Journal of Science and Technology 11(June 2013): 138-143

LONG TERM PERFORMANCE OF DIFFERENT CLONES FOR YIELD AND QUALITY TRAITS IN TEA

M. I. Hossain[1] and M. Sq. Rahman[2*]

[1]Principal Scientific Officer, Botany Division, BTRI, Srimangal, Moulvibazar, Bangladesh
[2]Department of Agricultural and Industrial Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

Received 10April 2012, revised 7 August 2012, accepted 12 August 2012

ABSTRACT

A long term experiment was carried out to investigate the yield and quality performance of four vegetatively propagated test clones of tea, namely Cha/J1/10, SH/B/6/59, SH/B/6/62 and A/8/24 during 1997-2010. Cuttings of the test clones were collected from the selected bushes of Chandpore, Shumshernugger and Amo Tea Estates and were raised at BTRI nursery. The saplings were put to long term yield and quality trial following Latin Square Design with 5 replications and the unit plot size was 25 m^2. The green leaves were harvested at one week interval during the plucking season starting from mid March to mid December in each year. Yield of green leaves at immature stage (2^{nd} – 5^{th} year) was highest in BT2 (331g/plant) but green leaves at mature stage (6^{th} - 13^{th} year) was maximum in A/8/24 (832g/plant). The results revealed that the test clone A/8/24 gave the highest yield of 3036 kg ha^{-1} compared to 2731 kg ha^{-1} made tea for the control BT2, 2613 kg ha^{-1} for Cha/J1/10, 2008 kg ha^{-1} for SH/B/6/59, 2121 kg ha^{-1} for SH/B/6/62 at mature stage (2002-2009). At immature stage (2^{nd} year to 5^{th} year after plantation) the highest made tea (1123 kg ha^{-1}) was estimated from the clone Cha/J1/10 and the yield differences amongst the test clones were insignificant. The overall cup quality of the test clones was assessed by conventional organoleptic test. The cup quality of all the clones including BT2 (control) was found to be above average. Twelve years (2^{nd} to 13^{th} year) data showed that the clone A/8/24 was the best in respect of yield and quality. Therefore, the outstanding clone, A/8/24 may be advanced for commercial exploration.

Key words: BTRI, cup quality, test clones, yield performance

INTRODUCTION

Tea is one of the most important cash crops in Bangladesh and south Asia. It is also an important food commodity of international trade. Tea is an important export item of Bangladesh accounting for about 0.81% of the GDP (BTB, 2010). The principal types of tea produced and consumed in the world are black and green tea with small amounts of other types. The summary of world tea production was 4,162 million kg in 2010 (ITC, 2011). Tea yield per hectare is quite low compared to other tea growing countries of the world, because a large portion of our tea area is covered with 60 year old plants which are unimproved varieties with low productivity. Moreover, a significant area of this old plantation has low plant population density resulting low yield and poor quality tea. The increasing cost of production along with adverse climatic condition has led to marginal economic return to the tea industry. In these circumstances, the industries need to replant and extend new tea areas with planting materials of higher yield and good quality. Due to the heterogeneous nature of tea seedlings, from the available seeds except biclonal stocks, could not expect higher tea production (Njuguna, 1990). Therefore, emphasis should be given on selection and plantation of vegetatively propagated high yielding quality clones for better yield and quality of tea (Dutta and Alam, 2001 and Hossain *et al.*, 2011).

Tea is propagated either by seeds or vegetative part like nodal leaf cutting. The progenies produced from nodal leaf cuttings are known as vegetative clones (Sana, 1989). Clonal selection is the most popular practice in tea for evolving better varieties. Potential plants are isolated from the seedlings that have been derived from superior varieties or breeding lines. Clonal selection is more or less same in all the tea growing countries (Visser and Kehl, 1958; Wight, 1961 and Barua, 1964). As tea plant is an allogamous species, a considerable variation of characters observes from bush to bush in existing seedlings and in separating progenies. Such variation can be exploited in a selection program to develop new tea varieties (Ranatunga, *et al.*, 2009). Cup quality is an inherent character and one of the most important considerations in selecting potential commercial cultivar. According to previous studies, rather than

**Corresponding author: M. Sq. Rahman, Department of Agricultural and Industrial Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh, Cell phone: +88 01713163319*

genetic inheritance, various factors such as climate /seasonal changes (Agarwal, 1989; Owuor and Othieno, 1991 and Botheju *et al.,* 2000), agricultural practices (Dutta, 1960 and Rahman *et al.,* 1978) and processing properties (Takeo, 1984 and Hajra, 2001) could determine the quality of tea. Besides, organoleptic or sensory evaluation is highly subjective and influenced by many factors which may not have been directly relation to quality (Biswas *et al.,* 1973). Although several methods are available to process green leaves from a single bush, the quantity is not adequate to a tea taster for an accurate estimation. About 500g green leaves are essential for organoleptic analysis (Ranatunga *et al.,* 2009). With an objective of evolving planting materials with high yield and quality potential BTRI has put its priorities on clonal selection and hybridization programme since its inception. The clonal selection programme was initiated by the institute in 1959 and hybridization programme in 1965 (Rashid and Alam, 1990). As an out come of these works, the institute has so far released eighteen vegetative clones in the BT-series to the tea industries (Hossain *et al.,* 2011). Few more test clones are in various stages of trial. The present experiment was carried out to study the long term yield and quality performance of four vegetatively propagated test clones of tea selected from Chandpore, Shumshernugger and Amo Tea Estates.

MATERIALS AND METHODS

The experiment was carried out with four test clones of tea in the experimental field of BTRI main farm, during the period from April 1997 to December 2010. The cuttings were collected from the selected bushes of Chandpore, Shumshernugger and Amo Tea Estates in 1996. Before collection of cuttings chloroform test was done in estimating fermentation rates of tea clones which influences on made tea quality (Sanderson, 1963 and Samaraweera and Ranaweera, 1988). This method was also used in early selection of quality cultivars in tea breeding programs (Seurei *et al.,* 1998 and Waheed *et al.,* 2001). After rooting trial in the nursery the selected test clones, namely Cha/J1/10, SH/B/6/59, SH/B/6/62 and A/8/24 were put to yield and quality trial during 1996 at BTRI Main Farm, Srimangal, Moulvibazar. The experiment was laid out in Latin Square Design with 105cm x 60cm spacing of a 5m x 5m plot. There were 25 plants plot^{-1}. BT2 was used as a standard (control) for yield and quality comparison. The experiment was conducted in rainfed condition. Fertilizers were applied at young and mature stages as per BTRI recommendations (Kibria and Uddin, 1998; Kibria and Rashid, 1994). Both young and mature tea plants were pruned followed as per BTRI recommendation (Shahiduzzaman *et al.,* 2002). Decentre-Prune-Skiff-Prune-Skiff was applied for tea plants and Light Prune-Deep Skiff-Medium Skiff-Light Skiff was for mature tea plants (Rashid, 1986). The green leaves were harvested at one week interval throughout the plucking season, starting from mid March to mid December in each year. Yield of green leaves were recorded and analysed statistically in MSTAT programme. The mean values were separated by DMRT. Yield of green leaves g plant^{-1} was separately obtained at immature (2nd - 5th year) and mature (6th - 13th year) stages. The made tea (kg ha^{-1}) was also calculated on the basis of 23% recovery from green leaves against 15875 plants at 105 cm x 60 cm spacing. The quality performance of all the test clones including the control were assessed after manufactured by CTC (Crushing, Tearing and Curling) method in the BTRI mini tea factory. General characteristics of four test clones and BT2 are given in Table 1 and the categories of tea clones as yield, standard and quality clones is shown in Table 2.

RESULTS AND DISCUSSION

The mean yield of green leaves (g plant^{-1}) over the experimental years for immature stage (2nd -5th year) and mature stage (6th-13th year) are presented in Table 3 and in Table 4 respectively. Green leaf yield was converted into made tea (kg ha^{-1}). The converted means for immature stage and mature stage are presented in Table 5 and Table 6 respectively. From Table 3 it was revealed that at initial growth stage of all the test clones produced same yield as control (BT2) but when the data were analysed year wise, their yield differences were significant except 2nd year. Although the test clones varied significantly when data were analysed over the years (average yield). At immature stage (2nd - 5th year) the highest average yield (1207.31 kg ha^{-1}) was obtained from the standard clone BT2, (Table 5). After maturity, the standard productivity level in the years of 6th, 7th, 8th, 9th, 10th, 11th, 12th and 13th yield variations were significant on the average of 8 year production; the test clone A/8/24 gave significantly higher yield over control BT2 (Table 4). The test clone A/8/24 showed statistically superior over the control BT2 in every year from 6th to 13th years (Table 4). The test clone A/8/24 gave significantly higher yield (3036.35 kg ha^{-1}) followed by Cha/J1/10 (2613.36 kg ha^{-1}), SH/B/6/62 (2121.20 kg ha^{-1}) and SH/B/6/59 (2007.94 kg ha^{-1}) whereas the control BT2 produced of 2730.64 kg ha^{-1} (Table 6). Thoroughout the experimental period test clone, A/8/24 maintained higher trend of yield over the control (Table 6).

Table 1. General Characteristic of selected test clones and BT2

Clone	Bush characters	Leaf type	Pruning recovery	Nursery rooting	Cup quality
Cha/J1/10	Assam,Light leaved vigorous, semi-orthotropic, good girth, fairly compact	Medium to large, light green with prominent pointed apex, semi erect	Good	Good	Above average
SH/B/6/59	Assam hybrid, medium bush,vigorous,orthotropic grower with good spread, quite compact plucking table.	Medium to large, semi dark green, erect, pointed apex.	Good	Good	Above average
SH/B/6/62	Assam hybrid, big bush, heavy girth, good grower with semi-orthotropic, and profuse branching	Medium, slightly broad, light green, semi erect, prominent leaf apex.	Good	Good	Above average
A/8/24	Assam hybrid, medium bush, vigorous orthotropic grower with a very good spread forming dense plucking table.	Large and broad, light green, glossy, semi-erect, serrated margin, not so prominent leaf apex.	Good	Good	Above average
T5-BT2 (Control)	Assam hybrid, orthotropic grower with a very good spread forming dense plucking table.	Medium to large, light green, glossy, erect, serrated margin, prominent leaf apex.	Good	Good	Above average

Note: Pruning recovery & Nursery rooting: Excellent, very good, good, fair/moderate
Cup quality: Excellent, Above average, Average, Below average.

Table 2. Category of tea clones

Category of clones	Yield clone	Standard clone	Quality clone
Yield	>4000 kg^{-ha}	3000-4000 kg^{-ha}	2500-3000 kg^{-ha}
Cup Quality	AA or A*	AA*	E*

* Quality score: E = Excellent (34 to >34 out of 50) , AA = above average (32 to <34 out of 50), A = average (30-32 out of 50), BA = Below Average (<30 out of 50)

Table 3. Mean yield of green leaves (g $plant^{-1}$) at immature stage (2^{nd} –5^{th} year)

Year / Clone	2^{nd} Year Prune 1998	3^{rd} Year Skiff 1999	4^{th} Year Prune 2000	5^{th} Year Skiff 2001	Average (g $plant^{-1}$)
Cha/J1/10	110.00	274.35	448.02	398.54	307.72
SH/B/6/59	99.14	233.56	272.21	278.01	220.73
SH/B/6/62	100.74	230.66	326.39	374.43	258.05
A/8/24	129.98	347.83	360.08	405.96	310.96
BT2	114.59	267.91	424.16	516.16	330.70
LSD at 0.05	NS	68.47	92.53	128.95	96.65

Table 4. Mean yield of green leaf (g/plant) at mature stage (6^{th} –13^{th} year)

Year / Clone	6^{th} Year LP 2002	7^{th} Year DSK 2003	8^{th} Year MSK 2004	9^{th} Year LSK 2005	10^{th} Year LP 2006	11^{th} Year DSK 2007	12^{th} Year MSK 2008	13^{th} Year LSK 2009	Average (kg ha^{-1})
C/J1/10	517.57	658.66	747.44	831.49	578.66	730.97	821.19	840.7b	715.83
SH/B/6/59	316.88	451.32	596.81	679.75	354.76	543.59	665.36	791.5b	550.00
SH/B/6/62	411.57	575.48	637.75b	696.65	434.58	583.09	616.74	692.5	581.02
A/8/24	535.01	837.46	936.52	973.32	566.79	900.58	927.87	976.1	831.69
BT2	517.66	654.34	756.42	804.17	565.83	837.67	900.16	947.2	747.96
LSD at 0.05	79.35	89.11	118.93	102.27	111.44	135.9	116.7	156.1	113.73

Table 5. Estimated made tea (kg ha^{-1}) at immature stage (2^{nd} – 5^{th} year)

Year / Clone	2^{nd} Year Prune 1999	3^{rd} Year Skiff 2000	4^{th} Year Prune 2001	5^{th} Year Skiff 2002	Average (kg ha^{-1})
Cha/J1/10	401.58	1001.59	1635.63	1454.98	1123.44
SH/B/6/59	361.94	852.68	993.78	1014.96	805.84
SH/B/6/62	367.78	842.09	1191.58	1366.97	942.10
A/8/24	474.54	1269.85	1314.58	1482.08	1135.26
BT2	418.35	978.08	1548.52	1884.39	1207.31

Table 6. Estimated made tea (kg^{-ha}) at mature stage (6^{th} –13^{th} year)

Year / Clone	6^{th} Year LP 2002	7^{th} Year DSK 2003	8^{th} Year MSK 2004	9^{th} Year LSK 2005	10^{th} Year LP 2006	11^{th} Year DSK 2007	12^{th} Year MSK 2008	13^{th} Year LSK 2009	Average (kg ha^{-1})
Cha/J1/10	1889.54	2404.63	2728.75	3035.61	2112.57	2668.62	2998.00	3069.2	2613.36
SH/B/6/59	1156.86	1647.68	2178.84	2481.64	1295.16	1984.54	2429.00	2889.85	2007.94
SH/B/6/62	1502.56	2100.96	2328.3	2543.34	1586.56	2128.74	2251.00	2528.18	2121.2
A/8/24	1953.21	3057.43	3419.05	3553.41	2069.24	3287.83	3387.00	3563.7	3036.35
BT2	1889.87	2388.86	2761.54	2935.9	2065.73	3058.16	3286.00	3459.1	2730.64

Table 7. Cup quality of different test clones (Average score of 10 years, from 2001 to 2010)

Test Clone	Infusion (10)	Liquour colour (10)	Briskness (10)	Strength (10)	Creaming down (10)	Total	Over all Quality
Cha/J1/10	7.49a	7.32a	7.38a	7.24a	3.12a	32.54a	AA
SH/B/6/59	7.39a	7.44a	7.53a	7.33a	2.99ab	32.65a	AA
SH/B/6/62	7.28a	7.56a	7.29a	7.24a	2.91ab	32.60a	AA
A/8/24	7.44a	7.35a	7.51a	7.32a	2.97ab	32.62a	AA
BT2	7.49a	7.37a	7.36a	7.34a	2.74b	32.27a	AA

Within column values followed by different letter (s) are significantly different by DMRT ($p \leq 0.05$)

Overall quality performance of the test clones and control BT2 was assessed by conventional organoleptic test (Table 7). It was observed that the cup characters of all the test clones were categorized as "Above average" (having 32 to less than 34 quality score out of 50 is considered as above average quality) while BT2 showed also above average cup quality. The four test clones consistently produced tea of above average quality and had bright infusion, coloury liquour with useful strength and briskness. (Table 7)

CONCLUSION

Considering the yield performance and quality standard throughout the study period compared to the control BT2, the test clone A/8/24 appeared superior may be released as a standard clone. The other test clone, Cha/J1/10 was also prospective in quality characters and yield and can be used as an alternative standard clone or may be maintained as a valuable breeding stock.

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