

## Field Evaluation of Selected Off-type and Elite Micro-propagated Banana Plants for its Characterization & Identification

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### ABSTRACT

Employee's performance is the major concern in every organization. Performance Appraisal is the vital Human Resource practices administered in many organizations with the goal of improving the individual performance of employees and thereby ensure the organizational effectiveness. The operationalisation of the concept of performance appraisal is different from one company to another, one industry to another and one sector to another sector. Similarly the performance appraisal practice of one country is different from one another. The nature and type, management styles, workforce behavior, working environment, regulatory mechanisms, etc are varied from one nation to another. HR practices are also different from one another. The Performance appraisal practice is a multi dimensional global initiative. The concept, methods, employee perception, methodology, technology, culture, legislations, etc are influenced by a Performance appraisal system. Hence the performance appraisal practices of each and every country having significant difference in the operationalisation level. This article aimed to identify the significant differences in the operationalization of the concept of employee performance appraisal of different countries. This study mainly aims in standardization of parameters to select and reject field planted banana as mother plant for initiation of stock culture for micro-propagation. For this study Grandnaine clone was selected and collected from four different agro-climatic zone of Chhattisgarh state and original clone of Grandnaine imported from Israel, was also taken for control check. All of these clones were initiated in the production facility of ABLR, Raipur and stringent quality check were performed during each stage of in-vitro as well as hardening stages for detection of any variants along with normal plants. These variants (mainly off-type plants) with normal plants were subjected to field evaluation for development of criteria of selecting mother plant. All the four selection of genotype were named as BHM (Bhimori), BAT (Bhatagaon), DRG (Rajnadgaon) and GA (Achouti) respectively according to their site of collection, along with a control and Off-type. Now these clones were then categorized into normal (N), Vigorous (V) and Poor (P) during the hardening stage along with control which also include 3 categories, but except off-types which had only normal plant suggesting as variants in their appearance. Under the field condition GA clone which was derived from a field selection done at Achouti farm proved to be the best one in terms of vegetative growth and fruit yield. In field evaluation it suggests that out of all other clones GA could be the better option for further multiplication according to climatic condition of Chhattisgarh. Three categories of off-type plants which were studied in the experiment viz. Variegated leaves, Deformed Pseudostem and Deformed leaves, out of these only variegated leaves remained off-type throughout while others got recovered soon after planting suggesting only epigenetic variation. This confirmed the characteristics of off-type plants not be included in the criteria for mother plant selection of banana.

**Keywords:** Grand naine, Micro-propagation, Off-types, Mother Plant and Somaclonal Variation.

### Introduction

Banana is most widely grown fruit crop in tropical and subtropical regions (Kalloo, 2002; Singh, 2002) and micro-propagated banana planting material offers several advantages over vegetative propagation. Somaclonal variations, either genetic or epigenetic in nature, have been considered an integral part of in-vitro regeneration process. In vitro micropropagation is widely applied for mass production of pest-free banana suckers (Banerjee and De Langhe, 1985; Talengera et al., 1994). Somaclonal variants are an important source of genetic variation especially in vegetatively propagated plants and have been used as a tool for plant improvement as well as development of new varieties (Cullis, 1992; Karp, 1993; Cassells *et al.*, 1999). These variations are often undesirable in a TC industry where the main aim is production of 'true to type' plants. Characterization of elite variants for traits superior to mother plants in terms of yield, fruit quality, resistance to biotic or abiotic stresses and higher regeneration efficiency in TC media might lead to development of new cultivar. Dwarf Cavendish, Grand Naine Israel, Lancefield, Chinese Cavendish are some of the proven examples where somaclonal variants/mutants have been characterized, selected and released

as new variety in different parts of the world. However, some of the somaclonal variants also show characteristic feature inferior to the mother plants and causes heavy yield and economic loss to farmers as well as TC industry. It is therefore important to characterize, select and assess the somaclonal variants for presence of off-types traits observed during in-vitro regeneration or in farmers' field. Genetic fidelity of tissue culture raised plants (banana, sugarcane, potato, papaya, vegetables) is critical to determine their yield and field performance. However the undesirable off-types (ranging from 3-25%) also cause significant economic loss to plant tissue culture industry and yield loss to farmers (Vasane et al., 2009; Stover, 1987). Considering the economic losses incurred due to planting of poor quality planting material and ambiguous genetic fidelity DBT has mandatory guidelines to test genetic fidelity of in-vitro regenerated plants (NCS-TCP, 2008). Any system, which can significantly reduce or eliminate variation generated during tissue culture, can be of much practical utility. Traditionally, morphological description, physiological supervision, karyological analysis, biochemical estimations and field assessment were used to detect any types of genetic variations. Since most of the plant and fruit characters are governed by many genes having additive or interactive effects, they show significant influence of the environmental factors and therefore precise identification of actual genetic variants remains highly subjective. Morphological description, physiological supervision, karyotyping, biochemical estimations and field assessment have been used conventionally to describe and characterize such somaclonal variants.

### Material and Methods

Present study was conducted in the research and development fields of Adithya Biotech Lab & Research Pvt. Ltd. during the year 2016-17. For selection for planting material first and foremost the plants from in-vitro stages selected for variant characteristics and further continued their observation selection in the hardening stages as well.

The elite and poor growing plants were indentified on the basis of no. of leaves/plant, leaf area index and plant height as per the following observations:

1. **Leaf Area Index:** The top three leaves are considered to involve in major photosynthesis activity in banana plantlets. Therefore leaf area of these leaves was recorded to assess biomass growth of banana plants and identify plant showing higher biomass assimilation.
2. **No. of green leaves per plant:** The new leaf emerges in every 5 – 8 days in banana plantlets. Rapid emergence of each new leaf reveals growth vigor of the plantlets. Thus no. of leaves per plant was recorded in seven days interval.
3. **Plant Height:** The length of pseudostem from base to the axis of emergence of top most leaf was recorded. The increase in plant height of each selected plant was recorded in each week.
4. Shorter pseudostem
5. Delayed emergence of new leaves,
6. Poor growth,
7. Variegated leaves,
8. Thicker leaf lamina,
9. Deformed leaves

On the basis of above observed characters a total of 252 plants were selected from secondary hardening stage including 84 vigorous healthy plants and 84 plants showing off-type growth. And another 84 plants were selected showing normal characteristics.

Plantlets of selected as vigor, normal and off-type categories from all the four clones obtained from *in vitro* technique were hardened and subsequently planted in open field for further field studies. The selected vigor, normal and poor plants including original Grand naine clone from Israel have also been planted in field for growth and yield studies. A total of 5 clones, one control, original Grand naine and 1 off type line were planted using randomized block design with three replications as shown in figure.1. Details of the experiment are as follows:

**Replications: 3**

**No. of plants: 12 /replication/treatment**

**Date of Planting: 15/6/2016**

**Total no. of plants: 252**

All the clones after planting on to the field according to the randomized block design were observed for all the growth related characteristics like, Plant height, pseudostem girth, Leaf area index, days to flowering and fruit yield. The observations of all the categories and clones were taken in equal interval of time till the harvest was done. Fruit yield parameters included various fruit characteristics like Bunch weight (kg), Average number of fingers per bunch, average number of hands per bunch and days it took to flower from

the date of planting. These characteristics were observed at the time of harvest giving clear picture of the plants to be selected as better mother plant for initiation of stock cultures for its mass multiplication in in-vitro level.

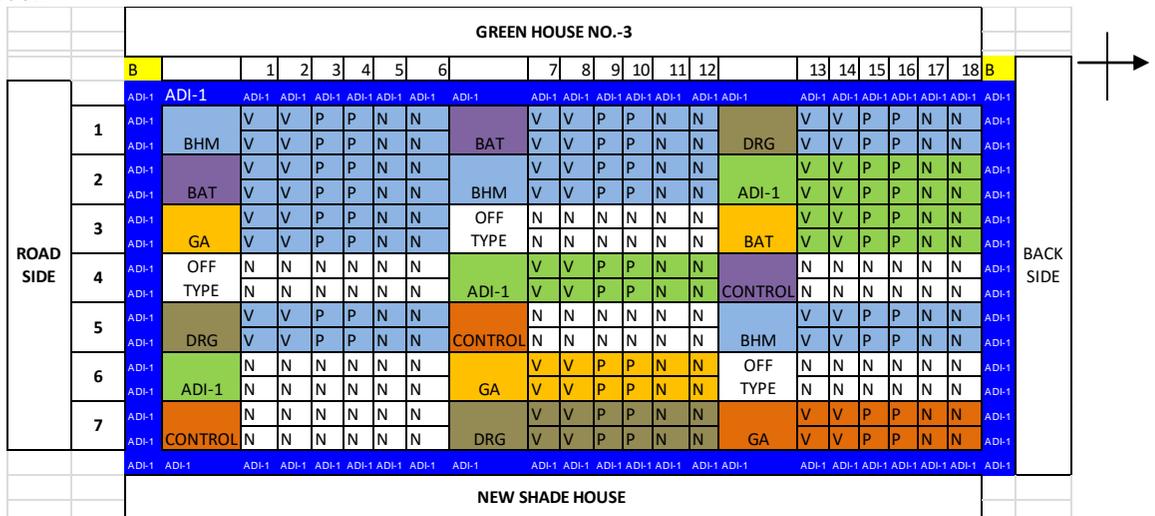


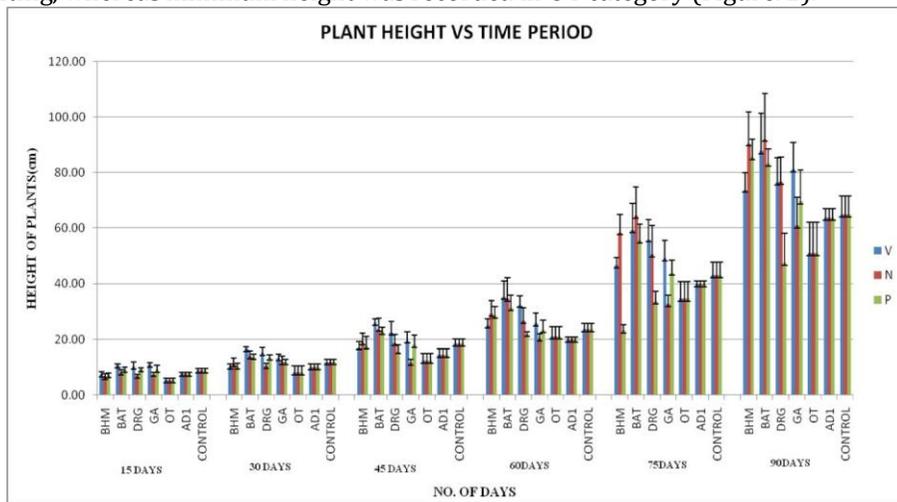
Figure.1 Experimental Field Layout.

During the experiment of field performances of the entire done the plants were given equal treatment of fertilizers. Regular application of weedicides and insecticides were applied to get optimum utilization of nutrients.

**Results and Discussion**

In tissue culture of any plant species production of true to type plants is very detrimental to ensure quality planting material to the end user and better quality of produce. These variation in planting material and loses in the produce can be easily minimized by superior selection of mother plants through stringent quality check in the field performance from where the mother tissue is been extracted. In the present study same has been demonstrated for selection of superior mother plant in the field and rejection of different off-types plants.

Vegetative growth of all the clones were observed and recorded to study and understand the growth pattern of banana plants under field condition. Out of all characters studied a graphical representation of plant height vs. time period was recorded and it was observed that all the clones their vigorous plants showed greater plant height as compared to others. Vigorous plant of BAT clone showed the maximum height after 90 days of planting, whereas minimum height was recorded in OT category (Figure. 2).



V- Vigor plant, P- Poor plant, N- Normal plant

Figure.2 Plant height Vs time period; categorized into vigorous, normal and poor in field with all clones

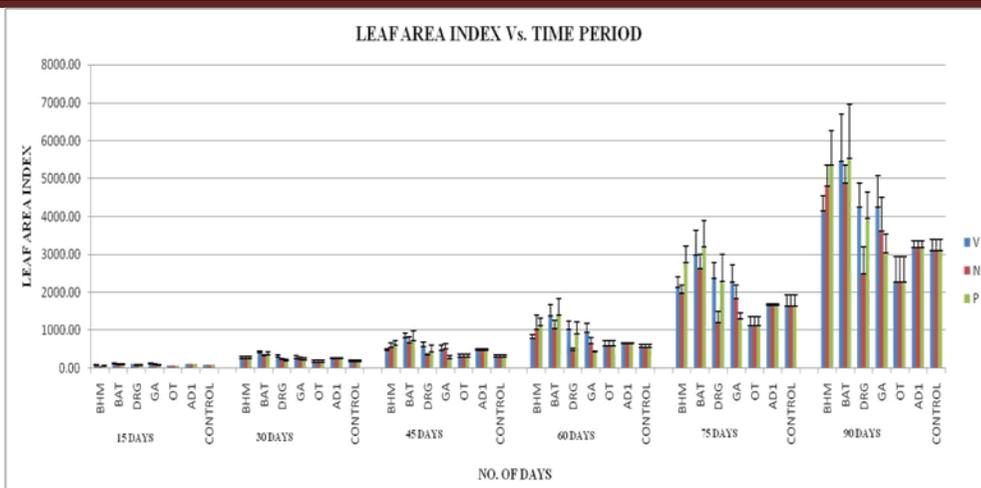


Figure.3 Leaf Area Index Vs time period; categorized into vigorous, normal and poor in field with all clones

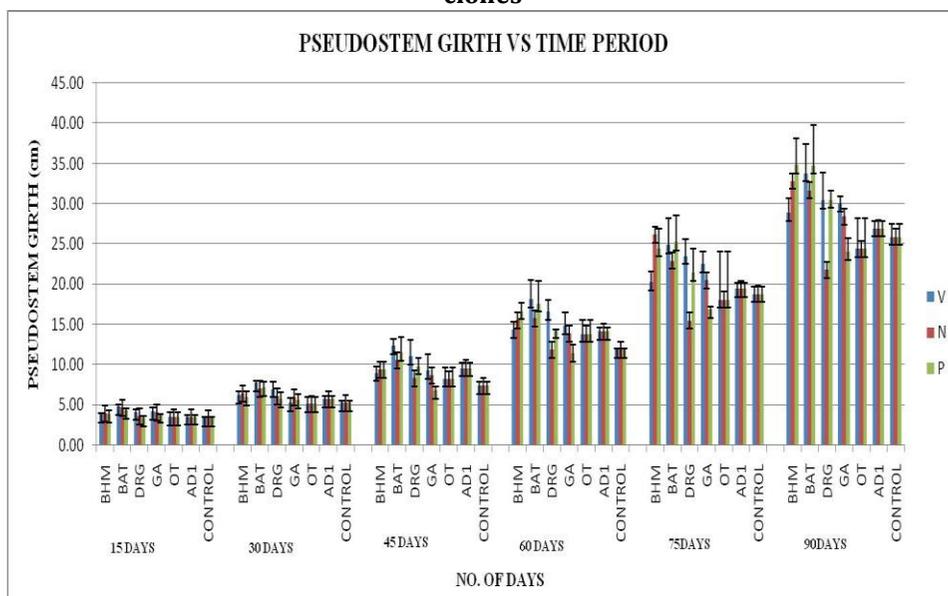


Figure.4 Pseudostem girth Vs time period; categorized into vigorous, normal and poor in field with all clones

Yet again similar results were recorded in other characters as well like leaf area index and pseudostem girth. BAT clone’s vigorous plant showed better characters than OT clone (Figure.3 & 4).

**Identification of elite plant plants showing superior yield and quality traits:-**

On the basis field performance it was observed that off-types plants taken more number of days as compare to other clones. Similarly if we compared the local as well as Grand naine (RM/control) with local clones; it was observed that BHM taken minimum number of days (~272 days) and RM taken more number of days as compare to all four local clones Figure.6 and Figure.7. BHM clone showed highest percent of flowering as compare to others clones while off-types showed minimum percent of flowering Table 1.

**Table.1 Percent flowering in all clones**

Clone Code	Total No. of Plants Observed	No. of Flowering Plants	Percentage of flowering
BHM	18	13	72.00
BAT	18	10	55.55
DRG	17	11	64.70
GA	17	10	58.82
OT	15	4	26.66
RM	35	15	42.85

CONTROL	18	7	38.88
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In trait of yield; it was observed that GA clone have highest average number of hands and average number of fingers as compare to others. The off-types showed good results for the both the traits as compare to Grand naine and three local clones (BAT, BHM, DRG) figure 5, but clearly quality of the fruits were not at all good for its resale value. In the field some variegated fruits were observed in the different clones' figure.6.

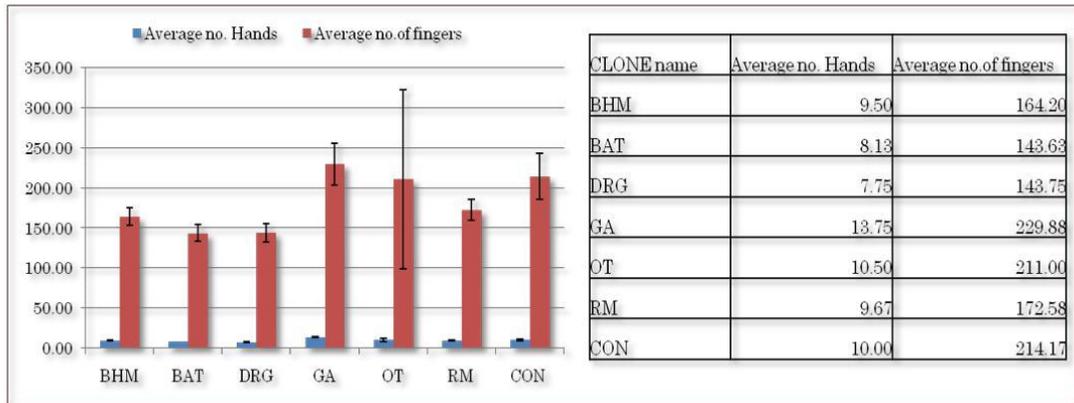


Figure 5 and Table 2: Average number of hands and fingers in all the clones

Clone name		Total no. of hands (Mean±SE)	Total no. of fruits (Mean±SE)	Total weight of harvested fruit (Kg) (Mean±SE)	Average weight of per fruit (Kg) (Mean±SE)	No. of days taken for maturation (Mean±SE)
BHM	V	8.67±0.21	135.33±1.99	16.68±0.15	0.10±0.0001	106.33±0.91
	O	8.50±0.47	135.00±6.70	15.83±0.30	0.09±0.1	108.00±0.44
BAT	V	8.83±0.16	142.50±1.11	15.10±0.32	0.10±0.003	105.50±0.34
	O	8.50±0.34	139.50±2.26	15.15±0.11	0.10±0.005	117.17±1.24
DGR	V	9.17±0.16	147.80±1.77	15.60±0.89	0.11±0.005	103.50±0.61
	O	8.33±0.33	145.00±1.50	15.16±0.34	0.10±0.003	113.67±1.40
GA	V	11.17±0.30	186.83±0.30	17.45±0.37	0.10±0.003	106.33±0.91
	O	7.50±0.25	120.24±1.71	13.25±0.20	0.08±0.001	120.00±0.79
GCR	V	8.80±1.11	172.60±7.52	15.93±0.39	0.09±0.010	97.60±0.59
	O	9.60±0.33	156.83±1.60	15.84±0.40	0.09±0.003	112.00±0.57

G9	V	10.08±0.68	161.23±8.54	15.80±0.67	0.10±0.003	104.15±0.32
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**Table.3 Field performance of plants on the basis of fruit yield.**



**Figure.6 Different types of fruits observed in field**

Field observation showed that local clone GA was superior in terms of average weight of harvested fruit (Kg) and average weight of per fruit (Kg). Most of the off-types plants were dead and remaining was inferior as compared to elite (GA) clone in terms of average no. of days taken for maturation and average weight of harvested fruit (Kg). The Grand naine (RM/control) was second after GA clone but superior from others. The Grand naine (RM/control) showed higher average number of fruits as compare to GA clone. In field three kind of off-type plants were planted (**variegated, deformed leaves and deformed pseudostem**) out of these plants having deformed leaves and deformed pseudostem were dead Table 2.

The field performance was observed till the fruit harvesting stage of all the clones. In the field it was observed that some plants fall down due to heavy rain during the rainy season, when the fruits have already emerged. All traits (Total no. of hands, total no. of fruits per bunch, Total weight of harvested fruit (kg), Average weight of per fruit (kg) and number of days taken for maturity) contributing to the yield were observed and it was observed that only off-types derived from the GA done was able to hold its off-type characteristics while off-types from other clones got recovered during the growth stages suggesting only epigenetic variation and behaved as normal. Among the clones GA showed out-group performance under both off-type and elite category. Off-type plants of GA had variegated leaves during selection and their fruit also become variegated (Figure.6 & 7).



**Figure.6 Fruiting of elite and off-type plants of all four clones with control**

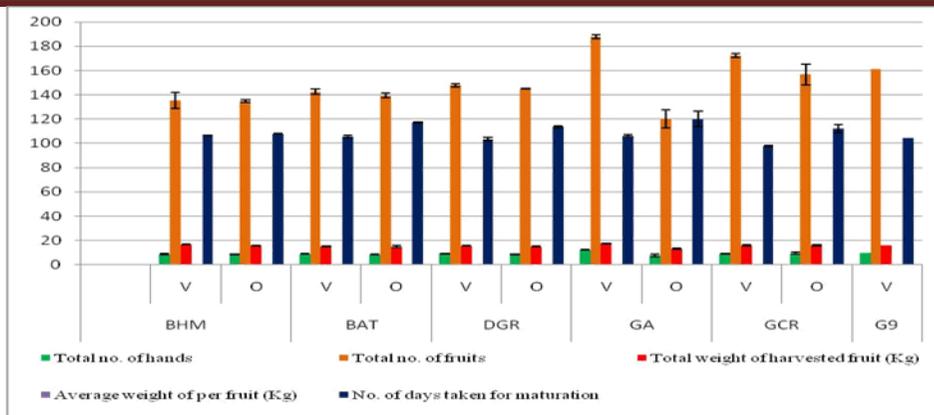


Figure.7 Field performances of all the clones

## Conclusion

In present study the morphological, physiological and agronomic characteristics were accomplished for different banana clones collected from different location of Chhattisgarh. Morphological studies cannot guarantee the selection of off-type plant in in-vitro level as it was evident that few plants after field planting got reverted back to normal suggesting only few epigenetic changes during production stages. Hence further detailed genotyping study of the clones would be more beneficial to select and eliminate off-types during early developmental stages. Though morphological studies done in the present experiment would be highly beneficial to select elite or vigorous growing plants in order to select superior mother plants. Evaluation of elite and off-type plants during the study suggest clear demarcation between superior qualities of mother plant than the inferior one. Under the field condition GA clone which was derived from a field selection done at Achouti farm proved to be the best one for further multiplication according to climatic condition of Chhattisgarh. Three categories of off-type plants which were studied in the experiment viz. Variegated leaves, Deformed Pseudostem and Deformed leaves, out of these only variegated leaves remained off-type throughout while others got recovered soon after planting suggesting only epigenetic variation.

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