Cold-tolerant Chickpea Varieties ICCV 88503, ICCV 88506, ICCV 88510

- **Sources of cold tolerance**
- **Long-duration chickpeas with high harvest indices**
- **Low shoot mass (inhibited vegetative growth) at a given yield level**
- **Adapted to late sowing in double cropping sequences following rainy-season crops**

ICCV 88503

ICCV 88506

ICCV 88510

ICRISAT

Plant Material Description no. 53

International Crops Research Institute for the Semi-Arid Tropics
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Purpose of identification

ICCV 88503, ICCV 88506, and ICCV 88510 are cold-tolerant chickpea varieties developed by ICRISAT that can set pods at low ambient temperatures, which restrict plant growth—thus, the tolerant cultivars have higher harvest indices (HIs) than conventional cultivars, which fail to set pods at similar temperatures. (Harvest Index is a ratio of seed mass to shoot mass.) Low temperature when the chickpeas are at the flowering and pod-set stage is a common constraint to production in subtropical South Asia, e.g., northern India and Pakistan, and also in some parts of Australia.

Origin and development

Cold-tolerant chickpea plants were identified in the F_3 segregating population of a three-way cross [G130 x (ICC 8923 x Chafa)] in the 1980/81 season at ICRISAT cooperative research station, Hisar, northern India (29°N 76°E, altitude 221 m). G130 and Chafa are desi (brown-seeded) chickpea cultivars of Indian origin and ICC 8923 is of Russian origin (identity K1189). In F_4, cold-tolerant plants were selected as parents and crossed with two high-yielding chickpea cultivars, Gaurav and Pant G114, in 1982/83, and advanced to F_2 generation in 1983/84. Cold-tolerant selections from the F_3 generation were bulked. Cold tolerance was judged by the ability of plants to set pods at the first and all the subsequent nodes, once flowering was initiated at low temperatures. The F_5 progenies (120 selections) with a wide range of values of two criteria, namely days to first flowering and days to pod-set at low temperatures, were evaluated in a replicated trial. The promising cold-tolerant progenies were compared to Pant G114 and Gaurav, the best adapted varieties of the region, which served as controls. ICCV 88506 and 88510 are derived from the cross Gaurav x [G130 x (ICC 8923 x Chafa)] and ICCV 88503 is derived from the cross Pant GI14 x [G130 x (ICC 8923 x Chafa)].

Performance

Varieties ICCV 88503 and 88506 showed greater cold tolerance by setting pods at day temperatures of 21.2 ± 0.69 °C and night temperatures of 5.9 ± 0.53 °C. They flowered and set pods 30 to 40 days before the two controls did (Table 1). ICCV 88510 was 4 to 10 days earlier in flowering and podding at day temperatures of 22.9 ± 0.64°C and night temperatures of 6.8 ± 2.56 °C. Although the cold-tolerant varieties matured earlier, the differences were not large (Table 1).

On an average, the yield of ICCV 88510 was 16% more than that of Pant G114 (Table 2) when both were sown at the normal time (October-November). When sown late (early December), ICCV 88510 and ICCV 88503, on average, yielded 24% more than Pant G114 and 11% more than Gaurav (Table 3). Day temperatures at the time of December sowing were 23.4 ± 0.46 °C, and night temperatures were 3.7 ± 0.28°C. Such temperatures are low enough to restrict early growth in conventional cultivars. Cold tolerance of these varieties was also confirmed in the All India Coordinated Pulses Improvement Project trials (Table 3). The better adaptation of ICCV 88510 and ICCV 88503 to late sowing could be exploited to fit these varieties into double cropping sequences for those regions of South Asia where winters are severe. Harvest indices of the cold-tolerant varieties were 7-10 percentage units higher than those of the controls (Table 2) and correlated with high yields ($r = 0.53^{***}$, $n = 40$). ICCV 88510 is also resistant to wilt, caused by *Fusarium oxysporum* f sp *ciceri.* The cold-tolerant varieties were as resistant/susceptible to pod borer (*Helicoverpa armigera*) as Pant G114.

Table 1. Days to flowering, pod set, and maturity, and plant height (cm), in three cold-tolerant varieties and the controls Pant G114 and Gaurav. Entisol, ICRISAT cooperative research station, Hisar.

Genotype	Days to flowering[1]	Days to pod set[1]	Days to maturity[1]	Plant height (cm) 1988/89
ICCV 88503	51	60	149	91
ICCV 88506	53	64	155	82
ICCV 88510	76	91	156	78
Controls				
Pant G114	87	101	159	69
Gaurav	80	95	158	87
S.Em	±1.0***	±1.3***	±0.9***	±1.4***

1. All values are the means of 2 seasons' data (1988/89 and 1989/90)
*** Significant at *P* >0.001

Table 2. Growth characters of three cold-tolerant varieties and the controls Pant G114 and Gaurav. Entisol, ICRISAT cooperative research station, Hisar.

Genotype	Shoot mass[1] (t ha^{-1})	Seed yield[1] (t ha^{-1})	Harvest Index[1] (%)	100-seed mass[1] (g)
ICCV 88503	5.73	2.27	41.2	12.9
ICCV 88506	6.24	2.36	42.3	14.8
ICCV 88510	6.80	2.61	41.1	14.6
Controls				
Pant GI14	6.72	2.26	35.1	11.6
Gaurav	7.56	2.29	32.6	19.1
S.Em	±0.307***	±0.118***	+1.67***	±0.36***

1. All values are the means of 2 seasons' data (1988/89 and 1989/90)
*** Significant at *P* >0.001

Plant characters

The cold-tolerant genotypes have a semi-erect growth habit and are taller than Pant G114 (Table 1). These are desi types, similar to Pant G114 and Gaurav, with pink flowers and the characteristic presence of anthocyanin in the shoot. Their cold tolerance is thought to be related to the ability of their pollen to germinate and grow even at low temperatures. ICCV 88503 and 88506 have lower HIs than those of the controls.

Seed characters

Seeds of the cold-tolerant varieties have brown seed coats, and are larger than those of Pant G114 and smaller than those of Gaurav (Table 2).

Potential uses

The new cold-tolerant varieties have potential for use as donor parents in breeding for cold tolerance and high HI, and whenever reduced vegetative growth is desirable. Because they can be sown late, they fit better in certain crop rotations after the rainy-season crop is harvested.

Table 3. Yield (t ha^{-1}) of three cold-tolerant varieties and the controls Pant G114 and Gaurav when sown in October (normal) and December (late). Entisol, ICRISAT cooperative research station, Hisar.

	Hisar, ICRISAT cooperative research station[1]		New Delhi, IARI[2] (1989/90)		Kanpur, DPR[3] (1989/90)	
	Oct (Normal)	Dec (Late)	Oct (Normal)	Dec (Late)	Oct (Normal)	Dec (Late)
ICCV 88503	1.89	2.64	1.21	1.23	2.71	1.62
ICCV 88506	2.36	2.36	1.15	1.17	2.87	1.88
ICCV 88510	2.55	2.66	1.08	1.32	2.62	1.67
Controls						
Pant GI14	2.38	2.14	1.14	0.95	3.57	1.35
Gaurav	2.19	2.39	1.06	0.98	2.77	1.54
S.Em	+0.167		+0.151		±0.156	
CV (%)	28.2		25.1		12.3	

1. All values are the means of 2 seasons' data (1988/89 and 1989/90)
2. Indian Agricultural Research Institute
3. Directorate of Pulses Research

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