International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 05 – Issue 10 || October 2020 || PP. 10-21

Synthesis of a Potassium Fertilizer from Banana Peels and its Fertility effect on Onion Growth and Ripening in Lubumbashi

Katumbwe Ndundula Franck[1&6], Nyandwe Muvula Eustache[2], Kilomba Seya Erick[3], Baderhekuguma Bafunyembaka Innocent[4], Kanyenga Franck[4], Ngoie Longwa Leontine[5], Muchiza Bachinyaga Israel[1], Bushabu Mingashanga Marcel[4], Mwanza Mutuza Edouard[7],Ntemunyi Ntata Cedric[1], Mayamba Makanda Gaillard[1&6],Banza mukalay John[1&6],

[1]*Faculty of Agricultural Sciences, Department ofManagement of Renewable Natural Resources, University of Lubumbashi, D.R. Congo BP :1825.*

[2]*Faculty of Arts, Department of Philosophy; Research Area: Environment and Sanitation, University of Lubumbashi, D.R. Congo BP :1825.*

[3]*Faculty of Agricultural Sciences, Department of Agricultural Economics, University of Lubumbashi, D.R. Congo BP :1825.*

[4]*Faculty of Agricultural Sciences, Department of Phytotechny, University of Lubumbashi, D.R. Congo BP :1825.*

[5]*Faculty of Agronomic Sciences, Biogeochemistry and Ecology of Tropical Soils and Ecosystems Research Unit, University of Lubumbashi, D.R. Congo BP :1825.*

[6]*Faculty of Agricultural Sciences, Land Evaluation and Agro-Meteorologiy Reseach Unit, University of Lubumbashi, D.R. Congo BP :1825.*

[7]*Faculty of Agricultural Sciences, University of Kalemie, D.R. Congo*

Abstract: The study focused on the Synthesis of a potassium fertilizer from banana skins and its fertility effect on onion growth and ripening. The main objective of this study was to extract potassium from plant waste (Banana peels) and to evaluate its efficiency on the crop that requires enough potassium in order to valorize household solid waste.

To carry out this study, we had to collect banana peels from different public dumps in the city of Lubumbashi. A quantity of 50 Kg was collected for further processing. The banana skins collected in the garbage cans were washed with clean water to remove the dust, the latter were exposed to the sun for about 7 days. After complete drying in the sun, the skins were calcined in a muffle kiln at a temperature of 350°C until ash was obtained. This operation lasted 8 hours. The obtained potassium mineral fertilizer was extracted following the four main operations of hyalurgy proposed by VAN'T HOFF and KOURNACOV for the manufacture of mineral salts. The extraction consists in mixing the ash powder with distilled water in a water-ash ratio of 0,25. This ratio allows a good leaching of the potassium. The obtained mixture was left under stirring for 24 hours. After one day of leaching the mixture was centrifuged at 4000 rpm for 10 minutes to separate the solid and liquid. Then the liquid obtained was heat treated at 100°C. At this temperature the white crystals were formed (86% potash). After obtaining the potassium salt, the latter was experimented on onion culture (Red creol) with a cycle of 150 days according to an experimental device in factorial 2*3*2 with 12 treatments for 3 repetitions in order to evaluate the synthetic product compared to ordinary fertilizers (NPK and Urea) sold on the market.

The 200Kg dose is more suitable for the type of soil (drill litter) used for this trial and gives results almost similar to NPK (10-20-10) but it is obvious to combine it with other major elements such as nitrogen and phosphorus to compensate for the crop's need.

Keywords: Hyalurgy, NPK, Red creol, Potassium Fertilizer

Introduction

Population growth in the world's cities is leading to progressive poverty (17). This population growth was more than 30% in African cities (22) and 4.08% on average in the major cities of the DR Congo (5). Indeed, the city of Lubumbashi has not escaped this situation, so population growth has reached nearly 5% during the period from 2010 to 2015 (32).

In addition, population growth is leading to an increase in waste production and management. This poses a challenge for developing countries, as the severity of the management problem is mainly due to rapid growth and the lack of adequate planning and strategies (5). Thus, in villages, waste is disposed of, if not valorized on a marginal basis and in a traditional way at the farm level in soil fertility management, animal feed or heat production, while at the city level, organic waste is mostly disposed of without any form of segregation in uncontrolled landfills (23). All the same, the little transformation of waste has often been oriented towards composting (38); and some in anaerobic digestion (or methanization), a complex biochemical process implemented in the absence of oxygen and involving different microbial communities in the degradation and conversion of polymers of organic matter into reduced end products, including a high energy value biogas (29).

At the same time, waste from banana trees, livestock manure and other green waste is often used in composting. Already in 1972, Le Dividich and Canope noted that banana waste can be a feed for growing pigs in tropical countries (Guadeloupe) and represents up to 55% of ingested dry matter. Afterwards, their dietary values were appreciated by (3), notably 78.1mg/100g of the dry matter of potassium in the banana peel. However, few studies have exploited the possibility of producing a mineral fertilizer from banana peel. However, rising fertilizer prices in the markets and soil degradation point to the need to make use of available nutrients at low cost in agriculture (9). Banana peel has high potassium content and can be used for the synthesis of a potassium salt (37). Indeed, in plant nutrition, potassium plays an essential role in root development, it ensures the transfer of assimilation to the reserve organs (bulbs and tubers) (14). Thus, the onion has NPK requirements of the order of: 150 Kg of N; 120 Kg of P and 195 Kg of K per hectare.

The main objective of this study was to extract potassium from plant waste (banana peels) and to evaluate its efficiency on the crop that requires enough potassium in order to valorize household solid waste. The recovery of banana waste would be a solution for waste management and would allow a possible synthesis of potassium salts. This salt could be used as a potassium mineral fertilizer and reduce their production cost in the region, through a possible reduction in the selling price of mineral fertilizers.

Materials and Methods

This experiment was conducted during the 2016-2017 cropping season at the Research Station of the Faculty of Agronomic Sciences of the University of Lubumbashi (UNILU). The site is located at 1243 m altitude, 11°39' South latitude and 27°28' East longitude. The climate of Lubumbashi is characterized by the alternation of a rainy season (November to May) and a dry season (May to September), with October and April as the transition months. July and August are the driest months (22). The average annual rainfall is 1270 mm with a rainy season of 118 days, while the average annual temperature is around 20°C with great interannual stability.

The average humidity level is 62% with an average minimum humidity level of 52% during the dry season (June - August) and a maximum of 80% during the rainy season (November - May). The soils of Lubumbashi and its surroundings are dominated by yellow, ochre-yellow and red ferralitic soils depending on the topographic position and drainage. And the synthesis of the potassium mineral salt was done in the laboratory of the Faculty of Agronomic Sciences of the University of Lubumbashi (UNILU).

The vegetation of Lubumbashi consists of three main types of plant formations which are: savannah, steppe and forest. The forest accounts for more than 80% and has three aspects: clear forest, edaphic forest and dry forest (22). From the phytogeographical point of view, the experimental field of the Faculty of Agricultural Sciences of the University of Lubumbashi (UNILU) is dominated by herbaceous species (*Cynodon dactylon, Hyparrhenia sp, Tithonia diversifolia, Imperata cylindrica,*). The soil of the experimental field used for this study was mixed with forest litter.

The trial was carried out in a 2 Kg pot with the same type of soil (sandy-clay) whose physico-chemical characteristics are shown in Table 1 and conducted according to the experimental device in factorial (2*3*2) without interaction with 12 treatments for 3 replicates.

The treatments consisted in varying different doses of fertilizer (NPK, Urea and local fertilizer synthesized from the banana peel) according to the treatments: **T0**: control (without fertilizer), **T1**: Urea 200 Kg;**T2**: 150 Kg of local fertilizer, **T3**: 200 Kg of Urea + 150 Kg of local fertilizer;**T4**: 200 Kg of local fertilizer;**T5**: 200 Kg of urea + 200 Kg of local fertilizer;**T6**: 600 Kg of NPK;**T7**: 600 Kg of NPK + 200 Kg of urea;**T8**: 600 Kg of NPK + 150 Kg of local fertilizer;**T9**: 600 Kg of NPK + 150 Kg of local fertilizer + 200 Kg of urea;**T10**: 600 Kg of NPK + 200 Kg of local fertilizer;**T11**: 600 Kg of NPK + 200 Kg of local fertilizer + 200 Kg of urea per hectare.

The red onion or Red Creole used as biological material in the experiment was transplanted after having spent 60 days in the nursery, the seedlings were transplanted to be harvested 3 months after 90 days. The pots were filled with light unsterilized soil (drill litter mixed with sand) for good development and easy bulb swelling. The crop management consisted in bringing different doses of NPK (10-20-10), Urea and local potassium fertilizer synthesized from the banana peel in order to meet the needs of the onion in these three major fertilizing elements ; The NPK supply was split into four doses of 150 kg/ha for each dose, which makes 600 kg/ha in total, and the potassium fertilizer is also split in the same way as the NPK, but at different doses;

the first dose is considered as high dose either because of 200 kg/ha and the second dose as low dose or because of 150 kg/ha, and the urea is spread as a single dose or because of 200 kg/ha. During this trial different parameters were observed in particular: leaf length, number of leaves per plant and bulb diameter and weight; the first two parameters were observed every two weeks after harvest and the last two after harvest.

It was reported that these three fertilizers were applied 20 days after transplanting and observation of the parameters started 15 days after the first dose. The different doses were given according to the needs of the onion which are: 150 Kg of N; 120 Kg of P and 195 Kg of K per hectare. The banana skins harvested from the public garbage cans were washed with clean water to remove dust. The washed skins were exposed to the sun for about 7 days. After complete drying in the sun, the skins were calcined in a muffle kiln at a temperature of 350 °C until ash was obtained. This operation lasted for 8 hours. An analysis of the total ash was performed by incineration following the same procedure described for calcination. The result was calculated according to the equation:

- $\% \text{ C} = \frac{P2}{P1} X100\%$

With:

P1: sample weight before calcination;
P2: sample weight after calcination;
% C: percentage of crude ash in dry matter.

The banana peel consists of about 3.9% ash. This allows us to say that from 100 Kg of banana peel waste we can have 3.9 Kg of ashes.

For each parameter observed, the mean as well as the standard deviation was calculated. The collected data were subjected to an analysis with a student test in case of two means, and in case of more than two means to the analysis of variance with the Anova test. The latter was accompanied by a test of the smallest significant difference by Turkeywith the software R.

Results

The results of the vegetative parameters according to two doses of NPK in table 2, show that there are no significant differences between the two doses of NPK when considering the recovery rate, the size (at 35 and 50 days) and the number of leaves (at 35 and 50 days). However, the plant size recorded at day 65 after transplanting varies between 42±12.84 and 52±10.56. Comparison of the means with Student's test reveals that the average size of plants that received 600kg of NPK is significantly larger than those that did not receive any amendment. In addition, the 600Kg dose of NPK gave significantly higher leaf counts and a significantly larger mean size of the plants that received the 600Kg dose of NPK. highly superior (P= 0.005935) to unamended soils. Similarly, when comparing plant weight and bulb weight in a Student's test, the results indicate that there is a highly significant difference (p<0.01) between the means of two doses of NPK for plant and bulb weight. Finally, the 600Kg dose of NPK gave a highly significant (p<0.001) mean diameter (p<0.001).

Comparison of the means of the recovery rate (RR) with the analysis of variance (ANOVA) test reveals that there are no significant differences (P>0.05) between the different doses of potassium (local) fertilizer applied in table 3. On the other hand, non-significant differences (P>0.05) were also found on the size sampled at 35 days, 50 days and 65 days when comparing the different doses of (local) potash fertilizer.

In addition, the number of leaves counted at 35 days, 50 days and 65 days were similarly indifferent to increasing doses of (local) potash fertilizer. Finally, comparison of the means of plant weight, bulb weight and bulb size (diameter) with the analysis of variance (ANOVA) test revealed that there were no significant differences (P>0.05) between the different doses of (local) potash fertilizer applied.

Comparison of the means of the recovery rate (RR) with the analysis of variance (ANOVA) test also reveals that there are no significant differences (P>0.05) between the different urea rates applied in table 4.

On the other hand, non-significant differences (P>0.05) were similarly found on the size collected at 35 days, 50 days and 65 days when comparing different doses of urea.

In addition, the number of leaves counted at 35 days, 50 days and 65 days were similarly indifferent to increasing urea doses.

Finally, the comparison of the means of plant weight, bulb weight and bulb size (diameter) with the analysis of variance (ANOVA) test revealed that there were not significant differences (P>0.05) between the different urea doses applied.

Table 5 shows that the reconciliation of the means of the recovery rate (RR) with the analysis of variance (ANOVA) test shows that there are no significant differences (P>0.05) between the different combined doses of NPK and (local) potash fertilizer applied.

On the other hand, non-significant differences (P>0.05) were also found on the size sampled at 35 days, 50 days and 65 days when evaluating the different doses of NPK and potassium fertilizer (local).

In addition, the number of leaves counted at 35 days, 50 days and 65 days were similarly indifferent to increasing doses of NPK and potassium fertilizer (local).

Finally, comparison of the means of plant weight, bulb weight and bulb size (diameter) with the analysis of variance (ANOVA) test shows that there are not also significant differences (P>0.05) between the different doses of NPK and potassium fertilizer.

Table 6 reveals that the comparison of the means of the recovery rate (RR) with the analysis of variance (ANOVA) test shows that there are no significant differences (P>0.05) between the different doses of NPK and urea applied.

On the other hand, non-significant differences (P>0.05) were also found on the size sampled at 35 days, 50 days and 65 days by comparing the different doses of NPK and urea. In addition, the number of leaves counted at 35 days, 50 days and 65 days were also indifferent to the increasing doses of NPK and urea. Finally, the comparison of the means of plant weight, bulb weight and bulb size (diameter) with the analysis of variance (ANOVA) test shows that there are not yet significant differences (P>0.05) between the different doses of NPK and urea provided.

Table 7 shows that the comparison of the means of the recovery rate (RR) with the analysis of variance (ANOVA) test shows that there are no significant differences (P>0.05) between the different doses of potassium (local) fertilizer combined with urea and between the combination of NPK, potassium (local) fertilizer and urea applied.

On the other hand, non-significant differences (P>0.05) were also found on the size sampled at 35 days, 50 days and 65 days when comparing the different doses of potassium (local) fertilizer and urea and between the combination of NPK, potassium (local) fertilizer and urea. In addition, the number of leaves counted at 35 days, 50 days and 65 days were also indifferent to the increasing doses of potassium (local) fertilizer and urea and between the combination of NPK, potassium (local) fertilizer and urea. Finally, comparison of the means of plant weight, bulb weight and bulb size (diameter) with the analysis of variance (ANOVA) test reveals that there are not yet significant differences (P>0.05) between the different doses of potash (local) fertilizer and urea and between the combination of NPK, potash (local) fertilizer and urea applied.

Discussion

The results in table 2 evaluate the recovery rate (RR), 35-day height (T35), leaf count (Nf1), 50-day height (T50), leaf count (Nf2), 65-day height (T65), leaf count (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of NPK fertilizer; show that there are no significant differences between the two doses of NPK when considering recovery rate, size (at 35 and 50 days) and leaf count (at 35 and 50 days). The situation observed at these two periods of plant growth can be correlated with the behaviour of the NPK fertilizer, which decomposes less rapidly to pass into the soil solution for assimilation by the plant. This is why it is used as a background fertilizer; in order to coincide its decomposition and the peak of plant growth (31). On the 65th day after application, significant differences in leaf size and number of leaves were recorded. This may explain the delayed nutrient availability of the NPK fertilizer. After the observation of the vegetative parameters, the other parameters are evaluated only at the end of the plant cycle yield parameters: bulb diameter, plant weight and bulb weight gave significant differences because the efficiency of the NPK fertilizer is felt by releasing the nutrients in the soil solution in a form that can be assimilated by the plant and this yield is a function of the element being in the lowest proportion in relation to the set of elements as announced by the law of minimum (Liebig).

The results in table 3 evaluate the recovery rate (TR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) according to the potassium fertilizer, this fertilizer was applied in three different doses: 0Kg, 150Kg and 200Kg; the results of the vegetative parameters obtained on the samples treated only with locally synthesized potassium fertilizer are similar to those obtained on the control samples. But a significant difference is obtained on the results of the yield parameters. These recorded results are justified by the fact that the local potassium fertilizer does not have a direct influence on the aerial growth of the plant, but rather efficiently on the underground part of the plant (26). Indeed, the role is crucial in root development; particularly in the transfer of assimilated elements to the reserve organs (bulbs and tubers) (14). Potassium plays a major role in the ability of plants to resist induced stress, such as drought, frost, excess light and pest attacks. Although stressed in the organs of the reserves, potassium allows the plant to reduce transpiration by conditioning the opening of the stomata, and indirectly facilitates plant growth (24).

As for the samples without fertilizer (controls), the results obtained from soil analysis in the laboratory before the trial, which are grouped in table 2below, showed a low availability of exchangeable potassium, i.e. 0.39%; this percentage is tolerable in our environment because in tropical Africa the content of exchangeable potassium in the soil generally does not exceed 1% (7). And this low concentration of potassium in tropical soil has a direct consequence on plants that have useful products underground (bulb, tuber and tuberous root) (45). According to Deblay (2006), the absence of organic and mineral inputs is accompanied by a loss of organic matter and nutrients, soil acidification, reduced biomass, microbial activity and low potassium solubilization. This situation contributes to a significant decrease or fall in crop yields. Similar observations were made on maize by (30). However, when soils are very poorly supplied in bases, these balances are not very significant, as any external contribution (plant ashes, fertilizers, etc.) totally modifies the proportion of elements present in the soil (22) Finally, there is a final restriction, that of plant physiology; thus, in waterlogged soil, the Robusta coffee tree suffers from a deficiency of potassium and an excess of calcium and magnesium, although soil analysis reveals nothing abnormal in the distribution of these elements. An experiment carried out in Kivu by Culot and van (46). Similarly, in the rare cases where the plant obtains its potassium supply preferably from deep horizons at about 50 cm, as confirmed by Farina and Graven (15) in South Africa, it is conceivable that the determination of exchangeable potassium normally made on the upper part of the soil is no longer meaningful.

The rapid growth of leaves on the control treatments at different dates of observation of the vegetative parameters is justified by the slightly high presence of nitrogen (0.29%) in the soil, which favours the aerial development of a growing plant through the photosynthesis reaction; these results are similar to those found on banana by Mazinga (25).

As for the treatments that received only the local potassium fertilizer synthesized from banana peels without interaction with other fertilizers at a dose considered average of 150 kg and a supposedly high dose of 200 kg, the two doses gave almost similar results, there were no significant differences; this can be explained by the availability of exchangeable potassium in the soil solution and its retention on the absorbent complex as exchangeable potassium occupies a number of preferential sites (1) and in addition to the common exchange sites where it competes with other soil cations in tropical soils (23). The combination of potassium with another element essentially would bring about a change in soil properties. According to the experiment carried out by Parkinson (34), a synergy would exist between nitrogen and potassium. High levels of N and K in a soil confirm that the organic matter present in the soil improves the chemical properties of the soil by making it favourable for crop growth and is a source of nutrients for crops (32). As for their roles, according to Roinila (38), fertilization with a nitrogen-rich fertilizer has a positive effect on onion growth. Potassium, on the other hand, has the essential role of activating numerous enzymes and it seems that to a lesser extent it actively participates in the propagation of mycorrhizae (16).

In addition, many authors have noted that a higher dose of NaCl strongly reduces vegetative growth and causes symptoms of burning and toxicity (38). It has been reported that the reduction in plant growth is due to the decrease in the osmotic potential in the soil, stomatal conductance, photosynthesis and also to the increase in the concentration of Na and Cl ions that reach levels toxic to the plant. It should also be pointed out that the excessive accumulation of K^+ causes marginal necrosis of the leaves, which is accompanied by a decrease in Mn, Mg and Zn in the plant organs (21).

arginale of the leaves which is accompanied by the decrease of Mn, Mg and Zn in the organs of the plant (21).

The treatments that were subjected to 600Kg of NPK, 200Kg of potassium fertilizer (local) and 200Kg of urea; gave a better yield compared to other treatments. The increase in yield would be due to the improvement of the soil properties (cation exchange capacity and water retention capacity) and the release of nutrients. This shows that, for these treatments; it is more the phosphorus that is the limiting element of the yield because it is found in small proportion compared to the nitrogen and potassium content. Similar result with Useni (42) under Lubumbashi conditions, on maize cultivation with the use of recycled human waste. Thus, an experiment by Furlan (1976) demonstrates not only the preponderant role of nitrogen in the propagation of endomycorrhizae on the roots of onions (*Allium cepa* L.), but also the inhibitory effect of phosphorus fertilization on the infection of roots by these organisms. Moreover, it appeared during this experiment that the negative effects of phosphorus could be mitigated when it was combined either with nitrogen alone or with a potassium-nitrogen combination. On the other hand, numerous experiments have shown that vesicle and arbuscular endomycorrhizae are known to stimulate plant growth by improving the absorption of mineral elements, especially phosphorus. Another study conducted by Charron (8), showed that there was a significant increasing linear effect on the diameter and dry matter mass of bulbs by increasing phosphorus concentrations in the soil.

Conclusion

The main objective of this study was to extract potassium from plant waste (banana peels) and to evaluate its effectiveness on a crop that shows high potassium needs in the context of the recovery of household solid waste.

To carry out this operation, we had to collect banana peels from various public dumps in the city of Lubumbashi. The banana skins collected in the garbage cans were treated in the laboratory to obtain a potassium fertilizer. The latter was experimented on onion (Red creol) culture according to a 2*3*2 factorial experimental device with 12 treatments for 3 replications in order to evaluate the synthetic product (local potassium fertilizer) compared to ordinary fertilizers (NPK and Urea) sold on the market.

The 200Kg dose is more suitable for the type of soil (drill litter) used for this trial and gives results almost similar to NPK (10-20-10) but it must be combined with other major elements such as nitrogen and phosphorus to compensate for the crop's need. Separately it can be combined with urea (46%) and phosphate (P_2O_5) or either combined with DAP (18N - 46- $0K_2O$) or used as a cover fertilizer after a bottom fertilizer (NPK).

References

[1]. Agbani M., (2012): *Analysis of the behavior of some Moroccan soils under the effect of different levels of potassium fertilization in long-term trials.* Postgraduate thesis. IAV Hassan II Rabat – Morocco, 30p

[2]. Badraoui M., (1988): *Mineralogy and potassium availability in soils from the Chaouia and Gharb Regions (North western of Morocco).* Ph-D, Thesis, Univ of Minnesota, 199p

[3]. Badraoui M. and M. Agbani., (2010): Potassium fertility of Gharb soils: Consequences on potassium fertilization of beet - day-debate on fertility and fertilization, 78-90p

[4]. Badraoui M., Agbani M., Bouabid,R. and Zeraouli M., (2001): Better fertilization of irrigated sunflowers: New standards for the Gharb region" Technology transfer in agriculture - *MADREE/DERD*, n°80,32-38p

[5]. Bamba G.H., (2011): Onions, harvesting, drying and conservation Chambre d'agriculture Rhônes-Alpes. Serail, 18p

[6]. Basri D., (1992): Prospects and methods of breeding varieties resistant to septoria: Regional Workshop, Beyrout, Lebanon, 14-17.

[7]. Cameron E, How N, Saggar S, Ross C., (2004): The costbenefits of applying biosolid composts for vegetable, fruit and maize/sweet corn. Landcare Research Science Series no. 27. Manaaki Whenua Press, Lincoln, Canterbury, NZ. 31 p.

[8]. Charron G., (1990): Response of onion plants to endornycorhization according to inoculation method, soil type and nitrogen and phosphate fertilization. Master's thesis, University Laval, Québec. 98 p.

[9]. Chuimika Z.R., (2005): Onion bunch under: cold shelter CETA d'Aubagne, 36 :44-57p

[10]. Culot A.T. and Van W., (2003): Potassium, an essential element for plant life, 746p

[11]. De Bon H., Parrot L., Moustier P., (2008):Sustainable urban agriculture in developing countries. A review. Agronomy for Sustainable Development 30:21-3

[12]. Didier Jammes - Bio de Provence, (2012): Technico-economic typology of organic market gardening farms, 350- 367p.

[13]. FAO, (2005):Soil Fertility Management for Food Security in Sub-Saharan Africa. Rome, Italy, 63 p.

[14]. FAO, (2005): Limitation of fertilizer application in order to guarantee the balance of nitrogen fertilization 80p

[15]. Farina Q.Z and Graven D.U., (2000): Potassium reserves in tropical soils, 190p

[16]. Furlan, V. (1976). *Étude de l'influence de la température, de la lumière et des fertilisants N-P-K sur les étapes de I'endomycorrhization et la croissance de 1'Alliuni cepa* L. PhD thesis, Université Laval, Québec. 188 p.

[17]. Grab T.S., (2010) : Organic white onion technique - Lot et Garonne Chamber of Agriculture, 93p

[18]. Grab T.S., (2014) :Onion Bio technique - Finistère Chamber of Agriculture / Farmers' Development Committee - Vegetable zone,260p

[19]. LowrisonG.C., (1999): Fertilizer Technology, Ellis Horwood, chichester, 24-26p.

[20]. Grab., (2012): Diversification in organic growing under cover in Provence onion variety trial in late winter boot onion (white and red) trials, 350p

[21]. Péron J-Y., (2006) : References vegetable productions – Onion,2nd edition p 591-623p

[22]. K.G.M Bouafou, André B.K, Koffi G.K (2012): Banana products and by-products in animal feed, 23p

[23]. Kitabala G.S.,(2016): Regional workshop on Potassium and Fertigation development in West Asia and North Africa; Rabat, Morocco, 24-28p

[24]. Mshandele K.N., (2008): Onion bunch under cold shelter CIVAM bio des Pyrénées-Orientales,13p

[25]. Mazinga K.M., Séverrin K.B.,Mukalay J.B., (2015): Case study on the impact of organic fertilizers on salinity in banana cultivation,*Journal of Appliet Bioscences,*152-160p

[26]. Mazinga K.M., Useni S.Y., Stefaan W., Nyembo K.L., Baboy L.L., (2012). Behavior of banana (Musa sp) vitroplants in ex-vitro environment: case of the FHA-01 hybrid (AAAB) in the peri-urban environment of Lubumbashi (DRC). *Journal of Appliet Bioscences,* 89 :4297-4306p
[27]. Mbanza M., Aloni R, Muteb M., (1989): Some considerations on the pollution of the area in Lubumbashi (Shaba, Zaire). *Géo-éco-trop*. 13 (1-4) 113-125p
[28]. Mondini K.U, Insam J.L., (2013):Vegetables bunch September, 123-125p
[29]. Mujinya B.B., Mees F., Beeck P., Bode S., Baert G., Erons H., Delofortrie s., Verdoodt A., Ngongo ML., Van Ranst E., (2011): The origin of carbonat in the termite mounts of the Lubumbashi area, DR Congo. *Geoderma,* 165, 95-105p
[30]. Nyembo K.L., Useni S.Y., Mpundu M.M., Bugeme M.D., Kasongo L.E., Baboy L.L., (2013): Improvement of physical and chemical properties of soil under the combined contribution of bio-waste and mineral fertilizers and influence on the behavior of maize (*Zea mays* L. variety Unilu) in Lubumbashi, southeast DR Congo. *Journal of Applied Biosciences,* 59: 3878-3892p
[31]. Nyembo K.L., Useni S.Y., Mpundu M.M., Bugeme M.D., Kasongo L.E., Baboy L.L., (2012): Effects of various doses of inorganic fertilizers (NPKS and Urea) on the yield and economic profitability of new varieties of *Zea mays* L. in Lubumbashi, southeast DR Congo. *Journal of Applied Biosciences,*59: 4286- 4296p
[32]. Ormvag (1999) potassium from the soils of Gharb -Technical Center for Sugar Crops, 90p
[33]. Ormvag (2013): Potassium fertilization of peppers in tunnels - Activity report of the Agricultural Experimental Station - *M'nasr*a - pp 27 and 28p
[34]. Parkinson, R. J., Furller, M. P. and Groenhof, A. C., (1999): An evaluation of greenwaste compost for the production of forage rnaize (*Zea mays* L). *Compost, Science &Usage*. 7 (1): 72-80.
[35]. Pypers P., (2010): Integrated soil fertility management: The TSBF definitions, seminar at UEA, 11th May 2010. Bukavu, DRC, 7698-7713p
[36]. Robert P., Scharff J.P., (2013): engineering school; industrial chemistry, 778p
[37]. Roinila P., (1998): Composting of fish and the use of fish compost as a fertilizer. Proceedings of the International Symposium on composting and use of Composted Materials for Horticulture. *Acta Horticulturae*. (469): 359-371p.
[38]. Sanginga N., Woomer P., (2009): Integrated soil fertility management in Africa: principles, practices and process developpement, TSBF-CIAT and FORMAT, Nairobi Kenya, 270p
[39]. HonguT., PhillipsGO., (1990): New Fibers, Ellis Horwood, chichester,34p
[40]. Tejada M., Hernandez M.T., Garcia C., (2006). Application of two organic amendments on soil restoration: Effects on the soil biological properties. *J Environ. Qual*, 35: 1010-1017p
[41]. Useni S.Y., Chukiyabo K.M., Tshomba K.J., Muyambo M.E., Kapalanga K.P., Ntumba N.F., Kasangij A-K.P., Kyungu K., Baboy L.L., Nyembo K.L., Mpundu M.M., (2013). Use of recycled human waste to increase maize (*Zea mays* L.) production on a ferralsol in southeastern DR Congo. *Journal of Applied Biosciences,* 66:5070 - 5081p
[42]. Useni S.Y.., Baboy L.L., Nyembo K.L., Mpundu M.M., (2012): Effects of combined inputs of biowaste and inorganic fertilizers on the yield of three varieties of Zea mays L. grown in the Lubumbashi region. *Journal ofApplied Biosciences,* 54: 3935- 3943p
[43]. Vanlauwe B., Tittonell P., Mukalama J., (2006): Withinfarm soil fertility gradients affect response of maize to fertilizer application in western Kenya. *Nutrient Cycling Agroecosystem,* 76:171-182p
[44]. Vranken H., (2008):*The vegetable garden in the tropics. Agromisa Foundation and CTA, Wageningen*, The Netherlands, 1st Edition 6p
[45]. Zehauf M., A. Harrak and Ennahari J., (1995): Synthesis of results over 4 years of experimentation. ORMVAG Report 17

International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 05 – Issue 10 || October 2020 || PP. 10-21

List of tables

Table 1: physico-chemical parameters of the soil

Parameters	pH_{eau}	pH_{KCl}	OC %	OM %	N total %	P total µg/g sol
Results	7.79	7.39	1.29	2.23	0.29	997.02
Parameters	**P Disp µg/g sol**	**K total %**	**Fe total %**	**Mn total µg/g sol**	**Ca total µg/g sol**	**Cu total µg/g sol**
Results	225.83	0.39	1.02	200	6500	300

The table below shows the result of the parameters selected as a function of 2 doses of NPK.

Table 2: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) versus NPK fertilizer

NPK (Kg)	TR	T35	Nf1	T50	Nf2
0	88.8± 32,3	20.5 ±9.4	4.2 ± 1.0	30.6±13.7	5.0± 1.9
600	72.2±46.0	24.7±5.3	4.7± 0.8	39.4±9.8	6.0± 0.7
P value	NS	NS	NS	NS	NS
NPK (Kg)	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	42±12.8	6.6±1.9	26.8±10.0	45.3±26.5	21.5±17.1
600	52±10.5	8.3±0.9	41.5±65	73.4±20.1	40.8±13.6
P value	*	**	***	*	**

The table below spreads the result of the parameters chosen according to 3 doses of potassium fertilizer (local).

Table 3: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of potassium fertilizer (local).

Urea(Kg)	TR	T35	Nf1	T50	Nf2
0	77.7±42.7	21.1±9.1	4.5±0.8	33.5±14.2	5.6±1.6
200	83.3±38.3	23.4 ±7.2	4.3±1.1	35.2±11.9	5.4±1.6
P value	NS	NS	NS	NS	NS
Urea(Kg)	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	43.3±15.2	7.3±2.1	32.3±14.2	54.1±34.8	29.1±23.5

200	49.4±9.9	7.4±1.5	33.9±8.3	60.5±20.9	30.5±12.8
P value	NS	NS	NS	NS	NS

The table below shows the result of the selected parameters according to 2 doses of urea.

Table 4: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1),size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of urea

Local Fertilizer	**TR**	**T35**	**Nf1**	**T50**	**Nf2**
0	83.3±38.9	21.8±7.6	4.6±0.6	35.8±11.8	5.8±1.1
150	66.6±49.2	25±8.0	4.5±0.8	35.5±13.2	5.5±1.1
200	91.6±28.8	20.6 ±8.7	4.2±1.3	31.4±13.9	5.2±2.0
P value	NS	NS	NS	NS	NS
Local Fertilizer(Kg)	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	51±11.7	7.8±1.3	34.7±11.4	59.9±22.4	30.8±17.1
150	42.4±15.3	6.5±2.5	31.9±13.1	55.1±36.3	28.0±21.3
200	45.9±11.3	7.7±1.2	32.8±10.5	57.3±26.1	30.5±18.2
P value	NS	NS	NS	NS	NS

International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 05 – Issue 10 || October 2020 || PP. 10-21

The table below shows the result of the parameters chosen according to 2 doses of NPK combined with 3 doses of potassium fertilizer (local).

Table 5: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of combined doses of NPK and potassium fertilizer

NPK (Kg)	**FERTILIZERK$_2$O (Kg)**	**TR**	**T35**	**Nf1**	**T50**	**Nf2**	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	**0**	83.3±40.8	17.3±6.6	4.2±0.4	30.9±11.4	5.4±1.5	46.5±13.4	13.3±7.4	27.3±9.4	47.2±16.8	20.6±11.2
	150	83.3±40.8	25.7±9.0	4.5±0.8	35.4±14.5	5.2±1.8	39.5±15.2	15.2±5.5	26.8±12.8	40.8±36.1	21.0±22.2
	200	100±0.00	18.0±10.9	3.8±1.60	25.6±15.2	4.6±2.5	40.9±10.9	10.9±7.1	26.5±9.2	48.3±26.2	22.7±18.5
600	**0**	83.3±40.8	26.4±6.0	5.0±0.70	40.7±11.12	6.2±0.44	55.7±8.97	8.97±8.2	42.2±8.14	72.5±21.1	41.0±16.7
	150	50.0±54.7	23.5±6.89	4.33±1.1	38.6±12.78	6.00±1.00	48.3±16.6	16.6±8.67	42.13±6.6	83.6±13.1	42.1±11.6
	200	83.3±40.8	23.8±4.42	4.80±0.8	38.50±9.17	6.00±1.00	52.0±9.46	9.46±8.40	40.42±6.3	68.2±23.9	39.7±14.4
P Value		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

The table below spreads out the result of the selected parameters according to 2 doses of NPK combined with 2 doses of urea.

Table 6: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2),size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of combined doses of NPK fertilizer and urea

NPK (kg)	**UREA (kg)**	**TR**	**T35**	**Nf1**	**T50**	**Nf2**	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	**0**	88.8±33.3	17.1±9.6	4.25±0.8	26.2±14.0	5.00±2.0	36.12±12.8	6.25±1.9	23.2±10.9	36.2±31.2	16.0±19.5
	200	88.8±33.3	23.5±8.6	4.17±1.2	34.5±13.5	5.17±2.7	47.3±10.93	7.0±1.94	30.0±8.4	53.5±20.8	26.4±14.0
600	**0**	66.67±50	26.5±4.8	5.00±0.6	43.1±7.5	6.55±0.5	53.00±13.9	8.8±1.33	44.5±7.1	78.0±21.3	46.5±16.1
	200	77.7±44.0	23.2±5.6	4.58±0.9	36.2±11.0	5.72±0.7	52.23±8.56	8.00±0.0	38.93±5	69.5±19.8	35.87±9.6
P	**Value**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table VII below gives the results of the selected parameters according to 3 doses of potassium fertilizer (local) and 2 doses of urea and also the P value values of the combination of 2 doses of NPK, 3 doses of potassium fertilizer (local) and 2 doses of urea.

Table 7: Evaluation of recovery rate (RR), size at 35 days (T35), number of leaves (Nf1), size at 50 days (T50), number of leaves (Nf2), size at 65 days (T65), number of leaves (Nf3), bulb diameter (DB), plant weight (PPlt) and bulb weight (Pb) as a function of combined doses of potassium (local) fertilizer and urea, and NPK fertilizer, potassium (local) fertilizer and urea

Local fertilizer (kg)	**Urea (kg)**	**TR**	**T35**	**Nf1**	**T50**	**Nf2**	**T65**	**Nf3**	**DB**	**PPlt**	**Pb**
0	**0**	66.6±51.6	18.1±10.2	4.2±0.50	30.1±15.3	5.25±1.5	45.7±16.07	7.25±1.8	30.6±17.2	53.3±31.0	27.3±27.3
	200	83,3±40.8	24.3±4.9	4.8±0.75	39.5±8.29	6.17±0.7	54.6±7.56	8.17±0.7	37.5±5.9	64.2±16.4	33.1±8.10
150	**0**	83.3±40.8	25.7±7.8	4.8±0.84	39.7±15.5	6.2±1.92	43.1±18.9	7.4±2.96	34.9±15.8	61.8±47.1	34.1±26.8
	200	50±54.7	24.0±9.2	4.12±0.8	32.5±10.59	4.6±0.47	41.6±11.9	5.5±1.73	28.12±9.3	46.7±18.3	25.5±10.9
200	**0**	100±0.0	18.9±9.3	4.6±1.14	39.5±8.29	5.4±1.81	41.7±13.8	7.4±1.82	31.1±13.1	47.1±25.7	25.5±21.5
	200	100±0.0	22.1±8.8	4.0±1.55	32.7±15.94	5.17±2.4	49.5±8.52	8.0±0.62	34.3±8.75	65.9±25.3	34.6±15.7
P/ L. Fertilizer*Urea		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
P/ NPK*L. Fertilizer*Urea		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**