Research Paper

Influence of the Organo-Mineral Fertilization on the Lettuce Growth (Lactuca Sativa L.) in the Gardening Site of Houeyiho (Benin)

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ABSTRACT

Fertilizers are products which are rich in mineral elements necessary to the growth and the harmonious development of cultivation. For that, a study on Lactua sativa L. fertilization (organic and mineral fertilizer) was undertaken in order to identify the best fertilizer adapted to Houéyiho site in Cotonou. The methodology adopted is based on agronomic trial using a complete randomly block with three treatments and three repetitions: organic fertilizer (OF), mineral fertilizer (MF) and no fertilizer (NF). Observations are made on the number of leaves, the cut diameter and the plant height. The results of this work show that all the three treatments have guaranteed a good growth of plants. Generally speaking, the treatment organic fertilizer has promoted the best growth and the best development of the plant. With regard to the two others treatments, mineral fertilizer and no fertilizer, the growth and the development are the same. This is due because the soil is rich in mineral fertilizer. Organic fertilizer, because its high level in organic matter, has improved the soil structure by promoting taking root of culture and its good feeding and growth. Some references have been given on the fertilizer type which will be used to cultures in the future.

Keywords : lettuce, compost, mineral fertilizer, yield, Benin

Urban market gardening is an income generating activity which grows more and more throughout the country in order to improve the increasing food deficiency of urban populations (Hounpkonou, 2003). Cotonou, economic capital of the country, has several sites where vegetable has been produced for 40 years. But this production is hampered by the depletion of soil nutrients because they consist of loose sand, permeable and poor in organic matter originally and over exploited (Assogba, 2001).

Thus, to adress the decline in soil fertility of their sites, gardeners have recourse to impacts organic and / or mineral fertilizers that play an important role in improving and maintaining soil fertility. They use for this purpose organic wastes (poultry manure, cow dung and other garbage, etc..) in combination with mineral fertilizers (Houndantodé, 2004). This contribution of fertilizing matter is not rational to associate quality agricultural production and soil protection. Indeed, with no respect of fertilization rules and terms of inputs, there are spraying in poor conditions and over fertilization phenomena resulting in a luxurious consumption at the level of crops. That is why an experimental study was established on the gardening site of Houéyiho in Cotonou, in order to identify the type of fertilizer to use for a better growth of lettuce.

Materials and Methods

Study area

The study was conducted at Houéyiho, a neighborhood of Cotonou city. The gardening perimeter of Houeyiho is located in the airport estate in the 12th district of Cotonou (figure 1).

Originally, the soil of the agricultural site of Houeyiho was hydromorphic, leached, podzolic, permeable and poor; however, this soil has been transformed at the beginning with a permanent use of household garbage for over 20 years (Health Eco-Benin, 2008). The study site covers an area of 15 hectares, and is exploited by 335 gardeners, (representing 59% of all the gardeners of Cotonou) and a composting factory. The city has a subequatorial climate with two rainy seasons and two dry seasons of unequal duration. The average annual rainfall is 1195.62 mm. Average monthly temperatures vary between 26 ° and 27 ° C (ASECNA, 1998-2008).

Figure 1: Localization of the gardening site of Houéyiho in Cotonou (Bénin)

Methods Used

The methodological approach consisted in the establishment of an experimental system in Complete Random Block with three replicates: organic compost (CO), mineral fertilizer (EC), finally Witness (T) without any addition of fertilizer (figure 2). The experimentation was conducted in a real environment with Lactuca sativa L. plant material, from the Compositae family and is part of the variety of leaf. The choice of this plant material is justified by its short production cycle (45 days) and also by the size of its production on the site. This species ranks second among all crops grown by gardeners of Houéyiho site, after the great nightshade (Solanum macrocarpum L.).

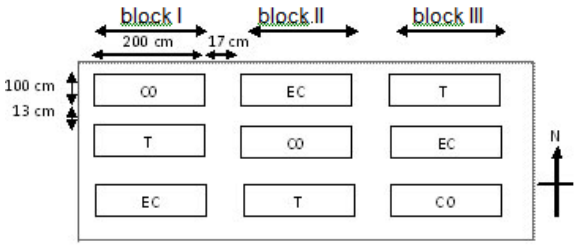

Figure 2: Experimental system in complete random block

The experimentation began with the establishment of the nursery that lasted two weeks. Feet of lettuce were then transplanted at 3-4 leaf stage in each block at 20 plants/m^2. Regarding fertilizers, 12kg of compost made by the Association for the Promotion of Organic Culture (association made of gardeners of the site) and 4 kg of mineral fertilizer (urea of NPK formula 15-15-15 formula) purchased on the market have been used.

This compost is made from urban wastes such as rotten fruits and vegetables, food scraps, cow dung (wet material); branches and leaves trimmed hedges, wood chips, cut shrubs and flower stems (dry matter).

The measured parameters include: the number of leaves, the stem diameter at soil and plant height (from ground level to the tops of the plant). These measurements were made every week from the date of transplanting with a caliper of brand STANLEY precision 0.1 mm accuracy as for the collar diameter.

Data Analysis

The data collected during this experimentation are analyzed using the Minitab 13.2 statistical tests ANOVA according to a criterion of change. The averages were compared by the method of least significant difference (LSD, 5%). The graphs were performed with Excel 2007 software.

RESULTS

Growth of lettuce plants was studied through changes in the number of leaves, plant height and diameter of the stem from the ground depending on the time.

Three stages have been recorded in the evolution of the member of leaves of lettuce plants (figure 3).

Number of leaves

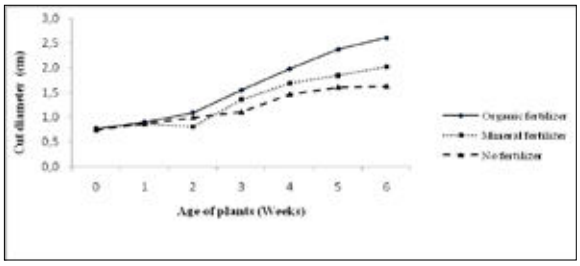

Figure 3: Growth of Lactuca sativa (lettuce) plant leaves depending on time

A first stage from T_0 to T_1 marked by a slight increase in the number of sheets for the three treatments. The second from T1 to T2 with a decrease in the number of leaves and the third from T2 to T6 corresponding to a faster progress in the number of leaves for all the treatments especially in plants produced with compost (maximum value 12).

So, results showed a more visible growth in terms of the number lettuce leaves produced with compost compared to those produced with chemical fertilizer and without manure from the 3rd week. But differences observed have proven to be significant according to statistical tests at 5% level with $P < 0.05$.

Height of plants

The average height of plants per treatment depending on time is shown in figure 4.

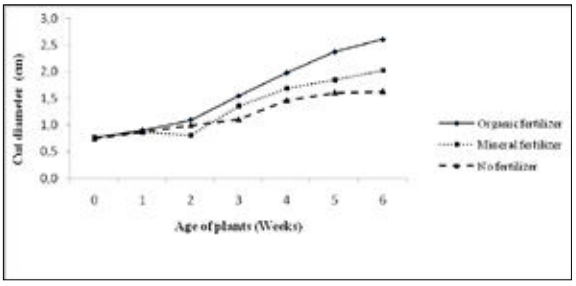

Figure 4: Growth in height of Lactuca sativa (lettuce) plants depending on time

From T_0 to T_3, the trend is the same for the three treatments. This stage corresponds to a decrease in height of the plants which is justified to the fall of the first leaves in favor of new small and shorter leaves. From T_3 to T_6 plant height increases and the best result was obtained in plants produced with compost.

In general, an increase in height of plants gets noticeable from the 4th week. Despite the relatively different heights, statistical analysis revealed no significant difference between treatments ($P > 0.05$).

Diameter of the stem

The stem diameter increased with time in all cases with a significant difference ($P < 0.05$) from the 2nd week. The diameter gets larger in plants produced with compost (figure 5).

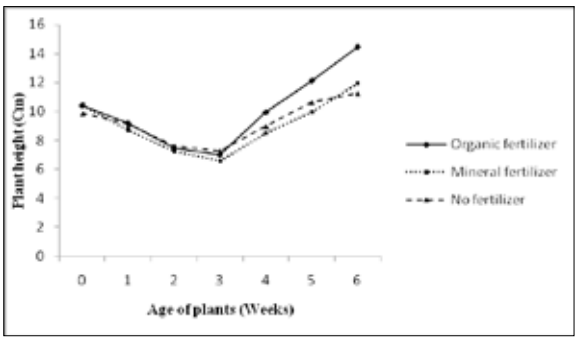

Figure 5: Growth in diameter of Lactuca sativa (lettuce) plants depending on time

DISCUSSION

In general, it was observed that the three treatments insured good growth to Lactuca sativa L. plants. However, plants produced with compost showed a better development than others. As for plants produced with mineral fertilizer and those maintained with no fertilizer (witness), the development is similar. The similarity in growth observed between plants grown with mineral fertilizer and witness plants shows that the initial richness of the soil was suitable to insure growth and harmonious development of the species in culture without adding any fertilizer. Even without any prior use of fertilizers, gardeners can produce lettuce. The fact that at each production, most gardeners consistently add both the organic and mineral fertilizers to the soil, this increases the soil's level of fertilizer. A soil analysis should be done first to know the quantity of fertilizer to be added or not. It has been observed in the perimeter that 35.82% of gardeners use compost without associating it with mineral fertilizer. The high concentration of minerals in the soil can be toxic to the crop and be a cause of high doses in the vegetal organs of the plant. Excessive use of fertilizers containing nitrogen favors the accumulation of nitrates in the leaves which are harmful to health (Weight et Kelly, 1999).

The best growth of plants grown with compost compared to others, shows that the compost is more beneficial than the

mineral fertilizer. Thanks to its high content of organic matter, the compost has improved the physical condition of the soil by favoring a good rooting of the crop which contributed to a good feeding of the plant with water and nutrients from the 4th week. As noted by several authors, the organic matter keeps the structural stability of the soil and makes it more permeable to water and air, serves as support and food to the biological activity and allows the storage of mineral elements which would otherwise be lost by leaching due to the very low absorption capacity of mineral colloids (Amadji, 2001; Soltner, 2003). Other authors have also shown that the use of compost to revitalize soils with organic matter content decreased due to over-intensive farming practices (Lefebvre et al., 2005). Similarly, according to Bukley (2006), a nutrient-rich compost can keep the performance of a crop during the transition towards a lesser use of chemical fertilizers.

Because of the immediate effects of mineral fertilizers on the growth and development of crops and low cost of using them, the gardeners prefer mineral fertilizer to the compost. Their decision is based on a socioeconomic level of profitability. This threshold reflects the effectiveness of technical innovation, its economic benefit (price ratio products / inputs) and above the level of risk incurred by its adoption. They believe that their use of compost is expensive and its influence on crop growth and performance is slow. They are looking for immediate results without thinking about future earnings. This behavior is confirmed by market gardeners Edwards et al. (2000) and Bruck (2003). In their view, limits the use of compost lies in the fact that producers are not familiar to the use of compost and are hesitant to use a new product which they know the quality and impact on soil and crops . Few farmers are aware of the rate applying compost on their land. Moreover, the beneficial properties of soil fertility and plant growth, compost products according to the rules of art are often unsuspected. Additionally, the beneficial effects of compost depend on the quality of the compost used, crop and soil conditions before the application. In some circumstances, crop yield is increased but still it is not always the case. The benefits are often long term and are rarely obvious in the first year of application (Lynch, 2007). Indeed, Slovakia, Lehocka et al. (2008), evaluated some indicators of soil quality on experimental plots in different mode of production. At the end of eight years of conventional or biological production, the biological system has improved the physical and chemical properties of the soil and the rate of the organic matter and the microbial biomass. The population of earthworms has increased. But an agronomic point of view, the use of compost should not be taken as a perfect substitute for chemical fertilizer but as a supplement if you want high productivity and maintain soil fertility in the soil major nutrients (Weight and Kelly 1999).

CONCLUSION

The study showed that the soil of the gardener site of Houeyiho in Cotonou, has a high concentration of minerals and does need currently an additional mineral fertilizer. To revitalize and maintain the fertilizing properties of the soil, the compost is recommended for the production of Lactuca sativa, as it has a positive effect on plants, while NPK fertilizer did not improve significantly the growth of vegetable. This study is expected to continue through the development of curves of response (in terms of performance) to various mineral fertilizers and different types of compost in order to define a suitable fertilizer regime for this vegetable in the ecological conditions of the soil of Houeyiho gardening site and the terms of contributions.

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