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# Spinach (*Basellaalba*)-Tomato (*Lycopersicumesculentum* Roma) Association: An Organic Alternative to the Impact of Some Diseases on Tomato Production at Kisangani, Democratic Republic of Congo (DR Congo)

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**ABSTRACT**

The objective of this study was to evaluate the agricultural performance in monocropping and in association of tomatoes affected by a few diseases in the city of Kisangani. The study was done following a non-randomized block device comprising two blocks of 6 plots each. Two types of crops were used namely tomato and spinach. The treatments consisted of tomatoes in pure culture and tomatoes in combination with spinach. Observations focused on the evolution of tomato diseases and the number of inflorescences, flowers, fruits, fruit weight, fruiting and yield per plant. The results obtained reveal that the combination of spinach with tomatoes reduces the spread of tomato diseases and increases tomato yield under the conditions of our study. information retrieval systems.



## Introduction

Market gardening is currently experiencing considerable growth in urban and peri-urban areas of the Democratic Republic of Congo (DRC). With the phenomenon of rural exodus that has been accentuated for almost two decades, horticulture allows many households clustered around large urban centers to improve both their incomes and their food security PNIA (2013). It is one of the most cultivated fruit vegetables in vegetable gardens, and easy to sow. It is a very popular crop in the DRC and its fruit is highly appreciated by consumers.

Among vegetable crops, tomatoes are also the ones that are most susceptible to cryptogamic diseases. The latter then progress very quickly if their development is not stopped, going so far as to destroy a harvest that promised to be promising. But what is less known is that she highly appreciates the presence at her side of certain plants that will benefit her in various ways.

Several agronomists using the vegetable garden have demonstrated that it is better to make an association of several plants since some of them are susceptible to diseases in monoculture than in association with others. To the extent that these plants can serve as barrier plants against the spread of these diseases. Thus, we cite the case such as that of the carnation of India and basil which hunt tomato nematodes and calendula which helps to fight against alternariasis on tomatoes ADEAR (2016).

Just as spinach depletes little of the soil, tomato finds its place after a green manure because it is too demanding and greedy a crop. According to Nechadi *et al.*, (2002), the ecological peculiarity of tomatoes exposes them to various nuisances, including predatory insects and diseases.

The associated crop, plant companionship or covercrop is a cropping system consisting of growing several plant species or varieties on the same plot simultaneously. These plants can exchange various services (fertilization, repellent or toxic action on specific insects and or weeds) and can act as barriers to the spread of diseases. These interactions are called positive allelopathy Andrews, & Kassam, (1976).

Thus, by combining the varieties of vegetables that are compatible, we could effectively fight against pests and diseases without using chemical phytosanitary products that are always harmful to health and the environment. According to Caplat (2014), the combination of several crops improves photosynthetic yield and ensures greater biomass production. In addition Naika *et al.*, (2005) report that growing tomatoes intercalary has advantages because it reduces the presence of diseases and pests.

The objective of this work was to evaluate the agricultural performance of tomatoes, to compare the evolution of diseases and the yield of tomatoes in association with spinach or in pure cultivation. It is for this reason that a study was concerned with monitoring tomato cultivation in association with Spinach and the impact of a few diseases on agricultural tomato production.

## Materials and Method

### Study Environment

The present work was carried out in Makiso Municipality, City of Kisangani, behind the Faculty of Renewable Natural Resources Management. According to Boyemba, (2006), the city of Kisangani is under the influence

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of the equatorial climate, hot and humid, of the Af type according to the Köppen classification. This type of climate corresponds to a regular and abundant rainfall (1750 mm per year on average) but variable in time and in space (1500 and 2000 mm). Thermal fluctuations are also significant between 20 and 30°C (average of 25°C) and the average monthly relative humidity is 84%. The city of Kisangani extends into the forest region of the eastern edge of the Central Congolese basin and is entirely included in the bioclimatic zone of the dense equatorial rainforest (Lejoly *et al*., 1988).

**Material**

**Biological Material**

The organic material consisted of varieties of tomato (*Lycopersicum esculentum* Roma) and spinach (*Basella alba* L.). The tomato varieties came from Rwanda while the spinach varieties came from DR Congo.

**Figure 1. Image of tomato and spinach**

**Method**

**Experimental design**

The area of the experimental field was 160 $m^2$ of which 16 m long and 10 m wide. We divided the field into two non-randomized blocks with spacing of 1 m having 6 plots each, including 2 types of cropping including tomato in monocroppingand tomato associated with spinach and 3 repetitions per type. Each plot measured 5 m x 2 m and had 30 tomato plants and 50 spinach plants that were planted in the tomato spacing. The plots were spaced 0.5 m apart. The spacing of the tomato was 1m x 0.5 m and that of the spinach was 30 x 10 cm.

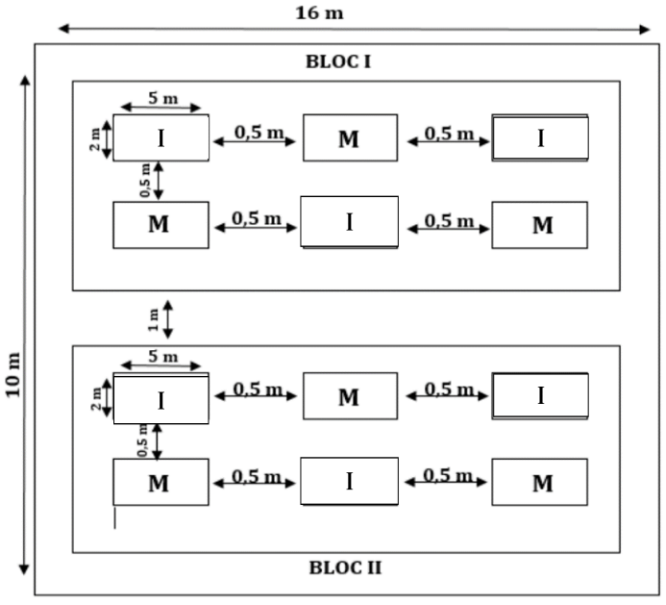


**Figure 2. Experimental design**

**Legend**

- I: Intercropping
- M: Monocropping

It should be noted that in each plot, there were 30 tomato plants and 50 feet of spinach per line in each plot in association. A total of 360 tomato plants including 180 plants in combination were considered and 1200 feet of spinach were evaluated due to 3 seeds per blood.

**Results and Discussion**

The objective of this work was to evaluate the behaviour of tomatoes in monocropping andin intercropping. The results obtained from the statistical analyses correspond to the various production variables including: the number of inflorescences, flowers, fruits, fruit weight, average fruit weight per plant, percentage of fruiting and yield per plant.

These results are recorded in the following tables and figures as well as the evaluation of diseased plants in combination and pure culture.

**Components of tomato production**

The average number of the inflorescence, flowers and fruits of the tomato are shown in Table 1 below.

**Table 1. Average number of inflorescences, flowers and fruits per plant**

| Types of cropping | Number of inflorescence per plant | Number of flowers per plant | Number of fruits per plant |
|---|---|---|---|
| Tomato-spinach | 18.59[a] . | 77,71[a] | 32.53[a] |
| Tomato | 9.40[b] | 37.11[b] | 13.37[b] |
| Meaning (p) | 0.0001[***] | 0.001[***] | 0.005[**] |

**Legend**

***: very high significant difference for p<0.001; **: highly significant difference for p<0.01. The Averages with the same letter did not differ statistically.

In Table 1, there is an increase in the number of inflorescences per plant in the intercropped (18.59) plot than in the monocroppedone (9.40). Similarly, the number of flowers is much higher in intercropping (77.71) than in monoculture (37.11). As for the number of fruits, tomato intercropped with spinach gave double fruiting (32.53) compared to tomato monocropped (13.37).

With regard to fruiting, the analysis in Figure 3 below shows that growing of tomato in association with spinach has a higher percentage of fruiting of tomatoes compared to monocropping, whose values are 52.11% and 34.39% respectively (p-value=0.037<0.05). This better fruiting in intercropping can be justified by the possible inputs of nutrients from the decomposition of organic matter from foliage of these two intercropped plants.

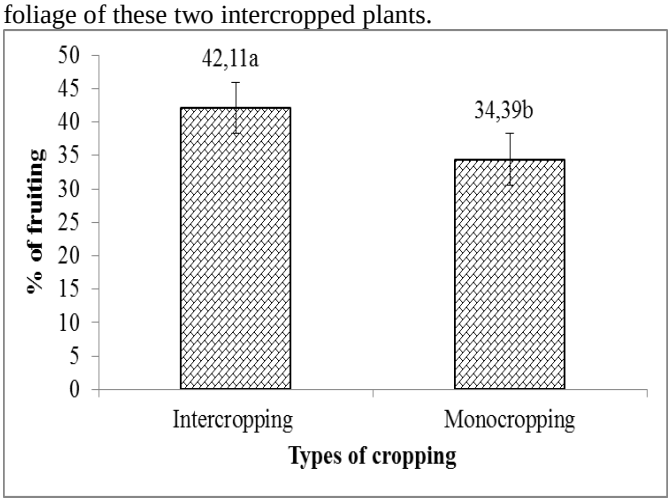


**Figure 3. Average fruiting (%)**

**Legend: (a, b)** The Averages with the same letter did not differ statistically.

With regard to fruit weights and tomato yield, Table 2 summarizes the result obtained.

**Table 2. Fruit weight and yield per plant**

| Types of cropping | Fruit weight per plant (g) | Yield per plant (kg/0,5 m²) |
|---|---|---|
| Tomato-spinach | 829.43[a] | 1.658[a] |
| Tomato | 373.43[b] | 0.746[b] |
| Meaning(p) | 0.028[*] | 0.029[*] |

**Legend**

*: significant difference for p<0.05 The Averages with the same letter did not differ statistically according to Smallest Significant Difference.

The results shown in Table 2 above indicate that the Tomato-spinach combination produced significantly high weight fruits per plant (829.43) than tomato monocropping **(373.43).**

As for the average weight, there was significant difference between this two types of cropping (p-value=0.138). In addition, the yield of the tomato was better and higher in intercropping than in monocropping. The important production of foliage by spinach, with leaves that age and fall continuously, could increase soil organic matter and contribute to improved tomato yield. One might also think that the tomato-spinach combination produces positive allelopathy.

**Rate of attack of tomatoes by diseases**

The result illustrated in Figure 4 below reveals that the association of spinach with tomato is more interesting, given the observed reduction in disease attack rates in tomatoes. Indeed, there is a significant decrease in yield in monocropping compared to the intercropping. In monocropping, more than half of the plants (58%) were quickly contaminated and attacked by diseases while in intercropping, the attack rate was 46%. In addition, our study reveals that plants of the same species (monocropping) promote the spread of diseases and pests, unlike species in intercropped plot that can serve as barriers against this threat. But, according to Katja *et al.* (2008), increasing plant diversity does not necessarily increase the presence of predators of crop pests.

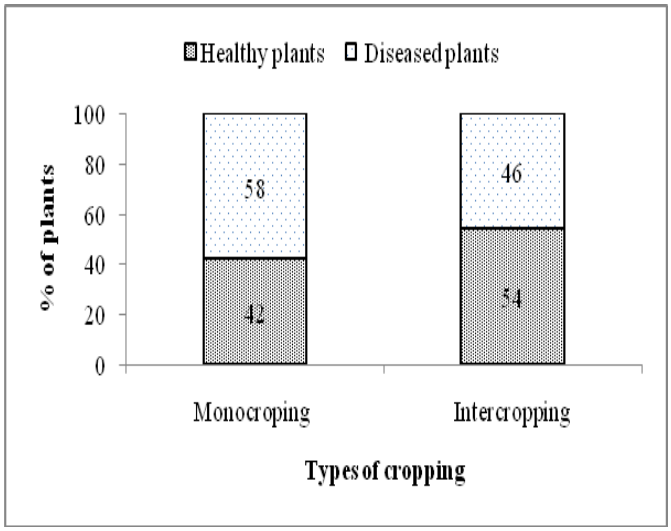


**Figure 4. Percentage of diseased plants according to the type of cropping**

Concerning the possible relationship between the variables of tomato production in intercropping, the summary of results is presented in Table 3.

Table 3 shows the correlations between the different production variables in association in particular: the number of inflorescences, flowers, fruits, percentage of fruiting, fruit weight, average fruit weight and yield per plant. We find that the number of inflorescence has a significant and strong correlation with the number of flowers and the number of fruits. That is to say, more the inflorescence is formed by several flowers, more numerous are the fruits.

Similarly, the number of fruits has a significant and strong correlation with the weight of fruits and yield per plant. This means that more fruits there are, higher weight of all the fruits are obtained because of the positive contribution of the association of these two crops. The positive correlation between the number of fruits and the yield indicates that the number of fruits reflects the yield. More are fruits, the more the yield increases. In short, it should be noted that the weight of fruit correlates highly and significantly with yield.

The result of table 4 demonstrates the importance of the tomato-spinach combination, since it promotes the relationships between the production variables under the conditions of disease use unlike pure cultivation.

**Table 3. Correlation coefficients between tomato production variables in intercropping**

| Correlation | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ |
|---|---|---|---|---|---|---|---|
| $X_1$: Number of inflorescence | 1 | | | | | | |
| $X_2$ : Number of flowers | $0.84^{***}$ | 1 | | | | | |
| $X_3$ :Number of fruits | $0.68^{***}$ | $0.60^{*}$ | 1 | | | | |
| $X_4$ : Fruiting | $0.11^{NS}$ | $-0.13^{NS}$ | $0.69^{**}$ | 1 | | | |
| $X_5$ : Fruits weight/plant | $0.30^{NS}$ | $0.34^{NS}$ | $0.73^{***}$ | $0.62^{**}$ | 1 | | |
| $X_6$ : Averageweight | $-0.44^{NS}$ | $-0.33^{NS}$ | $-0.22^{NS}$ | $0.04^{NS}$ | $0.47^{NS}$ | 1 | |
| $X_7$ : Yield/ plant | $0.30^{NS}$ | $0.34^{NS}$ | $0.73^{***}$ | $0.62^{NS}$ | $1.00^{***}$ | $0.47^{NS}$ | 1 |

**Table 4. Correlation coefficient between pure crop production variables**

| Correlation | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ |
|---|---|---|---|---|---|---|---|
| $X_1$ :Number of inflorescence | 1 | | | | | | |
| $X_2$ :Number of flowers | $-0.21^{NS}$ | 1 | | | | | |
| $X_3$ : Number of fruits | $-0,32^{NS}$ | $0.28^{NS}$ | 1 | | | | |
| $X_4$: Fruiting | $0.01^{NS}$ | $-0.44^{NS}$ | $0.11^{NS}$ | 1 | | | |
| $X_5$ :Fruits weight/plant | $-0.47^{NS}$ | $0.35^{NS}$ | $0.44^{NS}$ | $0.14^{NS}$ | 1 | | |
| $X_6$ :Average weight | $-0.18^{NS}$ | $0.1^{NS}$ | $-0.46^{NS}$ | $0.16^{NS}$ | $0.52^{*}$ | 1 | |
| $X_7$ : Yield/ plant | $-0.47^{NS}$ | $0.35^{NS}$ | $0.44^{NS}$ | $0.14^{NS}$ | $1.00^{***}$ | $0.52^{*}$ | 1 |

**Conclusion**

The objective of this work was to evaluate the agricultural performance of tomatoes affected by a few diseases, compares the evolution of the disease in mono and intercropping, and compares the yield of tomatoes mono or intercropped.

The results obtained indicate that the tomato was more attacked in monocropping, where a rate of the disease of 58% is observed. On the other hand, in intercropping, there is a reduction in the pressure of pests and diseases (46%), which favors the increase in tomato production. However, spinach cropping would also have served as a barrier to pests and diseases that are considered factors in the decrease in yield.

The combination of tomato with spinach showed positive allelopathy. Thus, a significant difference was observed between the tomato intercropped and that in monocropping in terms of inflorescence, flower and fruit numbers, fruit weight, percentage of fruiting and yield per plant. On the other hand, only the average weight of fruit did not show a significant difference between association and culture.

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