

## Original Research Article

Estimate of genotypic and phenotypic correlation and Path coefficients 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 experiment was conducted on different genotypes during crop season of *Rabi* 2021-2022 and 2022-2023 under normal (non-stressed) and late sown (heat-stressed) conditions. With the aim of to work out direct and indirect effects of different characters on yield. The field experiments were planted comprising 80 germplasm of bread wheat. Therefore, our experimental trials were conducted in 12 environments (E1 to E12), for the identification of superior yielding and stable germplasm accessions possessing heat-stress tolerance. The field experiments were laid out in Augmented Block Design (ABD). Observations were recorded on twenty-six quantitative characters. Grain yield per plant showed significant positive association with Grain weight per spike (0.7998\*\*), followed by Harvest index (0.7768\*\*), Spike bearing tillers per plant (0.6627\*\*), Number of grain per plant (0.658\*\*), Plant biomass (0.5754\*\*), Grain length (0.4203\*\*), Spike length (0.3174\*\*), Number of grain per spike (0.2734 \*). And significant negative association with Peduncle length (-0.4282\*\*), Plant waxiness (0.291\*\*), Plant height (-0.258\*), Chlorophyll content (-0.254\*). Grain yield per plant showed highly significant positive association with spike bearing tillers per plant (0.634\*\*), grain weight per spike (0.662\*\*), number of grain per plant (0.550\*\*), plant biomass (0.465\*\*), number of grain per spike (0.166\*\*), flag leaf area (0.1431\*), flag leaf length (0.127\*).

**Keywords:** Bread wheat (*Triticum aestivum* L.) correlation genotypic, phenotypic, path coefficient, quantitative trait.

### **INTRODUCTION**

Most wheat types grown now are hexaploid ( $2n=42$ ) species of the genus *Triticum*, which includes bread wheat (*Triticum aestivum* L.). The tetraploid durum wheat (*Triticum durum*), which has  $2n=28$ , is the second-most important species of wheat. It is a self-pollinating, hexaploid (AABBDD) plant with an estimated genome size of 16 GB and a number of chromosomes 42 ( $2n = 6x = 42$ ). Simple starches, or carbohydrates, make up 55–75% of the

dry grain weight of mature wheat grains, with storage proteins making up the remaining 10–20% of the starchy endosperm. With a level of protein of around 13%, which is comparatively high when compared to other main cereals, it is the primary source of vegetarian protein in human meals and the most significant source of carbohydrates in most nations worldwide. In addition to their importance in nutrition, wheat accounts for 20% of global dietary calories and about 55% of carbs. Its main contribution is the distinctive material known as "gluten," which is vital for bakers. Wheat straw is an excellent source of fodder for our country's cattle. The starchy endosperm of mature wheat grain is made up of carbohydrates (simple starches) that account for 55-75% of the total dry grain weight, as well as storage proteins that account for 10-20%. Wheat, when eaten whole, contains vitamins and dietary fibre. It includes minerals, vitamins, and lipids (Lafiandra *et al.*, 2014; Shewry *et al.*, 2015). Correlation in grouping with path analysis will provide a better understanding of the cause-and-effect relationship between distinct pairs of characters (Jayasudha and Sharma, 2010). Path analysis allows for the partitioning of total correlation into direct and indirect effects, which helps to make selection more successful. Correlation studies, along with path analysis, can offer a better knowledge of the interrelationship between different traits and grain yield, which can benefit breeders throughout the selection process. Correlation analyses are important for determining the degree and direction of the link between yield and its component qualities. Meanwhile, route coefficient analysis assesses the direct and indirect contribution of independent factors to dependent variables, which may help breeders determine yield components and identify the source of link between two variables. Path coefficient analysis provides information in indirect selection for yield genetic improvement, while direct selection does not supply enough information for a low heritable characteristic like yield.

## **MATERIAL AND METHODS**

The current investigation entitled “Unraveling genetic parameters of physio-morphological traits of terminal-heat stress tolerance in bread wheat (*Triticum aestivum* L.)” was conducted at three different locations; namely

- 1 Crop research farm, Nawabganj,
- 2 Crop research farm, Araul and
- 3 Crop research farm, Daleep Nagar.

during crop season of *Rabi* 2021-2022 and 2022-2023 under normal (non-stressed) and late sown (heat-stressed) conditions. The field experiments were planted comprising 80 germplasm of bread wheat. Therefore, our experimental trials were conducted in 12 environments (E1 to E12), for the identification of superior yielding and stable germplasm accessions possessing heat-stress tolerance. The field experiments were laid out in Augmented Block Design (ABD). Each experimental plot consisted of three rows of 2m length with 20 cm spacing between rows covering an area of 2 m x 0.20m (1.2 m<sup>2</sup>) under irrigated condition. Observations were recorded on twenty- six quantitative characters *viz.*, Days to 50% heading, Grain filling period(days), Flag leaf length(cm), Flag leaf width(cm), Flag leaf area(cm<sup>2</sup>), Plant height (cm), Peduncle length(cm), Spike bearing tillers per plant, Chlorophyll content, Canopy temperature depression(°C), Plant waxiness (0-10 scale), Leaf rolling (0-10 scale), Spike length(cm), Number of spikelets per spike, Physiological maturity(days), Plant biomass (g), Grain weight per spike, Number of grain per spike, Number of grain per plant, Grain length(mm), Grain width(mm), Grain L/W ratio, 1000-grain weight(g), Grain yield /plant(g), Harvest index (%), Yield per plot(g). The analysis of variance for 26 quantitative traits among 80 genotypes showed significant variation for all the traits studied. This indicates the presence of high degree of variability among the genotypes and ample scope of improvement by selection.

In plant breeding, correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. The phenotypic and genotypic correlation coefficients are ranged from -1 to +1 were calculated by following the method proposed by (Goulden, 1952).

#### **I. Genotypic correlation coefficient ( $r_{g(xy)}$ ):**

$$\text{Genotypic correlation coefficient } r_{g(xy)} = \frac{\text{COV. } g(xy)}{\sqrt{\sigma^2_{g_x} \times \sigma^2_{g_y}}}$$

Where,

$r_{g(xy)}$  = Genotypic correlation coefficient

COV.  $g(xy)$  = Genotypic covariance between the variables x and y

$\sigma^2_{g_x}, \sigma^2_{g_y}$  = Genotypic variance of the variables x and y respectively

x, y = Independent variable and dependent variable respectively

The significance of phenotypic correlation coefficients was tested against (n-2) degrees of freedom at 5% and 1% probability level. Where, n is the number of germplasm on which the observations were recorded.

**TABLE 1** Details of bread wheat accessions used in the study.

Sl.No	Genotypes	Sl.No	Genotypes
1	C-306	41	KRL-1-4
2	K-0307	42	KRL-19
3	K-0402	43	KRL-210
4	K-0607	44	KRL-213
5	K-1006	45	KRL-283
6	K-1317	46	EC-576930
7	K-1616	47	NINGMAI
8	K-1711	48	IC-35143
9	K-1803	49	IC-113734
10	K-1805	50	IC-116276
11	K-1809	51	IC-122126
12	K-1903	52	IC-128150
13	K-1905	53	IC-252429
14	K-1907	54	IC-252772
15	K-1908	55	IC-252794
16	K-1910	56	IC-290186
17	K-2001	57	IC-290195

18	K-2003	58	IC-335683
19	K-2007	59	IC-401927
20	K-2010	60	IC-449061
21	K-2101	61	IC-542051
22	K-2103	62	IC-574388
23	K-2104	63	IC-574476
24	K-2105	64	HD-2359
25	K-2107	65	HD-2967
26	K-2108	66	HD-3086
27	K-2109	67	HD-3388
28	K-2121	68	HD-3392
29	K-7903	69	HD-3399
30	K-8027	70	DBW-107
31	K-8434	71	DBW-175
32	K-8962	72	DBW-187
33	K-9107	73	DBW-222
34	K-9162	74	DBW-316
35	K-9351	75	HI-1563
36	K-9423	76	HI-1612
37	K-9465	77	PBW-826
38	K-9533	78	PBW-833
39	K-9644	79	PBW-835
40	WH-1142	80	PBW-852

## RESULT AND DISCUSSION

### Genotypic correlation:

Grain yield / plant had a significant positive correlation with grain weight per spike followed by harvest index, spike bearing tillers per plant, number of grain per plant, plant biomass, grain length, spike length and number of grain per spike. Yield per plot showed highly significant positive association with grain weight per spike, grain length and number of grain per plant. It was found that these results coincided with the findings of Laxman *et al.* (2014), Diyal *et al.* (2015), Abdul Hamid *et al.* (2017), Shimelis *et al.* (2019) and Akbarzai *et al.* (2022) for grain weight per spike; Ahmad *et al.* (2018) for spike length; Pooja *et al.* (2018) for harvest index, Shehrawat *et al.* (2021), Ezici *et al.* (2022), Tanveer *et al.* (2022), Akbarzai *et al.* (2023) and Hussain *et al.* (2023) for grain weight per spike, grain length and number of grain per plant. Traits such as grain weight per spike, grain length and number of grain per plant were found to be common in both grain yield per plant and yield per plot, thus selection based on these positively correlated characters will help in increasing the yield.

Days to 50% Heading showed highly significant positive association with Physiological maturity (0.318 \*\*), and Leaf rolling (0.295 \*\*), Grain filling period showed highly significant positive association with Number of spikelets per spike (0.625 \*\*), followed by Physiological maturity (0.585 \*\*), Leaf rolling (0.421\*\*), Number of grain per spike (0.240 \*), Chlorophyll content (0.236 \*), and significant negatively associated with Grain length (-0.481 \*\*), Grain L/W ratio (-0.359 \*\*), Plant waxiness (-0.358 \*\*), flag leaf length showed highly significant positive association with Flag leaf area (0.891\*\*), Chlorophyll content (0.385 \*\*) and significant negatively associated with Physiological maturity (-0.392\*\*), Flag leaf width showed highly significant positive association with flag leaf area (0.625\*\*), peduncle length (0.321\*\*), grain weight per spike (0.265\*), and significant negatively associated with plant waxiness (-0.309\*\*), 1000 grain weight (-0.259\*), flag leaf area showed highly significant positive association with grain weight per spike (0.334\*\*), chlorophyll content (0.3\*\*), number of spikelets per spikes (0.298\*), harvest index (0.280\*), grain yield per plant (0.244\*) and significant negatively associated with plant maturity (-0.372), plant waxiness (-0.228\*), plant height (-0.222\*), plant height showed highly significant positive association with peduncle length (0.882\*\*), chlorophyll content (0.281\*), and significant negatively associated with grain weight per spike (-0.530\*\*), leaf rolling (-0.363\*\*), yield per plot (-0.244\*), grain yield per plant (0.280\*), peduncle length showed highly significant positive association with chlorophyll content (0.331\*\*), and significant negatively associated with grain weight per spike (-0.624\*\*), leaf rolling (-0.478\*\*), physiological maturity (-0.435\*\*), grain yield per plant (-0.428), yield per plot (-0.403\*\*), spike bearing tillers per

plant showed highly significant positive association with number of grain per plant (0.738\*\*), followed by grain yield per plant (0.662\*\*), plant biomass (0.552\*\*), canopy temperature depression (0.489\*\*), harvest index (0.445\*\*) and significant negatively associated with yield per plot (-0.481\*\*), chlorophyll content (-0.354\*\*), plant waxiness (-0.293\*\*), Chlorophyll content showed highly significant positive association with number of grain per spike (0.246\*), and significant negatively associated with grain length (-0.310\*\*), plant biomass (-0.273\*), and grain yield per plant (-0.254\*), canopy temperature depression showed highly significant positive association with harvest index (0.344\*\*), grain length (0.341\*\*), 1000 grain weight (0.320\*\*), and significant negatively associated with number of grain per spike (-0.369\*\*), physiological maturity (-0.311\*\*), leaf rolling (-0.295\*\*), plant waxiness showed highly significant positive association with leaf rolling (0.233\*), 1000 grain weight (0.224\*), and significant negatively associated with plant biomass (-0.454\*\*), spike length (-0.437\*\*), number of spikelets per spike (-0.318\*\*), leaf rolling showed highly significant positive association with grain length (0.234\*), spike length showed highly significant positive association with number of spikelets per spike (0.609\*\*), followed by plant biomass (0.478\*\*), grain yield per plant (0.317\*\*), grain length (0.282\*), number of grain per plant (0.231\*), and significant negatively associated with 1000 grain weight (-0.267\*), Number of spikelets per spike showed highly significant positive association with grain width (0.298\*\*), followed by yield per plot (0.231\*), plant biomass (0.224\*), and significant negatively associated with grain length (-0.674\*\*), Grain L/W ratio (-0.496\*\*), Physiological maturity showed highly significant positive association with number of grain per spike (0.234\*), and significant negatively associated with 1000 grain weight (-0.370\*\*), harvest index (-0.282\*), plant biomass showed highly significant positive association with grain yield per plant (0.575\*\*), grain length (0.522\*\*), number of grain per plant (0.334\*\*), grain weight per spike (0.333\*\*), grain weight per spike showed highly significant positive association with grain yield per plant (0.799\*\*), followed by harvest index (0.728\*\*), grain length (0.422\*\*), yield per plot (0.367\*\*), number of grain per spike (0.244\*), number of grain per spike showed highly significant positive association with number of grain per spike (0.638\*\*), grain yield per plant (0.273\*), harvest index (0.257\*), and significant negatively associated with grain length (-0.743\*\*), Grain L/R ratio (-0.401\*\*), number of grain per plant showed highly significant positive association with Grain yield per plant (0.658\*\*), harvest index (0.481\*\*), and significant negatively associated with yield per plot (-0.388\*\*), grain length (-0.377\*\*), Grain L/R ratio (-0.241\*), grain length showed highly significant positive association with grain yield per plant (0.420\*\*), followed by Grain L/R ratio (0.332\*\*), yield

per plot (0.255\*), harvest index (0.225\*), and significant negatively associated with grain width (-0.370\*\*), grain width negatively associated with Grain L/R ratio (-0.893\*\*), Grain L/R ratio showed highly significant positive association with grain length (0.332\*\*) and significant negatively associated with number of spikelets per plant (-0.496\*\*), number of grain per spike (-0.401\*\*), 1000 grain weight showed highly significant positive association with canopy temperature depression (0.320\*\*), plant waxiness (0.224\*), significant positive association with Grain weight per spike (0.7998\*\*), followed by Harvest index (0.7768\*\*), Spike bearing tillers per plant (0.6627\*\*), Number of grain per plant (0.658\*\*), Plant biomass(0.5754\*\*), Grain length(0.4203\*\*), Spike length (0.3174\*\*), Number of grain per spike (0.2734 \*). And significant negative association with Peduncle length (-0.4282\*\*), Plant waxiness (0.291\*\*), Plant height (-0.258\*), Chlorophyll content (-0.254\*), harvest index showed highly significant positive association with grain weight per spike (0.728\*\*), grain yield per plant (0.776\*\*), number of grain per plant (0.481\*\*), yield per plot showed highly significant positive association with grain weight per spike (0.367\*\*), grain length (0.255\*), number of grain per plant (0.231\*), and significant negatively associated with spike bearing tillers per plant (-0.481\*\*), peduncle length (-0.403\*\*), plant height (-0.335\*\*).

### **Phenotypic correlation:**

Path coefficient analysis of different traits contributing towards grain yield per plant showed that flag leaf length had highest positive direct effect followed by number of grain per plant, flag leaf width, physiological maturity and yield per plot. Findings of Mohanty *et al.* (2016) supported the direct effect of number of grain per plant and yield per plot for grain yield per plant. Amin *et al.* (2017) also supported the direct effect of physiological maturity for grain yield per plant. Similar results were found by Khanal *et al.* (2020) for flag leaf width and Sapiet *et al.* (2017), Meena *et al.* (2021) Oliveira *et al.* (2021) Rohith *et al.* (2022) Abo-Elwafaet *et al.* (2023) Kumar *et al.* (2023) Santhoshini *et al.* (2023) and Singh *et al.* (2023) for number of grain per plant, flag leaf width, physiological maturity and yield per plot. Selection focusing on these traits may result in yield improvement.

Days to 50% heading showed significant positive association with physiological maturity (0.160\*), leaf rolling (0.153\*), grain filling period showed significant positive association with physiological maturity (0.147\*), and significant negatively associated with grain length (-0.133\*), harvest index (-0.129\*), flag leaf length showed highly significant positive association with flag leaf area (0.804\*\*), followed by grain weight per spike (0.174\*\*),

chlorophyll content (0.17\*\*), leaf rolling (0.167\*\*), harvest index (0.135\*), and significant negatively associated with plant waxiness (-0.147\*), flag leaf width showed highly significant positive association with flag leaf area (0.643\*\*), grain weight per spike (0.148\*), and significant negatively associated with plant waxiness (-0.180\*\*), 1000 grain weight (-0.171\*\*), flag leaf area showed highly significant positive association with grain weight per spike (0.207\*\*), chlorophyll content (-0.141\*), grain yield per plant (0.143\*), and significant negatively associated with plant waxiness (-0.193\*\*), plant height showed highly significant positive association with peduncle length (0.498\*\*), and significant negatively associated with leaf rolling (-0.199\*\*), grain weight per spike (-0.177\*\*), number of spikelets per spike, peduncle length showed highly significant positive association with chlorophyll content (0.149\*), and significant negatively associated with grain yield per plant (-0.265\*\*), grain weight per spike (-0.237\*\*), leaf rolling (-0.168\*\*), Spike bearing tillers per plant showed highly significant positive association with number of grain per plant (0.764\*\*), followed by grain yield per plant (0.634\*\*), harvest index (0.4485\*\*), plant biomass (0.295\*\*), and significant negatively associated with number of grain per plant, chlorophyll content showed highly significant positive association with flag leaf length (0.17\*\*), peduncle length (0.149\*), flag leaf area (0.141\*), Canopy temperature depression showed highly significant positive association with 1000 grain weight (0.202\*\*), number of spikelets per spike (0.136\*), and significant negatively associated with physiological maturity (-0.180\*\*), plant waxiness showed highly significant positive association with 1000 grain weight (0.179\*\*), and significant negatively associated with grain yield per plant (-0.156\*), leaf rolling showed significant positive association with flag leaf length (0.167\*\*), days of 50% heading (0.153\*), spike length showed significant positive association with number of spikelets per spike (0.152\*), and significant negatively associated with 1000 grain weight (-0.135\*), number of spikelets per spike showed highly significant positive association with plant biomass (0.143\*), and significant negatively associated with harvest index (-0.173\*\*), physiological maturity showed significant negatively associated with 1000 grain weight (-0.145\*), plant biomass showed highly significant positive association with grain yield per plant (0.465\*\*), grain weight per spike (0.270\*\*), number of grain per plant (0.216\*\*), and significant negatively associated with harvest index (-0.220\*\*), Grain weight per spike showed highly significant positive association with grain yield per plant (0.662\*\*), harvest index (0.498\*\*), yield per plot (0.136\*), number of grain per spike showed highly significant positive association with number of grain per plant (0.687\*\*), grain yield per plant (0.166\*\*), number of grain per plant showed highly significant positive association with grain yield per

plant (0.550\*\*), harvest index (0.388\*\*) and significant negatively associated with yield per plot (-0.144\*), grain length showed highly significant positive association with grain L/R ratio (0.433\*\*), grain width showed highly significant negatively associated with grain L/R ratio (-0.716), grain L/W ratio showed highly significant positive association with grain length (0.437\*\*), and significant negatively associated with grain width (-0.716\*\*), 1000 grain weight showed highly significant positive association with canopy temperature depression (0.202\*\*), plant waxing (0.179\*\*), and significant negatively associated with physiological maturity (-0.145\*), grain yield per plant showed highly significant positive association with spike bearing tillers per plant (0.634\*\*), grain weight per spike (0.662\*\*), number of grain per plant (0.550\*\*), plant biomass (0.465\*\*), number of grain per spike (0.166\*\*), flag leaf area (0.1431\*), flag leaf length (0.127\*), harvest index showed highly significant positive association with grain yield per plant (0.667\*\*), grain weight per spike (0.498\*\*), and significant negatively associated with grain filling period (-0.129\*), yield per plot showed highly significant positive association with grain weight per spike (0.136\*), and significant negatively associated with spike bearing tillers per plant (-0.213\*\*), peduncle length (-0.161\*).

### **Path coefficient analysis**

The estimation of genotypic path coefficient is depicted in Table 4 and 5.

#### **Genotypic path:**

##### **Direct effect:**

Path coefficient analysis of different traits contributing towards grain yield per plant showed that flag leaf length (24.356), had highest positive direct effect followed by number of grain per plant (17.724), flag leaf width (15.355), physiological maturity (4.701), yield per plot (4.355). All other traits showed direct effects which were mostly negative.

Days to 50% heading had maximum positive indirect effect on grain yield per plant through physiological maturity (1.496), and flag leaf length (1.456). While, it had negative indirect effect on grain yield per plant via flag leaf width (-0.726), and flag leaf area (-0.452), grain filling period had maximum positive indirect effect on grain yield per plant through number of grain per plant (2.905), physiological maturity (2.752), Grain weight per spike (1.465). While, it had negative indirect effect on Grain yield per plant via Plant waxiness (-0.897), flag leaf width (-0.628), flag leaf length had maximum positive indirect effect on grain yield per plant through flag leaf width (3.421), plant height (1.194), While, it had negative indirect effect on grain yield per plant via flag leaf area (-23.111), flag leaf width had maximum

positive indirect effect on grain yield per plant through flag leaf length (5.427), number of grain per plant (1.021), While, it had negative indirect effect on Grain yield per plant via flag leaf area (-16.215), grain weight per spike (-2.574), flag leaf area had maximum positive indirect effect on grain yield per plant through flag leaf length (21.722), flag leaf width (9.608), While, it had negative indirect effect on grain yield per plant via grain weight per spike (-3.251), physiological maturity (-1.753), plant height had maximum positive indirect effect on grain yield per plant through flag leaf area (5.772), followed by grain weight per spike (5.156), While, it had negative indirect effect on grain yield per plant via flag leaf length (-6.318), yield per plot (-1.461), peduncle length had maximum positive indirect effect on grain yield per plant through grain weight per spike (6.071), flag leaf width (4.934). While, it had negative indirect effect on grain yield per plant via plant height (-4.064), flag leaf length (-3.683), spike bearing tillers per plant had maximum positive indirect effect on grain yield per plant through number of grain per plant (13.095), followed by canopy temperature depression (1.785), plant biomass (1.386). While, it had negative indirect effect on grain yield per plant via yield per plot (-2.097), grain weight per spike (-0.825), chlorophyll content had maximum positive indirect effect on grain yield per plant through flag leaf length (9.377), followed by spike bearing tillers per plant (4.368), While, it had negative indirect effect on grain yield per plant via flag leaf area (-7.774), number of grain per plant (-2.481), canopy temperature depression had maximum positive indirect effect on grain yield per plant through number of grain per spike (3.084), number of grain per plant (1.948). While, it had negative indirect effect on grain yield per plant via: spike bearing tillers per plant (-6.036), physiological maturity (-1.462), plant waxiness had maximum positive indirect effect on grain yield per plant through flag leaf area (5.921), spike bearing tillers per plant (3.618), While, it had negative indirect effect on grain yield per plant via flag leaf width (-4.753), number of grain per plant (-4.907), leaf rolling had maximum positive indirect effect on grain yield per plant through flag leaf length (8.151), followed by plant height (1.673), spike per plant (0.602) While, it had negative indirect effect on grain yield per plant via flag leaf area (-5.139), spike length had maximum positive indirect effect on grain yield per plant through number of grain per plant (4.110), flag leaf length (1.679), number of grain per spike (1.490), While, it had negative indirect effect on grain yield per plant via spike bearing tillers per plant (-4.567), number of spikelets per spike, had maximum positive indirect effect on grain yield per plant through flag leaf length (5.807), flag leaf width (3.379). While, it had negative indirect effect on grain yield per plant via flag leaf area (-7.738), grain filling period (-1.276), physiological maturity had maximum positive indirect

effect on grain yield per plant through flag leaf area (9.664), number of grain per plant (1.610). While, it had negative indirect effect on grain yield per plant via flag leaf length (-9.550) had maximum positive indirect effect on grain yield per plant through number of grain per plant (5.921), flag leaf width (1.34). While, it had negative indirect effect on grain yield per plant via peduncle length (-0.608), grain weight per spike, had maximum positive indirect effect on grain yield per plant through flag leaf length (8.039), flag leaf width (4.067). While, it had negative indirect effect on grain yield per plant via flag leaf area (-8.667), number of grain per spike, had maximum positive indirect effect on grain yield per plant through number of grain per plant (11.308), flag leaf width (2.695). While, it had negative indirect effect on grain yield per plant via flag leaf width (-2.464), grain weight per spike (-2.372), number of grain per plant, had maximum positive indirect effect on grain yield per plant through harvest index (1.565), flag leaf width (0.884), plant biomass (0.838). While, it had negative indirect effect on grain yield per plant via number of grain per spike (-5.332), grain length, had maximum positive indirect effect on grain yield per plant through number of grain per spike (6.209), canopy temperature depression (1.243). While, it had negative indirect effect on grain yield per plant via number of grain per plant (-6.688), grain weight per spike (-4.102), grain width, had maximum positive indirect effect on grain yield per plant through number of grain per plant (3.548), flag leaf area (3.046). While, it had negative indirect effect on grain yield per plant via flag leaf length (-2.412), grain L/W ratio, had maximum positive indirect effect on grain yield per plant through number of grain per spike (3.355), flag leaf length (2.175). While, it had negative indirect effect on grain yield per plant via number of grain per plant (-4.289), 1000 grain weight, had maximum positive indirect effect on grain yield per plant through flag leaf area (1.687), canopy temperature depression (1.167). While, it had negative indirect effect on grain yield per plant via flag leaf width (-3.986), harvest index had maximum positive indirect effect on grain yield per plant through number of grain per plant (8.533), flag leaf length (6.631). While, it had negative indirect effect on grain yield per plant via; flag leaf area (-7.277), yield per plot had maximum positive indirect effect on grain yield per plant through spike bearing tillers per plant (5.939), flag leaf length (2.363). While, it had negative indirect effect on grain yield per plant via Number of grain per plant (-6.878), grain weight per spike (-3.568).

**Table 2 Genotypic correlation**

	<b>D50F</b>	<b>GFP</b>	<b>FLL</b>	<b>FLW</b>	<b>FLA</b>	<b>PH</b>	<b>PL</b>	<b>SBTPP</b>	<b>CC</b>	<b>CTD</b>	<b>PW</b>
<b>D50F</b>	1 **	-0.0392	0.0598	-0.0472	0.0175	-0.0286	-0.1693	-0.0542	-0.1439	-0.0724	-0.1521
<b>GFP</b>	-0.0392	1 **	-0.0032	-0.0408	-0.0295	-0.1593	0.056	-0.037	0.2368 *	0.1839	-0.3581 **
<b>FLL</b>	0.0598	-0.0032	1 **	0.2226 *	0.8919 **	-0.2594 *	-0.1512	0.0011	0.385 **	0.0551	-0.1447
<b>FLW</b>	-0.0472	-0.0408	0.2226 *	1 **	0.6253 **	-0.0219	0.321 **	-0.024	0.0328	-0.1623	-0.3093 **
<b>FLA</b>	0.0175	-0.0295	0.8919 **	0.6253 **	1 **	-0.2228 *	0.0035	0.0171	0.3 **	-0.0179	-0.2285 *
<b>PH</b>	-0.0286	-0.1593	-0.2594 *	-0.0219	-0.2228 *	1 **	0.8824 **	0.1134	0.2819 *	0.1472	-0.0926
<b>PL</b>	-0.1693	0.056	-0.1512	0.321 **	0.0035	0.8824 **	1 **	-0.1126	0.3312 **	0.0907	-0.2741 *
<b>SBTPP</b>	-0.0542	-0.037	0.0011	-0.024	0.0171	0.1134	-0.1126	1 **	-0.3542 **	0.4895 **	-0.2934 **
<b>CC</b>	-0.1439	0.2368 *	0.385 **	0.0328	0.3 **	0.2819 *	0.3312 **	-0.3542 **	1 **	0.0109	0.0284
<b>CTD</b>	-0.0724	0.1839	0.0551	-0.1623	-0.0179	0.1472	0.0907	0.4895 **	0.0109	1 **	0.0777
<b>PW</b>	-0.1521	-0.3581 **	-0.1447	-0.3093 **	-0.2285 *	-0.0926	-0.2741 *	-0.2934 **	0.0284	0.0777	1 **
<b>LR</b>	0.2952 **	0.421 **	0.3347 **	-0.145	0.1983	-0.3634 **	-0.4873 **	-0.0054	0.0155	-0.2955 **	0.2333 *
<b>SL</b>	-0.0673	0.0924	0.0689	-0.0708	-0.0316	0.1472	-0.0594	0.3704 **	-0.0524	0.1817	-0.4373 **
<b>NSPS</b>	-0.057	0.6253 **	0.2384 *	0.2197	0.2986 **	0.0446	0.0556	0.0541	-0.0365	0.2138	-0.3183 **
<b>PM</b>	0.3184 **	0.5855 **	-0.3925 **	-0.1134	-0.3729 **	-0.1196	-0.4358 **	-0.1453	-0.1168	-0.311 **	-0.099
<b>PB</b>	0.0764	-0.1575	-0.0257	0.0876	-0.0392	-0.0871	-0.3038 **	0.5525 **	-0.2732 *	0.0185	-0.4549 **
<b>GWPS</b>	-0.061	-0.1508	0.3301 **	0.2656 *	0.3344 **	-0.5303 **	-0.6245 **	0.0848	-0.0942	0.0494	-0.0524
<b>NGPS</b>	-0.0492	0.2404 *	-0.1012	0.1754	0.0174	-0.1706	-0.0541	-0.032	0.246 *	-0.369 **	-0.0178
<b>NGPP</b>	-0.07	0.1639	-0.0655	0.0576	0.0077	0.0168	-0.0861	0.7388 **	-0.14	0.1099	-0.2769 *
<b>GL</b>	0.1124	-0.4816 **	0.0438	-0.1184	-0.0197	-0.0268	-0.0817	0.2617 *	-0.3101 **	0.341 **	0.0937
<b>GW</b>	0.0542	0.1917	-0.099	-0.0662	-0.1175	-0.1091	-0.114	0.1378	-0.0011	0.203	0.1504
<b>GLWR</b>	0.0864	-0.3596 **	0.0892	0.0734	0.116	0.1874	0.101	-0.0014	-0.0567	-0.0826	-0.1275
<b>TW</b>	-0.0832	0.0654	0.0282	-0.2595 *	-0.0651	-0.1988	-0.1424	0.0217	0.0285	0.3201 **	0.2241 *
<b>GYPP</b>	-0.0245	-0.1834	0.1971	0.2127	0.244 *	-0.2589 *	-0.4282 **	0.6627 **	-0.254 *	0.178	-0.2915 **
<b>HI</b>	-0.0837	-0.3129 **	0.2723 *	0.1251	0.2809 *	-0.184	-0.2519 *	0.455 **	-0.1431	0.344 **	0.0168
<b>YPP</b>	-0.1091	-0.0952	0.097	0.0042	0.0627	-0.3355 **	-0.4034 **	-0.4816 **	-0.0479	-0.1593	0.129

	<b>LR</b>	<b>SL</b>	<b>NSPS</b>	<b>PM</b>	<b>PB</b>	<b>GWPS</b>	<b>NGPS</b>	<b>NGPP</b>	<b>GL</b>	<b>GW</b>	<b>GLWR</b>
<b>D50F</b>	0.2952 **	-0.0673	-0.057	0.3184 **	0.0764	-0.061	-0.0492	-0.07	0.1124	0.0542	0.0864
<b>GFP</b>	0.421 **	0.0924	0.6253 **	0.5855 **	-0.1575	-0.1508	0.2404 *	0.1639	-0.4816 **	0.1917	-0.3596 **
<b>FLL</b>	0.3347 **	0.0689	0.2384 *	-0.3925 **	-0.0257	0.3301 **	-0.1012	-0.0655	0.0438	-0.099	0.0892
<b>FLW</b>	-0.145	-0.0708	0.2197	-0.1134	0.0876	0.2656 *	0.1754	0.0576	-0.1184	-0.0662	0.0734
<b>FLA</b>	0.1983	-0.0316	0.2986 **	-0.3729 **	-0.0392	0.3344 **	0.0174	0.0077	-0.0197	-0.1175	0.116
<b>PH</b>	-0.3634 **	0.1472	0.0446	-0.1196	-0.0871	-0.5303 **	-0.1706	0.0168	-0.0268	-0.1091	0.1874
<b>PL</b>	-0.4873 **	-0.0594	0.0556	-0.4358 **	-0.3038 **	-0.6245 **	-0.0541	-0.0861	-0.0817	-0.114	0.101
<b>SBTPP</b>	-0.0054	0.3704 **	0.0541	-0.1453	0.5525 **	0.0848	-0.032	0.7388 **	0.2617 *	0.1378	-0.0014
<b>CC</b>	0.0155	-0.0524	-0.0365	-0.1168	-0.2732 *	-0.0942	0.246 *	-0.14	-0.3101 **	-0.0011	-0.0567
<b>CTD</b>	-0.2955 **	0.1817	0.2138	-0.311 **	0.0185	0.0494	-0.369 **	0.1099	0.341 **	0.203	-0.0826
<b>PW</b>	0.2333 *	-0.4373 **	-0.3183 **	-0.099	-0.4549 **	-0.0524	-0.0178	-0.2769 *	0.0937	0.1504	-0.1275
<b>LR</b>	1 **	-0.0751	-0.164	0.1182	0.0036	0.046	0.0144	-0.0028	0.2341 *	0.1547	0.0443
<b>SL</b>	-0.0751	1 **	0.6093 **	0.0124	0.4783 **	0.207	-0.1783	0.2319 *	0.2822 *	0.1584	-0.062
<b>NSPS</b>	-0.164	0.6093 **	1 **	-0.1344	0.2249 *	0.0428	0.0653	0.1839	-0.6746 **	0.2983 **	-0.4963 **
<b>PM</b>	0.1182	0.0124	-0.1344	1 **	0.0303	0.0058	0.2341 *	0.0909	-0.0491	0.0907	-0.0653
<b>PB</b>	0.0036	0.4783 **	0.2249 *	0.0303	1 **	0.3331 **	-0.1327	0.3341 **	0.5221 **	0.0512	0.1392
<b>GWPS</b>	0.046	0.207	0.0428	0.0058	0.3331 **	1 **	0.244 *	0.1914	0.4222 **	-0.0598	0.1434
<b>NGPS</b>	0.0144	-0.1783	0.0653	0.2341 *	-0.1327	0.244 *	1 **	0.638 **	-0.743 **	0.1848	-0.4013 **
<b>NGPP</b>	-0.0028	0.2319 *	0.1839	0.0909	0.3341 **	0.1914	0.638 **	1 **	-0.3774 **	0.2001	-0.2419 *
<b>GL</b>	0.2341 *	0.2822 *	-0.6746 **	-0.0491	0.5221 **	0.4222 **	-0.743 **	-0.3774 **	1 **	-0.3702 **	0.3322 **
<b>GW</b>	0.1547	0.1584	0.2983 **	0.0907	0.0512	-0.0598	0.1848	0.2001	-0.3702 **	1 **	-0.8933 **
<b>GLWR</b>	0.0443	-0.062	-0.4963 **	-0.0653	0.1392	0.1434	-0.4013 **	-0.2419 *	0.3322 **	-0.8933 **	0.9996 **
<b>TW</b>	0.0853	-0.2679 *	0.2084	-0.3708 **	-0.0702	-0.0188	0.0398	0.061	-0.1192	-0.1688	0.0893
<b>GYPP</b>	0.1251	0.3174 **	-0.0319	-0.0923	0.5754 **	0.7998 **	0.2734 *	0.658 **	0.4203 **	0.1148	0.0363
<b>HI</b>	0.0752	0.2109	-0.2161	-0.2821 *	0.1179	0.728 **	0.2573 *	0.4814 **	0.2258 *	0.0623	-0.0553
<b>YPP</b>	0.0824	-0.0908	0.2319 *	-0.1034	-0.1034	0.367 **	-0.0135	-0.3881 **	0.2553 *	-0.0892	0.1163

	<b>TW</b>	<b>GYPP</b>	<b>HI</b>	<b>YPP</b>
<b>D50F</b>	-0.0832	-0.0245	-0.0837	-0.1091
<b>GFP</b>	0.0654	-0.1834	-0.3129 **	-0.0952
<b>FLL</b>	0.0282	0.1971	0.2723 *	0.097
<b>FLW</b>	-0.2595 *	0.2127	0.1251	0.0042
<b>FLA</b>	-0.0651	0.244 *	0.2809 *	0.0627
<b>PH</b>	-0.1988	-0.2589 *	-0.184	-0.3355 **
<b>PL</b>	-0.1424	-0.4282 **	-0.2519 *	-0.4034 **
<b>SBTPP</b>	0.0217	0.6627 **	0.455 **	-0.4816 **
<b>CC</b>	0.0285	-0.254 *	-0.1431	-0.0479
<b>CTD</b>	0.3201 **	0.178	0.344 **	-0.1593
<b>PW</b>	0.2241 *	-0.2915 **	0.0168	0.129
<b>LR</b>	0.0853	0.1251	0.0752	0.0824
<b>SL</b>	-0.2679 *	0.3174 **	0.2109	-0.0908
<b>NSPS</b>	0.2084	-0.0319	-0.2161	0.2319 *
<b>PM</b>	-0.3708 **	-0.0923	-0.2821 *	-0.1034
<b>PB</b>	-0.0702	0.5754 **	0.1179	-0.1034
<b>GWPS</b>	-0.0188	0.7998 **	0.728 **	0.367 **
<b>NGPS</b>	0.0398	0.2734 *	0.2573 *	-0.0135
<b>NGPP</b>	0.061	0.658 **	0.4814 **	-0.3881 **
<b>GL</b>	-0.1192	0.4203 **	0.2258 *	0.2553 *
<b>GW</b>	-0.1688	0.1148	0.0623	-0.0892
<b>GLWR</b>	0.0893	0.0363	-0.0553	0.1163
<b>TW</b>	1 **	-0.0536	-0.0741	0.1499
<b>GYPP</b>	-0.0536	1 **	0.7768 **	0.0252
<b>HI</b>	-0.0741	0.7768 **	1 **	0.0273
<b>YPP</b>	0.1499	0.0252	0.0273	1 **

**Table 3 Phenotypic correlation**

	<b>D50F</b>	<b>GFP</b>	<b>FLL</b>	<b>FLW</b>	<b>FLA</b>	<b>PH</b>	<b>PL</b>	<b>SBTTP</b>	<b>CC</b>	<b>CTD</b>	<b>PW</b>
<b>D50F</b>	1 **	-0.0213	0.022	-0.019	0.0029	-0.018	-0.1184	-0.0458	-0.0851	-0.0506	-0.1151
<b>GFP</b>	-0.0213	1 **	-0.012	0.0768	0.0328	-0.0528	-0.0064	-0.0901	0.033	0.0054	-0.07
<b>FLL</b>	0.022	-0.012	1 **	0.0897	0.8041 **	-0.1525 *	0.0031	0.017	0.17 **	0.1085	-0.1475 *
<b>FLW</b>	-0.019	0.0768	0.0897	1 **	0.6435 **	0.044	0.1207	-0.1024	0.0309	-0.0757	-0.1808 **
<b>FLA</b>	0.0029	0.0328	0.8041 **	0.6435 **	1 **	-0.1118	0.0661	-0.0375	0.1416 *	0.0431	-0.1939 **
<b>PH</b>	-0.018	-0.0528	-0.1525 *	0.044	-0.1118	1 **	0.4984 **	0.064	0.0208	0.053	-0.0808
<b>PL</b>	-0.1184	-0.0064	0.0031	0.1207	0.0661	0.4984 **	1 **	-0.0965	0.1496 *	0.0637	-0.1327 *
<b>SBTTP</b>											
<b>P</b>	-0.0458	-0.0901	0.017	-0.1024	-0.0375	0.064	-0.0965	1 **	-0.1004	0.1993 **	-0.1266
<b>CC</b>	-0.0851	0.033	0.17 **	0.0309	0.1416 *	0.0208	0.1496 *	-0.1004	1 **	0.0841	0.0099
<b>CTD</b>	-0.0506	0.0054	0.1085	-0.0757	0.0431	0.053	0.0637	0.1993 **	0.0841	1 **	0.0835
<b>PW</b>	-0.1151	-0.07	-0.1475 *	-0.1808 **	-0.1939 **	-0.0808	-0.1327 *	-0.1266	0.0099	0.0835	1 **
<b>LR</b>	0.1537 *	0.0189	0.1674 **	-0.0483	0.1241	-0.1991 **	-0.1686 **	-0.0661	0.0088	0.011	0.0621
<b>SL</b>	-0.0319	0.0468	0.0244	-0.0483	-0.0291	0.0596	-0.0788	0.1078	-0.0573	0.0788	-0.1082
<b>NSPS</b>	-0.0016	0.0782	0.0838	-0.0154	0.0495	-0.1304 *	0.0262	0	-0.0205	0.1365 *	-0.0637
<b>PM</b>	0.1606 *	0.1476 *	-0.0657	-0.0595	-0.0994	-0.0216	-0.0779	-0.0587	0.0068	-0.1804 **	-0.0802
<b>PB</b>	0.0421	-0.0133	-0.0177	0.0765	0.0072	-0.0862	-0.1367 *	0.2956 **	-0.0982	0.0591	-0.0583
<b>GWPS</b>	-0.0503	-0.0098	0.174 **	0.1484 *	0.2076 **	-0.1772 **	-0.2375 **	0.0286	-0.1135	0.0444	-0.027
<b>NGPS</b>	-0.0344	-0.0197	0.0115	-0.0128	0.0217	-0.0406	-0.0106	0.0797	0.0752	-0.1172	0.0199
<b>NGPP</b>	-0.0477	-0.0678	0.0126	-0.0886	-0.0237	0.0441	-0.0657	0.7649 **	-0.0255	0.0651	-0.0888
<b>GL</b>	0.0379	-0.1335 *	-0.0693	-0.054	-0.0886	-0.0172	-0.0441	0.0768	-0.1266	-0.0078	0.0241
<b>GW</b>	0.0347	0.0513	-0.1102	-0.0558	-0.1215	0.0186	-0.0714	0.0369	-0.0183	0.0843	0.0837

<b>GLWR</b>	0.0466	-0.1209	0.0803	-0.0179	0.0442	-0.0044	0.0296	-0.005	-0.0769	-0.081	-0.0567
<b>TW</b>	-0.0786	0.0214	0.0035	-0.1719 **	-0.0711	-0.1184	-0.1068	0.0094	0.0293	0.2024 **	0.1794 **
<b>GYPP</b>	-0.0325	-0.0977	0.1278 *	0.101	0.1431 *	-0.109	-0.2651 **	0.6341 **	-0.1212	0.0919	-0.1565 *
<b>HI</b>	-0.0734	-0.1293 *	0.1359 *	-0.0047	0.0972	-0.0529	-0.1633 *	0.4485 **	-0.0571	0.1128	-0.0992
<b>YPP</b>	-0.0521	0.008	0.0202	0.0032	0.0036	-0.132 *	-0.1612 *	-0.2133 **	-0.1088	-0.1125	-0.0082

	<b>LR</b>	<b>SL</b>	<b>NSPS</b>	<b>PM</b>	<b>PB</b>	<b>GWPS</b>	<b>NGPS</b>	<b>NGPP</b>	<b>GL</b>	<b>GW</b>	<b>GLWR</b>
<b>D50F</b>	0.1537 *	-0.0319	-0.0016	0.1606 *	0.0421	-0.0503	-0.0344	-0.0477	0.0379	0.0347	0.0466
<b>GFP</b>	0.0189	0.0468	0.0782	0.1476 *	-0.0133	-0.0098	-0.0197	-0.0678	-0.1335 *	0.0513	-0.1209
<b>FLL</b>	0.1674 **	0.0244	0.0838	-0.0657	-0.0177	0.174 **	0.0115	0.0126	-0.0693	-0.1102	0.0803
<b>FLW</b>	-0.0483	-0.0483	-0.0154	-0.0595	0.0765	0.1484 *	-0.0128	-0.0886	-0.054	-0.0558	-0.0179
<b>FLA</b>	0.1241	-0.0291	0.0495	-0.0994	0.0072	0.2076 **	0.0217	-0.0237	-0.0886	-0.1215	0.0442
<b>PH</b>	-0.1991 **	0.0596	-0.1304 *	-0.0216	-0.0862	-0.1772 **	-0.0406	0.0441	-0.0172	0.0186	-0.0044
<b>PL</b>	-0.1686 **	-0.0788	0.0262	-0.0779	-0.1367 *	-0.2375 **	-0.0106	-0.0657	-0.0441	-0.0714	0.0296
<b>SBTP</b>								0.7649			
<b>P</b>	-0.0661	0.1078	0	-0.0587	0.2956 **	0.0286	0.0797	**	0.0768	0.0369	-0.005
<b>CC</b>	0.0088	-0.0573	-0.0205	0.0068	-0.0982	-0.1135	0.0752	-0.0255	-0.1266	-0.0183	-0.0769
<b>CTD</b>	0.011	0.0788	0.1365 *	-0.1804 **	0.0591	0.0444	-0.1172	0.0651	-0.0078	0.0843	-0.081
<b>PW</b>	0.0621	-0.1082	-0.0637	-0.0802	-0.0583	-0.027	0.0199	-0.0888	0.0241	0.0837	-0.0567
<b>LR</b>	1 **	-0.0625	-0.0635	0.0333	-0.0176	-0.0199	0.0202	-0.0391	-0.0671	0.0329	-0.049
<b>SL</b>	-0.0625	1 **	0.1521 *	0.0201	0.0921	0.0991	-0.0918	0.0332	0.0299	0.0376	-0.0206
<b>NSPS</b>	-0.0635	0.1521 *	1 **	-0.0081	0.1439 *	0.0059	-0.074	-0.0309	-0.0131	-0.0428	0.0333
<b>PM</b>	0.0333	0.0201	-0.0081	1 **	-0.0497	-0.0348	0.0253	-0.0221	-0.0771	-0.0034	-0.0405

<b>PB</b>	-0.0176	0.0921	0.1439 *	-0.0497	1 **	0.2703 **	0.0216	0.2161 **	0.0422	0.0198	-0.0236
<b>GWPS</b>	-0.0199	0.0991	0.0059	-0.0348	0.2703 **	1 **	0.0998	0.0728	-0.0389	-0.0351	-0.0097
<b>NGPS</b>	0.0202	-0.0918	-0.074	0.0253	0.0216	0.0998	1 **	0.6807 **	-0.0999	0.0838	-0.1287 *
<b>NGPP</b>	-0.0391	0.0332	-0.0309	-0.0221	0.2161 **	0.0728	0.6807 **	1 **	-0.0291	0.0757	-0.0864
<b>GL</b>	-0.0671	0.0299	-0.0131	-0.0771	0.0422	-0.0389	-0.0999	-0.0291	1 **	0.0423	0.4377 **
<b>GW</b>	0.0329	0.0376	-0.0428	-0.0034	0.0198	-0.0351	0.0838	0.0757	0.0423	1 **	-0.7169 **
<b>GLWR</b>	-0.049	-0.0206	0.0333	-0.0405	-0.0236	-0.0097	-0.1287 *	-0.0864	0.4377 **	-0.7169 **	0.9999 **
<b>TW</b>	0.0302	-0.1358 *	0.0892	-0.1451 *	-0.0441	-0.0116	0.0301	0.0328	-0.0561	-0.1023	0.0366
<b>GYPP</b>	-0.0659	0.1096	-0.0335	-0.0831	0.4658 **	0.6627 **	0.1662 **	0.5506 **	0.0116	0.0377	-0.0288
<b>HI</b>	-0.0714	0.0497	-0.173 **	-0.106	-0.2203 **	0.498 **	0.1062	0.3885 **	-0.013	0.0065	-0.0126
<b>YPP</b>	0.0033	-0.037	-0.0723	-0.0173	-0.0512	0.1366 *	-0.0115	-0.144 *	0.028	-0.0092	0.0091

	<b>TW</b>	<b>GYPP</b>	<b>HI</b>	<b>YPP</b>
<b>D50F</b>	-0.0786	-0.0325	-0.0734	-0.0521
<b>GFP</b>	0.0214	-0.0977	-0.1293 *	0.008
<b>FLL</b>	0.0035	0.1278 *	0.1359 *	0.0202
<b>FLW</b>	-0.1719 **	0.101	-0.0047	0.0032
<b>FLA</b>	-0.0711	0.1431 *	0.0972	0.0036
<b>PH</b>	-0.1184	-0.109	-0.0529	-0.132 *
<b>PL</b>	-0.1068	-0.2651 **	-0.1633 *	-0.1612 *
<b>SBTPP</b>	0.0094	0.6341 **	0.4485 **	-0.2133 **
<b>CC</b>	0.0293	-0.1212	-0.0571	-0.1088
<b>CTD</b>	0.2024 **	0.0919	0.1128	-0.1125
<b>PW</b>	0.1794 **	-0.1565 *	-0.0992	-0.0082
<b>LR</b>	0.0302	-0.0659	-0.0714	0.0033
<b>SL</b>	-0.1358 *	0.1096	0.0497	-0.037
<b>NSPS</b>	0.0892	-0.0335	-0.173 **	-0.0723
<b>PM</b>	-0.1451 *	-0.0831	-0.106	-0.0173
<b>PB</b>	-0.0441	0.4658 **	-0.2203 **	-0.0512
<b>GWPS</b>	-0.0116	0.6627 **	0.498 **	0.1366 *
<b>NGPS</b>	0.0301	0.1662 **	0.1062	-0.0115
<b>NGPP</b>	0.0328	0.5506 **	0.3885 **	-0.144 *
<b>GL</b>	-0.0561	0.0116	-0.013	0.028
<b>GW</b>	-0.1023	0.0377	0.0065	-0.0092
<b>GLWR</b>	0.0366	-0.0288	-0.0126	0.0091
<b>TW</b>	1 **	-0.0452	-0.0543	0.0911
<b>GYPP</b>	-0.0452	1 **	0.6677 **	-0.0222
<b>HI</b>	-0.0543	0.6677 **	1 **	0.0155
<b>YPP</b>	0.0911	-0.0222	0.0155	1 **

	<b>TW</b>	<b>GYPP</b>	<b>HI</b>	<b>YPP</b>
<b>D50F</b>	-0.0832	-0.0245	-0.0837	-0.1091
<b>GFP</b>	0.0654	-0.1834	-0.3129 **	-0.0952
<b>FLL</b>	0.0282	0.1971	0.2723 *	0.097
<b>FLW</b>	-0.2595 *	0.2127	0.1251	0.0042
<b>FLA</b>	-0.0651	0.244 *	0.2809 *	0.0627
<b>PH</b>	-0.1988	-0.2589 *	-0.184	-0.3355 **
<b>PL</b>	-0.1424	-0.4282 **	-0.2519 *	-0.4034 **
<b>SBTPP</b>	0.0217	0.6627 **	0.455 **	-0.4816 **
<b>CC</b>	0.0285	-0.254 *	-0.1431	-0.0479
<b>CTD</b>	0.3201 **	0.178	0.344 **	-0.1593
<b>PW</b>	0.2241 *	-0.2915 **	0.0168	0.129
<b>LR</b>	0.0853	0.1251	0.0752	0.0824
<b>SL</b>	-0.2679 *	0.3174 **	0.2109	-0.0908
<b>NSPS</b>	0.2084	-0.0319	-0.2161	0.2319 *
<b>PM</b>	-0.3708 **	-0.0923	-0.2821 *	-0.1034
<b>PB</b>	-0.0702	0.5754 **	0.1179	-0.1034
<b>GWPS</b>	-0.0188	0.7998 **	0.728 **	0.367 **
<b>NGPS</b>	0.0398	0.2734 *	0.2573 *	-0.0135
<b>NGPP</b>	0.061	0.658 **	0.4814 **	-0.3881 **
<b>GL</b>	-0.1192	0.4203 **	0.2258 *	0.2553 *
<b>GW</b>	-0.1688	0.1148	0.0623	-0.0892
<b>GLWR</b>	0.0893	0.0363	-0.0553	0.1163
<b>TW</b>	1 **	-0.0536	-0.0741	0.1499
<b>GYPP</b>	-0.0536	1 **	0.7768 **	0.0252
<b>HI</b>	-0.0741	0.7768 **	1 **	0.0273
<b>YPP</b>	0.1499	0.0252	0.0273	1 **

**Table.4. Phenotypic Path Analysis**

Traits	D50F	GFP	FLL	FLW	FLA	PH	PL	SBTPP	CC	CTD	PW	LR	SL
<b>D50F</b>	- <b>0.07405</b>	- 0.00013	- 0.05729	0.03858	0.00994	- 0.00131	0.00259	- 0.00266	- 0.00961	0.00445	0.01601	- 0.00697	- 0.00045
<b>GFP</b>	0.00158	<b>0.00605</b>	0.03071	-0.1598	0.11344	- 0.00386	0.00013	- 0.00527	0.0037	- 0.00055	0.00968	- 0.00084	0.00065
<b>FLL</b>	- 0.00164	- 0.00007	- <b>2.58083</b>	- 0.17949	2.75572	- 0.01115	- 0.00006	0.00101	0.01917	-0.0096	0.02056	- 0.00758	0.00034
<b>FLW</b>	0.00141	0.00048	- 0.22815	- <b>1.99716</b>	2.20396	0.00316	- 0.00256	- 0.00599	0.00362	0.00689	0.02522	0.00176	- 0.00083
<b>FLA</b>	- 0.00021	0.0002	- 2.07524	- 1.30579	<b>3.42743</b>	- 0.00817	- 0.00145	-0.0022	0.01599	- 0.00377	0.02702	- 0.00563	- 0.00041
<b>PH</b>	0.00133	- 0.00032	0.39383	- 0.08792	- 0.38315	<b>0.07304</b>	- 0.01092	0.00376	0.00236	-0.0047	0.01127	0.00904	0.00083
<b>PL</b>	0.00876	- 0.00004	- 0.00748	- 0.23695	0.22653	0.0364	- <b>0.02191</b>	- 0.00568	0.01688	- 0.00562	0.0185	0.00762	- 0.00109
<b>SBTP P</b>	0.00336	- 0.00054	- 0.04439	0.20711	- 0.12852	0.00467	0.00212	<b>0.05869</b>	- 0.01137	- 0.01762	0.01753	0.00301	0.00147
<b>CC</b>	0.00631	0.0002	- 0.43874	- 0.06518	0.48596	0.00153	- 0.00328	- 0.00591	<b>0.1128</b>	- 0.00743	- 0.00137	- 0.00039	-0.0008
<b>CTD</b>	0.00373	0.00004	- 0.28079	0.15858	0.14668	0.00389	-0.0014	0.01172	0.0095	- <b>0.08819</b>	- 0.01161	- 0.00056	0.00112
<b>PW</b>	0.00851	- 0.00042	0.38093	0.36751	- 0.66451	- 0.00591	0.00291	- 0.00738	0.00111	- 0.00735	- <b>0.13944</b>	- 0.00281	- 0.00152
<b>LR</b>	- 0.01139	0.00011	- 0.43126	0.07878	0.42564	- 0.01456	0.00368	- 0.00389	0.00096	- 0.00108	- 0.00864	- <b>0.04527</b>	- 0.00089
<b>SL</b>	0.00241	0.00028	- 0.06271	0.12203	-0.1011	0.00435	0.00173	0.00622	- 0.00647	- 0.00715	0.01524	0.0029	<b>0.01389</b>

<b>NSPS</b>	0.00013	0.00047	- 0.21653	0.02904	0.16998	- 0.00953	- 0.00057	0.0000	- 0.00229	- 0.01203	0.00881	0.00284	0.00211
<b>PM</b>	- 0.01189	0.0009	0.17033	0.11919	- 0.34065	- 0.00158	0.00171	- 0.00346	0.00076	0.01589	0.01113	- 0.00152	0.0003
<b>PB</b>	- 0.00313	- 0.00008	0.04568	- 0.15513	0.02467	-0.0063	0.00299	0.01735	- 0.01108	- 0.00521	0.00812	0.0008	0.00128
<b>GWP S</b>	0.00392	- 0.00007	- 0.44158	- 0.39655	0.70324	- 0.01288	0.00523	0.00178	- 0.01241	-0.0041	0.00301	0.00105	0.00124
<b>NGPS</b>	0.00255	- 0.00012	- 0.02968	0.02904	0.07471	- 0.00297	0.00023	0.00469	0.00848	0.01032	- 0.00277	- 0.00092	- 0.00127
<b>NGPP</b>	0.00353	- 0.00041	- 0.03252	0.1801	- 0.08122	0.00322	0.00144	0.04488	- 0.00288	- 0.00573	0.01237	0.00177	0.00046
<b>GL</b>	- 0.00274	- 0.00077	0.18505	0.0000	- 0.30638	-0.0012	0.00104	0.00453	-0.0141	0.00149	- 0.00327	0.00342	0.00027
<b>GW</b>	- 0.00282	0.00031	0.29344	0.0000	- 0.40474	0.00136	0.00151	0.00256	- 0.00233	- 0.00788	- 0.01297	- 0.00151	0.00036
<b>GLW R</b>	- 0.00344	- 0.00065	- 0.20853	0.0000	0.14394	- 0.00024	- 0.00058	0.0000	- 0.00911	0.0063	0.00691	0.00241	- 0.00038
<b>TW</b>	0.00581	0.00013	- 0.00877	0.35391	- 0.24401	- 0.00865	0.00234	0.00056	0.0033	- 0.01779	- 0.02502	- 0.00138	- 0.00188
<b>HI</b>	0.00543	- 0.00078	- 0.35073	0.00893	0.33311	- 0.00387	0.00358	0.02632	- 0.00645	- 0.00993	0.01382	0.00323	0.00068
<b>YPP</b>	0.00386	0.00005	- 0.05213	-0.0065	0.01234	- 0.00964	0.00353	- 0.01252	- 0.01227	0.00992	0.00114	- 0.00015	- 0.00051

<b>Traits</b>	<b>NSPP</b>	<b>PM</b>	<b>PB</b>	<b>GWPS</b>	<b>NGPS</b>	<b>NGPS</b>	<b>GL</b>	<b>GW</b>	<b>GLWR</b>	<b>TW</b>	<b>HI</b>	<b>YPP</b>
<b>D50F</b>	-0.00002	0.0146	0.02415	-0.01871	0.0041	-0.00728	-0.01453	0.03942	0.05049	-0.00007	-0.0412	-0.00243
<b>GFP</b>	0.00082	0.01345	-0.00778	-0.00414	0.00231	-0.01035	0.05012	0.05235	-0.11741	0.00002	-0.07279	0.00037

<b>FLL</b>	0.00089	-0.00600	-0.01013	0.06052	-0.00137	0.00192	0.02816	-0.11763	0.08792	0.0000	0.07639	0.00094
<b>FLW</b>	-0.00015	-0.00534	0.04373	0.06908	0.00171	-0.01354	0.0000	0.0000	0.0000	-0.00016	-0.00247	0.00015
<b>FLA</b>	0.00053	-0.00904	0.00412	0.07258	-0.0026	-0.00362	0.03511	-0.12218	0.0457	-0.00007	0.05463	0.00017
<b>PH</b>	-0.00139	-0.00196	-0.04934	-0.06236	0.00484	0.00673	0.00644	0.01924	-0.00359	-0.00011	-0.02979	-0.00616
<b>PL</b>	0.00028	-0.00708	-0.07824	-0.08446	0.00126	-0.01003	0.01858	-0.07118	0.02905	-0.0001	-0.09179	-0.00752
<b>SBTPP</b>	0.0000	-0.00535	0.16924	0.01075	-0.00953	0.11678	-0.03032	0.04521	0.0000	0.00001	0.25214	-0.00995
<b>CC</b>	-0.00022	0.00061	-0.0562	-0.03891	-0.00897	-0.00389	0.0491	-0.02142	-0.08792	0.00003	-0.03215	-0.00508
<b>CTD</b>	0.00145	-0.01638	0.03383	0.01645	0.01395	0.00992	0.00664	0.09239	-0.07769	0.00019	0.06329	-0.00525
<b>PW</b>	-0.00067	-0.00726	-0.03337	-0.00764	-0.00237	-0.01356	-0.00923	0.09632	-0.05397	0.00017	-0.05576	-0.00038
<b>LR</b>	-0.00067	0.00305	-0.01013	-0.00817	-0.00241	-0.00597	0.02962	0.03435	-0.05778	0.00003	-0.04008	0.00015
<b>SL</b>	0.00162	0.00195	0.05266	0.03166	0.01091	0.00507	-0.00766	0.02669	-0.02992	-0.00012	0.02765	-0.00173
<b>NSPS</b>	<b>0.01066</b>	-0.00077	0.08236	0.00301	0.00881	-0.00472	0.00365	-0.0508	0.04276	0.00008	-0.09729	-0.00337
<b>PM</b>	-0.00009	<b>0.09088</b>	-0.0285	-0.01238	-0.00302	-0.00337	0.02993	-0.00869	-0.04864	-0.00013	-0.05958	-0.00081
<b>PB</b>	0.00153	-0.00453	<b>0.57235</b>	0.09518	-0.00258	0.03299	-0.01693	0.02059	-0.02644	-0.00004	-0.12382	-0.00239
<b>GWPS</b>	0.00009	-0.00318	0.15402	<b>0.34959</b>	-0.01182	0.01111	0.02486	0.0000	0.0000	-0.00001	0.28008	0.00637
<b>NGPS</b>	-0.00079	0.0023	0.01236	0.03505	<b>-0.11927</b>	0.10392	0.03877	0.08432	-0.14189	0.00003	0.05964	-0.00054
<b>NGPP</b>	-0.00033	-0.00201	0.12368	0.02575	-0.08118	<b>0.15267</b>	0.01143	0.07811	-0.09423	0.00003	0.21836	-0.00672
<b>GL</b>	-0.0001	-0.00693	0.02467	-0.02239	0.01177	-0.00444	<b>-0.37923</b>	0.0000	0.52882	-0.00005	-0.00804	0.0013
<b>GW</b>	-0.00052	-0.00076	0.01139	0.0000	-0.00972	0.01153	0.0000	<b>0.9972</b>	-0.83871	-0.00009	0.00214	-0.00044
<b>GLWR</b>	0.00042	-0.00406	-0.01391	0.0000	0.01555	-0.01322	-0.19089	-0.79743	<b>1.04338</b>	0.00003	-0.0068	0.00042
<b>TW</b>	0.00095	-0.0132	-0.02536	-0.0035	-0.00359	0.00501	0.02325	-0.10304	0.04124	<b>0.00092</b>	-0.03058	0.00425
<b>HI</b>	-0.00184	-0.00964	-0.12609	0.17625	-0.01265	0.05931	0.00562	0.00393	-0.01317	-0.00005	<b>0.56207</b>	0.00072
<b>YPP</b>	-0.00077	-0.00157	-0.0293	0.04828	0.00137	-0.02198	-0.01096	-0.00972	0.0099	0.00008	0.00871	<b>0.04665</b>

Residual effect = 0.0764

**Table.5. Genotypic Path Analysis**

	<b>D50F</b>	<b>GFP</b>	<b>FLL</b>	<b>FLW</b>	<b>FLA</b>	<b>PH</b>	<b>PL</b>	<b>SBTPP</b>	<b>CC</b>	<b>CTD</b>	<b>PW</b>	<b>LR</b>	<b>SL</b>
<b>D50F</b>	<b>-0.5585</b>	0.0800	1.4560	-0.7265	-0.4525	0.1318	-0.3389	0.6680	0.0395	-0.2641	-0.3813	-0.2761	-0.1566
<b>GFP</b>	0.0219	<b>-2.0408</b>	-0.0775	-0.6282	0.7634	0.7335	0.1121	0.4564	-0.0650	0.6706	-0.8979	-0.3937	0.2154
<b>FLL</b>	-0.0334	0.0065	<b>24.3561</b>	3.4216	-23.1114	1.1949	-0.3028	-0.0139	-0.1057	0.2011	-0.3628	-0.3131	0.1606
<b>FLW</b>	0.0264	0.0835	5.4272	<b>15.3552</b>	-16.2150	0.1007	0.6434	0.2966	-0.0090	-0.5931	-0.7763	0.1358	-0.1645
<b>FLA</b>	-0.0098	0.0601	21.7222	9.6084	<b>-25.9134</b>	1.0260	0.0070	-0.2104	-0.0823	-0.0652	-0.5730	-0.1855	-0.0737
<b>PH</b>	0.0160	0.3250	-6.3189	-0.3357	5.7725	<b>-4.6058</b>	1.7668	-1.3985	-0.0774	0.5369	-0.2323	0.3399	0.3428
<b>PL</b>	0.0945	-0.1143	-3.6836	4.9344	-0.0907	-4.0642	<b>2.0022</b>	1.3881	-0.0909	0.3309	-0.6873	0.4558	-0.1383
<b>SBTPP</b>	0.0303	0.0755	0.0275	-0.3693	-0.4421	-0.5223	-0.2254	<b>-12.3322</b>	0.0972	1.7854	-0.7357	0.0050	0.8625
<b>CC</b>	0.0804	-0.4834	9.3770	0.5041	-7.7740	-1.2986	0.6631	4.3680	<b>-0.2744</b>	0.0397	0.0712	-0.0145	-0.1221
<b>CTD</b>	0.0404	-0.3752	1.3430	-2.4968	0.4631	-0.6780	0.1816	-6.0364	-0.0030	<b>3.6474</b>	0.1948	0.2764	0.4233
<b>PW</b>	0.0849	0.7308	-3.5238	-4.7538	5.9212	0.4267	-0.5488	3.6182	-0.0078	0.2833	<b>2.5074</b>	-0.2182	-1.0183
<b>LR</b>	-0.1649	-0.8591	8.1519	-2.2290	-5.1399	1.6736	-0.9757	0.0661	-0.0043	-1.0779	0.5849	<b>-0.9353</b>	-0.1749
<b>SL</b>	0.0376	-0.1888	1.6796	-1.0844	0.8202	-0.6781	-0.1189	-4.5677	0.0144	0.6630	-1.0964	0.0702	<b>2.3287</b>
<b>NSPS</b>	0.0319	-1.2760	5.8076	3.3791	-7.7383	-0.2052	0.1114	-0.6672	0.0100	0.7798	-0.7982	0.1533	1.4189
<b>PM</b>	-0.1778	-1.1948	-9.5587	-1.7417	9.6641	0.5509	-0.8726	1.7914	0.0320	-1.1344	-0.2482	-0.1106	0.0289
<b>PB</b>	-0.0427	0.3214	-0.6247	1.3457	1.0161	0.4012	-0.6083	-6.8134	0.0750	0.0674	-1.1407	-0.0034	1.1139
<b>GWPS</b>	0.0341	0.3077	8.0399	4.0670	-8.6670	2.4433	-1.2507	-1.0469	0.0259	0.1797	-0.1314	-0.0430	0.4823
<b>NGPS</b>	0.0275	-0.4906	-2.4646	2.6956	-0.4512	0.7856	-0.1083	0.3946	-0.0675	-1.3461	-0.0447	-0.0135	-0.4152
<b>NGPP</b>	0.0391	-0.3345	-1.5956	0.8848	-0.1990	-0.0772	-0.1724	-9.1114	0.0384	0.4010	-0.6943	0.0026	0.5401
<b>GL</b>	-0.0628	0.9823	1.0653	-1.8001	0.5115	0.1235	-0.1637	-3.2262	0.0851	1.2436	0.2348	-0.2189	0.6584
<b>GW</b>	-0.0303	-0.3914	-2.4120	-1.0466	3.0466	0.5028	-0.2284	-1.7016	0.0003	0.7407	0.3772	-0.1448	0.3697
<b>GLWR</b>	-0.0483	0.7345	2.1757	1.1357	-3.0091	-0.8637	0.2024	0.0162	0.0156	-0.3006	-0.3196	-0.0413	-0.1448
<b>TW</b>	0.0465	-0.1335	0.6873	-3.9865	1.6870	0.9157	-0.2852	-0.2676	-0.0078	1.1675	0.5619	-0.0798	-0.6237
<b>HI</b>	0.0468	0.6386	6.6311	1.9220	-7.2778	0.8474	-0.5044	-5.6114	0.0393	1.2549	0.0422	-0.0704	0.4911
<b>YPP</b>	0.0610	0.1943	2.3635	0.0651	-1.6243	1.5453	-0.8077	5.9397	0.0131	-0.5810	0.3233	-0.0771	-0.2115

	NSPP	PM	PB	GWPS	NGPS	NSPS	GL	GW	GLWR	TW	HI	YPP
<b>D50F</b>	0.2096	1.4969	0.1918	0.5935	0.4111	-1.2412	0.0174	-0.0360	-0.0140	-0.1270	-0.2722	-0.4754
<b>GFP</b>	-2.2970	2.7527	-0.3953	1.4655	-2.0092	2.9053	-0.0746	-0.1273	0.0583	0.0998	-1.0173	-0.4146
<b>FLL</b>	-0.8760	-1.8452	-0.0644	-3.2087	0.8457	-1.1611	0.0068	0.0657	-0.0145	0.0431	0.8852	0.4227
<b>FLW</b>	-0.8084	-0.5333	0.2200	-2.5746	-1.4672	1.0213	-0.0182	0.0452	-0.0120	-0.3962	0.4070	0.0185
<b>FLA</b>	-1.0971	-1.7535	-0.0984	-3.2511	-0.1455	0.1361	-0.0031	0.0780	-0.0188	-0.0994	0.9131	0.2730
<b>PH</b>	-0.1637	-0.5623	-0.2186	5.1565	1.4256	0.2972	-0.0042	0.0724	-0.0304	-0.3034	-0.5982	-1.4613
<b>PL</b>	-0.2044	-2.0491	-0.7625	6.0719	0.4522	-1.5262	-0.0127	0.0757	-0.0164	-0.2174	-0.8191	-1.7569
<b>SBTPP</b>	-0.1988	-0.6830	1.3866	-0.8252	0.2675	13.0951	0.0405	-0.0916	0.0002	0.0331	1.4794	-2.0978
<b>CC</b>	0.1341	-0.5491	-0.6856	0.9158	-2.0561	-2.4810	-0.0480	0.0008	0.0092	0.0435	-0.4653	-0.2085
<b>CTD</b>	-0.7854	-1.4623	0.0464	-0.4788	3.0845	1.9484	0.0528	-0.1348	0.0134	0.4885	1.1186	-0.6938
<b>PW</b>	1.1695	-0.4655	-1.1418	0.5096	0.1489	-4.9076	0.0145	-0.0998	0.0206	0.3420	0.0548	0.5616
<b>LR</b>	0.6022	0.5557	0.0090	-0.4473	-0.1208	-0.0495	0.0363	-0.1027	-0.0071	0.1302	0.2445	0.3588
<b>SL</b>	-2.2384	0.0583	1.2005	-2.0130	1.4901	4.1109	0.0438	-0.1053	0.0101	-0.4088	0.6856	-0.3957
<b>NSPS</b>	<b>-3.6737</b>	-0.6318	0.5644	-0.4151	-0.5461	3.2598	-0.1046	-0.1980	0.0804	0.3181	-0.7026	1.0101
<b>PM</b>	0.4937	<b>4.7017</b>	0.0760	-0.0553	-1.9568	1.6108	-0.0076	-0.0603	0.0106	-0.5659	-0.9171	-0.4503
<b>PB</b>	-0.8261	0.1424	<b>2.5098</b>	-3.2385	1.1090	5.9211	0.0809	-0.0340	-0.0225	-0.1071	0.3833	-0.4504
<b>GWPS</b>	-0.1569	0.0268	0.8362	<b>-9.7205</b>	-2.0397	3.3936	0.0654	0.0402	-0.0232	-0.0288	2.3675	1.5988
<b>NGPS</b>	-0.2400	1.1008	-0.3330	-2.3722	<b>-8.3579</b>	11.3083	-0.1151	-0.1227	0.0650	0.0607	0.8366	-0.0589
<b>NGPP</b>	-0.6757	0.4273	0.8384	-1.8612	-5.3325	<b>17.7241</b>	-0.0585	-0.1329	0.0392	0.0932	1.5653	-1.6904
<b>GL</b>	2.4783	-0.2313	1.3103	-4.1025	6.2097	-6.6887	<b>0.1550</b>	0.2467	-0.0538	-0.1820	0.7342	1.1119
<b>GW</b>	-1.0959	0.4272	0.1286	0.5893	-1.5446	3.5484	-0.0576	<b>-0.6636</b>	0.1447	-0.2578	0.2026	-0.3886
<b>GLWR</b>	1.8243	-0.3071	0.3494	-1.3951	3.3553	-4.2892	0.0515	0.5931	<b>-0.1619</b>	0.1363	-0.1796	0.5067
<b>TW</b>	-0.7656	-1.7435	-0.1761	0.1833	-0.3326	1.0819	-0.0185	0.1121	-0.0145	<b>1.5261</b>	-0.2410	0.6531
<b>HI</b>	0.7939	-1.3262	0.2959	-7.0780	-2.1507	8.5331	0.0350	-0.0414	0.0089	-0.1131	<b>3.2513</b>	0.1187
<b>YPP</b>	-0.8520	-0.4861	-0.2595	-3.5681	0.1130	-6.8787	0.0396	0.0592	-0.0188	0.2289	0.0886	<b>4.3555</b>

Residual effect = 0.8297

## CONCLUSION:

Based on the above result of correlation studies it could be concluded that characters like Yield per plot showed highly significant positive association with grain weight per spike, grain length and number of grain per plant. Path coefficient analysis of different traits contributing towards grain yield per plant showed that flag leaf length had highest positive direct effect followed by number of grain per plant, flag leaf width, physiological maturity and yield per plot. Thus, this finding indicated that these traits could utilize in various breeding as well as improvement programmes. The information may further help the breeders in formulating appropriate strategy aimed at getting higher yield and character improvement in Bread wheat.

## References:

- Abdul Hamid, M.I.E, Qabil, N. and El-Saadony, F.M.A.2017. Genetic variability, correlation and path analyses for yield and yield components of some bread wheat genotypes. *Journal of Plant Production*, 8(8), pp.845-852
- Abo-Elwafa, A, Taib, A, Abo-Sapra, H.M. and Bakheit, B.R. 2023. Path coefficient analysis for grain yield and some of its attributes in bread wheat (*Triticum aestivum* L.). *Assiut Journal of Agricultural Sciences*, 54(1), pp.1-18.
- Ahmad, T, Kumar, A, Pandey, D. and Prasad, B. 2018. Correlation and path coefficient analysis for yield and its attributing traits in bread wheat (*Triticum aestivum* L.). *Journal of Applied and Natural Science*, 10(4), pp.1078-1084.
- Akbarzai, D.K, Singh, V, Yashveer, S, Nimbai, S, Kumar, M, Dalal, M.S, Mor, V.S. and Devi, S. 2023. Evaluation of genetic diversity of wheat (*Triticum aestivum* L) lines under terminal heat stress in the Hisar Environment. *Science Letters*, 11(2), pp.59-66.
- Akbarzai, D.K, Singh, V, Yashveer, S, Nimbai, S, Kumar, M, Mor, V.S. and Mohammadi, L. 2022. Genetic variability and traits association in wheat under terminal heat stress in the Haryana environment. *International Journal of Agriculture and Food Science*, 4(2), 129-135.
- Amin, M.F, Hasan, M, Barma, N.C.D, Rahman, M.A. and Rahman, M.M. 2017. Character association and path co-efficient analysis in wheat (*Triticum aestivum* L.). *Bangladesh Journal of Agricultural Research*, 42(3), pp.571-588.

- Diyali, S, Priya, B. and Mukherjee, S.2015. Character association and path coefficient analysis among yield attributing traits in bread wheat. *An International Quarterly Journal of Environment Science*,6, 75-80.
- Ezici, A. A,Hızlı, H,Yaktubay, S, Ay, H, and Oluk, C. A 2022. Interpretation of morphological and quality characteristics affecting yield in some bread wheat (*Triticum aestivum* L.) genotypes by path, correlation analysis and genetic variability. *International Journal of Agriculture and Environmental Science*,9(2),15-21
- Hussain, S, Sadia, B, Sadaqat, H.A. and Awan, F.S.2023. Evaluation of yield component and heat susceptibility of Pakistani wheat (*Triticum aestivum* L.) germplasm subjected to induced terminal heat stress. *Pak. J. Bot*, 55(3), pp.873-891.
- Jayasudha, S. and Sharma, D. 2010. Genetic parameters of variability, correlation and pathcoefficient for grain yield and physiological traits in Rice (*Oryza sativa* L.) under shallow lowland situation. *Electronic J. Plant Breed*. 1: 33-38
- Khanal, D, Thapa, D.B, Dhakal, K.H, Pandey, M.P. and Kandel, B.P. 2020. Correlation and path coefficient analysis of elite spring wheat lines developed for high temperature tolerance. *Environment & Ecosystem Science*, 4(2), pp.56-59.
- Kumar, D, Rana, V, Rana, A. and Guleria, P. 2023. Genetic variability, correlation and path analysis studies for grain yield and morpho-physiological traits under moisture-stress conditions in bread wheat (*Triticum aestivum* L.) under north-western Himalayan conditions. *Journal of Cereal Research* 15 (1): 92-102.
- Lafiandra, D, Riccardi, G. and Shewry, P.R. Improving cereal grain carbohydrates for diet and health. *Journal of cereal science*, 2014; 59(3), pp.312-26.
- Laxman; Singh, V, Solanki, Y.P.S. and Redhu, A.S. 201. Phenological development, grain growth rate and yield relationships in wheat cultivars under late sown condition. *Indian Journal of Plant Physiology*, 19(3), pp.222-229.
- Matlala, M, Shimelis, H. and Mashilo, J. 2019. Genotype-by-environment interaction of grain yield among candidate dryland wheat genotypes. *South African Journal of Plant and Soil*, 36(4), pp.299-306.
- Meena, V.K, Sharma, R.K, Yadav, S, Kumar, N,Gajghate, R. and Singh, A. 2021. Selection parameters for improving grain yield of bread wheat under terminal heat stress. *Indian Journal of Agricultural Sciences*, 91(3), pp.468-73.
- Mohanty, S, Mukherjee, S,Mukhopadhyaya, S.K. and Dash, A.P. 2016. Genetic variability,

- correlation and path analysis of bread wheat (*Triticum aestivum* L.) genotypes under terminal heat stress. *International Journal of Bio-resource and Stress Management*, 7(6), pp.1232-1238.
- Oliveira, C.E.D.S, Andrade, A.D.F, Zoz, A, Lustosa Sobrinho, R. and Zoz, T. 2021. Genetic divergence and path analysis in wheat cultivars under heat stress. *Pesquisa Agropecuária Tropical*, 50. e65493
- Pooja, C, Singh, V. and Yadav, S. 2018. Path coefficient and correlation studies of yield and yield associated traits in diverse genotypes of bread wheat (*Triticum aestivum* L.). *Int. J. Chem. Stud*, 6, pp.73-76.
- Priya, AA. and Joel, AJ. 2009. Grain yield response of rice cultivars under upland condition, *Electronic J. Plant Breed*. 1: 6-11.
- Rohith, K, Talekar, N, Sree, C. C, and Pranay, J. 2022. Assessment of correlation and path analysis for yield and yield contributing traits in bread wheat (*Triticum aestivum* L. Em. Thell).
- Santhoshini, A, Dubey, N, Avinash, H.A, Thonta, R. and Kumar, R. 2023. Inheritance studies in segregating population of bread wheat (*Triticum aestivum* L.). *International Journal of Environment and Climate Change*, 13(9), pp.277-287.
- Sapi, S, Marker, S. and Bhattacharjee, I. 2017. Correlation and path coefficient analysis of some quantitative traits in bread wheat. *Journal of Pharmacognosy and Phytochemistry*, 6(4), pp.258-262.
- Shehrawat, S. and Kumar, Y. 2021. Genetic architecture of morpho-physiological traits in wheat accessions under terminal heat stress. *Ekin Journal of Crop Breeding and Genetics*, 7(1), pp.34
- Shewry, P.R. and Hey, S.J. 2015 The contribution of wheat to human diet and health. *Food and energy security*, 4(3), pp.178-202.
- Singh, H, Singh, B, Tiwari, S, Yadav, O. P, Kohli, S, Ali, Z. and Kumar, R. 2023. Study of correlation and path coefficient analysis for yield attributing traits in selected rils of diverse wheat (*Triticum aestivum* L.) genotypes for heat tolerance. *Environment Conservation Journal*, 24(2), 54–60.
- Tanveer, H, Singh, R. K, Singh, H and Singh, S. 2022. Genetic variability and character association in wheat (*Triticum aestivum* L.). *SKUAST Journal of Research*, 24(1),

46-52.

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