



## **Effect of Organic Manures and Inorganic Fertilizer on the Leaf Characters of Banana**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/IJECC/2021/v11i1230558

#### Editor(s):

(1) Dr. Wen-Cheng Liu, National United University, Taiwan.

#### Reviewers:

(1) Ashish Rai, India.

(2) S.Umavathi, India.

Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here: <https://www.sdiarticle5.com/review-history/79747>

**Received 06 October 2021**

**Accepted 12 December 2021**

**Published 14 December 2021**

**Original Research Article**

### **ABSTRACT**

A field experiment was carried out at Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, AAU, Biswanath Chariali to study the effects of organic manures and inorganic fertilizer on leaf characters of banana cv. Amritsagar (AAA) during 2016-2017. The research work was carried out with the treatments as follows T<sub>1</sub>: FYM (Farm Yard Manure) + Microbial Consortia, T<sub>2</sub>: Enriched Compost, T<sub>3</sub>: Vermicompost, T<sub>4</sub>: Microbial Consortia, T<sub>0</sub>: RDF (FYM + NPK). Healthy suckers were planted in each plot with spacing of 2.1m x 2.1m on 27<sup>th</sup> May 2016. The treatments T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> were laid out in certified organic block in RBD with 5 replications while the treatment T<sub>0</sub> was laid out outside the organic block with five replications. In the organics, T<sub>1</sub> recorded the highest number of functional leaves (7.97, 12.46 and 5.37) in vegetative stage, shooting stage and harvesting stage respectively. Highest leaf area of 2.69 m<sup>2</sup> at vegetative stage and 11.17 m<sup>2</sup> at shooting stage were recorded in T<sub>1</sub> while lowest leaf area of 2.41 m<sup>2</sup> at vegetative stage and 8.89 m<sup>2</sup> at shooting stage were recorded in T<sub>4</sub>. Leaf area index was highest in T<sub>1</sub>. Chlorophyll content index in both vegetative stage (45.29) and shooting stage (65.56) was also highest in T<sub>1</sub>. Comparing the leaf characters (number of functional leaves, leaf area, leaf area index and chlorophyll content index) under organic treatments with that of T<sub>0</sub> treated plants, it was found that plants treated with inorganic fertilizer had more number of functional leaves and better leaf character than that of the plants treated with organics.

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**Keywords:** Chlorophyll content index; enriched compost; farm yard manure; functional leaves; leaf area index; microbial consortia; vermicompost.

## 1. INTRODUCTION

Banana (*Musa* spp.) is one of the most important fruit crops especially in the tropics and sub tropics and is a strategic crop for global food security. Banana is believed to have originated in the hot, tropical regions of South East Asia [1-2] and was latter introduced to both tropical and sub-tropical regions [3]. The fruit is grown widely in india and one of the favourite fruit among all groups of people. In India 29.12 million tones of banana is produce from 0.85 million ha area with a productivity of 34.43 t/ha [4]. Banana cultivation has a strategic role in the world food production for its nutritional importance and yield potential which can reach upto 100t/ha [5]. Thus boosting banana production has become one of the important goal of the world agriculture to ensure food security in future. This could be achieved through proper management practices, use of improved varieties, proper fertilization and so no. To improve the yield of plants the leaf system plays a major role. Leaf is the assimilatory organ of a plant. Productivity in bananas is govern by 'source' and 'sink' unit of the plant system. The role of leaf characters such as numbers of functional leaves, leaf area, leaf area index and chlorophyll content in leaves retained mainly at shooting stage is crucial in determining the yield potential of banana plant. More the number of functional leaves, leaf area expose to the sun there is better interception and utilization of solar radiation and thereby rise the rate of photosynthesis consequently in more yield.

Thus the aim of the research was to realize the effect of organics and inorganic fertilizer on the leaf characters (number of functional leaves, leaf area, leaf area index and chlorophyll content index) of banana for a period of one year.

## 2. MATERIALS AND METHODS

The study was conducted in the Instructional cum Experimental Farm, Department of Horticulture, Biswanath College of Agriculture, AAU, Biswanath Chariali during 2016-2017. *Biswanath Chariali* District falls in the sub-tropical *climatic* region having hot and humid summer, dry and cold winter seasons. The station receives an average annual rainfall of 1980.0 mm. The experiment was carried out with five treatments. The treatments (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>) were laid out in randomized block design (RDB)

replicated five times. The plots size were 6 m x 6 m. In the organic block there were total twenty plots of equal size. Outside the organic block five equal size plots were laid out for the treatment T<sub>0</sub> (inorganic fertilizer application). The banana plantlets were spaced at 2.1m x2.1m. For the purpose of reference, the following notations were used to designate the different treatments.

- T<sub>1</sub>: FYM + Microbial Consortia
- T<sub>2</sub>: Enriched Compost
- T<sub>3</sub>: Vermicompost
- T<sub>4</sub>: Microbial Consortia (combination of *Azotobacter* and *Azospirillum*)
- T<sub>0</sub>: FYM + NPK (inorganic)

### 2.1 Details of the Treatment

- T<sub>1</sub>: At planting (May 2016) FYM @ 12 kg/plant + Microbial Consortia @ 30 g/plant was applied in pit and at 5 months after planting (October 2016) FYM @ 6 kg/plant+ Microbial Consortia @ 15 g/plant was applied at 60 cm away from base of the plant.
- T<sub>2</sub>: Enriched Compost @ 5 kg/plant in each pit at planting and Enriched Compost @ 3 kg/plant was applied at 60 cm away from base of the plant at 5 month after planting
- T<sub>3</sub>: Vermicompost @ 5 kg/plant at planting Vermicompost @ 3 kg/plant at 5 months after planting
- T<sub>4</sub>: During planting 30g/plant Microbial Consortia as slurry  
At 5 month after planting 15 g/plant Microbial by mixing with 1 kg compost
- T<sub>0</sub>: FYM @ 12 kg/plant at the time of planting (May 2016) and the recommended doses of inorganic fertilizer for banana for Assam condition *i.e.* N:P:K @ 110 g: 33 g: 330 g per plant were applied at 3<sup>rd</sup> month (August, 2016) and at 5<sup>th</sup> month (October, 2016) after planting. At 3<sup>rd</sup> month, 120 g of urea, 210 g of SSP and 275 g of MOP per plant were applied at 30 cm away from the base of the banana psuedostem and at 5<sup>th</sup> month 120 g of urea and 275 g of MOP per plant were applied at 60 cm away from the base of the plant.

### 2.2 Recording Number of Functional Leaves

The number of functional leaves at vegetative stage (at 4<sup>th</sup> month after planting), shooting stage

and at harvest were recorded and expressed in numbers. The green and healthy leaves where two third or whole of the total leaf lamina were photosynthetically active were considered as functional leaves. Whereas the leaves where more than two third of the total leaf lamina became yellowish or brown owing to ageing or attack of pest were rejected.

### 2.3 Recording Leaf Area and Leaf Area Index

Leaf area was recorded at vegetative stage and at shooting stage. The length of the 3<sup>rd</sup> youngest leaf from the top was measured along the mid rib from the lamina base to its apex and for width the measurement was taken from the broadest portion of the lamina. For calculating the leaf area of the third leaf the product of length and breadth of the lamina was multiplied with a factor 0.8 [6] and expressed in m<sup>2</sup>. And to compute the total leaf area of the plant, the number of functional leaves present at the time of observation was multiplied with the leaf area of the third leaf.

For calculating the Leaf area index (LAI) at vegetative stage and at shooting stage the method of (Williams, 1946) was adopted.

$$LAI = \frac{\text{Leaf area of plants}}{\text{Area of the land occupied by the plants}}$$

### 2.4 Recording Chlorophyll Content Index

The chlorophyll content index (CCI) values were estimated with the help of Chlorophyll Meter (Model: CCM-200, CID, Inc, USA). For measuring the CCI the third leaf from the apex of the plant was selected. The data were collected from three different segments - at the apex, middle and at the base of the lamina and the average chlorophyll content index was calculated. CCI values were measured at vegetative and shooting stage.

## 3. RESULTS AND DISCUSSION

### 3.1 Effect on Number of Functional Leaves

The number of function leaves at different growth stages is presented at Table 1 Leaves are the vital contributors of yield through the process of photosynthesis. Leaf production in banana is related to increased rate of plant growth [7]. The

yield and quality of fruits is highly influence by the number of functional leaves since they act as a source to the developing fruits [8]. The number of leaves produced and leaf longevity have keen effect on fruiting of banana [9-11]. Robinson et al. [12] found that retention of 8.0 numbers of leaves at flower emergence was sufficient to achieve maximum yield and finger length in banana. The T<sub>0</sub> (FYM + NPK) treated plants were found to have higher number of functional leaves than that of organics at all stages of observation. The plants treated with inorganic fertilizer produced functional leaves 9.52, 13.73 and 6.40 at vegetative stage, shooting and harvesting stage. Whereas in organic treated plants, the numbers of functional leaves were 7.92 at vegetative stage, 11.26 at shooting and 4.93 at harvest. This might be due to the combine effect of FYM which was incorporated at planting and inorganic fertilizer that improved the fertility and physio-chemical properties of soil that helped easy release nutrient for producing more number of leaves. Badgujar et al. [8] noticed highest pseudostem height, pseudostem girth, total number of leaves, days taken to shooting and less number of days for harvesting when the plants were fertilized with application of 20 kg FYM + 1 kg neem cake + 200:40:200 g NPK per banana plant. Among the organics, maximum numbers of functional leaves were produced in T<sub>1</sub> (FYM + microbial consortia) at shooting (12.46) and at harvest (5.37) which might be due the application of both organics and bio-fertilizer which have increased the soil microbial population and activities, and as a result the uptake of phosphorus and nitrogen had improved [11]. Similar results were reported with the application of organics and bio-fertilizers in colocasia by Mahajan [13]. Jeeva et al. [14] found that inoculation of banana cv. Poovan with *Azospirillum* enhanced the height and girth of pseudostem, leaf production, leaf area, total number of leaves and number of suckers.

### 3.2 Effect on Leaf Area and Leaf Area Index

Leaf area has great effect on photosynthetic efficiency of a plant as it determines light interception as well as light assimilation. Bigger leaf area supports the plant to synthesise more metabolites by exhibiting high photosynthetic rate during the period of growth and development in banana [15]. Leaf area index (LAI) of a crop plant is one of the primary factors influencing canopy net photosynthesis [16]. With the increase in LAI the accumulation of dry matter also increases

through the process of photosynthesis. It is a positive index with direct influence on plant growth. Significant effects on leaf area and leaf area index due to different organic treatments were observed on (Table 2) recorded at 4<sup>th</sup> month after planting and at shooting. Among the organic treatments, the maximum leaf area at 4<sup>th</sup> month after planting and at shooting was achieved at T<sub>1</sub> (FYM + microbial consortia). At 4<sup>th</sup> month after planting, T<sub>1</sub> (2.69 m<sup>2</sup>) was at par with T<sub>2</sub> (2.52 m<sup>2</sup>) and they were followed by T<sub>3</sub> (2.45 m<sup>2</sup>) and T<sub>4</sub> (2.41 m<sup>2</sup>). The highest leaf area was recorded at T<sub>1</sub> (11.17 m<sup>2</sup>) at shooting and was at par with T<sub>3</sub> (9.40 m<sup>2</sup>) and they were followed by T<sub>2</sub> (9.03 m<sup>2</sup>) and T<sub>4</sub> (8.89 m<sup>2</sup>). From the observation, it was found that the T<sub>0</sub> (FYM + NPK) was higher in both the stages *i.e.* at 4<sup>th</sup> month after planting (2.52 m<sup>2</sup>) and shooting (11.00 m<sup>2</sup>) than the mean of organic manures *i.e.* 2.51 m<sup>2</sup> at 4<sup>th</sup> month after planting and 9.62 m<sup>2</sup> at shooting. The maximum leaf area index among the organics at 4<sup>th</sup> month after planting and at shooting was achieved at T<sub>1</sub> (FYM + microbial consortia) *i.e.* 0.60 and 2.60 respectively. The T<sub>0</sub> (FYM + NPK) was higher in both the stages *i.e.* 0.57 at 4<sup>th</sup> month after planting and 3.57 at shooting than mean of organics *i.e.* 0.56 at 4<sup>th</sup> month after planting and 2.19 at shooting.

The higher leaf area and leaf area index in these treatments might be justified to be readily available nutrient in soil, improved biological properties and more moisture availability due to the treatment effects. Ray [17] reported that with the increase in soil moisture level the leaf area in banana increased.

### 3.3 Effect on Chlorophyll Content index

The chlorophyll content index was recorded at 4<sup>th</sup> month after planting and at shooting (Table 3). The photosynthetic pigments are one of the important factors which can limit the yield of crop by reducing photosynthesis. The organic treatments could not influence chlorophyll content index significantly at both the stages of observation. The data revealed that the maximum chlorophyll content index at 4<sup>th</sup> month after planting was achieved at T<sub>1</sub> (45.29) and lowest (42.26) at T<sub>3</sub>. At shooting, the maximum chlorophyll content index was achieved at T<sub>1</sub> (62.56) which decreased gradually *i.e.* 60.32 at T<sub>2</sub>, 54.91 at T<sub>3</sub> and 51.19 at T<sub>4</sub>. The values of chlorophyll content index in T<sub>0</sub> treated plants was higher in both the stages *i.e.* at 4<sup>th</sup> month after planting (49.17) and at shooting (66.29) as

**Table 1. Number of functional leaves at different growth stages**

Treatments	Functional leaves at		
	Vegetative stage	Shooting stage	Harvest stage
T <sub>1</sub> : FYM+ Microbial consortia	7.97	12.46	5.37
T <sub>2</sub> : Enriched compost	8.07	11.40	5.00
T <sub>3</sub> : Vermicompost	7.62	11.16	4.54
T <sub>4</sub> : Microbial consortia	8.02	10.04	4.82
SEd±	0.18	0.76	0.42
CD (P=0.05)	0.31	1.32	0.74
Organics (Mean)	7.92	11.26	4.93
T <sub>0</sub> : RDF (Mean)	9.52	13.73	6.40

RDF= Recommended dose of fertilizer

**Table 2. Leaf area and leaf area index at different growth stages**

Treatments	leaf area		leaf area index	
	Vegetative stage	Shooting stage	Vegetative stage	Shooting stage
T <sub>1</sub> : FYM+Microbial consortia	2.69	11.17	0.60	2.60
T <sub>2</sub> : Enriched compost	2.52	9.03	0.57	2.03
T <sub>3</sub> : Vermicompost	2.45	9.40	0.55	2.13
T <sub>4</sub> : Microbial consortia	2.41	8.89	0.54	2.02
SEd±	0.12	1.14	0.02	0.29
CD = (0.05)	0.20	1.99	0.04	0.51
Organics (Mean)	2.51	9.62	0.56	2.19
T <sub>0</sub> : RDF (Mean)	2.52	11.0	0.57	3.57

RDF= Recommended dose of fertilizer

**Table 3. Chlorophyll content index at different growth stages**

Treatments	Chlorophyll content index at	
	Vegetative stage	Shooting stage
T <sub>1</sub> : FYM+ Microbial consortia	45.29	62.56
T <sub>2</sub> : Enriched compost	44.70	60.32
T <sub>3</sub> : Vermicompost	42.26	54.91
T <sub>4</sub> : Microbial consortia	43.97	51.19
SEd±	3.31	6.60
CD (P=0.05)	NS	NS
Organics (Mean)	44.05	57.24
T <sub>0</sub> : RDF (Mean)	49.17	66.29

RDF= Recommended dose of fertilizer, NS = Non-significant

compared to mean of organics *i.e.* at 4<sup>th</sup> month after planting (44.05) and at shooting (57.24). The result of higher chlorophyll content in T<sub>0</sub> might be due the application of inorganic manure along with FYM. [18] Ghosh et al. [19] reported similar results in maize and soybean. By increasing dosage of inorganic fertilizer that supplemented with organic fertilizer found in the increase of total chlorophyll content [20-21]. The organics alone could not adequate the nutrient supply that responsible for chlorophyll biosynthesis as compared to T<sub>0</sub> treated plants. However FYM + inorganic fertilizer improved the nutrient absorption specially nitrogen and phosphorus thus chlorophyll biosynthesis was optimized.

#### 4. CONCLUSION

From the study it can be conclude that the leaf characters were superior when the plants were treated with inorganic fertilizer in contrast to organics. Organic cultivation required atleast a period of three years to perform equally good with inorganics and in due course the result would be better due to the improvement of soil status.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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