**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”. **(Singh *et al*., 2021) “**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”. (**Kumar *et al*., 2024**) 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***

Correlation coefficients of various yield-contributing factors are given in **Table 1.** Seed yield per plant demonstrated a highly significant, positive correlation with biological yield per plan (0.935), highlighting the significance of biomass accumulation in yield determination. It was also found to have a moderate and significant positive relationship with harvest index (0.360), indicating the effectiveness of biomass partitioning into economic yield. Moreover, SYPP had weak, non-significant but positive correlations with number of grains per spike (0.171), 1000-seed weight (0.156), spike length (0.142), plant height (0.066), days to 50% flowering (0.054), and spikelets per spike (0.014), showing a minimal but beneficial impact of these traits. Conversely, SYPP had negligible and non-significant negative correlations with Total tillers per plant (-0.026) and days to maturity (-0.022), indicating these traits may not play an effective role in seed yield improvement. Interestingly, tillers number per plant was highly and negatively correlated with harvest index (-0.656), which indicates that more tillering may compromise assimilate allocation efficiency. A very strong positive correlation was found between 1000-seed weight and spike length (0.298), which accentuates the contribution of longer spikes toward heavier seed development. Moreover, number of grains per spike was found to have a significant positive correlation with tiller number (0.262), implying a possible co-expression of yield attributes. Finally, a high and highly significant correlation was observed between days to maturity and days to 50% flowering (0.407), reflecting synchronized phenological development. 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 coefficient analysis is a very strong statistical method that allows the partitioning of total correlation into direct and indirect contributions of different traits towards a given dependent variable. A direct effect indicates the direct impact of an independent trait on seed yield per plant, while an indirect effect occurs when the impact is filtered through a linked character. Any residual variation that is not explained by factors left out in the analysis is accounted for by the residual effect. For the current analysis, the influence of 11 agronomic attributes on seed yield per plant was teased apart by using simple correlation-based path analysis, as shown in **Table 2.** The biological yield per plant attribute turned out to be the most significant factor, showing the highest direct effect on seed yield (0.9287). This was preceded by harvest index, which also had a significant direct effect (0.3582). Conversely, the other traits had only minor direct contributions, suggesting a more indirect contribution to seed yield determination. In terms of indirect contribution, number of grains per spike had the most positive indirect effect on seed yield through (0.2000). It was followed by number of tillers per plant (0.1989), spike length (0.1319), 1000-seed weight (0.1143), plant height (0.0852), days to 50% flowering (0.0403), and spikelets per spike (0.0337). These findings emphasize their supportive functions in boosting seed yield indirectly by enhancing biological yield. Similar study showed biological yield per plant (BYPP) and harvest index (HI) as significant donor to seed yield per plant **(Payal *et al.,* 2007, Jaiswal *et al.,* 2024, Singh *et al*., 2012, Dabi *et al.*, 2016, Singh2018, 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

**Disclaimer (Artificial intelligence)**

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