Technical Note

Production of Jatropha curcas *fruits at an agro-energetic farm*

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ABSTRACT: The study was conducted at a three-year-old area of *J. curcas*, in order to evaluate the production of unripe, ripe and total fruits of *Jatropha curcas* under pure crop and associated to cassava *(Manihot esculentum)*, and the fifth fruit production cycle of the plantation was taken into consideration. The treatments were constituted by the area of *J. curcas* as sole crop (T_1) and the one associated with cassava (T_2), with seven plots of 240 m^2 each. The results varied depending on the phenological stage of the fruits. There were no differences between the systems regarding the amount of unripe fruits; however, the production of ripe fruits increased significantly ($p < 0,05$) in the system where the crops were associated. The production of total fruits was 1 942 for T_1 and 2 080 for T_2. It is concluded that with the jatropha and cassava association similar total fruit productions can be obtained, compared with the system of jatropha under pure crop; but with the advantage of reaching additional agricultural productions, specifically of cassava, as well as a faster ripening of the jatropha fruits as a result of competition between crops. To repeat this experiment in time is recommended, as well as to associate jatropha to other crops, in order to determine whether this performance is maintained.

Key words: energy crops, intercropping, crop systems

INTRODUCTION

In recent years, biofuel production has become an important strategy to obtain a higher energetic security and mitigate the effects of the climate change which affect the planet. Many countries have implemented different policies to promote and increase the use of this kind of renewable energy (Torchiaro, 2008).

One of the most applied variants is the use of agro-energetic crops; however; the land surface that can be devoted to agricultural crops which are used for human feeding is rapidly reduced –especially as a consequence of erosion–, which is estimated in 100 000 km² per year. This unfavorable situation for the world has propitiated that diverse stakeholders look for alternatives that satisfy the food needs of every country, and that, at the same time, help to mitigate the climate change mainly caused by the use of toxic fuels that affect societies so much.

An important alternative to face the above-mentioned problems is the association of crops as a planting system that guarantees nutrient recycling. It also improves the environment –in general– and the agroecosystem –in particular–, and contributes to the protection against pests and diseases and weed control. Moreover, diversified food production, a better utilization of space and time and, consequently, a more suitable use of the soil and inputs, are achieved. For such reasons, this alternative constitutes a resource of great value in production systems under the principle of sustainable agriculture. However, it is known that the interaction between certain crops can have an inhibitory or stimulatory effect on yields (Rodríguez *et al.*, 2008; EuropaBio-ASEBIO, 2013).

Jatropha curcas, is considered the agro-energetic crop of the future, it offers a great variety of uses and opportunities of economic, ecological and agricultural importance that have barely been exploited. That is why, studies have been conducted in order to obtain information about the inter or intraspecific relationship between certain crops and *J. curcas*, to determine the application possibilities of this traditional agricultural technique on scientific bases in order to increase the efficiency of agro-energetic production systems. For such reason; the objective of this research was to evaluate the production of unripe, ripe and total fruits of *J. curcas* as pure crop and associated to cassava *(Manihot esculenta).*

MATERIALS AND METHODS

The experiment was conducted at the agro-energetic farm of the Pasture and Forage Research Station Indio Hatuey, in an area of jatropha which had been planted in June, 2009, with seedlings from nurseries, and had been established for three years.

To conduct the sampling the fifth fruit production cycle was used, which occurred in November-December, 2011. The climate data, since flowering until the end of the harvest, were: 21,2° C of mean temperature, 83,03 % of relative humidity, 7,8 mm of rainfall and 3,78 mm of evaporation.

The jatropha plants were sown at a distance of 6 m between rows and 2 m between plants. The treatments were the areas of *J. curcas* as pure crop (T_1) and the one associated with cassava (T_2). Each treatment had seven plots, of 240 m^2, and in each plot there were 20 plants. The net plots were 12 m wide x 6 m long. Five plants per plot were sampled, that is, 35 plants in each treatment.

During the establishment weeding activities were carried out and a formation pruning was applied during the first year, to guarantee the development of lateral branches. In every subsequent year a pruning was carried out at 50 cm above the soil level, in February. Each year, irrigation was also applied during the dry season, as well as organic fertilizers (poultry manure) at a rate of 1 kg per plant.

The observations were made weekly, during one month. The quantity of unripe and ripe fruits produced in T_1 and T_2 was counted; and the total amount was calculated in each case.

Cassava was the crop used for the association with jatropha. It was planted in March, 2011, through propagules, 20-25 cm long with five buds in good status and it was harvested in December of the same year. The planting distance was 80 cm between rows and 80 cm between plants. The variety Señorita was used, and the plants had an average height of 1.30 m during the stage in which the counts of jatropha fruits were made.

The production data of unripe and ripe fruits were processed through a sample inference for two independent samples, from a t-test, with a significance level of 0,05. For such purpose, the statistical pack Infostat version 1,1 was used.

For the total fruit production, the total of fruits produced by the plants in both treatments was taken into account, which was compared numerically.

RESULTS AND DISCUSSION

The effect of each crop system (T_1 and T_2) varied depending on the phenological state of the fruits. Figure 1 shows the production of unripe fruits for each treatment; there were not significant differences in the amount produced in the system with jatropha sown as pure crop (1 644) as compared with the ones that were in association with the cassava (1 574), after the last harvest. Everything seems to indicate that the plant performance during the flowering-fructification process was similar

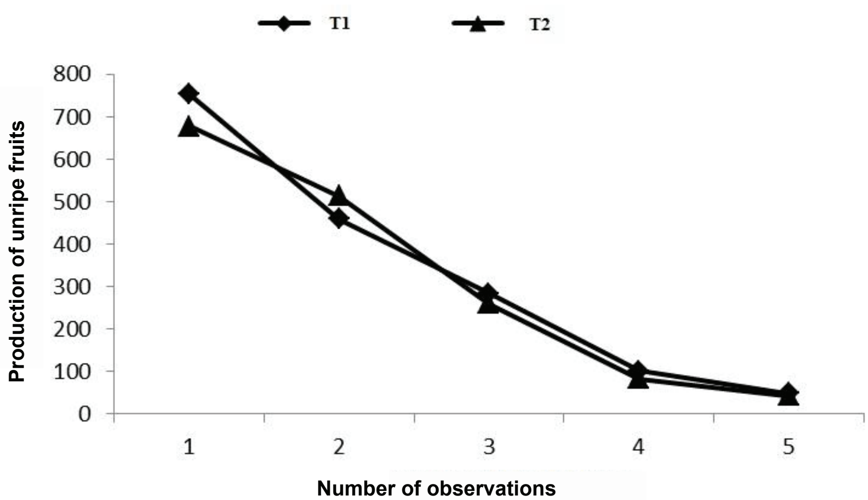


Fig. 1. Quantity of unripe fruits produced in each treatment (SE ± 1,10).

in both systems, and that there was not direct incidence of the competition that could occur between jatropha and the associated crop.

However, the performance was different when the fruits ripened (fig. 2). The highest amount of ripe fruits (506) was found in the associated system (T_2), which differed significantly (p < 0,05) from the pure crop (T_1) with 298 ripe fruits after the last harvest. This suggests that there was a higher utilization of hydric and nutritional resources in the area occupied by the association, which is favorable for the ripening of jatropha fruits.

In this sense, Vitta (2013) stated that the competition among crops plays an important role in the productive balance of agroecosystems; which can be defined as an interaction between individuals, caused by the common demand of a limited resource, which leads to their performance reduction.

The resources involved in competition are light, water and nutrients. Despite the- theoretical as well as practical- importance of defining in each situation which is the factor involved in the competition, a few studies have been oriented with such purpose. The scarcity of this type of information can be ascribed, in part, to the methodological difficulty of isolating the influence of each one in particular (Palomeque, 2009).

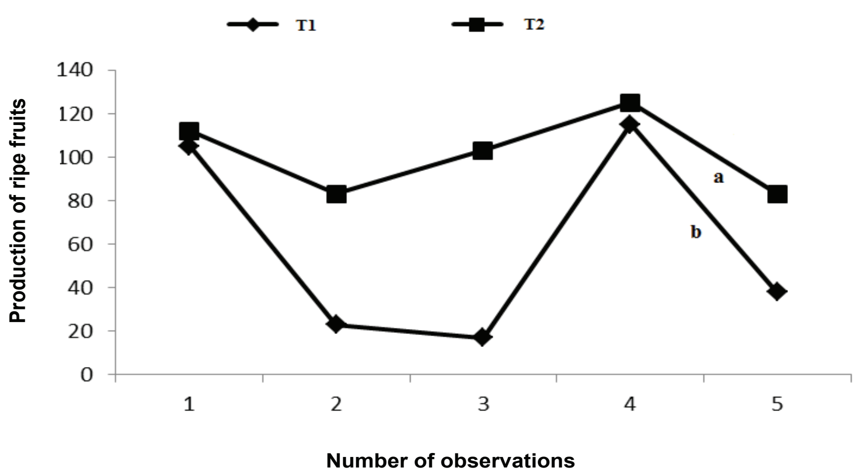
The minimal competition for light could be one of the factors that influenced the obtained results. This was mainly determined by the difference in height, because the jatropha plants were taller than the cassava plants. According to Vitta (2013), such difference between the crops that are used in association can have a marked effect on the light interception levels of each of the mixture components.

On the other hand, the competitive success of a species depends on the total proportion of resources that it can capture during its first growth stages (Berkowitz, 1988), even before the competition between crops appears. This is an aspect that must be considered because jatropha was three years old and had an adequate cultural attention at the moment of the evaluation.

To assert these criteria further physiological studies are required; however, the effect caused by the association of crops on fruit ripening is of great interest, if is taken into account that in the biochemical process for oil extraction they must fulfill this condition.

On the other hand, the total fruit production was 1 942 and 2 080 for the pure crop and the intercropping systems, respectively (fig. 3). Thus, the performance of T_2 was higher, which is significant, if is taken into consideration that this area had an additional production of cassava as agricultural crop for human consumption.

The benefits of associated crop plantations are related to obtaining different agricultural products, as well as to the improvement of the ecological conditions of the production system (Nicholls and Altieri, 2002; Rucoba *et al*., 2013). It also provides other advantages, including: better use of natural resources (water, soil nutrients and sunlight); protection of the soil against erosion, as well as



a, b: lines with different letters differ at p < 0,05

Fig. 2. Quantity of ripe fruits produced in each treatment (SE ± 0,39).

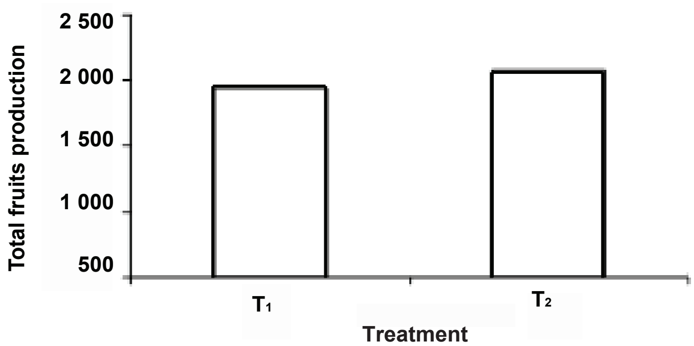


Fig. 3. Quantity of total fruits produced in each treatment.

reduction of the problems caused by weeds and by the attack of insect pests, due to the repellent action of some plants (Alternativa ecológica, 2013).

On the other hand, there are not too many works related to crop association with jatropha, for which this study constitutes one of the first steps in the search for alternative systems of agricultural production, where higher productions are reached per surface unit than the ones obtained in mono-crop areas. Such planting system can also provide important agricultural and economic benefits.

It is concluded that with the jatropha and cassava association total fruit productions can be obtained similar to the pure crops; but with the advantage of achieving additional agricultural productions, specifically cassava, as well as faster ripening of the jatropha fruits as a result of competition.

To repeat this experiment in time is recommended, as well as to associate jatropha to other crops in order to determine whether this performance is maintained.

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