

Genetic improvement of *Musa* sp. through clonal selection : NRCB Sel. 001 a better substitute for Indian Pisang Awaks (ABB)

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ABSTRACT

Performance of NRCB Sel. 001 was compared with cvs. Karpuravalli of Tamil Nadu, Kanthali of Bihar, Boodida Bokkisa of Andhra Pradesh and Boodi Bale of Karnataka. It was concluded that NRCB Sel. 001 excelled for all the important parameters contributing to yield, 1), pseudostem girth (96.8cm), which makes it as an ideal cultivar for wind prone areas, 2), leaf area (13.852 sq. cm), contributing for the higher yield, 3), higher bunch weight (35.0 kg), more number of hands per bunch (18.4) and more number of fingers per hand (17.3), which have been reflected in the higher yields, 4) well spaced hands defining a cylindrical shape, which facilitates packing, loading and transport with minimal damage. NRCB Sel. 001 also exhibited better fruit quality. The best sugar-acid blend and yellow-life enhanced its preference by the consumers and Kanthali ranked second in terms of performance and yield. These results suggest that NRCB Sel. 001 can very well be also a substitute for local Pisang Awak clones like Boodida Bukkisa, Boodi Bale, local Karpuravalli and Kanthali and most suited for wind prone areas.

Key words: Clonal selection, genetic improvement, NRCB Sel. 001, Pisang Awak (ABB).

INTRODUCTION

Banana is a delicious fruit with high nutritive value owing to its rich and easily digestible carbohydrates (Simmonds, 10). Banana and plantains play a vital role in the predominantly agri-based Indian economy. India is the largest producer of bananas with 16.4 mt of production contributing to 15% of total world production. Emerging pest and disease problems and growing population pose threat to the present day cultivation (Rodriguez, 9). This necessitates the strengthening of breeding programme to develop improved cultivars. However, banana is a recalcitrant crop for conventional breeding owing to its inherent problems like triploidy, sterility and parthenocarpic nature.

However, clonal selection, offers ample scope for the genetic improvement of agronomically elite clones and still remains a viable approach. Thus, single plant selection method was exploited in evolving NRCB Sel. 001. This single plant selection was made during the evaluation of location specific clones of the subgroup Pisang Awak (ABB) at NRCB field genebank (Anon, 1). Since the selection was found to give a higher and stable yield with better bunch qualities, it was subjected for *in-vitro* multiplication and evaluated further at NRC for Banana, Tiruchirapalli, Tamil Nadu.

Pisang Awak (ABB) subgroup offers a group of clones which are hardy, suitable to marginal soils, tolerant to low temperature, grown in all altitudes ranging from 50 to 1,400 m above MSL. These qualities of Pisang Awak members have enabled them to grow

in a wide range of geographic locations from southern states upto Arunachal Pradesh including Andaman and Nicobar Islands (Singh and Uma, 11). However, many states are still thriving on poor yielding local Pisang Awak cultivars for their livelihood. Hence, the present study was aimed at identifying a suitable high yielding substitute (NRCB Sel. 001) for Pisang Awak local cultivars.

MATERIALS AND METHODS

An evaluation trial was conducted at NRCB farm, Podavur, Trichy to assess the superiority of NRCB Selection 001 over other members of the same group viz., local Karpuravalli, Kanthali of Bihar, Boodida Bukkisa of Andhra Pradesh and Boodi Bale of Karnataka in terms of growth, yield, quality and reactions to major diseases.

The experimental field is situated between 11.50°E latitude and 74.50°E longitude at an altitude of 90 m above msl receiving an annual precipitation of about 800-900 mm from both North-East and South-West monsoons. The soil type is fine, mixed hyperthermic, silty clay loam (Typic-Haplustepts) with pH ranging from 7.5 - 8.0.

Suckers of uniform size (0.6 - 0.75 kg) were treated with a solution containing 0.1 % each of monocrotophos and bavistin for 15 min. and planted at a spacing of 2 m x 2 m. At the time of planting, furadon was added @ 15 g per plant. Since it is in wet-land system of cultivation, trench opening was done immediately after planting in such a way that beds of dimension 8 m x 4 m are formed and each bed consisted of eight plants.

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Trench deepening was done once in 15 days after planting and another after 3 months of planting. Trench deepening was normally followed by bed-digging that actually takes care of the weed problem.

Regular desuckering was done right from the time of shooting. Fertilizers were given in 3 split doses, i.e. during 3rd, 5th and 7th month after planting. During 3rd month, 100 g of urea, 300 g of super phosphate and 150 g of potash were applied, while during 5th month, 100 g of urea, 150 g of potash and 3-5 kg of vermicompost were applied, during 7th month 50 g of urea, 150 g of potash were applied and a final dose of 100 g potash was applied after flowering.

The experiment was laid out in a randomized block design with four replications. Plant height, pseudostem girth (5-10 cm above soil), petiolar length, number of leaves at the time of shooting and harvesting, leaf area, time taken for shooting and bunch maturity, bunch weight, number of hands per bunch and number of fingers per hand were the agronomic variables recorded at appropriate times. Quality parameters namely, TSS, acidity, green-life, yellow-life and pulp : peel ratio of the test cultivars were also studied. The response of cultivars to Yellow Sigatoka was also appraised at flowering stages. The data were analysed statistically using the software B-STAT. Plant height was measured from 10 cm above the base of the pseudostem to the axil of the youngest leaf and expressed in cm. The girth of the pseudostem was measured at 30 cm height from the ground level and expressed in cm.

The leaf area was calculated by multiplying the product of leaf length and width at the broadest part of the third leaf by the factor 0.8 (Murray, 7) and expressed in cm².

RESULTS AND DISCUSSION

There was a significant difference with respect to plant height among all five test clones (Table 1). Boodida Bukkisa was the shortest with 3.58 m and the tallest was Local Karpuravalli with 3.99 m. NRCB Sel. 001 was medium with 3.77 m. Similarly, pseudostem girth also exhibited significant differences among the test clones. The least was recorded in Boodibale with 85.1 cm, while Boodida Bukkisa and local Karpuravalli were on par with each other. NRCB Sel. 001 exhibited a maximum pseudostem girth of 96.8 cm. Plant height and pseudostem girth contribute to the overall stature of the plant. Tall cultivars are generally prone to strong winds during the off season (Jones, 6). Considering these two parameters, local Karpuravalli, Boodi Bale and Boddida Bukkisa offer thin and tall stature, which makes them more susceptible to strong winds. While NRCB Sel. 001 with medium plant height of 3.77 m and maximum pseudostem girth of 96.8 cm exhibited

robust stature conferring tolerance to strong winds and less in need of propping. Propping is one of the important field operations, which contributes approximately 15% of the total production cost of banana.

The leaf petiolar length also differed significantly among the varieties. The least was expressed by Boodi Bale with 75.4 cm and other varieties Boodida Bukkisa and local Karpuravalli were on par with each other. NRCB Sel. 001 and Kanthali exhibited higher petiolar length of 87.3 and 86.1 cm, respectively. Generally petiolar length decides the extent of leaf spread around a plant. Usually, *acuminata* diploids exhibit shorter petiolar length, leading to erect leaf orientation. Though the test accessions were ABB triploids and exhibit an overall better leaf spread. Among the test accessions, NRCB Sel. 001 had the maximum leaf spread owing to highest petiolar length. This indirectly helped better exposure of leaves to sunlight without much of overlapping, which eventually helped in better photosynthetic activity.

The number of leaves at shooting exhibited non-significant differences among the test accessions. However, the maximum of 19.7 leaves was produced by NRCB Sel. 001 and minimum of 17.2 was produced by Boodida Bukkisa. Significant differences existed among the cultivars for leaf area. Similarly, maximum photosynthetic leaf area of 13, 852 cm² was recorded by NRCB Sel. 001. This might have contributed for the higher yield because light interception by the leaf surface has been reported to be one of the important factors governing the ultimate yield in banana and plantains (Yoshida, 14; Cayon, 3).

Leaf area was minimum in Boodi Bale (10,940.4 cm²), which was on par with local Karpuravalli. These parameters like petiolar length, number of leaves at shooting, number of leaves at harvest and total leaf area contribute to a greater extent for better vegetative growth and eventually good yields. NRCB Sel. 001 exhibited all desirable attributes like maximum petiolar length, leading to better leaf spread, recording highest number of leaves both at shooting and harvest and maximum photosynthetically active leaf area.

The number of days taken for shooting also differed significantly among the test cultivars. Boodi Bale was the earliest to shoot (288.5 days), while Local Karpuravalli recorded the maximum of 354.8 days. Irrespective of the days taken for shooting, days taken for bunch maturity did not show any significant differences among the cultivars evaluated. However, the least was recorded with Boodi Bale (102.2 days) and maximum with Kanthali (109.5 days). But the overall crop duration exhibited significant differences, where none of the test cultivars were on par with each other. Boodibale exhibited shortest crop duration of

Table 1. Evaluation of NRCB Sel.001 with other local cultivars for growth parameters.

Cultivar	Plant height (m)	Pseudostem girth (cm)	Petiole length (cm)	No. of leaves at shooting	No. of leaves at harvest	Leaf area (sq. cm)	Days taken for shooting	Days taken for bunch maturity	Crop duration (days)
Kanthali	3.61	90.9	86.1	16.9	7.9	11,892.4	311.3	109.5	420.8
Boodida Bukkisa	3.58	87.2	77.2	17.2	9.5	11,632.2	301.5	108.5	410.0
Boodi Bale	3.94	85.1	75.4	17.3	9.4	10,940.4	288.5	102.2	390.7
Local Karpuravalli	3.99	85.7	77.0	17.3	9.3	11,240.6	354.8	105.3	460.1
NRCB Sel. 001	3.77	96.8	87.3	17.9	10.0	13,852.4	302.4	103.4	405.8
CD (P = 0.05)	12.44	2.3	2.48	NS	0.89	639.19	7.19	NS	4.33

390.0 days followed by NRCB Sel. 001 (405.8 days). Local Karpuravalli recorded the longest crop duration of 460.0 days.

Boodi Bale was the earliest with regard to days to shooting, bunch maturation and overall crop duration. This was followed by NRCB Sel. 001. Crop duration is an important trait governed by genotypic, phenotypic and environmental factors along with their interactions. In Indian production system, Pisang Awaks (all the test accessions) are maintained for one crop and two ratoons, which are expected to be completed by three years. Any variety with longer crop duration fails to fit into the three year production cycle.

In banana, number of hands per bunch, number of fingers per hand, finger length and bunch weight contribute to the total yield components. Bunch weight exhibited significant differences among the test cultivars evaluated. Boodida Bukkisa recorded the least 13.8 kg followed by Boodi Bale (18.0 kg), which was on par with local Karpuravalli. Kanthali recorded 23.9 kg and the maximum bunch weight of 35.0 kg was recorded by NRCB Sel. 001. The number of hands per bunch was also statistically significant, least was recorded by Boodi Bale and Local Karpuravalli each with only 11.1 hands per bunch. This was followed by Boodida Bukkisa and Kanthali, while 13.6 hands per bunch was recorded by NRCB Sel. 001. The number of fingers per hand was also statistically significant. However, all

the test cultivars were on par with each other except NRCB Sel. 001, which produced a maximum of 17.3 fingers per hand. Finger length was also found to be statistically significant among the test cultivars. The least finger length of 14.3 cm was recorded by Boodi Bale followed by Kanthali and local Karpuravalli, which were on par with each other. NRCB Sel. 001 recorded a maximum of 16.2 cm.

The results of yield attributes suggest that NRCB Sel. 001 was the best with highest bunch weight, maximum number of hands per bunch, highest number of fingers per hand and maximum finger length.

The internodal length refers to space between two successive hands on a bunch and it decides the total height and quality of the bunch, eventually that of the fingers in a bunch. Higher internodal spacing offers more space for hand spread, finger orientation and finger development. NRCB Sel. 001 offered a maximum internodal length of 16.1cm followed by Kanthali (15.8 cm) and the least was recorded by local Karpuravalli (12.5 cm). Probably this feature has contributed to the geometric orientation of hands on the bunch peduncle, complete development of fruit, defining a cylindrical shape to the bunch with an orientation parallel to the peduncle and making it less prone to bruises during transport, facilitating packing and loading (Daniells, 4). This trait is usually exhibited in export oriented Cavendish clones like Novaria, Williams, Grand Naine, etc.

Table 2. Evaluation of NRCB Sel.001 with other local cultivars for yield parameters.

Cultivar	Bunch weight (kg)	Number of hands per bunch	Number of fingers per hand	Finger length (cm)	Internodal length (cm)
Kanthali	23.9	14.4	14.9	15.1	15.8
Boodida Bukkisa	13.8	13.6	15.0	16.1	14.1
Boodi Bale	18.0	11.1	14.6	14.3	13.2
Local Karpuravalli	18.2	11.1	14.7	15.5	12.5
NRCB Sel. 001	35.0	18.4	17.3	16.2	16.1
CD (P = 0.05)	2.28	0.77	0.88	0.49	0.45

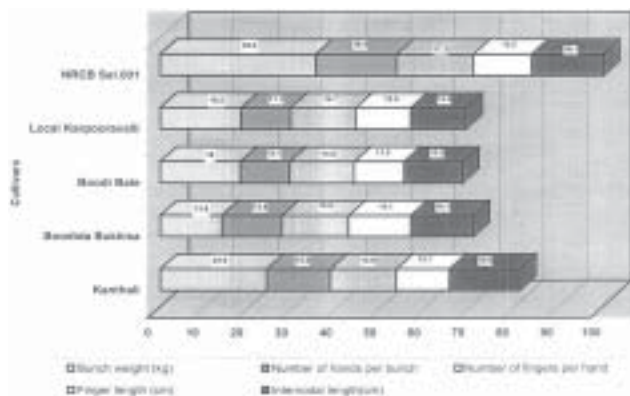


Fig. 1. Evaluation of NRCB Sel.001 and other local cultivars for yield parameters.

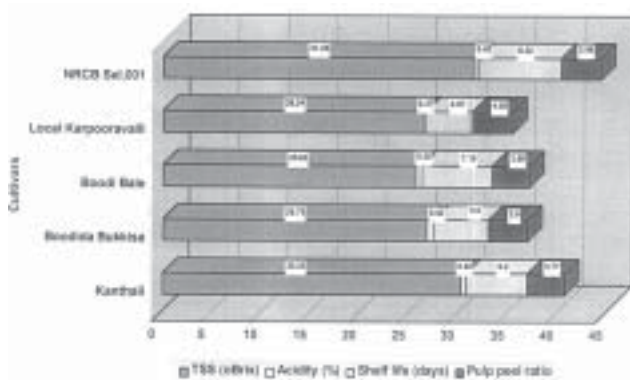


Fig. 2. Evaluation of NRCB Sel.001 and other local cultivars for quality parameters.

Significant differences existed among the test cultivars for all the traits evaluated. The highest TSS of 31.55 °Brix was registered in NRCB Sel. 001 followed by 30.25 °Brix (Table 3) and the lowest TSS of 25.63 was registered in Boodi Bale. Acidity was minimum in Local Karpuravalli (0.37 %) closely followed by NRCB Sel.001 (0.42 %), while the maximum acidity was recorded in Boodida Bukkisa. Green-life, is very vital in determining the suitability of a variety to long distance transportation. The statistically non significant results suggest that all varieties are suitable uniformly for long distance transportation. Maximum yellow-life was exhibited by NRCB Sel. 001 (8.32 days) followed by Boodi Bale (7.15 days). The minimum yellow-life was noticed in Local Karpuravalli (4.67 days). The pulp : peel ratio was lowest in Boodi Bale followed by Kanthali and highest ratio of 4.05 was registered in Local Karpuravalli.

Edible fruit quality in a broad sense depends on TSS, acidity and their blend. Of the four cultivars evaluated Boodida Bukkisa recorded a poor blend of 26.95 °B TSS and 0.62 % acidity making it less preferred over others. This was followed by Boodi Bale. NRCB Sel. 001 and Kanthali exhibited the best blend of high TSS and medium acidity making them highly suitable for dessert purpose and preparation of value added products (Anon, 2).

Similarly, higher pulp:peel ratio is desirable and in general, thin skinned cultivars like Silk (Malbhog), Ney Poovan (Elakki Bale) and Pisang Awak members

Table 3. Evaluation of NRCB Sel. 001 with other local cultivars for quality parameters.

Cultivar	TSS (°Brix)	Acidity (%)	Green-life (days)	Yellow-life (days)	Pulp : peel ratio
Kanthali	30.25	0.45	5.25	6.20	3.77
Boodida Bukkisa	26.75	0.62	5.52	5.61	3.90
Boodi Bale	25.63	0.55	5.74	6.15	3.69
Local Karpuravalli	26.24	0.37	5.55	4.67	4.05
NRCB Sel. 001	31.55	0.42	5.95	6.82	3.98
CD (P = 0.05)	0.60	0.05	NS	0.20	0.07

Table 4. Evaluation of NRCB Sel.001 with other local cultivars for specific traits.

Genotype	Fruit position	Fruit shape	Flesh texture	Pedicle length (mm)	Fruit spacing on hand
Kanthali	Parallel to the stalk	Straight	Firm	≥ 21	Well spaced
Boodida Bukkisa	Parallel to the stalk	Straight	Firm	11-20	Medium spaced
Boodi Bale	Curved upward at an angle of 45°	Straight	Firm-medium	11-18	Proximal ends touch each other
Local Karpuravalli	Curved upward at an angle of 45°	Straight	Firm-medium	11-18	Proximal ends touch each other
NRCB Sel. 001	Parallel to the stalk	Straight	Firm	≥ 21	Well spaced

Table 5. Reaction to fusarium wilt (*Fusarium oxysporum* f.sp. *cubense* race 1) and yellow sigatoka (*M. musicola*).

Cultivar	Youngest leaf spotted	Disease severity	Reaction to fusarium wilt
Kanthali	34.52	9.31	+
Boodida Bukkisa	36.57	8.13	+
Boodi Bale	41.18	4.49	+
Local Karpuravalli	31.38	12.17	++
NRCB Sel. 001	35.86	9.03	+
CD (P = 0.05)	0.38	0.15	-

(+ : Susceptible ; ++ : Highly susceptible)

exhibit a ratio more than 2.5. In the present study also NRCB Sel. 001 exhibited a high pulp : peel ratio only next to Local Karpuravalli but were statistically on par with each other.

Green- and yellow-life together contribute for the total shelf-life of banana. Though green-life among test cultivars was statistically non-significant, longest green-life of 5.95 days was exhibited by NRCB Sel. 001. NRCB Sel. 001 exhibited an overall highest shelf-life of 12.77 days followed by Boodi Bale (11.89) and Kanthali (11.45).

Highly significant differences existed among the cultivars evaluated for Youngest Leaf Spotted (YLS) and disease severity (Table 5). The youngest leaf spotted was 41.12 in Boodi Bale and 36.58 in Boodida Bukkisa followed by NRCB Sel. 001 (35.89). Similarly, the disease severity was minimum in Boodi Bale (4.50) followed by Boodida Bukkisa (8.1) and NRCB Sel. 001 (9.05).

Boodi Bale was found to be more tolerant among the Pisang Awak test cultivars evaluated in terms of YLS and Disease Severity (DS), while local Karpuravalli was more susceptible. NRCB selection exhibited medium tolerance with 35th leaf exhibiting leaf spotting due to Sigatoka incidence and disease severity being only 9.03. This attribute in combination with more number of leaves at shooting and at harvest, better leaf spread owing to increased petiolar length assisted in enhanced photosynthetic area, higher assimilation eventually resulting in increased yield.

General observations on field susceptibility to *Fusarium oxysporum* f.sp. *cubense* indicated that, Local Karpuravalli was the earliest to succumb to FOC. race 1 compared to all other test cultivars.

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