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Influence of Nutrient Sources on Chlorophyll Content and other Leaf Parameters of Banana *Musa* (AAB) Nendran

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ABSTRACT

Background: Chlorophyll is a green molecule found in plant cells that aids photosynthesis. It absorbs sunlight and converts the energy into carbohydrates using CO_2 and water as a starting point. Chlorophyll 'a' and chlorophyll 'b' are the two forms of chlorophyll found in plants and each serves as a photoreceptor in photosynthesis, assuming higher electron transport, thus improving photochemical capacity.

Methods: The present study was conducted at Banana Research Station, Kannara, Kerala Agricultural University, Thrissur, Kerala during 2017-2018 to elucidate the response of banana Musa (AAB) 'Nendran' in terms of growth, yield and quality to nutrient sources. Variation in leaf parameters, phyllochron and chlorophyll content in leaf tissue of banana raised with different nutrient sources was analysed. The amount of chlorophyll present in the leaves, is an indication of photosynthetic efficiency.

Result: Highest Leaf Area Index (2.34) were recorded in T_4 (integrated use of organic manures with biofertilzers practised). Highest amount of chlorophyll 'a' (1.20 mg), chlorophyll 'b' (1.62 mg), total chlorophyll (2.82 mg) and lowest phyllochron (7.33) were obtained in T_8 (Fertigation with organic sources FYM @29 kg, lime @0.5 kg and wood ash @4 kg as basal; fertigation once in four days with 14 kg FYM till one month after bunch emergence,+ *in situ* green manuring) which was followed T_3 (POP recommendation of KAU with organic manures FYM @15 kg + lime @0.5 kg as basal + Poultry manure @ 14 kg/plant + Wood ash @4 kg/plant applied in two splits *i.e*. one as basal and one 3 MAP + *in situ* green manuring) at 150 days after planting. The results indicated that the manuring Nendran banana with organic manures had advantage over chemical fertilizers in term of chlorophyll production and increase in photosynthetic efficiency.

Key words: Banana, Chlorophyll, Nendran, Nutrients, Phyllochron.

INTRODUCTION

Banana (*Musa* spp) is one of the most important herbaceous fruit crop in world belonging to the family Musaceae. By virtue of its multiple uses banana is popularly known as "Kalpataru" (Randhawa *et al*., 1973). It is a important crop of sustenance and farmers can ensure year-round production and income. Banana accounts for 33.4 % total fruit production in India with an area of 0.89 million hectare with a total production of 33.89 million MT and productivity of 37.10 metric tonnes per hectare (Anonymous, 2018). Banana requires large quantities of nutrients for its growth, development and yield (Hazarika and Ansari, 2010). Nutrition of banana with organic manures and inorganic fertilizers affects chlorophyll synthesis during vegetative stage. Chlorophyll 'b' contributes to the photosynthetic process by broadening the spectrum of light that can be used. Higher photosynthetic activity gives a good indication of banana plants that are physiologically productive. This can be determined by the amount of chlorophyll present in the leaves which indicates efficiency of photosynthesis.

MATERIALS AND METHODS

The present study was carried out at Banana Research Station, Kannara, Kerala Agricultural University Thrissur, Kerala during November, 2017 to September, 2018. For the experiment, 45 days old tissue cultured plants of Nedunendran clone *Musa* Nendran were planted in the pits at 2 m × 2 m spacing. Total nine treatments replicated thrice with randomized block design statistically. Plot size was 16 plants and observations were recorded from 4 plants in the inner rows to avoid border effect. Chlorophyll content and other leaf parameters were recorded periodically.

Treatment details

T_1: POP recommendation of KAU for TC banana (N: P_2O_5: K_2O @ 300 g: 115 g: 450 g + Lime 1.0 kg + FYM 15.0 kg per plant). T_2: POP recommendation of KAU with organic manures 15 kg FYM and 0.5 kg lime as basal + FYM @ 28 kg/plant + ash @4 kg/plant which were applied in two splits *i.e*. one as basal and one at 3 MAP + *in situ* green

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manuring. T_3: POP recommendation of KAU with organic manures 15 kg FYM and 0.5 kg lime as basal + Poultry manure @ 14 kg/plant + ash @4 kg/plant which were applied in two splits *i.e*. one as basal and one 3 MAP + *in situ* green manuring (per plant). T_4: Best treatment from AICRP trials at Banana Research Station, Kannara (FYM 10 kg + Neem cake 1.25 kg + vermicompost 5 kg + wood ash 1.75 kg + biofertilizers (AMF 25 g + Azospirillum 50 g + PSB 50 g + *Trichoderma harzianum* 50g per pit) + 0.5 kg lime.T_5: Best treatment from AICRP trials at BRS, Kannara with native isolates of biofertilizers (FYM 10 kg + Neem cake 1.25 kg + vermicompost 5 kg + wood ash 1.75 kg + biofertilizers (native isolates of AMF 25 g + Azospirillum 50 g + PSB 50 g + *Trichoderma viridae* 50 g per pit) + 0.5 kg lime. T_6: Modified POP recommendation of KAU including micro nutrients as per soil test.T_7: Fertigation with inorganic manures FYM @ 15.0 kg/plant.T_8: Fertigation with organic sources; FYM @ 29 kg, lime @ 0.5 kg and ash @ 4 kg as basal; Extract of 14 kg FYM through irrigation water till one month after bunch emergence, once in four days+ *in situ* green manuring. T_9: Control (without manures and fertilisers).

Analysis of different growth and physiological parameters

Number of leaves per plant

The total number of fully opened green functional leaves capable of photosynthesis retained by the plant were recorded.

Leaf area index (LAI)

The LAI of functional leaves was calculated by using the formula suggested by Watson (1952).

Phyllochron index

Phyllochron is the rate of leaf production. The number of days required for phyllochron was counted and expressed as number of days. The interval between leaf appearances can be recorded in both standard measurements of time as we as thermal time.

Chlorophyll extraction method

Chlorophyll was extracted using Hiscox and Israelstam's (1979) DMSO extraction method. The samples were held at 65°C until the leaf discs were fully colourless. Absorption of the DMSO-chlorophyll extractions were compared to a control (pure DMSO). Using a spectrophotometer, measurements were taken at 645 nm and 663 nm. Spectrophotometer (RAD SmartspectTM Plus). Equations (1), (2) and (3); Chlorophyll content was analysed in the third leaf from the top portion of banana plant at 90 days and 150 days after planting.

$$\text{Chlorophyll 'a' (mg/g)} = \frac{12.7\ (A663) \times 2.69\ (A645) \times V}{(1000 \times W)}$$

$$\text{Chlorophyll 'b' (mg/g)} = \frac{22.9\ (A645) \times 4.68\ (A663) \times V}{(1000 \times W)}$$

$$\text{Total chlorophyll (mg/g)} = \frac{20.2\ (A645) \times 2.69\ (A663) \times V}{(1000 \times W)}$$

Here
V = Volume of sample.
W= Fresh weight of leaf tissue.

RESULTS AND DISCUSSION

Research data on leaf parameters and chlorophyll content of Nendran banana leaves as influenced by different nutrient sources are given in Table 1 and Table 2.

Leaf parameters at 90 and 150 days after planting

Number of functional leaves

Results indicated that no significant differences were recorded for number of functional leaves of Nendran banana between the treatments. The number of leaves per plant was varied from 12.58 to 13.83. Combination of inorganic fertilizers with organic manures, biofertilizers and bioagents significantly increase growth parameters, leaf characteristics and leaf nutrient status of banana (Thangaselvabai *et al*., 2009; Rajput *et al*., 2015). The duration of efficient and functional leaves has more relevance in influencing productivity than the total number of leaves.

Table 1: Number of functional leaves, Leaf area index (LAI) and phyllochron Index of Nendran banana.

Treatment	Number of functional leaves		Leaf area index (LAI)		Phyllochron index	
	90 DAP	150 DAP	90 DAP	150 DAP	90 DAP	150 DAP
T_1	8.75	13.00	1.48	2.20	7.67	9.17
T_2	9.83	13.17	1.66	2.23	8.25	8.25
T_3	10.25	13.25	1.73	2.24	7.83	7.92
T_4	9.75	13.83	1.65	2.34	8.00	8.58
T_5	10.25	13.25	1.73	2.24	7.17	8.92
T_6	10.50	12.75	1.78	2.16	8.08	8.50
T_7	8.58	11.83	1.45	2.00	7.67	9.17
T_8	9.42	13.08	1.59	2.21	7.33	7.33
T_9	8.58	12.58	1.45	2.13	9.58	10.08
SE (d)	0.69	0.70	0.12	0.12	0.66	0.67
C.D.	NS	1.18	NS	NS	NS	1.43
C.V.	8.83	6.59	8.86	6.61	10.12	9.47

Table 2: Chlorophyll content in Nendran banana leaves as influenced by nutrient sources.

Treatment	Chlorophyll content (mg/g of leaf) in Nendran banana					
	90 DAP			150 DAP		
	Chlorophyll a	Chlorophyll b	Total chlorophyll	Chlorophyll a	Chlorophyll b	Total chlorophyll
T_1	0.61	1.13	1.74	0.97	1.38	2.35
T_2	0.74	1.12	1.87	1.06	1.39	2.45
T_3	0.83	1.31	2.15	1.14	1.67	2.80
T_4	0.75	1.21	1.95	1.05	1.49	2.54
T_5	0.77	1.23	2.00	1.05	1.58	2.62
T_6	0.68	1.17	1.85	0.98	1.44	2.41
T_7	0.73	1.16	1.88	1.03	1.44	2.47
T_8	0.87	1.32	2.18	1.20	1.62	2.82
T_9	0.59	1.05	1.65	0.91	1.31	2.22
SE(d)	0.05	0.06	0.08	0.05	0.07	0.10
C.D.	0.11	0.12	0.17	0.12	0.16	0.22
C.V.	8.31	5.73	5.00	6.32	6.15	4.97

Leaf area index (LAI)

There were no significant differences found in Leaf Area Index of Nendran banana at 90 and 150 days after planting stage. Among the different treatments, maximum LAI was recorded in T_4 (2.34) followed by T_3 (2.24). Minimum LAI (2.13) was recorded in T_9 at 150 days after planting which was with no manures and fertilisers (control).

The leaf characteristics in terms of functional leaves, total number of leaves, phyllochron, leaf area and leaf area index were significantly influenced by the combination of inorganic fertilizers with different biofertilizers and organic manures (Aremu *et al.,* 2012).

Similarly, a study conducted by Hazarika *et al*. (2015) reported that leaf nutrient status like nitrogen, phosphorus pentoxide, potassium dioxide, and leaf relative water content were also influenced greatly by different nutrients. Treatment involving combination of 100 percent recommended dose of fertilizer + Arbuscular mycorrhizal fungi + *Azospirillum* + *Trichoderma harzianum* showed overall superiority in the growth parameters of banana.

Phyllochron index (PI)

The minimum days for successive leaf production (phyllochron) by plant crop was recorded. There were no significant difference in phyllochron index of at early vegetative stage of Nendran banana. But significant difference were observed at 150 days after planting. Among the different treatments, minimum phyllochron (7.33) was recorded in T_8 followed T_3 (7.92). Treatments T_6 (8.50), and T_4 (8.58) were found to be statistically on par. Maximum phyllochron (10.08) was recorded in T_9 (Control). The lowest phyllochron was registered and increased emergence of leaf production in organic treatments. Further, better utilization of natural resources led to better nutrients uptake resulted greater leaf production. Shortening of time interval between the successive leaves was due to optimum suuply of nutrients at appropriate growth stages. Reduction in leaf emergence rate in inorganic treatments was associated with lack of continuous supply of nutrients in banana. Chaudhuri and Baruah (2010) reported extended phyllochron at higher density, especially at 7 MAP.

Chlorophyll content at 90 and 150 days after planting
Chlorophyll 'a' content

Results indicated that there were significant differences in Chlorophyll 'a' content among the treatments. The highest chlorophyll 'a' content (0.87 mg) was obtained in T_8, which was followed by T3 (0.83 mg) and treatments T_4 (0.75 mg) and T_5 (0.77) were on par. Lowest chlorophyll 'a' content (0.59 mg) was obtained in control (T9). Selvarajan (1991) observed that application of 110: 35: 330g of NPK in three splits combined with 2, 4-D foliar spray increased chlorophyll 'a' and' b' contents in Nendran.

At 150 days after planting, highest chlorophyll a content (1.20 mg) was obtained in T_8, which was followed by T_3 (1.14 mg). However, the treatments T_2 (1.06 mg), T_4 (1.05 mg), and T_5 (1.05 mg) were on par with each other. Lowest chlorophyll 'a' (0.91 mg) was obtained in control (T9).

Nalina, (2002) reported that maximum photosynthates in terms of high biomass and translocating the assimilated materials to the developing sink resulted in heavier bunch weight. The role of nitrogen and potassium in the functioning of chlorophyll is well established. Nitrogen is the chief constituent of chlorophyll, proteins and amino acids, the synthesis of which is accelerated through increased supply of nitrogen. Fertigation with organic manures improved soil organic carbon and nutrient availability to banana plant. It may be due to the decomposition of organic matter, which facilitated humus formation preventing leaching of nutrients. Fertigation with organic manures ensure the supply of nitrogen, magnesium and amino acid which are directly involved in chlorophyll synthesis (Kaswala *et al*., 2017).

Chlorophyll 'b' content

Chlorophyll 'b' content of the Nendran banana leaf was significantly influenced by nutrient sources. Among the

different treatments maximum chlorophyll b (1.32 mg) content was also recorded in T_8 which was statistically on par (1.31 mg) with T_2 followed by T_4 (1.21 mg), T_6 (1.17 mg) and T_2 (1.12 mg). Minimum chlorophyll 'b' content (1.65 mg) was recorded in T_9 which was given no manures and fertilisers (Control).

At 150 days after planting, maximum chlorophyll 'b' was recorded in T_3 (1.67 mg) which was statistically on par with T_8 (1.62 mg) followed by T_5 (1.58 mg) and T_4 (1.49 mg). Minimum chlorophyll 'b' content (1.31) was recorded in T_9 which was with no manures and fertilisers (control). Selvarajan (1991) observed that application of 110:35:330g of NPK in Ney Vannan with three splits combined with 2, 4-D foliar spray increased chlorophyll 'a' and 'b' contents in Nendran. Ingle *et al*. (2001) observed that tissue cultured plants of Robusta had significantly higher photosynthetic rate and stomatal conductance compared to suckers.

Total chlorophyll content

Among the different treatments, maximum total chlorophyll (2.18 mg) was recorded in T_8 followed by T_3 (2.15 mg). Treatments T_5 (2.00 mg), T_4 (1.95 mg) and T_7 (1.88 mg) were found to be on par. Minimum total chlorophyll content (1.65 mg) was recorded in T_9 (Control). Mahalakshmi (2000) found that chlorophyll 'a', chlorophyll 'b' and total chlorophyll were higher in fertigated treatments than in control, indicating that fertigated treatments were effective in maintaining a high physiological status of the plant.

At 150 days after planting, maximum total chlorophyll (2.82 mg) was recorded in T_8 followed T_3 (2.80). Treatments T_5 (2.62 mg) and T_4 (2.54 mg) were found to be statistically on par. Minimum total chlorophyll content (2.22 mg) was recorded in T_9 (Control). Selvarajan (1991) observed that application of 110:35:330 g of NPK in Ney Vannan with three splits combined with 2, 4-D foliar spray increased chlorophyll 'a' and 'b' contents in Nendran. Photosynthetic rate is the most important physiological activity taking place in a plant. In the present investigation plants in treatment T_8 had the maximum photosynthesis rate. This indicates that the plants are physiologically active in exhibiting maximum photosynthetic rate, which may be due to the integration of higher rates of stomatal conductance and transpiration rate (Mahalakshmi, 2000).

CONCLUSION

Organic nutrition in Nendran banana with combination of vermicompost, FYM with biofertilizers (AMF, Azospirillum, PSB and *Trichoderma harzianum*) resulted in maximum number of leaves, LAI and minimum phyllochron. Fertigation with organic sources in Nendran resulted in highest chlorophyll 'a', chlorophyll 'b' and total chlorophyll content at 90 and 150 days after planting**.** Fertigation with organic manures ensure continuous supply of nitrogen, magnesium and amino acid which are directly involved in chlorophyll synthesis. From the present study it could be seen that the leaf parameters and chlorophyll level in banana leaves were higher when organic manures alone was used compared to integrated use of manures and fertilisers.

Conflict of interest

All authors declare that they have no conflict of interest.

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