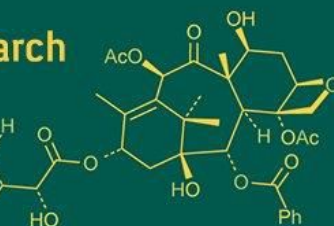


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MR Bhanu Sree
Department of Horticulture,
Agricultural College, Palem,
PJTAU, Telangana, India

K Ravi Kumar
Department of Horticulture,
Agricultural College, Naira,
Andhra Pradesh, India

CP Suresh
Department of Plant
Pathology, Uttar Banga Krishi
Viswavidyalaya, Pundibari,
West Bengal, India

S Khalko
Department of Horticulture,
North Eastern Hill University
(Tura Campus), Tura,
Meghalaya, India

Corresponding Author:
K Ravi Kumar
Department of Horticulture,
Agricultural College, Naira,
Andhra Pradesh, India

Influence of leaf retention levels on growth and yield attributes of banana (*Musa* spp., AAA) cv. Grand Naine

MR Bhanu Sree, K Ravi Kumar, CP Suresh and S Khalko

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Abstract

A field trial was conducted in the Terai Zone of West Bengal at the Experimental Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, India, with the objective of studying the effect of different levels of leaf retention on plant growth, yield, and disease incidence. The experimental results clearly indicated that the number of functional leaves retained on the plant had a significant influence on growth and yield performance. Plants maintained with 12 functional leaves recorded the highest yield of 55.42 t ha⁻¹, which was associated with superior growth and yield attributes such as enhanced vegetative vigor, better assimilate production, and improved bunch development. A progressive decline in yield was observed as the number of retained leaves decreased from 10 to 4, highlighting the importance of adequate leaf area for photosynthesis and biomass accumulation. The lowest yield (27.32 t ha⁻¹) was obtained from plants retaining only a minimum number of functional leaves, indicating severe limitation in photosynthate availability.

However, the study also revealed a trade-off between higher leaf retention and disease incidence. Retaining 10 or more functional leaves resulted in an increased incidence of Sigatoka leaf spot, likely due to the creation of a favorable microclimate for pathogen development within the denser canopy. In contrast, plants with fewer retained leaves showed reduced or negligible disease incidence, owing to better aeration and lower humidity around the foliage. Thus, while higher leaf retention favored yield enhancement, it also increased susceptibility to Sigatoka leaf spot, suggesting that an optimum balance between leaf retention and disease management is essential for achieving sustainable productivity under the Terai conditions of West Bengal.

Keywords: Leaf retaining, grand Naine, growth, yield

Introduction

Banana is one of the most important fruit crops in India, contributing about 31.7% of the total fruit production. It is cultivated across diverse agro-climatic regions of the country under different production systems (Mustaffa, 2011) [14]. In West Bengal, however, banana cultivation is predominantly based on local cultivars, which are generally low yielding. As a result, the average productivity of banana in the state is only 24.1 t ha⁻¹, compared to 64.1 t ha⁻¹ in Gujarat (Anon., 2013) [1]. This wide yield gap has led to a renewed emphasis on achieving higher productivity, improved fruit quality, extended shelf life, and reduced susceptibility to major pests and diseases. To meet these objectives, expansion of area under high-yielding cultivars such as Grand Naine, Robusta, and Dwarf Cavendish has become increasingly important. Among these, Grand Naine is the most widely accepted international cultivar due to its high yield potential and superior fruit quality (Mustaffa, 2011) [14].

In banana, plant stature and bunch weight are closely associated with both the number and size of functional leaves (Martinez Garnica, 1984) [11]. The growth and development of the bunch largely depend on the physiological activity of functional leaves present from the emergence of the inflorescence at the apex of the pseudostem through the entire fruit development period (Barrera *et al.*, 2009) [3]. Studies have indicated that the presence of 12-14 functional leaves at the time of flowering is essential for optimum bunch development (Vargas *et al.*, 2008) [33]. This requirement is attributed to the fact that maximum leaf area in banana coincides with the emergence of the inflorescence; thereafter, no new leaves are produced as the bunch is terminal, and total leaf area gradually declines due to senescence of

older leaves (Robinson and Galan, 2010; Turner *et al.*, 2010) [19, 30]. Since continuous leaf production and retention are critical determinants of plant growth and productivity, the existing leaves must remain functional from flowering until the completion of fruit development.

Moreover, leaf management practices play a vital role in disease control. Older leaves often serve as initial sites for pathogen establishment, and colonies of *Fusarium* and other pathogens may spread from older to younger leaves. Therefore, selective leaf pruning helps in minimizing the incidence of Sigatoka leaf spot by removing infected or senescent leaves, thereby improving canopy aeration and reducing disease pressure (Robinson, 1996) [17]. As Grand Naine is a relatively new cultivar in this region and is cultivated under varying leaf pruning regimes, it is essential to evaluate its performance and to standardize appropriate leaf retention practices. However, scientific information on optimum leaf retaining practices for banana cv. Grand Naine under the agro-climatic conditions of West Bengal is limited. In view of these considerations, the present study was undertaken to investigate the effect of different levels of leaf retention on growth, yield, and disease incidence in banana cv. Grand Naine.

Material and Methods

The experiment was carried out during 2015-16 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal, India. The experimental site is geographically situated at 26°19' N latitude and 89°29' E longitude, with an altitude of 43 m above mean sea level. The soil of the experimental field was sandy loam in texture, coarse in nature, and characterized by poor water-holding capacity. It was acidic in reaction (pH 5.23) with low fertility status, containing organic carbon (0.93%), available nitrogen (217.21 kg ha⁻¹), available phosphorus (18.24 kg ha⁻¹), and available potassium (111.89 kg ha⁻¹).

The Terai agro-climatic zone is typified by high annual rainfall (exceeding 3000 mm), high relative humidity, moderate temperatures, and a prolonged winter season with high residual soil moisture. The experiment was laid out in a Randomized Block Design (RBD) comprising six leaf retention treatments, namely retention of 4, 6, 8, 10, 12, and all functional leaves, with four replications. All recommended package of practices for banana cultivation were followed uniformly for all treatments. Observations on growth and yield parameters were recorded at appropriate stages of crop growth. The recorded data were subjected to statistical analysis using analysis of variance (ANOVA) as described by Gomez and Gomez (1984), employing the 'OPSTAT' software package to test the significance of treatment effects.

Results and Discussion

Retaining of different numbers of functional leaves significantly affects the most of the vegetative growth parameters of Grand Naine (table 1). Pseudostem height and girth significantly differed at shooting and recorded the highest pseudostem height (209.25 cm) and girth (72.35 cm) when 12 functional leaves were retained while lowest height (175.51 cm) and girth (59.16 cm) was recorded when only four functional leaves were retained. This result, in general, is contrast with Satyanarayana (1986) [25] reported that in Dwarf Cavendish the different number of functional leaves did not affect plant height. This clearly indicates that

retaining 4-8 leaves generally have similar influence on height and girth increment as the difference are insignificant whereas retaining 10-12 are significantly better than retaining 4-8 leaves. The difference among retaining 10-12 leaves is also insignificant. This is because retaining 10-12 functional leaves have enough green area to produce required quantity of photosynthates to maintain the physiological and morphological activity of the plant efficiently for its proper growth and development (Salisbury and Ross, 2002) [24]. But less than 10 leaves retained decreases the effective green area to assimilate enough photosynthates for efficient morphological and physiological activity. Retaining more than 12 leaves decreased both the height and girth though non-significant. This indicates overstocking of canopy which might have interfered wind movement and sunlight interception by lower and middle layer leaves effecting photosynthesis and less penetration of light to deeper layer and ground surface. This condition might have decreased the evaporation from the soil and increased dampness effecting growth and development of the plants. Another possible reason that can explain reduction of growth that the conditions discussed above might have increased incidences of fungal infection in the lower mature leaves which destroys the photosynthetic capability of the plants.

Suckers emerged per plant from the mother plant due to effect of leaf retaining was not significantly influenced. The number of suckers emerging from the mother plant is independent of the number of functional leaves retained as it depends on the extensiveness of the sucker mat from which the sucker emerged. The suckers per plant at shooting were more than 12 in numbers. The food storage in the sucker mat on which the emerging sucker develops is accumulated with the photosynthates developed by the leaves. Retaining lesser leaves lead to significantly lesser height and girth of pseudostem than as compared to retaining higher leaves as discussed above but irrespective of the leaves retained lesser or optimum had no significant effect on number of suckers emerged. This clearly indicates that the photosynthates assimilated by the leaves are translocated as storage food in the mat first than if remaining partitioned to actively growing parts of the plant. Retaining lesser number of functional leaves could produce enough assimilates only to fulfill mat accumulation for sucker emergence and not for growth and development of developing mother plant. Therefore retaining optimum numbers of functional leaves is essential so that enough photosynthates can be assimilated that is satisfactorily partitioned both to mat and also to mother plant for its efficient growth and development. The number of leaves per plant at shooting was significantly influenced by the number of functional leaves retained (table 1). The leaves emerged was effected by the number of functional leaves retained as was also reported by (Stover, 1979; Stover and Simmons, 1987) [28, 29]. More the functional leaves retained, more the leaves emerged; lesser the leaves retained less the leaves emerged. However the mature lower leaves were pruned as and when new emerged to retain the leaves as per treatment. The highest number of leaves emerged per plant was recorded when all the functional leaves were retained and the least when four leaves were retained only. The number of green leaves reduced was more when 10 or more than 10 leaves retained at shooting as photosynthates were translocated for bunch development which accelerated the drying of the mature

lower leaves, whereas leaf drying was less where leaves retained were less than 10.

Leaf length was significantly influenced at shooting, however leaf breadth was not significantly influenced at shooting but generally more the leaves retained widest are the leaves. During vegetative and shooting stage the length and breadth increased with increase in numbers of leaves retained from 4 to 12 leaves but then decreased with more than 12 leaves retained which however was non-significant. As the number of leaves retained increased, the leaf length and breadth increased, correspondingly increasing the leaf area which was significant at shooting stage (table 1). The plants retained with 12 functional leaves had highest length and breadth at shooting thus also had highest leaf area developed (0.95 m²), non-significantly followed by 10 leaves; substantiate the claim of higher production of photosynthates due to efficient capability of photosynthetic apparatus as discussed earlier while supporting the higher dimensions of growth parameter with 10-12 functional leaves in the plant.

The days intervening between the emergences of two successive leaves obviously was significantly influenced by the number of leaves retained which is directly related to the quantity of photosynthates being translocated to the dividing meristematic cells of the leaves at its apex which was fulfilled by the plants which has got 12 leaves retained. This much number of leaves retained supplied the required amount of photosynthates to the actively growing meristematic tissues efficiently, continuously and timely; explaining least phyllocron of 14.49 days (at shooting). Leaves emerge on an average rate from 8.3-12.8 days per leaf depending on number of leaves currently on the plant (Stover, 1979; Stover and Simmons, 1987) [28, 29].

The longest period to shooting (405.33 days) and then to maturity (130.22 days) was related to longest phyllocron (14.62 days) in the plants with lowest number of four functional leaves retained. Thus the cropping period on an average extended from 485.06 to 535.55 days i.e. the crop where 12 functional leaves were retained was harvested about 51 days earlier than the crop where only four leaves were retained.

The bunch characters viz. length, diameter, weight, hands per bunch and fingers per bunch was also significantly influenced by number of leaves retained except the length which was not significant (table 2). Longest (65.65 cm), thickest (37.20 cm) and heaviest (22.19 kg) bunch along with highest number of hands (10.44/bunch) and fingers (150.92/bunch) were produced by the plants with 12 functional leaves while the least of 46.74 cm, 28.85 cm, 10.93 kg, 8.2 hands/bunch and 108.25 fingers/bunch were recorded in the plants with only four functional leaves (Fig 1 and 2). The plants producing best bunches had also better and efficient growth, leaves produced faster and achieved earlier reproductive maturity with proper bunch establishment, development and setting because of efficient photosynthetic apparatus producing sufficient photosynthates those were translocated to bunches resulting better size and weight with more number of hand and fingers than the bunches produced by plants with lesser number of functional leaves. Reduction in bunch weight was reported when less than 10 leaves were retained (Daniells *et al.*, 1994) [6]. On the contrary no reductions were reported with retaining 8 leaves by Robinson and Anderson (1990) [18]; Robinson *et al.* (1992) [20] and Vargas *et al.* (2009) [32].

Similarly, no reductions were also reported in bunch weight of Grand Naine when the plants were left with 6, 8, 10 or 12 leaves (Rodriguez *et al.* (2006) [21]. Furthermore, under Costa Rican conditions also moderate defoliation of bananas at flower emergence did not reduce bunch weight (Saborio and Granados, 2005; Segura and Valle, 2005; Vargas *et al.*, 2005) [23, 26, 31]. In the present study leaf retaining practices as per treatment started as soon as possible after emerging when that much leaves could be retained pruning the extra leaves affecting growth and development due to reduction of photosynthetic apparatus leading to sub-optimal photosynthesis producing and storing lesser assimilates whereas studies reporting no reduction of growth and yield due to different intensity of leaf retained only at shooting stage. The lack of reduction of bunch weight when leaves were removed, in contrast to the present study, means that the banana plant produced more leaves than required for fruit-filling (Stover and Simmonds, 1987; Robinson and Anderson, 1990) [29, 18] and it is the type of leaf eliminated and not the intensity of defoliation that effects bunch weight (Arcila *et al.*, 1995) [2].

The finger characters viz. length, diameter and weight was significantly influenced by number of leaves retained. Longest (15.09 cm), widest (3.84 cm) and heaviest (332.05 g) fingers were produced in the bunches of plant retained with 12 functional leaves which then progressively decreased as number of leaves retained decreased and least values (10.83 cm, 3.27 cm and 161.27 g, respectively) were recorded in the plants retained with only four functional leaves. Retaining more than 12 leaves also decreased the finger size and weight. As was explained earlier for superior bunch characters, retaining 12 functional leaves were optimum enough to have efficient photosynthetic apparatus for to produce sufficient assimilates to be translocated continuously for proper and efficient bunch establishment, development and setting producing larger and heavier bunches because of larger and heavier fingers being set in them.

Further younger leaves were retained pruning the older leaves which has a higher photosynthetic rate as is also supported by earlier studies reporting higher photosynthetic activity in younger (upper) leaves compared to older (lower) leaves in both plantains and bananas (Hidalgo, 2000; Rodriguez and Serrano, 2002) [10, 22] which contribute more or completely to fruit filling than the older ones. The present exercise of different intensities of leaf retaining in Grand Naine is well supported by earlier works on banana and plantain leaf retaining that reported bunch weight and fruit dimensions were reduced depending on the number of leaves retained (Mathew, 2006; Barrera *et al.*, 2009) [12, 3]. It was reported that reduction in total leaf area due to retaining less number of leaves reduced bunch weight as enough photosynthates were not assimilated to support translocation for proper and efficient bunch development (Girija and Srinivasan, 1998) [7].

Plants retained with 12 functional leaves yielded highest (55.42 t/ha) and it reduced progressively as leaf retained reduced from 10 to 2 and a lowest 27.32 t/ha was yielded by plants retained with only functional leaves. This can be explained that as retaining 12 functional leaves produced largest and heaviest fingers and so the bunches that ultimately was realized as highest yield. Fully expanded leaves can be removed during the vegetative period retaining at least 12 leaves without apparently affecting

growth and yield as was also reported by Pound and Fernandez (1981) ^[15]. This number can be recommended as optimum for Terai zone of West Bengal for realizing optimum yield. Retaining as low as 4 leaves had a yield reduction of 50.75 % cannot be regarded as total crop failure. This indicates that with minimum 4 leaves of Grand Naine in Terai Zone of West Bengal can put up growth, yield and may still produce marketable banana however with inferior morphological characters and yield parameters. Under tropical conditions a banana plant can produce an average of 35-47 leaves during each crop cycle (Mira *et al.*, 2004) ^[13]. Under Costa Rican conditions banana cultivars

Grand Naine, Valery and Williams had 12-13 or more functional leaves that produced best yield (Soto and Ruiz, 1992) ^[27]. In Cavendish banana retaining 14-16 leaves at shooting produced heavier bunches, however retaining lesser than this retaining only four leaves severely reduced bunch weight while retaining 8 leaves reduced bunch weight but was not significant (Robinson *et al.*, 1992). Reports regarding retaining minimum number of leaves varied from 6-14 functional leaves which should be enough for normal vegetative and bunch growth and development without altering the yields (Ramirez *et al.*, 2008; Gonzalez *et al.*, 2012) ^[16, 8].

Table 1: Effect of leaf retaining on growth characteristics of banana cv. Grand Naine at shooting

Leaf Retained	Height (cm)	Girth (cm)	Suckers per plant	Leaves per plant	Leaf length (cm)	Leaf breadth (cm)	Area (m ²)	Phyllocron (days)	Shooting (days)	Shooting to maturity (days)
All	207.50	70.00	11.00	19.95 (7.41)*	174.25	52.66	0.92	14.90		
12	209.25	72.35	12.25	18.32 (7.19)	177.32	53.42	0.95	14.49	376.33	108.73
10	203.11	69.49	10.12	17.19 (6.09)	172.22	51.00	0.88	17.30	382.33	112.00
8	199.46	68.87	11.00	15.31 (3.44)	169.00	50.67	0.86	17.58	385.22	117.29
6	179.75	65.08	11.25	13.67 (3.43)	154.50	47.24	0.73	18.37	391.33	124.55
4	175.51	59.16	9.25	11.40 (2.17)	146.75	46.42	0.68	18.43	405.33	130.22
CD _{P=0.05}	20.28	5.90	NS	1.91 (1.16)**	20.07	NS	0.08	1.60	8.56	1.56

*Figures in parenthesis are number of dried leaves, **Dried leaves CD

Table 2: Effect of leaf retaining on yield attributes of banana cv. Grand Naine at shooting

Leaf Retained	Finger Length (cm)	Finger diameter (cm)	Finger weight (g)	Fingers/bunch	Hands/bunch	Bunch length (cm)	Bunch diameter (cm)	Bunch Weight (kg)	Yield (t/ha)
All	13.07	3.65	328.56	147.75	9.75	62.74	34.71	21.61	54.02
12	15.09	3.84	332.05	150.92	10.44	65.65	37.20	22.19	55.48
10	14.78	3.60	275.50	135.00	9.25	55.89	34.44	20.63	51.57
8	13.50	3.27	230.17	130.65	8.75	49.82	33.73	19.33	48.32
6	12.23	2.79	205.50	122.32	8.21	47.15	32.28	17.62	44.06
4	10.83	3.27	161.27	108.25	8.20	46.74	28.85	10.93	27.32
CD _{P=0.05}	0.92	0.009	63.39	9.25	1.33	NS	1.08	0.14	0.36



A



B

Fig 1: Retaining of 12 functional leaves (A) and subsequently produced bunch (B)



A



B

Fig 2: Retaining of 4 functional leaves (A) and subsequently produced bunch (B)

Conclusion

Plants retained with 12 functional leaves yielded highest (55.42 t/ha) along with better growth, yield attributes and yield parameters. The yield reduced progressively as leaf retained reduced from 10 to 4 and a lowest 27.32 t/ha was yielded by plants retained with only functional leaves. Hence, retaining of 12 functional leaves can be recommended for production of banana cv. Grand Naine with better growth and highest yield for this terai region.

References

- Anonymous. Indian horticulture database. Gurgaon: National Horticulture Board, Ministry of Agriculture, Government of India; 2013. p. 1-284.
- Arcila MI, Belalcázar S, Cayón G. Influencia del número de hojas en postfloración sobre el llenado de los frutos del clon plátano Dominico-Hartón (*Musa* AAB Simmonds). In: Belalcázar S, García O, Valencia JA, Arcila MI, Mejía H, García Y, editors. Mejoramiento de la producción del cultivo del plátano. Bogotá: Produmedios; 1995. p. 90-93.
- Barrera JL, Cayón G, Robles J. Influencia de la exposición de las hojas y el epicarpio de frutos sobre el desarrollo y calidad del racimo de plátano Hartón (*Musa* AAB Simmonds). Agron Colomb. 2009;27:73-79.
- Belalcázar S, Valencia JA, Arcila MI, Cayón G. Efecto de la defoliación selectiva durante la floración sobre el llenado de los frutos del clon de plátano Dominico-Hartón (*Musa* AAB Simmonds). In: Belalcázar S, García O, Valencia JA, Arcila MI, Mejía H, García Y, editors. Mejoramiento de la producción del cultivo del plátano. Bogotá: Produmedios; 1995. p. 1-256.
- Cayón G, Morales H, Celis LD. Efecto de la defoliación sobre el comportamiento postcosecha del fruto de plátano Dominico-Hartón (*Musa* AAB Simmonds). Acta Agron. 2002;51:25-30.
- Daniells JW, Lisle AT, Bryde NJ. Effect of bunch trimming and leaf removal at flowering on maturity bronzing, yield and fruit quality of bananas in North Queensland. Aust J Exp Agric. 1994;34:259-265.
- Girija T, Srinivasan PS. Certain physiological aspects of leaf removal in banana cv. Rastali. Orissa J Hortic. 1998;26:79-81.
- Gonzalez CR, Salinas DGC, Castillo JJM. Effect of number of functional leaves at flowering on yield of banana Grand Naine (*Musa* AAA Simmonds). Rev Fac Agr Medellin. 2012;65:6591-6597.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research. New York: John Wiley & Sons; 1984. p. 1-680.
- Hidalgo M. Efecto de la reducción del área foliar por medios bióticos o abióticos sobre la fotosíntesis foliar del banano (*Musa* AAA cv. Valery) [thesis]. San José: Universidad de Costa Rica; 2000. p. 1-58.
- Martinez-Garnica A. Determinación del área mínima foliar en plátano en el trópico húmedo. Rev ICA. 1984;19:183-187.
- Mathew S. Studies on the intensity of dehandling and leaf removal on production characteristics and fruit quality of banana (*Musa* spp.) [MSc thesis]. Mohanpur: Bidhan Chandra Krishi Viswavidyalaya; 2006. p. 1-120.
- Mira JJ, Díaz A, Hernández M. Influencia del régimen de lluvias sobre la productividad bananera de Urabá. In: Memorias XXXIV Congreso Sociedad Colombiana de Control de Malezas y Fisiología Vegetal. Bogotá: Comalfi; 2004. p. 72-72.
- Mustaffa MM. Vision 2030. Tiruchirapalli: National Research Centre for Banana; 2011. p. 1-50.
- Pound B, Fernandez A. Yield of plantain grown for fruit and forage: effects of defoliation and spacing. Trop Anim Prod. 1981;6:1-3.
- Ramirez M, Saenz MV, Vargas A, Araya M. Leaf pruning intensities at flowering of banana did not influence fruit green and yellow life and quality. Sci Hortic. 2008;115:319-322.
- Robinson JC. Bananas and plantains. Wallingford: CAB International; 1996. p. 1-238.
- Robinson JC, Anderson T. Banana bunch development in relation to leaf pruning at flowering. Inf Bull Citrus Subtrop Fruit Res Inst. 1990;216:1-4.
- Robinson JC, Galán V. Bananas and plantains. 2nd ed. London: CABI; 2010. p. 1-311.
- Robinson JC, Anderson T, Eckstein K. Influence of functional leaf removal at flower emergence on yield and photosynthetic compensation in banana. J Hortic Sci. 1992;67:403-410.
- Rodríguez GC, Cayón DG, Mira CJJ. Número mínimo de hojas funcionales a floración y cosecha en banano (*Musa* AAA Simmonds). In: Soprano E, Adami TF, Lichtemberg LA, Silva MC, editors. Proc XVII ACORBAT. Joinville: Brazil; 2006. p. 318-319.
- Rodríguez W, Serrano E. Respuesta de hojas de banano (*Musa* AAA cv. Grande Naine) de diferente edad a la radiación incidente. CORBANA. 2002;28:71-82.
- Saborío G, Granados F. Defoliación controlada de plantas florecidas de banano (*Musa* AAA) como estrategia de manejo integrado de Sigatoka negra. In: Sandoval F, editor. 1er Congreso Científico-Técnico Bananero Nacional. San José: CORBANA; 2005. p. 1-58.
- Salisbury FB, Ross CW. Plant physiology. 3rd ed. New Delhi: CBS Publishers & Distributors; 2002. p. 1-540.
- Satyanarayana M. Effect of number of functional leaves on growth and yield of Dwarf Cavendish banana. Banana Newsl. 1986;9:34-36.
- Segura A, Valle H. Niveles de defoliación controlada y su efecto sobre el racimo en banano. In: 1er Congreso Científico-Técnico Bananero Nacional. San José: CORBANA; 2005. p. 1-56.
- Soto M, Ruiz E. Descripción botánica. In: Soto M, editor. Bananos: cultivo y comercialización. 2nd ed. Costa Rica: Litografía e Imprenta Lil; 1992. p. 22-103.
- Stover RH. Pseudostem growth, leaf production and flower initiation in Grand Naine banana. La Lima: SIATSA; 1979. p. 1-120.
- Stover RH, Simmonds NW. Bananas. 3rd ed. London: Longman; 1987. p. 1-467.
- Turner DW, Fortescue JA, Thomas DS. Bananas and crop physiology. In: Damatta F, editor. Ecophysiology of tropical tree crops. New York: Nova Science Publishers; 2010. p. 7-36.
- Vargas A, Araya M, Guzmán M, Murillo G. Effect of defoliation at flowering on Sigatoka negra and

- production. In: Proc Int Congr Black Sigatoka Management. San José: CORBANA; 2005. p. 1-64.
32. Vargas A, Araya M, Guzmán M, Murillo G. Effect of leaf pruning at flower emergence on fruit yield and black Sigatoka. *Int J Pest Manag.* 2009;55:19-25.
33. Vargas A, Guzmán M, Araya M, Murillo G, Blanco FA. Effect of defoliation at flowering on banana yield and black Sigatoka severity. *CORBANA.* 2008;34:39-54.