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Research Note

GJG 6: A high yielding wilt resistant chickpea variety for conserved moisture condition of Gujarat

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Abstract
A high yielding wilt resistant chickpea culture tested as GJG 1003 was a cross derivative of GJG 0105 x FG 711, matures in 110 to 112 days, with an average grain yield of 1867 kg/ha under rainfed condition of Gujarat and recorded high yield by 13.6 %, 21.9 % and 5.2 % over check varieties Gujarat Gram 1 (1643 kg/ha), Gujarat Gram 2 (1531 kg/ha) and Gujarat Junagadh Gram 3 (1775 kg/ha), respectively. It was notified and released in the name of GJG 6 (Gujarat Junagadh Gram 6) during 2016. The GJG 6 variety is resistant to wilt and shown good level of resistance against stunt diseases and comparable pod borer damage. This variety has more protein content (19.9 %) and carbohydrate content (67.84 %) than the check varieties. The variety was released for cultivation under conserved soil moisture condition of Gujarat during 2016.

Key words
Chickpea variety, Conserved moisture condition

Chickpea (*Cicer arietinum* L.), one of the major pulses cultivated and consumed in India. India is the major producing country for chickpea, contributing for over 75 % of total production in the world. In India, the area under chickpea was 8.39 million hectares with a production of 7.06 million tones and productivity of 840 kg/ha during *Rabi* 2015-16. In Gujarat state, area under chickpea was 1.15 Lakh hectares with a total production of 1.53 Lakh tones and productivity of 1330 kg/ha during 2015-16 (Anonymous, 2017) and this crop is largely cultivated as rainfed (under conserved moisture condition) crop in Bhal, Ghed and Panchmahal region. Land of these pockets is submerged by rainy water during *Kharif* season and no crop will be grown during rainy season. After cessation of monsoon and drying of surface water, the chickpea is sown in the second fortnight of October without any supplementary irrigation. Generally no rainfall was recorded during the winter in Gujarat. Area has increased 1.36 lakh ha. in 2012-13 to 2.93 lakh ha. in 2017-18 in the state during last five years. In 1999, chickpea variety Gujarat Gram 1 was recommended for central zone including Gujarat state and desi chickpea variety Gujarat Gram 2 (GG 2) was also released for cultivation under un-irrigated condition in the state. After that another chickpea variety Gujarat Junagadh Gram 3 (GJG 3) was released for same production condition in the year 2010. There is an urgent need to have a desi chickpea variety with high yield potential, resistance to wilt and stunt diseases with good nutritional quality.

Chickpea contains 17.21% protein, 61.5% carbohydrates, 4.5% fat, 0.49% lysine, 0.11% methionine, 0.04% tryptophan (Jukanti *et al.*, 2012). It is a good source of protein for humans and as a component of feed for ruminants and non-ruminants (Rathore and Sharma, 2003). The culture GJG 1003 (GJG 6) is high yielding, good nutritional quality and good level of resistance against wilt and stunt diseases. *Fusarium oxysporum* have different races and it causes the wilt disease in chickpea and affects the all major chickpea cultivars (Gurjar *et al*., 2009). As per survey conducted by Sunit *et al*. (2012), the yield loss was up to 72.16 per cent due to this disease.

Hybridization programme was attempted by using GJG 0105 as female parent and FG 711 as male parent during 2002. The female parent (GJG 0105) has high yield efficiency but lacking in resistance to wilt, while male parent FG 711 was donor for wilt. Selection was focused on single plant in F_2 and subsequent generation (upto F_5) for early flowering and more pods per plant during 2003 to 2009. All promising stable progenies of this cross were simultaneously tested for yield in replicated trial and also for wilt resistance in sick plot during 2010-11. The culture GJG 1003 (GJG 6) has a combination of wilt resistance along with high yield which was sent for multi-location testing during *Rabi* 2011 to 2013 at Arnej, Dahod, Dhandhuka, Vallabhipur & Tanchha center of Gujarat state. Simultaneously, it was also evaluated in the All India Co-ordinated Trials during *Rabi*

2012-13 under Initial Varietal Trial (IVT) rainfed in all zones. Field screening was also carried out for its pests and diseases reaction.

This genotype was tested in state trials from 2010-11 to 2013-14 along with check varieties. On an average, Gujarat Junagadh Gram 6 (1867 kg/ha) has registered 13.6 %, 21.9 % and 5.2 % seed yield superiority over checks GG 1 (1643 kg/ha), GG 2 (1531 kg/ha) and GJG 3 (1775 kg/ha), respectively (Table 1). This variety was also tested in Co-ordinated trials (IVT-RF) during 2012-13 in Central Zone and recorded 7.5 % and 16.1 % higher yield than national check varieties GG 1 and Vijay, respectively in Central Zone. (Table 2).

The variety GJG 6 significantly out yielded the check variety in 7 instances out of 15 instances and found consistent during its evaluation in different years. Its superiority ranged from 14.8 to 34.6 % in 2011-12, 3.0 to 16.5 in 2012-13 and 4.5 to 9.9 in 2013-14. (Table 1). GJG 6 variety has exhibited very good level of resistance against wilt and stunt diseases (Table 3, 4, 5 and 6). GJG 6 also showed comparable pod borer damage of 6.31 % against check varieties GG 1 (7.23 %), GG 2 (6.12 %) and GJG 3 (4.96 %) (Table 7). This variety has more protein content (19.9 %) than check varieties GG 1 (17.3 %), GG 2 (17.7 %) and GJG 3 (18.6 %). The carbohydrate content of this variety is also high (67.84 %) than all the three checks GG 1 (63.85 %), GG 2 (60.11 %) and GJG 3 (59.98 %) (Table 8).

As per the guidelines from PPV and FRA, New Delhi distinguishing morphological characters of the variety GJG 6 was formulated and compared with check variety GG 1, GG 2 and GJG 3 (Table 9). GJG 6 has attractive dark brown colour of seed with tuberculated surface; angular seed shape with medium seed size (22.45 g/100 seeds) and semi-erect plant type with medium green colour of foliage.

The chickpea variety Gujarat Junagadh Gram 6 (GJG 6) was notified and released under section 5 of the seeds act, 1966 by Department of Agriculture and Co-operation and Farmers Welfare, New-Delhi vide S.O. 3540 (E), Dt. 22/11/2016 for cultivation in Gujarat state.

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Table 1. Performance of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) in comparison to checks under un-irrigated condition at different locations in the Gujarat state

Year/Trial	Location	GJG 6	GG 1	GG 2	GJG 3	CD at 5%	CV %
2010-11	Dahod	2722	1743	1799	3896	1009	23.1
PET(RF)	Arnej	1516@	1354	1104	1354	260	12.15
	Mean (2 location)	2119	1549	1452	2625		
	% Inc. Over		36.8	45.9	-19.3		
2011-12	Arnej	1465	1361	1406	1389	282	12.7
SSVT(RF)	Dahod	1972	2028	1611	1736	392	12.4
	Tanchha	1889***	1250	948	1194	386	18.3
	Vallbhipur	1274@@	1174	972	826	265	14.6
	Dhandhuka	1160***	946	827	845	152	9.8
	Mean (5 location)	1552	1352	1153	1198		
	% Inc. Over		14.8	34.6	29.5		
2012-13	Arnej	1872***	1579	1667	1410	202	8.6
LSVT(RF)-1	Dahod	2174@	1779	1378	2289	395	13.6
	Tanchha	1023	1156	1307	1224	233	16.1
	Dhandhuka*	781*	650*	779*	276*	231	42.3
	Mean (3 location)	1690	1505	1451	1641		
	% Inc. Over		12.3	16.5	3.0		
2013-14	Arnej	1811	1708	1659	1885	175	6.8
LSVT(RF)-2	Dahod	2641***	1667	1820	1909	312	9.8
	Tanchha	2527	2852	2834	2602	NS	18.7
	Vallbhipur	2052	2048	1893	2040	275	9.6
	Dhandhuka	1901	2005	1745	2031	NS	19.9
	Mean (5 location)	2186	2056	1990	2093		
	% Inc. Over		6.3	9.9	4.5		
Over all Mean (15 location)		1867	1643	1531	1775		
Over all% increase over check		-	13.6	21.9	5.2		
Top ranking of GJG 6 over the checks		-	11/15	13/15	8/15		
Total number of frequency in top non- significant group		10/15	4/15	2/15	6/15		

(Figures in parenthesis indicates number of trials)
* Data not included due to below state average yield and high C.V. %
*** Statistically superior than best check, @ Statistically superior than GG 2 @@ Statistically superior than GG 2 & GJG 3

Table 2. Yield performance of Gujarat Junagadh Gram 6 (GJG 6) in Coordinated Trial (IVT - RF) in Central Zone

Entries / Locations	Seed yield Kg/ha.				CD at 5%	CV %
	GJG 6	GG 1 (Ch)	JG 16 (Ch)	Vijay (Ch)		
Badnapurr	1988	1837	2151	1869	382	11.9
Rahuri	3645	3819	3618	3777	711	13.2
Sehore	2591	2359	2426	2068	406	11.6
Raipur	1472	1131	1167	972	252	13.8
Banaswara	1288	1055	1163	1028	302	18.2
Indore	2668	2624	2916	2111	428	10.9
Kota	2945	3304	2827	2812	581	13.4
Arnej	**1795**	**1694**	**2003**	**1673**	**254**	**11.2**
Akola	1145	983	1489	919	217	14.0
Bhatpara	1833	1074	1722	1167	339	14.7
Mean	**2137**	**1988**	**2148**	**1840**	**-**	**-**
% increase over Checks	**-**	**7.5**	**-0.5**	**16.1**	-	-
Freq. in top non-significant group	**9/10**	**5/10**	**7/10**	**3/10**	-	-

Table 3. Reaction of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks to *Fusarium* wilt

Name of entry	*Fusarium* wilt diseases (%)				Range	Reaction		
	2010-11	2011-12	2012-13	2013-14		R	MR	S
GJG 6	13.3	1.9	11.1	8.5	1.9-13.3	2	2	0
GG 1 (Ch)	13.0	33.0	13.5	12.4	12.4-33.0	0	3	1
GG 2 (Ch)	45.5	17.0	64.4	40.3	17.0-64.4	0	1	3
GJG 3 (Ch)	22.7	12.7	8.7	11.4	8.7-22.7	1	2	1

R = 0 to 10 % MR = > 10 to 20 % S = > 20 %

Table 4. Reaction of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks to *Fusarium* wilt in AICRP nursery

Center	Entries				LSI
	GJG 6	JG 315 (Ch)	JG 62 (Ch)	L 550 (Ch)	
Badanapur	12.2	24.8	100	50.8	40.8
Indore	10.5	11.0	96	27.5	25.0
Jabalpur	13.3	5.3	98.9	-	51.3
Junagadh	11.1	9.2	100	-	56.3
Rahuri	7.2	1.7	100	89.7	54.5
Sehore	23.8	6.1	100	-	56.5
Mean	**13.0**	**9.7**	**99.2**	**44.9**	
R	**1**	**4**	**0**	**0**	
MR	**4**	**1**	**0**	**0**	

R = 0 to 10 % MR = > 10 to 20 % S = > 20 %

Table 5. Reaction of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks to stunt

Name of entry	*Stunt* diseases (%)				Mean	Reaction	
	2010-11	2011-12	2012-13	2013-14		R	MR
GJG 6	4.0	2.0	6.8	7.3	5.0	4	0
GG 1 (Ch)	8.7	1.9	3.5	8.0	5.5	4	-
GG 2 (Ch)	20.5	2.1	4.8	18.1	11.4	2	2
GJG 3 (Ch)	15.0	8.4	4.3	9.0	9.2	3	1

R = 0 to 10 % MR = > 10 to 20 % S = > 20 %

Table 6. Reaction of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks to stunt in AICRP in nursery at Junagadh during 2012-13

Center	Entries			LSI
	GJG 6	GCP 105 (R)	JG 315 (S)	
Junagadh (CZ)	13.0	7.5	18.5	13.8
Mokama (NEPZ)	6.7	8.1	15.3	9.4
R	**1**	**2**	**0**	
MR	**1**	**0**	**2**	

R = 0 to 10 % MR = > 10 to 20 % S = > 20 %

Table 7. Pod damage (%) caused by *Helicoverpa armigera* in chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks at Junagadh

Name of entry	Pod damage (%)				Average
	2010-11	2011-12	2012-13	2013-14	
GJG 6	1.28* (1.65)	1.86 (3.47)	2.48 (6.15)	5.45* (13.95)	6.31
GG 1 (Ch)	2.35 (5.53)	1.78 (3.18)	2.51 (5.78)	5.85 (14.42)	7.23
GG 2 (Ch)	1.64 (2.69)	2.28 (5.20)	1.52 (1.81)	6.01 (14.77)	6.12
GJG 3 (Ch)	1.79 (3.20)	1.71 (2.93)	1.69 (2.37)	3.57 (11.37)	4.96
C.D. at 5 %	0.56	NS	0.64	4.07	
CV %	18.99	19.52	18.37	17.10	

$\sqrt{x}$ Transformation
Figures in parenthesis are re-transform values
* indicates significantly lower pod damage than check

Table 8. Milling performance of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks

Sr. No.	Parameters	Varieties			
		GJG 6	GG 1 (Ch)	GG 2 (Ch)	GJG 3 (Ch)
1	**Milling Quality (%)**				
	Dhal	**70.29**	69.27	69.85	37.09
	Unhusked dhal	1.38	5.18	0.66	4.01
	Broken	3.07	2.38	4.06	1.45
	Husk	12.12	12.16	13.05	12.62
	Powder	7.22	5.67	10.52	10.32
	Gota	5.92	5.33	1.86	34.51
2	Initial Moisture Content (%) (W.B.)	9.83	9.60	10.07	8.48
3	Actual Dal (%)	**87.72**	87.15	86.94	86.84
4	Actual Husk (%)	12.28	12.85	13.06	13.16
5	Cooking Time Min	27.00	28.00	26.00	32.00
6	Protein content (%)	**19.90**	17.30	17.70	18.60
7	Total carbohydrates (%)	**67.84**	63.85	60.11	59.98
8	Total soluble sugar (%)	5.44	5.85	6.04	5.92
9	Phenol (%)	0.24	0.45	0.55	0.48

Table 9. Ancillary observations of chickpea variety Gujarat Junagadh Gram 6 (GJG 6) along with checks

SN	Character	GJG 6	GG 1 (Ch)	GG 2 (Ch)	GJG 3 (Ch)
1.	Days to 50 % flowering	63	63	52	53
2.	Plant height	46.9	47.4	45.7	44.8
3.	Maturity days	112	111	104	104
4.	No. of branches/plant	5.3	5.1	4.6	4.4
5.	No. pods/plant	36	35	31	32
6.	No. seeds/pod	1.5	1.4	1.2	1.3
7.	100-seed weight (g)	22.45	18.20	28.99	23.98
8.	Seed shape	Angular	Owl's Head	Owl's Head	Owl's Head
9.	Seed colour	Dark Brown	Brown	Brown	Yellow
10.	Seed surface	Tuberculated	Rough	Smooth	Tuberculated
11.	Plant habit	Semi-erect	Semi-erect	Semi-erect	Semi erect
12.	Plant green colour intensity of foliage	Medium Green	Dark Green	Dark Green	Medium Green

(Each value is the average of 15 trials)