INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

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ASSOCIATION STUDIES IN PIGEONPEA [*CAJANUS CAJAN* (L) MILLSP.] FOR YIELD AND YIELD ATTRIBUTES INCLUDING PHYSIOLOGICAL TRAITS

Chithrameenal, K. & Jebaraj, S.
Centre for Plant Breeding & Genetics, Tamil Nadu Agricultural University, Coimbatore- 641003 India

ABSTRACT
Pigeonpea forms a vital part in Indian diet as a protein source. At present, considerable efforts are being taken to exploit hybrid vigour in order to have spectacular yield increase through the use of GMS and CMS lines. Genotypic correlation studies enable breeders to assess the inherent pattern relationship between various traits since it is based on heritability. Investigation was done by line x tester analysis using two GMS lines *viz*., IMS 1 and ms CO 5 and one CMS line GT 288 A with ten testers *viz*., VBN 1, ICPL 83024, APK 1, ICPL 83027, ICPL 86020, ICPL 87, ICPL 90028, ICPL 91045, ICPL 84031 and ICPL 94032. Genotypic and phenotypic correlations in the parents were estimated to evaluate their performance. The study was conducted at Millet Breeding Station, Centre for Plant Breeding & Genetics, Tamil Nadu Agricultural University, Coimbatore during 2000 - 2002. The correlations between yield and various biometric yield components including physiological traits were evaluated. The various yield components taken into consideration were days to maturity, plant height, number of branches per plant, number of pods per plant, 100 seed weight and the physiological components were harvest index, specific leaf weight, chlorophyll content, nitrate reductase activity in leaves, leaf area, leaf nitrogen content, dry weight of leaves per plant, dry weight of stem per plant, dry weight of roots per plant, dry weight of husk per plant, dry weight of seeds per plant, total dry weight per plant, photosynthetic rate, transpiration rate, stomatal conductance and leaf temperature. The association analysis indicated that grain yield was positively associated with days to 50 percent flowering, days to maturity, number of branches per plant, plant height, number of pods per plant, hundred seed weight, leaf area, dry weight of leaves per plant, dry weight of roots per plant, dry weight of husk per plant, dry weight of seeds per plant, total dry matter produced per plant, photosynthetic rate, transpiration rate and leaf temperature. So these characters can be given due importance during the selection of parents and hybrids in a breeding programme.

KEY WORDS: Correlation, Pigeonpea, CMS & GMS hybrids, Yield components, Physiological traits

INTRODUCTION
Pigeonpea or redgram has originated and domesticated in India. It plays a major role in Indian livelihoodas each and every part of the plant provides subsistence economic return to the farmer. It is a low input crop that can be grown under wide range of environmental conditions. The ultimate aim of a breeder is to develop high yielding varieties. Yield being a complex character is influenced by various components. Falconer (1960) stated that selection of a specific character is known to result invariably in correlated response for some other character. Therefore information on association of component characters with yield and among themselves and the extent to which these are influenced by the environment should be known. Hence, the present investigation was carried out with the aim to study the genotypic and phenotypic correlation between yield and yield contributing characters including physiological traits in pigeonpea.

MATERIALS & METHODS
The experiments were carried out with 10 pigeonpea genotypes which were used as parents for production of hybrids during *Kharif* 2001.The three male sterile lines (female parents) and the ten testers (male parents) were raised staggeredly in three rows of each four meters length with a spacing of 45 x 15 cm at Millet Breeding Station, Centre for Plant Breeding & Genetics, Tamil Nadu Agricultural University, Coimbatore-3. Each of the three female lines was crossed with each of the ten testers in a line x tester fashion and thus a total of thirty hybrids were produced. The thirty hybrids along with their parents were raised in two replications using Randomised Block Design (RBD) at Millet Breeding Station, TNAU Coimbatore during summer 2002. In this study, genotypic and phenotypic correlations for seven important biometric traits viz., days to 50 % flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, single plant yield and hundred seed weight and eight physiological traits *viz*., harvest index, total dry matter produced per plant and partitioning, leaf area, specific leaf weight, leaf chlorophyll content, photosynthetic rate, nitrate reductase activity in leaves and nitrogen content in leaves were analyzed. Phenotypic and genotypic correlation coefficients were computed as per the formula suggested by Robinson *et al.* (1951).

RESULTS & DISCUSSION
It has been generally accepted that correlation between different characters represents a coordination of physiological processes, which is often achieved through well regulated gene expression (Mather and Jinks, 1971). Based on the genotypic and phenotypic variances and co-

variances, the genotypic and phenotypic correlation coefficients were estimated. The correlation coefficients between seed yield and yield components including physiological traits and inter correlations among themselves are furnished in table 1 and 2. In the analysis, sub-characters of total dry matter produced per plant *viz.*, dry weight of leaves per plant, dry weight of stem per plant, dry weight of roots per plant, dry weight of husk per plant, dry weight of seeds per plant and characters related with photosynthetic rate like transpiration rate, stomatal conductance and leaf temperature were also taken into consideration.

TABLE I. Phenotypic and genotypic correlation for seed yield and biometric yield components in pigeonpea

Characters		Days to maturity	Plant height	No. of branches/plant	No. of pods/plant	100-seed weight	Seed yield /plant
Days to 50% flowering	GC	0.830**	0.745**	0.102	0.618*	-0.023	0.238
	PC	0.714**	0.644**	0.064	0.541	-0.007	0.204
Days to maturity	GC		0,849**	-0.125	0.712**	0.115	0.507
	PC		0,848**	-0.116	0.710**	0.114	0.502
Plant height	GC			0.070	0.874**	0.254	0.762**
	PC			0.063	0.873**	0.252	0.756**
No.of branches/plant	GC				0.186	0.346	0.197
	PC				0.163	0.325	0.143
No.of pods/plant	GC					0.086	0.878**
	PC					0.086	0.872**
100-seed weight	GC						0.300
	PC						0.292

*Significant at 5 per cent level GC- Genotypic correlation
**Significant at 1 per cent level PC- Phenotypic correlation

In the present study, it was found that seed yield was positively correlated with days to 50% flowering, days to maturity, number of branches per plant, plant height, number of pods per plant, hundred seed weight, leaf area, dry weight of leaves per plant, dry weight of roots per plant, dry weight of husk per plant, dry weight of stem per plant, dry weight of seeds per plant and total dry matter produced per plant, photosynthetic rate, transpiration rate and leaf temperature. These results suggest that these characters contribute mainly for yield and thus could be used in selection for improvement of yield in pigeonpea. Since seed yield was positively associated with total dry matter produced and negatively with harvest index, multipurpose role of the crop like fuel (stem), composting, enriching fertility of the soil can be achieved. Balakrishnan and Natarajaratnam (1989) reported that harvest index percentage was negatively correlated with yield. The physiological traits *viz*., harvest index, specific leaf weight, leaf chlorophyll content, nitrate reductase activity in leaves, nitrogen content in leaves and stomatal conductance showed non-significant negative association with seed yield. Singh and Gumber (1995) reported that magnitude of correlation between seed yield and harvest index was very low in parents and F1 generation. To improve harvest index, phytothermal conditions could be strongly induced to shorten the time to flowering so that plants are less vegetative. Thus large yields could be obtained. Days to 50% percent flowering showed significant association with days to maturity. This result was in agreement with Holkar et al., (1991), Dhameliya and Pathak (1994) and Sidhu *et al*. (1985). Therefore it would be possible to identify early maturing genotypes using the pre-flowering duration as an index. Days to maturity were positively associated with number of pods per plant. This was reported by Sandhu *et al.* (1994). Number of branches per plant exhibited positive association with number of pods per plant and as number of branches increases, number of pods per plant will also increase. Similar association was observed by Godawat (1980), Dhameliya and Pathak (1994) and Singh and Gumber (1995). Number of pods per plant exhibited positive association with days to maturity. This could be supported by the result of Sidhu *et al*. (1985). Khapre and Nerkar (1985) reported the positive association of harvest index with total dry matter produced per plant. This was in contrast with the result of the present study wherein harvest index was negatively associated with total dry matter produced per plant. This indicates that more of source was partitioned to stem, leaf and other parts except seeds. Specific leaf weight showed positive association with photosynthetic rate, leaf chlorophyll content, nitrate reductase activity in leaves, nitrogen content in leaves, leaf temperature and dry weight of seeds per plant. Thicker leaves are supposed to have additional layers of mesophyll cells thus improving photosynthesis in crop plants. Leaf chlorophyll content exhibited positive association with photosynthetic rate, nitrate reductase activity in leaves, nitrogen content in leaves, dry weight of stem per plant and stomatal conductance. Thus by increasing leaf chlorophyll content, the photosynthesis and correlated traits could be improved. This in turn might increase the yield to a greater extent. Nitrate reductase activity in leaves expressed positive association with nitrogen content in leaves, photosynthetic rate, stomatal conductance and leaf temperature. More nitrogen would be reduced by high nitrate reductase activity which would lead to better nitrogen use. Leaf area was positively associated with dry weight of leaves per plant, dry weight of roots per plant, dry weight of stem per plant, dry weight of husk per plant, dry weight of seeds per plant, total dry matter produced and transpiration rate.

ISSN 2229 – 6441

Table II. Phenotypic and genotypic correlation for seed yield and physiological traits in Pigeonpea

Characters		Specific leaf weight	Chlorophyll content	Nitrate reductase activity	Leaf area	Leaf nitrogen content	DM- Leaves	DM- Stem	DM- Roots	DM- Husk	DM- Seeds	DM- Total	Photosynthetic rate (P)	Transpiration rate (E)	Stomatal conductance (C)	Leaf temperature (TL)	Seed yield per plant
Harvest index	GC	0.124	-0.303	0.379	-0.413	0.256	-0.457	-0.704**	-0.594**	-0.627*	0.056	-0.447	0.016	-0.251	-0.040	0.425	-0.081
	PC	0.122	-0.300	0.373	-0.410	0.253	-0.458	-0.695*	-0.586**	-0.621*	0.055	-0.444	0.235	-0.244	-0.046	0.351	-0.075
Specific leaf weight	GC		0.298	0.281	-0.500	0.391	-0.305	-0.185	-0.317	-0.101	0.186	-0.089	0.597*	-0.411	-0.475	0.120	-0.073
	PC		0.296	0.268	-0.498	0.379	-0.300	-0.186	0.317	-0.101	0.184	-0.090	0.445	-0.375	-0.462	0.101	-0.071
Chlorophyll content	GC			0.170	-0.490	0.188	-0.443	0.059	-0.286	-0.143	-0.542	-0.367	-0.673*	-0.445	0.228	-0.371	-0.548
	PC			0.168	-0.490	0.187	-0.435	0.059	-0.286	-0.142	-0.539	-0.366	-0.156	-0.409	0.223	-0.320	-0.544
Nitrate reductase activity	GC				-0.839**	0.821**	-0.823**	-0.392	-0.684**	-0.598*	-0.157	-0.521	0.879**	-0.754**	0.263	0.052	-0.276
	PC				-0.826**	0.807**	-0.789**	-0.379	-0.673*	-0.585*	-0.152	-0.509	0.100	-0.724**	0.261	0.041	-0.269
Leaf area	GC					-0.643*	0.976**	0.516	0.872**	0.720**	0.409	0.745**	-0.323	0.794**	-0.207	-0.026	0.587*
	PC					-0.638*	0.957**	0.514	0.870**	0.716**	0.408	0.743**	-0.106	0.729**	-0.202	-0.022	0.582*
Leaf nitrogen content	GC						-0.512	-0.298	-0.416	-0.279	0.041	-0.265	0.658*	-0.885**	0.379	-0.160	-0.053
	PC						-0.500	-0.290	-0.409	-0.283	0.043	-0.261	0.134	-0.800**	0.370	-0.153	-0.047
DM- Leaves	GC							0.535	0.898**	0.785**	0.487	0.803**	-0.247	0.688**	-0.279	-0.051	0.634*
	PC							0.522	0.877**	0.771**	0.477	0.793**	-0.027	0.633*	-0.272	-0.005	0.613*
DM- Stem	GC								0.746**	0.547	0.432	0.780**	0.222	0.528	-0.071	-0.024	0.545
	PC								0.743**	0.540	0.431	0.780**	0.011	0.479	-0.069	-0.034	0.540
DM- Roots	GC									0.900**	0.597*	0.929**	-0.570*	0.631*	-0.139	-0.202	0.751**
	PC									0.889**	0.594*	0.926**	-0.011	0.576*	-0.138	-0.172	0.747**
DM- Husk	GC										0.480	0.795**	-0.665*	0.376	-0.105	-0.339	0.609*
	PC										0.471	0.788**	-0.046	0.337	-0.108	-0.258	0.592*
DM- Seeds	GC											0.823**	0.629*	0.353	-0.393	0.124	0.944**
	PC											0.822**	0.450	0.319	-0.380	0.110	0.941**
DM- Total	GC												0.108	0.589*	-0.284	-0.038	0.904**
	PC												0.193	0.538	-0.277	-0.023	0.894**
P	GC													0.298	-0.902**	0.678*	0.453
	PC													-0.042	-0.417	0.136	0.249
E	GC														-0.456	0.285	0.493
	PC														-0.414	0.155	0.436
C	GC															-0.474	-0.237
	PC															-0.429	-0.225
TL	GC																0.052
	PC																0.048

*Significant at 5 per cent level **Significant at 1 per cent level GC- Genotypic correlation PC- Phenotypic correlation

Ganesamurthy and Durairaj (1990) reported that LAI and dry matter production were positively associated which could be exploited by concentrating on higher leaf area. Increased source size leads to increase in translocation to sink and thus yield may be increased. Nitrogen content in leaves was positively associated with photosynthetic rate, dry weight of seeds per plant and stomatal conductance. As nitrogen content in leaves increases, photosynthetic rate also increases which in turn leads to increased seed yield per plant. Dry weight of leaves per plant showed significant positive association with dry weight of roots per plant, dry weight of husk per plant, total dry matter produced per plant and transpiration rate. Also significant positive association was there between dry weight of stem per plant and dry weight of roots per plant and total dry matter produced. Dry weight of roots per plant was significantly and positively associated with dry weight of husk per plant, dry weight of seeds per plant, total dry matter produced and transpiration rate. Dry weight of husk per plant expressed significant positive association with total dry matter produced per plant. Dry weight of seeds per plant was positively associated with total dry matter produced and photosynthetic rate. As the photosynthetic rate is increased, it will eventually lead to increase in seed yield. Total dry matter produced per plant was positively correlated with transpiration rate and photosynthetic rate. As high photosynthetic rate and transpiration rate leads to increased dry matter, the yield may in turn increase. Photosynthetic rate was positively associated with leaf temperature and transpiration rate. Transpiration rate in turn was associated positively with leaf temperature. From the results obtained, it can be noted that characters showing positive correlation with seed yield and among themselves could be taken into consideration while going for selection of high yielding segregants in later generations. In this study, the estimated correlation coefficients showed that not all the characters were interrelated with seed yield or among themselves.

CONCLUSION

It is concluded from the present study that seed yield per plant had positive associations with plant height, number of pods per plant, leaf area, dry weight of leaves per plant, dry weight of roots per plant, dry weight of husk per plant, dry weight of seeds per plant and total dry matter produced per plant, days to 50 % flowering, days to maturity, number of branches per plant, hundred seed weight, dry weight of stem per plant, photosynthetic rate, transpiration rate and leaf temperature. Therefore, these traits are to be given priority during selection programme to increase the single plant yield in pigeonpea.

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