Moroccan Journal of Chemistry
ISSN: 2351-812X
http://revues.imist.ma/?journal=morjchem&page=login
Lahlou & al./ Mor. J. Chem. 7 N°2 (2019) 320-336

Effects of sludge compost as an amendment on the morphological responses and on production parameters of radish and potato

K. Lahlou [1*], F. Elmadani[1], M. BEN ABBOU[2], O. Karzazi[1], F. El-Hajjaji [1], M. Taleb[1], A. Chetouani[4], M. El Haji[3], Z. Rais[1]

(1) Laboratory of Engineering, Electrochemistry and Modeling Environment (LEEME), Faculty of Sciences Fez, Morocco
(2) Laboratory of Natural Resources and Environment, Faculty Poly Disciplinary-Taza, Sidi Mohamed Ben Abdellah University, 1223, Taza, Morocco
(3) Laboratory Engineering research - OSIL team Optimization of Industrial and logistics Systems, University Hassan II,
Superior National School of Electricity and Mechanic (ENSEM), 8118, Casablanca, Morocco.
(4) Laboratory of Applied Analytical Chemistry, Materials and Environment (LC2AME).Faculty of Science Oujda, Mohamed I university

** Corresponding author:*
kenzalahlou202@gmail.com
Received 07 Dec 2018,
Revised 24 April 2019,
Accepted 10 May 2019

Abstract
The elimination of sewage sludge is one of the current environmental problems; their valorisation appears as a matter of organization and optimization of the techniques of their management or elimination can play the role of organic fertilizer because of their richness of organic matter and mineral compounds. This study examines the use of sludge compost elaborated as a fertilizer and compares it with compost without sludge, Manure (traditional input) and bare soil (no input). We studied the impact of these fertilizers on the soil (before and after cultivation), on the parameters of vegetative growth (morphological) and on the parameters of production. The application test was carried out on two crops: radishes and potatoes. The obtained results showed a significant increase in vegetative growth and production levels compared to bare soil (without input) and manure. For the physicochemical characterizations studied of the soil before and after the planting of the culture tested, the results show that the compost has an effect on soil

Keywords: *Sludge; Valorisation; Compost; Cultivation.*

1. Introduction

Since many decades, most countries have set up wastewater treatment plants as part of public policy to preserve the quality of natural waters. However, Sewage sludge is generated as an inevitable by-product of wastewater treatment activity. Wastewater treatment plants, also called sewage treatment plants remove most pollutants from wastewater before it is released to local waterways and to sludge. These later are composed from water and organic and mineral matter. The sludge is either liquid, when it comes from small rural stations, or pasty, when it is coming from medium-sized stations, or limed, when it is coming from medium and large stations [1]. The considerable amount of sludge produced every year throughout the world is a growing environmental problem. The cost of sludge management accounts for about 50-60% of the total costs for wastewater treatment (WWTP) [1]. Furthermore, during sludge treatment (elimination and/or reuse), the organic matter is converted to carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), depending on environmental conditions [2]. The CO2, the CH4, and the N2O are the main greenhouse gases (GES) [2]. Therefore, the recovery of sludge has become an important challenge in waste disposal.

In this direction, in our first work, which consisted in the valorization of the sludge of WWTP of the of Fès city in the co-composting process [3]. We have been able to develop some composts on a semi industrial scale: compost with sludge and a control one without sludge. Both of them meet the standards quality requirements for sludge NFU 44-095 and urban NFU 44-051. In those days, we have speculated on their use in the field of agriculture especially with the wave of modernization that knows the sector of agriculture in Morocco and its direction towards the organic agriculture. Morocco has made considerable investments in agricultural development with a view to modernizing its agriculture and consequently ensuring food self-sufficiency. Many agricultural zones have been developed on a regional scale and this development has been accompanied by intensive use of nitrogenous fertilizers and plant protection products [4]. Although this intensification has a positive effect on agricultural yields, it nevertheless has negative impacts on the degradation of the quality of soils and of the receiving environments in particular the groundwater. Indeed, studies have shown the existence of salinity problems, solidification, congestion and nitric pollution of groundwater in most regions of the country [5-7]. This degradation is caused in large part by the abuse of agrochemicals, including nitrogen fertilizers and pesticides, and drainage of cultivated plots. Hence, the objective of this study is to apply these composts as soil fertilizer, to remedy the problem of poor and degraded soils and to find a solution for these wastes. Therefore, for this purpose, we studied the effect of the compost (with and without sludge) on the soil and on the cultivation of radishes and potatoes. In addition, we compared their effect with that of manure and bare soil (without amendment) in the order to evaluate their action as fertilizers of the soil and their effect on the growth and the crop yield of the radishes and the potato.

2. Material and Methods

2.1. Plant material

The amendments used for this study are:

- Manure (M) : obtained from farms in the Tawnat region ;
- Compost C and CB: made up from sludge and other substrates of different nature and composition (LAHLOU K. et al; 2017).

The plant material used for planting tests:

- Radish of variety Raphanus sativus ;
- Potato of variety Resy-Solanum tuberosum.

2.2. Sampling

The sampling method applied in this work is the systemic random method using a square mesh. The area available for agriculture was 4 m^2. It was divided into four to have 4 unities. Equal masses of samples were taken from the centre of each unity. The sample set was mixed and homogenized to form a compound sample.

2.3. Sampling

Soil sampling was carried out, in compliance with AFNOR X 31-100 Standard requirements, by a spade. This standard proposes the basic rules To provide samples with high quality; which consists of sampling 15 minimum cores with a depth of 10 cm (to reach the area receiving the fertilizer, high fertility and drought). Once the soil is removed, it is homogenized in a clean bucket, placed in labelled packaging with an information sheet, stored and transported at room temperature away from direct sunlight.

The plot map is shown in the figure1.

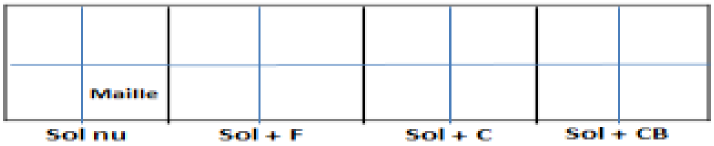

Figure 1: Plot map

2.4. Statistic study

A descriptive statistical study was carried-out for the different results obtained by the univariate linear model, the aim of this study was to analyze differences effect of the product on each test and parameter morphological and production. It is a random-block test with three repetitions. In the case where we are interested in two variables simultaneously, the bi-varied descriptive statistics are used. If the data set is derived from the observation of several variables, multivariate descriptive statistical methods must be used [8].

2.5. Methods

2.5.1. Amendments Characterization

All materials were characterized by pH, conductivity (EC), organic matter (% MO), Kjeldahl nitrogen (NTK), mineral nitrogen, phosphorus (expressed as P2O5), and potassium (expressed as K2O).

2.5.2 .Concept testing

Field trials, where the potato and radish was cultivated, were conducted at Faculty of Science Dhar EL Mehraz-Fez Faculty of Science. The land was divided into eight plots of 4m^2 each, 4 plots for each plantation. The preparation of the plots was as follows:

- ✓ Refinement of the Earth ;
- ✓ Turning the ground ;
- ✓ Distribution of parcels :
    - Bare floor
    - Floor + F
    - Floor + C
    - Floor + CB

The soil amendment for the planting of radish and potato was carried-out with quantities related to the data in the table1.

Table 1: Amount of amendment used for the planting of both crops according to Chamber of Agriculture Martinique 2007 (t/ha)

	Type of amendments		
Amount of amendment	**F**	**C**	**CB**
To plant Radish (t/ha)	3	3	3
To plant potatoes (t/ha)	6	6	6

- The Plantation was completed after a week of amendment.

For the planting of the radishes, we traced long furrows spaced 30 cm apart, and placed the seeds of the radish in line, without tightening them. Recovered with 2cm of soil and we tamped the soil slightly and watered just after.

For the potato plantation, we sprouted the germinated potato 20 cm deep and space the 30 cm potatoes and the 70 cm rows. We covered the plant gently and bring the soil back to the potatoes forming a mound.

2.5.3. Success of plantations

The crops were accompanied by regular monitoring of the morphological parameters up to the day of harvest. Measurement of all parameters was performed three times to ensure reproducibility and repeatability of the results. The value taken into consideration is the average of the three measures.

The measured parameters are:

- ✓ The number of stems / plant ;
- ✓ Stem length / plant ;
- ✓ Leaf Area.

On the day of harvest, we evaluated:

- ❖ The radish :
  - ✓ The total yield ;
  - ✓ The length and diameter of the root fruit.
- ❖ The potatoes :
  - ✓ The number of tubers / plant ;
  - ✓ Yield / plant ;
    - The length and diameter of tubers ;
    - The total yield.

- Length of stem / plant: The stem is the aerial axis that extends from the root and carries the buds and leaves. Measurements of the length of the stem were made using a graduated scale, due to three replications. The average shows the final value.
- Number of leaves / plant: The leaf is the specialized part in photosynthesis in plants [9]. It is the seat of breathing and sweating. Leaves can specialize, especially for storing nutrients and water. This parameter is an important indicator to measure vegetation biomass. The number of leaves was determined by averaging the first three plants for each row and field.
- Leaf area : This parameter indicates the production of vegetative biomass is related to photosynthesis.

For the surface of the radish leaves, we calculated it from the following relation With SF: Leaf area in cm^2 ; K: Coefficient relating to the shape of the radish leaf (K=0,871); L: Length of sheet in cm and l: Width of sheet in cm:

$$S_F = L \times l \times K$$

For leaves of potatoes, the leaf area was calculated by using two methods:

- ✓ The first method is similar to that of radish [10].
- ✓ The second method consists of drawing the sheet on a white paper, cutting and weighing it (known mass and unknown leaf area). Another square white paper of known surface and mass and then deduce the leaf area using the rule of three [11].

Yield : The production yield (Kg / ha) was calculated by using the following relation With P: is the total weight of radishes or potatoes of each plot in Kg and Sp: is the Plot size in hectare (ha):

$$Red = \frac{P}{Sp}$$

- Calibre : The Calibre consists of measuring the length and diameter of the radish and potato (5 radishes per parcel and 3 for the potato). Measurements were taken using callipers to take into account the average.

3. Results and discussion

3.1. Characterization of the amendments used

The results of the physico-chemical characterization of the amendments used: the compost C and CB and the manure F as it is shown in Table 2. It indicates that the products have basic compared to the manure. In addition, characterized by a high organic load and a low mineral charge. Moreover , the results of the total organic carbon, total nitrogen Kjeldahl, C / N, mineral nitrogen, phosphorus and potassium analysis of products C and CB are greater than those of manure and consequently they are classified in ascending order F <C <CB. This difference is equivalent to adding STEP sludge to CB compost. The sludge from the plant treatment is generally rich in phosphorus and in nitrogen and in potassium [12, 13], which has played in favour of CB composition.

Table 2: Characterization of the studied amendments (CB, C and F)

	Products		
Settings	**CB**	**C**	**F**
pH	8.15	8.13	7,57
CE (mS/cm)	4.03	2.55	3,44
Dry matter (%)	93.52	92.43	90,56
Organic material (%)	41,67	49,84	38,07
COT (%)	24.17	28.91	20,5
NTK (%)	1.95	2.22	1,45
C/N	12.38	13.02	14,13
Phosphorus (expressed in P2O5) in ppm	1785,95	412,80	367,83
Potassium (expressed in P2O5) in ppm	9914,40	6432,80	5853,23
Azote (expressed in azote mineral) in ppm	55,9	53,70	49,65

3.2. Soil characterization before cultivation

The soil results of the experimental site studied before amendment show that there is a clayey-sandy-silty texture soil, close to neutrality, rich in organic matter, low in nitrogen but with a C/N satisfactory for cultivation and high mineralization and with very high nitrogen availability. Although its electrical conductivity is very low, this means a very low level of elements to support the rigorous growth. Electrical conductivity also indicates that it is a non-salted

soil suitable for crops sensitive to soil salinity [14-16]. After amendment, the soil retained its initial characterization except for the pH that changed from neutral to basic and the nitrogen that passed from poor to medium indicates that the organic products used have improved the nitrogen content of the soil.

Table 3: Soil characterization before planting

	Floor + types AM			
Settings	Bare floor	**Floor + F**	**Floor + C**	**Floor + CB**
pH	7,5	7,74	8,02	7,87
CE (mS/m)	0,03	0,04	0,05	0,04
CE (dS/m)	0.03	0.02	0.05	0.04
%MO	6.3	8.61	8.08	9.58
%COT	3.65	4.98	4.67	5.7
%N	0.7	1.06	1.3	1.6
C/N	5.21	3.5	2.72	2.21

3.3. Culture of Radish

Radish growth was monitored by measuring the morphological parameters, namely stem length, leaf number, leaf area and production parameters, which are the amount of seed to plant per plot, yield and fruit size.

3.3.1. Morphological parameters

3.3.1.1. Stem length / plant

Figure 1 shows the stem length per plant. We note that the stem length / plant in the first days is almost the same in the different organic products. The difference appears only after the second week where the rate of growth begins to differentiate between the varieties. The best stem length was observed in radish modified by CB with a length of 16.44 cm. This can be explained by the high content of CB in (N, P, K) sence they are responsible for the development of green parts in plants and elements that play a major role in plant growth [17].

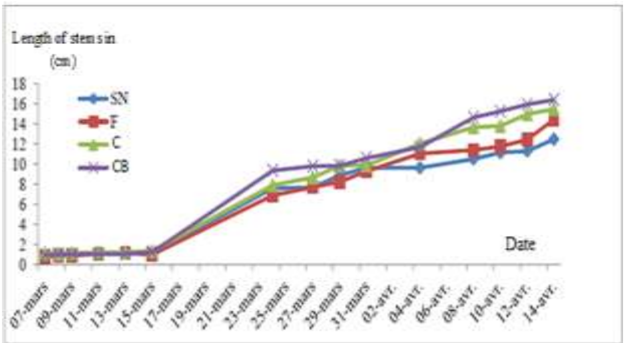

Figure 1: Evolution of the stem length of radish as a function of time

In Figure 2, the variance analysis joining the stems / plant length follow-up results shows a significant effect on stem length. The stem length range from 1 cm to 12.52 cm obtained with the bare soil, from 0.8 cm to 14.49 cm for the manure, from 1.2 cm to 15.52 cm for C and from 1 cm to 16.44 cm for the BC, an increase of 16% for manure, 24 and 13, 8% respectively for products C and CB.

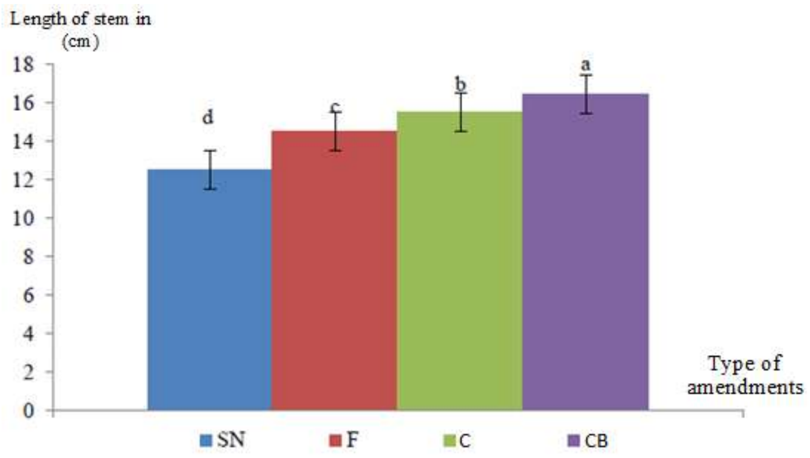

Figure 2: Comparative effect on the length of the radish shaft depending on the type of amendment

3.3.1.2. Number of leaves by plant

In FIG. 3, the analysis of the variation relative to the number of leaves per plant shows a significant effect of the different types of amendments on this parameter. The number of leaves varies from 7 leaves per plant obtained with the bare soil (without input) and the manure to 8 and 9 leaves respectively for C and CB. Which presents an increase of the order of 14,28 and 28,57% respectively for C and CB to bare soil (control).

This increase of the number of leaves in radishes amended by products C and CB can be explained by their richness in organic matter that is mineralized to form the mineral phosphorus responsible for the flowering, photosynthesis and respiration of young plants [18].

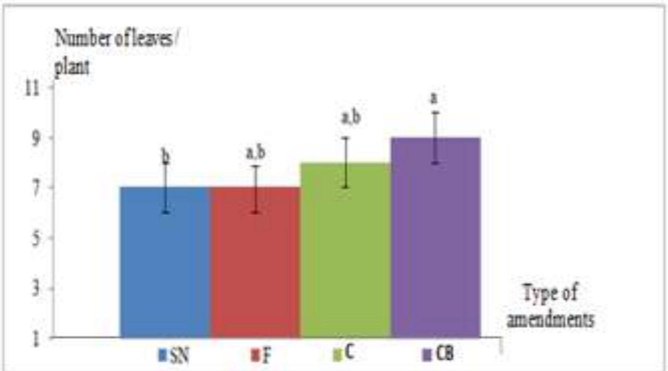

Figure 3: Comparative effect of the number of leaves per radish plant depending of the type of amendments

3.3.1.3. Leaf area

Figure 4 shows the follow-up of leaf area of radish leaves as a function of time. The results showed that the leaf area of plants has changed since the early days of growing radishes. The best surface area is noted in the leaves of CB-modified radish. The leaf surface determines both the amounts of water used by the plant in the form of perspiration and the amounts of carbon fixed by the photosynthetic route. It determines the resistance to drought, since a large leaf area will lose more water than a small leaf area. Reducing leaf area tends to minimize water loss by reducing sweating according to Slama et al., 2005. According to Johnson et al. and Adjab, 2002, plants with larger leaf area can tolerate dehydration and maintain a high water potential. On the other hand, Kirkham et al. suggest that a reduced leaf area may be beneficial, because it effectively reduces the total water loss of the plant [19-20].

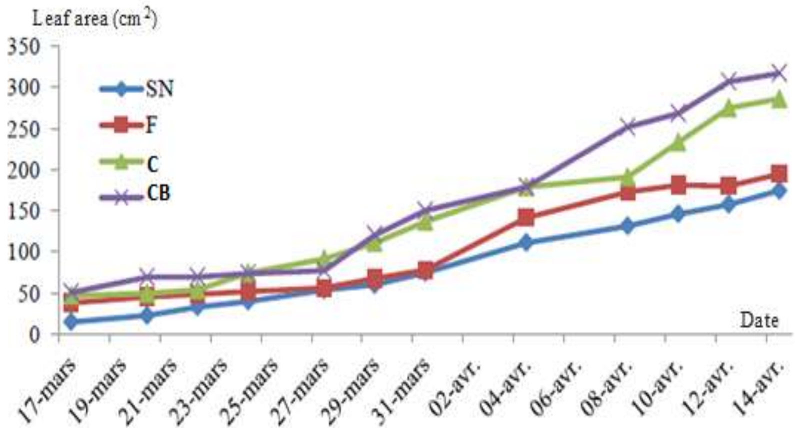

Figure 4: Follow-up of leaf area of radish leaves as a function of time

The analysis of the variance of leaf area presented in FIG. 5 shows a significant effect of different organic types organic products on this parameter. The area varies from 174.47 cm2 obtained with the bare soil (without input) to 194.51 cm2 with the manure and 286 to 317.16 cm^2 respectively for the C and CB. Therefore, an increase in the order of 11.5, 63.38 and 81.75% respectively for manure, compost C and compost CB compared to bare soil (control). Although a plant with a small leaf area is capable of using better light energy per unit [22].

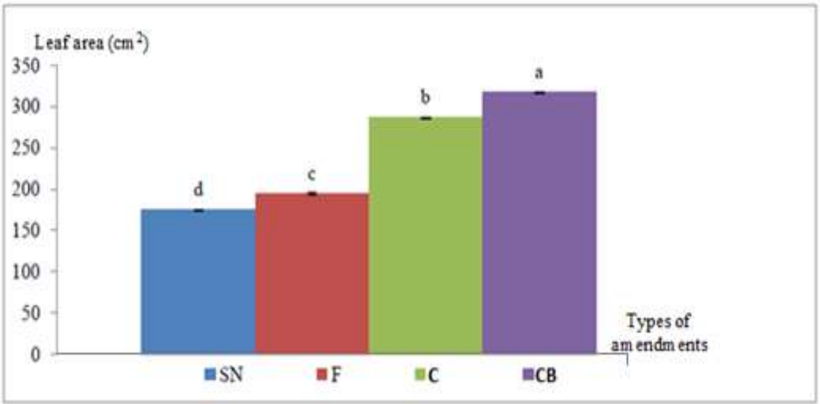

Figure 5: Comparative effect of the leaf area of radish leaves depending on the type of amendments

3.3.2. Production parameters

The radish was harvested after 2 months of planting.

Figure 6: Harvesting radish

3.3.2.1. Yield

The total yield was influenced in a very highly significant way with the change of soil amendments. The bare soil harvest was 10000 kg / ha compared to 23750 kg / ha obtained with manure, 29250 kg / ha obtained with C and 39750 kg / ha obtained with CB. That said an increase of 13% for manure, 19.25% for C and 29.75% for CB.

The difference in yields can be explained by the quality of the product used for the amendment. The results show that CB compost is better than compost C and manure, providing the plant with more elements necessary to promote a seed germination and to accelerate maturation of plants [23]. So, the sludge added to the composition of CB compost improved its quality compared to the compost C.

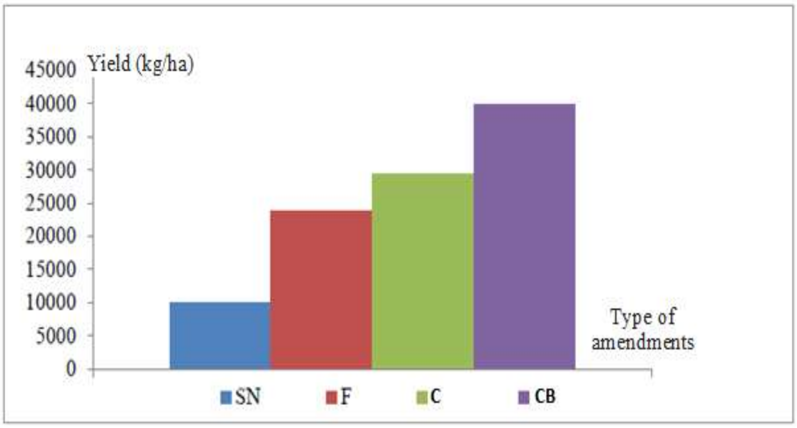

Figure 7: Comparative effect of the total yield of the radish crop according to the type of amendments

3.3.2.2. Root Fruit Caliber

The results of the variance test shown in Figures 8 and 9 indicate that the three types of organic amendments significantly improved the size of the radish. The best caliber is noted for radishes modified by C and CB, the difference is significant in both parameters (length and tuber diameter) compared to bare soil. In this case, we can say that the products C and CB have improved the development of the root part and the maturation of the fruit.

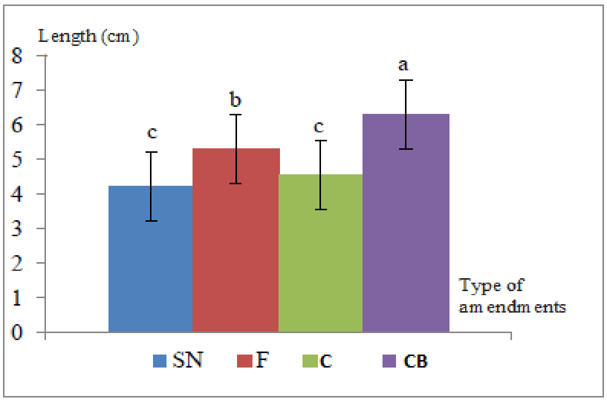

Figure 8: Comparative effect of the length of the radish root fruit according to the type of amendments

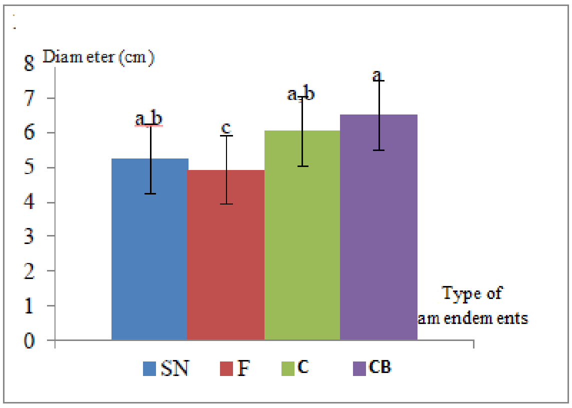

Figure 9: Comparative effect of the diameter of the radish root fruit according to the type of amendments

3.4. Cultivation of potatoes

Potato growth was monitored by measuring the morphological parameters, namely stem length, leaf number, leaf area, and production parameters, which are the number of seeds sown per plot, size, yield per plant and the number of tubers per plant.

3.4.1. Morphological parameters

3.4.1.1. Number of leaves by plant

In Figure 10, the analysis of the variance relative of the number of leaves per plant showed a significant effect compared to the types of amendments on this parameter. This number varies from 53 leaves per plant obtained with the bare soil, to 66 leaves with manure to 73 and 98 leaves respectively for compost C and CB. In addition, the external characteristics of the plants shape and color were regularly checked also during the growing period and no anomalies were found.

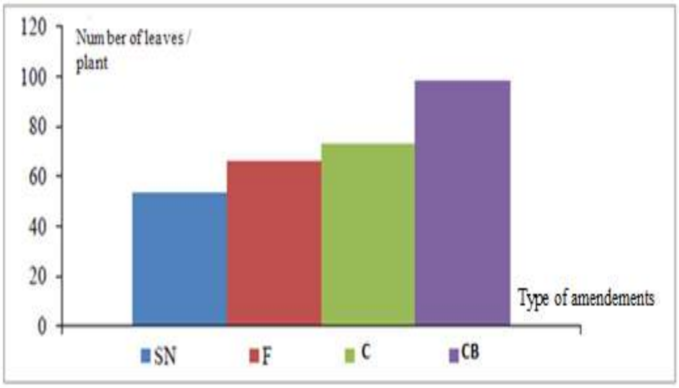

Figure 10: Comparative effect of the number of leaves per potato plant depending on the type of amendments

3.4.1.2. Leaf area

Figure 11 shows the results of leaf area measurements by the two methods. The results show that the leaf area of the plants experienced a change from the first days of potato growth; the best area is noted in the leaves of the CB-modified potato for both methods. These results confirm those obtained with radish and we can deduce that manure-modified crops will withstand drought periods more than those amended with C and CB and can therefore withstand greater dehydration and maintain high water potential [24-26]. The results of an analysis of variance showed a very significant effect. This parameter varies from 161.51 cm^2 obtained by the manure to 167.23 cm^2 obtained by bare soil (control), 174.7 cm^2 obtained by C and the greatest leaf area is obtained on the site modified by CB with a value of 179.3 cm^2.

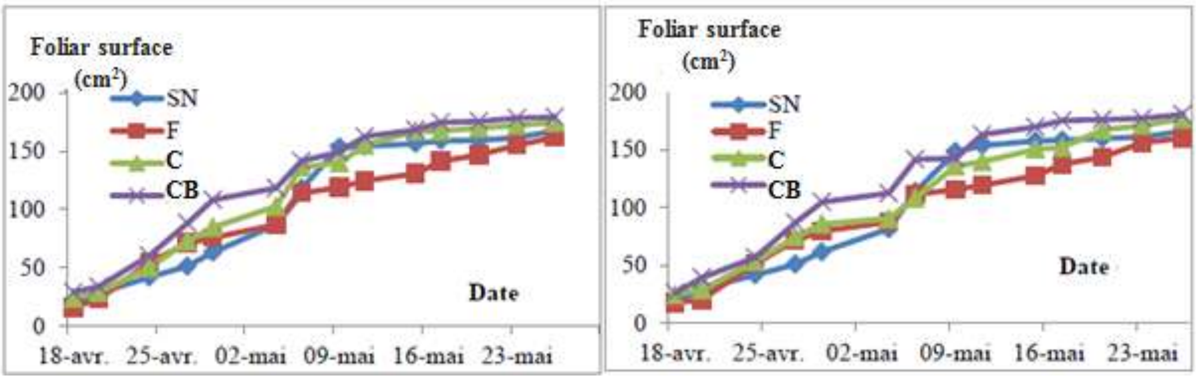

Figure 11: Evolution of the leaf area of the potato leaves as a function of time

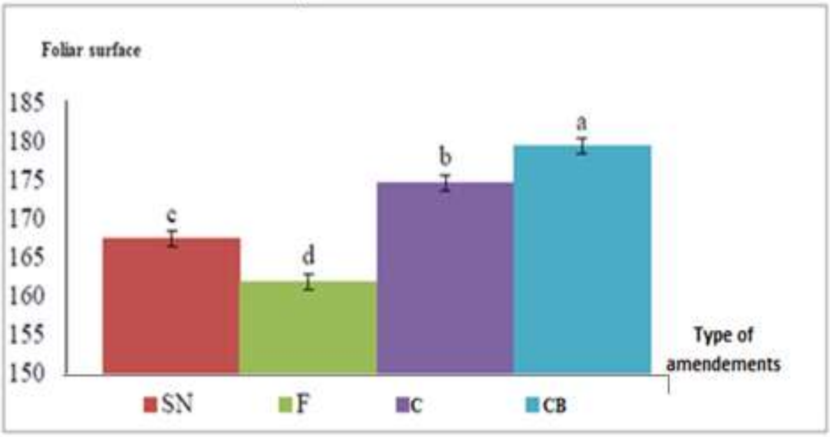

Figure 11: Comparative effect of leaf area of potato leaves on different types of amendments

3.4.1.3. Number of stems per plant

The potato has two types of stems: aerial stems of circular or angular section, on which are placed the leaves and underground stems, the stolons, on which the tubers appear. Aerial stems are born from buds present on the tuber used as seed. They are herbaceous, succulent, and may range from 0.6 to 1.0 m in length and vary in number from 3 to 6 main stems [27, 28]. The results of the variation of the number of stems per plant as a function of the type of the amendment are presented in Figure 12. Analysis of the variance shows no significant effect of the amendments on number of stems per plant. This parameter varies from 3 stems per plant obtained with manure to 4 stems per plant obtained for the bare soil and soil amended with C and 5 stems obtained for CB.

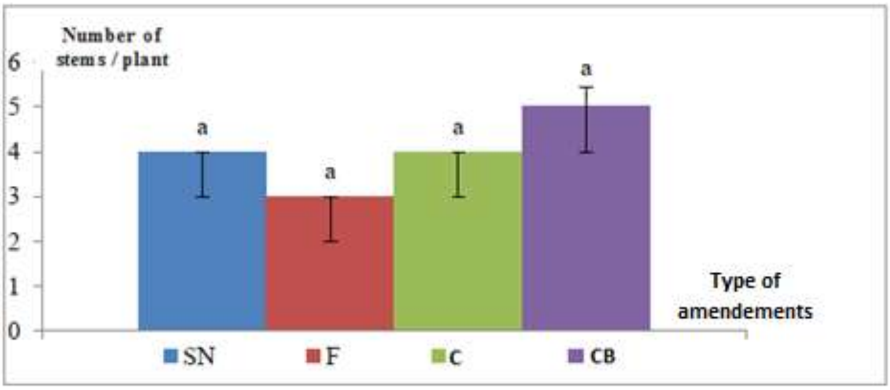

Figure 12: Comparative effect of the number of stem of the potato per plant depending on the type of amendments

3.4.1.4. Stem length per plant

The stem in plants is generally the axis aerial or subterranean (tuberule caulinaire, rhizome), which extends the root and carries the buds and the leaves. Figure 13 shows the length of the stems per plant; it should be noted that the length of the plants changed in the early days of planting. The best length of the stems is observed in the CB modified potato with a length of 57.2 cm. These results confirm those obtained with radish; the high CB content in nitrogen is responsible for the development of green parts in plants and it is the major element which plays the main role in plant growth. The potato comprises aerial rods of circular or angular section on which are arranged sheets. It also includes underground stems, or stolons, formed by lateral buds of varying length, which originate at the base of the aerial stems and develop horizontally below the surface of the soil. The results of analyses of the variance showed a very significant effect compared to the different types of fertilizers used. This parameter varies from 161.51 cm obtained by

the manure to 167.23 cm obtained by bare soil (control), 174.7 cm obtained by C and 179.3 cm obtained by CB, an increase of approximately 11% compared to the control.

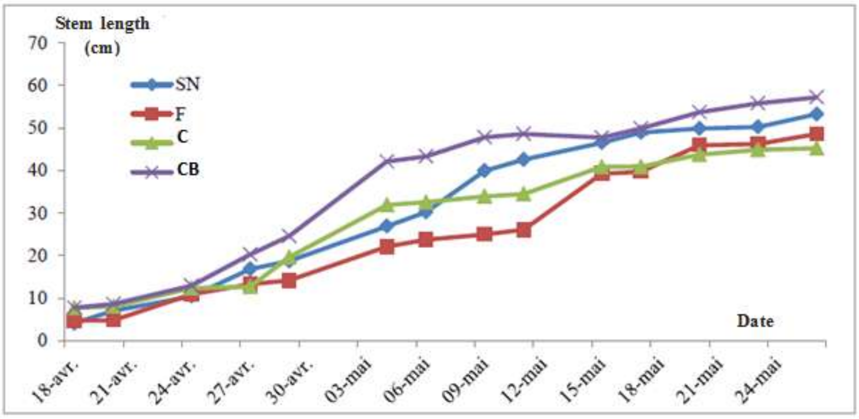

Figure 13: Evolution of the stem length of the potato as a function of time

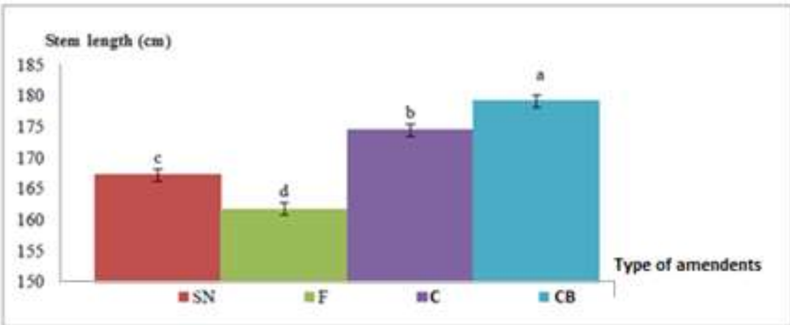

Figure 14: Comparative effect of stem length of potato depending on type of amendments

3.4.1.5. Number of plants sown per plot

Analysis of the variance of the number of plants sprouting per plot (Figure 15) showed no significant effect for the different types of amendment. All apples were germinated except for the bare soil or the germinated number was 11 apples out of 12 planted. As a hypothesis, we can say that the three amendments have provided the potato and by equality with the necessary elements that promote seed germination, flowering and acceleration of plant maturation [30].

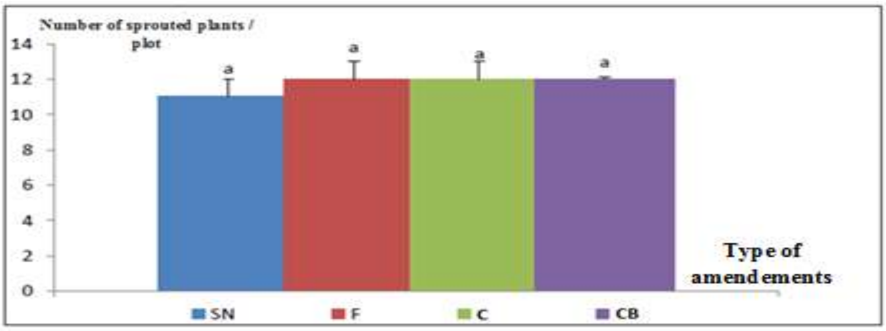

Figure 15: Comparative effect of the number of sprouted plants per potato plot according to the type of amendments

3.4.2. Production parameters

The harvesting of the potato was carried out after 3 months of its planting, after observing the flowers that faded and was carried out with the help of a fork-spade.

Figure 16: Potato harvest

3.4.2.1. Number of tubers per plant

In Figure 17, the analysis of the variance relative to the number of tubers per plant shows a significant effect of the different types of amendment on this parameter. The number of tubers varies from 6 tubers per plant obtained with manure and C, 4 tubers for the bare soil and 7 for CB is an increase of 14 and 28% for C and CB, respectively, relative to the bare soil (Witness). The increase in the number of tubers in soils modified by compost C, manure and CB compost can be explained by their richness in organic matter and nitrogen, which mineralizes to give the potato the nutrients responsible for its reproduction according to KHEDIR H. and LETOUFA S. [28, 31-33].

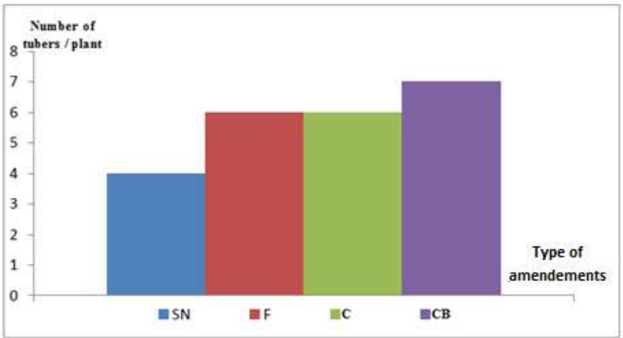

Figure 17: Comparative effect of the number of tubers per potato plant depending on the type of amendments

3.4.2.2. Yield per plant

The yield per plant was significantly influenced by the soil amendments. The difference in this yield can be explained by the contribution of the organic matter and nitrogen of potassium and phosphorus provided by the amendments used. The products have provided the potato with more necessary elements that promote its reproduction and maturation. In general and according to previous studies, the physical characterization of bio-waste shows that the latter contain more than 95% of organic matter. The chemical composition shows that the bio-waste contains a major content of elements (N, P, K ...) allowing their use in horticulture. The experiment showed its efficiency by increasing the yield compared to the unmodified ones [34-35].

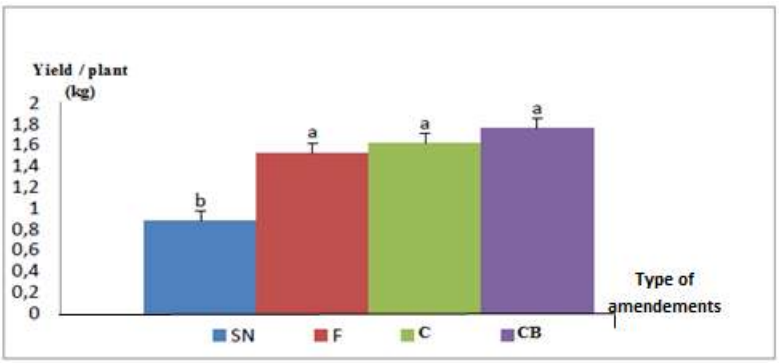

Figure 18: Comparative effect of yield per potato plant according to the type of amendments

3.4.2.3. Total efficiency

The total yield was significantly influenced by the change in soil amendments. A significant increase in yield was obtained with the amended treatments compared to the unmodified treatments. The bare soil harvest was 12,750 kg / ha compared with 16,750 kg / ha obtained with manure, 18,000 kg / ha obtained with C and 22,500 kg / ha obtained with CB. That said, an increase of 9% for manure, 13% for C and 26% for CB. The difference in yields can be explained by the quality of the product used for the amendment. The results show that CB compost is better than compost C and manure. According to SOUFI R., CB may has provided the potato with more necessary elements that promote its germination, reproduction and maturation [36-39].

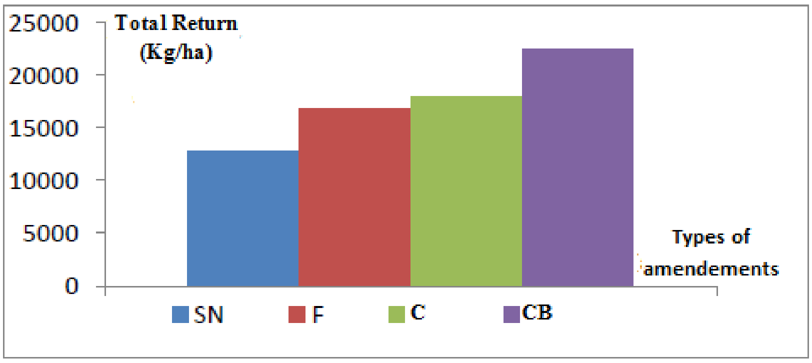

Figure 19: Comparative effect of total potato yield on the type of amendments

3.4.2.4. Caliber of tubers

The results of the variance study shown in Figures 20 and 21 show that the three types of amendments significantly improved the size of the tubers. The best caliber is noted for potatoes amended by Composts C and CB, the difference is significant compared to the bare soil. In this case, we can say that the composts have improved the development of tubers during maturation. This can be explained by the difference in potassium content; potassium deficiency occurs mainly at the initiation of tubers when the potassium requirement is maximal and extends over a period of 30 to 40 days [40-41]. Normally potassium increases the average size and the proportion of tubers Archer found that the proportion of marketable tubers was 84.4% with 0 kg K_2O / ha; 85.6% with 188 kg K_2O / ha and 86.6% for the 282 kg K_2O / ha dose [42].

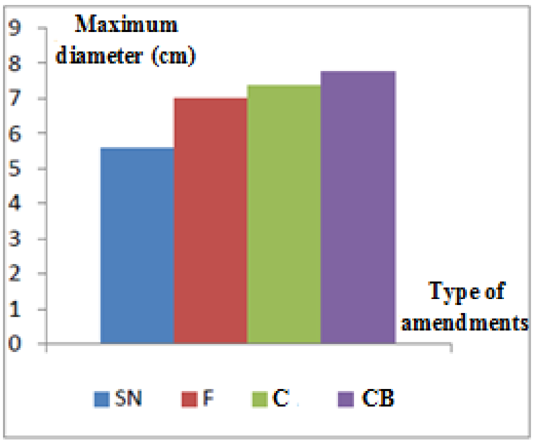

Figure 20: Comparative effect of tuber length of potato according to the type of amendments

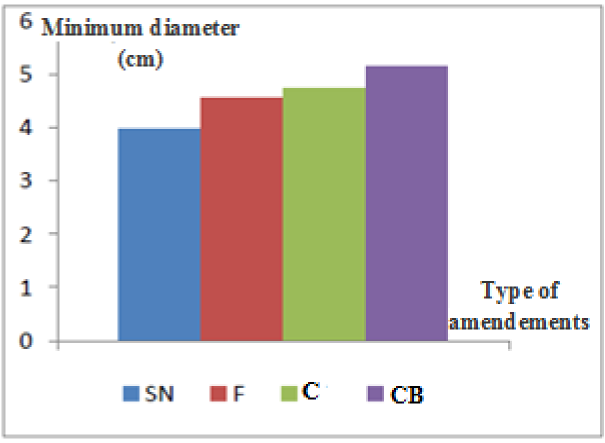

Figure 21: Comparative effect of tuber diameter of potato according to the type of amendments

3.5. Soil characterization after cultivation

The results of physicochemical analyses of the soil after harvest show that the pH of the soil has increased slightly and the soil has moved from a neutral soil to a slightly basic soil. As for organic matter, total nitrogen and organic carbon, they have decreased. This could be explained by the consumption of crops of these elements, which are necessary for the growth of the plant. On the other hand, the increase in pH could be due to elements relegated by radish such as sulfur etc. Similarly, the rate of mineralization or loss of soil organic matter depends on soil properties (texture, pH), environmental conditions (temperature, humidity, oxygen) and soil tillage that influence the degree of mineralization and organic matter by soil microorganisms [43-46].

Table 4: *Soil characterization after planting*

	Floor			
Setings	**Bare floor**	**Floor + F**	**Floor + C**	**Floor + CB**
pH	8.29	8.47	8.32	8.14
CE (mS/cm)	0.3	0.2	0.5	0.4
CE (dS/m)	0.03	0.02	0.05	0.04
%MO	5.3	7.41	7.07	7.05
%COT	3.65	3.7	3.54	3.53
%N	0.4	0.9	1.00	1.12
C/N	9.13	4.11	3.54	3.15

4. Conclusion

Analysis of the results of the three soil amendments and the vegetative growth parameters for radish and potato showed that there was a significant increase in soil and soil characteristics the vegetation. Soil characterization before and after the amendment by the three amendments C, CB, and F reveals that CB has higher levels of nitrogen, potassium, phosphorus and carbon than compost C and manure F. In addition, these results showed significant differences between these types of amendments for the morphological growth and production parameters studied (number of leaves / plant, leaf area, stem length / plant, etc.). For both crops, radishes and potatoes, the best results for these morphological and production parameters were recorded for the CB amendment, the compost with sludge.

The amendments have provided our samples with an additional dose of organic matter, elements necessary for the growth of radishes and potatoes, carbon and nitrogen, which initially promote the development of foliage, and then the formation and growth of the root fruit of radish and tubers of the potato. Our results corroborate those of SOUFI [35], who has demonstrated that soil improvement improves crop yields and improves soil quality and those of Chuimika Mulumbati Magnifique which has shown that bio-waste, sanitation products, are potentially good fertilizers. And they can somewhat mitigate the thorny problem of low soil productivity by their contribution, reduce the cost of production due to the use of inorganic amendment alone and improve the physicochemical qualities of soils [34-46]. These results further confirm the important role of household waste in soil fertilization. Regardless of crop and for all parameters studied, the results showed the value of the valorisation of composts in agriculture in order to increase crop yields.

Consequently, the use of composts appears as a palliative solution to the double problem of insalubrity of the Moroccan soil and lack of food due to the infertility of soils.

References

[1] A. Dudkowski, L'épandage agricole des boues de stations d'épuration d'eaux usées urbaines. *Le Courrier de l'environnement de l'INRA, Paris : Institut national de la recherche agronomique Délégation permanente à l'environnement;* (2015) 134-135.

[2] R. D. Tyagi, Évaluation des technologies de prétraitement des boues pour améliorer l'efficacité de la digestion anaérobie: bilans massique et énergétique et émissions de gaz à effet de serre. Thèse de 3éme cycle : *Doctorat en sciences de l'eau, Université du Québec, Institut national de la recherche scientifique* (2015).

[3] K. Lahlou, M. Ben Abbou, Z. Majbar, Y. Zaytouni, O. Karzazi, F. El-Hajjaji, M. Taleb, M. EL Haji, Z. Rais, *J. Mater. Environ. Sci*, 8 (12) (2017) 4582-4590.

[4] A. El Hassane, Z. Kadiri, Kuper M., Quarouch H., *Cahier Agriculture*, Vol. 24, No 6 (2015).

[5] F. BOUCHEMAL, Diagnostic de la qualité des eaux souterraines et superficielles de la région de Biskra. *Thèse de 3éme cycle Université Mohamed Khider – Biskra* (2017).

[6] A. EL Amri, L. Dridi, Y. Barhoumi, M. Zairi, *International Journal of Innovation and Scientific*., (9) (2014) 344-353.

[7] Y.YHA, B. Dongui, A. Trokourey, Y. Barima, Y. Essis, P. Etheba, *International Journal of Biological and Chemical Sciences*., 8 (3) (2014).

[8] K. Baba, L. Bahi, L. Ouadif, M. Cherradi, *J. Mater. Environ. Sci., 5(*4) (2014) 1005-1012.

[9] D. Rochat, E. Desouhant, Exploitation de la plante hôte pour l'alimentation et la reproduction, *Interactions Insectes-Plantes, Editions Quae., Chapitre 17* (2013) 263 -2013.

[10] C. Lecarpentier, R. Barillot, I. Goldringer, J. Enjalbert, B. Andrieu, *Colloque présentant les méthodes et résultats du projet Climagie (métaprogramme ACCAF) Poitiers, France. INRA.,* (2015).

[11] R. SOUFI, La réponse physiologique et biochimique de la pomme de terre (variété Spunta) à la salinité en présence de fertilisant organique (fumier des volailles) (Cas de Ouargla). *Mémoire de Master., Université de KASDI MERBAH – OUARGLA, Algérie* (2011).

[12] M. Kone, Y. Ouattara, P. Ouattara, L. Bonou, *Int. J. Biol. Chem. Sci*., 10(6) (2016) 2781-2795.

[13] K. NADJEM, Contribution à l'étude des effets du semis direct sur l'efficience d'utilisation de l'eau et le comportement variétal de la culture de blé en région semi-aride. *Mémoire de Master, Université FERHAT ABBAS SETIF, Algérie* (2012).

[14] A. Tahiri, J. Destain, P. Druart, P. Thonart, *Biotechnologie, Agronomie, Société et Environnement; Gembloux* 18 (3) (2014) 436-445.

[15] A. C. Abdeldjalil, Quelques aspects germinatifs, rhizogéniques et écologiques chez Sinapis arvensis L. dans la région de Tlemcen. *Thèse de 3éme cycle, Universite Abou Bekr Belkaid Tlemcen UABT Département d'Ecologie et Environnement* (2014).

[16] M. Barbouchi, R. Lhissou, K. Chokmani, A. Riadh, A. El Harti, N. Ben Aissa, Caractérisation de la salinité des sols à l'aide de l'imagerie radar satellitaire : cas de Tunisie et du Maroc. *Rapport N° R1480 Centre Eau Terre et Environnement, Institut national de la recherche scientifique (INRS-ETE)* (2013).

[17] F. Ruget, R. Bonhomme, M. Chartier, *Agronomie*., (16) (1996) 553-562.

[18] L. Longanza, L. Kidinda, D. Tamina, A. Jacob, M. Ikatalo, *Afrique Science Revue Internationale des Sciences et Technologi*., 11 (2) (2015).

[17] P. Grieu, P. Maury, E. Debaeke, A. Sarrafi, *Innovations Agronomiques*., 2 (2008) 37-51.

[18] F. Louat, Etude des effets liés à l'exposition aux insecticides chez un insecte modèle, Drosophila melanogaster. *Thèse de 3éme cycles. Sciences agricoles. Université d'Orléans.*, (2013).

[19] M. Mazinga Kwey, J. Banza Mukalay, J. Kabongo Ngoy, *International Journal of Innovation and Applied Studies*., 10 (4) (2015) 1150-1155.

[20] J. H. Matthew, N. Owens Vance, D. Beck, P. Sexton, *Canadian Journal of Plant Science*., 93(4) (2013) 589-597.

[21] H. Ben Ali, M. Hammami, R. Boukchina, A. Saidi, *International Journal of Innovation and Applied Studies.*, 6 (4) (2014) 860-870.

[22] D. Ayad, R. Sayoud, K. Benbelkacem, Z. Bouznad, *Nature & Technology*., 11 (2014) 34-45.

[23] R. Majdoub, A. Salem, Y. Ben M'sadk, Khlifi S., D. Boujnah, *Nature & Technology*., 12 (2015) 2-9.
[24] R. Irié, B. Djè, I. Kouadio, K. Kouamé, L. Kouakou, J. Baudoin, A. Zoro, *Biotechnologie, Agronomie, Société et Environnement.*, 21 (4) (2017).
[25] A. Tirchine, H. Madani, W. Benlahmoudi, Y. Attali, A. Allam, *Revue des Bioressources*., (5) 2 (2015) 67-76.
[26] H. Khedir, S. Letoufas, Contribution à l'étude de l'effet de la fertilisation azotée-potassique sur la culture de pomme de terre (var Spunta) dans la région du Oued Souf. *Mémoire de fin d'étude, Université KASDI MERBAH OUARGLA, Algérie* (2008).
[27] C. Landry, M. Marchand-Roy, S. Godbout, L. Belzile, R. Hogue, *Rapport présenté au Programme de soutien à l'innovation en agroalimentaire, Cultivons l'avenir 2, AAC –MAPAQ. Projet IRDA* (2017).
[28] A. Chaouechi, Lixiviation du potassium sous culture de pomme de terre irriguée en sol sableux Impact des engrais azotés. *These de 3éme cycles. Université LAVAL du Québec* (2014).
[29] I. Nechad, K. Fadil, *Afrique Science.*, 10 (3) (2014) 193- 204.
[30] M. Chuimika Mulumbati, L. Kidinda Kidinda, M. Mazinga Kwey, L. Baboy Longanza, *International Journal of Innovation and Applied Studies*., 11 (4) (2015) 908-913.
[31] L. Kasongo, M. Mwamba, M. Tshipoya, MJ. Mukalay, S. Useni, K. Mazinga, KL. Nyembo, *Journal of Applied Biosciences*., 63 (2013).
[32] C. Svetoslav, S. Rabia, V. Yanka, V. Tyufekchieva, I. Yaneva, U. Yordan, E. Varadinova, *Water Research and Management*., 1 (3) (2011) 55-58.
[33] T. Woignier, L. Rangon, P. Fernandes, C. Florence, J. Magalie Lesueur, S. Alain, *Sciences Eaux & Territoires*., 16 (1) (2015) 24-27.
[34] L. Thuriès, A. Arrufat, M. Dubois, C. Feller, P. Herrmann, M.C. Larré-Larrouy, C. Martin, A. Pansu Marc, R. Claude, M. Viel, *Etude et Gestion des Sols, CIRAD Agritop*., 7 (1) (2000)73-88.
[35] M. Bystricky, M. Alig, T. Nemecek, G. Agroscope, *Institut des sciences en durabilité agronomique IDU*., 6 (6) (2015) 264–269.
[36] A.A. Yattara Almouner, Coulibaly K. Amadou, F.Francis, *Érudit*. 94 (1) (2014) 1-7.
[37] M. Doumbouya, Diagnostic de sol et recommandations potassiques pour la culture de pomme de terre en sol minéral. *Thèse de 3éme cycles. Québec, Canada* (2015).
[38] A.R Salama, J.M. Ramalanjoana , *African Crop Science Journal*. (22) (2014) 959-968.
[39] F. Marc, Rotations dans la culture de la pomme de terre : bilan humiques et logiciel de calcul, *Rapport du centre de référence en agriculture et agroalimentaire du Québec*. Clément 13 (2009).
[40] B. Béatrice, O. Somda Badiori, I. Serme, M.B. Pouya, F. Lompo, S. J Taonda, M. Sedogo, *International Journal of Biological and Chemical Sciences*., 11 (2) (2017).
[41] J. Cesar Ramirez, Developement d'une culture durable de laitue de transformation en sol minéral, *Thèse de 3éme cycle. QUÉBEC, CANADA* (2015).
[42] D. Some, E. Hien, K. Assigbetse, J.J. Drevon, D. Masse, *Tropicultura*., 34 (1) (2016) 56-68.
[43] P. G. Mutiviti, C. Bielders, B. Delvaux, V. L. Ndungo, *Revue Scientifique et Technique Forêt et Environnement du Bassin du Congo*., (3) (2014) 64-66.
[44] U. Yannick, B. Louis, K. Antoine, A. Lukangila, M. Matthieu, K. Nathan, M. Jerry, M. Mpundu, K., Nyembo Journal of Applied Biosciences., 76 (2014) 6326– 6337.