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Evaluation of the Productive Performance of Tomato (*Lycopersicum Esculentum* Mill.) grafted, Cultivation of Full Fields in the Rainy Season of Congo Brazzaville

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Abstract

In Congo Brazzaville, tomato cultivation is preferentially carried out by market gardeners during non-rainfall periods in order to curb productive constraints, particularly heavy rains resulting in high parasitic pressure. Indeed the rain disturbs the fruit set and this cause the fall of production of the tomato. This study was conducted to evaluate the productive potential of tomato grafted on African eggplants because of their dense root systems increasing the sap flow of the graft. The experimental design used was in completely random blocks with four replicates for one factor (rootstock) and four treatments (ungrafted tomato, tomato grafted on Diablette, tomato grafted on Bissukulu, tomato grafted on Nkeka). The results demonstrated the compatibility of African eggplant rootstocks Diablette, Nkéka and Bissukulu with the ninja tomato graft. Indeed, the ninja tomato grafted on these eggplants has an average yield of 8.870kg / m² or 3.737kg more than non-grafted subjects with 5.133kg / m².

Key words: Ninja tomato, rootstock, rainy season, yield

INTRODUCTION

From South America, tomato is a fleshy fruit considered as one of the most important vegetables in the human diet (Blancard, 2009). It is, after the potato, the second fresh or processed vegetable, the most consumed in the world (De Broglie and Guéroult, 2005). The importance of the tomato results both from its nutritional value and its high use in processing (Degioanni, 1997).

In Congo Brazzaville, it occupies a prominent place in the urban vegetable production system, because of its strong demand on local markets (CIRAD-AGRICONGO, 1991). The ecological peculiarity of the tomato crop exposes it to various nuisances, to the point of affecting the quantitative supply (Nechadi et al., 2002). Moreover, in the major urban centers of consumption in the Congo, tomato availability thresholds fluctuate with the climatic season (Moustier and David, 1996). During rainy periods (October to December and March to May), soils that are often soggy and high temperatures mainly cause root asphyxiation and then disruption of fruit set resulting in production falls (Black et al. 2003). Faced with this situation, Brazzaville market gardeners generally prefer to grow the tomato in dry seasons (June to September and January to February), a cool period without precipitation. It is important for them to optimize the growing season as much as possible in order to make the investment made profitable. We argue that, as a rootstock, the African eggplant Bissukulu, Nkéka and Diablette with a dense root system, efficiently removing water and nutrients from the soil will help improve the agronomic performance of the tomato in the rainy season.

MATERIAL AND METHOD

Field of study

The study was carried out in open field in Djiri - bilolo, about 1 km from the 2nd national highway. The agro-ecological zone of which Djiri-bilolo is part is characterized by a humid tropical climate, with alternating two rainy seasons (October

Table 1. Description of the experimental device

Factors	Terms	Treatments	Plant workforce				Total
			Bloc 1	Bloc 2	Bloc 3	Bloc 4	
GRAFT	Ninja variety	Ungrafted ninja tomato	6	6	6	6	24
	Egg plant bissukulu	Ninja tomato grafted on Bissukulu	6	6	6	6	24
PORTE - GREFFE	Egg plant Nkéka	Ninja tomato grafted on Nkeka	6	6	6	6	24
	Egg plant Diablette	Ninja tomato grafted on Diablette	6	6	6	6	24
	Total		24	24	24	24	96

Figure 1 : Principales étapes du greffage de tomate sur aubergine africaine

to December and March to May) and two dry seasons (June to September and January to February) . Annual rainfall averages are in the order of 1200 to 1500 mm and monthly average temperatures range between 24 ° C and 27 ° C in the rainy season and 21 ° C to 23 ° C in the dry season. The relative humidity is always above 70% with a relative minimum in February and March, while the minimums range between 49% and 59%. The maxima remain above 80% and vary between 88 and 94% (Makany, 1976). Monthly averages of sunshine for the 2014-2018 period range from 132 to 182 hours / month.

According to Makosso et al. (2007), these soils are very strongly acidic (pH <6), ferralitic with a sandy texture, with a very low content of exchangeable bases and a degree of saturation of less than 20%. They have 2.5% organic matter with a C / N ratio ≤ 12.

The vegetation cover observed in Djiri - bilolo is dominated by the savannah. The lowlands are marshy meadows of grasses and sedges. Forest areas are relatively well-supplied from different species.

Plant material

The plant material used for this study consists of the variety of tomato Ninja (*Lycopersicum esculentum* Mill.) As a graft and local cultivars of African eggplant Bissukulu (*Solanum* spp.), Nkeka (*Solanum* spp.) and Diablette (*Solanum torvum*) as a transplant.

Method

Experimental setup: The experimental design adopted is in completely random blocks with four replicates for one factor and four treatments. The rootstock factor is Bissukulu, Nkéka and Diablette. The treatments are as follows: Ungrafted ninja tomato, ninja tomato - grafted on Eggplant Bissukulu with elongated fruit, ninja tomato - grafted on eggplant Nkeka, ninja tomato - grafted on wild eggplant Diablette.

The experiment involves 96 plants, divided into four random blocks each carrying 24 plants at a rate of 6 per treatment (Table 1). The total area of the experiment is 40,8m² (6m wide and 6,8m long) and a useful area of 36,8m². Each plot is 1.6m long and 1.4m wide. The distance between blocks is 1m. The space between the experimental units (plot) is 1m. The experimental unit consists of 6 plants .. The spacings between the plants are on a nutritional surface of 0.3m² (0.50m × 0.60m). After disinfection of the soil of the experimental site by heat treatment, each experimental unit was

fertilized in bottom manure (2kg of chicken waste per m²).

Conduct and follow-up of the study: The nursery was carried out on a plot of 3.5m long and 1.5m wide, which was disinfected by heat treatment. Then, 2kg / m2 of organic fertilizer then 50g / m2 of mineral fertilizer (NPK 12 12 17) were brought. Irrigation was carried out in rain at a rate of 10 liters per m² every other day during the 40 days of nursery. During the nursery stage, spraying with the phytosanitary product Benlate at 5 g / 10 L was treated by spraying.

The plant material was sown at a spacing of 10 cm on the line of 2 g for the graft and 2 g for the rootstocks. They were followed for 54 days. During this phase, the sowing and maintenance of eggplant cultivars Bissukulu, Diablette and Nkeka as rootstock was carried out for 20 days. At this date, the tomato ninja graft was sown and maintained for 20 days, before a few are grafted on the 21st day after sowing. The transplant took place from 15h 30mn, 40 days after the sowing of rootstocks. The technique used consisted of making a V-notch with a razor blade on the rootstock. Then, the graft was cut in double bevel, inserted on the graft taking care of an intimate assembly, then ligated with a ribbon of plastic film before being transplanted, grafted ninja plants were observed for 12 days.

Transplanting was done at 40 cm line and 80 cm line spacing, resulting in a planting density of 31250 plants per hectare or 3.125 plants / m². Manual and hoe weeding was done on demand to avoid weed competition. Watering was done every other day in case of absence of rain, with a watering can of 10 liters per m². The staking was performed on the 30th day after transplanting.

Parameters

Observations and measurements included flowering, fruit set, fruit count, fruit weight and yield per feet. To do this:
Flower counts were performed 7 days after transplanting every 10 days for 30 days.
Fruit set was taken into consideration at the beginning of the growth of young fruits to determine its rate starting from the formula adopted by Krid (2013):
The number of fruits was determined by simple counting from the first harvest until the end of the study.
The average fruit weight was measured from a sample of 8 fruits taken randomly at each harvest.
The yield per feet was determined by the average of the production on 5 crops.

Statistical analyzes of the data

The data collected was captured on EXCEL 2010, which was also used to plot the figures. Next XLSTAT 7.5.2. was used to perform the Kruskal-Wallis Test, multiple pairwise comparisons of treatment by the Steel-Dwass-Critchlow-Fligner procedure. The differences were considered significant at the 5% level.

RESULTS

The preparation of the grafted tomato plants for transplantation lasted 54 days and those of the non-transplanted subjects were made 35 days after sowing. The result of this analysis of the observations concerned the flowering, the fruit set, the number of fruits, the weight of the fruit and the yield per feet.

Flowering

Observations of flowering were made during 35 days. It has been noted independently of the treatment of tomato plants, the average numbers varying between 10 and 16 flowers (Figure 2). However, according to the Kruskal-Wallis test presented in Table 3, flower counts have a statistically significant difference at the 5% threshold, between the treatment of tomato plants (grafted and ungrafted).
The average numbers of flowers in descending order are ninja tomato with rootstock Diablette (16), Nkéka (13), Bissukulu (12) and ungrafted ninja tomato (10). Multiple pairwise comparisons of flower numbers from different tomato treatments show three groups by Steel-Dwass-Critchlow-Fligner procedure among plant treatments (P-value = 0.002 <alpha = 0.05) as a function of number of flowers (Figure 2).
Diablette-grafted tomato plants are the group with the most flowers, unlike those with Bissukulu rootstocks and ungrafted. The plants grafted on Nkeka are an intermediate group in terms of flower numbers.

Fruit set

The tomato flowering plants with a fruit set rate of 67 to 74%. According to the Kruskal-Wallis test, fruit set is significantly different between treatments of tomato plants because of the p-value less than alpha (Table 5).

Table 2. Diaries of the main cultural activities of grafted and non-grafted tomato plants

Operation	dates
Sowing of rootstock (local eggplant, Bissukulu and Nkéka)	1 st July 2018
Transplanting rootstocks	July 20, 2018
Seedlings of grafts (Variety ninja tomato)	July 22, 2018
transplanting	August 10, 2018
Grafting of tomato on African eggplant	August 18, 2018
Transplantation, maintenance and monitoring of transplanted and non-transplanted plants	September 03, 2018
Start of harvest	November 15, 2018
End of harvest	January 11, 2019

Table 3. Kruskal-wallis test between flowering treatments of tomato plants

K (Observed value)	K (Critical value)	DDL	p-value (bilateral)	alpha
14,701	7,815	3	0,002	0,05

In addition, multiple comparisons of tomato plant treatments in pairs following the Steel-Dwass-Critchlow-Fligner procedure as a function of rank average yielded three groups presented in Figure 3. The most important designs are those of tomato plants grafted on Diablette (74%) assisted by grafted subjects on Bissukulu (68%).
In other words, flower abortions are barely 25% for tomato plants grafted on Bissukulu, while they are 34% for ungrafted ninja plants. The ninja plants grafted on Nkeka and Diablette have flower abortions of 35%.
The tomato plants grafted on Diablette are the group of subjects whose fruit set is the most important. They are supported by an intermediate group of tomato plants grafted on Nkeka. Ungrafted tomato plants have the lowest fruit set.

Number of fruit

Fruit counts were significantly different (p-value = 0.0001 <alpha = 0.05) between tomato plant treatments based on the Kruskal-wallis test (Table 7).

Multiple comparisons of fruit numbers of tomato plant treatments in pairs following the Steel-Dwass-Critchlow-Fligner procedure according to the rank average established two groups (Figure 4).

Ninja tomato plants grafted on Diablette, Nkéka and Bissukulu have the largest fruit numbers with an average of 12, 9 and 8 per feet respectively. On the other hand, the least important fruit numbers are those of ungrafted ninja plants with an average of 7 per feet (Figure 4).

Ninja tomato plants grafted on Diablette give more fruit compared to other grafted tomato plants or not. As such, they constitute a group opposed to other types of treatments.

Average weight of fruits

The weight of tomato fruit was monitored during 5 harvests (Figure 3). To be done at each harvest, 9 randomly selected fruits were weighed to determine the average weight of a fruit. It has been noted an oscillation of average tomato fruit weight between 134 and 145 grams.
In general, the tomato fruits produced by the transplanted subjects have a greater weight than those of the ungrafted ninja plants.
From the analysis of variance presented in Table 7, the size of the fruit varies significantly with the position of the crop.
The peaks of large fruits are obtained at the 3rd harvest with average weights of 155g to 164g. It should also be emphasized that at this stage, the largest fruits are those of tomato plants grafted on Diablette (164g) and Nkeka (162g).
The lowest fruit sizes are those of the 4th and 5th harvests (Table 8).

Table 4. Kruskal -Wallis test between tomato plant treatments

K (Observed value)	K (critical value)	DDL	p-value (bilateral)	alpha
13.732	7.815	3	0,003	0.05

Table 5. Kruskal- Wallis test between fruit numbers and treatments of tomato plants

K (Observed value)	K (critical value)	DDL	p-value (bilateral)	alpha
35.985	7.815	3	<0.0001	0.05

Table 6. Multiple comparisons of actual fruit paired processing tomato plants by the procedure of Steel - Dwass - Critchlow - Fligner

Sample	Effective	Sum of ranks	Average rank	Groups
Ninja ungrafted	24	8042.500	111.701	AT
Ninja grafted on Bissukulu	24	9452.500	131.285	AT
Ninja grafted on Nkeka	24	10338.500	143.590	AT
Ninja grafted on Diablette	24	13782.500	191.424	B

Table 7. Analysis of Variance in Fruit Weight by Harvest

Source	DDL	Sum of squares	Average squares	F	Pr> F
Model	4	5912.805	1478.201	63.181	**<0.0001**
Fault	15	350.942	23.396		
Total corrected	19	6263.747			

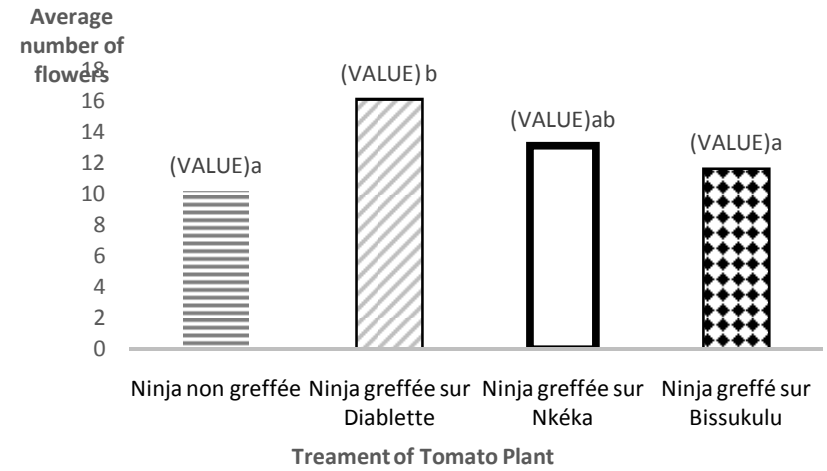
Table 8. Evolution of fruit weight (gram) according to the harvest and processing of tomato plants

Treatments **Tomato plants**	**1 st** **harvest**	**2 nd** **harvest**	**3 rd** **harvest**	**4 th** **harvest**	**5 th** **harvest**	**Average weight** **fruit (g)**
Ninja grafted on Bissukulu	152	145	157	122	117	**139**
Ninja grafted on Diablette	157	155	**164**	128	119	**145**
Ninja grafted on Nkeka	158	149	**162**	124	116	**142**
Ninja ungrafted	146	142	155	118	110	**134**
Average weight of the fruit (g)	153	148	159	123	116	**140**

Production

The evaluation of fruiting tomato plants was done on the accumulation of 5 harvests for each foot. The quantities of fruit harvested vary from 1,711kg to 3,444kg at the end of the cycle. However, according to the kruskal-wallis test it was highlighted a statistically significant variability of production according to the processing of the tomato plant (P-value = 0.002> alpha = 0.05). pairs of production of different treatments of tomato plants following the procedure of Steel-Dwass-Critchlow-Fligner was performed (p-value = 0.021 <alpha = 0.05).

The productions of the most important ninja tomato plants are those of the grafted subjects. In descending order, we distinguish between the subjects with grafting, Diablette (3,444kg / feet), Nkeka (2,856kg / feet) and Bissukulu (2,572kg / feet). In contrast, ungrafted ninja tomato plants have an average production of 1.711kg.



Note: similar letters indicate that there is no significant difference to the 5% threshold according to Steel-Dwass-Critchlow-Fligner

Figure 2. Average number of flowers according to the treatment of the tomato plant

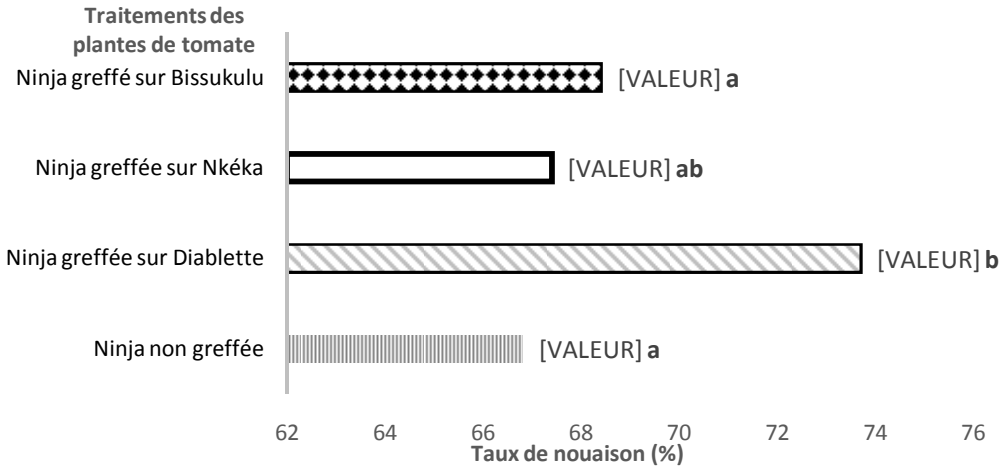


Figure 3. Fruit set rate according to treatments

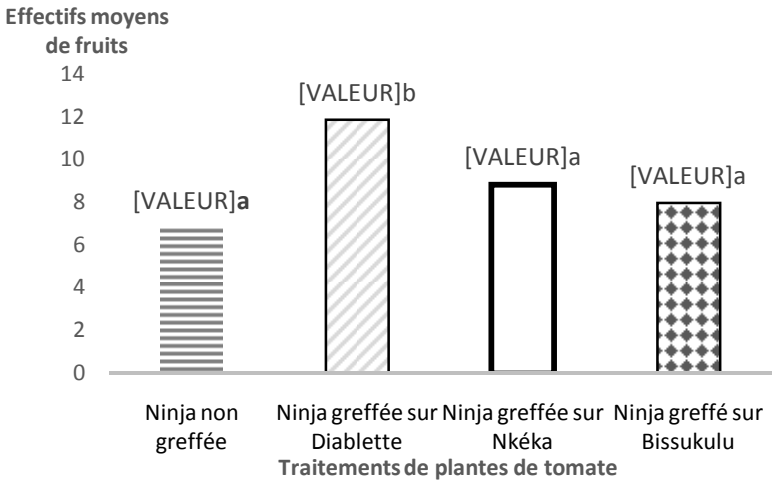


Figure 4. Average Headcount s fruit per vine tomato in function are processings

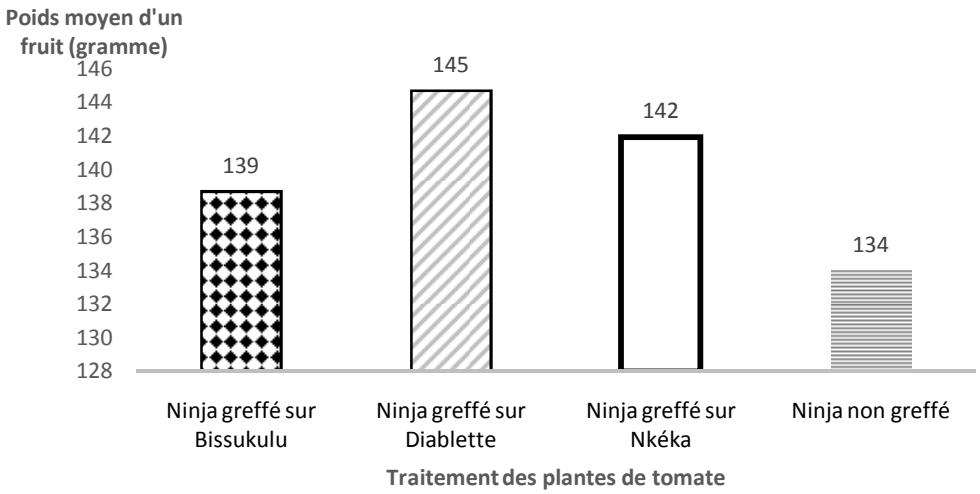


Figure 5. Average weight of tomato fruit according to the treatments

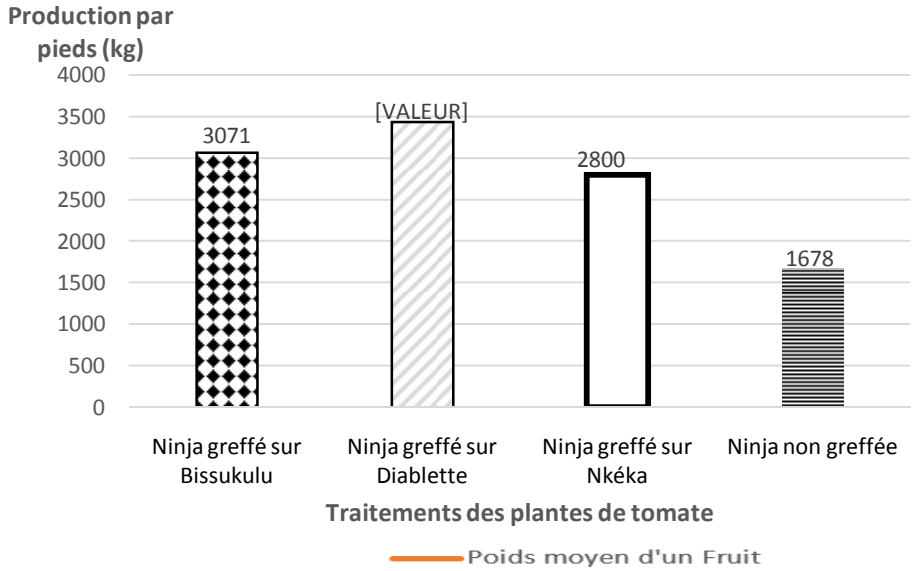


Figure 6. Cumulative Production e fruit by 5 feet on crops under the s treatment S

DISCUSSION

The results of the study show that the number of flowers in tomato plants varies from 10 to 16 with a dependence on the treatment in question (p-value = 0.0001 <0.05). According to the Steel-Dwass-Critchlow-Fligner test, the most important flower numbers are those of tomato plants grafted onto Diablette. On the other hand, according to the same test, Ninja Tomato plants grafted on Nkeka constitute an intermediate group succeeded by Bissukulu grafted subjects. The non-grafted ninja tomatoes are the group that gives fewer flowers. The ninja variety seems to be indifferent to grafting on Nkeka and Bissukulu, while its flowering tendency varies significantly when grafted onto the Diablette. This significant effect found in our experimental conditions, could be intrinsic to the interaction of the Diablette rootstock with the tomato ninja graft and therefore not subject to the influences of external factors. It would therefore seem that the rootstock Diablette, contributed to reinforce the effectiveness of the combination of organo-mineral fertilizer so that the nutrients are also better absorbed by the graft. Indeed, according to Massome (2003), the number of flowers in a plant depends on the interaction of the fertilizer with the tomato plant.

The tomato productions observed in this study are based on kruskal-wallis (P-value = 0.002> alpha = 0.05) dependent on plant treatment (Figure 6). There was an average production of 1,711kg / feet for ungrafted ninja tomatoes, 2,572kg / feet for Bissukulu grafted ninja tomatoes, 2,856kg / feet for Nkeka grafted tomatoes and 3,444kg / feet for tomatoes.

Grafted on Diablette. Production levels of the larger Diablette, Nkéka and Bissukulu eggplant grafts compared to ungrafted ninja plants may be explained by the relatively higher average fruit weights (Table 7). Moreover, according to the work of Zuang, (1984) the average fruit production per plant depends both on the number of fruits per plant and the average fruit weight. Much more, the work of Villeneuve, (2013), reveals that the vigorous rootstock by bringing through its root system an influx of sap tomato graft, it will produce larger fruits in greater quantity. It should be said that the rootstocks Diablette, Nkéka and Bissukulu significantly optimize the graft feeding to the point of positively affected production. By comparing tomato yields per foot at a density of 3 feet / m², the yield is 10,332 kg for Tomato grafted on Diablette, 8,568 kg for tomato grafted on Nkéka, 7,711 kg for tomato grafted on Bissukulu and 5,133 kg for ungrafted ninja tomato. Ninja grafted on grafted eggplants has an average yield of 8.870kg / m² or 3.737kg more than non-grafted subjects with 5.133kg / m². Comparing the yield of grafted tomato plants (8.870kg / m²) with the average performance of 6kg / m² in tropical regions by De Lannoy (2001), a 2kg productivity gain induced by grafting on aubergines African. However, the performance of tomato plants grafted on African eggplants, still requires evaluation with variability in fertilization and infested soil.

CONCLUSION

All in all, we can accept the compatibility of the graft of the eggplant cultivars Bissukulu, Nkeka and Diablette with the tomato as a graft. Beyond this observation, it is then affirmable that the grafting of tomatoes on African eggplant cultivars makes it possible to optimize tomato production during the long rainy season. The performance observed in the rainy season, however, could be improved by the combination of grafting with the use of fertilizer foliar fertilizer. This practice would help to circumvent soil leaching constraints, especially since the work of Zaoui et al. (2011), show that foliar fertilization increases the efficiency of fertilization on hard-to-work soils.

REFERENCES

Blancard D. (2009). Tomato diseases, to identify, to know, to control. Edition: quæ. Paris. 691p

De broglie l. And gueroult ad., 2005. Tomato of yesterday and today. Lavoisier. Pp 15-20

De lannoy g., 2001. Fruit vegetables in agriculture in tropical africa, directorate general for international cooperation, ministry of foreign affairs, foreign trade and international cooperation, brussels, belgium, 503-513p.

Cirad-agricongo eds, 1991. Market gardening sectors in brazzaville. First elements. Cirad edition, 231p.

Krid, k., m., s., 2013. Effectiveness of the resistance of six tomato varieties to tuta absoluta under plastic cover at hassi ben abdellah itdas (ouargla) .memory, master / agronomic sciences / supported 2013.121p.

Moustier p. And david o., 1996. Food supply and distribution project for francophone african cities. Case study of the dynamics of peri-urban market gardening in sub-saharan africa. Cirad-flhor, ur economie des filières. Monpelier cedex, 36p.

Masome h. 2013. Effects of different levels of growth and yield of tomatoes. Journal of novel applied sciences. 3 (2): 1031-1035.

Nechadi s., benddine f., moumene a. And khaddam m. (2002). State of tomato viral diseases and control strategies in algeria. Eppo bulletin, 32 (1): 21-24

Nono w.r., swai i.s. & chadha m.l., 2001. Management of vegetable diseases in eastern and southern africa: case study of tomato. In: anonym, proceedings of the workshop on vegetable research and development in west africa. Eds. Avrdc africa regional program, arusha tanzania.19-31 pp.

Fao 2003. Fertilizers and their application. Brochure, 4th edition. 5 p.

Zaoui e. And g. Brun. 2011. Efficiency of fertilization: new challenge for modern agriculture. Maghreb agriculture, no. 51, 139 p.

Villeneuve, C., 2013. Field tomato, grafting technique. Mapaq, montérégie west, 22p

Zuang h., 1984. Climatic hazards related to the quantitative and qualitative production of tomatoes. In: agro-meteorology and vegetable production. A tenuous seminar in avignon from february 29 to march 1, 1984. Inra symposiums no. 33, paris pp77-79.