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Study of Genetic Association and Direct and Indirect Effects among Yield and Yield Contributing Traits in Chickpea.

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ABSTRACT

Eight chickpea varieties were evaluated to determine the relationship among yield and its components using correlation and path-coefficient analysis. Correlation studies revealed that seed weight per plant expressed positive significant correlation with number of primary branches at maximum flower, number of secondary branches at maximum flower, number of pods per plant, pod weight per plant and number of seeds per plant at genotypic level. In phenotypic level, seed yield showed positive significant correlation with number of pods per plant, pod weight per plant and number of seeds per plant. Path-coefficient analysis expressed that the highest positive direct effect was observed for number of seeds per plant followed by pod weight per plant and 1000-seed weight at genotypic level and at phenotypic level number of seeds per plant followed by 1000-seed weight and number of secondary branches per plant on seed yield. These traits could be used for the improvement of seed yield.

INTRODUCTION

Chickpea is the third most important grain legume in the world [12]. It is an important source of carbohydrates and proteins and has a major role in human nutrition. Yield is a complex trait controlled by number of genes and highly influenced by environment. The identification of important traits and their interrelationship would be useful for developing improved genotypes. Selection based on yield is not effective. It is almost desire for plant breeders to know the extent of relationship between yield and its various components, which will inevitably facilitate selection of desirable characteristics. The aim of correlation studies is primarily to know the association of yield component characters with yield when more characters are involved in the association analysis would difficult to ascertain which really contributes towards yield. In such case path coefficient analysis is an important tool for plant breeders to help in partitioning the contribution into components of direct and indirect influence and provide better insight on character and their relationship with yield. So, the objective of this investigation was to estimate the association of yield contributing characters and their direct contribution to yield and indirect effects through other characters on chickpea yield.

MATERIALS AND METHODS

For this investigation, eight varieties of chickpea (BARI chola-1, 2, 3, 4, 5, 6, 7 and 8) were collected from Regional Agriculture Research Station, Ishurdi, Pabna, Bangladesh. Above lines were irradiated with Co^{60} source considering different doses i.e., no irradiation (D_0), 20kr (D_A), 30kr (D_B) and 40kr (D_C) in the Institute of Food and Radiation Biology, Atomic Energy Research Establishment Savar, Dhaka. The experiment was conducted in the research field of the department of Genetic Engineering and Biotechnology, University of Rajshahi during the Rabi crop season of 2008-2009 and 2009-2010. Layout of the experimental field and trial of the irradiated lines were conducted under randomized complete block

design with four replication having sixty four plots in each. The plot size was 120 cm × 150 cm with three rows and in each row having five hills. Data of eleven characters are viz. days to maximum flower (DMF), number of primary branches at maximum flower (NPBMF), number of secondary branches at maximum flower (NSBMF), plant height at maximum flower (PHMF), plant weight after fully dried (PWFD), root weight after fully dried (RWFD), number of pods per plant (NPPP), pod weight per plant (PdWPP), number of seeds per plant (NSPP), 1000-seed weight (1000-SW) and seed weight per plant (SWPP).The measurement of a character was done following CGS system. The collected data were analyzed following the biometrical techniques of analysis [10,7]. The path-coefficient analysis was done by using the standard formula [21,22,6].

RESULTS AND DISCUSSION

Correlation coefficient (Genotypic and phenotypic levels) computed between different pairs of characters are presented in Table-1. The values of genotypic correlation coefficient were higher than phenotypic correlation coefficient. The high genotypic correlation indicating the strong inherent association between pairs of characters dose not always reflects nature and magnitude of phenotypic variation indicating an apparent association due to genetic reason. Higher magnitudes of genotypic correlations than phenotypic one were also found in chickpea [18,12]. The lower values of phenotypic correlation may be attributed to lower modifying effect of environment on the association of characters at gene level [16]. In the present study, at genotypic level yield contributing character like DMF showed positive significant correlation with PWFD and negative significant correlation with RWFD. The characters NPBMF expressed positive significant correlation with NSBMF, NPPP, PdWPP and NSPP, while it expressed negative significant correlation with 1000-SW. NSBMF showed positive significant correlation with NPPP, PdWPP and NSPP and negative significant correlation with RWFD and 1000-SW. RWFD expressed positive significant correlated with 1000-SW. It showed negative significant correlation with NPPP and NSPP. The character NPPP exhibited positive significant correlation with PdWPP and NSPP and negative significant relationship with 1000-SW. PdWPP showed positive significant correlation with NSPP. At phenotypic level yield associate characters like NPPP showed positive significant correlation with PdWPP and NSPP. The character, PdWPP expressed positive significant correlation with NSPP.

Table 1: Phenotypic (above diagonal) and genotypic (below diagonal) correlation coefficient between yield and yield contributing characters in chickpea.

Traits	Traits										
	DMF	NPBMF	NSBMF	PHMF	PWFD	RWFD	NPPP	PdWPP	NSPP	1000-SW	SWPP
DMF	-	-0.058	0.219	0.037	0.249	0.023	-0.002	-0.001	0.015	-0.057	-0.002
NPBMF	0.068	-	0.159	0.161	0.071	-0.165	0.289	0.244	0.261	-0.325	0.227
NSBMF	0.648	0.900**	-	0.234	0.345	-0.137	0.004	-0.009	-0.017	-0.189	-0.035
PHMF	0.154	0.039	0.344	-	0.186	-0.040	-0.140	-0.120	-0.103	-0.213	-0.144
PWFD	0.955**	0.316	0.519	0.415	-	0.148	-0.022	-0.023	-0.026	-0.008	-0.730*
RWFD	-0.91**	-0.676	-0.729*	-0.182	-0.309	-	-0.140	-0.042	-0.178	0.373	-0.093
NPPP	0.101	1.005**	0.787*	0.170	0.026	-0.786*	-	0.912**	0.956**	-0.138	0.942**
PdWPP	-0.004	1.021**	0.739*	0.054	0.029	-0.477	0.942**	-	0.906**	0.003	0.954**
NSPP	0.178	0.981**	0.846**	0.257	0.119	-0.827*	0.981**	0.869**	-	-0.218	0.950**
1000-SW	-0.583	-0.730*	-0.894**	-0.674	-0.548	0.864**	-0.85**	-0.669	-0.93**	-	0.040
SWPP	-0.073	1.045**	0.734*	-0.071	-0.110	-0.621	0.965**	0.961**	0.922**	-0.693	-

.*, ** indicated significant at 5% and 1% levels respectively.

Seed weight per plant (SWPP) expressed positive significant correlation with NPBMF, NSBMF, NPPP, PdWPP and NSPP at genotypic level. In phenotypic level, SWPP showed positive significant correlation with NPPP, PdWPP and NSPP. This positive significant result indicated that these characters are genetically related with SWPP more than those of the other yield components and suggested that with the increase of these characters. SWPP will also be increased. Similar observations were reported by several workers[14,19,17] stated that positive and significant relationships were found between seed yield and number of pods per plant. Seed in chickpea yield had a highly significant positive correlation with seed numbers[3]. Positive significant relationship between seed yield and number of branches and number of pods per plant also observed in pea [20]. The grain yield per plant in chickpea had significant genotypic and highly significant phenotypic relationship with primary branches, pods per plant, and seeds per plant [2].

Seed yield was associated positively (p>0.01) with yield contributing characters like number of branches per plant, number of pods per plant and seeds per plant in lentil [1]. PdW/P and NS/P showed significant positive correlation with yield at phenotypic level in chickpea [5]. Seed yield no. of primary branches expressed positive significant correlation in lentil [23].

Seed yield was significantly and positively correlated with number of primary branches, number of secondary branches and number of pods per plant at both the levels of chickpea [12]. Primary branches per, number of pods per plant showed significant positive correlation with yield in pigeon pea [13]. In common bean that significant correlation between number of seeds per pods and number of pods per plant with grain yield[15]. Number of pods per plant is one of the major components on yield and there is a significant positive correlation between number of pods per plant and grain yield in bean[9].

The path coefficients was calculated and partitioned into direct and indirect effects by using seed yield as a dependent variable. A path-coefficient, measuring the direct as well as indirect effects of one variable through another was worked out at phenotypic and genotypic levels. At genotypic level (Table-2A) the highest positive direct effect was exerted by NSPP PdWPP and 1000-SW. In case of phenotypic level (Table-2B), the highest positive direct effect was expressed by NSPP, NSBMF, and 1000-SW. Number of seeds per plant had the highest direct effect on seed yield in chickpea [8] and in lentil [11]. Number of pods per plant had high positive directs effects on seed yield in chickpea [4].

Table 2A: Path coefficient analysis showing direct and indirect effects of yield and yield components of chickpea at genotypic level.

Traits	Traits									
	DMF	NPBMF	NSBMF	PHMF	PWFD	RWFD	NPPP	PdWPP	NSPP	1000-SW
DMF	0.000405	0.0003	0.0294	-0.0208	-0.0465	-0.0465	-0.0164	-0.0015	0.1812	-0.153
NPBMF	0.000028	0.0042	0.0409	-0.0052	-0.0154	-0.0346	-0.1632	0.4126	0.9969	-0.192
NSBMF	0.000262	0.0038	0.0454	-0.0465	-0.0253	-0.0373	-0.1278	0.2960	0.8604	-0.235
PHMF	0.000062	0.0002	0.0156	-0.1352	-0.0202	-0.0093	-0.0276	0.0217	0.2608	-0.177
PWFD	0.000386	0.0013	0.0235	-0.0561	-0.0487	-0.0158	-0.0042	0.0118	0.1213	-0.143
RWFD	-0.000368	-0.0028	-0.0331	0.0246	0.0151	0.0511	0.1276	-0.1890	-0.8405	0.227
NPPP	0.000041	0.0042	0.0357	-0.0230	-0.0012	-0.0402	-0.1625	0.3773	0.9971	-0.222
PdWPP	-0.000001	0.0043	0.0335	-0.0073	-0.0014	-0.0241	-0.1530	0.4007	0.8837	-0.176
NSPP	0.000072	0.0041	0.0384	-0.0347	-0.0058	-0.0423	-0.1593	0.3483	1.0166	-0.244
1000-SW	-0.000236	-0.0031	-0.0406	0.0912	0.0267	0.0442	0.1374	-0.2680	-0.9435	0.2625

The residual effect = 0.06388. Under line value denote the direct effect.

Table 2B: Path-coefficient analysis showing direct and indirect effects of yield and yield components of chickpea at phenotypic level.

Traits	Traits									
	DMF	NPBMF	NSBMF	PHMF	PWFD	RWFD	NPPP	PdWPP	NSPP	1000-SW
DMF	0.1573	-0.0051	0.0628	0.0041	-0.2209	0.0035	-0.0002	-0.0001	0.0127	-0.016
NPBMF	-0.0091	0.0872	0.0454	0.0179	-0.0632	-0.0249	0.0200	0.0249	0.2215	-0.093
NSBMF	0.0345	0.0138	0.2864	0.0259	-0.3062	-0.0207	0.0003	-0.0009	-0.0143	-0.054
PHMF	0.0058	0.0141	0.0669	0.1109	-0.1650	-0.0060	-0.0096	-0.0122	-0.0876	-0.061
PWFD	0.0391	0.0062	0.0987	0.0206	-0.8886	0.0222	-0.0015	-0.0023	-0.0218	-0.002
RWFD	0.0037	-0.0144	-0.0393	-0.0044	-0.1312	0.1506	-0.0097	-0.0043	-0.1508	0.1066
NPPP	-0.0004	0.0252	0.0012	-0.0155	0.0192	-0.0211	0.0691	0.0931	0.8108	-0.040
PdWPP	-0.0002	0.0212	-0.0025	-0.0133	0.0202	-0.0063	0.0630	0.1020	0.7685	0.001
NSPP	0.0023	0.0228	-0.0048	-0.0114	0.0228	-0.0268	0.0661	0.0924	0.8483	-0.062
1000-SW	-0.0090	-0.0284	-0.0540	-0.0236	0.0075	0.0562	-0.0095	0.0003	-0.1849	0.286

The residual effect = 0.7793 Under line value denote the direct effect

From the result of this investigation, it was revealed that the main reason for strong direct effect of NSPP was due to the strong positive correlation of this character with seed yield at both genotypic and phenotypic levels. The relationship between correlation and direct positive effect was at conformity with a few scientists [18,24] in chickpea. The characters NSPP had highest positive indirect contributions through NPBMF, NSBMF, NPPP and PdWPP on seed yield at genotypic level and at phenotypic level NPPP and PdWPP showed highest positive indirect effect on seed yield.

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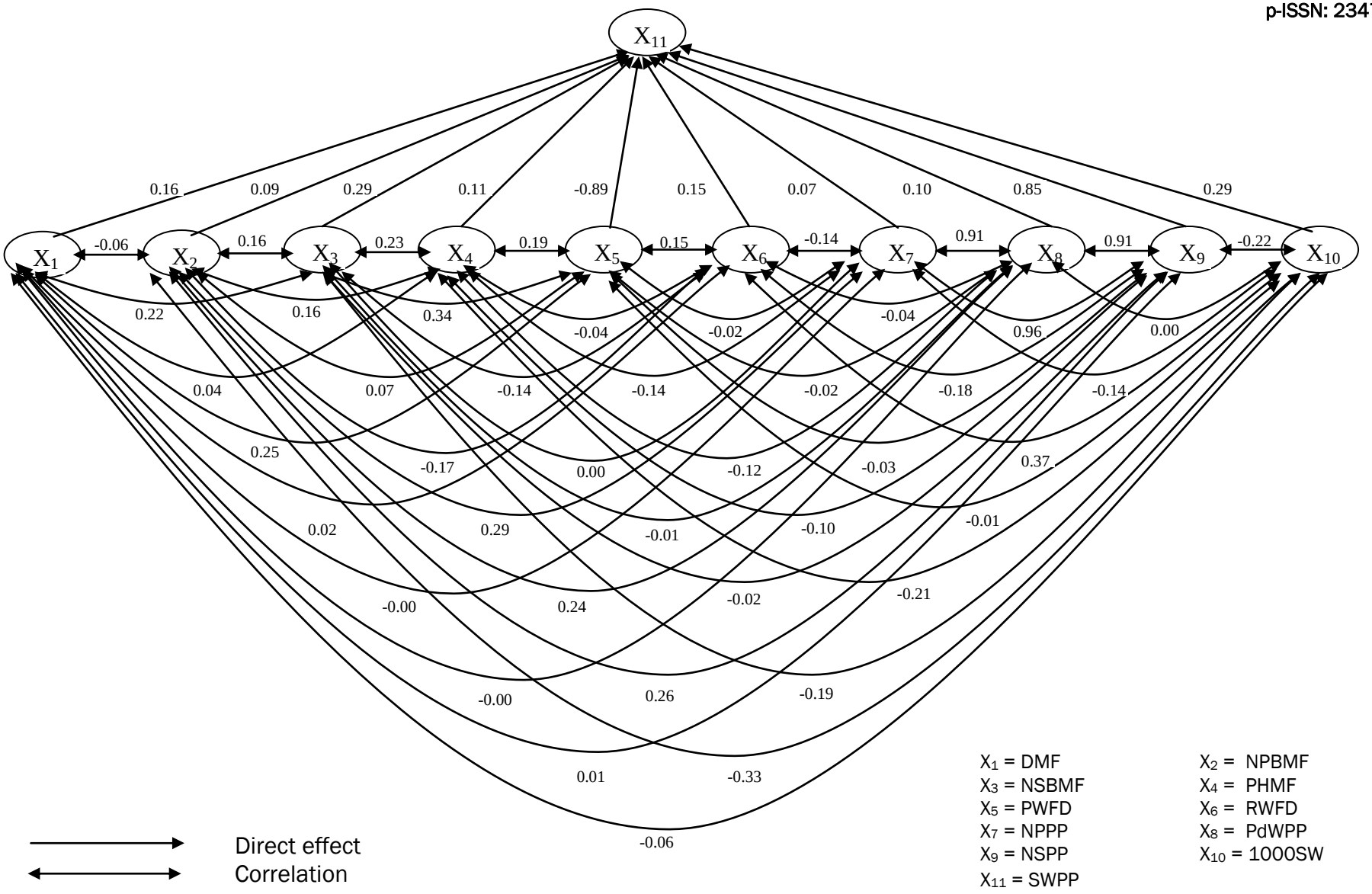

Figure 1: Path diagram of different yield contributing characters at phenotypic level.

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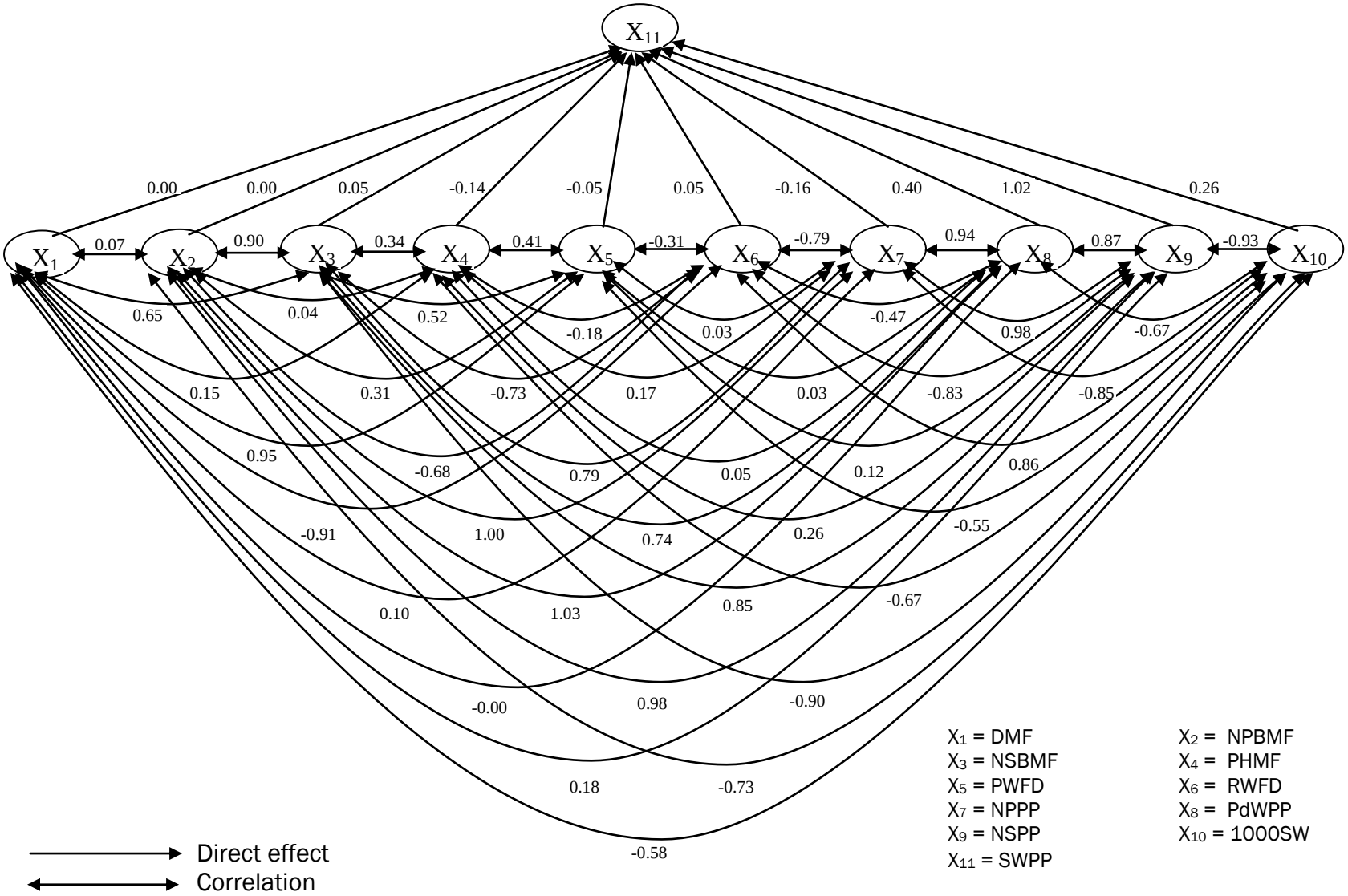

Figure 2: Path diagram of different yield contributing characters at genotypic level

Genetic improvement in chickpea is mainly focused on seed yield by breeders. Yield and yield components are strongly affected by biotic and abiotic factors. The residual effect at genotypic level was 0.0639 and phenotypic level was 0.7793. According to the researcher[24] 78.7% residual effect indicates that there were many other factors than these included in this study affecting seed yield. While two researchers [14,1] found that residual effect was low (0.251) and (0.123) towards seed yield which indicated that about 75% of the variability in seed yield was contributed by the plant characters studied.

On the basis of correlation and path studies, pod weight per plant and number of seeds per plant exerted high direct influence and strong positive correlation on seed yield per plant and this should be taken into consideration while selecting desirable genotypes for higher seed yield in chickpea.

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