Studies on Early Podding Varieties and Post-Harvest Management of Immature Green Grains of Chickpea to be Used as Vegetable

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Abstract

The experiments were conducted on short-duration chickpea genotypes and post-harvest management of green grains for expanding the period of green grain availability in northern India. Two super-early chickpea breeding lines, ICCV 96029 and ICCV 96030, developed at ICRISAT were evaluated for green grain yield and other ancillary characters. Both lines were found early in flowering and podding and produced >2.0 t ha^{-1} fresh green seed yield in 75 days after sowing when sown in first week of October. Though the early podding lines could make available green grains for a longer period, the acceptability of these lines was restricted due to their susceptibility to diseases and less-preferred pale yellowish grain color. Hence, efforts were made to improve these traits by crossing super-early lines with well adapted cultivars/elite lines. Over 260 progenies (F_4 to F_6) were evaluated along with checks ICCV 96030 and PBG 1 during crop season 2005/06. Many progenies were found superior to the best check ICCV 96030 and selected for further evaluation. Experiments conducted on different packaging and storage methods showed that green grains and pods packed with/without peduncles in polyethylene (PE) packs in presence/absence of $CaCl_2$ extended the shelf life. In PE packs, green grains without $CaCl_2$ in thermocol box could be stored for up to 15 days at refrigeration temperature. Green pods showed better shelf life than shelled green grains. Acetic acid solutions with salt solutions could be used to enhance the shelf life of green grains. Thus, the early podding varieties can be used for expanding the availability of green grains and the storage methods identified in this study can be used for extending shelf life of green pods/grains of chickpea.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the third most important food legume grown annually on an area of about 10 m ha in about 50 countries, and over 95% of its production and consumption is in the developing countries (FAOSTAT data 2006). It is a cheap and important source of protein (20-22%), fiber and minerals (P, Ca, Mg, Fe and Zn) and its lipid fraction is high in unsaturated fatty acids. It contains higher amounts of carotenoids such as β-carotene, cryptoxanthin, lutein and zeaxanthin than genetically-engineered 'golden rice' (Abbo et al., 2005). Most widely used form of chickpea is dry seeds, dehulled grains (splits or *dhal*) and flour. Leaves, eaten as leafy vegetable in some developing countries, contain a number of important minerals, relative to either spinach or cabbage (Ibrikci et al., 2003). The immature green grains (*chholia*) are used as vegetable and grains from roasted green pods (*hollan*) as snack in India, particularly northern India. The green grains are easily digested and are low in anti-nutritional factors like phenols and flatulence inducing oligosaccharides. In northern India, the green grains are available for a short period as the available varieties are late maturing and take too long to initiate podding. Early flowering and low temperature tolerance traits are needed in a chickpea variety for early podding in northern India. Two such lines, ICCV 96029 and ICCV 96030, called super-early lines have been developed at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India (Kumar and Rao, 1996). Several experiments were conducted on evaluation of these lines for their

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suitability for cultivation in northern India and post harvest management of green seeds/pods for enhancing shelf life. Efforts were also made to transfer earliness and cold tolerance traits to locally adapted cultivars.

MATERIALS AND METHODS

Two super early chickpea genotypes, ICCV 96029 and ICCV 96030, developed at ICRISAT, Patancheru, India (Kumar and Rao, 1996), were evaluated for green grain yield, biomass and phenological characters under different sowing dates and spacing at Punjab Agricultural University, Ludhiana, India during 2000 to 2003. Green grain and biomass yields were recorded after 75 days of sowing in each year. Simultaneously, hybridization program was initiated to transfer the earliness trait of these super early lines and of two other lines, ICCV 93929 and ICCV 88503, to five locally adapted cultivars (PBG 1, GPF 2, GNG 469, PBG 5 and CSG 89-62). The populations derived (F_3 to F_7) from hybridization program were evaluated for early podding and other traits like early flowering, number of pods per plant, number of grains per 10 pods, seed size and seed colour and compared with the super early line ICCV 96030.

The nutritional and cooking quality of green grains and matured dry grains of both the super early genotypes was tested. Besides these traits, a series of experiments were conducted to enhance shelf life of green grains and pods to extend the period of their marketing. Packaging materials like polyethylene (PE), PE laminated and aluminum foil laminated packs were used. Green grains and pods with/without peduncles were stored in PE packs in presence/absence of $CaCl_2$ at different temperatures and for different durations. Blackish grains were counted which gave an indication of the spoilage of sample. In a separate experiment, green grains packed in PE bags were stored up to 21 days in a thermocol box with ice packets (0 to 4^0C temperature). It was to avoid direct contact of ice with samples. Observations were recorded on moisture content, weight loss, number of blackish grains and total sugars after different days of storage. In another experiment, 1, 2 and 3% solution combinations with 0.5, 0.75 and 1% citric acid/acetic acid were used for storage of green grains for different durations in PE, laminated and aluminum foil laminates packs and percent weight loss was recorded for each sample.

RESULTS AND DISCUSSION

The super early lines ICCV 96029 and ICCV 96030 were found very early in flowering and podding as compared to the local check variety PBG 1 (Table 1). The phenology of ICCV 96029 and ICCV 96030 is ideal for chickpea crop to be exploited for green seed vegetable (Sandhu et al., 2006). The early podding chickpea varieties will prove beneficial to farmers as the green crop (pods or grains) sold for vegetable purpose will be available early in the season and provide higher net income than the crop harvested for dry grain. The fields will be vacated early and the farmers would be able to take an additional crop in spring season. More importantly, introduction of a legume crop in cereal based cropping system will have beneficial effects on soil fertility and productivity and sustainability of the cropping system.

Sowing during first fortnight of October gave higher yields than September sowing. ICCV 96029 gave the highest green seed yield (1869 kg/ha) from the crop sown on October 1, while ICCV 96030 gave the highest yield (1785 Kg/ha) from the crop sown on October 10 (Table 2). In both the genotypes, highest biomass and yield was obtained on crop sown on October 10 with row-to-row spacing of 20 cm (Table 3).

Some negative traits associated with the super early lines included their susceptibility to two major diseases, fusarium wilt (*Fusarium oxysporum* sp. f. *ciceri*) and ascochyta blight (*Ascochyta rabiei*), and pale green seed color. In addition, one of these lines, ICCV 96029, had small seeds. Segregating populations (F_3 to F_7) from ICCV lines and local cultivars crosses were evaluated and promising plants were identified (Table 4). These elite lines are being advanced and their reaction to diseases will be checked.

The studies on nutritional and cooking quality of green grains and dry grains showed that ICCV 96029 was slightly superior to ICCV 96030 in all traits studied at

immature green grain stage. However, at dry grain stage, ICCV 96029 was better for hard shelled grains after soaking, cooking time, water absorption and volume expansion after cooking and protein content, while ICCV 96030 was superior for 100-seed weight, 100-seed volume, grain density, water absorption after soaking and solid dispersal (Sharma et al., 2005). Percentage of blackish grains (not suitable for consumption) was recorded from green grains or pods with/without peduncles stored in PE packs in presence/absence of $CaCl_2$ at different temperatures and different duration of storage (Table 5). The green grains and pods with/without peduncles showed better shelf life in presence of $CaCl_2$ than without $CaCl_2$ irrespective of temperatures and days of storage. Low temperature (4-6°C) was found favorable to extend the shelf life irrespective of days of storage at different temperatures. Pods with/without peduncles could be stored up to 11 days with/without $CaCl_2$ at all storage temperatures. Green grains packed in PE packs and kept in thermocol box containing ice packets could be stored up to 15 days without any loss of texture, colour and quality (Table 6). The pods could be stored safely up to 21 days in presence of $CaCl_2$ under refrigerated temperature (0-4°C). Green grains/pods stored in PE packs are handy, more hygienic and with reasonable shelf life to enhance the marketable period. Secondly, the green pods instead of shelled green grains have offered a better option for hygienic conditions and longer storage period. The storage of green grains in acetic acid solution in aluminum foil laminate packs recorded highest shelf life of 23 days. In laminate packs the samples remained fresh up to 18 days. However, the citric acid solutions were not found suitable for storage of green grains as it caused farthing and high leaching losses.

CONCLUSIONS

The super-early cold tolerant lines of chickpea offer opportunity for early availability of chickpea green seeds for vegetable purpose. Super-early chickpea for vegetable purpose can be harvested in about 75 days and can be used as a catch crop following a rainy season rice crop and preceding a post-rainy season wheat crop in northern India. Inclusion of chickpea in rice-wheat cropping system will be beneficial for long term sustainability of the system productivity. The shelf life of green pods/grains can be extended by following simple storage techniques.

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Tables

Table 1. Phenological traits of super early chickpeas lines in comparison to check.

Sr. No.	Character	PBG 1 (check)	ICCV 96029	ICCV 96030
1	Days to 1st flower	58	24	27
2	Days to 1st pod initiation	125	31	34
3	Plant height (cm)*	-	37.8	45.6
4	No of pods/plant*	-	30	26
5	100-seed weight*	-	21.3	26.4

* Observation after 75 days after sowing on October 1 sown crop

Table 2. Effect of sowing date on green seed yield and biomass of super early lines during 2000 to 2003.

Sowing date	Green seed yield* (kg/ha)		Biomass* (kg/ha)	
	ICCV 96029	ICCV 96030	ICCV 96029	ICCV 96030
21 September	985	1043	5873	4951
1 October	1869	1542	7368	6937
10 October	1685	1785	7696	8996

* Harvested at 75 days after sowing

Table 3. Effect of row spacing on green seed yield and biomass of super early lines.

Row spacing	Green seed yield* (kg/ha)		Biomass* (kg/ha)	
	ICCV 96029	ICCV 96030	ICCV 96029	ICCV 96030
20 cm	1572	8466	1602	8884
30 cm	1435	7662	1464	7611

*Average of three years

Table 4. Evaluation of different generations for early podding and other traits.

Sr. No.	Generation	No. of Progenies studied	No. of lines superior than check ICCV 96030			
			Flower initiation	No. of pods/plant	No. of grains/10 pods	100 seed weight
1	F_3	14	10	1	-	1
2	F_4	195	159	75	96	81
3	F_5	10	1	-	-	4
4	F_6	12	2	2	1	3
5	F_7	3	2	3	-	3

Table 5. Effect (percent blackish grains**) on green grains/pods at different temperatures and days of storage in PE packs in presence /absence of $CaCl_2$.

Treatments	Pods/ grains	Days to storage								
		4		6		8		11		37
Temp. °C		4- 6	15-18	4-6	15-18	4-6	15-18	4-6	15-18	15- 18
Without $CaCl_2$	Grains	2.5	21.5	2.06	27.7	4.6	*	10.2	*	*
	without peduncle	0	0	0	0	0	0	17.7	4.4	*
	with peduncle	0	0	0	1.74	0	2.33	13.7	5.3	*
WithCaCl$_2$	Grains	1.12	18.0	1.7	20.2	3.6	*	8.4	*	*
	without peduncle	0	0	0	0	0	0	0	0	*
	with peduncle	0	0	0	0	0	0	0	0	*

*Complete destruction of samples
**Values in the table represent per cent blackish grains

Table 6. Quality characters of green grains stored in PE packs at 0-4°C packed in ice cubes packets in thermocol boxes.

Days of storage									
Parameters	0	3	7	9	12	15	18	19	21
Moisture content retained (%)	66.8	66.7	61.2	62.8	70.0	66.5	66.8	71.0	71.1
Weight loss (%)	-	2.8	4.5	9.8	7.0	5.6	4.5	6.9	5.8
Blackish grains (%)	-	-	-	-	-	-	2.7	2.8	2.8
Total sugar (%)	1.9	1.5	1.5	1.5	1.9	3.4	2.9	2.7	2.5

Table 7. Storage studies of green grains in different salt solution.

Days of storage								
Package Structure	8		13		18		23	
	CA	AA	CA	AA	CA	AA	CA	AA
Polyethylene packs								
A	7.8	4.4	*	2.8	*	1.9	*	1.6
B	8.7	4.8	*	1.2	*	0.1	*	0.1
C	9.2	5.9	*	1.8	*	0.2	*	0.1
Laminated A								
A	9.6	5.4	12.2	0.1	9.6	0.0	12.3	0.1
B	15.6	4.9	15.1	0.1	10.5	0.1	18.5	0.1
C	9.8	2.9	13.7	0.5	10.2	1.7	19.7	1.5
Laminated B								
A	16.4	1.1	26.8	1.8	21.1	2.1	29.6	2.5
B	16.7	1.3	21.5	2.8	25.6	2.8	24.2	4.9
C	11.8	1.2	12.9	4.6	14.1	2.5	16.1	2.7

* Termination of experiment beyond 8 days
CA Citric acid concentration a: 0.5%, b: 0.75%; c: 1.00 %, AA Acetic acid concentration a: 1.0 %; b: 2.0 %: c: 3.0 %, Salt solution 2% fixed for all packing conditions