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YIELD RESPONSES OF TWO BANANA cvs. 'ROBUSTA' AND 'GIANT CAVENDISH' (WILLIAMS HYBRYD) TO DIFFERENT LEVELS OF IRRIGATION

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ABSTRACT

A field trial to evaluate fruit yield responses of two banana cultivars 'Robusta' and 'Giand Cavendish' to three levels of irrigation and a non-irrigated control was conducted on Soucis clay loam in St. Lucia. The results show that potential fruit yield responses of each of the two cultivars to irrigation were not significantly different and maximum yield increase with irrigation were 5, 17.5 and 13 per cent for the first second and third crops respectively.

The susceptibility of each cultivar to wind damage increased with irrigation but 'Giant Cavendish' was less susceptible than 'Robusta' at all levels of irrigation. Mainly on account of its lower susceptibility to wind damage, the harvested yield of 'Giant Cavendish' exceeded 'Robusta' on the average by 0.5, 9.1 and 3.8 tonnes per hectare in the first, second and third crops.

INTRODUCTION

Wind damage represents the biggest single source of loss of banana fruit in nearly all the major banana growing areas of the world (SIMMONDS, 1966). The taller banana plants are more susceptible to wind damage than shorter plants. (WALKER, 1970) was able to show that the banana cv. 'Valery' was superior to the cvs. 'Lacatan' and 'Robusta' because of its lower height and greater yield.

More recent research in Jamaica has shown that the banana cv. 'Giant Cavendish' (Williams hybrid) has agronomic characteristics considered more desirable than those of cv. 'Valery' (SHAND, 1979; THOMPSON and RAWLE, 1979). Furthermore SHILLINGFORD and SHAND (1979). have demonstrated that there is very little difference if any, in the storage and ripening quality between the cvs. 'Valery' and

'Giant Cavendish'. Based on their assessments, SHILLINGFORD and SHAND (1979) recommended 'Giant Cavendish' as an approved cultivar for more extensive commercial banana production.

In the Windward Islands, the banana trade is dominated by the cv. 'Robusta' or 'Poyo' with smaller areas under 'Valery' and 'Giant Cavendish'. Cultivation of 'Giant Cavendish' is restricted to the high rainfall areas as recommended by Winban (1976).

Increasing interest in the use of irrigation for banana production along with a lack of reported work on cultivar responses to irrigation in the Caribbean amply justifies a cultivar-irrigation study. In this study, the yield responses of the two important banana cultivars in the Caribbean, 'Robusta' and 'Giant Cavendish' (Williams Hybrid) to different levels of irrigation were evaluated.

MATERIALS AND METHODS

The study was conduted on Soucis clay loam (STARK et al., 1966) belonging to the subgroup Fluvaguentic Eutropepts (SMITH, 1974), et Winban Research Farm in the Roseau Valley of St. Lucia (Latitude, 14º north, Longitude, 61º west). Sword suckers of the banana cultivars 'Robusta' and 'Giant Cavendish' (Williams hybrid) were planted in the form of a split-split-plot desing. The main effects were the two banana cultivars and each main plot was 30.5m x 80m. The sub-effects were irrigation levels and there were three irrigated treatments and a non-irrigated control, while the sub-effects were three nitrogen rates. There were four replicates.

Planting was done on cambered beds, not previously tilled and suckers were spaced 2.4m apart. There were 384 plants in each main plot, 144 were monitored in the plant crop and the two succeeding crops while 240 plants were guards. The crops were grown according to the recommendations outlined in the Banana Growers Manual (Winbar, 1976).

Irrigation was applied with a sub-canopy sprinkler irrigation system similar to that used by ARSCOTT et al. (1965). During the plant crop, the moisture contents of the irrigated treatments were raised to field capacity when the soil available moisture levels were 75,66, and 50 per cent respectively, referred to as $I_{0.75}$, $I_{0.66}$ and $I_{0.50}$. At 40 weeks, the treatments were applied on the basis of the irrigation requirement (IR) defined by BORDEN (1975). The $I_{0.50}$ and $I_{0.60}$ treatments were changed to irrigation at 50 per cent of consumptive use less effective rainfall every 8 and 4 days ($^{0.5}I_8$ and $^{0.5}I_4$) respectively; and the $I_{0.75}$ treatment, to irrigation at 100 per cent consumptive use less effective rainfall every 2 days ($^{1.0}I_2$). A non-irrigated control (I_0) was maintained throughout.

The change in the method of irrigating occurred at the time when harvesting of the plant crop was already in progress. Therefore, the new method of irrigating, adopted because it was simpler to apply in practice was confined essentially to the second and third crops. The volumetric soil moisture content determined gravimetrically at regular intervals was converted to soil available moisture using a pF curve determined for the experimental area. This provided a comparison of the moisture regimes of the different treatments.

Yield was expressed in terms of potential and harvested fruit yield per hectare. Potential fruit yield is the product of the average bunch weight and the total number of plants per hectare. Harvested fruit yield is the product of potential fruit yield and the harvest per cent defined as the per cent of plants with intact peudostems from which bunches were harvested.

RESULTS

The average monthly soil moisture potentials of the three irrigated treatments and the non-irrigated control are presented for the plant crop in Fig. 1 and for the second and third crops in Fig. 2. Bunch emergence and fruit development occurred in the dry season for the first crop and during the wet season for the second crop. In each of these crops, bunch emergence coincided with the transition between wet and the dry season. However, in the third crop, bunch emergence occurred in the dry season.

The potential and harvested fruit yields of the plant crops of the two cultivars 'Robusta' and 'Giant Cavendish' under three irrigated treatments and a non-irrigated control are presented in Table 1. Differences in potential yield between the $I_{0.50}$ and I_0 treatments and between the $I_{0.66}$ and $I_{0.75}$ treatments for each cultivar were non-significant. However, potential yields from the latter two treatments were significantly larger than the former two treatments at P=0.05 for 'Robusta' and P=0.01 for 'Giant Cavendish'. The actual harvest yields of Robusta fruit from the irrigated treatments were not significantly different from the non-irrigated control while for 'Giant Cavendish' actual fruit yields from the $I_{0.66}$ and $I_{0.75}$ treatments were significantly greater (P=0.05) than from the $I_{0.50}$ and I_0 treatments. Differences in harvested yield between the latter two and between the former two treatments were non-significant. Harvests from the $I_{0.75}$ and $I_{0.66}$ treatments were larger for 'Giant Cavendish' than for 'Robusta' but the differences were not significant. For each cultivar, the per cent of fruit loss (i.e.difference between potential and harvested fruit yields as per cent of potential fruit yield) was greatest in the non-irrigated control.

Potential fruit yield and harvested fruit yield of the second and third crops of the two banana cvs. under different irrigation treatments are given in Table 2. In the second crop, differences in potential fruit yield of each cultivar between the I_0 and ${}^{0.5}I_8$ treatments and between the ${}^{0.5}I_4$ and ${}^{1.0}I_2$ treatments were non-significant. However for each cultivar, potential yield of the latter two treatments was significantly larger (P=0.01 for each cultivar) than the former two treatments. Maximum increases in potential yield due to irrigation was 16.5 per cent for 'Robusta' and 17.5 per cent for 'Giant Cavendish'.

Harvested 'Robusta' fruit from the non-irrigated control pf the second crop accounted for 76 per cent of the potential yield and was not significantly different from the harvested yield from the ${}^{0.5}I_8$ treatment. Harvested 'Robusta' fruit from the ${}^{0.5}I_4$ and ${}^{1.0}I_2$ treatments were significantly smaller (P=001 each) than from the control (I_0) treatment. Harvested fruit from the ${}^{0.5}I_4$ and ${}^{1.0}I_2$ treatments of 'Robusta' accounted for 59 and 56 per cent respectively of the potential yield.

Harvested fruit yield from the I_0 treatment of 'Giant Cavendish' though 89 per cent of the potential yield was not significantly different from harvested yield from the ${}^{0.5}I_8$ treatment in the second crop. Both were however significantly (P=0.1) smaller than the harvested yield from the ${}^{0.5}I_4$ treatment but not significantly different from the most frequently irrigated treatment, ${}^{1.0}I_2$. In the latter case, only 74 per cent of the potential yield was harvested. At each level of irrigation, including the control, more 'Giant Cavendish' than 'Robusta' fruit was harvested the differences were significant for the two highest levels of irrigation, i.e $^{0.5}I_4$ and $^{1.0}I_2$ treatments, at P=0.01 and P=0.05 respectively.

In the third crop there were significant increases in potential yield of 'Robusta' due to irrigation and the maximum increase in yield was 13.1 per cent. Increases due to the $^{0.-}I_8$ and $^{0.5}I_4$ treatments were significant at P=0.05 while at P=0.01 for the $^{1.0}I_2$ treatment. There were no significant responses in potential yield of 'Giant Cavendish' to irrigation. However, the harvested fruit yield of 'Giant Cavendish' was larger than 'Robusta' for each of the four treatments though not significantly larger. Significantly more 'Giant Cavendish' fruit was harvested from the $^{1.0}I_2$ treatment (P=0.01) and from the $^{0.5}I_8$ and $^{0.5}I_4$ treatments (P=0.05 each) than from the non-irrigated control (I_0).

The irrigated treatment also produced significantly larger harvested of 'Robusta' fruit, $^{0.5}I_8$ and $^{1.0}I_2$ at P=0.01 level while $^{0.5}I_4$ at P=0.05 level, than the non-irrigated control (I_0). The harvested fruit yield of 'Giant Cavendish' averaged over the four treatments was 0.5, 9.1 and 3.8 tonnes per hectare larger than 'Robusta' in the first, second and third crops respectively.

Final pseudostem heights of the second and third crops of the two banana cultivars are presented in Table 3. The two highest levels of irrigation produced significantly larger final pseudostem heights of 'Robusta' and of 'Giant Cavendish' (P=0.01 each) than the lowest level of irrigation ($^{0.5}I_8$) and the non-irrigated control (I_0). In the third crop, differences in final pseudostem height between treatments for each cultivar were non-significant. However, for each crop, the final pseudostem height of 'Robusta' was significantly (P=0.01) larger than 'Giant Cavendish' for each treatment. In the second and third crops, the average final pseudostem heights of 'Robusta' was 54cm and 74cm respectively greater than 'Giant Cavendish'.

DISCUSSION

'Giant Cavendish' had a larger potential yield at the maximum level of irrigation than 'Robusta'. The difference was however not significant. The difference in fruit losses from the two cultivars was the major contributing factor to the differences in harvested yield. Wind damage (i.e broken pseudostems) accounted for over 85 per cent of the fruit losses in the first and second crops. Unpublished data of the authors show that in the first crop, the average pseudostem height of 'Robusta' was 20cm larger than'Giant Cavendish' which, it is believed, makes the former cultivar more susceptible to wind damage.

The second crop experienced heavy winds between bunch emergence and harvesting and irrigation increased the susceptibility of the plants to wind damage. Irrigation especially the two highest levels (i.e $^{0.5}I_4$ and $^{1.0}I_2$) significantly increased the average bunch weigts of each cultivar as shown by the potential yields. This increased weight, along with the increased pseudostem height both increase the torque about the pseudostem under windy conditions. For 'Robusta' fruit losses from the non-irrigated control was about 24 per cent and increased with irrigation up to some 44 per cent for the highest level of irrigation, $^{1.0}I_2$. 'Giant Cavendish', however, was better able to withstand the high winds even under irrigation. There was, for example, no significant difference in fruit loss between the second highest level of irrigation and the non-irrigated control. A maximum loss of 25 per cent was sustained by 'Giant Cavendish' at the highest level of irrigation. The percentage of fruit loss in the non-irrigated treatments, which still remains high is probably the result of reduced shear strength of the pseudostem under dry conditions. It would seem that the present system of proping bananas i.e the guideline and peg method is rendered less effective especially for the cv. 'Robusta' under wet or irrigated soil conditions due to reduced soil strength. Under conditions of high winds which are not uncommon in the Windward Islands, an average of 9.1 tonnes per hectare more fruit was harvested from 'Giant Cavendish' than from 'Robusta'.

In the third crop, the difference in average pseudostem heigth between the two cultivars increased from 54cm in the second crop to 74cm and wind peeds were considered more normal. The low response of potential yield to irrigation is probably due to over-irrigating, producing waterlogged conditions at the highest level of irrigation and consequently a reduction in potential yield. However, the harvested yield obtained during an intense dry period showed large and very significant increases in yield due to irrigation. The lower harvested yield of 'Robusta' from each treatment underlines its greater susceptibility to wind damage even under wind conditions considered to be normal. For each cultivar, the greatest loss in yield of the third crop was from the non-irrigated control (I_0). In addition to reduced shear strength of the psedostem and consequently breakage under dry conditions, the cultivar 'Giant Cavendish' suffered additional losses due to 'Choking' and deformed bunches, both morphological responses of the cultivar to drougth (KUHNE and

GREEN, 1970). Although the cv. 'Robusta' exhibited none of these drought symptoms, it nevertheless had a grater per cent loss of fruit in the non-irrigated treatment than 'Giant Cavendish' because of higher number of pseudostem breakage. In this third crop, an average of 3.8 tonnes per hectare more fruit were harvested from 'Giant Cavendish' than 'Robusta'. In the plant crop, in which vegetative growth of the crop coincided with the wet season, the $I_{0.66}$ treatment was as effective in influencing potential yield of the two cultivars and harvested yield for 'Giant Cavendish' as was the $I_{0.75}$ treatment. The yield from the $I_{0.50}$ treatment was not significantly different from the non-irrigated control. This partly supports the earlier finding of SHMEULI (1953) that 66 per cent available moisture content was critical for banana growth. In the second and third crops, the ${}^{1.0}I_2$ treatment was an over-irrigated treatment in which water-logging was manifested. The ${}^{0.5}I_4$ treatment was the best and would certainly warrant an analysis based on costs and benefits.

While irrigation increased the potential yield of both cultivars, a higher level of harvestable yield was obtained from the cv. 'Giant Cavendish'. 'Robusta' because of its larger final pseudostem height and consequently larger susceptibility to wind damage, is less suitable for an irrigated croping system than 'Giant Cavendish' under the presently recommended agronomic practices in the Windward Islands.

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