Short communication

Preliminary results of the pruning and application of FitoMas-E on the yield of Jatropha curcas and associated crops

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ABSTRACT: In order to determine the effect of pruning and application of FitoMas-E on the yield of *Jatropha curcas* and associated crops, through a completely randomized block design, six treatments were studied: T1: control without pruning and without leaf application; T2: control without pruning with leaf application; T3: pruning at 50 cm without leaf application; T4: pruning at 50 cm with leaf application; T5: pruning at 100 cm without leaf application; T6: pruning at 100 cm with leaf application. The days to sprouting, number of emerged sprouts, number of productive branches per plant, number of racemes per plant, number of fruits per raceme, harvested fruits, weight of the fruits, weight of the seeds, were evaluated, and the fruit and seed yields were also estimated. During the experimental stage squash and beans were intercropped and the agricultural yield was calculated. T4 was the most precocious in sprouting (6 days), and it also reached the highest number of sprouts (10), of productive branches (12) and 1,2 t of seed/ha. The squash and beans had yields of 7,0 and 2,7 t/ha, respectively. It is concluded that pruning, combined with the leaf application of FitoMas-E influences favorably the morphological and productive variables of *J. curcas*, for which continuing these studies is recommended.

Keywords: biostimulators, sprouting, crop yield

INTRODUCTION

Physic nut (*Jatropha curcas* L.) belongs to the *Euphorbiaceae* family, was originated in Mesoamerica, but it is cultivated in diverse countries for agroenergy purposes.

The research results indicate that physic nut will be one of the substitutes of fossil fuels in biodiesel production; this species could ensure an abundant provision for its use as element of other fuels, which turns it into the most promising environment-friendly plant fuel of the future (EuropaBio, 2013). However, to achieve the highest efficiency of its production, it is necessary to take into consideration some aspects of agronomic management, including pruning, one of the most important practices (González-Rodas, 2011) for the production of flowers and fruits, which depend on the number of terminal panicles per plant.

When applying this cultural measure in physic nut it is intended that the plants have a higher number of branches and, proportionally, higher production; as well as to allow the penetration of sun rays, facilitate the wind passage, enhance the productive branches, regulate plant size, facilitate the manual collection of fruits and eliminate the damaged or unproductive branches (Alfonso and Reyes, 2009).

Until now there is not a pruning sequence recommended for this crop, and the established management practices are based on the general criteria for the maintenance and shaping of the plant structure; but it is unknown which would be the adequate management to provide acceptable fruit yields, as well as the productive variations that can be caused by the edaphoclimatic conditions of each region and by the characteristics of the provenances (Machado, 2011).

At the Pastures and Forages Research Station Indio Hatuey (EEPFIH) –Matanzas, Cuba– prunings have been carried out at 50 cm of height over the soil level, preferably after the fructification stage, in March, so that productive branches are developed, because the collected and introduced provenances only emit one main stem. However, there are still many questions related to the adequate management of pruning, so that it allows to obtain a considerable production of fruits, without affecting

the survival of the plant associated to crops intended for food.

It has been proven that other factors, such as nutrition, also determine the productive yield of the species. In this sense, the utilization of biological products and organic stimulators, which propitiate the expected yields and are in harmony with the environment, is a healthy and less costly alternative that should be taken into consideration in future projects and studies (Soarez, 2014).

The utilization of biofertilizers and stimulators is a progressing practice, accepted by farmers; for this purpose many nutrient-solubilizing microorganisms, soil antagonistic fungi with biostimulator effect and plant hormones are used which, in small quantities, achieve significant effects, such as FitoMas-E, obtained at the Cuban Research Institute of Sugarcane Byproducts (ICIDCA, for its initials in Spanish) –Havana, Cuba–. It is a natural product that contains up to 20 % organic matter, and it has been proven to stimulate the growth of roots, stems and leaves. It also improves nutrition, flowering, fruit filling, and, frequently, reduces the vegetative cycle of crops (López *et al*., 2002).

Considering these benefits, it is appropriate to use food crop systems in association with physic nut (Quimbayo *et al*., 2010), due to its feasibility to improve the soil utilization, with clean management practices that do not affect or contaminate the environment; thus the dependence on only one crop is avoided.

Taking the above-mentioned facts into consideration, the objective of the study was to determine the effect of pruning and application of FitoMas-E on the yield of *J. curcas* and of associated crops.

MATERIALS AND METHODS

The study was conducted in the integrated food and energy production farm of the EEPFIH. For such purpose, *J. curcas* Cape Verde provenance was used, six years after becoming established.

A year before starting the study a homogenization pruning was made on all the plants, at a height of 10 cm on the soil level. The planting distance was 6 x 2 m (833 plants/ha).

The trial was conducted for two years. Each year the two fructification periods of physic nut for the edaphoclimatic conditions of Cuba (July-September and December-February) were taken into consideration.

The rough area of the plot was 24 m wide by 10 m long, and that of the net plot, 12 m wide by 6 m long. Each plot was constituted by 20 plants and four replications (80 per treatment); and six plants were evaluated in each one, for a total of 24 plants.

A completely randomized block design was used, with the following treatments:

- T1: control without pruning and without leaf application
- T2: control without pruning with leaf application
- T3: pruning at 50 cm without leaf application
- T4: pruning at 50 cm with leaf application
- T5: pruning at 100 cm without leaf application
- T6: pruning at 100 cm with leaf application

FitoMas-E was applied on all the branches of each plant, at a rate of 1 L/ha (according to the dose recommended by the ICIDCA), at three moments: a week after pruning, a month before the flowering period, and at the onset of the tree fructification.

The morphological and productive evaluation was carried out on all the plants that made up the net plot. When they were fructifying, the mature and dry fruits were weekly collected, until the end of such phase.

The variables to be measured were adjusted to the descriptors proposed by Campuzano (2009); they were:

- Days to sprouting (DS): it was evaluated after pruning until the emergence of the sprouts from the buds.
- Number of emerged sprouts (ES): the quantity of emerged sprouts after pruning was counted, in each treatment.
- Number of productive branches per plant (PB): The quantity of branches that produced fruits in each plant was counted.
- Number of racemes per branch (RB): The number of racemes per primary branch, in two branches per plant, in each fructification phase of the plant, was weekly counted.
- Number of fruits per raceme (FR): the number of fruits per raceme was counted, in two racemes per plant on different branches, weekly, in each fructification phase of the plant.
- Harvested fruits (HF): the fruits per plant in each harvest were added.
- Weight of the fruits (WF): the weight in grams of 10 mature fruits (color of the shell: yellow) was quantified with the aid of a scale.
- Weight of the seeds (WS): The weight of 100 seeds (g) was quantified with the aid of a scale.

Some of these variables served to estimate the fruit yield (FY) and the seed yield (SY), expressed in kilograms per hectare.

During the experimental stage squash (*Cucurbita maxima*) var. R-G and beans (*Phaseolus vulgaris*) var. Cuba Cueto 25-9, were planted. In the case of squash, the planting distance was 1 m between plants and only one row was planted between two rows of physic nut, separated by a 3-m distance. In beans a planting distance of 70 cm between rows and 30 cm between plants was used, for which between two rows of physic nut there were five rows of the legume (120 cm between both species).

For the maintenance of the plantations the technical standards described for each crop were taken into consideration.

For the data processing one-way ANOVA was used, after verifying that the assumptions met the fitting of variance homogeneity and normal distribution; for such purpose the Infostat statistical package, version 1.1, was used. The means were compared through Duncan's test, for a significance level of $p \leq 0,05$.

RESULTS AND DISCUSSION

The results of pruning in physic nut, for the variables days to sprouting, number of emerged sprouts and number of productive branches per plant, are shown in table1.

T4 significantly differed from the other treatments ($p < 0,05$) in all the variables. It was the most precocious in sprouting (at six days), reached the highest number of sprouts (10) and produced more productive branches (12).

This performance could have been caused by the fact that when pruning at a lower height with regards to the soil level, the plant can make an efficient use of its reserves due to a higher concentration of nutrients, compared with a higher pruning height.

The studies about the effect of pruning height on other trees report contradictory results; thus, due to the absence of conclusive information about the subsequent influence of such practice, only speculative comments can be made. Nevertheless, it is likely that in the systems where pruning is made at a higher height there is a lower recovery of the plants (Stür *et al*., 1994). In this sense, Medina *et al*. (2007) stated that the low cutting (10 cm over the soil level) favors a more accelerated growth of the plant, because perhaps this behavior constitutes a survival strategy of the species.

On the other hand, the use of FitoMas-E could have positively influenced these aspects, because it is a product acknowledged by its anti-stress effectiveness with natural substances inherent to plant metabolism; it also stimulates and invigorates germination or sprouting until the fructification of crops and decreases the damage that can be caused by biotic and abiotic factors (Montano *et al*., 2007).

The development of a higher number of productive branches in T4 turned out to be a relevant aspect, because according to Alfonso and Reyes (2009) this is the main objective pursued with the pruning in physic nut, specifically with the Cape Verde provenance. Physically, this provenance shows a main stem from which several primary and in turn secondary and tertiary branches emerge (Machado, 2011), for which the productivity of the plant will depend on the quantity of branches that are formed from the pruning.

Figure 1 shows the average of racemes per branch (RB) and the fruits per raceme (FR) which were produced in physic nut. Pruning influenced positively the variable RB because no significant differences were found among the treatments with

Table 1. Morphological characteristics of *J. curcas* Cape Verde provenance after pruning.

Treatment	Days to sprouting	Number of emerged sprouts	Number of productive branches per plant
T1	-	2^{c}	4^{d}
T2	-	3^{c}	4^{d}
T3	7^{b}	8^{b}	10^{b}
T4	6^{a}	10^{a}	12^{a}
T5	8^{c}	7^{b}	8^{c}
T6	7^{b}	8^{b}	10^{b}
SE (±)	0,68*	1,12*	0,94*

a, b, c, d: different letters in each row indicate significant differences at $p < 0,05$.

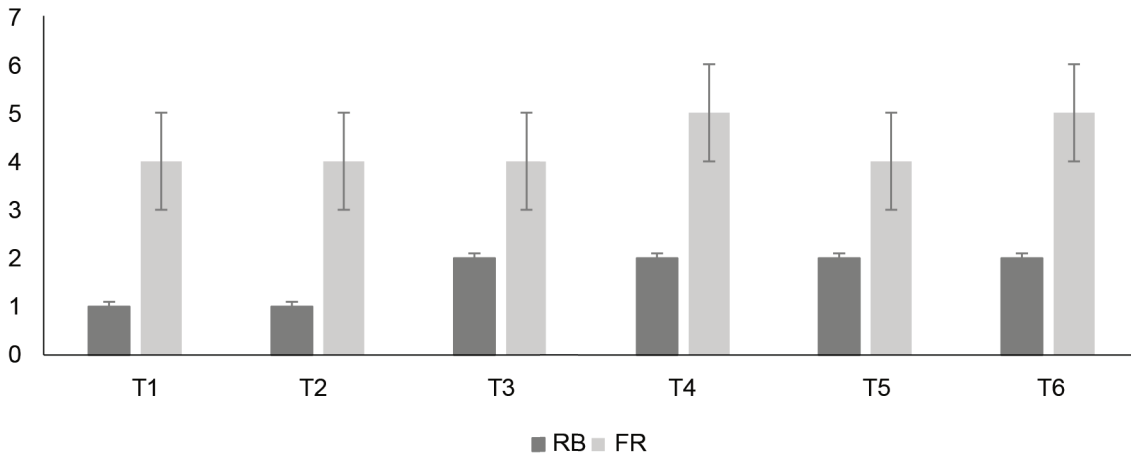

Figure 1. Quantity of racemes per branch and fruits per raceme in *J. curcas* due to pruning.

such practice (T3, T4, T5 and T6), but they differed with regards to T1 and T2.

Guerrero *et al.* (2011) when studying the morphological and agronomic characterization of a *J. curcas* collection, stated that the species generally forms a raceme per branch and only when an adequate agricultural management is applied two RB can be obtained, which was corroborated in the results of this study.

Regarding FR there were no significant differences among the treatments, although there were numerical differences, in favor of T4 and T6, which is important, because it can have incidence on the crop productivity.

The average values of harvested fruits (HF), weight of the fruits (WF), weight of the seeds (WS), fruit yield (FY) and seed yield (SY) are shown in table 2. All the studied treatments produced fruits, with significant differences among them; T4 showed the highest quantity of harvested fruits.

No significant differences were found among the treatments for variables WF and WS. In the case of FY the best treatments were T3, T4 and T6, which did not differ among them, but they did differ from the others, and yields of 22,91; 23,95 and 22,56 kg/ha of fruits, respectively, were obtained.

Regarding SY, 1 243,80 kg/ha (1,2 t/ha) were reached with T4 and it significantly differed from the others. These yields coincide with the ones reported in Peru by Gonzáles-Rodas (2011), who obtained between 0,51 and 1,79 t/ha for the first and second renovation pruning. However, if compared with the ones reported by Loyola-Vargas (2011) they are considered low, because the author refers that the physic nut seeds yield approximately from 6 to 8 t/ha, although he stated that such results were possible after seven years of exploiting the crop, period after which the species starts to stabilize the productive yield.

If it is taken into consideration that the results are preliminary, because the plant only has two years of exploitation, the yields reported by Loyola-Var-

Table 2. Productive characteristics of physic nut due to pruning.

Treatment	Harvested fruits	Weight of the fruits (g)	Weight of the seeds (g)	Fruit yield (kg/ha)	Seed yield (kg/ha)
T1	677^{f}	712	1196	16,66^{d}	843,09^{f}
T2	759^{e}	714	1216	18,74^{c}	961,02^{e}
T3	921^{b}	721	1234	22,91^{ab}	1 183,40^{b}
T4	961^{a}	721	1243	23,95^{a}	1 243,80^{a}
T5	844^{d}	718	1246	21,17^{b}	1 095,00^{d}
T6	902^{c}	720	1243	22,56^{ab}	1 167,44^{c}
SE (±)	12,4*	0,66$^{n.s}$	0,12$^{n.s}$	1,98*	10,50*

a, b, c, d, e, f: different letters in each row indicate significant differences at $p < 0,05$.

gas (2011) could be achieved, as long as an adequate agronomic maintenance of the plantation is guaranteed.

On the other hand, the yields of the associated crops were 7,0 and 2,7 t/ha (for squash and beans, respectively). They were lower than the ones found when such species are planted as monocrop, which constitutes a disadvantage of association systems, because the yields decrease in 30 % approximately. However, their advantage lies on the fact that species diversity can be obtained, the land is better utilized and the soil is protected.

It is concluded that pruning at 50 cm and the application of FitoMas-E was the treatment with better results. In addition, the productive yields of the intercropped annual crops are not affected, for which through these association systems productions for energy and food purposes can be obtained. It is advisable to continue these studies.

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