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Direct and Indirect Effects between Yield and Yield Components in a Recombinant Inbred Population Developed for Mapping Seed Traits in Chickpea (*Cicer aretinum* L.)

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Abstract: *Direct selection for the grain yield could be illusory but the indirect selection via yield contributing traits with high heritability might be more effective than the direct selection for yield. Direct and indirect effect of various traits on yield was studied in a RIL population and it was observed that the maximum direct positive and negative contribution to seed yield was observed from 100 seed weight and maximum direct negative was from days to flowering. Pods per plant , 100-seed weight and total number of seeds were most important characters which can be used to improve yield in chickpea.*

Keywords: *Chickpea, Path analysis, Recombinant Inbred lines, Yield.*

INTRODUCTION

Among pulses, Chickpea (*Cicer arietinum* L.) is a multi-purpose pulse crop of India. It is well known due to providing dietary protein as a consumption in the form of immature, matured and several processed forms. Chickpea is the third most important pulse crop produced in the world after dry bean and peas. Chickpea contributes 48% among the total pulse production. The highest growth rate among different pulses was observed in chickpea production with 5.89% followed by pigeonpea with 2.61%. Chickpea production is mainly concentrated in central and southern parts of India. Production trends during the past fifteen years indicated that except for a few years in the early 2000s, the fluctuation in the output of chickpea was at around six million tons for over a decade till 2007-08. However production has steadily increased thereafter and largely in tune with the trends in yield levels and reached about 8.8 million tons in 2012-2013. This increase in production is possible due to development of high yielding disease resistant varieties, matching production and protection technologies and better rainfall in chickpea growing areas.

Grain yield is a quantitative trait which is also affected by many genetic factors as well as environmental inconstancy. In crop breeding programmes selection is based on yield and yield contributing traits. To select the favorable plant types for an effective chickpea breeding, the determination of correlation coefficients between yield and its contributing trait is very important. Direct selection for the grain yield could be illusory but the indirect selection via yield contributing traits with high heritability might be more effective than the direct selection for yield Toker 1998 [14]. Traditionally, correlation, regression and path

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coefficient analysis have been used in determining trait interrelationship and yield criteria for indirect selection (Singh *et al*., 1989 [11];). Path coefficient analysis is used to separate the direct effects from the indirect effects through other related traits by partitioning the correlation coefficient and to determine the amount of direct and indirect effects of casual component on the effect component Eser *et al* [4]., Erman *et al* [3]., and Phadnis *et al* [8].,

MATERIALS AND METHOD

One hundred seventy seven RILs of the cross SBD377 (Desi Bold type with 100Seed weight 40 g, and seed number per plant of 34 per plant) and BGD 112 (Desi small seeded with 100 seed weight of 12-15g and seed number per plant of 90) was developed at Division of Genetics, IARI. New Delhi. To ensure appropriate plant growth and development, preparation of land and pest control was carried out by standard agronomic practices. The RILs were orderly planted in 2 m row with a gap of 0.5 meter between the rows.

The recombinant inbred line (RILs) have been extensively phenotyped. Path coefficient analysis was carried out for seed yield per plant and its six component traits in one hundred seventy seven RILs. The direct and indirect contribution of various traits to yield were calculated through path coefficient analysis as suggested by Wright (1921)[15] and elaborated by Dewey and Lu (1959)[2]. Later the path coefficients were rated based on the scales given by Lenka and Misra, (1973)[6]. The estimates of path coefficients are presented in Table 1. The cause and effect relationship is diagrammatically represented in Figure 1.

RESULT AND DISCUSSION

Correlation with yield to the trait days to flowering was positive with a value of (r = 0.057).This trait exhibited a low negative direct effect (–0.107). Indirect effect were also observed negative through days to maturity (–0.008), pods per plant (–0.095) and 100 seed weight (–0.079). This trait had positive indirect effect through plant height (0.224) and total number of seed per pod (0.122). Days to maturity had a correlation with yield of (r = 0.1456). This trait exhibited a positive and low indirect effect through plant height (0.149) and total number of seeds per plant (0.012). A low negative indirect effect were observed via pods per plant (–0.104) and 100 seed weight (–0.142).

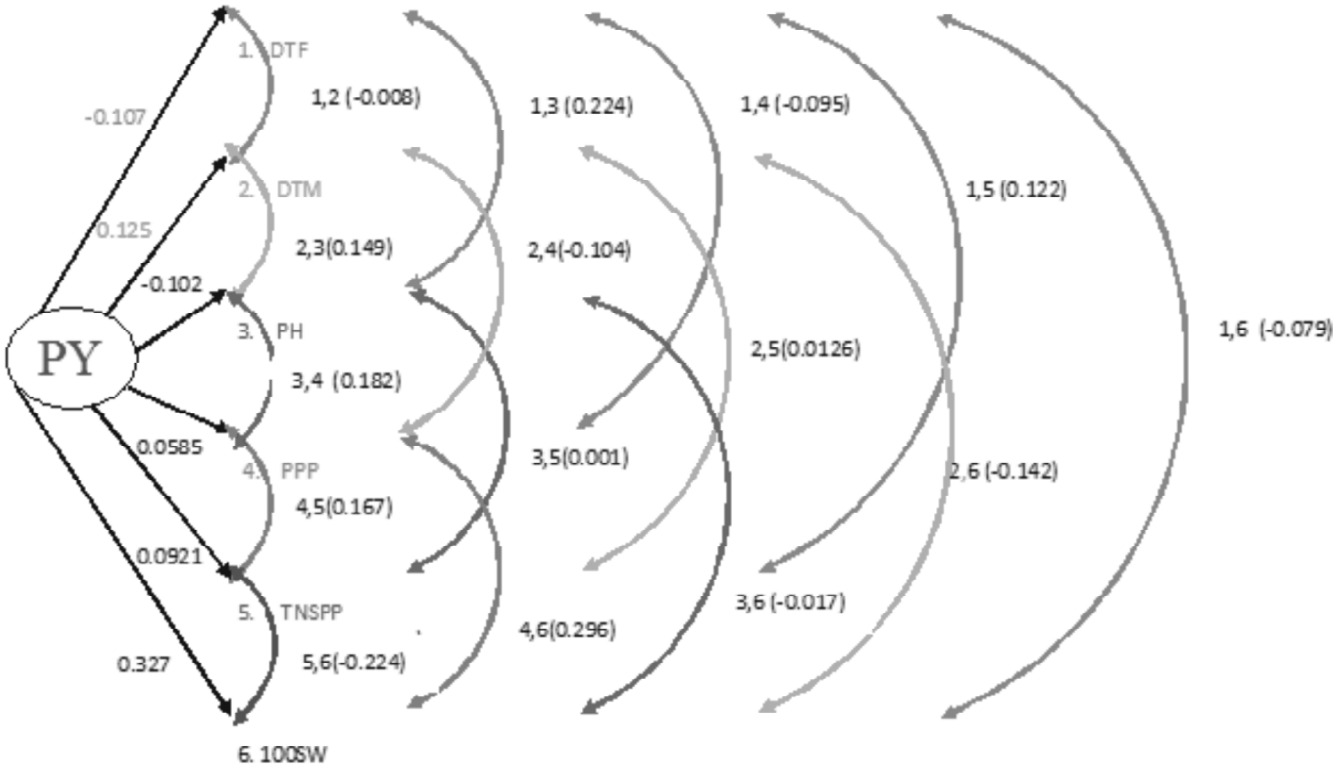
Plant height had a high positive and significant correlation with yield (r = 0.2127). plant height exhibited a positive indirect effect through pods per plant (0.182) and number of seeds per plant (0.001). This trait had low and negative direct effect (–0.102) and indirect negative effect through 100 seed weight (–0.017). The number of pods per plant had positive and low indirect effect through number of seeds per plant (0.167) where as a moderate and negative indirect effect via 100 seed weight (–0.296) was observed. This trait was significantly and positively correlated with yield (r = 0.1425). The total number of seeds per plant had a negligible direct effect with a value 0.0921 while had a moderate negative indirect effect via 100 seed weight (–0.224). It was positively and significantly correlated with

Table 1
Estimates of direct and indirect effects between yield and yield components in 177 RILs of the cross SBD 377 × BGD 112.

Traits	*DTF*	*DTM*	*PH*	*PPP*	*TNSPP*	*100SW*	*Correlation with yield*
DTF	–0.107	–0.008	0.224	–0.095	0.122	–0.079	0.057
DTM	0.105	0.125	0.149	–0.104	0.0126	–0.142	0.1456
PH	0.024	0.1247	–0.102	0.182	0.001	–0.017	0.2127*
PPP	–0.102	0.171	0.144	0.0585	0.167	–0.296	0.1425*
TNSPP	0.011	0.149	0.02	0.289	0.0921	–0.224	0.3371**
100SW	0.021	0.111	0.102	–0.146	–0.217	0.327	0.198**

** Significant at 1% , * Significant at 5%.

1. DTF (Days to flowering), 2. DTM (Days to maturity), 3. PH (Plant height), 4. PPP (Pods per plant), 5. TNSPP (Total number of seeds per plant), 6. 100SW (100 Seed weight).



Path diagram showing cause effect relationship of direct effect with grain yield

yield (r = 0.3371). A moderate to high positive direct effect for 100 seed weight was observed with a value of 0.327 and also had positive and significant correlation with yield (r = 0.198).

According to present investigation the greatest positive direct effect was observed on 100 seed weight indicating that selection for this trait should be done considering its positive indirect effects. This was in accordance with the findings of Naveed *et al*., 2012[7]. Maximum positive direct effect was recorded for 100 seed weight followed by days to maturity, total number of seeds per plant, and pods per plant. This was in agreement with the results of Jivani *et al*., 2013[5].Considering the direct and indirect effects of various traits on yield it seems possible to develop an ideal plant type with more number of seeds per plant and seed weight. Negative direct effect of days to flowering on seed yield was observed and supported with the similar findings of Renukadevi 2006 [10].

Direct selection for the grain yield could be illusory but the indirect selection via yield contributing traits with high heritability might be more effective than the direct selection for yield. Direct and indirect effect of various traits on yield in the above studies in a RIL population indicated that the maximum direct positive and negative contribution to seed yield was observed from 100 seed weight and maximum direct negative was from days to flowering. Pods per plant, 100-seed weight and total number of seeds were most important characters which can be used to improve yield in chickpea.

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