Tobacco Research 40 (2) : 65-72, 2014

CH 1- A PROMISING FCV TOBACCO HYBRID FOR NORTHERN LIGHT SOILS OF ANDHRA PRADESH

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(Received on 3rd July, 2014 and accepted on 10th October, 2014)

With the objective of increasing the productivity level of tobacco under Northern Light Soils (NLS) of Andhra Pradesh, a number of tobacco hybrids were developed and evaluated. CH-1 is one such high yielding Cytoplasmic Male Sterile (CMS) flue-cured Virginia tobacco hybrid produced by crossing a promising CMS line of FCV cultivar, Kanchan and a pollen parent, P15-6. In the station varietal trials and multi-location evaluation under the All India Network Research Project – Tobacco (AINRPT), the hybrid CH-1 exhibited a cured leaf yield potential of 2500 to 2900 kg/ha with a standard heterosis of 16-31%. Topping at 26 leaves and application of 115 kg N/ha and 150 kg K/ha were found to be optimum for realizing high yields with the hybrid CH-1 in NLS. The reaction of the hybrid CH-1 to various pests and diseases was found to be similar to the variety the Kanchan. The cured leaf chemical quality parameters of CH-1 in different experiments were at a par with variety Kanchan. In smoke analysis of cigarettes, CH-1 proved superior over control Kanchan and showed significantly higher levels of neutral aroma volatile compounds. The storage and manufacturability characteristics of the hybrid CH-1 were comparable to Kanchan. The plant type, leaf colour, maturity and flowering behavior of CH-1 were similar to Kanchan and hence suit to the requirements of NLS tobacco. Besides incremental yield, the hybrid CH-1 showed enhanced ripeness characteristics, higher grade index and superior smoke profile as compared to the variety Kanchan. In view of all the above mentioned positive traits, the hybrid CH-1 was recommended by the CTRI Research Council and the XIX Workshop of AINRPT (2009) for commercial release in NLS of Andhra Pradesh and the release proposals were submitted to A.P. State sub-committee on variety release.

Key words: FCV tobacco, Hybrid, NLS

*ITC Limited, Agri Business Division – ILTD

INTRODUCTION

Among various types of tobacco grown in India, Flue-cured Virginia (FCV) tobacco is the major exportable type with specific quality requirements. FCV tobacco grown in the irrigated Alfisols of the Northern Light Soils (NLS) encompassing West Godavari and Khammam districts of Andhra Pradesh is known for its premium leaf quality and is exported to several countries. Only one variety Kanchan is grown in NLS area and hence there is need to release more varieties/hybrids having high productivity and leaf quality so as to improve economic returns to the NLS farmers. Although hybrid tobacco cultivars of FCV type are in vogue in several countries, hybrids have yet to find commercial status in India. Tobacco is a self pollinating crop with predominance of additive gene action for yield and related traits. Earlier studies at CTRI revealed variable heterosis levels for leaf yield of FCV tobacco (Bhima Sastry, 1990; Ramanarao *et al.*, 1993; Murthy *et al.*, 2005). In non-flue-cured tobacco types where the chemical and smoke quality standards are not very rigid, considerable heterosis has been reported (Lakshminarayana, 1987). *Bidi* tobacco hybrids are increasingly used for commercial cultivation in Gujarat. In chewing tobacco also, appreciable heterosis has been reported (Anonymous, 2003). Keeping these things in view, a collaborative breeding programme was initiated by CTRI, Rajahmundry and ITC Limited, Agri Business Division – ILTD, Rajahmundry to develop high yielding hybrid with superior quality and flavour characteristics suitable for NLS area. The development and evaluation of tobacco hybrid, CH-1 suitable to NLS area were presented here.

MATERIALS AND METHODS

Several Cytoplasmic Male Sterile (CMS) hybrids were developed using CMS Kanchan with *Nicotiana suaveolens* as the cytoplasm donor. Nine best performing hybrids were evaluated jointly by CTRI and ITC Limited-ILTD in a replicated trial for two consecutive seasons during 2004-06 at CTRI Research Station, Jeelugumilli.

As per varietal testing programme under AINRP (Tobacco), multi-location testing of CH-1 was done in Initial Varietal Trial (IVT) during 2006-07 season, Advanced Varietal Trial (AVT) during 2007-09 and bulk trials at CTRI RS, Jeelugumilli. Collaborative on-farm trials were conducted at 11 locations spread over four seasons (2005-09) in NLS. The effect of plant spacing, nitrogen, potassium and topping levels on yield and quality of CH-1 hybrid was assessed for two seasons (2007-09) at Jeelugumilli. Observations were recorded on agronomical characters *viz.,* green and cured leaf yields, quality, reaction to pests and diseases, smoke and manufacturing quality of cured leaf.

RESULTS AND DISCUSSION

In the station varietal trials conducted at CTRI RS, Jeelugumilli (2004-06), the entries, CH-1 and CH-3 significantly out yielded all the other entries and the check, Kanchan. The hybrid, CH-1 proved superior with an increase of 15% in green leaf yield, 17% in cured leaf yield and 20% in grade index over Kanchan, followed by the hybrid CH-3 with 6.16 and 17% in green and cured leaf yields

Table 1: Yield Performance of advanced breeding lines and hybrids in station trial at CTRI RS, Jeelugumilli (2004-06)

S. No	Genotype	Green leaf yield (kg/ha)			Cured leaf yield (kg/ha)			Grade index		
		2004-05	2005-06	Pooled	2004-05	2005-06	Pooled	2004-05	2005-06	Pooled
1.	CH-1	18403*	15625	17014*	3484*	2235	2859*	1656*	1331	1494*
2.	CH-3	17583*	13726	15655	3322*	2346*	2834*	1546	1367	1456*
3.	ITC 112	13194	15083	14139	2458	2093	2275	1127	1039	1083
4.	ITC 113	13750	11958	12854	2618	1881	2249	1251	1190	1221
5.	ITC 115	14444	12056	13250	2706	1854	2280	1239	1006	1123
6.	ITC 116	15639	12097	13868	3001	1724	2362	1411	1003	1207
7.	ITC 117	17306*	14278	15792	3194	2000	2597	1462	1183	1323
8.	ITC 118	14819	11903	13361	2763	1940	2352	1263	1168	1215
9.	ITC 122	13875	14125	14000	2637	2094	2366	1169	1168	1168
10.	Kanchan	15028	14458	14743	2812	2056	2435	1296	1189	1242
Grand Mean		15404	13531	14468	2900	2022	2461	1342	1164	1253
SEm±		**743**	**588**	**474**	**153**	**72.5**	**84.9**	**99.6**	**65.3**	**59.6**
CD (P= 0.05)		**2209**	**1750**	**1314**	**457**	**215**	**235.5**	**296**	**194**	**165.1**
CV (%)		**8.36**	**7.54**	**8.03**	**9.18**	**6.21**	**8.46**	**12.86**	**9.72**	**11.64**
Seasons										
2004-05				15404			2900			1342
2005-06				13531			2022			1164
SEm±				**365.6**			**62.71**			**46.46**
CD (P=0.05)				**1435**			**246**			**NS**
CV (%)				**13.84**			**13.96**			**20.3**
Season x Treatment										
SEm±				**670.6**			**120.14**			**84.25**
CD (P=0.05)				**1859**			**333**			**NS**

* Significant over best check, Kanchan at 5% level

respectively and grade index (Table 1). Seasons differed significantly for green and cured leaf yields but not grade index; in general the yield levels were higher in 2004-05 season. The season x entry interaction was also significant for green and cured leaf yields (Table 1). The hybrids, CH-1 and CH-3 were further tested to evaluate their suitability to NLS as per the prescribed procedure for varietal testing and release.

In the Initial Varietal Trial (IVT) conducted at CTRI RS, Jeelugumilli, the hybrid CH-1 along with CH-3 showed significantly higher green and cured leaf yields and grade index than variety Kanchan (data not shown). Analysis of data from Advanced Varietal Trial (AVT) conducted during 2007-08 and 2008-09 seasons at Jeelugumilli confirmed significant superiority of the hybrid CH-1along with another hybrid CH-3 over the variety Kanchan. On pooled basis, the hybrids CH-1 and CH-3 showed increase of 12 and 13% in green leaf yield, 16 and 18% in cured leaf yield and 28 and 27% in grade index, respectively over variety Kanchan (Table 2).

Table 2 : Performance of FCV tobacco hybrid CH-1 in Advanced Varietal Trials (Pooled 2007-08 and 2008-09)

S. No	Genotype	Green leaf yield (kg/ha)			Cured leaf yield (kg/ha)			Grade index		
		AVT-I (2007-08)	AVT-II (2008-09)	Pooled	AVT-I (2007-08)	AVT-II (2008-09)	Pooled	AVT-I (2007-08)	AVT-II (2008-09)	Pooled
1.	CH-1	19132* (10)	14451* (13)	16792* (12)	2811* (14)	2451* (15)	2631* (16)	2139* (25)	1663* (32)	1901* (28)
2.	CH-3	19722* (13)	14319* (12)	17020* (13)	3032* (23)	2347* (10)	2689* (18)	2295* (33)	1497* (18)	1896* (27)
3.	CM-12 (C)	14937	9764	12350	2220	1594	1907	1405	887	1147
4.	Kanchan (C)	17347	12743	15045	2463	2126	2274	1716	1263	1490
Grand Mean		17785	12919	15302	2633	2129	2380	1889	1328	1608
SEm±		**402.8**	**378.1**	**276.2**	**95.7**	**69.3**	**59.1**	**84.15**	**59.1**	**514**
CD (P=0.05)		**1214**	**1139**	**798**	**288**	**210**	**171**	**254**	**179**	**148**
CV (%)		**7.55**	**7.22**	**6.25**	**8.91**	**7.97**	**8.60**	**10.91**	**10.91**	**11.07**
Seasons										
	2007-08			17785			2632			1889
	2008-09			12819			2129			1328
	SEm±			**329**			**63.1**			**61.6**
	CD (P=0.05)			**1037**			**199**			**194**
	CV (%)			**10.53**			**12.98**			**18.78**
Season x Treatment										
	SEm±			**390.7**			**83.54**			**72.71**
	CD (P=0.05)			-			-			-

* Significant increase over Kanchan at 5% level.

Table 3: Effect of spacing on yield and quality of CH 1 (Pooled 2007-09)

Treatments	Yield (kg/ha)			Green leaf/ cured leaf	Grade index/ cured leaf (%)
Hybrid	Green leaf	Cured leaf	Grade index		
CH 1	12001	2128	1661	5.63	78
CH 3	11800	2110	1632	5.58	78
SEm±	**167**	**31.68**	**23.02**	**0.02**	**0.03**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**
Spacing					
100 x 60 cm	13569	2335	1735	5.80	74
100 X 70 cm	11721	2108	1648	5.58	78
100 X 80 cm	10411	1915	1556	5.43	81
SEm±	**205**	**38.80**	**28.19**	**0.03**	**0.03**
CD (P=0.05)	**592**	**112**	**81**	**0.08**	**1.00**
CV (%)	**6.89**	**7.32**	**6.85**	**2.09**	**1.30**
Season					
2007-08	12122	2122	1661	5.70	79
2008-09	11679	2116	1632	5.50	77
SEm±	**116**	**26.28**	**18.41**	**0.03**	**0.03**
CD (P=0.05)	**401**	**NS**	**NS**	**0.11**	**1.00**
CV (%)	**4.77**	**6.08**	**5.48**	**2.77**	**1.57**
Interactions	**NS**	**NS**	**NS**	**NS**	**NS**

Plant spacing, topping and fertilizer requirements of CH-1

Plant spacing of 100 x 60 cm was found to be optimum for the hybrid CH-1 and gave significantly higher green and cured leaf yields and grade index than 100 x 80 cm and 100 x 70 cm (Table 3). The study on the effect of nitrogen, potassium and topping levels on yield and quality of CH-1 hybrid revealed that application of 115 and 130 kg N/ha being comparable recorded significantly higher grade index as compared to application of 100 kg N/ha (Table 4). The improvement in cured leaf yield with application of 115 and 130 kg N/ha was 229 kg (10.12%) and 362 kg (16.00%), respectively as compared to 100 kg N/ha. The improvement in grade index with application of 115 and 130 kg N/ha was 111 (6.60%) and 153 (9.09%), respectively as compared to 100 kg N/ha. Application of potassium resulted in progressive and significant increase in green leaf yield, cured leaf yield, grade index. Topping the hybrid at 26 leaves recorded significantly higher green leaf, cured leaf and grade index as compared to topping at 24 leaves (Table 4).

Based on the above studies, application of 115 kg N/ha and 150 kg K_2O/ha, topping at 26 leaves and plant population of 16,666/ha were found to be optimum for realizing higher productivity and leaf quality in the hybrid CH-1.

In view of its promise in station trials and multi-location trials, the hybrid CH-1 was evaluated in bulk trials along with the check variety Kanchan. In bulk trials CH-1 proved its superiority over Kanchan (data not shown). Results of on-farm trials conducted at 15 locations spread over four seasons (2005-06 to 2008-09) showed that the hybrid CH-1 was superior to check, Kanchan with an increase of 3 - 31% in cured leaf and 16 - 55% in bright leaf yields (data not shown).

Table 4: Leaf yield (kg/ha) as influenced by nitrogen, potassium and topping in the hybrid CH 1 (pooled 2007-09)

Treatment	Green leaf	Cured leaf	Grade index
Nitrogen (kg/ha)			
100	12906	2262	1683
115	14765	2491	1794
130	16013	2624	1836
SEm±	**154**	**26.24**	**18.35**
CD (P=0.05)	**431**	**73.5**	**51.4**
Potassium (K_2O kg/ha)			
120	13053	2299	1711
135	14654	2474	1768
150	15977	2604	1834
SEm±	**154**	**26.24**	**18.35**
CD (P=0.05)	**431**	**73.5**	**51.0**
Topping			
24 leaves	14338	2411	1723
26 leaves	14784	2507	1819
SEm±	**126**	**21.43**	**14.98**
CD (P=0.05)	**352**	**60.00**	**42.00**
CV (%)	**6.35**	**6.40**	**6.22**
Season			
2007-08	14266	2445	1785
2008-09	14856	2493	1757
SEm±	**197**	**27.44**	**13.92**
CD (P=0.05)	**NS**	**NS**	**NS**
CV (%)	**9.93**	**8.20**	**5.78**

Morphological features of CH-1 and its parents

The hybrid CH-1 was a cross between CMS Kanchan (female parent) and an advanced breeding line P15-6. Line P 15-6 has open habit, green coloured stem, medium inter nodal length and broad lanceolate leaves with acute tip. The cured leaf is lemon orange to orange in colour, medium bodied and has very good ripeness. CMS Kanchan has semi-erect plant habit, green coloured stem and short to medium inter nodal length. Leaf is long, lanceolate with acute to acuminate tip and wavy lamina. The cured leaf is lemon orange to deep orange in colour, medium bodied with medium ripeness.

Hybrid CH-1 has semi-erect habit with green coloured stem and short to medium inter nodal length (5.5 cm on an average). Leaf lamina is long, wavy, medium broad with very good puckering and acute to acuminate tip. The average length was 65 cm in 5th leaf, 70 cm in 10th leaf and 68 cm in 15th leaf. The average width was 28 cm, 30 cm and 26 cm, in 5th, 10th and 15th leaf, respectively. Leaf is green cast in nature, sessile with high auricle development. The plant produces a total of 28 to 35 leaves with at least 26 economic leaves.

The hybrid CH-1 flowers in about 65-70 days like its parents and completes the life cycle in 170-180 days from seed to seed.

Quality parameters of cured leaf

In bulk evaluation trials, the hybrid CH-1 produced higher per cent ripe leaf (55%) than

Table 5: Leaf ripeness in CH-1 (CTRI RS, Jeelugumilli 2007-08)

Cured leaf	Kanchan	CH-1
Mature to nearly ripe (%)	52	20
Fully ripe (%)	21	55
Total (%)	73	75

Table 6: Chemical quality traits in cured leaf of hybrid CH-1 at 'X' and 'L' positions (CTRI RS, Jeelugumilli)

Year		Nicotine (%)		Reducing sugars (%)		Chlorides (%)	
		X	L	X	L	X	L
2004-05	CH-1	2.42	3.30	17.8	14.0	0.29	0.21
	Kanchan	2.43	2.96	12.3	11.5	0.47	0.30
2005-06	CH-1	1.90	3.22	12.6	11.6	0.32	0.32
	Kanchan	2.00	3.12	13.2	10.4	0.40	0.39
2006-07	CH-1	2.33	3.32	15.2	13.6	0.22	0.19
	Kanchan	2.26	3.11	12.6	11.2	0.30	0.33

Table 7 : Smoke tar and carbon monoxide (mg/cigarette) levels in the hybrid CH-1 (2006-2007)

Parameter	Genotype	
	CH-1	Kanchan
X- Position		
Tar	26.4	26.8
Nicotine	2.61	2.54
Carbon monoxide	12.2	13.4
L- Position		
Tar	29.4	29.4
Nicotine	3.91	4.02
Carbon monoxide	12.4	12.4

Kanchan (21%) (Table 5). The percentage of nicotine, reducing sugars and chlorides in CH-1 recorded in station trial were on a par with Kanchan (Table 6). In smoke analysis of cigarettes, the hybrid CH-1 was rated higher than control in smoke characteristics (Table 7).

Analysis of flavour compounds using GC-MS showed that the entry CH-1 recorded higher values of neutral volatile compounds than the variety Kanchan (Table 8). In the storage and manufacturability test, the hybrid CH-1 was graded on a par with Kanchan in various parameters taken for the study (Table 9).

Reaction to major diseases and insect pests

Reaction of the hybrid CH-1 to tobacco mosaic virus, brown spot, cucumber mosaic virus, *Orobanche*, *Spodoptera litura, Heliothis armigera* and *Myzus nicotiana* under field conditions in NLS was found to be similar to Kanchan (Table 10).

Table 8: Analysis of flavour compounds in the hybrid CH-1 (2006-07)

Compound (mg/100 g cured leaf)	CH-1	Kanchan
Furfural	0.56	0.22
Solanone	2.96	3.02
Trans beta damascenone	1.47	0.96
Benzyl alcohol	0.62	0.78
Neophytadiene	60.42	45.65
Total megastigmatrienone	14.60	7.92

Table 9: Manufacturability of cured leaf of hybrid CH-1

Parameters	CH-1	Kanchan
Dimensions (mm)		
Cigarette	70.0	70.0
Circumference	24.47	24.49
Pressure drop (cm WG)		
Total cig. Open	5.0	5.4
Weight / Density		
Moisture content	13.3	13.1
Total cig wt.	0.879	0.839
Net wt of tob/cig.	0.829	0.790
Density at 13.5% MC	255	243
Paper		
Paper permeability (CU)	47.2	50.0
Physical quality		
Firmness at 13.5% MC	68.9	72.0
Filling value @ 13.5% MC (cc/10 g)	44.04	47.25
Sieve analysis (%)		
Quality ratio	90.87	87.89
Dust	3.02	3.78
EMC @ 64% RH	13.4	12.9

Table 10: Natural reaction to diseases, insect pests and *Orobanche* in CH-1 (CTRI RS, Jeelugumilli) (No. of planted observed = 120) (2008-09)

S.No.	Disease/Pest	No. of affected plants	
		CH-1	Kanchan
1	*Spodoptera litura*	20	20
2	*Myzus nicotianae*	5	5
3	*Helicoverpa armigera*	1	1
4	TMV	25	35
5	CMV	0	1
6	*Orobanche**	50	74

Natural infestation by *Orobanche* was severe during 2008-09 season

In all the evaluation trials, the proposed hybrid CH-1 out yielded the check variety Kanchan. Besides incremental yield, the hybrid CH-1 showed enhanced ripeness characteristics, higher grade index, good manufacturability and superior smoke profile over the ruling variety, Kanchan. These attributes besides helping the NLS farmer to achieve higher returns than with the existing variety, Kanchan, also increase the export potential of NLS tobacco so as to sustain it for an extended period. As a result of genetic homeostasis associated with hybrids, the hybrid CH-1 can exhibit stable performance over the different micro-zones of NLS area. In view of all the above mentioned positive traits, the hybrid CH-1 has been recommended by the Institute Research Council and the XIX AINRPT Workshop (Anonymous, 2009) for commercial release in Northern Light Soils of Andhra Pradesh and the release proposal has been submitted to the AP State Subcommittee on variety release.

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