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Genetic relatedness among *desi* and *kabuli* chickpea varieties of India

AK SRIVASTAVA, GP DIXIT, SK CHATURVEDI, NP SINGH and MOHAMMAD NISAR

ICAR-Indian Institute of Pulses Research, Kanpur, 208 024, U.P. India.

E-mail : bhu.avinash@gmail.com

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ABSTRACT

More than 200 chickpea varieties released in India have resulted in achieving 8-9 million tonnes of production annually. However, its production remains unstable over years and locations due to vulnerability of present day varieties to fluctuating weather condition and various biotic stresses. The narrow genetic base of the cultivars is mainly responsible for vulnerability to biotic and abiotic stresses. The present study takes stock of the current genetic base by analysing genetic relatedness of 105 *desi* and 33 *kabuli* chickpea varieties released in India till 2015 through pedigree analysis. The genetic base of *desi* and *kabuli* varieties could be traced back to 120 and 53 parents, respectively. IP 58 (27), C 1234 (26), JG 62 (18), S 26 (18) and Chaffa (15) were the most utilised parents in *desi* while Rabat (26), Pb 7 (24), Banda Local (14), Etah Bold (14), Guamchil 2 (14), P 458 (14) and GW 5/6 (14) were the frequently used lines in *kabuli* varieties. More than 50% of total genetic base could be traced to 24 parents among *desi* and only 9 parents among *kabuli* varieties. It is a high time that concerted efforts should be made for utilization of diverse germplasm lines involving wild species and primitive landraces to broaden genetic base so that vulnerability to biotic and abiotic stresses can be minimized.

Keywords: *Desi*, Genetic relatedness, *Kabuli*, Pedigree Analysis

Pulses have been grown since millennia by the Indian farmers and are considered indispensable part of the balance food of largely vegetarian masses in the country (Nene, 2006). Chickpea is the most important pulse crop in the country accounting for more than 46% (8.09 m tonnes) of the total pulse production (17.33 m tonnes) and 87% of total pulse export during 2015-16 (DAC, 2016). Chickpea has a rich history of breeding in India. Initial breeding efforts through selection among germplasm lines at the then Imperial Agricultural Research Institute (IARI), Pusa, Bihar led to development of purelines like NP 17, NP 25, NP 28 and NP 58 in 1926 while C12/34 and Type 87 were developed through hybridization in early forties. Systematic breeding programme through hybridization for incorporating disease resistance, development of short duration and heat tolerant varieties for late sowing condition and high input responsive varieties have led to development of more than 200 high yielding varieties. Recently, efforts have been made to develop large/ extra-large seeded *kabuli* varieties for export Ali *et al.,* 2003. Although *kabuli* chickpea varieties have lower yield potential than the *desi* varieties (Kaul *et al*., 2005), yet it fetches better return to farmers as well as adds to the country's export basket (Gaur *et al*., 2006). Similarly, the development of varieties suitable for mechanical harvesting and herbicide tolerance are likely to help in reducing the cost of cultivation (Chaturvedi *et al*., 2014). The narrow genetic base of current day cultivars is mainly responsible for unstable yield of chickpea over years and locations (Udupa *et al.,* 1993; Kumar *et al.,* 2004), although a conscious effort has been made to utilize diverse parents in chickpea breeding all over the country. The present study attempts to take stock of the current genetic base of chickpea varieties by analysing genetic relatedness of *desi* and *kabuli* chickpea varieties through pedigree analysis.

MATERIALS AND METHODS

The pedigree analysis was performed on 105 *desi* and 33 *kabuli* chickpea varieties developed through hybridization and released through Central Sub-Committee on Crop Standard, Notification and Release of Varieties till 2015 for cultivation in different parts of the country (Project Coordinator Report, 2015). Pedigrees of these varieties were obtained from the available records maintained at ICAR-Indian Institute of Pulses Research, Kanpur or Department of Agriculture, Cooperation and Farmers Welfare, New Delhi. The number of times (frequency) an ancestor appeared in the pedigree of various varieties were counted. The relative genetic contribution (RGC) of different ancestors to a given variety was computed by partitioning the genetic constitution of a cross into theoretical percentage attributable to different ancestors assuming that every time a cross is made each parent transmits 50% of its genes to the progeny with equal probability (Lin, 1991). The mean genetic contribution of a given ancestor was estimated by the means of RGC's of this ancestor to all the varieties developed through hybridization.

RESULTS AND DISCUSSIONS

The genetic base of *desi* and *kabuli* varieties could be traced to 120 and 53 parents, respectively. The most frequently used parent in *desi* varieties included IP 58 (27), C 1234 (26), JG 62 (18), S26 (18) and Chaffa (15) (Table 1). Among these, 84 parents were used only once or twice while 19 parents were utilised 3-6 times in the pedigree of *desi* varieties. IP 58 and C 1234 led to development of more than 25% of *desi* varieties followed by JG 62 (17%) and S 26 (17%) (Fig 1A). Among *kabuli* varieties, Rabat (26), Pb 7 (24), Banda Local (14), Etah Bold (14), Guamchil 2 (14), P 458 (14) and GW 5/6 (14) were predominantly utilized (Table 2). Further, 36 parents were used only once or twice while 8 parents were utilised 3-6 times in the pedigree of *kabuli* varieties. Incidentally, Rabat is utilised as a parent in development of nearly 80% of *kabuli* varieties followed by Pb 7 (73%) (Fig 1B). In general most of the frequently used parents have been used indirectly in the hybridization programme in both *desi* and *kabuli* varieties (Table 3 and 4). This is the outcome of step wise improvement in performance of the genotype wherein the advanced lines are used time and again in making future crosses. Thus, the original parents come in the pedigree of the line although they are not used directly. Repeated use of these parents reduces the genetic base of varieties making them vulnerability to the changing climate.

Table 1. Parents and their frequency in pedigree of 105 *desi* chickpea varieties in India

Parents	Total appearances
IP 58, C 1234, JG 62, S 26, Chaffa, G 24, Pb 7, Rabat, M 546 W, B 75, Banda Local, Etah Bold	10 and above
P 1231, P 1265, F 496, E 100 Ym, 708, Annigeri 1, T 3, P 1630, 850-3/27, P 481	6-9
GW 5/7, H 233, L 168, RSG 515, 197, H 75-35, Narsinghpur Bold, Bheema, 76, BG 203, P 179, G 1540, Guamchil 2, P 458	3-5
GNG 146, JG 74, P 827, P 9847, PDG 84-10, Phule G 91028, RSG 524, BG 303, F 61, GNR 14, P 327, GW 5/6, 195, AF 7-10, AKG 46, BDN 9-3, BG 1, BG 257, Bhawanipatna, C 168, Ceylon 2, CSJ 146, FG 712, G 140, G 549, GC 654, GCP 2, GF 8976, GG 578, GG Bijapuri, GJG 9707, GNG 1365, Green Mutant 121-1, H 89-78, H 89-84, Hima, ICC 10301, ICC 12237, ICC 3935, ICC 4958, ICCL8424, ICCV 89230, ICCV 933001, ICCX860263-BG-BP-91-BP, ILG 613, JG 1258, JG 315, K 315, K 468, K 607, Khanur 6, KPG 279-3, L 245, NEC 206, P 127, P 1353, P 340, P 556, PG 5, Pink 2, RS 10, RSG 255, RSG 289, RSG 538, RSG 581, RSG 668, RSG 817, ST 4, BG 1003, BG 1048, BG 364, *C. reticulatum*, DCP 20, F 378, FLIP 88-20, GF 88421, ICCV 91902, IG 9216, JAKI 92-26, P 436, P 922, RS 11, NP 34, ICC 8923	1-2

Table 2. Parents and their frequency in pedigree of 33 *kabuli* chickpea varieties in India

Parents	Total appearances
Rabat, Pb 7, Guamchil 2, P 458, GW 5/6, Banda Local, Etah Bold, L 2, S 26	10 and above
IP 58, C 1234, G 24	6-9
ICCC 49, 850-3/27, JG 62, USA 613, E 100 Ym	3-5
ICC 7344, RSGK 628, BEG 482, ICC 32, FLIP 88-20, Surutoto, FLIP 82-1C, ICCV 95412, P 6613, ICC7344-ICCX870026-PB-PB-14B-63AK-7AK-BAK, ICCX76581BRH-10H-BH, GNG 149, Bheema, GNG 421, HK 92-94, GNG 1382, GLK 88016, FLIP 88-34C, MPJG 2, F 61, Surutoto 77, ICC 7676, FLIP 82-8C, H 82-5, CPS 1, Phule G 92307, F 370, FLIP 82-16C, BG 315, ILC 72, ICCV 13, FLIP 85-11, ICCV 88507, ICCL 8100, GW 5/7, Annigeri 1	1-2

Earlier study on pedigree analysis reported that 86 chickpea varieties including both *desi* and *kabuli* types could be trace to 95 ancestors with Pb7 being most commonly used followed by IP 58, Rabat and S26 (Kumar et al, 2004). This presents a skewed picture making parents utilised in development of *kabuli* varieties more prominent. In India, development of *kabuli* chickpea varieties have started relatively recently than *desi* varieties. As such, there is dearth of adequate *kabuli* type parents adaptable to Indian climate leading to repeated utilization of some of the parents. On the other hand, there is no such limitation on *desi* parents leading to widespread utilization in developing *desi* varieties. Our study indicates that there has been a sharp decline in the use of known parents in hybridization programmes especially for *desi* types and a conscious effort has been made to involve new donors for different traits. Among *kabuli* varieties, more than 50% of the genetic base could be traced to only 9 parents (Table 4). This represents an alarming scenario regarding the genetic bases of the released *kabuli* chickpea varieties and has an impact on relatively lower yield potential and poor adaptability of *kabuli* varieties in the country. The situation is grim for *desi* varieties as well wherein about 24 parents constitute more than 50% of genetic base of the released varieties (Table 3). Although conscious efforts have been made to include diverse parents in the chickpea breeding

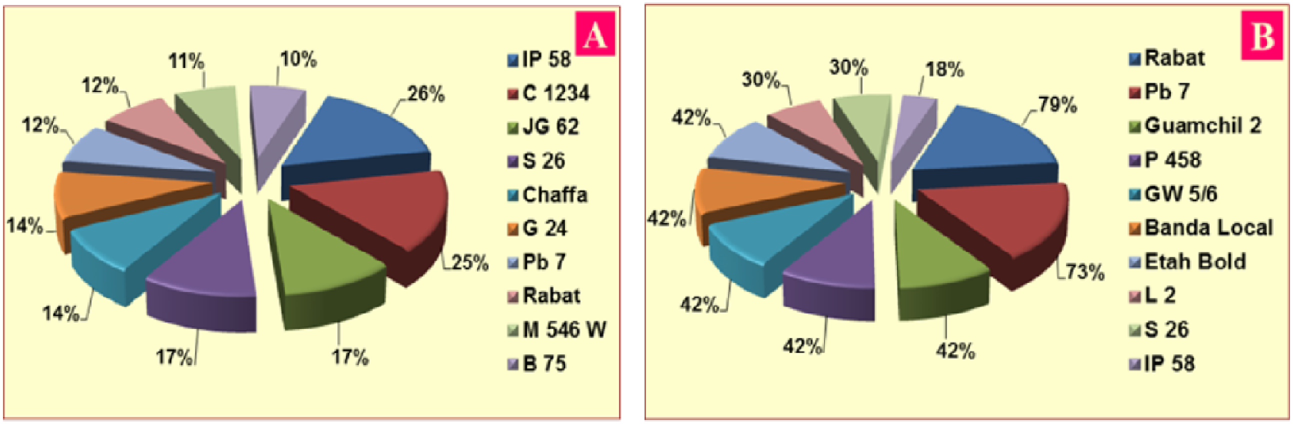

Fig. 1. Occurrence of parents in pedigree of 105 *desi* varieties (A) and 33 *Kabuli* Varieties (B).

Table 3. Frequency of direct and indirect occurrence of ancestors in pedigree and their genetic contribution in 105 *desi* chickpea varieties in India

S No	Parents	Appearance in pedigree			Relative genetic contribution	Mean genetic contribution	Cumulative genetic contribution	Occurrence (%)
		Direct	Indirect	Total				
1	JG 62	1	17	18	3.69	0.0351	0.0351	17.14
2	IP 58	1	26	27	3.50	0.0333	0.0685	25.71
3	Chaffa	3	12	15	3.34	0.0318	0.1003	14.29
4	C 1234	1	25	26	3.25	0.0310	0.1313	24.76
5	E 100 Ym	5	2	7	3.00	0.0286	0.1598	6.67
7	S 26	3	15	18	2.75	0.0262	0.1860	17.14
6	B 75	4	7	11	2.75	0.0262	0.2122	10.48
8	Annigeri 1	4	2	6	2.38	0.0226	0.2348	5.71
9	M 546 W	1	11	12	2.31	0.0220	0.2568	11.43
10	F 496	1	7	8	2.25	0.0214	0.2783	7.62

Table 4. Frequency of direct and indirect occurrence of ancestors in pedigree and their genetic contribution in 33 *kabuli* chickpea varieties in India

S No	Parents	Appearance in pedigree			Relative Genetic Contribution	Mean Genetic Contribution	Cumulative genetic contribution	Occurrence (%)
		Direct	Indirect	Total				
1	Rabat	3	23	26	4.70	0.1425	0.1425	78.79
2	Pb 7	2	22	24	3.58	0.1084	0.2509	72.73
3	L 2	1	9	10	1.94	0.0587	0.3097	30.30
4	Guamchil 2	0	14	14	1.38	0.0417	0.3513	42.42
5	P 458	0	14	14	1.38	0.0417	0.3930	42.42
6	S 26	1	9	10	1.26	0.0381	0.4311	30.30
7	ICC 7344	2	0	2	1.00	0.0303	0.4614	6.06
8	RSGK 628	2	0	2	1.00	0.0303	0.4917	6.06
9	USA 613	1	2	3	0.88	0.0265	0.5182	9.09
10	BEG 482	1	1	2	0.75	0.0227	0.5410	6.06

programme, yet it has not materialized into concrete products. A large number of germplasm lines including land races available with International Crops Research Institute for the Semi-Arid Tropics (19187 accessions), International Centre for Agricultural Research in the Dry Areas (12647 accessions) and National Bureau of Plant Genetic Resources (14566 accessions) still remains unutilised in want of precise information or not resulted in varieties. A study of pedigree of different genotypes under initial evaluation trial (IVT) conducted under AICRP on Chickpea for past 10 years (2005-06 to 2014-15) revealed that utilization of about 2% of the available germplasm resources resulted in IVT entries. Limited utilization of variability has led to reduction in pace of development of widely adapted cultivars with resistance to biotic and abiotic stresses (Siddique *et al.*, 2000). There is need to add value to these germplasm so that systematic utilization can lead to good varieties. The narrow genetic base as indicated by the pedigree analysis further suggests for pre breeding efforts to broaden genetic base using primitive landraces and wild species of future varieties. It is high time that concerted efforts should be made for need based utilization of the germplasm resources as well as modern techniques of breeding to incorporate multiple biotic and abiotic stress resistance. This will not only lead to improvement and stabilization of yield but also in improvement in farmers preferred traits including extra-large seeded *kabuli* varieties for export purpose.

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