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Niyati Jain
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Anita Babbar
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Sarla Kumawat
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Rakesh Kumar Yadav
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Ruchi Asati
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Niyati Jain
Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India

Correlation and path coefficient analysis in the promising advance chickpea lines

Niyati Jain, Anita Babbar, Sarla Kumawat, Rakesh Kumar Yadav and Ruchi Asati

Abstract
The present investigation was undertaken in the year 2018-19 during *Rabi* season for correlation and path coefficient analysis of yield and yield contributing traits in 30 promising chickpea advance lines under randomized completely block design with three replications. The data was recorded for days to flower initiation, days to 50% flowering, days to pod initiation and days to maturity, plant height, stem height at first fruiting node, number of primary branches per plant, number of secondary branches per plant, total number of pods per plant, number of effective pods per plant, number of seeds per pod, 100 seed weight, biological yield per plant, harvest index and seed yield per plant. Seed yield per plant shared highly significant and positive association with biological yield, total number of pods per plant, number of effective pods per plant, number of seeds per pod, plant height , days to flowering and days to 50% flowering, while seed yield per plant shared significant and negative association with harvest index. These are yield attributing traits selection of one can increase the other one, consider these traits for constricting plant type for high yield. Path analysis revealed that days to flower initiation, days to 50% flowering, number of primary branches per plant, biological yield, number of seeds per pod, harvest index and plant height exerted maximum positive direct effect on seed yield per plant. Hence, for enhancement of yield these traits can be selected directly.

Keywords: Chickpea, correlation coefficient, path coefficient

Introduction
The chickpea (*Cicer arietinum* L.), 2n=2x=16 also known as garbanzo bean, Indian pea, Bengal gram is an edible, self-fertilizing, annual, diploid grain legume of the family Fabaceae and sub family Papilionaceae. Chickpea seeds contain on an average 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber and 2% ash. It is also reported to contain high mineral content: phosphorus (340 mg/100 g), calcium (190 mg/100 g), magnesium (140 mg/100 g), iron (7 mg/100 g), zinc (3 mg/100 g) (Jukanti *et al*., 2012) [6]. Correlation analysis is the statistical tool, provides degree and direction of relationship between variables at phenotypic, genotypic and environmental levels. It provides information about the nature, extent and direction of selection pressure to be applied for practical consideration. Path coefficient analysis measures direct and indirect contribution of various independent characters on the dependent character. It reveals whether the association of these independent characters with seed yield is due to their direct effect on yield or is consequence of their indirect effect via other component characters.

Material and Methods
The experiment was conducted at the Seed Breeding Farm, Department of Plant Breeding and Genetics, College of Agriculture, Jabalpur (M.P) during *Rabi* 2018. The experimental material consists of 30 advance lines and were planted in randomized block design with three replications. Fertilizer was applied in the ratio of $20N:40P_2O_5:20K_2O:20ZnSO_4$ kg/ha. The experiment was conducted with recommended agronomic practices. Five random plants were selected from each lines and observations were recorded on these plants for characters like days to flower initiation, days to 50% flowering, days to pod initiation, days to maturity, plant height (cm), stem height at first fruiting node (cm), number of primary branches per plant, number of secondary branches per plant, total number of pods per plant, number of effective pods per plant, number of seeds per pod, 100- Seed weight (g), biological yield per plant (g), harvest index (%) and seed yield per plant (g).

Statistical analysis

Correlation Analysis: Correlation coefficients by the formula given by Miller *et al*. (1958) [10]. The significance of correlation coefficients was tested by comparing the genotypic and phenotypic correlation coefficients with table value [Fisher and Yates (1967)] [5] at (n-2) degrees of freedom at 5% and 1% level where, 'n' denotes the number of treatments used in the calculations.

Path coefficient analysis: Path coefficient analysis was carried out by the procedure originally proposed by Sewall Wright (1921) [12] which was subsequently elaborated by Dewey and Lu (1959) [3] to estimate the direct and indirect effects of the individual characters on yield. The path coefficients were rated based on the scales given below (Lenka and Mishra, 1973) [8].

Results and Discussion

Correlation coefficient analysis

In present investigation, the genotypic correlation coefficients between most of the characters were higher than the phenotypic correlation coefficients. This indicated that there was a strong inherent association between various characters studied and less influenced by environment.

Seed yield per plant shared highly significant and positive association with biological yield per plant, total number of pods per plant, number of effective pods per plant, number of seeds per pod, plant height, days to flower initiation and days to 50% flowering, while seed yield per plant shared significant and negative association with harvest index. Positive correlation coefficient between any two characters suggested that they can improve simultaneously and improvement in one will automatically improve the other however negatively correlated traits can be improved by indirect selection. Similar results were previously confirmed by Paneliya *et al*. (2017) [11] and Bhanu *et al*. (2017) [2] and Agarwal *et al*. (2018) and Kumawat *et al.* (2020) [7].

Path coefficient analysis

The path analysis revealed that days to flower initiation showed highest direct effect on seed yield per plant followed by 100 seed weight, days to 50% flowering, number of primary branches per plant, biological yield per plant, number of seeds per pod, harvest index, plant height, total number of pods per plant and days to maturity. Hence the above characters are most prominent direct influencing on seed yield and thus selection of these traits may cause increase in yield. Similar result was also reported by Dhuria and Babbar (2015) [4], Paneliya *et al*. (2017) [11], Bhanu *et al*. (2017) [2], Agrawal *et al*. (2018) [1] and Manikanteswara *et al*. (2019) [9].

The highest negative direct effect exhibited days to pod initiation, number of secondary branches per plant and stem height at first fruiting node.

In addition to this, majority of indirect effects of various independent traits via other traits were extremely low of either signs. The indirect effect of days to flower initiation, days to 50% flowering, days to pod initiation, plant height, stem height of the first fruiting node, number of primary branches, number of secondary branches per plant, number of pods per plant, number of effective pods per plant, 100 seed weight and biological yield per plant were positive on seed yield per plant. Such all this indirect effects also find its contribution via different traits for causing increase in seed yield. These results are in agreement by findings of Manikanteswara *et al*. (2019) [9] Agarwal *et al*. (2018) and Bhanu *et al*. (2017) [2].

Table 1: Genotypic and phenotypic correlation coefficient for yield and its attributing traits in chickpea genotypes

Traits		DTF	DT50%F	DTP	DTM	PH	SH at 1st F	PB	SB	TNPP	NEPPP	NSPP	1OOSW	BY	HI%	SYPP
DTF	G		0.8755	0.8281	0.3105	-0.0039	0.2854	0.0066	0.5154	0.3225	0.2997	0.2138	0.0373	0.341	-0.1887	0.3183
	P		0.8357***	0.7814***	0.2361*	0.0105	0.255*	0.0488	0.4241***	0.3084**	0.2913	0.1814	0.0375	0.3155**	-0.1648	0.2941**
DT50%F	G			0.8999	0.358	-0.0367	0.2202	0.2704	0.5346	0.2508	0.2019	0.1534	-0.0324	0.2228	-0.0029	0.2665
	P			0.8587***	0.2458*	-0.0028	0.1846	0.2345*	0.4496***	0.2347*	0.1998	0.1019	-0.0278	0.2007	0.0111	0.2416*
DTP	G				0.4953	-0.1921	0.0919	0.2613	0.3558	0.2108	0.157	0.1196	-0.0436	0.072	0.0298	0.0976
	P				0.4097***	-0.1527	0.0887	0.2087*	0.3015**	0.1968	0.1506	0.1161	-0.032	0.0721	0.026	0.0943
DTM	G					-0.1565	0.1076	0.1074	0.1915	0.026	-0.041	0.1997	-0.0232	-0.0788	-0.2468	-0.1632
	P					-0.1257	0.0761	0.0098	0.1651	0.021	-0.0397	0.1917	-0.0107	-0.0703	-0.2274 *	-0.1435
PH	G						0.4763	-0.0621	0.1319	0.0624	0.1053	-0.2549	0.4739	0.5396	-0.1364	0.5485
	P						0.439***	-0.0664	0.1014	0.0768	0.1102	-0.2555	0.4419***	0.5058***	-0.1269	0.5058***
SH at 1st F	G							-0.1276	0.0763	0.0271	0.0823	0.1156	0.0542	0.0663	0.0866	0.1026
	P							-0.0996	0.067	0.0278	0.0791	0.1053	0.051	0.0627	0.0802	0.0919
PB	G								0.4342	0.3121	0.2302	-0.028	-0.1874	0.0651	0.2858	0.2615
	P								0.387***	0.2492*	0.1905	-0.0036	-0.1421	0.0445	0.2313*	0.2023
SB	G									0.2853	0.2629	0.446	-0.1039	0.3043	-0.0534	0.3585
	P									0.2502*	0.2399*	0.3808***	-0.1023	0.2794**	-0.0346	0.3322**
TNPP	G										0.9686	-0.119	-0.1074	0.4541	-0.1631	0.5397
	P										0.9623***	-0.1231	-0.1048	0.4484***	-0.1565	0.5223***
NEPPP	G											-0.1083	-0.1434	0.4054	-0.1073	0.4971
	P											-0.1202	-0.1378	0.4000***	-0.1002	0.4841***
NSPP	G												-0.4415	-0.1696	0.0172	-0.1561
	P												-.4076***	-0.1523	-0.002	-0.1478
1OOSW	G													0.6807	-0.4829	0.5642
	P													0.6685***	-0.4615***	0.5431***
BY	G														-0.6302	0.93
	P														-0.6037***	0.9151***
HI%	G															-0.3304
	P															-0.2639*
SYPP	G															
	P															

* Significant at 5%, ** Significant at 1% and *** Highly Significant at 1%

If correlation r => 0.2076 0.2702 0.2934 0.3411261

Table 2: Phenotypic path coefficient analysis for yield and its component characters in chickpea genotypes

Traits	DTF	DT50%F	DTP	DTM	PH	SH at 1st F	PB	SB	TNPP	NEPPP	NSPP	1OOSW	BY	HI%
DTF	-0.0115	-0.0096	-0.009	-0.0027	-0.0001	-0.0029	-0.0006	-0.0049	-0.0035	-0.0033	-0.0021	-0.0004	-0.0036	0.0019
DT50%F	0.0402	0.0481	0.0413	0.0118	-0.0001	0.0089	0.0113	0.0216	0.0113	0.0096	0.0049	-0.0013	0.0096	0.0005
DTP	-0.0669	-0.0735	-0.0856	-0.0351	0.0131	-0.0076	-0.0179	-0.0258	-0.0168	-0.0129	-0.0099	0.0027	-0.0062	-0.0022
DTM	0.0172	0.0179	0.0299	0.0729	-0.0092	0.0055	0.0007	0.012	0.0015	-0.0029	0.014	-0.0008	-0.0051	-0.0166
PH	-0.0003	0.0001	0.005	0.0041	-0.0329	-0.0145	0.0022	-0.0033	-0.0025	-0.0036	0.0084	-0.0146	-0.0167	0.0042
SH at 1st F	-0.0034	-0.0025	-0.0012	-0.001	-0.0059	-0.0135	0.0013	-0.0009	-0.0004	-0.0011	-0.0014	-0.0007	-0.0008	-0.0011
PB	0.0019	0.0091	0.0081	0.0004	-0.0026	-0.0039	0.0387	0.015	0.0096	0.0074	-0.0001	-0.0055	0.0017	0.009
SB	-0.0177	-0.0187	-0.0126	-0.0069	-0.0042	-0.0028	-0.0161	-0.0417	-0.0104	-0.01	-0.0159	0.0043	-0.0116	0.0014
TNPP	0.0137	0.0104	0.0088	0.0009	0.0034	0.0012	0.0111	0.0111	0.0445	0.0428	-0.0055	-0.0047	0.0199	-0.007
NEPPP	0.0058	0.004	0.003	-0.0008	0.0022	0.0016	0.0038	0.0048	0.0192	0.0199	-0.0024	-0.0027	0.008	-0.002
NSPP	0.0082	0.0046	0.0052	0.0087	-0.0115	0.0048	-0.0002	0.0172	-0.0056	-0.0054	0.0452	-0.0184	-0.0069	-0.0001
1OOSW	-0.0004	0.0003	0.0004	0.0001	-0.0051	-0.0006	0.0016	0.0012	0.0012	0.0016	0.0047	-0.0116	-0.0077	0.0053
BY	0.3869	0.246	0.0884	-0.0862	0.6201	0.0769	0.0546	0.3426	0.5498	0.4904	-0.1867	0.8196	1.2261	-0.7402
HI%	-0.0796	0.0054	0.0126	-0.1098	-0.0613	0.0387	0.1117	-0.0167	-0.0756	-0.0484	-0.001	-0.2229	-0.2916	0.4829
SYPP	0.2941	0.2416	0.0943	-0.1435	0.5058	0.0919	0.2023	0.3322	0.5223	0.4841	-0.1478	0.5431	0.9151	-0.2639

Table 3: Genotypic path coefficient analysis for yield and its component characters in chickpea genotypes

Traits	DTF	DT50%F	DTP	DTM	PH	SH at 1st F	PB	SB	TNPP	NEPPP	NSPP	1OOSW	BY	HI%
DTF	0.6377	0.5583	0.5281	0.198	-0.0025	0.182	0.0042	0.3287	0.2056	0.1911	0.1363	0.0238	0.2175	-0.1203
DT50%F	0.376	0.4294	0.3864	0.1537	-0.0158	0.0945	0.1161	0.2296	0.1077	0.0867	0.0659	-0.0139	0.0957	-0.0012
DTP	-0.7066	-0.7678	-0.8532	-0.4226	0.1639	-0.0784	-0.2229	-0.3036	-0.1799	-0.134	-0.1021	0.0372	-0.0615	-0.0254
DTM	0.018	0.0208	0.0287	0.058	-0.0091	0.0062	0.0062	0.0111	0.0015	-0.0024	0.0116	-0.0013	-0.0046	-0.0143
PH	-0.0011	-0.0103	-0.0539	-0.0439	0.2805	0.1336	-0.0174	0.037	0.0175	0.0295	-0.0715	0.1329	0.1513	-0.0382
SH at 1st F	-0.0824	-0.0636	-0.0265	-0.0311	-0.1376	-0.2888	0.0369	-0.022	-0.0078	-0.0238	-0.0334	-0.0157	-0.0192	-0.025
PB	0.0027	0.1121	0.1082	0.0445	-0.0257	-0.0529	0.4143	0.1799	0.1293	0.0954	-0.0116	-0.0776	0.027	0.1184
SB	-0.2116	-0.2196	-0.1461	-0.0786	-0.0542	-0.0313	-0.1783	-0.4107	-0.1172	-0.108	-0.1832	0.0427	-0.125	0.0219
TNPP	0.0743	0.0577	0.0485	0.006	0.0144	0.0062	0.0719	0.0657	0.2303	0.223	-0.0274	-0.0247	0.1046	-0.0375
NEPPP	0.0386	0.026	0.0202	-0.0053	0.0135	0.0106	0.0296	0.0338	0.1246	0.1287	-0.0139	-0.0185	0.0522	-0.0138
NSPP	0.0775	0.0556	0.0433	0.0724	-0.0924	0.0419	-0.0102	0.1616	-0.0431	-0.0392	0.3623	-0.16	-0.0615	0.0062
1OOSW	0.0194	-0.0168	-0.0226	-0.012	0.2458	0.0281	-0.0972	-0.0539	-0.0557	-0.0744	-0.229	0.5186	0.3531	-0.2504
BY	0.131	0.0856	0.0277	-0.0303	0.2072	0.0255	0.025	0.1169	0.1744	0.1557	-0.0651	0.2614	0.3841	-0.242
HI%	-0.055	-0.0008	0.0087	-0.0719	-0.0397	0.0252	0.0833	-0.0156	-0.0475	-0.0313	0.005	-0.1407	-0.1837	0.2914
SYPP	0.3183	0.2665	0.0976	-0.1632	0.5485	0.1026	0.2615	0.3585	0.5397	0.4971	-0.1561	0.5642	0.93	-0.3304

Where, DTF: Days to flower initiation, DT50%F: Days to 50% flowering, DTP: Days to pod initiation, DTM: Days to maturity, PH: Plant height, SH at 1st F: Stem height at first fruiting node, PB: Number of primary branches per plant, SB: Number of secondary branches per plant, TNPP: Total Number of pods per plant, NEPPP: Number of effective pods per plant, NSPP: Number of seeds per pod, 100SW: 100 seed weight, BY: Biological yield per plant, HI%: Harvest index, SYPP: Seed yield per plant.

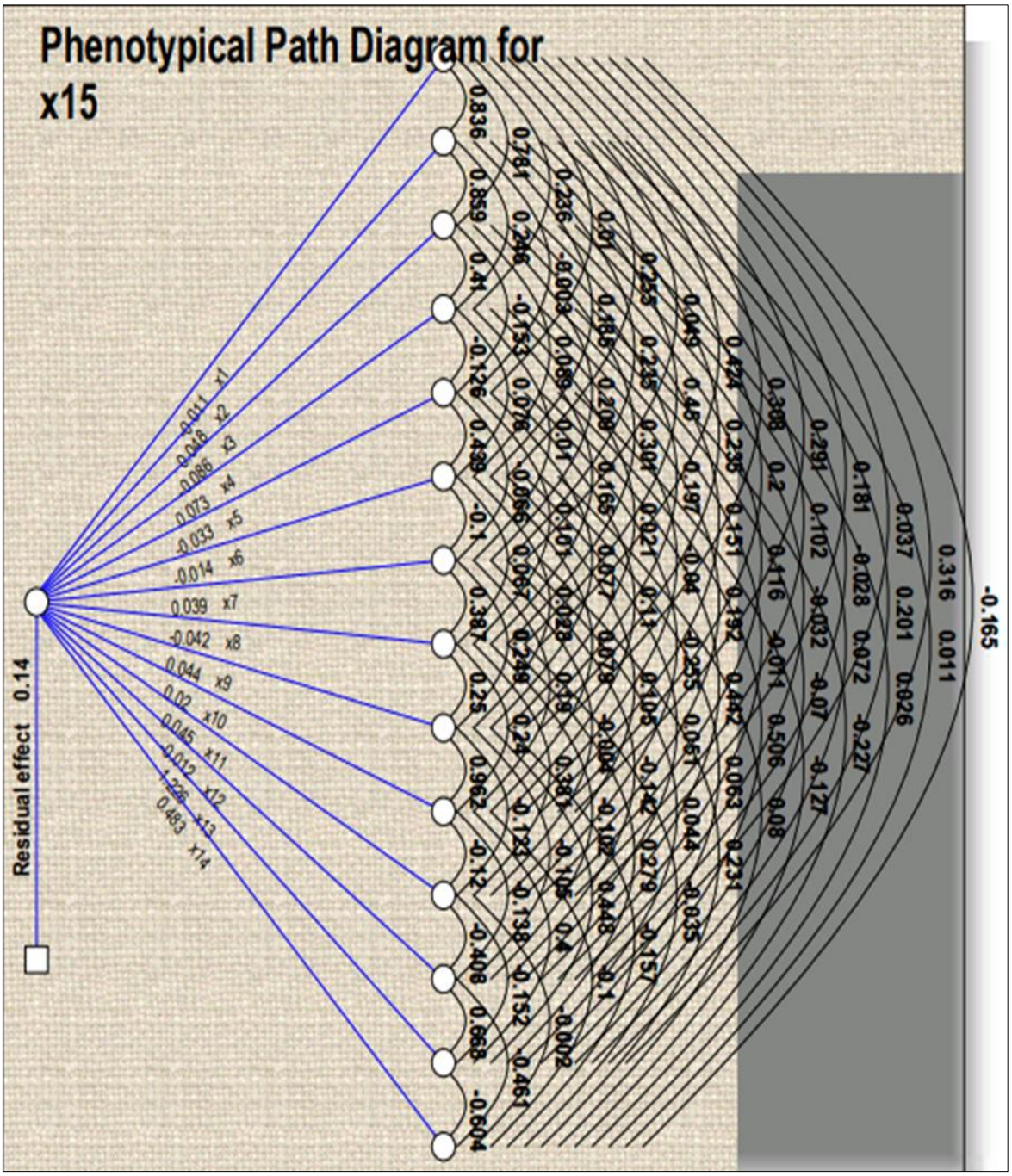

Fig 1: Phenotypical path diagram from ×15

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