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Growth and Productivity of Williams Banana Grown Under Shading Conditions

M.M.S. Saleh

Pomology Department, National Research Center, El-Tahrir St., Dokki, Cairo, Egypt.

Abstract: Williams banana plants were grown in (2001- 2002) and (2002- 2003) seasons under black saran condition to investigate the effect of shading on vegetative growth, leaf mineral content and bunch yield. Results indicated that, although there was no infections or shredding were occurred through the plant leaves and the number of total and green leaves/plant were increased under shading with black saran, the irradiance level was reduced by about 76% than open field condition which in turn negatively affected on vegetative growth, minerals and chlorophyll content in the leaves, number of emerged suckers/plant and yield of Williams banana plants. Also shading lengthened the period from sucker emergence to bunch shooting and to bunch harvesting.

Key words: Williams Banana, shading, black saran, growth, leaf mineral content, yield.

INTRODUCTION

Bananas show wide adaptability to a range of environments. Areas between 20º and a little beyond 30° N and S latitude (like Egypt) will be considered under the subtropics[1]. Nonetheless the establishment of industries in these diverse environments (temperature, radiation, wind and humidity) has often led the adoption of unique cultural practices that modify the impacts of adverse environments on the plants[2]. Planting bananas under shading house may overcome the unsuitable environmental conditions. In this respect, Murry[3] reported that 50% shading of full sunlight dose not reduce yield of banana. So, the aim of this study is to evaluate vegetative growth, leaf mineral content and yield of banana grown under shading house comparing with open field conditions.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons (2001 – 2002) and (2002 – 2003) on mother plant and first ratoon crop of Williams banana plants grown in private plantation located in Banha district, Khalubia governorate, Egypt.

In late April of the first season, *In vitro* propagated suckers were planted in holes at 2X2 m apart using the complete randomized design. Forty suckers were planted either under open field condition as control plants or under green house covered with black saran as shading condition. White plastic sheets were used upon the black saran through the winter months (late autumn to early spring). In early July, only one sucker was selected per each hole and the others were removed.

Sample of the soil was analyzed at the beginning of the experiment as shown in Table (1). In this respect, soil texture was sandy clay loam.

All plants received the traditional and regular fertilization program, of which about 40 kg balady manure (FYM) + 250 gm super phosphate (15.5% P_2O_5)/plant/year added in December, about 500 gm N/plant divided into fourteen equal doses from April to October intervals and 1200 gm potassium sulphate (48-52% K_2O)/plant/year added in three equal doses (April, June and July). As for irrigation, plants either under shading or open field conditions were irrigated when the soil reached the field capacity (using soil moisture determination instruments). At shooting stage, leaf sample was taken from the middle of the third leaf from the top of each plant[4], washed with tap water then with distilled water and dried at 70EC till constant weight and finally ground and digested to determine total nitrogen, phosphorus and potassium percentages as the methods described in A.O.A.C.[5].

- Total chlorophyll in the fresh leaves was determined as spad units (spad = 100 mg chlorophyll/gm fresh weight) by using Minolta chlorophyll meter (spad, 501).
- Number of emerged suckers per plant was calculated among the growing season for each plant.
- Infected plants with virus diseases (Bunchy Top virus or Banana Streak virus (BSV)) were calculated as percentage for each shading or open field conditions.

Corresponding Author: M.M.S. Saleh, Pomology Department, National Research Center, El-Tahrir St., Dokki, Cairo, Egypt.

Table 1: Chemical properties of the soil sample.

pH	E.c. mmohs	O.M%	$CaCO_3$ %	Soluble cations Meq/100g				Soluble anionsMeq/100g				Macro nutrients %		
				Na^+	K^+	Ca^{++}	Mg^{++}	$CO_3^=$	HCO^-_3	Cl^-	$SO4^-$	N	P	K
7.14	1.20	1.83	2.20	2.3	0.9	4.7	1.7	-	2.5	0.4	6.7	0.013	0.003	0.05

- Number of days from planting to shooting and to harvest, also number of days from shooting to harvest was calculated.
- Length and girth of pseudostem, total and green leaves per plant, also third leaf area were measured at shooting for each plant.
- At harvest stage, bunch, hand and finger weight were determined, also number of hands and fingers per bunch were calculated for each plant.
- The data were subjected to analysis of variance and the method of Duncan was used to differentiate means[6].
- Day light intensity, temperature and humidity were measured under shading and open field conditions at midday through the summer months. In this respect, day light intensity under shading was reduced by about 76% than open field condition. Temperature was 12% lower under shading comparing with open field. Humidity was higher under shading by about 71% than open field condition.

RESULTS AND DISCUSSIONS

Vegetative growth: The effect of shading condition on vegetative growth of Williams banana plants are shown in Table (2) as follows:

As for length and girth of pseudostem, Data showed that length of pseudostem did not significantly affect by shading, although plants were taller than those grown under open field condition. As for girth of pseudostem, it was significantly reduced under shading comparing with open field. This was true in the first and second seasons.

Regarding number of leaves per plant and third leaf area, shading condition significantly increased number of green leaves in both seasons, while number of total leaves was significantly increased in the second season only. In contrast, it reduced third leaf area in both seasons, but this reduction lacked significance.

On the other hand, number of emerged suckers per plant was significantly decreased with shaded plants, since it recorded (0.8 and 2.1) suckers/plant for shading in the first and second seasons, respectively, while it reached (2.5 and 4.0) suckers/plant for open field condition in the first and second seasons, respectively.

Concerning infected plants percentage, it is clear that there was no infection with virus diseases and no infected plants were detected under shading in both seasons. While about (18 – 22%) was recorded as infected plants under open field condition in the first and second seasons, respectively.

Leaf mineral and chlorophyll content: Results in Table (3) showed the effect of shading conditions on both mineral and chlorophyll content in the leaves.

As for leaf mineral content, it is clear that shading had a negative effect on nitrogen percentage, since this treatment significantly reduced nitrogen in the leaves compared with those plants grown under open field condition. Phosphorus content in the leaf did not significantly affect by treatments, although it tended to decrease with shading condition. This was true in the first and second seasons. Regarding potassium, it is observed that shading reduced potassium content in the leaf than those under open field condition. This reduction was significant in the second season only.

Chlorophyll content in the leaves was reduced under shading compared with open field, but this reduction lacked significance.

Period from bunch shooting to harvesting: Results in Table (4) show the effect of shading conditions on the period from sucker emergence to bunch shooting and to bunch harvesting, also from bunch shooting to bunch harvesting. In this respect, all of this parameters were significantly lengthened under shading than open field condition except the period from bunch shooting to harvesting which lacked significance. This was true in both seasons of the study.

Yield and fruit quality: Data recorded in Table (5) showed the effect of shading with black saran on yield and fruit quality of Williams banana.

As for bunch weight, it is clear that shading condition significantly reduced bunch weight in both seasons of the study. Since, it reached (8.67 and 10.33 kg) in the first and second seasons, respectively. While under open field condition it recorded (12.27 and 22.75 kg) in the first and second seasons, respectively.

Regarding number of fingers and hands per bunch, these parameters tended to increase under open field than shading condition. This increment lacked significance except for number of fingers in the second season.

Table 2: Effect of shading on vegetative growth, number of suckers/plant and infected plant percentage of Williams banana through 2001-2002 and 2002-2003 seasons.

Treatments	Pseudostem				No. of green leaves		No. of total leaves		Third leaf area (m^2)		No of suckers/plant		Infected plant (%)	
	Length (cm)		girth (cm)											
	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
Shading	268	282	68.7 b	71.3 b	15.3 a	16.0 a	40.3	42.0 a	1.33	1.40	1.1 b	2.1 b	0.0 b	0.0 b
Open field	260	267	80.0 a	88.0 a	11.3 b	11.7 b	37.7	38.0 b	1.48	1.69	2.5 a	4.0 a	18.0 a	22.0 a
Significance	N.S	N.S	S.	S.	S.	S.	N.S	S.	N.S	N.S	S.	S.	S.	S.

Means having the same letter(s) within a column are not significantly different at 5% level.

Table 3: Effect of shading on nitrogen, phosphorus, potassium and chlorophyll content in Williams banana leaves through 2001-2002 and 2002-2003 seasons.

Treatments	N %		P %		K %		Chlorophyll (spad)	
	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
Shading	2.14 b	2.27 b	0.11	0.13	2.33	2.36 b	59.8	59.2
Open field	2.53 a	2.61 a	0.14	0.17	2.48	2.93 a	63.2	62.8
Significance at 5% level	S.	S.	N.S	N.S	N.S	S.	N.S	N.S

Means having the same letter(s) within a column are not significantly different at 5% level.

Table 4: Effect of shading on the period from sucker emergence to bunch shoot, to bunch harvest and from bunch shoot to bunch harvest through 2001-2002 and 2002-2003 seasons.

Treatments	Period in days					
	from sucker emergence to bunch shoot		from bunch shoot to bunch harvest		from sucker emergence to bunch harvest	
	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
Shading	416 a	428 a	128	134	544 a	562 a
Open field	356 b	358 b	100	109	455 b	468 b
Significance at 5% level	S.	S.	N.S	N.S	S.	S.

Means having the same letter(s) within a column are not significantly different at 5% level.

Table 5: Effect of shading on yield and fruit quality of Williams banana through 2001-2002 and 2002-2003 seasons

Treatments	Bunch weight (kg)		No. of fingers/bunch		No. of hands/bunch		Finger weight (gm)		Hand weight (Kg)	
	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
Shading	8.67 b	10.33 b	156	173 b	10.0	10.0	56.3	40.3 b	0.86	1.03 b
Open field	12.57 a	22.75 a	173	231 a	11.7	11.7	72.7	98.0 a	1.07	1.94 a
Significance at 5% level	S.	S.	N.S	S.	N.S	N.S	N.S	S.	N.S	S.

Means having the same letter(s) within a column are not significantly different at 5% level.

Concerning hand and finger weight, both of them were increased under open field than shading, but this increment was significant in the second season only. This was true for both parameters.

The previous results of shading could be explained due to the negative effect of black saran on plant biosynthesis which in turn reduced pseudostem girth, third leaf area and number of emerged suckers per plant, also decreased minerals and chlorophyll content in the leaves and consequently the final bunch yield compared with open field condition. Moreover, the period from sucker emerged to bunch shooting and to harvest were lengthened under shading condition. In this respect, Thomas[7] and Turner[8] reported that, banana leaf canopies are sensitive to shading and the reduced rates of leaf gas exchange of older banana leaves are most likely a result of shading, especially in hot, arid environment.

Israeli[9] studied The effect of 3 levels of black saran shade on Grand Nain (AAA) bananas. The resultant photosynthetic photon flux density (PPFD) was reduced to 80, 60 or 30% of the unshaded control. They found that only the heaviest shade affected plant vegetative growth, delayed flowering date, reduced the rate of leaf emergence, leaf and foliage area, and pseudostem circumference. Also bunch weight was reduced by 7 and 32% under medium and heavy shade, respectively. During the second cycle, bunch weight was reduced by 8, 21 and 55% under light, medium and heavy shade, respectively.

All levels of shade reduced yield. These observations indicate that long-term shade has a significant effect on bananas and that bananas are able to utilize high levels of PPFD.

Israeli[10] planted Grand Nain banana under shading with black saran comparing with different irradiance levels. They found that time-integrated parameters such as leaf mass to area ratio and banana production were linearly correlated with irradiance level.

Eckstein[11] reported that Windbreak shading reduced average photosynthetically active radiation (PAR) by 69%, which in turn reduced photosynthesis rate by 27%, transpiration rate by 38% and stomatal conductance by 40% compared with plants growing in full sun, this led to a reduction in monthly leaf emergence rate and an extended cycle time, also caused an overall reduction of 13% in annual yield per ha, compared with plants growing in full sun.

On the other hand, the positive effect of open field condition may due to the influence of environmental factors (relative humidity of the atmosphere, air movements, air temperature, light intensity and soil conditions) on transpiration rate and the rate of absorbed water and mineral nutrients by the root system of the plant[12], which resulted in increasing leaf mineral content, leaf area, girth of circumference and consequently bunch weight.

From the abovementioned results it could be concluded that although, there was no infections or shredding were occurred through the plant leaves and increasing number of total and green leaves/plant, shading with black saran is not recommended for banana plants, since it reduced irradiance level by about 76% than open field condition which in turn negatively affected on vegetative growth, leaf mineral content and yield of Williams banana plants. We suggest investigating other shading materials which increase irradiance level than that of black saran.

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