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Research Article

PATH ANALYSIS IN M4 MICRO MUTANTS IN WHEAT

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Abstract- Information on the mutual association of traits is important for effective selection in plant breeding program. An experiment was conducted at R. B. S. College, Bichpuri, Agra to evaluate the direct and indirect effects of yield related traits on grain yield. Path coefficients were studied for twelve characters in six desired mutants of wheat. Days to 50% flowering, exerted high order of positive direct effects towards yield per plant followed by plant height at flag leaf stage and germination percentage. Days to germination made positive contribution towards yield per plant, spike length and weight of 500 seeds. This implies the true relationship between these traits and grain yield; therefore, due attention should be given on such traits during selection for further improvement.

Keywords- *Path coefficients, Mutation, Correlation, Selection*

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Introduction

Bread wheat (*Triticum aestivum* L.) is one of the most important food crops of the world, and continuous improvement in its productivity will be required to keep pace with global population growth. Induced mutations are of considerable values for comprehending evolution and accelerating the process of plant improvement. Radical changes in agriculture techniques and human needs and their prejudices as well, force the plant breeder to employ all available methods, including mutation for the improvement of cultivated plants.

The correlation coefficient simply indicates degree of association among the characters, contributing towards economic yield and it has been quite useful as basis of selection. However, it does not provide measure of casual relationship existing among variables. Selection based on simple correlation coefficient without considering interactions among yield and yield components may mislead the breeders to reach their main breeding purpose [1,2]. Path analysis can be used to calculate the quantitative impact on grain yield through direct and indirect effects caused by one or the other component traits [3,4]. It provides an effective means of partitioning correlation coefficients into direct and indirect effects and illuminates the relationship in a more meaningful way. Path analysis thus permits a critical examination of specific factors that produce a given correlation and can be successfully employed in formulating an effective selection strategy [5].

Material and Methods

Present investigation was carried out at Agricultural Research Farm of R.B.S.College, Bichpuri, Agra. The experimental material used in the present investigation comprised of six M4 mutants of HD 2329 variety of *Triticum aestivum* L. induced by gamma rays. Dwarf plant, Semi-dwarf plant, long spike, Tall plant, Long seed and High tillering plants were selected as desirable mutants from the M3 generation. Three varieties *viz*., UP 2338, HD 2329 and RR 21 were used as a check. The experiments were laid out in a simple Randomized Block Design with three replications. Each of the treatment accommodated four rows of three meter length with a spacing of 9x22.5 cm. Seeds were shown in the field with spacing of row to row was kept 5 cm. All the agronomical packages and practices were applied to raise healthy crop.

Observations were recorded both on the plot basis and single plant basis. For single plant observations ten competitive plants from each plot were randomly selected. Average of these plants in respect to different plant characters was taken for statistical analysis. The data were recorded from the randomly selected plant from the field for various quantitative characters viz., days to germination, germination percentage, plant height at flag leaf stage, days to 50% flowering, seedling injury, spike length, numbers of effective tillers, number of seeds per spikelet, number of seeds per spike, number of spikelets per spike, weight of 500 seeds and yield per plant. Path coefficient of different characters were estimated according to Wright (1921) [6] and Dewey and Lu (1959) [7].

Results and Discussion

With the help of path coefficient analysis, correlation coefficients of all the characters with yield per plant were partitioned into the direct and indirect effects.

Direct effect

Days to 50% flowering (0.791), exerted high order of positive direct effects towards yield per plant followed by height at flag leaf stage (0.784) and germination percentage (0.752).

Days to germination, number of seeds per spikelet, number of seeds per spike and weight of 500 seeds also made direct positive contribution towards yield per plant, but in low order. However, number of spikelets per spike exerted high direct negative contribution towards yield per plant. Seedling injury, spike length and number of effective tillers exerted lower direct negative contribution towards yield per plant.

Indirect effects

Days to germination made positive contribution towards yield per plant, spike length and weight of 500 seeds followed by high positive contribution via number of spikelets per spike and number of seeds per spike. However, it made high negative contribution towards days to 50% flowering, height at flag leaf stage, seedling injury and germination percentage.

Table-1 Path coefficient analysis showing direct and indirect effects of yield components on yield per plant

Characters	Plant	Yield per Germination	Days to % age	Germination to 50% Flowering	Days length	Spike flag leaf stage	Height at effective tillers	No. of spikelets per spike	No. of seeds per spikelet	No. of Seeds per spike	No. of of 500 seeds	Weight injury	Seedling
Days to germination	0.236	0.242	-0.319	-0.888	0.195	-0.986	-0.14	0.646	-0.222	0.394	0.1	-0.523	
Germination % age	-0.311	0.242	0.752	-0.845	-0.142	0.326	0.154	0.521	0.944	-0.364	-0.392	-0.324	
Days to 50% flowering	0.957	0.934	-0.537	0.791	0.262	-0.407	-0.665	-0.156	-0.319	0.612	0.765	-0.220	
Spike length	0.585	-0.436	-0.332	0.790	-0.161	-0.163	-0.246	-0.396	-0.419	0.120	0.112	-0.728	
Height at flag leaf stage	0.143	-0.486	-0.558	0.793	-0.162	0.784	-0.420	0.183	-0.355	-0.152	0.911	-0.549	
Number of effective tillers	-0.423	0.478	0.193	-0.248	0.874	-0.783	-0.490	0.719	0.372	-0.102	-0.647	0.193	
Number of spikelets per Spike	-0.313	-0.258	-0.311	0.640	0.612	-0.115	-0.488	-0.604	-0.391	0.114	0.578	-0.704	
Number of seeds per Spikelet	0.868	-0.378	-0.385	0.547	-0.954	-0.481	-0.315	-0.606	0.158	0.150	0.113	-0.115	
Number of seeds per spike	-0.559	-0.559	-0.345	0.602	0.157	-0.508	-0.354	-0.577	0.157	0.160	0.106	-0.851	
Weight of 500 seeds	0.144	-0.581	-0.254	0.543	-0.904	-0.309	-0.172	-0.420	0.102	0.164	0.235	-0.102	
Seedling injury	-0.164	-0.104	0.752	0.156	-0.349	0.120	0.201	0.202	0.310	-0.724	-0.554	-0.220	

Number of effective tillers and number of seeds per spikelet exerted lower negative contribution with days to germination. Germination percentage caused high negative effects towards yield per plant via days to 50% flowering, seedling injury, number of seeds per spike and weight of 500 seeds It was negatively correlated with spike length. It had high positive effects through number of seeds per spikelet (0.944), number of spikelets per spike and height at flag leaf stage, while positive effects through days to germination and number of effective tillers, seedling injury exerted negative contribution towards yield per plant via days to germination. It had high negative effects through number of seeds per spike, weight of 500 seeds and spike length. However, it made high positive contribution towards height at flag leaf stage, number of effective tillers and number of spikelets per spike. Days to 50% flowering exhibited high positive contribution towards yield per plant via days to germination, weight of 500 seeds and number of seeds per spike. It had positive effects through spike length. On the other hand, it exerted high negative effect towards germination percentage, height at flag leaf stage, number of effective tillers and number of seeds per spikelet. It caused negative effects via seedling injury and number of spikelets per spike.

Spike length exhibited high positive contribution towards yield per plant via days to 50% flowering. It caused positive effects via number of seeds per spike and weight of 500 seeds. On the other hand, it exerted high negative effect towards seedling injury, days to germination percentage, number of spikelets per spike. It caused negative effects via height at flag leaf stage and number of effective tillers.

Height at flag leaf stage made positive contribution towards grain yield via number of spikelets per spike. It caused high positive effects towards weight of 500 seeds and days to 50% flowering. It had high negative effects through days to germination, germination percentage, seedling injury, number of effective tillers and number of seeds per spikelet, while negative effects through spike length and number of seeds per spike.

Number of effective tillers exerted high negative effects towards yield per plant via weight of 500 seeds while negative effect through days to 50% flowering and number of seeds per spike. On the other hand, it exhibited high positive effects via days to germination, spike length, height at flag leaf stage, number of spikelets per spike and number of seeds per spikelet, while it had positive effect towards germination percentage and seedling injury.

Number of spikelets per spike made high negative effect towards yield per plant via germination percentage, seedling injury, number of effective tillers and number of seeds per spikelet followed by lower order of negative contribution via days to germination and height at flag leaf stage. It contributed high positively via days to 50% flowering, spike length and weight of 500 seeds, while it had positive effect towards number of seeds per spike.

Number of seeds per spikelet caused high positive contribution towards grain yield via days to 50% flowering followed by lower order of positive contribution via number of seeds per spike and weight of 500 seeds. On the other hand, it exerted high negative effect towards days to germination, seedling injury, spike length, height at flag leaf stage, number of effective tillers and number of spikelets per spike, while it caused negative effect towards seedling injury.

Number of seeds per spike exerted high positive contribution towards yield via days to 50% flowering followed by a lower order of positive contribution via spike length, number of seeds per spikelet and weight of 500 seeds. However, it had high negative effect towards days to germination, germination percentage, seedling injury, height at flag leaf stage, number of effective tillers and number of spikelets per spike. Weight of 500 seeds made positive effect towards yield per plant via number of seeds per spikelet and number of seeds per spike.

Seedling injury had high positive effect towards days to 50% flowering. However, it made high negative effect towards days to germination, spike length, height at flag leaf stage and number of spikelets per spike and it caused negative effect towards germination percentage, seedling injury and number or effective tillers.

In the present investigation, path coefficient analysis was carried out taking yield per plant as dependent variable and rest of the eleven traits as independent variables. Days to germination showed direct positive effects on yield.

Positive direct effects of germination percentage on yield per plant was also observed. The direct effect of germination percentage on yield per plant was less than the total correlation coefficient. Positive indirect effects of germination percentage via days to germination, height at flag leaf stage, number of spikelets per spike and number of seeds per spikelet are expected to be responsible for reducing correlation coefficients. Seedling injury showed direct negative effects on yield per plant.

Days to 50% flowering had high positive effects on yield per plant. Positive indirect effects of days to 50% flowering via days to germination, spike length, number of seeds per spike and weight of 500 seeds are expected to be responsible for reducing correlation coefficients.

Spike length exhibited very low negative direct effects on yield per plant and supported by Singh *et al*. (2001) [8]. However, these findings are in disagreement with the findings of Okuyama *et al*., (2004) [9] and (2005) [10]; Naserian *et al*., (2007) [11]; Mecha *et al*., (2017) [12] who reported direct positive effects of spike length on grain yield per plant. Positive correlation of spike length with yield per plant may be due to positive indirect effects to yield *via* number of seeds per spikelet, number of spikelets per spike and days to germination.

Height at flag leaf stage had high positive effects on yield per plant, which shows pairty with the findings of Anand *et al*.(1978) [13] and Bhullar and Nijjar (1984) [14].On the other hand Mitsiwa, (2013) [15] and Ayer *et al*., (2017) [16] reported that plant height showed negative direct effect on grain yield.

Number of effective tillers had high direct negative effects on yield per plant. These results are in contradiction with Kumbhar *et al*.(1982) [17] and Singh *et al*. (2001). On the other hand, Nayak *et al*., (2001); Khedikar *et al*., (2004) and Hasib and Kole, (2004) reported that number of effective tillers had positive direct effect on yield per plant.

In agreement to Singh *et al*. (2001), number of spikelets per spike showed direct negative effect on yield per plant. Whereas, Lad *et al*., (2003) [18], Anwar *et al*., (2009) [19]; Khan and Dar, (2010), Mecha *et al*., (2017) reported positive direct effects. Positive correlation of this character to yield per plant may be due to high positive indirect effects of spikelets per spike towards yield per plant via days to 50% flowering, spike length and weight of 500 seeds, while high negative indirect effect of spikelets per spike via seedling injury and number of effective tillers are also found in the present study.

Days to 50% flowering had high positive effects on yield per plant. These results are in of Nayak *et al*., (2001); Khedikar *et al*., (2004) and Hasib and Kole, (2004).

Number of seeds per spikelet had positive direct effects on yield per plant. Direct effects were lower than the correlation coefficient because it shows positive indirect effect to yield per plant via days to 50% flowering, number of seeds per spike and weight of 500 seeds.

Number of seeds per spike had low direct positive effects on yield per plant and thus confirmed the findings of Dencic *et al*., (2000) [20]; Naserian *et al*., (2007); Kotal *et al*., (2010). However, it showed sharp disagreement with Kumbhar *et al*. (1982) and Zhuzhukin (1983) [21], who reported high direct effects of seeds per spike on yield per plant. The total correlation coefficients of number of seeds per spike with yield per plant was higher than it’s direct effects.

500 seeds weight showed positive direct effect on yield per plant. Therefore, the findings are in contrast with Khan *et al*., (2013) [22,23]; Mecha *et al*., (2017). The total association of this character with yield per plant is less contributed by direct effect but more by indirect effects through days to 50% flowering.

Conclusion

Positive direct effects of days to 50% flowering, plant height at flag leaf stage and germination percentage with yield per plant indicated that selection of these genotypes with days to 50% flowering, plant height at flag leaf stage and germination percentage should be emphasized while selection for improving grain yield.

Application of research: The current study confer that these characters which exerting maximum direct positive effect should be considered suitable for further future wheat breeding programme.

Research Category: Plant breeding

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