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ADVANCES IN BREEDING KABULI CHICKPEA IN INDIA

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ABSTRACT

Kabuli chickpea (*Cicer arietinum* L.) varieties released in India before 1989 were adapted only to cool temperatures and long growing season. This limited their cultivation to Northern and Northwestern India. About one third of 17,250-world chickpea germplasm maintained at ICRISAT is kabuli type. These also require relatively cooler growing season for their proper development. This limits the available kabuli gene pool for the Indian chickpea growing regions. Major constraints to increased productivity in India are: lack of suitable varieties, susceptibility to biotic and abiotic stresses and lack of response to irrigations and fertilizers. Indian kabuli varieties do not command a premium price due to their small seed size. Recent successes in shortening the growing-duration of kabuli types and incorporation of fusarium-wilt resistance from desi types at ICRISAT have helped extend their adaptation to tropical environments. Further breeding efforts should aim at widening the gene pool and enhancing resistance to other root and foliar diseases, pod borer, drought and salinity and increasing the seed size.

Chickpea (*Cicer arietinum* L.) is the third most important food legume globally with an area of 11 m ha and production of 9 m t (FAO 1999). It is the most important pulse crop in India where it accounts for two third of the world area and production. Chickpea has two major types -- desi and kabuli. Desi type usually has pink flowers and small, rough, angular and light brown seeds. Kabuli type has white flowers and relatively large, smooth, owl's head–shaped and creamy white seeds. Precise estimates are not available but kabuli type may account for up to 15% of the world and about 5% of the total chickpea production in India. While much of the desi type is consumed as dhal (decorticated split cotyledons) and as besan (chickpea flour), kabuli is invariably consumed as whole seed in curries, snacks and salads and as sauce. Thus, the latter commands a premium price sometimes up to three times of the smaller seeded desi types. It is, therefore, desirable to intensify research on kabuli chickpea, aimed at developing right kind of varieties.

Chickpea originated in South-eastern Turkey and desi type was introduced in India some 7000 years ago (van der Maesen, 1987). Introduction of kabuli type via Kabul is fairly recent on the evolutionary scale, early to mid 17th century. Kabulis are better suited to cooler climates and longer growing season as they originated from such conditions. These are grown in relatively cool and long-duration environments of Northern and Northwestern India. Before 1989, kabuli cultivation was limited to areas north of Calcutta-Ahmedabad latitude roughly corresponding to the Tropic of Cancer (23.50N). Abiotic and biotic constraints limit productivity of the two types and the kabuli appears to suffer relatively more because of drought, heat, root diseases, pod borer and bruchids. This may be related to lack of anthocyanin in kabuli plant parts and seed and relatively thinner seed coat (Kumar *et al.*, 1991).

In view of the large number of improved varieties developed in desi and only about a dozen in kabuli (Table 1), it is apparent that very little attention has been paid in the past for the improvement of the latter types. One of the most significant landmarks in kabuli improvement in India is the development of

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Table 1. The year of release, seed size and maturity duration of the kabuli varieties released in India

Variety	Year of release	100-seed weight (g)	Maturity duration	Adaptation area
K 4	1960	37	Long	North West Plain Zone (NWPZ)
C 104	1960	26	Long	Punjab and Haryana
L 144	1975	35	Long	Haryana
L 550	1977	22	Long	All India
Gora Hisari	1988	22	Long	Haryana
Pusa 267	1988	17	Long	All India
ICCV 2	1989	26	Extra-short	A.P. and Maharashtra
Pusa 1003	1996	25	Long	Eastern India
L 551	1999	20	Long	Punjab
BG 1053	1999	30	Long	NWPZ
KAK 2	1999 (identified)	37	Medium	Maharashtra, M.P., Gujarat, and Orissa (CZ)

fusarium-wilt resistant, fast growing, extra-short duration (85-90 days) variety ICCV 2 at ICRISAT, Patancheru, near Hyderabad which extended the adaptation of kabulis to Central and Peninsular India and other similar environments in the world (Kumar *et al.*, 1999). Named as Swetha in Andhra Pradesh, ICCV 2 escapes almost certain end-of-season drought. It carries a major gene *ef1*-1 for early flowering and maturity (Kumar and van Rheenen, 2000). It has stabilized mean seed yields at a relatively high level. Kabuli chickpea is now considered a cash crop and is replacing tobacco, chilies, Rabi sorghum and cotton (as soybean – chickpea rotation) in Andhra Pradesh and Maharashtra.

The future kabuli breeding should aim at reducing the crop-duration in sub-tropical India from the present 150 - 180 days to 120 - 130 days. In addition to fusarium-wilt, resistance to collar and dry root rots, Ascochyta blight, Botrytis gray mold and chickpea stunt will be required to increase the stability of the crop. It is difficult to breed resistance to the polyphagous insect-pest like Helicoverpa pod borer [*Helicoverpa armigera* (Hubner)]. Early maturing varieties, generally, escape damage by this insect-pest. Among the abiotic stresses, tolerance to drought, chilling and salinity are important. Increasing seed size, undoubtedly, must be a major objective. Large seeded types are preferred both by the consumers and traders especially in the international trade. Cooking quality of large seeded types, by and large, is distinctly better than the small seeded ones. Problems and prospects of kabuli chickpea breeding are being described in the present paper in this back ground.

Major constraints limiting production

1. Day-length sensitivity of germplasm, much of which originated in the temperate region of South-eastern Turkey.
2. Long growing season and cooler temperature requirement for growth and development.
3. Lack of genetic variation among the limited Indian kabuli germplasm.
4. Susceptibility to several biotic and abiotic stresses.

Biotic : Collar rot (*Sclerotium rolfsii*), fusarium-wilt (*Fusarium oxysporum.* Sp. ciceris), dry root rot (*Rhizoctonia bataticola*), Ascochyta blight (*Ascochyta robiei*), chickpea stunt (Gemini and luteo viruses), Helicoverpa pod borer [*Helicoverpa armigera* (Hubner)] and bruchids (*Callosobruchus spp.*).

Abiotic : Drought, heat, chilling and salinity.

Desi and kabuli gene pools

It is believed that kabuli type originated by selection for white flower colour from the

Table 2. Seed size, days to flowering, fusarium-wilt resistance and parentage of some recently developed kabuli breeding lines at ICRISAT, Patancheru

Line name	100-seed weight (g)	Days to flower	Fusarium-wilt reaction	Parentage
ICCV 92311 (KAK 2)	38	33	R	[(ICCV 2 x Surutato 77) x ICC 7344]
ICCV 92325 (KAK 6)	36	34	R	-do-
ICCV 3	23	61	R	[(K 850 x GW 5/7) x P 458] x (L 2/550 x Guamuchil)-2
ICCV 95333	36	42	R	[(ICCC 32 x ICCV 88507) x ICCC 32] x IIGAC-83-4-85-M-2-M
ICCV 95423	26	50	R	[(ICC 7676 x ICCC 32) x [(ICCC 49 x FLIP 82-IC) x ICCV 3]
ICCV 94304	31	27	R	(ICCV 2 x ICC 7344)
ICCV 97302	39	34	R	[(ICCV 2 x Surutato 77) x ICC 7344] X Blanco Lechozo
ICCV 94305	36	27	R	(ICCV 2 x ICC 7344)
ICCV 96326	41	30	R	[(ICCC 32 x ICCV 88507) x (ICCC 32 x ICC 7344)]
L 551	18	57	S	(L 550 x L 2) x ICCX 780581-BM-10H-BH
ICCV 2	25	30	R	[(K 850 x GW 5/7) x P 458] x (L 550 x Guamuchil)

R= Resistant and S = Susceptible

Table 3. Performance of bold seeded kabuli genotypes developed at IARI, New Delhi

Genotype	Yield kg/ha	100-seed weight (g)	Growth habit	Wilt resistance
BG 1048	2600	30	Semi spreading	Moderate
BG 1053	2700	34	Semi spreading	"
BG 1072	2800	42	Semi erect	"
BG 1073	2600	43	Semi erect	"
BG 1082	2400	42	Semi erect	"
BG 1083	2500	41	Erect	"
BGD 117	2300	44	Tall erect	"
BDG 118	2500	42	Semi erect	"
PUSA 1003 (ch)	1900	25	Semi spreading	"
PUSA 267 (ch)	1800	20	Spreading	"

more primitive desi type about 2000 years ago (van der Maesen, 1987). This hypothesis is supported by the dominant nature of most desi type characters, for example; small leaflets, leaves, pods, seeds and more seeds per pod. Apart from their flower and seed colours, other differences also exist between the two types. Compared to desi type, kabulis generally have larger seed size, fewer seeds per pod, more upright and taller growth habit, more primary branches, greater cold tolerance, longer fruiting duration, thinner seed coat and lesser fibre content. As the two types can be crossed without any difficulty, these differences are not so distinct in newly developed varieties (Jagdish Kumar, ICRISAT, Patancheru, unpublished results) and criss-cross characters can be found in the two forms.

Sources of variation

Over 17,200 world chickpea

germplasm, one third of which is kabuli type, has been collected, assembled and maintained at ICRISAT, Patancheru. Most of the kabuli germplasm is from temperate regions of the Middle East and Russia. A limited germplasm from Mexico is also available. Little efforts have been made to widen genetic variation in this type (Maynez *et al.*, 1993). A large number of desi x kabuli crosses were made at ICRISAT to increase the variability for both types. Many populations of kabuli x desi and desi x kabuli crosses were made available to National Pulses Programmes during the last 25 years for improving either type. However, not many breeders were comfortable with such crosses as the large number of unusable segregants mainly intermediate (pea type) seed with varying colours appeared in the segregating generations and had to be rejected. This limited the size of segregating populations more so for the kabuli types. In the early 1980s, two kabuli type genotypes were developed from desi x kabuli crosses. These were ICCC 32 and ICCC 33 which combined high yield and fusarium-wilt resistance. However, these were still suitable for cooler and longer duration environments only and also have small seeds similar to L 550.

Kabuli Breeding in India

Kabuli research is mostly clubbed with the desi breeding work and that too at only a few centres in Northern India. These include Ludhiana, Hisar, New Delhi, Sriganganagar and Kanpur. In recent years, ICRISAT has done considerable research on the kabuli type. Using parents from different geographic areas, scientists at ICRISAT developed much needed fusarium-wilt resistant and large seeded kabuli (Table 2). Recently large seeded varieties have also been developed at IARI, New Delhi (Table 3).

Crosses among kabuli types only should be preferred as they produce the acceptable seed colour and size. However, such parents often lack desirable variation particularly resistance to biotic stresses. Desi and kabuli crosses were attempted to incorporate resistance to biotic and abiotic stresses. The recovery of kabuli segregants in the resulting segregating populations was often very low varying from less than 1 percent to about 5 per cent depending on the parents used. This limited the size of these populations for selection of kabuli types and progress in breeding for this type has been slow as only a few varieties have been released so far (Table 1).

In recent years the trends in breeding of kabuli types include: short duration i.e. reducing vegetative phase and incorporation of earliness allele(s), fusarium-wilt resistance, Ascochyta blight resistance, large seed size and chilling tolerance.

Future prospects

Kabuli chickpea provides more number of delicious food preparations as compared to desi types. It provides 100 percent food ingredient from known quantity of clean raw chickpea, whereas in desi types, only 70-75 percent (dhal/besan) is usable as human food while rest is lost in processing and used as cattle feed. On this ground, former types need to be popularised more.

In recent years there has been increased demand for kabuli chickpea in India and the world. Given the increasing world trade and premium price, the research efforts, area, production and productivity of this type are expected to increase. It is hoped that farmers will provide improved cultural conditions for its cultivation and better plant protection to kabuli types to achieve higher productivity.

The future research efforts should focus on increased seed size, short growing duration and multiple resistance to major biotic and abiotic stresses so that high stable yields are ensured. Major advances occurring in

molecular marker-assisted-selection are expected to bring substantial progress on this front in the near future. Mechanical mass selection for seed size range of 25 to 35 g/100-seed, followed by rigorous selection for other desired traits is expected to yield productive populations. From such populations, pure lines can be derived. Earlier, Singh (1996) reported that a seed size group of 20 to 25 g/100-seed in kabuli chickpea had maximum positive association with seed yield.

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