COAL RESIDUE USE AND BANANA IRRIGATION DEPTHS EFFECTS DURING THE SECOND CICLE IN NORTHERN MINAS GERAIS

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SUMMARY: Banana production is an important economic activity for job and wealth generation in Northern Minas Gerais. In this region, water availability is scarce. There is also the vegetable coal residue availability in Northern Minas Gerais, and this residue needs to be used for the environmental conditions improvement. Banana plants received different irrigation depths (80%, 100%, and 133% of the recommended depth) with and without the application of the residue (biocoal). The biocoal dose when used was 8 ton ha^{-1}. The plants heights, pseudostem diameter and leaf number were evaluated during bunch emissions. We also measured, in the first and second production cycles, the bunch weight and the yield components (rachis weight, hands weight, average fruit weight, diameter, and length). As expected, there was a tendency of reduced banana yield under reduced irrigation depths, although the effect was not very remarkable in the first two cycles, some growth parameters and yield components were affected by irrigation in the second cycle, indicating the need for an adequate water management for banana production with and without the residue application. The preliminary results did not show statistical differences due to biocoal application, indicating the potential for the residue use. This research can support an environmentally beneficial residue use and also support the development of irrigation management strategies for better water use efficiency in banana plantations.

KEYWORDS: *Musa* spp.; Biocoal; Irrigation Management

USO DE RESÍDUO DE CARVOARIA E LÂMINAS DE IRRIGAÇÃO NO SEGUNDO CICLO DA BANANEIRA NO NORTE DE MINAS GERAIS

RESUMO: A bananicultura irrigada promove importante geração de emprego e renda no Norte de Minas Gerais sendo, entretanto, limitante a disponibilidade de água para a atividade. Há

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também na região disponibilidade do resíduo de carvoaria vegetal (moinha/biocarvão) sendo necessário, do ponto de vista ambiental, o aproveitamento do mesmo. As bananeiras foram submetidas a distintas lâminas de irrigação (80%, 100% e 133% da lâmina recomendada) com ou sem a aplicação do resíduo (biocarvão). O resíduo, quando aplicado, foi utilizado na dose de 8 ton ha^{-1}. Durante a emissão do cacho, foram avaliadas as alturas das plantas, os diâmetros de pseudocaule e os números de folhas. Também se obteve durante o primeiro e segundo ciclos a produção (peso do cacho) e seus componentes (peso das pencas, do engaço, peso médio dos frutos, diâmetro dos frutos e comprimento dos frutos). Como esperado, houve uma tendência na redução da produtividade com a lâmina de irrigação reduzida, mesmo os resultados preliminares não apontando diferenças destacadas nos primeiros dois ciclos, alguns parâmetros de crescimento e componentes da produção foram alterados no segundo ciclo, indicando a necessidade de um manejo de água adequado para a produção de banana. Os resultados preliminares não indicaram diferenças estatísticas devidas à aplicação do resíduo de carvoaria, indicando o potencial de aproveitamento do resíduo. Esta pesquisa pode propiciar beneficio ambiental através do aproveitamento de resíduo e dar suporte a estratégias de manejo de irrigação para maior eficiência no uso de água na produção de bananas.

PALAVRAS-CHAVE: *Musa* spp.; Biocarvão; Manejo de Irrigação

INTRODUCTION

Alternatives for improving water use efficiency in irrigated banana plantations in semiarid regions are necessary. Recent studies suggested that the residue of vegetable charcoal (biocoal) can influence the physical and hydraulic characteristics of the soils.

Irrigated banana plantations have great social and economic importance in Northern Minas Gerais. Due to the climatic conditions, banana orchards must be irrigated in this region. Water management can affect banana yield and quality (GOENAGA and IRIZARRI, 1995; GOENAGA and IRIZARRI, 2000). Beyond the direct effects on water conditions and plant growth, inappropriate irrigation management can affect banana increasing soil salinity (CARMO et al., 2003). Inappropriate irrigation management also can cause leaching of pesticides used in the banana plantation management damaging the environment (DIAZ-DIAZ et al., 1998).

Previous research recommended microsprinkler irrigation for banana plants irrigation in Northern Minas Gerais (ALMEIDA, 1999). For the conditions of Jaiba and Gorutuba irrigation

districts, the effects of irrigation depths for banana production were determined and coefficients for irrigation water management were suggested (FIGUEIREDO, 2002; SIMÃO, 2002; SIMÃO, 2004), however, there is a need to adjust the proposed coefficients to their use in specific conditions different from the ones from their development.

In the semiarid region of Northern Minas Gerais, banana production clusters generates thousands of jobs with revenues in the order of millions of reais. However, water availability is a threat to irrigated banana production sustainability in the region. Due to prolonged droughts occurred in the last years the government restricted irrigation water use in the region districts due to lack of good quality water for the population supply and irrigation (MINAS GERAIS, 2013). Therefore, in that period, water availability for irrigation was reduced even though when the irrigation district had the appropriate water use rights. The reduction was determined in order to guarantee the high-priority water uses such as human and livestock consumption. The critical situation created a population and water users' demand for alternatives to increase water use efficiency in irrigated banana plantations located in semiarid regions.

Agricultural practices such as the organic matter soil application in the form of mulch composed of shredded corn (*Zea mays* L.) and grasses (*Paspalum* spp.) can affect soil water retention in banana plantations (Mc INTYRE et al., 2000). Furthermore, the benefits of organic matter are known and its application is recommended for banana plantations (SILVA and BORGES, 2008; SOUZA et al., 1999).

Biocoal is recently considered an alternative for improving water holding capacity and reducing prejudicial water stress effects (MANGRICH et al., 2011; SANTOS et al., 2011; GUEDES, 2010). The modifications in the hydraulic soil characteristics due to biocoal application can, potentially, influence in the irrigation effects in banana plants. Since there is availability of vegetable coal from eucalyptus forests in Northern Minas Gerais, its residue can be a valuable source of biocoal at low cost to the fruit producers.

In soybean production, biocoal application changes the bacterial communities favoring bacterial diversity and increasing yield (SANTOS et al., 2011). Furthermore, it was suggested that biocoal application can harmonize energy and food production, increase soil fertility, and promote carbon sequestration (MANGRICH et al., 2011).

Therefore, the objective of this work was to determine the join effect of irrigation levels under vegetable charcoal residue application in irrigated banana plants growth and yield in the two initial production cycles.

MATERIALS AND METHODS

The experiment was conducted in the Minas Gerais State Research Institute Experimental Field in Montes Claros-MG-Brazil (EPAMIG/CEMC) located in the Brazilian semiarid region, in Northern Minas Gerais. CEMC soil is fine textured with high water holding capacity.

The banana plants were planted in the 3 x 2,5 m^2 spacing, and the plantation practices followed EPAMIG's recommendations (RODRIGUES et al., 2008; SILVA e BORGES, 2008; COSTA et al., 2008). When the vegetable coal residue (biocoal) was applied the dose used was 8 t ha^{-1}.

The irrigation system was by microsprinkles with one emitter to each four plants. Irrigation was applied in a two days turns, and depths were percentages of the orchard irrigation recommendation that was determined with the use of climatic data provided by an automatic weather station located in the experimental field (CEMC) following FAO recommendations (ALLEN et al., 1998). The irrigation treatments were nearly 80%, 100% and 133% of the standard irrigation.

The experiment treatments were the irrigation levels with and without the biocoal application as observed on Table 1.

Table 1 – Treatments used in the research

Treatment	Biocoal (ton ha^{-1})	Irrigation (%)
T1	0	80
T2	0	100
T3	0	133
T4	8	80
T5	8	100
T6	8	133

Experimental design was a factorial with blocks (Factorial RBD). There were four repetitions per block totaling 24 experimental units. Each experimental unit were composed of the four central plats of a group of 16 plants irrigated by four microsprinklers adapted to the irrigation treatment flow, the other 12 plants served as borders.

During the bunch emission, we measured the plant growth parameters height, pseudostem diameter, and number of leaves. During harvest, the bunch weight and the yield components number of banana hands, rachis weight, number of fruits per bunch, average fruit weight, average fruit diameter, and fruit length, and the number of leaves per plant were determined as

well. The significance of each treatment for each variable was tested with analysis of variance at 5% and 1% probability levels.

RESULTS AND DISCUSSION

In the first banana production cycle, the bunch weight (and its components) did not differ as a function of irrigation and vegetable coal residue (biocoal) application (Table 2), however, in the second year, banana production was slightly lower when the irrigation was reduced (Figure 1). The bunch weight can be explained by the average fruit weight that followed the same pattern with slight lower values observed in the reduced irrigation treatments but with no biocoal interaction (Figure 2).

Table 2 – Banana production components statistical significance as a function of irrigation, vegetable coal residue (biocoal) application, and their interaction

Yield component	Irrigation	Biocoal	Interaction
1st cycle			
Bunch weight	n.s.	n.s.	n.s.
Number of banana hands	n.s.	n.s.	n.s.
Rachis weight	n.s.	n.s.	n.s.
Number of fruits per bunch	n.s.	n.s.	n.s.
Average fruit weight	n.s.	n.s.	n.s.
Average fruit diameter	n.s.	n.s.	n.s.
Fruit length	n.s.	n.s.	n.s.
Number of leaves	n.s.	n.s.	n.s.
2nd cycle			
Bunch weight	n.s.	n.s.	n.s.
Number of banana hands	n.s.	n.s.	n.s.
Rachis weight	n.s.	n.s.	n.s.
Number of fruits per bunch	n.s.	n.s.	n.s.
Average fruit weight	*	n.s.	n.s.
Average fruit diameter	*	n.s.	n.s.
Fruit length	*	n.s.	n.s.
Number of leaves	n.s.	n.s.	n.s.

n.s. = non-significant at the 5% level

* = significant at the 5% level

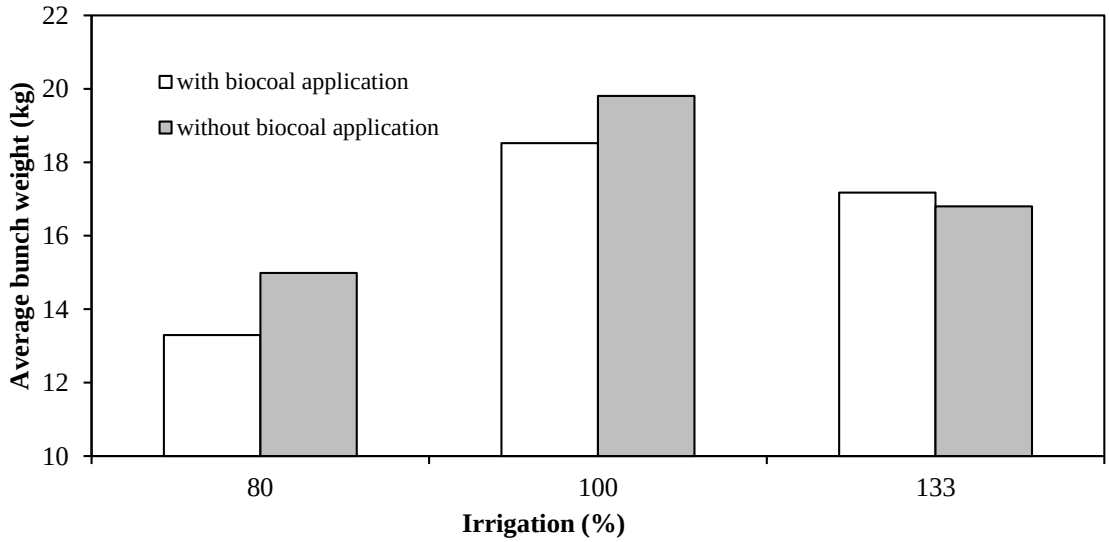

Figure 1 – Second cycle banana production average bunch weight as a function of the irrigation percentage with and without biocoal application in Northern Minas Gerais – Brazil

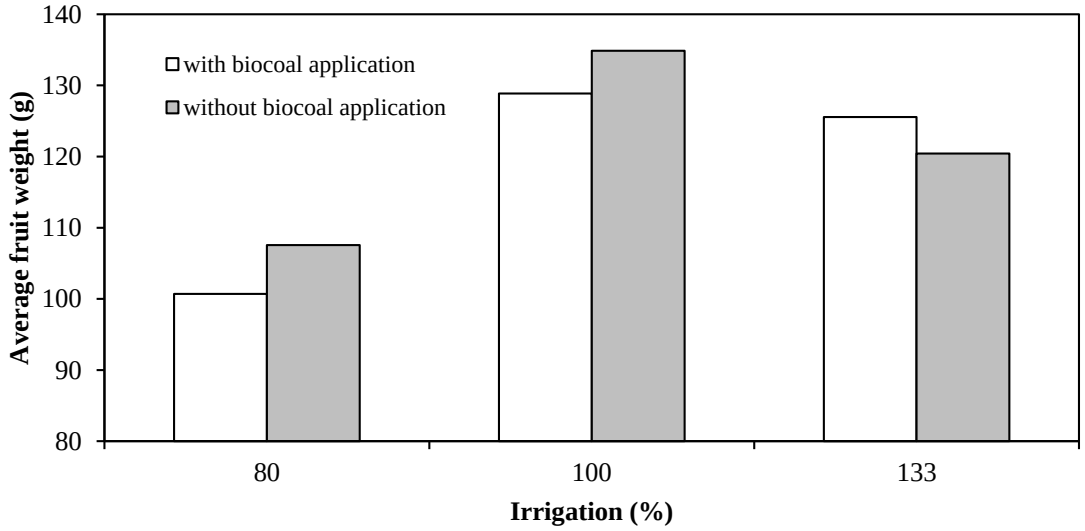

Figure 2 – Second cycle banana production average fruit weight as a function of the irrigation percentage with and without biocoal application in Northern Minas Gerais - Brazil

The effects of irrigation in the first banana cycles are often smaller than in the latest ones, probably due to the influence of the reproductive material reserves. We also expect that the biocoal application major effect will occur in the in the interaction of the irrigation depths effects, therefore, the size of the irrigation effect will be dependent of the size of the biocoal effect.

The irrigation effect on bunch weight (Figure 1) was a reflex of the effects on the average fruit weight (Figure 2). Banana fruits weight are also related with their diameter and length

(figures 3 and 4), since when irrigation was insufficient all theses parameters were reduced, similar to previous research (FIGUEIREDO, 2002; GOENAGA and IRIZARRI, 2000; SIMÃO, 2002; SIMÃO, 2004). However, differently from the cited related studies (FIGUEIREDO, 2002; GOENAGA and IRIZARRI, 2000; SIMÃO, 2002; SIMÃO, 2004) when the irrigation was increased further than the recommended, yield did not increase in this experiment, probably, due to the finer soil texture on the Montes Claros Research Field (CEMC) than in some of the other research sites, that had sandy characteristics (FIGUEIREDO, 2002; SIMÃO, 2002; SIMÃO, 2004) or presented high drainage (GOENAGA and IRIZARRI, 2000).

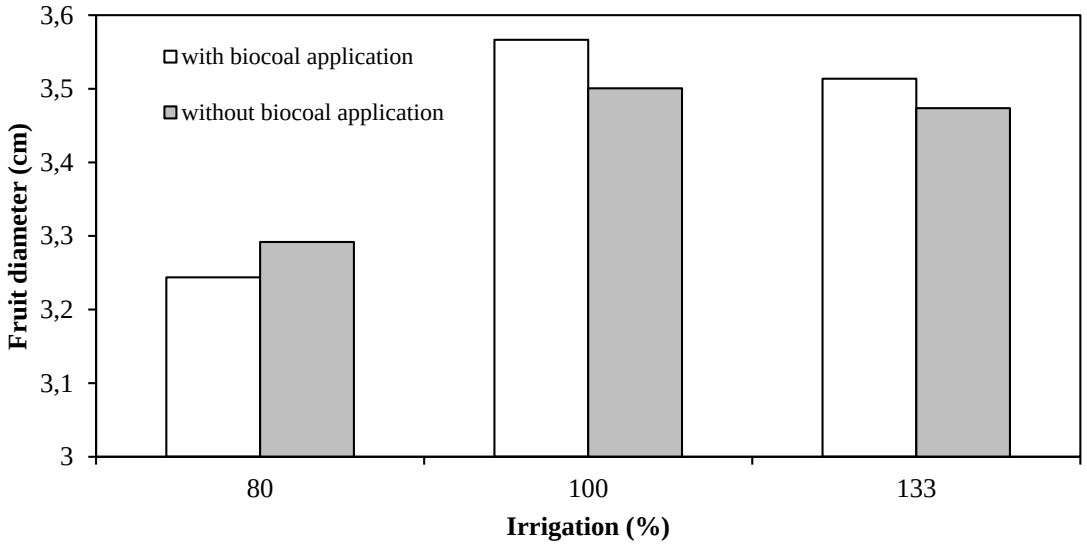

Figure 3 – Second cycle banana production average fruit diameter as a function of the irrigation percentage with and without biocoal application in Northern Minas Gerais - Brazil

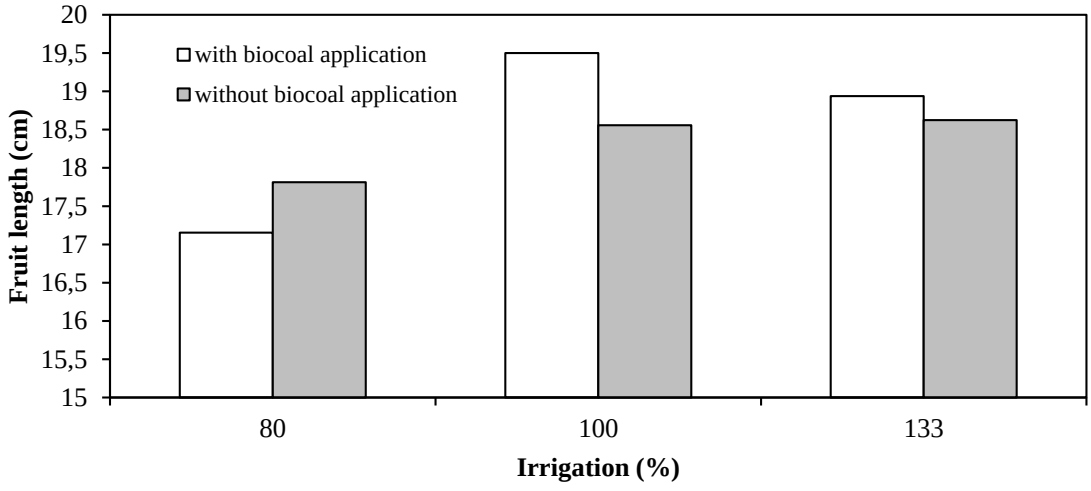

Figure 4 – Second cycle banana production average fruit length as a function of the irrigation percentage with and without biocoal application in Northern Minas Gerais - Brazil

The effects of the treatments in the banana yield are preceded and affected by the effects in plants growth (Table 3). It is also very well known that pseudostem diameter shows high correlation with banana yields (SIMÃO, 2002; SIMÃO, 2004).

Table 3 – Banana plant growth characteristics statistical significance as a function of irrigation, vegetable coal residue (biocoal) application, and their interaction

Growth characteristic	Irrigation	Biocoal	Interaction
1st flowering			
Plant height	n.s.	n.s.	n.s.
Pseudostem diameter	n.s.	n.s.	n.s.
Number of leaves	n.s.	n.s.	n.s.
2nd cycle			
Plant height	**	n.s.	n.s.
Pseudostem diameter	*	n.s.	n.s.
Number of leaves	*	n.s.	*

n.s. = non-significant at the 5% level

* = significant at the 5% level

** = significant at the 1% level

CONCLUSION

As expected, there was a tendency of reducing banana yield for reduced irrigation depths, although the effect was not very remarkable in the first two cycles, some growth parameters and yield components were affected by irrigation in the second cycle indicating the need of an adequate water management for banana production.

The preliminary results did not show statistical differences due to biocoal application, indicating the potential for the residue use.

This research can support an environmentally beneficial residue use and support irrigation management strategies for a better water use efficiency in banana plantations.

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