**Correlation and Path Coefficient Analysis for Yield and Yield-Related Traits in Bread Wheat (*Triticum aestivum* L.)**

**Abstract**

The significant positive correlation of phenotypic and genotypic performance as well as path correlation of crops helps in selection of the superior cultivars. Based upon important significance of these estimates, it was applied in our research. For this an experiment was carried out at the Main Experiment Station of the Department of Genetics and Plant Breeding, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during Rabi season of 2021-22. The experimental materials in the present study seventy-five genotypes of wheat including three checks viz., NW-5054, HD-2967, HD-3086 were evaluated to estimate the correlation and path coefficients for yield. A study on eleven characters revealed that there was a highly significant and positive association of seed yield per plant exhibited highly significant and positive correlation with biological yield per plant and harvest index Also, the seed yield per plant exhibited non-significant and negative correlation with number of tillers per plant and days to maturity. The highest positive direct and indirect effect on seed yield per plant was exerted by biological yield per plant followed by harvest-index. The characters contributed negative direct effect on seed yield per plant were spikelets per spike and 1000-seed weight. on the other hand, days to maturity showed negative indirect effect on grain yield per plant. As a result, these characters should be given weightiness for the future wheat improvement.

**Keywords:** Wheat, seed yield, Correlation, Path coefficient.

**Introduction**

Wheat (*Triticum aestivum* L*.)* is among the earliest and most widely cultivated cereal crop of the world whose seed is named as caryopsis. With the origin in Asia Minor region, it is designated as king of cereal due to its excessive productiveness and acreage. Temperate and tropical climates are best suitable for the growth of this crop. Wheat is also the second most important food grain crop in Indian agriculture, after rice whose farming is considered as the backbone of Indian agriculture due to its nutritional superiority as compare to other grains. Wheat is the world's largest cereal crop in terms of land area and total output volume. In 2023-24, global wheat output was estimated to be 789 million metric tons. Wheat demand is forecast to rise by 60% from its current level by 2050, but supply is expected to fall by 30% due to adverse weather conditions. (**Alam *et al*.,2022**). India's wheat output for the 2023-24 harvest season, which ended in June, is officially predicted to be around 112.92 million tons from an acreage of approximately 31.78 million hectares with a productivity of 36.15 q/ha. **(ICAR-IIWBR, 2024).** In terms of area and output, the states that cultivate the most wheat are Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, and Rajasthan. Uttar Pradesh is the biggest producer of wheat among these states, yielding 35.43 million tonnes from 9.31 million hectares of land. (**ICAR-IIWBR, 2024)**. Yield being a multiplex character is a function of many elemental characters and their interaction with the environment. Exploration of structure of yield involves assessment of mutual relationship among numerous characters contributing to the yield. In this regard, genotypic and phenotypic correlation reveals the degree of association between totally different characters and therefore, aid in selection to boost the yield and yield attributing characters at the same time. Further, path coefficient analysis helps in partitioning of correlation coefficients into direct and indirect effects and in the assessment of relative contribution of every elemental character to the yield. Keeping these things in view, the present investigationwas proposed to gather information on correlation and path coefficient for yield in set of wheat genotypes.

**Materials and Methods**

The present experiment was conducted at Main Experiment Station of Department of Genetics and Plant Breeding, A.N.D.U.A.T, Kumarganj, Ayodhya during Rabi season 2021-22. The experimental material was grown using augmented block design in which total seventy-five germplasm lines including three checks (NW-5054, HD-2967 and HD-3086) were grouped into 8 blocks consisted of 12 plots each. Each plot consisted of two rows of 2.5 m length with intra-row spacing of 5 cm and inter-row spacing of 20 cm. Five plants of each genotypes were selected at random for the purpose of recording observations on days to maturity (DM), days to 50 percent flowering (DFF), plant height which was in cm (PH), number of tillers per plant (TPP), spike length in cm (SL), number of spikelets per spike (SPS), number of grains per spike (GPS), thousand-seed weight in gm (TSW), biological yield per plant in gm (BYPP), harvest index in percent (HI) and seed yield per plant in gm (SYPP). Coefficient of correlation was measured using method given by **Searle (1961)** on the other hand analysis of path coefficient was done using statistics given by **Dewey and Lu (1959).**

**Results and discussion**

***Correlation coefficients Analysis***

In order to get degree and direction of association between yield and its component, knowledge of correlation coefficient is must. Estimates of correlation coefficients for various characters have been represented in **Table 1**. The seed yield per plant (SYPP) exhibited highly significant and positive correlation with biological yield per plant (BYPP) (0.935), harvest index (HI) (0.360), and showed non-significant and positive correlation with number of grains per spike (GPS) (0.171), 1000-seed weight (TGW) (0.156), spike length (SL) (0.142), plant height (PH) (0.066), days to 50% flowering (DFF) (0.054) and spikelet’s per spike (SPS) (0.014). Also, the seed yield per plant exhibited non-significant and negative correlation with number of tillers per plant (TPP) (-0.026) and days to maturity (DM) (-0.022). Harvest-index (HI) showed highly significant and negative correlation with number of tillers per plant (TPP) (-0.656). 1000-seed weight (TGW) exhibited highly significant and positive correlation with spike length (SL) (0.298). Also, number of grains per spike (GPS) showed significant and positive correlation with number of tillers per plant (TPP) (0.262). In case of days to maturity (DM), highly significant and positive correlation was recorded with days to 50% flowering (DFF) (0.407). Previous reports of some workers also showing a strong and positive association of one or more above traits with seed yield per plant **(Prasad *et al.,* 2006, Sharma *et al.,* 2006, Saxena *et al.*, 2007, Bisht *et al.,* 2009, Sharma and Singh, 2009, Tripathi *et al*., 2011, Dutamo *et al*., 2015, Baye *et al.,* 2020)**. The balance or overall net effect produced by several yield components interacting with one another directly and indirectly is the basis of the genetic architecture of seed yield in wheat and other crops. Without selection for the numerous component traits that condition seed production, selection for seed yield would be pointless. Therefore, determining important component qualities and understanding how they relate to yield and to one another is essential to creating a successful breeding plan for high-yielding cultivars.

***Path coefficient analysis***

Path analysis is a statistical technique that divides correlation coefficient estimates into direct and indirect effects. While an indirect effect occurs when an independent character influences a dependent character through another character, a direct effect occurs when an independent trait directly influences a dependent trait. The effect that another independent variable that is not included in the study has on a dependent trait is known as the residual effect. In the present study, the direct and indirect effects of 11 characters on seed yield per plant determined by path coefficient analysis utilizing simple correlations are given in **Table 2**. The highest positive direct effect on seed yield per plant was exerted by biological yield per plant (0.9287) followed by harvest-index (0.3582) while all the other characters exhibited negligible direct effect. The highest positive indirect effect on seed yield per plant via biological yield per plant was exerted by number of grains per spike (GPS) (0.2000), number of tillers per plant (TPP) (0.1989), followed by spike length (SL) (0.1319), 1000-seed weight (TGW) (0.1143), plant height (PH) (0.0852), days to 50% flowering (DFF) (0.0403) and spikelets per spike (SPS) (0.0337). The estimate of residual effect (0.00147) was found quite low. Similar study showed biological yield per plant (BYPP) and harvest index (HI) as significant donor to seed yield per plant **(Payal *et al.,* 2007, Singh *et al*., 2012, Dabi *et al.*, 2016, Pooja *et al.,* 2017, Devesh *et al.*, 2021)** Path analysis differs from simple correlation in that it identifies the reasons and their relative importance, whereas the latter only considers mutual connection while ignoring the cause. In the current study, route analysis identified biological yield per plant, harvest index, and plant height as significant direct yield contributing factors. The aforementioned characteristics had relevance since they were considered when establishing a wheat selection strategy aimed at developing high yielding varieties.

**Conclusion**

The combined correlation and path coefficient studies identify biological yield per plant and harvest index as the most important predictors of seed yield per plant in wheat. SYPP had a high positive association with BYPP and HI, whereas other features including number of grains per spike and 1000-seed weight had minor, non-significant effects. Path analysis revealed that BYPP and HI had the greatest beneficial direct effects on yield, while variables such as number of grains per spike and tillers per plant influenced yield. The low residual effect shows that the examined characteristics account for the vast majority of yield variance. Unlike correlation, path analysis clarifies cause-and-effect linkages, allowing for more exact trait selection. These findings indicate that breeding efforts should concentrate Harvest Index and plant height in order to generate high-yielding wheat cultivars with increased productivity and selection efficiency.

**Table 1: Estimates of simple correlation coefficients between 11 characters in wheat**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Characters | DM | PH | TPP | SL | SPP | GPS | TGW | BYP | HI | GYP |
| DFF | 0.407\*\* | -0.049 | -0.088 | -0.090 | 0.018 | 0.038 | -0.043 | 0.043 | 0.026 | 0.054 |
| DM |  | -0.207 | -0.125 | 0.043 | 0.107 | 0.077 | 0.142 | -0.058 | 0.074 | -0.022 |
| PH |  |  | 0.197 | -0.096 | 0.121 | 0.090 | -0.120 | 0.092 | -0.077 | 0.066 |
| TPP |  |  |  | 0.154 | -0.012 | 0.262\* | -0.051 | 0.214 | -0.656\*\* | -0.026 |
| SL |  |  |  |  | 0.169 | 0.180 | 0.298\*\* | 0.142 | 0.018 | 0.142 |
| SPP |  |  |  |  |  | 0.057 | 0.162 | 0.036 | -0.040 | 0.014 |
| GPS |  |  |  |  |  |  | 0.140 | 0.215 | -0.105 | 0.171 |
| TGW |  |  |  |  |  |  |  | 0.123 | 0.122 | 0.156 |
| BYP |  |  |  |  |  |  |  |  | 0.008 | 0.935\*\* |
| HI |  |  |  |  |  |  |  |  |  | 0.360\*\* |

\* Significant at 5% level

\*\* Significant at 1% level

**Table 2: Direct and indirect effects of 11 characters on seed yield per plant in wheat**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Charact-ers | DFF | DM | PH | TPP | SL | SPP | GPS | TGW | BYP | HI | GYP |
| DFF | **0.0024** | 0.0033 | -0.0005 | -0.0006 | -0.0004 | -0.0001 | 0.0002 | 0.0001 | 0.0403 | 0.0094 | 0.054 |
| DM | 0.0010 | **0.0081** | -0.0020 | -0.0009 | 0.0002 | -0.0008 | 0.0004 | -0.0003 | -0.0539 | 0.0264 | -0.022 |
| PH | -0.0001 | -0.0017 | **0.0095** | 0.0014 | -0.0004 | -0.0009 | 0.0005 | 0.0003 | 0.0852 | -0.0275 | 0.066 |
| TPP | -0.0002 | -0.0010 | 0.0019 | **0.0070** | 0.0007 | 0.0001 | 0.0013 | 0.0001 | 0.1989 | -0.2348 | -0.026 |
| SL | -0.0002 | 0.0004 | -0.0009 | 0.0011 | **0.0043** | -0.0013 | 0.0009 | -0.0007 | 0.1319 | 0.0063 | 0.142 |
| SPP | 0.0000 | 0.0009 | 0.0012 | -0.0001 | 0.0007 | **-0.0078** | 0.0003 | -0.0004 | 0.0337 | -0.0142 | 0.014 |
| GPS | 0.0001 | 0.0006 | 0.0009 | 0.0018 | 0.0008 | -0.0005 | **0.0051** | -0.0003 | 0.2000 | -0.0375 | 0.171 |
| TGW | -0.0001 | 0.0012 | -0.0011 | -0.0004 | 0.0013 | -0.0013 | 0.0007 | **-0.0024** | 0.1143 | 0.0439 | 0.156 |
| BYP | 0.0001 | -0.0005 | 0.0009 | 0.0015 | 0.0006 | -0.0003 | 0.0011 | -0.0003 | **0.9287** | 0.0028 | 0.935\*\* |
| HI | 0.0001 | 0.0006 | -0.0007 | -0.0046 | 0.0001 | 0.0003 | -0.0005 | -0.0003 | 0.0073 | **0.3582** | 0.360\*\* |

Residual effect: 0.00147

Bold values indicate direct effects

**References**

**Alam, M. S., Naresh, R. K., Vivek, K. S., & Singh, H. L. (2022).** Effect of sowing methods and irrigation scheduling on production and productivity of wheat crop. In *Biological Forum–An International Journal* (Vol. 14, No. 2a, pp. 445-452).

**Baye, A., Berihun, B., Bantayehu, M. & Derebe, B. (2020).** Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (*Triticum aestivum* L.) lines. *Cogent Food & Agriculture*, 6:1.

**Bisht; Gahalain S.S. (2009).** Interrelationships and path coefficient analysis in wheat germplasm of kumaun Himalayas. *Vegetos,* 22(2): 19-26.

**Dabi, A., Mekbib, F. and Desalegn, T. (2016).** Estimation of genotypic and phenotypic correlation coefficients and path analysis of yield and yield contributing traits of bread wheat (*Triticum aestivum* L.) genotypes. *Int. J. of Natural Resource Ecology and Management*, 1(4): 145-154.

**Devesh,P.; Moitra, P.K. and Shukla, R.S. (2021).** Correlation and path coefficient analysis for yield, yield components and quality traits in wheat. *Electronic Journal of Plant Breeding,* 12(2): 388-395.

**Dewey, D.R. and Lu, K.H. (1959).** Correlation and path-coefficient analysis of components of crested wheat grass seed production. *Agron. J.,* 51: 515-518.

**Dutamo, D., Alamerew, S., Eticha, F. and Assefa, E. (2015).** Path coefficient and correlation studies of yield and yield associated traits in bread wheat (*Triticum aestivum* L.) Germplasm. *World App. Sci.s J.,* 33(11): 1732- 1739.

**ICAR-IIWBR (2024).** Director’s Report of AICRP on Wheat and Barley 2023-24, Eds: Ratan Tiwari, BS Tyagi, Sindhu Sareen, Anuj Kumar and Mamrutha HM**,** ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India. P.72

**Payal, Saxena., Rawat, R. S., Verma, J. S. and Meena, B. K. (2007).** Variability and association analysis for yield and quality traits in wheat. *Pant. J. of Res*., 5 (2): 85-92.

**Pooja, S.S.; Dhanda, N.R.; Yadav, R.S.; Beniwal and Anu. (2017).** Correlation and path coefficient analysis of some quantitative traits in recombinant inbred lines of bread wheat. *Inte. J. of Chem*., 6(3):350-354.

**Prasad, J.; Kerketta, V.; Prasad, K. D. and Verma, A. K. (2006).** Study of genetic parameters under different environment conditions in wheat (*Triticum aestivum* L.). *J. of Res. Birsa Agril. Uni*., 18 (1): 135-140.

**Saxena, P., Rawat, R.S., Verma, J.S. and Meena, B.K. (2007).** Variability and association analysis for yield and quality traits in wheat. *Pantnagar J. Res*., 5(2), 85-92.

**Searle, S.R. (1961).** Phenotypic, genotypic and environmental correlations.    *Biometrics*, 17: 474-480.

**Sharma A.; Singh H. (2009).** Studies on correlation and path coefficient analysis in bread wheat [*Triticum aestivum* (L.) em. Thell]. *National Journal of Plant Improvement*, 5(2): 106-109.

**Sharma, V.; Pawar, I.S.; Munjal R. (2006).** Variability parameters, correlation and path coefficients for yield, its components and quality traits in bread wheat. *National Journal of Plant Improvement* 8(2): 153-155.

**Singh A. K.; Singh, S. B.; Singh, A. P. and Sharma, A. K. (2012).** Genetic variability association and path analysis for seed yield and its component characters in wheat (*Triticum aestivum* L.). *In. J. of Ag. Research*, 46(1) 48-53.

**Tripathi, S. N., Shailesh, Marker., Praveen, Pandey., Jaiswal, K. K. and Tiwari, D. K. (2011).** Relationship between some morphological and physiological traits with grain yield in bread wheat (*Triticum aestivum* L.em.Thell.). *Trends in* *Applied Sci. Res.*, 6 (9): 1037-1045.