters | Days to 75% heading | Plant Height (cm) | No. of tillers per meter | Grains per spike | 1000- grain weight (g) | Spike length (cm) | Grain Yield (g/plot) |
|-----------------------|---------------------|-------------------|--------------------------|------------------|------------------------|-------------------|----------------------|
| Days to 75% heading | 1.000 | 0.069 | -0.105 | 0.059 | -0.293** | -0.084 | -0.253* |
| Plant Height | | 1.000 | -0.122 | -0.111 | 0.056 | 0.165 | 0.142 |
| Tillers per meter | | | 1.000 | 0.306** | -0.098 | -0.170 | 0.105 |
| Grains per spike | | | | 1.000 | 0.029 | -0.151 | 0.127 |
| 1000- grain weight(g) | | | | | 1.000 | -0.112 | 0.263* |
| Spike length | | | | | | 1.000 | 0.178 |
| Grain Yield (g/plot) | | | | | | | 1.000 |

*,** significant at 5% and 1% level, respectively

Path coefficient analysis revealed that 1000- grain weight (0.236) exerted high positive direct effect on grain yield followed by spike length (0.209), grains per spike (0.140), plant height (0.137) and number of tiller per meter (0.120). However, days to 75% heading (-0.171) had negative direct effect on grain yield.

Abd El-Mohsen *et al.* (2014) for grain yield and its various component characters.

All the 90 genotypes were classified into 7 non-overlapping clusters. Cluster -I had 13 genotypes whereas cluster -II had 20 genotypes, cluster- III had 8 genotypes, cluster -IV had 12 genotypes, cluster -V had 9 genotypes, cluster-VI has 15 genotypes and cluster-VII had genotypes 16 genotypes.

The maximum intra cluster distance was found for cluster-IV (2.096) which revealed maximum genetic diversity among its constituents, followed by the

cluster-III (1.994), cluster-VII (1.941), cluster-II (1.927), cluster-VI (1.923), cluster-V (1.623) and cluster-I (1.532) had minimum intra cluster distance.

Inter cluster distance was found maximum distance between cluster -III and cluster -IV (4.166), followed by cluster -III and cluster-V (4.112), cluster -IV and cluster-V (3.543), cluster -IV and cluster -VI (3.344), cluster-IV and cluster-VII (3.420), cluster -V and cluster -VII (3.173) indicated that cluster - III, IV, V were distantly related to each other. Minimum cluster distance was found in cluster -I and cluster -II (2.076) followed by cluster -I and

Table 3: Path coefficient analysis with grain yield (g/plot)

| Characters | Days to 75% heading | Plant Height (cm) | No. of tillers per meter | Grains per spike | 1000- grain weight(g) | Spike length (cm) | Grain Yield (g/plot) |
|--------------------------|---------------------|-------------------|--------------------------|------------------|-----------------------|-------------------|----------------------|
| Days to 75% heading | -0.171 | 0.009 | -0.013 | 0.008 | -0.069 | -0.018 | -0.253* |
| Plant Height | -0.012 | 0.137 | -0.015 | -0.016 | 0.013 | 0.034 | 0.142 |
| No. of tillers per meter | 0.018 | -0.017 | 0.120 | 0.043 | -0.023 | -0.036 | 0.105 |
| Grains per spike | -0.010 | -0.015 | 0.037 | 0.140 | 0.007 | -0.031 | 0.127 |
| 1000- grain weight (g) | 0.050 | 0.008 | -0.012 | 0.004 | 0.236 | -0.023 | 0.263* |
| Spike length | 0.014 | 0.023 | -0.020 | -0.021 | -0.026 | 0.209 | 0.178 |

Resi = 0.0483; *,** significant at 5% and 1% level, respectively

Table 4: Number of Genotypes in each cluster

| Clusters | No of genotypes | Genotypes |
|----------|-----------------|---|
| I | 13 | DBW 71, DBW 252, HI 8737 (d), HI 8805 (d), HS 611, PBW 777, TL 3011 (t), VL 3014, HI 1619, KRL 370, PBW 780, DBW 179, HI 8708 (d) |
| II | 20 | HD 3086, HI 1609, HI 1628, MACS 4058 (d), MP 1203, RAJ 3765, RAJ 4083, UAS 466 (d), HS 627, PBW 760, TL 3013, TL 3014, DBW 251, DBW 246, FLW 10, FLW 22, DWAP 1530, DWAP 1531, RAJ 4079, Sonalika |
| III | 8 | AKAW 4927, CG 1018, DBW 71, DBW 107, HD 3237, HI 1621, DWAP 1103, FLW 16 |
| IV | 12 | K 1317, RAJ 3077, HS 665, UAS 462 (d), HPW 439, HS 644, HS 646, DDK 1051, DDK 1052, DDK 1053, MACS 5049, AKAW 3717 |
| V | 9 | VL 3013, DM 6, DM 7, WH 117, WAPD 1505, WAPD 1508, WAPD 1516, WAPD 1519, WAPD 1524 |
| VI | 15 | HI 8777, HI 8802 (d), PBW 778, WH 1232, DBW 129, DBW 150, HI 8751 (d), WH 730, GW 499, GW 1339 (d), MPO 1336 (d), RAJ 4238, TL 3012 (t), TL 3015 (t), HI 8713 |
| VII | 16 | AKAW 4901, DBW 93, DBW 110, DBW 173, DBW 222, HD 3043, HD 3118, HD 3171, HD 3271, HI 1620, UAS 375, HI 1612, HI 8765 (d), DBW 221, MP 1338, HD 2967 |

Table 5: Inter and intra distances between the characters studied

| Clusters | I | II | III | IV | V | VI | VII |
|----------|-------|-------|-------|-------|-------|-------|-------|
| I | 1.532 | | | | | | |
| II | 2.076 | 1.927 | | | | | |
| III | 2.479 | 2.850 | 1.994 | | | | |
| IV | 2.270 | 2.584 | 4.166 | 2.096 | | | |
| V | 2.721 | 2.497 | 4.112 | 3.543 | 1.623 | | |
| VI | 2.533 | 2.631 | 3.817 | 3.344 | 2.655 | 1.923 | |
| VII | 2.756 | 2.248 | 2.947 | 3.420 | 3.173 | 2.560 | 1.941 |

Table 6: Cluster Mean of the characters studied

| Cluster | | Days to 75% heading | Plant Height (cm) | Tillers per meter | Grains per spike | 1000- grain weight (g) | Spike length (cm) | Grain Yield (g/plot) |
|---------|------|---------------------|-------------------|-------------------|------------------|------------------------|-------------------|----------------------|
| I | Mean | 97.69 | 86.85 | 68.62 | 57.00 | 38.08 | 8.38 | 406.15 |
| | ± SE | 1.80 | 10.33 | 10.11 | 3.83 | 2.67 | 1.12 | 83.31 |
| II | Mean | 94.08 | 88.90 | 93.33 | 54.43 | 32.32 | 9.34 | 465.83 |
| | ± SE | 3.61 | 6.61 | 16.19 | 5.04 | 3.87 | 1.05 | 118.95 |
| III | Mean | 93.62 | 94.00 | 57.75 | 49.25 | 41.56 | 10.12 | 591.75 |
| | ± SE | 3.38 | 7.05 | 10.01 | 4.56 | 5.43 | 1.25 | 162.69 |
| IV | Mean | 103.25 | 92.58 | 86.08 | 56.00 | 30.76 | 8.33 | 317.67 |
| | ± SE | 3.57 | 11.19 | 17.34 | 6.74 | 4.22 | 1.23 | 48.83 |
| V | Mean | 95.22 | 62.67 | 100.56 | 61.00 | 35.76 | 8.44 | 495.44 |
| | ± SE | 2.59 | 7.14 | 12.89 | 5.20 | 4.18 | 0.88 | 71.42 |
| VI | Mean | 96.09 | 92.18 | 105.42 | 62.56 | 39.65 | 7.11 | 574.22 |
| | ± SE | 3.34 | 11.72 | 11.90 | 5.30 | 4.14 | 0.97 | 98.66 |
| VII | Mean | 97.12 | 94.65 | 90.98 | 61.00 | 35.74 | 10.27 | 718.54 |
| | ± SE | 1.96 | 10.66 | 15.37 | 6.15 | 3.65 | 1.10 | 121.18 |

cluster -IV (2.270), cluster -I and cluster -II (2.479), cluster -II and cluster -V (2.497), cluster -I and cluster -VI (2.533) indicated that cluster -I and II possess similar expression. The higher inter cluster distance indicated greater genetic diversity between the genotypes of those clusters, while lower cluster values between the clusters suggested that the genotypes of these clusters were not genetically diverse.

On the basis of cluster mean value, we can conclude that cluster -VII can be used as donor parent for the characters like plant height, spike length and grain yield, whereas cluster -VI can be used as donor for tillers per meter and grains per spike, cluster -IV as donor parent for character like days to 75% heading and cluster-III can be used as donor parent for characters like 1000- grain weight and spike length. Similar findings are reported by the Sanghera *et al.* (2014) and Rahman *et al.* (2015) studied genetic divergence of wheat genotypes using Mahalanobis D^2 . Intercluster distances were more than intra cluster distances. The result of this study showed the high amount of genetic variation.

CONCLUSION

It is therefore present research findings concluded that the significant differences with respect to mean sum of square, genotypic and phenotypic variance, heritability, genetic advance for different characters under studied among different genotypes indicated the presence of considerable amount of genetic

variation. All the characters were positively and significantly correlated. Genotypes of cluster -VII can be used as donor parent for the characters like plant height, spike length and grain yield, whereas cluster -VI can be used as donor for tillers per meter and grains per spike, cluster -IV as donor parent for character like days to 75% heading and cluster-III can be used as donor parent for characters like 1000-grain weight and spike length.

REFERENCES

- Abd El-Mohsen, A. A. and Abd El-Shafi (2014). Regression and path analysis in Egyptian bread wheat. *Journal of Agri-Food and Applied Sciences*, 2(5): 139-148.
- Ali, Y., Atta, B. M., Akhter, J., Monneveux, P. and Lateef, Z. (2008). Genetic variability, association and diversity studies in wheat (*Triticum aestivum* L.) germplasm. *Pak. J. Bot.*, 40(5): 2087-2097.
- Anonymous (2017). Progress Report of All India Coordinated Wheat and Barley Improvement Project, 2017-2018, Director's Report. Ed. G.P. Singh, ICAR-Indian Institute of Wheat and Barley Research, Karnal, India, 96p.
- Anonymous (2018). Progress Report of All India Coordinated Wheat and Barley Improvement Project, 2018-2019, Director's Report. Ed. G.P. Singh, ICAR-Indian Institute of Wheat and Barley Research, Karnal, India, 101p.
- Anwar, J., Ali, M. A., Hussain, M., Sabir, W., Khan,

- M. A., Zulkiffal, W. and Abdullah, M. (2009). Assessment of yield criteria in bread wheat through correlation and path analysis. *The Journal of Animal and Plant Sciences*, 19(4): 185-188.
- Asif, M., Mujahid, M. Y., Kisana, N. S., Mustafa, S. Z. and Ahmed, I. (2004). Heritability, genetic variability and path coefficient of some traits in spring wheat. *Sarhad Journal of Agriculture*, 20(1): 87-91.
- Aydin, N., Mut, Z. and Ozean, H. (2010). Estimation of broad sense heritability for grain yield and some agronomic and quality traits of bread wheat (*Triticum aestivum* L.). *Journal of Food, Agriculture and Environment*, 8(2): 419-421.
- Bergale, S., Billore, M., Holkar, A. S., Ruwali, K. N. and Prasad, S. V. S. (2002). Pattern of variability, character association and path analysis in wheat (*Triticum aestivum* L.). *Agricultural Science Digest*, 22(4): 258-260.
- Bhushan, B., Bharti, S., Ojha, A., Pandey, M., Gourav, S. S., Tyagi, B. S. and Singh, G. (2013). Genetic variability, correlation coefficient and path analysis of some quantitative traits in bread wheat. *Journal of Wheat Research*, 5(1): 21-26.
- Cicfi, E. A. (2012). Estimate of heterosis, correlation and path analysis for grain yield per spike and some agronomic traits on durum wheat (*Triticum durum* desf). *The Journal of Animal Science and Plant Sciences*, 22(3): 747-752.
- Crowley, C., Jones, P. and Foley, L. (1993). Analysis of crop physiology in a high biomass winter variety; using induced mutants. *An Aspect of Applied Biology*, 34: 173-178.
- Dwivedi, A. N., Panwar, I.S. and Shashi, M. (2002). Studies on variability parameters and character association among yield and quality attributing traits in wheat. *Haryana Agricultural University Journal of Research*, 32(2): 77-80.
- Dubey, N. K., Tripathi, N. N. and Dixit, S. N. (1984). Higher plants a promising source of antifungal constituents. In *Recent trends in Botanical Research Ed. R.P. Sinha, Murlidhar Printers Patna*, Pp. 221-228.
- FAOSTAT (2019-20). www.fao.org.in
- Federer, W. T. (1956). Augmented designs. *Hawaii Planter's Record*, 55:191-208.
- Federer, W. T. (1961). Augmented designs with one way elimination of heterogeneity. *Biometrics*, 17: 447-443.
- Federer, W.T. and Raghavarao, D. (1975). Augmented designs. *Biometrics*, 31:29-35.
- Ferdous, M. F., Shamsuddin, A. K. M., Hasna, D. and Bhuiyan, M. M. R. (2010). Performance and variability for yield and yield contributing characters in spring wheat. *J. Bangladesh Agril. Univ.*, 8(2): 195-197.
- Fikre, G., Alamerew, S., and Tadesse, J. (2015). Genetic variability studies in bread wheat (*Triticum aestivum* L.) genotypes at Kulumsa Agricultural Research Center, South East Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 5(7): 89-98.
- Fonseca, S. and Peterson, F. L. (1968). Yield components heritabilities and inter-relationship in winter wheat (*Triticum aestivum* L.). *Crop Science*, 8(5): 614-617.
- Gulmezoglu, N., Alpu, O. and Ozer, E. (2010). Comparative performance of triticale and wheat grains by using path analysis. *Bulgarian Journal of Agricultural Signs.*, 16(4): 443-453.
- Hirachand, Srivastava, K. S. and Metha, S. K. (1978). Genetic variability, correlation on coefficient analysis in wheat (*Triticum aestivum* L.). *Madras Agricultural Journal*, 65: 17-27.
- Ibrahim, K. I. M. (1994). Association and path coefficient analysis of some traits in bread wheat. *Annals of Agricultural Science Moshtohor.*, 32(3): 1189-1198.
- Joshi, R. P. (1984). Character association analysis in wheat, across varying environments. Unpublished Msc Ag. thesis submitted to G. B. Pant Uni. of Ag. and Tech., Pantnagar.
- Khaliq, I., Parveen, N. and Chaudhari, M. A. (2004). Correlation and path coefficient analysis in bread wheat. *International Journal of Agriculture and Biology*, 6(4): 633-655.
- Khan, A. J., Azam, F. and Ali, A. (2010). Relationship of morphological traits and grain yield in recombinant inbred wheat lines grown under drought conditions. *Pak. J. Bot.*, 42(1): 259-267.

- Kotal, B. D., Das, A. and Chaundhary, B. K. (2010). Genetic evaluation and association of characters in wheat (*Triticum aestivum* L.). *Asian Journal of Crop Science*, 5(1): 17-24.
- Kumar, B., Singh, C. M. and Jaiswal, K. K. (2013). Genetic variability, association and diversity studies in bread wheat (*Triticum aestivum* L.). *The Bioscan.*, 8(1): 143-147.
- Kumar, D., Sharma, S. C. and Gupta, S.C. (1986). Correlation and path studies in wheat under normal and saline conditions. *Wheat Information Service*, 61/62: 64-67.
- Kumar, N., Markar and Kumar, V. (2014). Studies on heritability and genetic advance estimates in timely sown bread wheat (*Triticum aestivum* L.). *Biosci. Disc.*, 5(1): 64:69.
- Lu, P., Huang, H. L., Liu, Q. Y. and Gu, M. Z. (1991). Heritability and usefulness of traits of Tibetan wheat varieties. *Crop Genetic Resources*, 1: 11-13.
- Majumder, D. A. N., Shamsuddin, A. K. M., Kabir, M. A. and Hassan, L. (2008). Genetic variability, correlated response and path analysis of yield and yield contributing traits of spring wheat. *J. Bangladesh Agri. Univ.*, 6(2): 227-234
- Mohammad, T., Mohjammad, A., Faizal, E. S., Khan, S.I. and Khan, S.J. (2008). Identification of traits in bread wheat genotypes (*Triticum aestivum* L.) contributing to grain yield through correlation in path coefficient analysis. *Pakistan Journal of Botany*, 40(6):2393-2402.
- Mohammadi, S. A. and Prasanna, B. M. (2003). Analysis of genetic diversity in crop plants salient statistics tools and consideration. *Crop science*, 43(1): 1235-1248.
- Mohan, D. S. R., Singh, H., Khola, O. P. S. and Singh, H. (1993). Correlation and path analysis in late sown bread wheat (*Triticum aestivum*). *Crop Research Hisar*, 6(1): 72-77.
- Mohsin, T., Khan, N. and Naqvi, F. N. (2009). Heritability, phenotypic correlation and path coefficient studies for some agronomic characters in synthetic elite lines of wheat. *Journal of Food, Agriculture and Environment*, 7(3&4): 278-282.
- Mukherjee, S., Gupta, D., and Maji A., Gupta, S. and Bhowmilk, N. (2008). Character association and path coefficient analysis of wheat (*Triticum aestivum* L.) genotypes under late sown conditions. *Environment and Ecology*, 26(4C): 2218-2220.
- Paul, A. and Ganguli, D. K. (1996). Association of grain yield and its component characters over environment in wheat (*Triticum aestivum* L.). *J. of Res. Birsa Agric. Univ.*, 8: 127-129.
- Pawar, I. S., Paroda, R. S. and Singh, S. (1990). A study of correlation and path analysis in spring wheat. *Wheat Information Service*, 71: 24-26.
- Peterson, G. R. (1985). Augmented Designs for preliminary yield trials. *Rachis*, 4(1): 28.
- Rahman, M. S., Hossain, M. S., Akbar, M. K., Islam, M. S. and Ali, L. (2015). Genetic divergence in spring wheat genotypes (*Triticum aestivum* L.). *Eco-friendly Agril. Journal*, 8(01): 01-03.
- Rangare, N. R., Krupakar, A., Kumar, A. and Singh, S. (2010). Character association and Component analysis in wheat (*Triticum aestivum* L.). *Electronic Journal of Plant Breeding*, 1(3): 231-238.
- Sandhu, D. A. and Lal, R. (1989). Divergence analysis in wheat genotypes through discrimination functions. *Crop Improvement*, 16(2): 185-187.
- Sanghera, G. S., Kashyap, S. C., Rana, V. and Parray, G. A. (2014). Agro-morphological and genetic diversity among elite wheat genotypes grown under Kashmir conditions. *International Journal of Current Research*, 6(8): 7735-7740.
- Saxena, P., Rawat, R. S., Verma, J. S., Meena, B. (2007). Variability and association analysis for yield and quality traits in wheat. *Pantnagar Journal of Research*, 5(2): 85-92.
- Sherif, H. S., El Hosary, A. A., Bekhit, M. M., Moustafa, M. A. and Meghraby, M. A. (2005). Correlation and path coefficient analysis of yield characters in bread wheat (*Triticum aestivum* L.). *Annals of Agriculture Science, Moshtohor*, 43(4): 1677-1687.
- Sidharthan, B. and Malik, S. K. (2007). Variability studies in wheat. *Internat. J. Agric. Sci.*, 3(1): 142-144.
- Singh, D., Singh, S. K. and Singh, K. S. (2009).

Diversity of salt resistant in a large germplasm collection of bread wheat (*Triticum aestivum* L.). *Crop Improvement*, 36(1): 9-12.

Ullah, K., Khan, S. J., Irfaq, M., Muhammad, T. and Mohammad, S. (2011). Genotypic and phenotypic variability, heritability and

genetic diversity for yield components in bread wheat (*Triticum aestivum* L.) germplasm. *African Journal of Agricultural Research*, 6(23): 5204-5207.

Received: September 20, 2023

Accepted: December 11, 2023