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EFFECT OF SLUDGE OF WASTEWATER FROM THE TREATMENT PLANT ON THE GROWTH IN PEPPER (*CAPSICUM ANNUUM.L*) CULTIVATED ON TWO DIFFERENT GROUNDS

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ABSTRACT

The objective of this work is to study the effect of sewage sludge from the treatment plant wastewater (WWTP) of Beni Mellal on the culture of a market garden plant, pepper, on two different soils: soil of Maâmora and Beni-Mellal (Morocco). The results show that:
-For witnesses, pepper grows best on ground Maâmora sandy texture on the sandy clay loam soil of Beni Mellal, characterized by a compact structure reducing the germination rate and limiting the growth of the plant;
-Fertilization of the two types of soil by sewage sludge with increasing doses of the order of 10, 20, 30, 40 and 50% leads to a significant improvement of agronomic parameters pepper. The best results are obtained with a contribution of 50% of sludge yields were 150% and 80% in number and 70% and 100% by weight of fruit, respectively on soils Beni Mellal and Maâmora. The difference in yields in terms on fruit weight is explained by the rich soil of Beni Mellal on major elements and the role of mud in improving the physico-chemical properties of the soil.

Keywords: Sewage sludge, Soil, Pepper, agronomic parameter, Wastewater treatment plant.

RESUME

L'objectif de ce travail est d'étudier l'effet des boues résiduaires de la station de traitement des eaux usées (STEP) de Beni Mellal sur la culture d'une plante maraichère, le poivron, cultivé sur deux sols différents: sols de Maâmora et de Beni-Mellal (Maroc). Les résultats montrent que:
- Pour les témoins, le poivron pousse mieux sur le sol de Maâmora à texture sableuse que sur le sol argilo-limoneux de Beni Mellal, caractérisé par une structure compacte réduisant le taux de germination et limitant ainsi la croissance de la plante;
- La fertilisation des deux types de sols par les boues résiduaires avec des doses croissantes de l'ordre de 10, 20, 30, 40 et 50% conduit à une amélioration significative des paramètres agronomiques du poivron. Les meilleurs résultats sont obtenus avec un apport de 50%, les rendements sont de 150% et 80% en nombre et 70% et 100% en poids de fruits respectivement dans les sols Beni Mellal et de Maâmora. La différence de rendement en termes de poids de fruit peut être interprétée par la richesse du sol de Beni Mellal en éléments majeurs et par le rôle de la boue dans l'amélioration des propriétés physico-chimiques du sol.

Mots-clés: boues résiduaires, sol, poivron, paramètres agronomiques, STEP

INTRODUCTION

The contributions of new organic matter in soils can quickly improve their productivity. However, the fertilizing efficiency of these depends on their chemical composition. The nitrogen mineralization and availability to plants of this element are connected to the C / N ratios and the form of nitrogen (Amato et al., 1987; Dayegamiye et al., 2004). Organic matter with C / N ratios less than 25, such as green manure, manure, slurry and mixed sludge mineralize quickly and can release large amounts of nitrogen to crops.(Abdallahi and Dayegamiye, 2000) By cons, those who have C / N ratios higher, such as wood residues (wood chips, paper mill deinking sludge, etc.). Provide less nitrogen to crops.

Work carried out on plants showed the sewage sludge fertilizer, resulting in a significant improvement in growth parameters and performance (Kassaoui 2009; Fethallah 1991) power. The test objective was to evaluate the effects of added waste sludge WWTP on agronomic parameters and the performance of a market garden plant: pepper (Capsicum annuum.L).

MATERIALS AND METHODS

Materials

Soil

We used two types of soil: soil and soil Maâmora Beni Mellal. The two soil samples for testing were previously homogenized and dried in the open air and screened. Physicochemical soil parameters were obtained using the method of soil analysis (Aubert, 1978).
Table 1 shows the physico-chemical characteristics and metal contents of soils Maâmora and Beni Mellal.

Table 1: Physicochemical characteristics of soils Maâmora and Beni Mellal.

Parameters%	Ground Maâmora	Ground Beni-Mellal
Clay	4.8	38.8
Loam	2.7	19.4
coarse silt	0.8	22.2
sand	66.6	11.1
coarse sand	24.5	5.6
total limestone	0.8	4.9
organic carbon	0.14	1.27
organic matter	0.7	2.22
total nitrogen	0.05	0.125
water pH	7.53	7.81
Salinity (mg / l)	0.01	-
total Phosphorus	1.39	-
available phosphorus	0.048	19.2
Calcium (meet / 100 g)	6.3	18.5
Magnesium (meq / 100g)	0.2	11.1
Sodium (mEq / 100 g)	0.3	0.65
Potassium (meq / 100g)	0.15	1.63
Cation exchange capacity	7.0	-

Table 1 shows that the two soils Maâmora and Beni Mellal have different physico-chemical characteristics:

- ***Ground of Maâmora***

It is a ground with sandy texture and movable structure. Its pH is slightly alkaline. Its content limestone makes it possible to classify it among the grounds not limestones (Missante *et al*, 1964). It presents organic matter 0.7% with organic carbon 0.14%.

- ***Ground of Béni-Mellal***

It is about a ground isohumic, calcimanesic brown and hydromorphic (Unpleasant 1989; Loudyi 1989). Granulometric analysis and physicochemical watch which the ground of Blessed-Mellal has a fine clay texture limono-sand spreader (ALS), with alkaline pH (7.81). Its percentage of organic carbon (1.27%), organic matter (2.22%), nitrogenizes total and cogitates assimilable is average. The ground is rich in assimilable potassium, calcium and out of magnesium. Its content limestone is weak.

Mud

Mud used comes from sewage treatment plant (WWTP) of waste waters of the town of Béni Mellal (Morocco).

The taking away was carried out in April 2010. The samples, made up by 4 bags for a total volume of 150 kg, were dried with the free air, were crushed, then passed on a sieve with a mesh of 2 mm. The preparation of the mud samples intended for the physicochemical and spectroscopic analysis was made same manner as the ground. Table 2 represents the got results.

Table 2: Physico-chemical characteristics of studied mud.

Paramètres	**Résultats**
pH-water	6.57
Organic carbon (%)	20.56
Organic matter (%)	22.4
Nitrogenize total (%)	2.11
N/C	9.74
Cogitates total (‰)	1.16
Assimilable phosphorus (Olsen) (‰)	1.66
EC (ns/kg)	5.8

The data of the table show that these muds are rich in organic matter (22.4 % of the matter weight dry). The organic matter of an amendment is an agronomic parameter which is of a great importance in agriculture, since it improves porosity and the power of retention of water of the grounds (Dayegamiye et al., 2004). It thus supports the rooting of the crop plants, their water provision and in nutritive elements while bringing a source of food to the earthworms and the useful micro-organisms (Dayegamiye et al., 2004; Estevez et al., 1992). This mud contains high percentages of compounds nitrogenized (2.11 %) and cogitated (1.16 %). Report C/N, ranging between 9 and 11, indicates a good mineralisation of the organic matter.

Vegetable equipment

The market-gardening plant used is the sweet pepper (Capsicum annuum, variety: marconi), whose immature fruit can be intended directly for human consumption.

METHODS

Test of germination

The sweet pepper seeds are disinfected by steeping fifteen minutes in bleach to 10%, then dried on blotting paper and placed in pots which are subdivided in two batches of 15 pots each one. The first batch contains the ground of Maâmora and the other the ground of Béni Mellal. The two grounds are amended by waste mud with amounts of 0%; 10%; 20%; 30%; 40% and 50%. The percentage of germination is calculated after fifteen days of incubation.

Conditions of culture

Seeds of sweet pepper, disinfected like previously then dried on blotting paper, were put to germinate in seedbed in basins filled with peat. The developed seedlings are mended in buckets of 5 dm^3 of volume, disinfected beforehand by bleach to 10% and bored at their base to allow a percolation in the event of excess of watering. The four weeks old plants were cultivated in the grounds of Maâmora or of Blessed-Mellal amended with mud contents of 0%, 10%, 20%, 30%, 40% and 50%. The tests at a rate of three pots were carried in a greenhouse of culture. Watering with drinking water is carried out three times per week.

Measured agronomic parameters

Harvest took place after three months of culture. The given parameters are six: Length of the principal stem, diameter of the stem, many sheets per plant, many sheets deteriorated by plant, many fruits per plant and fresh weight of the fruit.

RESULT AND DISCUSSION

Effect of the incorporation of mud on the pH and the conductivity of the two grounds

The addition of increasing quantity of mud on the two ground involves a progressive reduction in the pH of the grounds (figure 1) because of the acid character of mud.

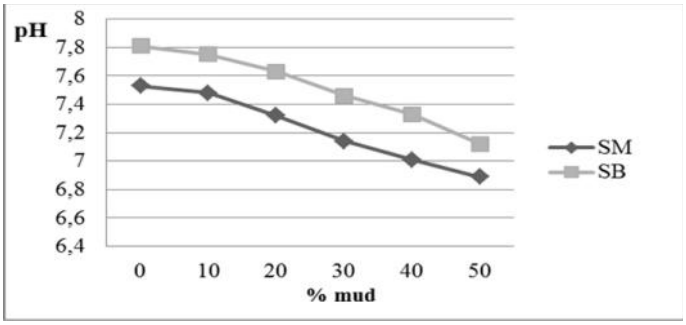

Figure1: Influence mud contribution on the pH grounds of Maâmora and Béni Mellal with25°c.

The study of the effect of the incorporation of mud on electric conductivity shows an increase in the salinity of the ground with the mud contribution (figure 2). It reaches its maximum with mud 50% 9.26 µs/cm and 9.39 µs/cm in the grounds of Maâmora and Béni Mellal respectively.

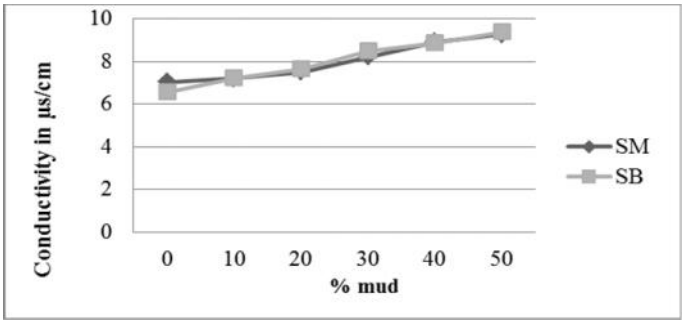

Figure2: Influence mud contribution on electric Conductivity grounds of Maâmora and Béni Mellal with 25°c.

Effect of mud on the agronomic parameters of Sweet pepper

Table 3 represents the effect of mud on the various agronomic parameters studied after three months of culture of sweet pepper, respectively on ground of Maâmora and ground of Béni Mellal.

Table 3 a: Effect of mud on the parameters of growth of sweet pepper on the ground of Maâmora; R = Efficiency in %.

% of mud	0	10	20	30	40	50
Many fruits per plant	2 .0	2.3	3.0	3.7	4.0	5.0
		R= 15	R=50	R=85	R=100	R=150
Fresh weight of the fruit (g)	52.1	54.8	55.5	66.0	78.4	90.2
		R=5	R=7	R=27	R=51	R=76
Many flowers per plant	4.0	4.0	4.0	6.0	6.33	7.0
Many sheets per plant	10.66	13.7	14.3	15.0	18.7	22.0
Many sheets deteriorated by plant	2	5.3	5.7	6	6.7	9.0
Length of the principal stem (cm)	23.7	28.4	34.2	35.8	40.1	42.6
Diameter of the stem (mm)	3.2	3.5	3.7	3.7	4.4	4.5

Table 3b: Effect of mud on the parameters of growth of sweet pepper on the ground of Béni Mellal.

% of mud	0	10	20	30	40	50
Many fruits per plant	2.33	3.0	3.66	3.66	4.0	4.0
		R= 28	R= 57	R= 57	R= 71	R= 71
Fresh weight of the fruit (g)	53.7	66.1	77.1	87.9	99.33	105.6
		R= 23	R=43.5	R= 63.5	R= 85	R= 96
Many flowers per plant	3.33	4.33	4.33	5.0	5.33	6.66
Many sheets per plant	10.33	13.33	14.0	15.0	17.66	21.0
Many sheets deteriorated by plant	3.0	5.33	6.0	6.66	7.33	8.0
Length of the principal stem (cm)	19.8	22.6	28.4	34.9	38.8	41.1
Diameter of the stem (mm)	2.9	3.3	3.6	3.7	4.2	4.3

- ***Fresh have-weight of the fruit***

The data of tables 6 show that the contribution of increasing mud amounts of about 10%; 205; 305; 40% and 50% involved a clear improvement of the fresh weight of the sweet pepper fruit. The values obtained are respectively 52.1g; 54.8g; 55.5g; 66g; 78.4g and 90.2g by using the ground of Maâmora and 53.7g; 66.1g; 77.1g; 87.9g; 99.33g and 105.6g on ground of Béni Mellal. Figure 3 illustrates the evolution of these parameters.

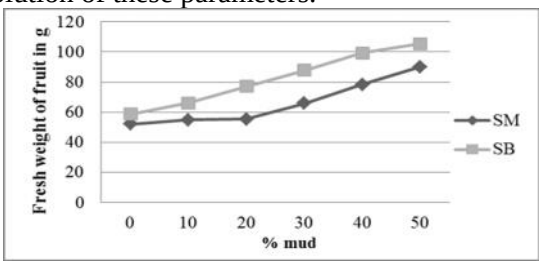

Figure 3: Effect of mud on the evolution of the fresh weight of cultivated sweet pepper on ground of Maâmora and ground of Beni Mellal.

This increase in the output can be explained by the wealth of muds in nutritive substances (table3). Indeed, muds can cover partly or entirely the needs for the nitrogen, cultures, cogitates, magnesia, calcium and out of sulphur and can also correct deficiencies except for that in K (Warman and Mkhabela, 2005). We also note that the output of the culture on ground of Béni Mellal is more important than on ground of Maâmora. Thus for contents of 40% and 50%, the outputs are respectively 51% and 76% on ground from Maâmora and 85% and 96% on ground of Béni Mellal. This difference can be explained by the wealth of the ground of Béni Mellal in major elements (table 1) and by the role of mud in the improvement of the physicochemical properties of the ground.

- ***Number of fruits***

In the two grounds, the mud contribution made it possible sweet pepper to produce more fruits compared to the witness. Indeed with an amount of mud 50%, the number of fruits passes from 2 to 5 on ground will de Maâmora is an output of 150% and 2.33 to 4 on ground of Béni Mellal with an output of 71%. Figure 4 represents the evolution of these parameters. These results can be allotted to the fertilizing effect of mud on the growth and the flowering of the plant. It should be also noted that the output is more important on ground of Maâmora.

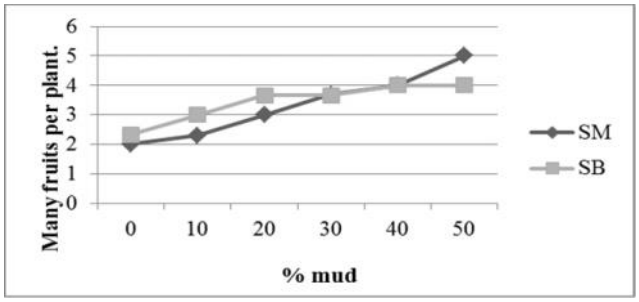

Figure 4: Effect of mud on the evolution amongst fruits at sweet pepper cultivated on ground of Maâmora and of Béni Mellal.

- ***Number of flowers***

Concerning the number of flowers, the addition of increasing mud amounts on the two ground increases in a linear way the number of flowers per plant. The maximum number of flowers is reached with a contribution of mud 50%. It is of 7 and 6.66 in the grounds of Maâmora and of Béni Mellal respectively. These data reveal the fertilizing power of mud.

- ***Number of sheets and many faded sheets***

The mud contribution supports the development of the foliar system of sweet pepper cultivated on the two standard grounds. By way of an example, the number of sheets passes from 10.66 and 10.33 respectively on the grounds of Maâmora and Béni Mellal for a rate of mud 0% to 22 and 21 sheets for a rate of mud 50% in the two grounds. For the number of sheets deteriorated by plant, the results show that the contribution of mud influences slightly on this number which varies between 5.33 and 6.66 on ground of Maâmora and between 4 and 7.33 on ground of Béni Mellal while passing from 10% to mud 40%. Nevertheless this influence is marked by a high number of faded sheets which is about 9 and 8 sheets for the treatment with mud 50%. Studies carried out on the tomato culture (Fethallah, 1991) showed that the number of sheets yellowing at this plant which increases with the mud contribution translates a deficit into manganese. Indeed, manganese intervenes in the activation of certain enzymes, the synthesis of chlorophyl, photosynthesis, the reduction of nitrates, the synthesis of the amino-acids and the proteins (Rented, 1986).

- ***Growth in length and diameter of the stem***

The got results reveal a significant growth and in a way comparable the height of the plant according to the amount of mud managed with the two soil types. Figure 5 illustrates this observation.

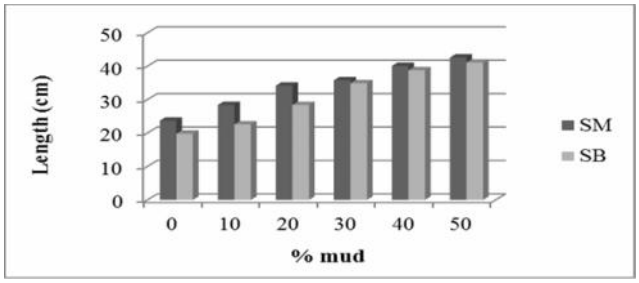

Figure 5: Evolution length in cm of the stem according to proportion mud brought on the ground of Maâmora and Béni Mellal.

This considerable growth in length is due to the nutritive role of mud and its improvement of the structure of the ground. The best results of the contribution of mud on the height of the plant were got for the amount of 50% with a height of 42.6 cm and 41,1cm on grounds of Maâmora and Beni Mellal. For the other studied agronomic parameter which is the diameter of the stem. The got results show that it increases gradually with the contribution of mud. The diameter of the stem of sweet pepper passes from 3.5 mm and 3.3 mm respectively on the grounds of Maâmora and Beni Mellal for 10% of mud to 4.5 mm 4.3 mm in the two grounds for mud 50%. This growth in thickness is explained by the wealth of mineral and waste organic fertilizer mud allowing the development of the plant.

CONCLUSION

In this study, we applied the waste mud of a sewage treatment plant to sweet pepper in order to evaluate its impact on the agronomic parameters of the plant. This study was conducted in two grounds presenting of the characteristics différents en using variable mud concentrations. The results showed a significant improvement of the agronomic parameters of sweet pepper for the two grounds, allotted to the contribution of nutritive matter mud. Nevertheless it is noted that the best output in terms of fresh fruit weight is recorded on ground of Beni Mellal who shows a clear improvement of his structure.

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