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Estimation of path analysis of mutant lines of lentil (*Lens culinaris* Medik L.)

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Abstract
Seed of 9 induced mutant lines of lentil (*Lens culinaris* Medik. L.) were used for the experimental purpose. These mutants were isolated from variety K -75 with gamma ray and EMS treatment. The self-seeds of all mutants were sown in randomized block designed in three replications at Agricultural Research Farm, Institute of Agricultural sciences, B.H.U, Varanasi, during Rabi 2017-18.Distance between row to row and plant to plant was maintained 30cm and 5cm respectively. In genotypic path analysis, the secondary branches showed the highest positive direct effect (0.991) on grain yield followed by test weight (0.8706) and number of pods per plant (0.2640) in year 2017-18. In phenotypic path analysis, the number of pods per plant showed highest positive direct effect (1.054) followed by days to 50% flowering and test weight (0.0436) in year 2017-18. So that maximum importance of these characters might be given in selection program me.

Keywords: Path analysis, lentil, mutant line

1. Introduction
Lentil is important legume crop in India and mostly grown in rabi season. Lentil is also used as nitrogen fixing crop. According to FAO statistical report, 2014 world lentil production 2012 in totaled to 4,557,972 tonnes from 4,206,024 ha area harvested. India alone produce 20.84% of world production. Lentil is self-pollinated crop (2n=14) and large genome size 41063 Mbp. Mutation breeding is feasible and sustainable technique to create a gene pool of numerous desirable traits of economic importance. Mihov (1994) reported strong lethal effect of methyl methane sulphonate (DMSO) than that of EMS in lentil. Lentil is responsive to both chemical and physical mutagens. Path analysis and correlation is used to the selection of elite cultivar. This crop grown in India mainly for pulse. Path coefficient analysis deals about direct and indirect effect of traits on yield. It also deals inter relationship between different traits. So that during selection of superior cultivar breeder should know about characters which is mostly affecting the yield.

2. Material and Methods
2.1 Seed material
Seed of 9 induced mutant lines of lentil (*Lens culinaris* Medik. L.) were used for the experimental purpose. These mutants were isolated from variety K -75 with gamma ray and EMS treatment.

2.2 Methods
The self-seeds of all mutants were sown in randomized block designed in three replications at Agricultural Research Farm, Institute of Agricultural sciences, B.H.U, Varanasi, during Rabi 2017-18.Distance between row to row and plant to plant was maintained 30cm and 5cm respectively. All the recommended agronomic and cultural practices were adopted for raising good plant population.

2.3 Observations
The observation on following characters was taken for the present study.

Days to 50% flowering: Days from sowing date to the stage when 50% of the plants have started flowering per pot.

Days to 100% flowering: Days from sowing date to the stage when 100% of the plants have started flowering per pot.

Plant height: The plant height was measured in cm at time of harvesting from tip to the base of the largest branch.

Number of primary branches: Number of primary branches coming out of base of each plant was recorded.

Number of secondary branches: Number of secondary branches coming out from the primary branches is recorded.

Number of pods per plant: Total number of pods was counted of each plant at time of maturity.

Day to maturity: Number of days has been calculated from sowing to maturity date.

Grain yield per plant: From each plant pods were detached and then pods were threshed and then weight was taken on weighing machine.

100 Seed weight: Weight was taken of the selected 100 seeds on the electronic balance and recorded in gram. 5 randomly selected plants in each observation were recorded treatments in each replication.

3. Path–Coefficient analysis

Path analysis was developed around 1918 by geneticist Sewall Wright, who wrote about it more extensively in the 1920s.

Path analysis is a straightforward extension of multiple regressions. Its aim is to provide estimates of the magnitude and significance of hypothesized causal connections between sets of variables. This is best explained by considering a path diagram.

Path coefficients are standardized partial coefficient which provides information of direct effect of causal factors or independent factors and effect of dependent variables. The permit partitioning of the correlation between the independent factors and effect of variable into component of direct and indirect effects that thus makes the association of the causal factors with the effect variable more clearly.

In this study, the grain yield per plant (Y) was taken as effect. The other traits likes, day to maturity (X_1), plant height (X_2), number of primary branches per plant (X_3), number of secondary branches per plant (X_4), number of pods per plant (X_5), 100 seeds weight (X_6) and so on were related to yield as causal factors.

The path coefficients were obtained by solving a set of simultaneous equations.

The schematic diagrams of the and the path as well as the equation generated as follows:

$r_{X1Y}= P_{X1Y}+r_{X1X2}P_{X2Y}+r_{X1X3}P_{X3Y}++r_{X1X4}P_{X4Y}+r_{X1X5}P_{X5Y}+r_{X1X6}P_{X6Y}$

$r_{X2Y}=r_{X2X1}P_{X1Y}+P_{X1Y}+r_{X2X3}P_{X3Y}+r_{X2X4}P_{X4Y}+r_{X2X5}P_{X5Y}+r_{X2X6}P_{X6Y}$

$r_{X3Y}=r_{X3X1}P_{X1Y}+r_{X3X2}P_{X2Y}+P_{X3Y}+r_{X3X4}P_{X4Y}+r_{X3X5}P_{X5Y}+r_{X3X6}P_{X6Y}$

$r_{X4Y}=r_{X4X1}P_{X1Y}+r_{X4X2}P_{X2Y}+r_{X4X3}P_{X3Y}+P_{X4Y}+r_{X4X6}P_{X5Y}+r_{X4X6}P_{X6Y}$

$r_{X5Y}=r_{X5X1}P_{X1Y}+r_{X5X2}P_{X2Y}+r_{X5X3}P_{X3Y}+r_{X5X4}P_{X4Y}+P_{X5Y}+r_{X5X6}P_{X6Y}$

$r_{X6Y}=r_{X6X1}P_{X1Y}+r_{X6X2}P_{X2Y}+r_{X6X3}P_{X3Y}+r_{X6X4}P_{X4Y}+r_{X6X5}P_{X5Y}+P_{X6Y}$

r_{XiY}=correlation between X_i^{th}trait and yield

P_{XiY}=path coefficient between the X_i^{th}trait and yield

r_{XiXj}=coefficient of correlation between i^{th} andj^{th} trait

$r_{XiXj}P_{XiY}$=Indirect effect

The residual factor i.e. variation in yield uncounted for causal effect was designated as P_{RY} or path value for residual effect

Residual factor=$\sqrt{1-R^2}$

Where,

R^2=$\sum P_{XiY}r_{XiY}$

4. Result and Discussion

Path coefficient analysis is important tools in quantifying the individual components towards grain yield in terms of their direct and indirect effects.

In genotypic path analysis, the secondary branches showed the highest positive direct effect (0.991) on grain yield followed by test weight (0.8706) and number of pods per plant (0.2640) in year 2017-18. In phenotypic path analysis, the number of pods per plant showed highest positive direct effect (1.054) followed by days to 50% flowering and test weight (0.0436) in year 2017-18. Test weight showed positive direct effect (0.8706 and 0.0436) on grain yield. Similar result was reported by Bicer & Şakar (2008) and Tyagi and khan (2010) [6] for number of pods on grain yield.

Table 1: Estimate of direct and indirect effects between yield and its component characters in induced mutant of lentil Path matrix of grain yield per plant

		Phenotypic	Path					
Character	**Plant Height (cm)**	**Days to 50% Flowering**	**Days to 100% Flowering**	**Primary Branches Per Plant**	**Secondary Branches Per Plant**	**Pods Per Plant**	**Days to Maturity**	**Test Weight**
Plant Height (cm)	-0.2229*	0.0371	0.1158	0.0095	-0.0441	-0.0660	0.0944	-0.0129
Days to 50% Flowering	0.0159	-0.0954*	-0.0544	-0.0471	-0.0398	-0.0505	-0.0148	-0.0202
Days to 100% Flowering	-0.0410	0.0450	0.0790*	0.0290	0.0222	0.0103	0.0551	0.0224
Primary Branches Per Plant	0.0017	-0.0198	-0.0148	-0.0402*	-0.0163	-0.0204	-0.0003	-0.0052
Secondary Branches Per Plant	-0.0197	-0.0414	-0.0279	-0.0403	-0.0994*	-0.0771	0.0198	0.0064
Pods Per Plant	0.3121	0.5582	0.1368	0.5340	0.8179	1.0543*	-0.3326	-0.0731
Days to Maturity	0.0040	-0.0015	-0.0065	-0.0001	0.0019	0.0030	-0.0094*	-0.0026
Test Weight	0.0025	0.0092	0.0124	0.0056	-0.0028	-0.0030	0.0121	0.0436*
Grain Yield Per Plant	0.0526	0.4914	0.2403	0.4505	0.6395	0.8504	-0.1758	-0.0417
Partial R^2	-0.0117	-0.0469	0.0190	-0.0181	-0.0636	0.8966	0.0016	-0.0018

R Square = 0.7751 Residual Effect = 0.4742

*Values are direct effect

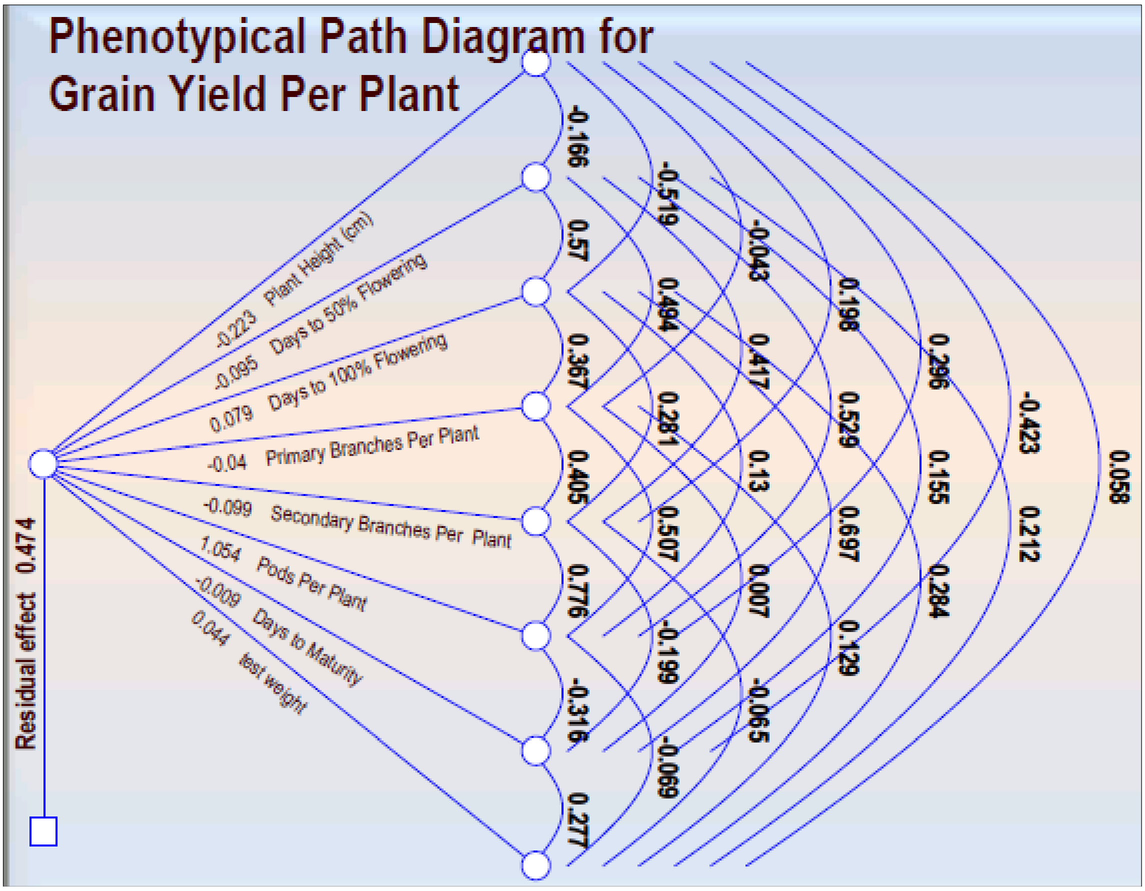

Fig 1: Path diagram and coefficient of factors influencing grain yield per plant for nine traits of induced mutants in lentil at phenotypic level.

An important consideration is taken in formulation the path analysis, that the entire important factors affecting the grain yield are included. Yield being a complex character, limits the possibility of inclusion of related factors. The residual effect determines how best the casual Factor account for variability of dependent factors (yield).In present study, the residual effect of phenotypic level were 0.4772 and genotypic level SQRT (1 -1.1829). This indicates that other factors which have not be considered need to include in study for to account variation in yield.

Table 2: Path matrix of grain yield per plant

			Genotypic	Path				
Character	**Plant Height (cm)**	**Days to 50% Flowering**	**Days to 100% Flowering**	**Primary Branches Per Plant**	**Secondary Branches Per Plant**	**Pods Per Plant**	**Days to Maturity**	**Test Weight**
Plant Height (cm)	-0.615*	0.0862	0.4354	0.1268	0.1085	-0.2081	0.3507	-0.0636
Days to 50% Flowering	0.0183	-0.1309*	-0.0766	-0.1494	-0.0789	-0.0910	-0.0236	-0.0554
Days to 100% Flowering	0.3256	-0.2695	-0.4603*	-0.3089	-0.1493	-0.0285	-0.3412	-0.1536
Primary Branches Per Plant	0.0108	-0.0597	-0.0351	-0.0523*	-0.0376	-0.0224	0.0040	-0.0071
Secondary Branches Per Plant	-0.1748	0.5974	0.3217	0.7125	0.9914*	0.9262	-0.3117	-0.2834
Pods Per Plant	0.0893	0.1836	0.0163	0.1132	0.2467	0.2640*	-0.1259	-0.0362
Days to Maturity	0.1541	-0.0488	-0.2004	0.0208	0.0850	0.1289	-0.2704*	-0.1058
Test Weight	0.0900	0.3683	0.2904	0.1177	-0.2488	-0.1192	0.3407	0.8706*
Grain Yield Per Plant	-0.1020	0.7266	0.2913	0.5805	0.9169	0.8499	-0.3774	0.1656
Partial R^2	0.0628	-0.0951	-0.1341	-0.0304	0.9091	0.2244	0.1021	0.1442

R Square = 1.1829 Residual Effect = Sqrt(1-1.1829)
*values are direct effect

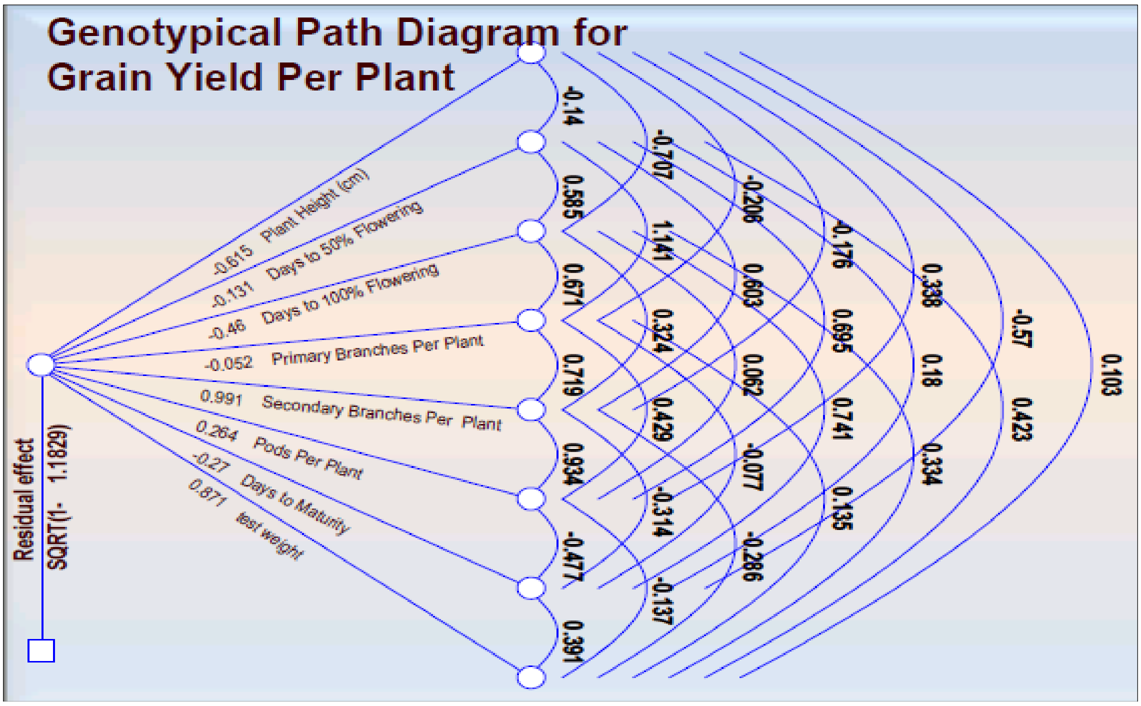

Fig 2: Path diagram and coefficient of factors influencing grain yield per plant for nine traits of induced mutants in lentil at genotypic level.

In general magnitude of phenotypic correlation coefficient is higher than magnitude of genotypic correlation which was found for most of the characters, but in few traits was found reverse. It indicates that assumption $G_{G\times E}$=0, in portioning of phenotypic variance is not fulfilled for such character pairs. Under such condition, the estimate of genotypic variance and covariance of the characters pairs should be obtained only after eliminating the effect of Genotypic and environment.

5. Summary

In genotypic path analysis, the secondary branches showed the highest positive direct effect on grain yield followed by test weight and number of pods per plant in this year. In phenotypic path analysis, the number of pods per plant showed highest positive direct effect followed by days to 50% flowering and test weight. So that maximum importance of these characters might be given in selection program me.

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7. References

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