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A medium maturing high yielding pigeon pea variety Gujarat tur 106 (GT 106: Mahi) for middle & North Gujarat

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Abstract
A medium duration pigeon pea variety Gujarat Tur 106 (GT 106: Mahi) breed through selection from local germplasm collected from Vadodara district of Gujarat. This genotype first time evaluated in PET *kharif* 2014 in name of AAUVT 13-20 at PRS, Vadodara. The genotype performance was excellent over prevailing varieties AGT 2 and BSMR 853 in trial. Due to good performance, genotype was evaluated in state trial format during *kharif* 2015 to 2018. Also this genotype evaluated in AICRP trial during *kharif* 2019 in medium maturity group. This genotype was tested total 26 times in station, Zonal and state trial along with prevailing varieties *viz.*, AGT 2, BDN 2, Vaishali and GJP 1. Out of 26 tests, this genotype stood 15 times in top non-significant group. Overall, GT 106 gave 1820 kg/ha grain yield which was 28.85, 10.32, 8.35 and 0.67 per cent higher than local check varieties *viz*, AGT 2, BDN 2, Vaishali and GJP 1 respectively. This variety has semi spreading growth habit, medium maturity (165-180 days), green stem, yellow flower and pure green pod with 5-6 grain, grain is creamish white, bold seeded (11-12 g). In terms of quality, it contains 19.37% protein, 43.80% carbohydrate, 3.90% total soluble sugar which is comparable with other check varieties. This variety found resistant to wilt and moderately resistant to SMD (Sterility Mosaic Disease) under natural field condition.

Keywords: Pigeon pea, *kharif*, yield, morphological traits, wilt

Introduction
Pigeonpea consider as second most important pulse crop after chickpea. It belongs to member of family *Fabaceae* and it is invariably cultivated as annual crop. Pigeon pea is an often cross pollinated (20-70%) crop with 2n = 2x = 22 diploid chromosome number (Kumara *et al.*, 2014) [6]. Pigeon pea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop extensively grown in different cropping systems on almost all types of soil and in all the districts of Gujarat state. In Gujarat, it is cultivated in an area of 2.54 lakh hectares with productivity of 1154 kg/ha (DAC & FW, New Delhi. 2018-19). Middle Gujarat is main pigeon pea growing region of our state, where it is cultivated in approximate 0.91 lakh hectares of area with a productivity of 1236 kg/ha. Both, early and mid late varieties are grown in the state.
There is a specific demand of medium duration varieties in the cotton black soil of middle Gujarat. Therefore, there is a need to develop variety with medium maturity, high yield potential and resistant to disease; Looking to the demand of the farmers of middle Gujarat, at Pulses Research Station, AAU, Vadodara has developed this genotype favourable for black cotton soil as well as suitable for ecology of Gujarat State. In plant breeding, improvement in yield and resistance to specific disease is a continue process by identify suitable culture from existing sources or reforming genetic background and released for the benefit of farming community is the main goal of University. At present cultivars BDN 2, AGT2, Vaishali and GJP 1 recommend for farming community but none of the varieties have green pod colour. This newly developed genotype AAUVT-13-20 (GT 106) have medium maturity, green pod, yellow flower, semi spreading type, indeterminate growth habit, 5-6 & bold seeded, Wilt resistant and moderately resistance to SMD.

Material and Methods
GT 106 variety breed through selection from existing germplasm at Pulse Research Station, Anand Agricultural University, Vadodara, Gujarat with the name of AAUVT 13-20. The genotype was identified and tested in preliminary evaluation trial (PET) trial during *kharif* 2014.

It was found promising and further, it was tested in state trail from *Kharif* 2015 to 2018 across Gujarat state. As per format, in PET plot size was 3.6 x 4.0m (4 rows), SSVT has 5.4 x 4.0 m (6 rows) whereas LSVT having 7.2 x 4.0 m (8 rows). The culture was also screened for major disease and pest in natural as well as artificial sick pot. The DNA fingerprinting of variety GT 106: Mahi along with check varieties (AGT 2, BDN 2 and Vaishali) were done using SRAP primers.

Results and Discussion

The Pigeonpea variety GT 106 was evaluated in PET trial during *kharif* 2014 along with check varieties *viz*., BDN 2, AGT 2, and Vaishali (BSMR 853). The test genotype exhibited a significantly higher grain yield (2162 kg/ha) with a yield increment of 74.92 and 45.10 per cent over check AGT 2 and Vaishali respectively. The Pigeonpea variety GT 106 was tested under 26 different station, Zonal and state trials during *kharif* 2015 to 2018 against various checks varieties *viz*., BDN 2, AGT 2, Vaishali and GJP1. In Gujarat, overall mean grain yield performance of AAUVT 13-20 (GT106) was 1820 kg/ha including PET trial. Based on relative mean analysis, this variety produced 28.85, 10.32, 8.35 and 0.67 per cent higher grain yield over check BDN 2, AGT2, Vaishali and GJP1 (Table1).

Table 1: Grain yield (kg/ha) of pigeon pea genotype AAUVT-13-20 (GT 106) with check varieties in the Gujarat.

Year / Trials	Location	Yield (kg/ha)					S. Em.±	C. D. at 5%	C. V. %
		AAUVT13-20 (GT 106)	BDN 2 (a)	AGT 2 (b)	Vaishali I	GJP 1(d)			
2014 PET	Vadodara	2162 [bc]	2142	1236	1490	-	195.00	574	17.1
	% Inc. over the check		0.93	74.92	45.10				
2015 SSVT	Vadodara	132 [abc]	659	1071	993	1327	79.60	228	19.0
	SKNagar	1080	1281	1085	1744	1605	130.22	373	19.3
	Junagadh	2740 [ab]	1960	2133	2527	2941	154.31	443	11.0
	Derol	1664	1501	2039	1971	2228	168.04	473	16.8
	Navsari	1421[a]	1079	1588	1594	1560	89.90	258	11.3
	Bharuch	1137	1127	1442	1361	1495	87.00	249	19.6
	Mean (6)	1561	1268	1560	1698	1859			
	% Inc. over the check		23.08	-	-	-			
2016 SSVT	Vadodara@	913	498	767	664	776	64.80	186	16.1
	SKNagar	2324 [cd]	2113	1906	1696	1444	189.41	544	17.4
	Junagadh	3135 [c]	2766	2927	2258	3395	150.18	432	9.8
	Derol	1882 [abcd]	844	1208	1321	1129	123.10	354	16.1
	Navsari	872	1028	1366	1290	1245	88.10	253	12.8
	Bharuch	1896 [d]	1611	1768	1650	1472	106.97	307	10.7
	Mean (5)	2022	1672	1835	1643	1737			
	% Inc. over the check		20.89	10.18	23.06	16.40			
2017 LSVT	Vadodara@	770	113	354	1072	39	69.60	202	25.2
	SKNagar	1444 [abcd]	928	927	635	1106	114.00	331	17.3
	Junagadh	2379	2006	2392	2495	2990	157.30	457	10.8
	Derol	1652 [ac]	964	1628	1047	1619	102.80	299	12.5
	Navsari	962	886	1109	1450	790	71.00	206	10.6
	Bharuch	1669	1420	1454	1622	1793	105.10	306	11.4
	Mean (5)	1621	1241	1502	1450	1660			
	% Inc. over the check		30.66	7.94	11.82	-			
2018 LSVT	Vadodara	2140 [abd]	1038	1349	1822	1554	117.00	342	12.1
	SKNagar	2564 [abcd]	1696	1994	2014	1904	90.00	263	7.2
	Junagadh	2153	2152	2380	2664	2882	179.90	525	12.5
	Derol	1786 [acd]	1257	1753	1464	1413	93.70	274	10.5
	Navsari	827	790	840	1565	897	55.00	161	8.5
	Bharuch	2302 [a]	1663	2055	2213	2314	94.00	274	7.5
	Mean (5)	1962	1433	1729	1957	1827			
	% Inc. over the check		36.95	13.51	0.26	7.37			
2018 ZVT	Vadodara	1855 [abc]	925	1530	1493	-	111.80	325	13.3
	Derol	1614 [ac]	1087	1407	1278	-	83.80	244	11.6
	Dahod	2343 [ab]	1804	1946	2019	-	134.00	389	12.5
	Mean (3)	1937	1272	1628	1597				
	% Inc. over the check		52.31	21.55	21.34				
Over all mean (26)		1820	1413	1650	1680				
Over all mean (22)		1789				1777			
Relative % increase over checks			28.85	10.32	8.35	0.67			
Total no. of freq. in top non-sign. group		15/26	02/26	10/26	09/26	10/22			

@ indicate trial was consider as vitiated due to heavy rainfall in 2016 and 2017
(Figure in parenthesis indicates number of trials), a – BDN-2, b – AGT-2, c – Vaishali, d – GJP-1

In middle Gujarat, based on ten testing AAUVT 13-20 (GT 106) exhibited higher grain yield (1842 kg/ha) with an yield advantage of 50.72, 21.44, 23.63 and 12.68 per cent over checks respectively (Table2). In North Gujarat, based on ten testing AAUVT 13-20 (GT 106) exhibited higher grain yield (1853kg/ha) with an yield advantage of 23.16,25.37, 21.73 and 22.33 per cent over checks respectively (Table3).

Table 2: Grain yield (kg/ha) of pigeon pea genotype AAUVT-13-20 (GT 106) with check varieties in the middle Gujarat.

Year / Trials	Location	Yield (kg/ha)					S. Em. ±	C. D. at 5%	C. V. %
		AAUVT-13-20 (GT 106)	BDN 2 (a)	AGT 2 (b)	Vaishali I	GJP 1 (d)			
2014 PET	Vadodara	2162[bc]	2142	1236	1490	-	195.00	574	17.1
	% Inc.over		0.93	74.92	45.10				
2015 SSVT	Vadodara	1321[abc]	659	1071	993	1327	79.60	228	19.0
	Derol	1664	1501	2039	1971	2228	168.04	473	16.8
	Mean (2)	1493	1080	1555	1482	1778			
	% Inc. over the check		38.19		0.71				
2016 SSVT	Vadodara@	913	498	767	664	776	64.80	186	16.1
	Derol	1882[abcd]	844	1208	1321	1129	123.10	354	16.1
	Mean (1)	1882	844	1208	1321	1129			
	% Inc. over the check		122.99	55.79	42.47	66.70			
2017 LSVT	Vadodara@	770	113	354	1072	39	69.60	202	25.2
	Derol	1652[ac]	964	1628	1047	1619	102.80	299	12.5
	Mean (1)	1652	964	1628	1047	1619			
	% Inc. over the check		71.37	1.47	57.78	2.04			
2018 LSVT	Vadodara	2140[abd]	1038	1349	1822	1554	117.00	342	12.1
	Derol	1786[acd]	1257	1753	1464	1413	93.70	274	10.5
	Mean (2)	1963	1148	1551	1643	1484			
	% Inc. over the check		71.07	26.56	19.48	32.32			
2018 ZVT	Vadodara	1855[abc]	925	1530	1493	-	111.80	325	13.3
	Derol	1614[ac]	1087	1407	1278	-	83.80	244	11.6
	Dahod	2343[ab]	1804	1946	2019	-	134.00	389	12.5
	Mean (3)	1979	1272	1628	1597	-			
	% Inc. over the check		55.54	21.55	23.91	-			
Over all mean (10)		1842	1222	1517	1490	-			
Over all mean (06)		1741				1545			
Relative % increase over checks			50.72	21.44	23.63	12.68			
Total no. of freq. in top non-sign. group		08/10	01/10	05/10	03/10	03/06			

Table 3: Grain yield (kg/ha) of pigeon pea genotype AAUVT-13-20 (GT 106) with check varieties in the North Gujarat.

Season / Year / Trials	Location	Yield (kg/ha)						S. Em. ±	C. D. at 5%	C. V. %
		AAUVT-13-20 (GT 106)		BDN 2 (a)	AGT 2 (b)	Vaishali I	GJP 1 (d)			
2015 SSVT	SKNagar	1080		1281	1085	1744	1605	130.22	373	19.3
	% Inc. over the check			-	-	-	-			
2016 SSVT	SKNagar	2324	cd	2113	1906	1696	1444	189.41	544	17.4
	% Inc. over the check			9.99	21.93	37.03	60.94			
2017 LSVT	SKNagar	1444	abcd	928	927	635	1106	114.00	331	17.3
	% Inc. over the check			55.60	55.77	127.01	30.56			
2018 LSVT	SKNagar	2564	abcd	1696	1994	2014	1904	90.00	263	7.2
	% Inc. over the check			51.18	28.59	27.31	34.66			
Over all mean (04)		1853		1505	1478	1522	1515			
Relative % increase over checks				23.16	25.37	21.73	22.33			
Total no. of freq. in top non-sign. group		02/04		01/04	01/04	01/04	00/04			

Table 5: Description of Morphological characters of GT-106 as per DUS test

Sr. No.	Characteristics	AAUVT-13-20 (GT-106)	AGT-2 (LC)	Vaishali (LC)
1.	Plant: Anthocyanin colouration of hypocotyl	Present	Present	Present
2.	Plant: Branching pattern	Semi-spreading	Semi-spreading	Semi-spreading
3.	Plant: Growth habit	Indeterminate	Indeterminate	Indeterminate
4.	Stem: Colour	Green	Green	Green
5.	Leaf: Shape	Oblong	Oblong	Oblong
6.	Leaf: Pubescence on lower surface of the leaf	Absent	Absent	Absent
7.	Flower: Colour of petal (standard)	Yellow	Yellow	Red
8.	Flower: Pattern of streaks on petal (standard)	Absent	Absent	Absent
9.	Pod: Colour	Green	Green with brown streak	Green with brown streak
10.	Pod: Pubescence	Absent	Absent	Absent
11.	Pod: Waxiness	Absent	Absent	Absent
12.	Pod: Surface stickiness	Absent	Absent	Absent
13.	Pod: Constriction	Prominent	Slight	Slight
14.	Pod: Size (cm)	>5	<5	<5
15.	Pod: No. of seeds	4-6	4-5	4-5
16.	Plant: Height (cm)	Tall (>150)	Tall (>150)	Tall (>150)
17.	Seed: Colour	Cream	Cream	Cream

18.	Seed: Colour pattern	Uniform	Uniform	Uniform
19.	Seed: Shape	Oval	Oval	Oval
20.	Seed: Size (weight of 100 seeds) g	Large (10-12)	Large (9-11)	Large (9-11)

The AAUVT 13-20 (GT 106) having an attractive suture in field view (Fig. 1). It has yellow flowered, green stem, Pure green pod with 5 to 6 seeded with prominent constriction on pod and larger seed size (10-12 g). (Table 5 and Fig.1). There is good scope for yield improvement through selection for pods/plant, seeds/plant and yield/plant and directly affect yield per plant. (Kumar and Dubey *et al*., 1996) [5]. Singh *et al*. (2009) [7] reported that number of pods per plant and number of seeds per pod are important yield contributing traits and same trend observed with GT 106 (Mahi).

Flowering Plant Poded Plant

Leaf Shape: Oblong Green Pod

Dry Pod Grain Quality

Fig 1: Important DUS characters of AAUVT 13-20 (GT 106)

Table 5a: Diseases Reactions (%) in Pigeonpea genotype AAUVT-13-20 during *Kharif* 2014-15 to 2018-19 at Vadodara

Sr. No.	Disease	Season	Promising Genotype/varieties				
			AAUVT-13-20	BDN2	Vaishali	AGT2	GJP1
1	Wilt	2014-15	9.00	13.00	11.00	8.00	-
		2015-16	2.00	4.66	3.33	2.66	-
		2016-17	0.00	1.51	1.56	1.65	2.26
		2017-18	1.58	4.18	2.80	0.00	2.00
		2018-19	0.39	1.96	2.35	0.00	-
		Range	0.00-9.00	1.51-13.00	1.56-11.00	0.00-8.00	2.00-2.26
	Reaction grade		R	MR	MR	R	R
2	SMD	2014-15	4.00	8.00	7.00	5.00	-
		2015-16	1.33	4.00	4.00	3.00	-
		2016-17	0.96	1.51	1.04	1.10	1.35
		2017-18	23.68	46.30	0.40	21.41	66.33
		2018-19	0.00	0.00	0.00	0.00	-
		Range	0.96-23.68	0.00-46.30	0.00-7.00	0.00-21.41	1.35-66.33
	Reaction grade		MR	S	R	MR	S
Diseases Reactions (%) in Pigeonpea genotype AAUVT-13-20 during *Kharif* 2017-18 at S. K. Nagar							
1	Wilt		0.00	0.00	0.00	0.00	0.00
2	SMD		6.66	50.00	12.50	33.33	20.00
Anand (Artificial Wilt Sick pot condition)							
1	Wilt		0.00	0.00	0.00	0.00	0.00

Table 5b: Reaction to wilt disease under wilt sick plot of AICRP centers *kharif* – 2019

Sr. No.	Variety	Akola	Badnapur	Khargone	Rahuri	SKNagar	Range	Reaction Grade
1.	AAUVT13-20	5.8	100.0	6.7	100.0	0.00	0.00-100	HS
2.	ICP 2376 I	50.0	100.0	93.33	100.0	40.67	40.67– 100.0	HS

Table 5c: Reaction to SMD disease under field condition of AICRP centers *kharif* – 2019

Sr. No.	Variety	Badnapur	Rahuri	Range	Reaction Grade
1.	AAUVT-13-20	5.6	33.4	5.6-33.4	MS
2.	ICP 8863 (NC)	100	100	100	HS

In pest & Disease reaction concern, this variety shows resistance reaction against wilt and moderately resistance against sterility mosaic disease (SMD) at PRS, AAU, Vadodara and SDAU, S. K. Nagar. However, in AICRP trials, this variety shows susceptible reaction against wilt and moderately resistance reaction against SMD (Table 5a, 5b, 5c & 6a,6b)

Table 6a: Insect Pest Incidence in Pigeonpea genotype AAUVT-13-20 during *Kharif* 2014-15 to 2018-19 at Vadodara

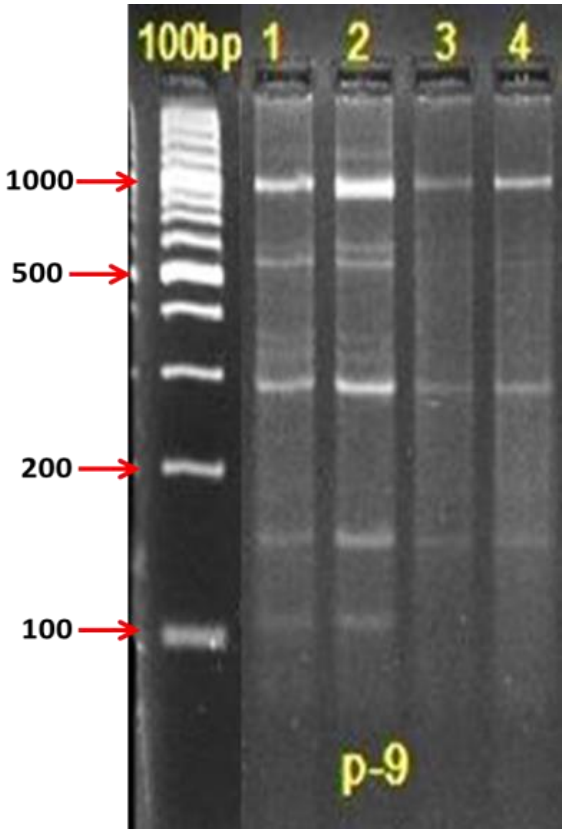
Sr. No	Insect/ pest/	Year	Promising Genotype/varieties				
			AAUVT-13-20	BDN2	Vaishali	AGT2	GJP1
1	Pod damage (%) *H. armigera*	2014-15	18.00	21.00	20.00	17.00	-
		2015-16	6.33	8.00	6.66	6.33	-
		2016-17	7.00	13.00	14.00	9.00	10.00
		2017-18	10.00	14.00	12.00	8.00	12.00
		2018-19	10.00	8.00	10.00	12.00	-
		Range	6.33-18.00	8.00-21.00	6.66-20.00	6.33-17.00	10.00-12.00
2	Pod damage (%) *M. obtusa*	2015-16	5.66	7.66	7.00	6.00	-
		2016-17	8.00	12.00	12.00	11.00	11.00
		2017-18	9.00	13.00	10.00	10.00	11.00
		2018-19	11.00	7.00	9.00	12.00	-
		Range	5.66-11.00	7.00-13.00	7.00-12.00	6.00-12.00	11.00
3	Grain weight loss (%) *M. obtusa*	2014-15	10.5	13.5	13.0	10.10	-
		2015-16	7.00	7.00	6.66	6.00	-
		2016-17	5.00	8.00	7.00	4.00	6.00
		2017-18	7.50	10.00	8.50	8.00	9.00
		2018-19	8.70	8.65	8.50	9.15	-
		Range	5.00-10.5	7.00-13.50	6.66-13.00	4.00-10.10	6.00-9.00

Table 6b: Insect Pest Incidence in Pigeonpea genotype during *Kharif* 2017-18 to 2018-19 at S. K. Nagar

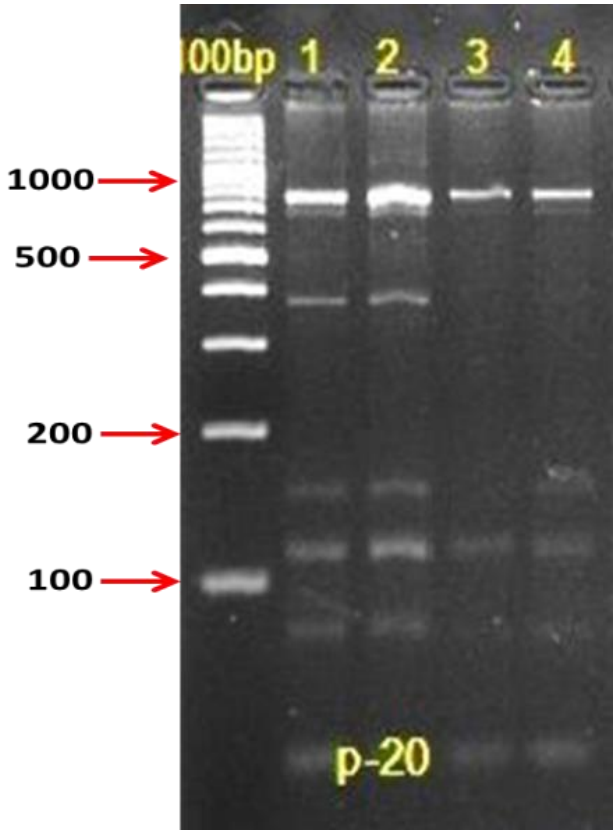
Sr. No.	Insect/ pest/	Year	Promising Genotype/varieties					S. Em. ±	CD at 5%	CV%
			AAUVT-13-20	BDN2	Vaishali	AGT2	GJP1			
1	Pod damage (%) *H. armigera*	2017-18	17.74 (9.33)	21.11* (14.0)	25.57 (18.67)	18.41 (10.0)	17.52 (9.33)	1.43	4.19	12.62
		2018-19	23.50 (29.0)	6.4 (14.67)	44.8* (42.0)	6.7 (15.0)	11.0 (19.33)	2.80	8.22	18.45
2	Pod damage (%) *M. obtusa*	2017-18	15.23 (7.0)	18.71 (10.33)	21.95 (14.0)	15.67 (7.33)	15.31 (7.00)	1.17	3.42	11.97
		2018-19	6.4 (14.67)	32.4 (34.67)	18.3* (25.33)	7.3 (15.67)	6.4 (14.67)	1.54	4.52	10.29

Arcsine transformed value figures in parenthesis are retransformed value

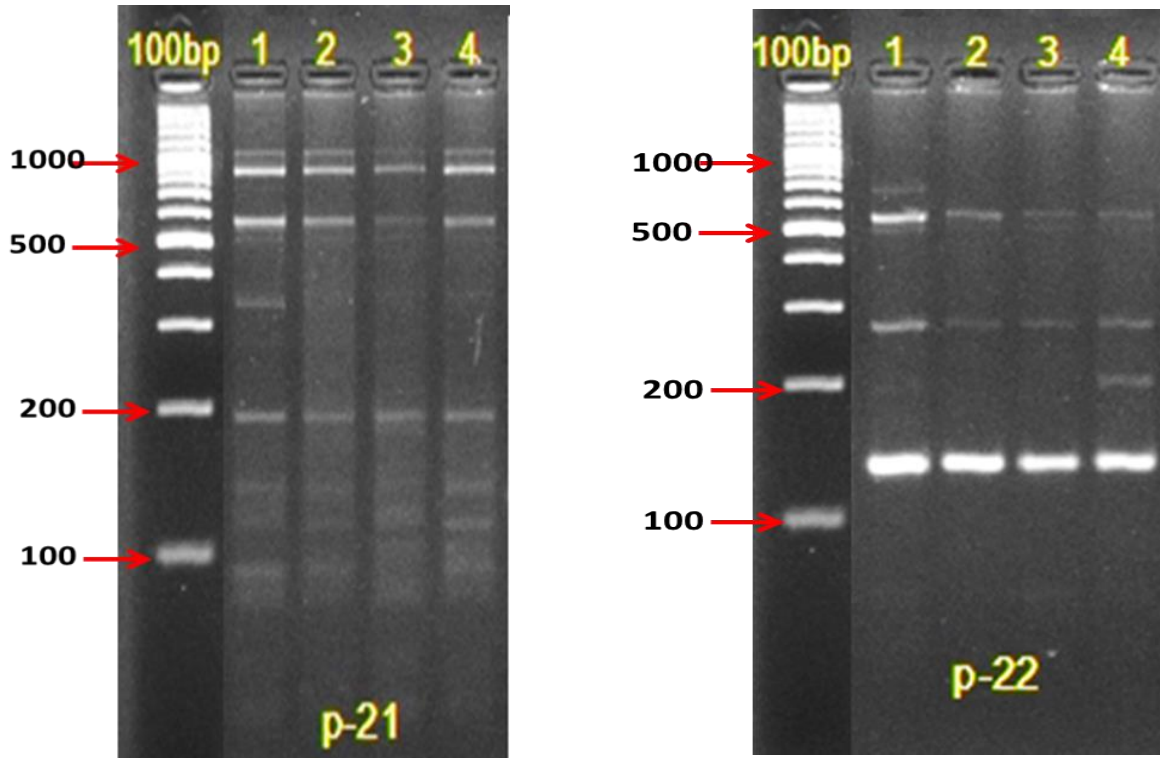
DNA fingerprinting of variety GT 106 (Mahi) along with four checks (AGT 2, Vaishali, & BDN 2) was performed using 50 SRAP primers. SRAP markers demonstrated greater utility in detecting genetic variation among igeonpea genotypes in comparison with SSR and AFLP-RGA systems (.Out of 50 primers, 4 primers (SRAP9, SRAP 20, SRAP 21 and SRAP 22) were showed polymorphic bands between AAUVT-13-20 and checks used in fingerprinting. Polymorphic bands were demonstrated using the arrow symbol in Fig. 2. SRAP and AFLP-RGA techniques have been widely used in many crops for genetic diversity analysis (Agbagwa *et. al.*, 2014) [1].



M(Marker): 100 bp plus ladder
Primer SRAP 9(SRAP Me2+ SRAP eM3)



M(Marker): 100 bp plus ladder
Primer SRAP 20(SRAP Me4 + SRAP eM2)



M(Marker): 100 bp plus ladder
Primer SRAP 21(SRAP Me4+ SRAP eM3)

M(Marker): 100 bp plus ladder
Primer SRAP 22(SRAP Me4+ SRAP eM4)

Fig 2: DNA fingerprinting of igeonpea genotype aauvt-13-20 (gt-106) using srap marker

Yield with quality is also of prime importance as the igeonpea is being used grain as well as green vegetable purpose. The grain colour of released cultivar AUUVT 13-20 (GT 106) is creamish which may be commonly requirement among farmers for fetching higher market price in this region. The AUUVT 13-20 (GT 106) have a 19.37 per cent crude protein which was comparable against check cultivars *viz*., BDN 2 (18.49%), AGT 2 (20.68%) and Vaishali (19.37%). The AUUVT 13-20 (GT 106) have higher total carbohydrate as compared to all other check varieties. It may indicate test of grain is good as compared to other varieties. On the other hand, the released cultivar AUUVT 13-20 (GT 106) has comparable micronutrient content as compared to check varieties (Table 7). For crude protein content, significant variation among the genotypes was observed with a range of 17.48 – 24.79 g/100g and a mean of 20.88 g/100g crude protein (*Cheboi et. at.*, 2019) [3]. This variation may be attributed to crop production environment, input used in crop production, seed storage, samples processing methods and presence of polyphenols which affect the activity of digestive enzymes which in turn affect the protein quality (Digbeu *et al.*, 2018) [4].

Table 7: Biochemical parameters of variety AAUVT 13-20 (GT 106) with checks varieties.

Sr. No.	Quality parameters	AAUVT-13-20 (GT-106)	BDN-2 (NC)	AGT-2 (LC)	Vaishali (LC)
1.	Moisture (%)	8.06	9.20	9.23	8.59
2.	Protein content (%)	19.37	18.49	20.68	19.37
3.	Total Carbohydrate (%)	43.80	41.18	41.65	41.95
4.	Total Soluble Sugar (%)	3.90	4.16	3.81	4.99
5.	Phenol (%)	0.412	0.527	0.640	0.528
6.	Flavanoid (mg/100 gm)	23.67	33.54	16.15	25.17
	Mineral nutrient content in AAUVT-13-20 and check varieties ($mgkg^{-1}$)				
1	Fe	33.60	31.58	30.67	34.82
2	Mn	9.51	8.94	8.72	8.87
3	Zn	22.87	24.82	24.44	23.71
4	Cu	8.64	9.17	9.23	9.13

Looking to the yield performance of newly developed genotype AAUVT-13-20 (GT 106) along with medium maturity, green pod with 5-6 seed, yellow flower, semi spreading type, indeterminate growth habit, cream coloured & bold seeded, Wilt resistant and moderately resistance to SMD. This genotype AAUVT-13-20 (GT 106) is proposed for recommendation in medium duration Pigeonpea cultivated area of Middle and North Gujarat. The IC number of this genotype is IC637190 and also this variety was notified by central variety release committee.

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