Vol. 16(12), pp. 1631-1639, December, 2020
DOI: 10.5897/AJAR2020.15071
Article Number: DBAD69A65510
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Effects of two growth hormones and three manure formulas on a variety of papaya (*Carica papaya* L.) in the Sudano-Sahelian zone of Mali

SIDIBE Abdoulaye[1]*, TRAORE Bakary Mamourou[2] and YAHAYA Tassiou[3]

[1]Horticultural Unit, Department of Studies and Research (DER) of Agricultural Sciences and Techniques (STA), the Polytechnic Rural Institute of Training and Applied Research (IPR / IFRA) of Katibougou, Koulikoro, Mali.
[2]Agronomy Unit, Department of Studies and Research (DER) of Agricultural Sciences and Techniques (STA), Polytechnic Rural Institute of Training and Applied Research (IPR / IFRA) of Katibougou, Koulikoro, Mali.
[3]Engineer of Agriculture and Rural Engineering, Directorate General of Agriculture, Niamey, Niger.

Received 9 July, 2020; Accepted 10 September, 2020

This study was conducted in the orchard of the Rural Polytechnic Institute for Training and Applied Research (IPR / IFRA) in Katibougou to assess the growth and production of solo papaya (*Carica papaya* L., 2n = 18) in Sudano-Sahelian zone of Mali as well as the effects of the hormone and manuring formulas. A split plot device, comprising 2 factors with 3 levels of variation each, was used. The main factor was the hormone represented by gibberellic acid (GA3) and the synthetic auxin Trichloro phenoxi acetic acid (2-4-5-T). The secondary factor was the manure formulas consisting of organic manure (OF); organic + mineral manure (FOM) and Liquid manure (FL). The test was characterized by 9 treatments (GA3 + FO, GA3 + FOM (Organic and mineral manure), GA + FL (Liquid manure) ; 2-4-5-T + FO, 2-4-5-T + FOM, 2-4-5-T + FL; SH (No hormone) + FO (Organic manure) ; SH + FOM and SH + FL). It was carried out on a ferruginous tropical hydromorphic soil with a strong flapping of water tables. Each treatment was applied to 3 rows of 4 plants. It appears from the study that the application of the combination of hormones (GA3 + 2-4-5-T) and the formula of organic manure + mineral manure stimulates growth and that the application of hormones (GA3 and 2-4-5-T) on the papaya tree makes it possible to reduce planting - flowering cycle and early fruit setting.

Key words: Biomass, flowers, height of plants, number of leaves, planting-flowering.

INTRODUCTION

Agriculture represents a huge challenge for the development of Mali. In fact, around 80% of the population earn their income there. The majority of it is made up of small vulnerable family farms practicing mainly food crops (Sidibé and Ballo, 2013).The practice of industrial, vegetable and fruit crops is also

*Corresponding author. E-mail: abdoulayesidibe@yahoo.fr. Tel:+223 76 31 04 40/66 31 04 40.

considerable. In Mali, fruits are a source of food necessary to fight malnutrition and poverty, even if their production is still relatively low. Indeed, according to a survey of food consumption standards in West Africa, the consumption of fruit by a Malian is 3 kg / year. According to CIRADGRET (2006), papaya production was 13.7 million tons worldwide and 54,664 tons in Mali (TECHNISEM, 2014). The main papaya production areas in Mali are the regions of Sikasso, Ségou, Koulikoro, and the District of Bamako. The papaya tree (*Carica papaya* L.) is said to be from Mexico. It is cultivated in many tropical countries, notably in the Antilles, Brazil and Central America (CRFG, 1998 ; Fabert, 2011). From the nutritional point of view, it should be remembered that the consumption of papaya is particularly recommended; generally not treated with pesticides. It is classified as one of the best digestible tropical fruits. It can be eaten fresh, as a salad or as a dessert; or made into juice, syrups, or jam. Papaya is not very energetic because its sugar content is low (33 kcal versus 55 kcal on average for other fruits). Thanks to its richness in vitamin C, beta carotene (70%) and its very remarkable mineral concentration (rate high of calcium, potassium and magnesium), it contributes very effectively to the defense of the organism, and to fight against infections. For a proportion of 100 g of the fruit, up to 85 % of the recommended nutritional intake is ensured (which is 80 mg for adults), which contributes to meeting the body's needs for provitamin (A) around 30% (caribfruits.cirad.fr/fruits_des_antilles/papaye). Despite these multiple advantages, the culture is confronted with several constraints in Mali which are among others the yield, the choice of an adequate fertilization, the unsuitability of the soils, the poor control of irrigation, the varieties and their resistance to diseases (ITV, 2003). These problems can only be resolved by agricultural research and technical progress, particularly with regard to plant breeding and conservation techniques (Dankoro, 2018; Sidibé et al., 2017). In addition, given the abundance of poultry droppings due to the expansion of poultry farms on the outskirts of Koulikoro, it seemed appropriate to us to seek a manure formula based on poultry droppings favorable for the production of papaya. This is the context of this study, which will attempt to answer the following research questions: a) does the spraying of hormones on the papaya tree improve its growth? b) does spraying the hormones on the papaya tree shorten its cycle ? and c) what is the best combination of hormone and manure formula which can be used on papaya?

MATERIALS AND METHODS

Experimentation site

The experiment was done in the orchard of the Rural Polytechnic Institute for Training and Applied Research (IPR/IFRA) in Katibougou, Mali. This area is characterized by a ferruginous tropical hydromorphic soil with strong beating of aquifers. This soil has a clayey-silty texture, poor in nitrogen and phosphorus, moderately rich in potassium and slightly acidic.

Plant materials

The plant material used consisted of seeds of *Carica papaya* L. (Solo 8 variety). The seeds of this variety were purchased from authorized resellers, in this case, Green Seed - Mali. At the beginning of the rainy season, the seeds were sown in the seed bed.

Hormones and fertilizers used

Hormones were:

(i) Gibberellin acid (GA3): it is powdery in nature, whitish in color and dissolved in alcohol, and;
(ii) 2-4-5-T Trichloro-phenoxy-acetic acid (2-4-5 -T) solid crystalline water soluble.

Fertilizers were:
(i) Urea (46% nitrogen);
(ii)Potassium sulphate (50% potash);
(iii) Poultry manure, and;
(iv) Liquid and organic fertilizers (Aton AZ, Turbo root, Codabor, Coda maxi and Boramin Ca).

Experimental setup and size of the plots

The experimental device used was the split-plot, with 3 repetitions; the hormones were the main factor with 3 levels of variation which constitute the main treatments (Gibberellic acid (GA3), Trichloro-phenoxy-acetic acid (2-4-5-T)), and a control (hormone free or No hormone); the manure formula was taken as a secondary factor at 3 levels of variations which constitute the secondary treatments: organic manure formula, organic manure formula + mineral manure, and the liquid fertilizer formulas. The repetitions were separated by aisles of 1 m, subdivided into main plots of 6 m × 6 m and secondary plots of 6 m × 2 m. The test plot covered an area of 360 m², 20 m long and 18 m wide.

Observations and measurements

Observations were carried out every two months on two plants of the central line of each sub-plot and related to the measurement of the height of the plant (cm), the counting of the number of leaves, the dry leaf biomass, the number of flowers, planting-flowering cycle (number of days between planting and flowering on 50% per elementary plot), average number and diameter of the fruits.

Statistical analysis

The results of the various observations were subjected to analysis of variance using the GENSTAT software with the application of the Newman - Keuls 5% test for the comparison of treatment averages.

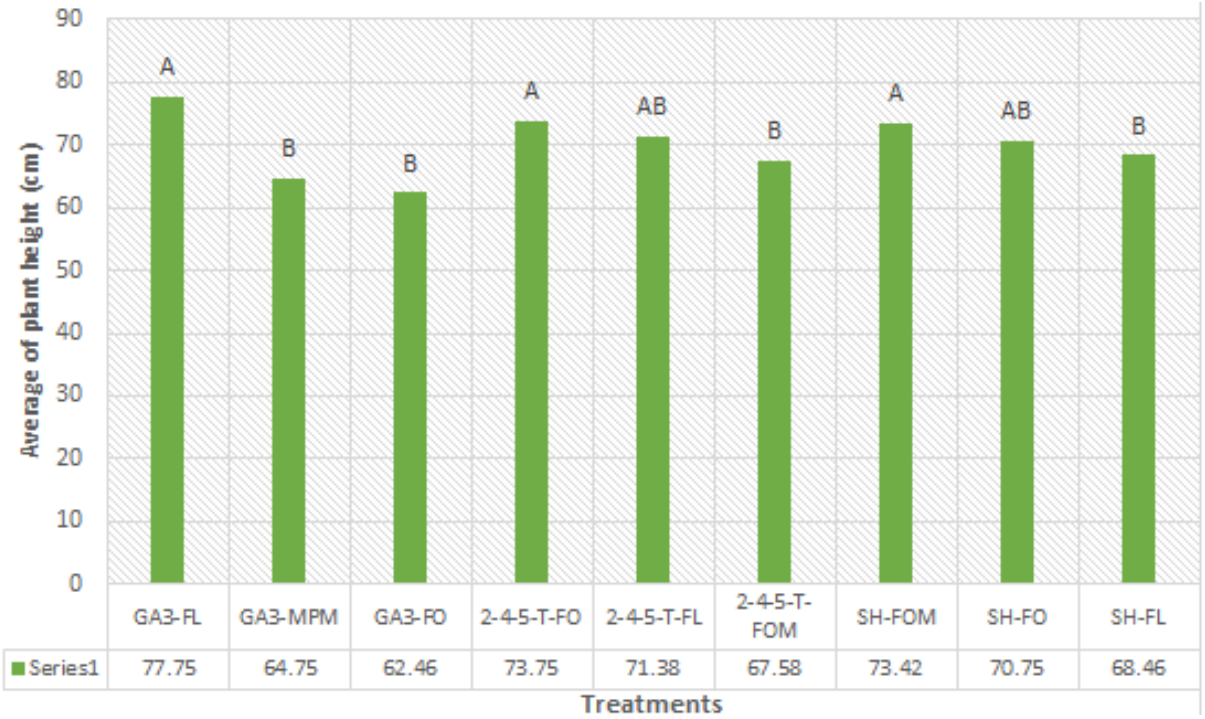

Figure 1. Effects of the manure formulas and the interaction between the hormones on the height of the plant 2 months after recovery. FOM, Organic manure + mineral manure + Mineral; FO, Organic manure; FL, Liquid manure; SH, No Hormone), GA3 (Giberrellic acid), 2-4-5-T (Trichloro-phénoxy-acetic acid).
Columns with the same letters are not statistically different.

RESULTS

All the measurements made on the plants allowed us to draw bar graphs of their growth or development after processing the variance data.

Analysis of plant height data 2 months after recovery

Analysis of the variances in the data revealed no significant difference between the effects of the hormones. It revealed a highly significant difference between the effects of the fertilizer formulas and their interaction between the effects of the hormones (Figure 3). According to the Newman-Keuls test, we have seen that the plants which received the GA3 + liquid manure obtained the largest size than those which received the combinations GA3 + formulas of organic manure and mineral manure + organic manure. The combination of 2-4-5-T + organic manure gave plants larger than those given 2-4-5-T and formula of organic manure + mineral manure. Without hormones, the plants having received the formula of organic manure + mineral manure obtained the greatest height than the plants treated with the formula of liquid manure (Figure 1).

Analysis of plant height data 4 months after recovery

The analysis of variance revealed a significant difference between the effects of hormones and the effects of mineral formulas. It was not detected a significant difference between the effects of the interaction of hormones and manure formulas. The classification according to the Newman-Keuls test made it possible to observe that the plants that received GA3 obtained the largest size while without hormones the largest plants were observed on the plots that received the formula of organic manure + mineral manure (Figures 2 and 3).

Analysis of plant height data 6 months after recovery

The analysis of variance revealed not only a significant difference between the effects of fertilizer formulas and those of the interaction between hormones and fertilizer formulas, but also a non-significant difference between the effects of hormones. The classification according to the Newman-Keuls test made it possible to notice the plants that received GA3 and formulas of organic fertilizer + mineral fertilizer obtained a larger size in height than those with combinations of GA3 and organic

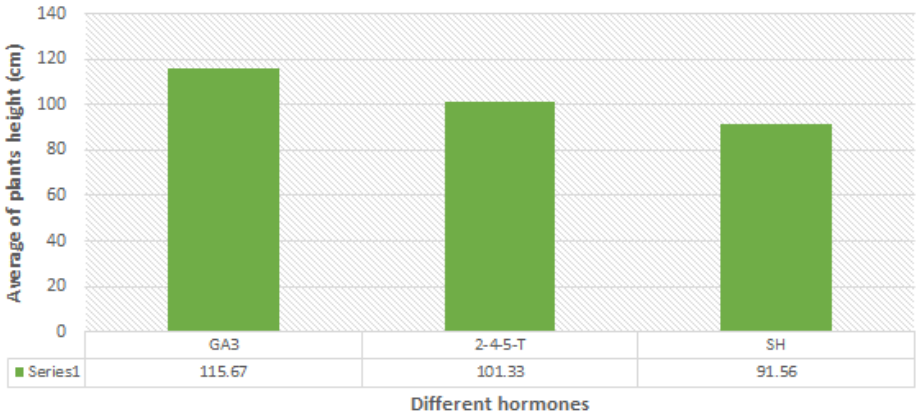

Figure 2. Effect of hormones formula on plant height 4 months after recovery.

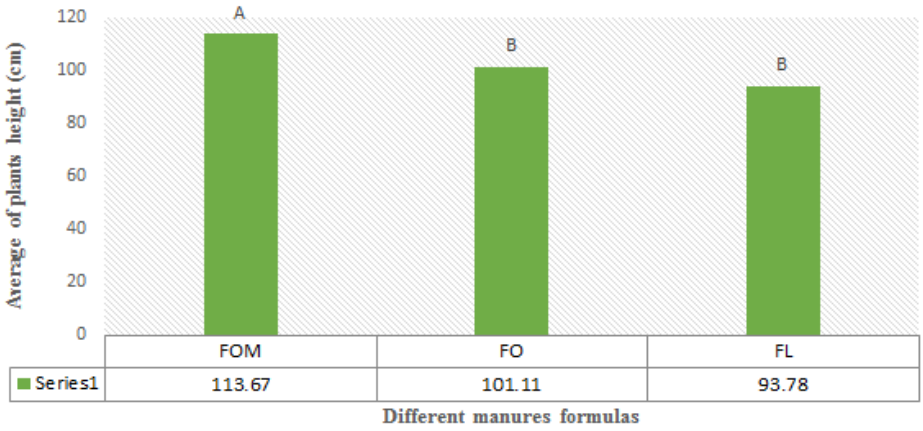

Figure 3. Effects of the manure formula on the height of the plant 4 months after recovery.

fertilizer; GA3 and liquid manure formula.

The plants that received 2-4-5-T and the organic manure + mineral manure formulas were larger than those that received the combinations of 2-4-5-T and liquid manure formula; 2-4-5-T and organic fertilizer formula. Plants without hormones that received organic manure + mineral manure obtained the greatest height as against those that received organic manure and / or liquid manure (Figure 4).

Analysis of the data on the number of leaves 2 months after recovery

The analysis of variance of the obtained data found no significant difference between the effects of hormones and fertilizer formulas or between the effects of their interaction. It should be noted that the plants have the same number of leaves whatever the treatment.

Analysis of the data on the number of leaves 4 months after recovery

The analysis of variance in the data found no significant difference between the effects of hormones and fertilizer formulas or between the effects of their interaction. It should be noted that the plants have the same number of leaves regardless of the treatment.

Analysis of the data on the number of leaves 6 months after recovery

Analysis of variance in the data revealed a highly significant difference between the effects of hormones, the effects of fertilizer formulas, and those of the interaction between hormones and fertilizer formulas. The classification, according to the Newman-Keuls test, made it possible to notice the plants that received the

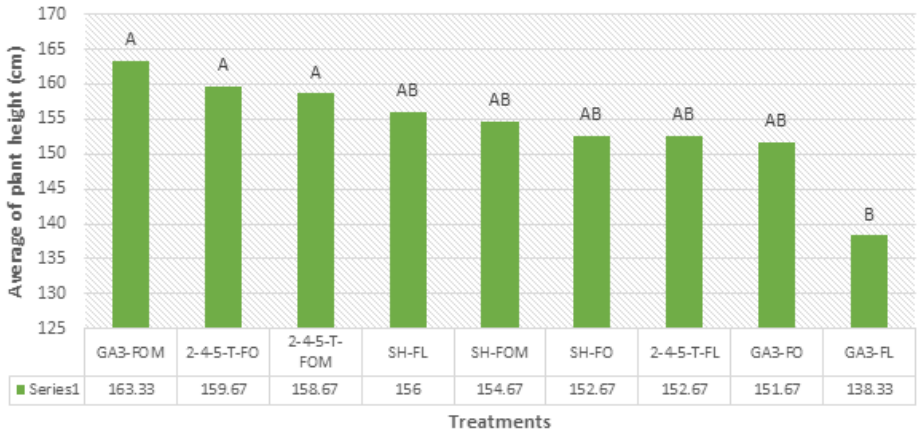

Figure 4. Effects of the interaction of hormones and fertilization formulas on the height of plants 6 months after recovery.

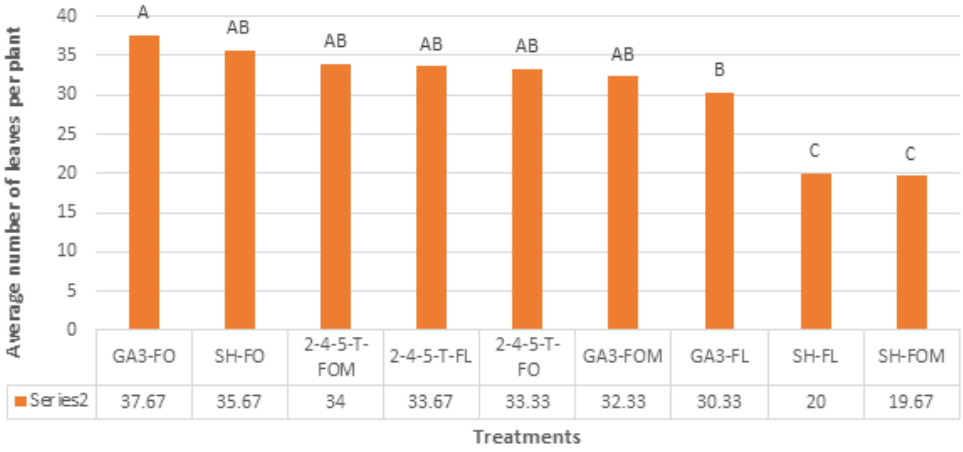

Figure 5. Effect of the interaction of hormones and manure formulas on the number of plant leaves 6 months after resumption.

combination of GA3 and formulas of organic manure emitted more leaves than the plants without hormones and those which received GA3 + liquid manure (Figure 5).

Dry leaves biomass data 2 months after recovery

Analysis of variance in the data revealed a significant difference between the effects of the hormones. It made it possible to detect a highly significant difference between the effects of the manuring formulas and those of their interaction with hormones. The classification according to the Newman Keuls test made it possible to note that the plants that received the combination of GA3 + Liquid manure formula and GA3 + Organic and Mineral manure formula gave the highest amount of dry leaf biomass. However, the lowest amount was obtained in plants without hormones and those that received GA3 + organic manure formula (Figure 6).

Analysis of data on dry leaves biomass 4 months after recovery

Analysis of variance in the data revealed a highly significant difference between the effects of the hormones and a significant difference between the effects of the interaction and the fertilizer formulas. The difference between the effects of the fertilizer formula was statistically insignificant. The classification, according

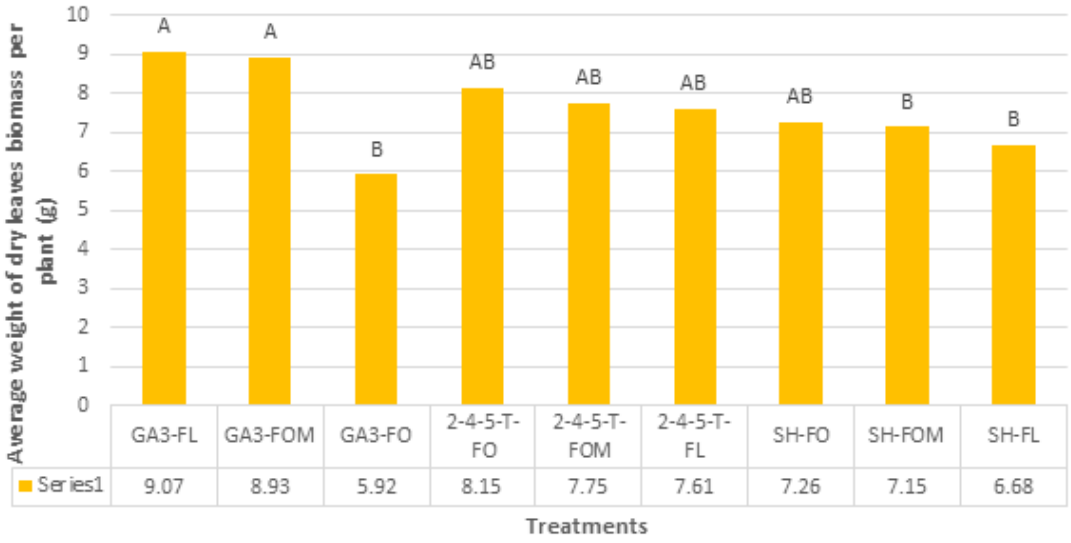

Figure 6. Effects of the interaction between hormones and fertilization formulas on dry biomass 2 months after recovery.

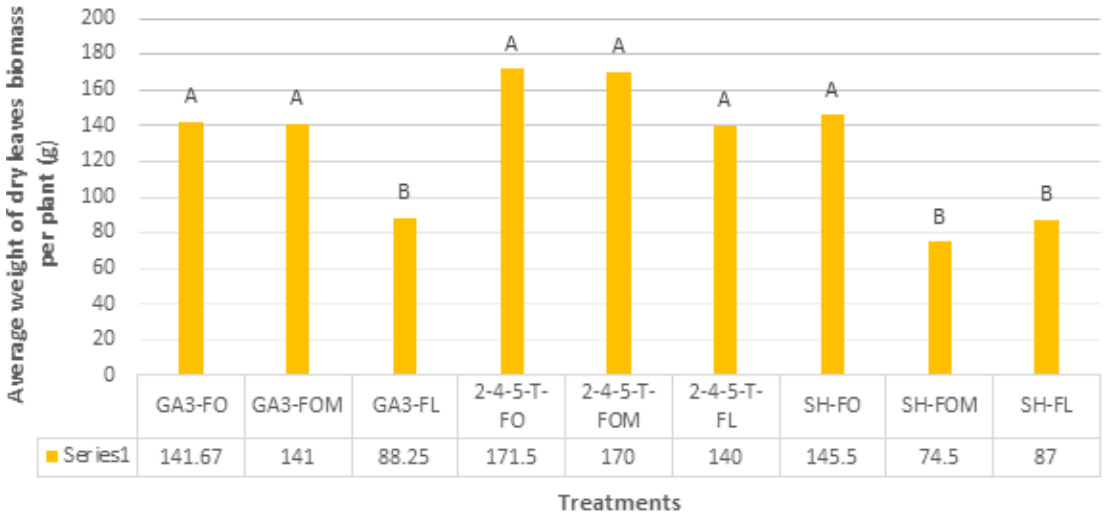

Figure 7. Effects of the hormone interaction and manure formula on dry leaves biomass 4 months after recovery.

to the Newman-Keuls test, made it possible to note that the greatest quantity of dry biomass was obtained by the plants having received the combinations GA3 + formulas of organic manure and GA3 + formulas of organic manure + mineral manure. Plants that received 2-4-5-T combinations had the same amount of dry biomass. Without hormone, the plants that received the organic manure + mineral manure formula produced more dry biomass than those having received the combinations GA3 + liquid manure formula and organic manure + mineral manure; Hormone-free liquid fertilizer formula (Figure 7).

Analysis of the dry leaf biomass data 6 months after recovery

Analysis of variance in the data revealed a significant difference between the effects of the fertilizer formulas and those of the interaction between hormones and

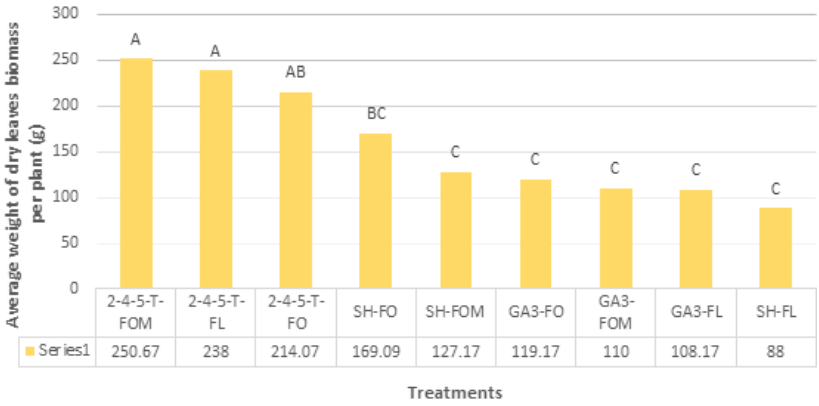

Figure 8. Effects of the interaction of hormones and fertilizer formulas on dry leaf biomass, 6 months after recovery.

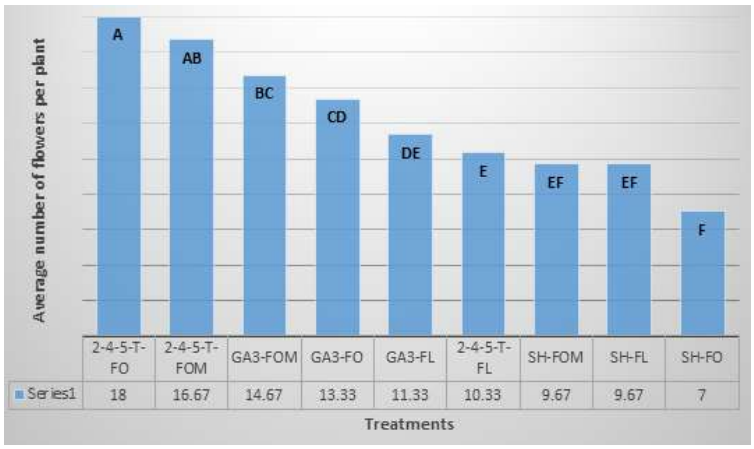

Figure 9. Effects of the interaction of hormones and manures formulas on the number of flowers 6 months after resumption.

fertilizer formulas. It also revealed a highly significant difference between the effects of hormones. The classification according to the Newman-Keuls test made it possible to note the plants having received the combination of 2-4-5-T + formulas of organic manure + mineral manure and that of 2-4-5-T + liquid manure provided the highest amount of dry leaf biomass ; they are followed by plants having received the combination of 2-4-5-T + organic manure. The plants that provided the lowest dry biomass were obtained from the plots that received the other combinations (Figure 8).

Number of flowers

The analysis of variance revealed a significant difference between the effects of the fertilizer formulas and those of the interaction between hormones and fertilizer formulas. It, also revealed a highly significant difference between the effects of hormones. The classification according to the Newman-Keuls test made it possible to note the plants having received the combination of 2-4-5-T + formulas of organic manure + mineral manure and that of 2-4-5-T + liquid manure provided the largest number of flowers ; they are followed in descending order by the plants having received the combinations of 2-4-5-T + organic manure, GA3 + organic and mineral manure, GA3 + organic manure, GA3 + manure and 245T + liquid manure. The plants with the lowest number of flowers were obtained from plots that did not receive hormones (Figure 9).

Planting - flowering cycle

Analysis of variances showed a highly significant

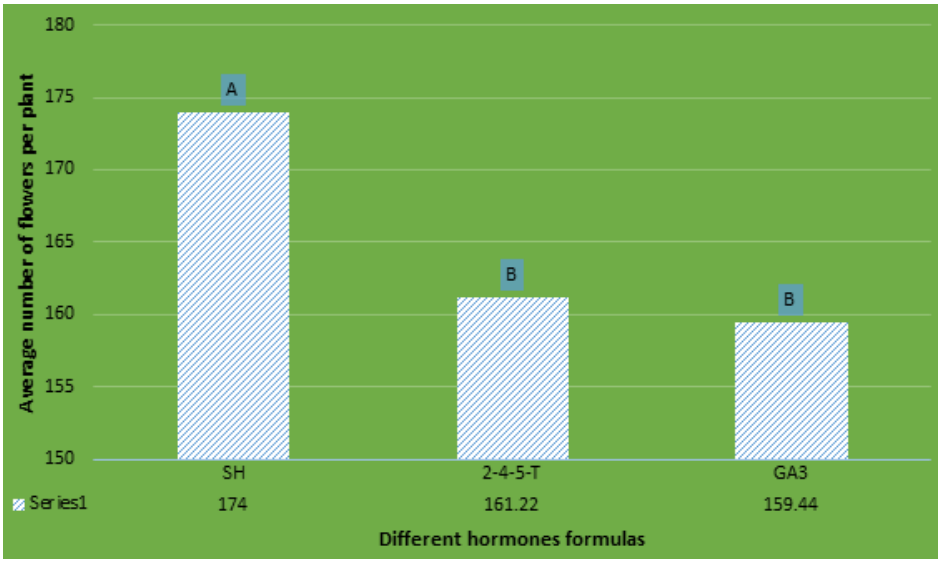

Figure 10. Effects of hormones formula on the flowers number.

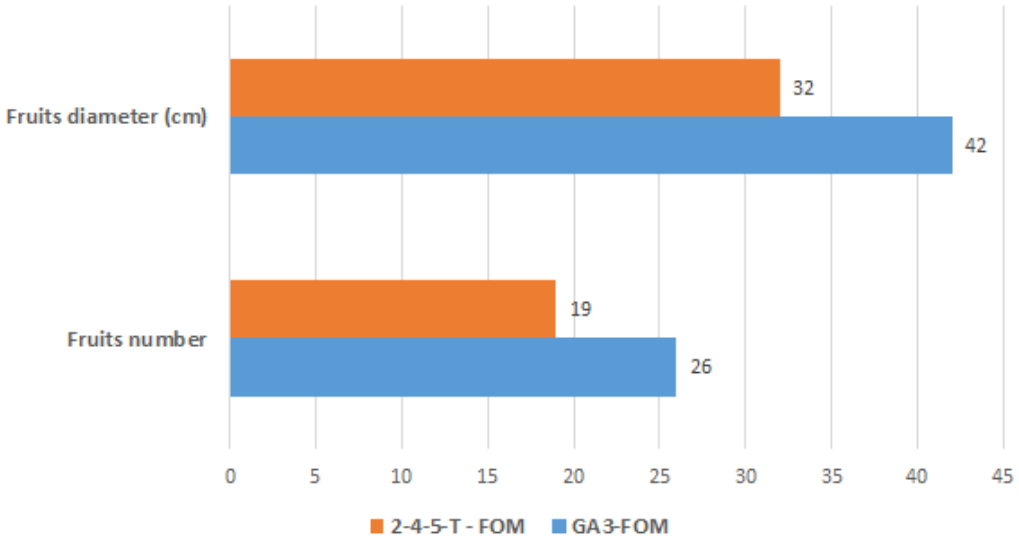

Figure 11. Hormones effect on the average of fruits number and the fruits diameter (in cm).

difference only between the effects of hormones. The Newman Keuls test allowed us to know that the contribution of the hormones reduced the vegetation cycle of the plants independently of the fertilization formula (Figure 10).

Number and diameter of fruits

We noted the formation of the fruits on the plants having received the hormones GA3 + organic manure + mineral manure and 2-4-5-T + organic manure + mineral manure. Plants that received AG3 appear to produce more fruit than those that received 2-4-5-T (26 versus 19). Plants that received AG3 appear to provide larger diameter fruits than those obtained on 2-4-5-T (4.2 cm versus 3.2 cm) (Figure 11).

DISCUSSION

The results obtained by this experiment show that the plants which received GA3 + the formula of organic manure + mineral manure and those which received 2-4-

5-T + the formula of organic manure + mineral manure had the greatest pruning, highest amount of dry biomass, highest number of flowers, shortest planting-flowering cycle and earliest fruit production. Our results corroborate with a study conducted on the behavior of bean plants, *Phaseolus vulgaris* (Fortin and Nadeau, 2002), under the influence of growth hormones: auxin and gibberellic acid. Growth hormones have the effect of growing plants faster, industrially producing seedless fruit in addition to several other applications (Sidibé et al., 2012). The plants under their influence are disproportionate and extremely large since the hormones act in particular on the roots, stem and the proliferation of the leaves. However, to observe this phenomenon, it is necessary to grow enough plants for the experiment to be statistically valid. In addition, the growth period must be long enough to see a major difference and all plants must absorb an adequate amount of the hormone (Sidibé et al., 2012; Fabert, 2011). According to the hypothesis, plants treated with auxin of concentration 1 x 10 - 4 mol / L, and those treated with gibberellic acid of concentration 500 ppm have faster growth.

Conclusion

FRom the results obtained, the plants of larger diameters were obtained at the level of the plots that received the formulas of organic manures + mineral manure and organic manure. Plants that received GA3 + organic fertilizer formulas + mineral fertilizer produced the highest number of leaves than those that received other combinations of GA3 2-4-5-T which did not stimulate leaf production in the plants. Without hormones, the plants that received the organic fertilizer formula had the highest number of leaves than those that received organic fertilizer + mineral fertilizer and liquid fertilizer. The greatest amount of dry biomass was obtained by the plants that received the combinations 2-4-5-T + formulations of organic manure + mineral manure and 2-4-5-T + formulations of manure. The lowest amount of dry biomass was provided by the plants that received the combinations GA3 + organic manure formula and GA3 + liquid manure formula. The addition of hormones reduced the plant's cycle of vegetation regardless of the fertilization formula. Fruit formation was obtained on plants that received the hormones GA3 + organic manure + mineral manure and 2-4-5-T + organic manure + mineral manure. Plants that received GA3 appear to produce more fruit than those that received 2-4-5-T (26 versus 19). Plants that received GA3 appear to provide larger diameter fruits than those that obtained 2-4-5-T (4.2 cm versus 3.2 cm).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Centre de coopération Internationale en Recherche Agronomique pour le Développement, CIRAD-GRET (2006). Mémento de l'agronome, pp. 994 - 997.

California Rare Fruits Growers, Inc. (CRFG) (1998). Fruit Facts 1 :53-57.

Dankoro A (2018). Effets de deux hormones de croissance et de trois formules de fumures sur une variété de papayer (*Carica papaya* L., 2n = 18) en zone soudano-sahélienne du Mali. Mémoire de Fin de Cycle, IPR / IFRA de Katibougou 44 p.

Fabert CM (2011). Le papayer (*Carica papaya* L.,) de la médecine traditionnelle à la médecine actuelle. Études botanique et pharmaco gnosique. Thèse pour le Diplôme d'État de Docteur en Pharmacie, 119p.

Fortin JS et Nadeau A (2002). L'influence des phytohormones sur la croissance des plantes 107 p. http://caribfruits.cirad.fr/fruits_des_antilles/papaye (page consultée le 20/06/2019)https://agritrop.cirad.fr (page consultée le 30/06/2019).

Instituto Tecnológico Veracruz (ITV) (2003). Pawpaw : Opérations après récolte. Edition AGSI / FAO, 65 p.

Sidibé A, Ladan Harouna MS, Traoré BM, Abdoulaye M, Niangaly O (2017). Micro propagation de deux variétés de papayer (*Carica papaya* L.) à l'IPR / IFRA de Katibougou, Mali 23 p.

Sidibé A, Traoré B M, Sakiliba M, Kanouté M (2012). Effets de trois phytohormones (ANA, BAP et AG3) sur la croissance du karité (*Vitellaria paradoxa*, Sous-espèce : *Vitellaria paradoxa paradoxa* (Gaertner F.) Hepper, Sapotaceae, Revue Scientifique du CNRST pp. 26-43.

Sidibé A, Ballo M (2013). Contribution à l'amélioration des revenus par la production et la transformation de la papaye du Village Technologique à l'IPR/IFRA de Katibougou 44:45-46.

TECHNISEM (2014). Fiche technique : Papayer, variétés Solo 8:3.