Evaluation of Exotic Germplasm of Kabuli Chickpea

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The objective of the present study was to identify high yielding, large (>40g/100 seeds) and extra-large (>50g/100 seeds) germplasm accessions of Kabuli chickpea with resistance/tolerance against Fusarium wilt. Consequently, during *rabi* 2002-03,150 exotic germplasm accessions belonging to diverse geographical regions were raised in augmented design and studied for phenological and agro-morphological traits. The results indicated high variability for traits, *viz.*, yield/plant, pods/plant and 100 seed weight, respectively. While moderate variability was detected for plant height. 13 accessions found desirable for seed size were further studied during *rabi* 2003-04, for plant type, yield (kg/ha), 100 seed weight and seed coat characteristics. Four accessions, namely, ICC12033, ICC14199, ICC14197 and ICC14203 demonstrated high yield potential of >18q/ha. Their respective 100 seed weight was recorded as 60.2, 54.73, 58.31 and 46.16. Based on screening in wilt sick nursery, an accession ICC14199 displayed complete resistance whereas ICC14203 showed moderate resistance against *Fusarium* wilt (race 2). Efforts are underway to utilize the desirable accessions in Kabuli improvement.

Key Words: Kabuli chickpea, exotic accessions, yield potential, seed size, *Fusarium* wilt

Chickpea is among the major pulse crops in Indian subcontinent. India leads the chickpea producing countries with 75% and 73% as its share in area and production, respectively (FAO, 2005). However, most of the varieties of kabuli types have low yield potential, small to medium seed size and eventually succumb to various biotic and abiotic stresses. Narrow genetic base is attributed as one of the reasons of non-performance of these varieties. In countries like Turkey, Spain, Canada etc., varieties with 50-60g/100-seed weight are cultivated as these fetch premium price in the market. Hence, exotic material with wider genetic variation for yield and yield contributing traits, resistance/tolerance to *Fusarium* wilt, *Ascochyta* blight, drought and cold and plant type which is amenable to mechanical harvesting as well as suitable for different environmental niches is urgently sought. This investigation is an attempt to evaluate the phenological and yield and its component traits in exotic kabuli accessions as well as screen their reaction against wilt (*Fusarium oxysporum* f. sp. *ciceri*) race 2 so as to identify the promising entries to be utilized in augmenting breeding programmes.

Material and Methods

The investigation was carried out at Kanpur, which falls in Northern part of India; its latitude and longitude being 20°27'N and 80°14'E, respectively. A total of 150 kabuli germplasm accessions (98 from NBPGR, New Delhi and 52 from ICRISAT Hyderabad), originating from diverse geographical regions was selected. The accessions were sown on November 2, 2002 and evaluated by a Petersen's augmented design (Petersen,1985) with three commercial varieties, namely, KAK2, L550 and BG1003 as checks. Therefore, five blocks were formed each one having 30 different genotypes and a replication of the checks. The experimental plots consisted of two rows, 3 m long, each with row to row and plant to plant distance of 30 cm and 10 cm, respectively. Cultural operations, weed control and fertilizations were made according to standard practices. Observations were recorded on days to flower (50%), days to pod (1st), days to maturity (95%), %wilt incidence and plant height (cm) upon maturity. On the basis of five competitive plants, information was collected on number of primary branches/plant, secondary branches/plant, pods/plant, and seed/pod and yield/plant (g). Plot yields (g) were converted into kg/ha using the formula (plot yield (g)/plot size x 10). 27 accessions were designated as promising entries on the basis of their overall performance. However, 13 entries were identified as large to extra-large seeded with low to moderate wilt incidence. These entries along with two checks namely KAK2 and L550 were raised in RBD with two replications during *rabi* 2003-04. The entries were raised on a plot size of 2.7 sqm with row to row and plant to plant spacings of 30 cm, and 10 cm, respectively. The cultural practices, etc as followed during previous year were resorted to. Information was gathered on various traits as done previously. Recorded data were analysed using the INDOSTAT programme.

Seven most promising lines displaying low wilt incidence under natural conditions were screened for scoring their reaction against *Fusarium* wilt (race 2).

During rabi 2004-05, the accessions along with three commercial varieties, *viz.,* KAK2 and L550 were sown in a wilt sick plot (WSP) – a 15-year old diseased nursery wherein pathogen inoculum was continuously added and followed by growing highly susceptible varieties/strains every year since 1989-90.The accessions were planted in 4.5 m long rows with row-row and plant-to-plant spacing of 30 cm and 10 cm, respectively. The susceptible check entry, JG62–a twin-podded desi was sown after every test entry. Two rows of each entry alternated with one row of infector JG62 enabling the development of heavy pathogen inoculum and maintenance of high disease pressure in the nursery. The extent of disease incidence in the susceptible infector rows served as a standard check for susceptibility of the test material. The crop was raised as per the recommended cultural practices for the chickpea pathological trials. The wilt incidence in each accession was scored and the lines characterized as per the guidelines of All India Co-ordinated Research Project on improvement of chickpea (Anonymous, 2004). Accordingly, plant count upon emergence was noted and the entries were regularly observed for wilt incidence. A count of wilted plant/s per accession was made and final data was recorded 2-weeks before maturity. The information on plant count upon emergence and maturity and the number of dead plants because of infection were compiled and % FW due to mortality was calculated .

Results and Discussion

Chickpea is quantitatively a long day plant (van der Maesen, 1972) . Its sown during October-November and matures during last week of March-mid April. Under North Indian conditions the crop thus encounters decreasing temperature and decreasing photoperiod until flowering begins, and increasing temperature as well as day length during pod development and maturity (Khanna-Chopra and Sinha, 1987).

During our investigation, 20 accessions showed first flush of flowering within 50-60 DAS (date of sowing being 02/11/2002). This period was an exceptional phase characterized by high day as well as night temperatures which started falling from last week of December with next 30 days being exceptionally cold, humid and foggy, with mean day temperature below 5^{o}C at the time of pod establishment (weather bureau, IIPR, data not given). The flowers /pods degenerated and the lines eventually re-flowered during 103-110 DAS. Such lines produced only a few pods by 117-120 DAS. These lines also displayed 100 % wilting at podding stage. Eventually shrivelled seeds were harvested. No further studies could be conducted on these accessions.

The mean values, range and CV (%) for the ten traits recorded, are given in Table 1. All the accessions displayed 50% flowering between 100-126 DAS with the mean of 108.68 DAS. An average of 115.81 DAS were taken for pod initiation. The accessions were found to mature by 152.01 DAS. A low coefficient of variation (cv) for these three parameters was discernible (Table 1). The plant height ranged from 27.3 cm to 68.3cm. Furthermore, only two accessions namely, ICC9593 and ICC16463 possessed 2 seeds/pod. Traits, *viz.,* yield/plant, number of pods/plant and 100 seed weight exhibited higher variability, % cv being 83.87, 74.26, and 64.27, respectively, followed by number of primary (39.94) and secondary (31.22) branches. On the other hand, moderate variability (20.18%) was found for plant height. These figures indicated the scope of exercising selection for direct improvement in yield and indirectly through the number of primary and secondary branches. Raju *et al.* (1978) and Sood and Kumari (2000) have also reported similar observations in kabuli chickpea.

Based on yield and its contributing traits, 27 accessions were found promising. In kabuli types, grain quality determines its desirability for consumption purposes and hence acts as a yard stick for price determination. In recent times, the demand for large (>40g/100 seeds) and extra - large (>50g/100 seeds) kabuli varieties is on the rise. Currently, this demand is met through import. Hence, there is a strongly felt need to boost production of l ırge and extra large varieties so as to be self sufficient nc ı only in meeting the domestic need but also having surplus for export by evolving a suitable strategy. In other words, donors possessing target trait/s need to be identified and exploited in developing the target varieties. This implies the intense screening of exotic germplasm from diverse world regions as one of the first steps for varietal development. During this investigation, out of 27 promising kabuli accessions, 13 were found to be large to extra large seeded and were therefore studied further. These entries were analyzed thoroughly for plant type, grain yield (kg/ha), 100-seed weight (g) and seed coat characteristics. This information is compiled in Table 2. All the entries were found to be taller than both the local checks. Furthermore, seven entries, *viz.,* ICC12033, 12034, 14197, 14199, 14203, 14204 and 14204 were found to be erect with semi-compact growth habit. Six accessions, namely, ICC7344, 14214, 14194, 14195 and

Table 1. Phenological and agro-morphological variability in exotic germplasm accessions of kabuli chickpea

Trait	Mean	Range	CV (%)	Extreme accession/s
DF(50%)	108.68	100-126	4.31	EC381867, EC382436
DP(Ist)	115.81	102-130	4.57	EC381867, EC382352
DM(95%)	152.01	150-165	1.39	EC381909, EC381616/EC381617
Plant height(cm)	48.39	27.3-68.3	20.18	ICC1969, EC 387190
Primary branches/plant	4.62	2.0-9.0	39.94	ICC16552, ICC4753
Secondary branches/plant	7.92	2.3-18.0	31.22	EC382383, ICC16673
Pods per plant	33.72	1.0-103.0	74.26	EC382379, ICC4753
Seed/pod	1.01	1.0-2.0	9.95	ICC9593, ICC16463
Yield/plant	6.46	0.2-36.12	83.87	EC382379, ICC12033
100 seed weight (g)	24.79	2.5-61.4	64.27	EC381893, ICC12034

Table 2. Yield (kg/ha), 100-seed weight (g), plant types and testa characteristics of highly promising exotic kabuli germplasm accessions

Accession #	Source of origin	Yield kg/ha	G/100 seeds	Plant type	Testa characteristics
ICC14214	Mexico	250	55.90	Tall spreading, open canopy	Milky white,bursting type
ICC14194	„	561	50.01	Tall, semi-spreading, open canopy	„
ICC14195	„	945	45.34	„	Beige, non-bursting type
ICC14196	„	800	53.80	Tall, spreading open canopy	Milky white, non-bursting
ICC7344	„	1160	51.80	Tall, semi-spreading, open canopy	Milky white non-bursting
ICC12034	„	1078	61.0	Tall, erect, semi-open canopy	Beige, bursting
ICC12033	„	2060	60.20	„	Beige, bursting+non-bursting
ICC14197	„	1877	58.31	„	Milky white non-bursting
ICC14199	„	2020	54.73	„	Beige, non-bursting
ICC14205	„	360	52.79		Milky white non-bursting
ICC14204	„	880	53.53	„	Beige, non-bursting
ICC14203	„	1840	46.16	„	Milky white non-bursting
EC381882	Turkey	501	51.91	Tall, spreading type, open canopy	Milky white, bursting+ non-bursting
KAK2 (local check)		981	38.0	Medium height, semi-spreading, open canopy	Beige, non-bursting
L550 (local check)		1230	18.0	Medium height, erect, semi-open canopy	„
		CV(%) 13.04 CD @5% level 310.43	CV(%) 5.636 CD @5% level 6.07		

14196, and EC381882, displayed open canopy. Three accessions each displayed spreading and semi-spreading canopies, respectively. The study further established four accessions, namely, ICC12033, ICC14199, ICC14197 and ICC14203 as high yielding entries. The yield potential of these accessions was found above 18q/ha. The 13 test entries were also studied for their seed size and testa characteristics (Table 2). Entries namely ICC12033 &12034 displayed 100 seed weight of >60g while nine others viz. ICC14204, 14214, 14194, 14196, 14197, 14199, 7344, 42051 and EC381882 showed in the range of 50-60 g.Two entries *viz.*, ICC14195 and14203 displayed 100 seed weight of around 45 g. The best check KAK2 showed 100-seed weight of 38 g. Additionally, eight accessions displayed milky white testa while rest exhibited beige. However, it was found to be intact (non-bursting type) in seven of these entries, *viz.*, ICC14195, 14196, 14197, 14199, 14203, 14204 and 14205, respectively . Four accessions exhibited bursting type seed coat, whereas, two namely, ICC12033 and EC 381882 produced both the types.

Table 3. Reactions of highly promising exotic kabuli germplasm accessions against FOC race 2 under WSP conditions

Accession #	% FW	Reaction type*
ICC14199	5.6	R
ICC14203	18.7	MR
ICC14195	36.2	S
ICC14196	48.1	S
ICC7344	39.2	S
ICC14197	22.4	S
ICC14205	56.4	S
KAK2 (ch)	23.7	S
L550 (ch)	80.6	S
JG62 (susceptible ch)	100.0	Highly susceptible

* R: resistant, MR: moderately resistant, S: susceptible

Table 4. Highly desirable accessions of exotic kabuli chickpea germplasm and their useful trait/s

Useful trait/s	Desirable accession/s
Primary branches/plant	ICC4753, ICC16541
Secondary branches/plant	ICC5099, ICC16673
Plant height (cm), 100-seed weight (g)	IC accessions given in Table 2
Pods/plant	ICC 4753, ICC9361, ICC11255
Yield (kg/ha)	ICC12033, ICC14199, ICC14197, ICC14203
Resistance against *Fusarium* wilt	ICC14199, ICC14203

Wilt caused by *Fusarium oxysporum* f. sp. *ciceri* (FOC) is a major biotic factor capable of reducing chickpea yield by 10 to 15 per cent with 100 % loss under specific situations (Singh and Dahiya, 1973; Haware and Nene, 1980). Of the four physiological races reported from India (Haware and Nene, 1982) Kanpur isolate (race 2) is known to be the most aggressive (Gurha and Mishra, 1982). Hence, one of the major breeding objectives is to develop cultivar/s with resistance to FOC race 2. In the present investigation, an attempt has been made to screen exotic kabuli accessions against *Fusarium* wilt both under natural as well as sick plot conditions. The results on wilt incidence under natural conditions indicated low (<5%) to high including 100% in exotic material. 20 accessions were found to wilt completely before the on-set of maturity. However, 27 accessions showed upto 40% mortality due to wilt. Based on their low wilting (0-20%), 13 large to extra-large seeded accessions were earmarked for screening under sick plot conditions. However, six of these entries exhibited bursting seed coat (Table 2) and could not be studied further. Therefore, seven entries were grown in sick nursery (*Rabi* 2004-05) and reactions against wilt were scored as per the guidelines of AICRP on chickpea improvement (Anonymous, 2004). The results are presented in Table 3. One entry ICC14199 showed 5.6% mortality (i.e. % FW) and was thus designated as resistant (R) on account of wilting of plants below 10%. Likewise, an accession ICC14204 exhibited wilt incidence in the range of 10-20% and was thus classified as moderately resistant (MR), its % FW being 18.7. Rest of the four entries were found susceptible, % FW being in the range of 20.1 to 100.0 (Table 3).

Limited genetic variation has been a major constraint in attaining improvement in different pulse crops including chickpea. Use of exotic material is necessary when desired gene/s are not available in local cultivars. All available kabuli varieties besides being low yielders are susceptible to a number of biotic and abiotic stresses and have small to medium sized seeds. A clear understanding of genetic variability and interrelationship between yield and yield-related traits would complement breeders' efforts in evolving superior varieties. During this investigation some accessions of the exotic germplasm of kabuli chickpea displayed useful variations for important traits especially wilt, plant height, primary and secondary branches, pods/plant, yield potential,100 seed weight (Table 4).These accessions especially ICC14199, 14203, 14197 and 12033 offer possibilities in broadening the genetic base of the local kabuli cultivars as well as providing a better chance to recover transgressive segregants. Efforts are being made to utilize these accessions in kabuli improvement.

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