RESEARCH ARTICLE

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Application of Chicken Manure and Organic Compost to Produce Onion (*Allium cepa* L.) and Turnip (*Brassica rapa* L.) in Greenhouse

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ABSTRACT

In recent years awareness of the impacts of intensive agriculture on soil quality and its impacts on the environment has increased. This paradigm increased interest in biological products. In this context, the present trial was conducted to evaluate the performance of two organic fertilizers on onion and turnip crop yield grown in greenhouse. We used two kinds of organic fertilizers made in Portugal, a compost and a chicken manure evaluated in two plant species: onion (*Allium cepa* L.) and turnip (*Brassica rapa* L.). Both experiments consisted in a completely randomized design, with the same treatments which are: control (zero application), 1 kg/m² of compost, 2 kg/m² of compost, 3 kg/m² of compost, 5 kg/m² of compost, 2.65 kg/m² of chicken manure, 5.3 kg/m² of chicken manure, 10 kg/m² of chicken manure, 15.9 kg/m² of chicken manure, 21.2 kg/m² of chicken manure. For turnip the evaluated traits were plant weight (Pw), plants length (Pl), number of leaves, and for onion were as follows: plant weight, bulb yields, and bulbs diameter. This study concludes that chicken manure in the dose of 2.65 kg/m²application represents a sustainable alternative to synthetic fertilizers, mainly in the current challenging situation of agriculture in the context of climate change.

Keywords: Chicken Manure, Onion, Organic Compost, Organic Fertilizer, Turnip.

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I. Introduction

In the growing global demand for food, in context of global climate changes and optimization of natural resources, increasing crop yields without compromising soil microbial activity which is an important component of soil healthis a complex challenge [1]–[3]. Application of manure as fertilizer is an alternative to increase in soil organic matter and creates conditions for increase beneficial microbes, besides also delivering N and other elements to plants [2], [3]. It has been emphasized more recently that diversity in soil microbial composition is critical to maintain soil health due to their contributions to soil structure formation, decomposition of soil organic matter, and the biogeochemical cycling of nutrients [3]–[5].

Onion (Allium cepa L.) and turnip (Brassica rapa L.), two crops from different species are commonly grown in Portugal, in greenhouse crops productions, it´s easier to control pests, on the other hand, it´s important to apply the fertilizers adequately to ensure better yields. For organic fertilizers, such as poultry manure, it has been reported that they improve soils physical, chemical, and biological properties, including bulk density [6], organic carbon [7], and microbial biomass [8]. Poultry manure has traditionally been treated as a waste product and applied to surrounding crop and pasturelands to recycle nutrients, primarily nitrogen (N), phosphorus (P), and potassium (K) [9]. A recent review of 90 studies examined the effect of poultry manure on crop yield, when compared to inorganic fertilizer application, the studies demonstrate that such results depend on soil types, tillage, method of application, and cropping system [10].

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Among the nutrients present in wastes, byproducts, and

compost, N stands out [17], [18], shortage of this macronutrient limits the development of most crops and poses a particular problem for smallholders who cannot afford commercial fertilizers. Therefore, the use of organic fertilizers may be a feasible option to replace mineral fertilizers and restore soil chemical features [19].

In Portugal, there´s a lack of information on adequate organic fertilizer doses for onion and turnip, mainly in greenhouse production cases. Thus, the present study aimed to evaluate the effects of chicken manure and compost doses on the performance of onion and turnip in greenhouse production.

II. Materials and Methods

The experiments were conducted in a greenhouse with an area of 400 m^2, completely covered with plastic, with lateral openings to allow ventilation and it has an irrigation system. The study was conducted from November 2012 to April 2013. The greenhouse is located at the Experimental Station of Loreto in Coimbra, Portugal. The main soil characteristics of the study are. The study area is characterized by having /soils with a pH that varies between 7.26–7.36, soil organic matter 4.7–4.9%, 158 ppm of K, 116 ppm of Mn, 1.08 g/kg of N and 200 ppm of P [20]. Two kinds of organic fertilizers were produced in Portugal, compost and chicken manure, evaluated in two plant species, onion (Allium cepa L.), variety Top Star and turnip (Brassica rapa L.), variety San Cosme. The compost is produced from crops residues (50%), animal feces (25%) and peat (25%). The chemical compositions of the fertilizers are described in Table I.

In the greenhouse, the experiment was conducted in pots, in a completely randomized design with 5 doses for chicken manure, five doses for the compost, and at last, a control (zero application of fertilizer) with five replications. The pots used for onion had 14 cm high and 22 cm diameter (0.038 m^2 area) and the pots for turnip had 14 cm high and 17 cm diameter (0.023 m^2 area). We placed approximately 2.5 kg of soil in each pot, the fertilizer doses for each fertilizer were calculated considering the recommended doses for the region. The fertilizers doses were manually incorporated into the pots to 0.1 m depth. The compost and chicken manure doses are described in Table II.

After mixing the fertilizers with the soil in the pots, onion seedlings were transplanted to the centre of each pot, for turnip, three turnip seeds were placed in each pot at a depth of 5 mm. Seven days after the emergence of turnip seeds thinning was performed in two plants, leaving only one plant per pot, and the irrigation was performed manually. For turnip we evaluated the following traits: plant weight, plants length, number of leaves and for onion: plant weight, bulb yields, bulbs diameter.

A. Statistical Analysis

For statistical analysis, all the results were submitted to the Bartlett test of homogeneity of variances and the Shapiro-Wilk normality test. Afterwards, treatment means comparison was performed using the Scott-Knott test, the great advantage of the Scott-Knott test is that it doesn´t allow the same treatment to belong to two or more different groups at the same time, thus, it facilitates the interpretation of the means comparison. Simple linear regression was also performed, and to group the treatments based on their similarities, we performed the Tocher´s clustering approach based on the Euclidean distance. Principal components analysis (based on the correlation matrix) was also conducted to reduce the dimensionality of the data and to describe better the variation observed on the data. All the data analysis was performed at 5% in the R programming language [21].

TABLE I: Chemical Compositions Of The Chicken Manure And The Compost

Chemical composition	Chicken manure	Compost
pH-H_2O	7.0-8.0	8.4
Organic matter	70%	47-55%
Moisture	50 - 60%	57.6%
Nitrogen (N)	400 - 1200 mg/l ≈ 0.7 – 2.3 g/kg	1.9-2.2% ≈ 19-22 g/kg
Phosphorus (P_2O_5)	700 - 1000 mg/l ≈ 1.3 – 1.9 g/kg	1-1.25% ≈ 10-12.5 g/kg
Potassium (K_2O)	1000 - 1300 mg/l≈ 1.9 – 2.5 g/kg	3-3.5%≈ 30-35 g/kg

TABLE II: Description of the fertilizer doses used in the experiment

Fertilizers doses
0 kg/m^2, control (no fertilizer application)
1 kg/ m^2 of compost
2 kg/ m^2 of compost
3 kg/ m^2 of compost
5 kg/ of compost
2.65 kg/ m^2 of chicken manure
5.3 kg/ m^2 of chicken manure
10.6 kg/ m^2 of chicken manure
15.9 kg/ m^2 of chicken manure
21.2 kg/ m^2 of chicken manure

III. Results and Discussion

For turnip, significant differences ($p<5\%$) were obtained for all the traits (Table III), for plant weight (Pw), the highest value was obtained by the application of 5.3 kg/m² of chicken manure which was similar to 2.65 kg/m² of chicken manure, the minimum Pw was observed by the 21.2 kg/m² of chicken manure which was similar to 10.6 kg/m² of chicken manure and 15.9 kg/m² of chicken manure. Comparing only the control and the treatments under different compost doses an increase of Pw is observed from the control (zero fertilizer application) to 5 kg/m² of compost (the highest fertilizer dose), due to the increase of soil nutrients, however, absence of significant differences were observed among 2 kg/m², 3 kg/m² and 5 kg/m² of compost. When comparing only chicken manure doses (including the control), the increase in one unit in the dose, caused a reduction of approximately 0.96 g/plant in the Pw (Pw=38.64-0.96 *chicken manure dose, R^2=0.37). According to Aisha et al [22], adding organic compost manure (produced from recycling the agriculture residues) at different doses had a significant effect on the percentage of cruse protein, N, P, K and carbohydrate contents of turnip roots. Such contents increased with increasing the dose of organic compost manure, however, the high level of organic compost manure significantly increased these contents of root tissues compared to low level [22].

Observing only the compost doses, the increase in one unit caused an increase of approximately 4.18 g in the Pw (Pw =

15.15 + 4.18 *compost doses, R^2 = 0.56). For plant length (Pl), the highest value was observed for 5.3 kg/m² of chicken manure which was similar to 5 kg/m² of compost and 2.65 kg/m² of chicken manure. The minimum Pl values were observed for 21.2 kg/m² of chicken manure which was similar to the control and 15.9 kg/m² of chicken manure. When comparing only chicken manure doses (including the control), the increase in one unit in the dose, caused a reduction of approximately 0.40 cm in the Pl (Pl = 29.29-0.40 *chicken manure dose, R^2 = 0.32). On the other hand, observing only the compost doses, the increase in one unit caused an increase of approximately 2.21 cm in the Pl (Pl = 20.34+2.21 *compost doses, R^2 = 0.57). For the number of leaves (Nl), the highest value was observed for 2.65 kg/m² of chicken manure and the minimum value was observed for 21.2 kg/m² of chicken manure.

Comparing only chicken manure doses the increase in one unit in the dose, caused a reduction of approximately 0.11 in the Nl (Nl = 11.16-0.11 *chicken manure dose, R^2 = 0.33). as also seen before, comparing only the compost doses, the increase in one unit of the compost caused an increase of approximately 0.45 in the Nl (Nl = 9.18+0.45 *compost dose, R^2 = 0.33). These relationships justify the better results observed for lower chicken manure doses and for higher compost doses. In general, the lowest values observed for the control mainly for plant weight and plant length are justified by the absence of fertilizers resulting in insufficient nutrients for the crop. For chicken manure doses, the dose recommended by the manufacturer is 10.6 kg/m2 of chicken manure, however, in our study, 5.3 kg/m² of chicken manure was the best for all the traits, it is important to highlight that this experiment was conducted in a greenhouse which is different from field environment, and it would be to expect that for chicken manure doses, the increase in the dose would cause an increase in some traits, this situation was not verified in this study [23], [24]. Application of high doses of chicken manure showed negative effects on turnip productivity, due to the increased availability of Arsenic, which is toxic to plants [25], [26]. In addition, arsenic residues have been reported in turnip crops fertilized with chicken manure [26].

For the compost, the recommend dose by the manufacturer is 2 kg/m2 of compost, our study reveals that comparing only composts doses (including the control), higher doses such as the ones we studied result in significant gains. The compost in terms of N, P and K is richer than chicken manure (Table I), thus it provides more macronutrients to the soil, but it may be slower to mineralize the nutrients than chicken manure, this fact may justify some results obtained for some compost doses when specially compared to 2.65 kg/m² and 5.3 kg/m² of chicken manure. Several studs study revealed that chicken manure is a potential source of plant nutrients and contributes to the improvement of the physical-chemical characteristics of soil [23], [24]. For instance, the soil electrical conductivity together with exchangeable bases increased with application rate in all soil types, thus indicating positive effects on soils. Similarly, significant increases of N (up to 50%) and P (up to 80%) were observed following addition of chicken manure [23]. While the pH at various application rates of the soil chicken manure mixtures were found to be circumneutral, significant increases of exchangeable calcium with manure were observed [24]. For principal component analysis, the principal component 1 (86.5 %) and 2 (9.99 %) explained together approximately 96.5% of the total variability observed in the data (Fig. 1).

The PCA revealed that all the evaluated traits are positively correlated, but plant length (Pl) and plant weight (Pw) are more correlated., Pl and Pw are more represented by the principal component (PC) 1 whereas number of leaves is more represented by PC 2. PCA also revealed that the treatments form different clusters. The Tocher´s clustering approach revealed the presence of five clusters, cluster 1: 10.6 kg/m², 15.9 kg/m², and 21.2 kg/m² of chicken manure, in cluster 2: 3kg/m² and 5kg/m² of compost, cluster 3: 5.3 kg/m² and, 2.65 kg/m² of chicken manure, cluster 4: 1 kg/m² of compost, control and finally in cluster 5: 2 kg/m² of compost. Cluster 1 is comprised by the treatments with the worst performance, hence, lowest plant weights, plant lengths and number of leaves.

Cluster 2 is comprised by the treatments which may be considered of intermediate performance.

In cluster 3, we find the best treatments for all the traits, cluster 4 is comprised by the treatments with the lowest plant weights values and finally in cluster 5 we find the treatment which had only equal performance to the best ones in the number of leaves trait. Thus, considering the costs involved in the fertilizer production, the 2.65 kg/m² of chicken manure application is the best for this study's traits.

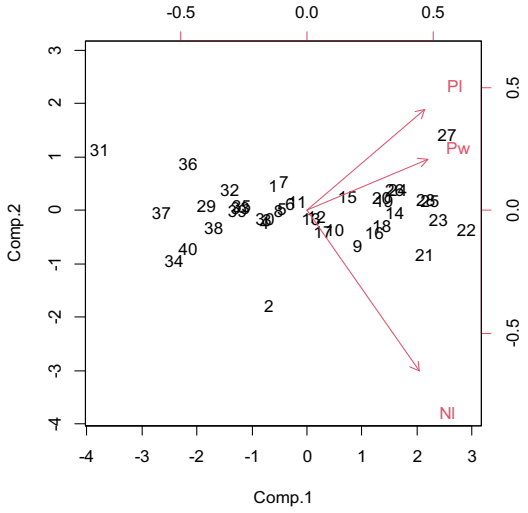

Fig. 1. Principal component analysis for tunirp. Plant weight (Pw) plants length (Pl), number of leaves (Nl).

TABLE III. MEANS OF PLANT WEIGHT, LENGTH AND NUMBER OF LEAVES OF TURNIP

Fertilizers	Pw (g)	Pl (cm)	Nl
Control	13.75 c	18.87 c	9.5 a
1 kg/m² of compost	17 c	23.92 b	8.75 b
2 kg/m² of compost	28 b	24.32 b	10.5 a
3 kg/m² of compost	32.25 b	28.65 b	11 a
5 kg/m² of compost	33 b	30.35 a	11.25 a
2.65 kg/m² of chicken manure	51 a	33.05 a	13 a
5.3 kg/m² of chicken manure	53.25 a	35.82 a	11.25 a
10.6 kg/m² of chicken manure	5.25 d	15.82 c	6.25 b
15.9 kg/m² of chicken manure	4.25 d	15.9 c	7.25 b
21.2 kg/m² of chicken manure	2.75 d	12.77 c	7.5 b

Pw: Plant weight, Pl: plants length, Nl: number of leaves, means followed by the same letter are not significantly different by the Scott-Knott test at 5%.

For onion, significant differences (p<5%) were obtained for all the traits (Table IV), for plant weight (Pw), the minimum value was observed in 21.2 kg/m² of chicken manure which was similar to the control, 15.9 kg/m² and 10.6 kg/m² of chicken manure. Highest Pw was observed in 2.65 kg/m² of chicken manure, comparing only the based on the compost doses and the control, the increase in unit of the dose increased the Pw in approximately 11.63 g ($Pw = 11.63 * compost\ dose + 52.51, R^2 = 0.39$), on the contrary, comparing only chicken manure doses (including the control), the increase in one unit in the dose didn´t cause a significant effect on the Pw (p>5%), this results shows that the application of 2.65 kg/m² of chicken manure is the best among all treatments based on chicken manure doses. Similar results were obtained in other studies aimed to evaluate the effects of the application of different organic fertilizers for production organic onions [27], [28]. The highest bulb yield recorded with application of chicken manure may be due to the supply of optimum amount of nutrients required for plant growth and development, coupled with improved soil physical and chemical condition.

For bulbs yields (By), the minimum value was observed at 21.2 kg/m² of chicken manure which was similar to the control and 15.9 kg/m² of chicken manure, in general, the highest By value was observed by the application of 2.65 kg/m² of chicken manure. Comparing only compost doses (including the control), the increase in one unit increased the By in approximately 6.86 g (By = 6.86*compost dose + 31.10, R^2 = 0.29). On the contrary, the increase in one unit in the chicken manure doses didn´t cause a significant effect on the By, showing that among the chicken manure doses, the 2.65 kg/m² of chicken manure is the best for this trait. For bulbs diameter (Bd), the minimum value was observed in 21.2 kg/m² of chicken manure being similar to the control, 15.9 kg/m² and 10.6 kg/m² of chicken manure. Comparing only the compost doses, the increase in one unit of the compost doses did not cause a significant effect on the By (p>5%), meaning that for this case, the application of 1 kg/m² of compost is more indicated than the higher ones. On the contrary, comparing only chicken manure doses, the increase in one of chicken manure doses caused a reduction of approximately 0.48 cm (Bd=-0.48*chicken manure doses, R^2=0.24), showing that for this case, the 2.65 kg/m² of chicken manure is the best among all chicken manure doses. This result agrees with the results obtained by Erkalo et al [29], which studied the application of chicken manure and blended fertilizer to onion production in low input production systems.

The principal component 1 (93%) and 2 (4%) explained 97.7 % of the total variability observed in the data (Fig. 2), it shows that the three evaluated traits are positively correlated, but the plant weight (Pw) and bulbs yields (By) are extremely more correlated. Pw and By are more represented by the principal component (PC) 1 whereas the bulb's diameter is more represented by PC 2. It also showed that the treatments form different clusters. The Tocher´s clustering approach revealed the presence of four clusters, clusters 1: 2 kg/m² and 3 kg/m² of compost, 5.3 kg/m² of chicken manure, 1 kg/m² of compost, 5 kg/m² of compost, in cluster 2: 15.9 kg/m² of chicken manure, control, 21.2 of kg/m² chicken manure, cluster 3: 10.6 kg/m² chicken manure and finally in cluster 4: 2.65 kg/m² of chicken manure. Cluster 2 is comprised by the treatments with the worst performance in all the traits, cluster 4 is the opposite of cluster 2 as it is comprised by the treatment which had by far the highest values for all the traits, and cluster 3 is comprised by the treatments which had values inferior to the treatments in cluster 1 (despite the absence of significant differences in the bulbs yield trait).

The PCA revealed that all the evaluated traits are positively correlated, but plant length (Pl) and plant weight (Pw) is more correlated., Pl and Pw are more represented by the principal component (PC) 1 whereas the number of leaves is more represented by PC 2. PCA also revealed that the treatments form different clusters. The Tocher´s clustering approach revealed the presence of five clusters, cluster 1: 10.6 kg/m², 15.9 kg/m², and 21.2 kg/m² of chicken manure, in cluster 2: 3kg/m² and 5kg/m² of compost, cluster 3: 5.3 kg/m² and, 2.65 kg/m² of chicken manure, cluster 4: 1 kg/m² of compost, control and finally in cluster 5: 2 kg/m² of compost.

In the compost, at a dose of 3 kg/m^2 it was observed a greater shoot growth, suggesting that higher quantities of this fertilizer induce greater vegetative growth, however, this trend was not confirmed in the application dose higher than 5 kg/m^2. Different results were found by Boyhan *et al.* [30] that obtained maximum yields with doses above 1 kg/m^2. For the chicken manure, there was a decrease in crop yield from the application dose of 5,3 kg/m^2, suggesting that the optimal dose for this fertilizer is 27 kg/m^2. This was the dose that had a higher yield in all the evaluated variables. Similar results were obtained by Boyhan *et al.* [30].

TABLE IV: PLANT WEIGHT, BULBS YIELDS, AND BULBS DIAMETER OF ONION GROWN IN THE GREENHOUSE

Fertilizers	Pw (g)	By (gt)	Bd (cm)
Control	25.75 b	14.25 c	19.75 b
1kg/m² of compost	77 a	36.25 b	40.4 a
2 kg/m² of compost	96.5 a	69 a	46.75 a
3 kg/m² of compost	97.5 a	61 a	43.75 a
5 kg/m² of compost	93.75 a	50.5 a	35.75 a
2.65 kg/m² of chicken manure	127.5 a	76 a	50.17 a
5.3 kg/m² of chicken manure	82 a	54.5 a	32.75 a
10.6 kg/m² of chicken manure	58.33 b	32 b	29.23 b
15.9 kg/m² of chicken manure	21 b	13.5 c	22.5 b
21.2 kg/m² of chicken manure	15.66 b	9.66 c	11.73c

Pw: plant weight, By: Bulb yields, Bd: Bulbs diameter, means followed by the same letter are not significantly different by the Scotte-Knott test at 5%

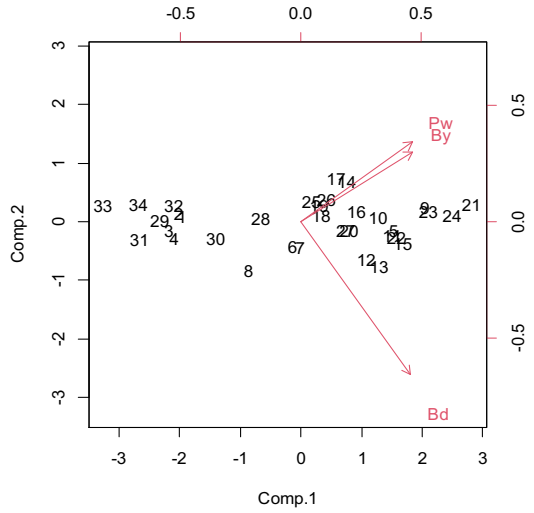

Fig. 2. Principal component analysis for onion. Plant weight (Pw) bulbs yield (By), bulb diameter (Bd).

The higher doses of the two fertilizers used in this study didn't have a good yield in spite they show significant differences from the control. These results contradict the results obtained by Mourão *et al.* [20] in which there was a higher yield with the application of 40 t/hectare of compost onion, this dose is double the compost application dose which had a higher yield in this study. Yoldas *et al.* [31] didn´t obtain significant differences between 2 and 4 kg/m^2 of cattle manure on onion. The present results suggest that chicken manure is better for onion than the compost, despite having less N, P, and K than the compost.

In the experiment, the highest plant weight, bulb yield, and diameter were obtained by applying 2 kg/m2 of compost (Table IV). Both organic fertilizers had similar bulbs diameter, but different plant weights and bulb yields, in the three variables, the control had the worst performance.

IV. Conclusion

For the compost in the greenhouse, there was an increase in the fresh weight of plants with the increase of doses applied, however, there was no difference between the 3 kg/m^2 and 5 kg/m^2 doses. The losses weren´t only due to the low productivity of this fertilizer in the dose recommended by the supplier, but also to the high application costs per ha. Animal manure application represents a sustainable alternative to the current challenging situation of agriculture in the context of climate change. In this study, chicken manure is the organic fertilizer that provided a higher turnip and onion growth, even at low doses. In the greenhouse, the compost is the most profitable fertilizer for both crops, chicken manure has profits only for turnip. The application of the compost can be very useful in the production of seedlings or in urban agriculture using pots, which in addition to improving the diet contributes to the reduction of greenhouse gas emissions.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

[1] Silva AA, Carvalho M, Coutinho J, Vasconcelos E, Carboni G, Sofo A, *et al.* Can Dairy Slurry Application to Stubble, without Incorporation into the Soil, Be Sustainable? *Plants.* 2022 May 31;11(11):1473. DOI: 10.3390/PLANTS11111473.

[2] Silva AA, Fangueiro D, Carvalho M. Slurry Acidification as a Solution to Minimize Ammonia Emissions from the Combined Application of Animal Manure and Synthetic Fertilizer in No-Tillage. *Agronomy*, 20;12(2):265. DOI: 10.3390/AGRONOMY12020265.

[3] Ozlu E, Sandhu SS, Kumar S, Arriaga FJ. Soil health indicators impacted by long-term cattle manure and inorganic fertilizer application in a corn-soybean rotation of South Dakota. *Scientific Reports*. 2019 Aug 13;9(1):1–11. DOI: 10.1038/s41598-019-48207-z.

[4] Shen W, Lin X, Gao N, Zhang H, Yin R, Shi W, *et al.* Land use intensification affects soil microbial populations, functional diversity and related suppressiveness of cucumber Fusarium wilt in China's Yangtze River Delta. *Plant and Soil.* 2008 Apr 9;306(1–2):117–27, DOI: 10.1007/S11104-007-9472-5/FIG.S/2.

[5] Mele PM, Crowley DE. Application of self-organizing maps for assessing soil biological quality. *Agriculture, Ecosystems & Environment.* 2008;126(3–4):139–52, DOI: 10.1016/J.AGEE.2007.12.008.

[6] De Sousa Lima JR, De Goes M da CC, Hammecker C, Antonino ACD, De Medeiros ÉV, De Sá Barretto Sampaio EV, *et al.* Effects of poultry manure and biochar on acrisol soil roperties and yield of common bean. a short-term field experiments. *Agriculture (Switzerland)*. 2021;11(4):1–11, DOI: 10.3390/agriculture11040290.

[7] Chang EH, Wang CH, Chen CL, Chung RS. Effects of long-term treatments of different organic fertilizers complemented with chemical N fertilizer on soils' chemical and biological p. *Soil Science and Plant Nutrition.* 2014;60(4):499–511, DOI:10.1080/00380768.2014.917333.

[8] de Santiago A, Recena R, Perea-Torres F, Moreno MT, Carmona E, Delgado A. Relationship of soil fertility to biochemical properties under agricultural practices aimed at controlling land degradation. *Land Degradation and Development.* 2019;30(9):1121–9, DOI: 10.1002/ldr.3298.

[9] Lorimor JC, Xin H. Manure production and nutrient concentrations from high-rise layer houses. *Applied Engineering in Agriculture.* 1999;15(4):337–40.

[10] Lin Y, Watts DB, Van Santen E, Cao G. Influence of poultry litter on crop productivity under different field conditions: A meta-analysis. *Agronomy Journal.* 2018;110(3):807–18, DOI: 10.2134/agronj2017.09.0513.

[11] Taokaenchan N, Areesrisom P, Satienperakul S. Vitamin C, Chlorophyll Content and Total Phenolic Compounds in Artemisia lactiflora as Affected by Different Organic Fertilizers. *Chiang Mai University Journal of Natural Sciences.* 2020;19(4):1029–41, DOI: 10.12982/CMUJNS.2020.0064.

[12] Santamaria P. Nitrate in vegetables: Toxicity, content, intake and EC regulation. *Journal of the Science of Food and Agriculture.* 2006;86(1):10–7, DOI: 10.1002/jsfa.2351.

[13] Paredes C, Cegarra J, Bernal MP, Roig A. Influence of olive mill wastewater in composting and impact of the compost on a Swiss chard crop and soil properties. *Environment International*. 2005;31(2):305–12, DOI: 10.1016/j.envint.2004.10.007.

[14] Ibrahimi K, Gaddas F. Soil nutrient content and olive tree nutritional status after composted olive husk application in an olive orchard of Northern Tunisia. Journal of new sciences, Agriculture and Biotechnology, 2015;19(2):708–14.

[15] Regni L, Nasini L, Ilarioni L, Brunori A, Massaccesi L, Agnelli A, et al. Long term amendment with fresh and composted solid olive mill waste on olive grove affects carbon sequestration by prunings, fruits, and soil. *Frontiers in Plant Science*. 2017;7(January):1–9, DOI: 10.1016/j.geoderma.2015.12.027.

[16] Salamandane A. Toxicity of dimethoate and mancozeb to Brassica rapa L. *Ambiência*, 2015, DOI: 10.5935/ambiencia.2015.03.06.

[17] Alejandro E, Chacón V, De Sá Mendonça E, Ribeiro Da Silva R, César De Lima P, Ribeiro Da Silva I, et al. Decomposição de fontes orgânicas e mineralização de formas de nitrogênio e fósforo. *Revista Ceres*. 2011 Jun;58(3):373–83, DOI: 10.1590/S0034-737X2011000300019.

[18] Carneiro WJ de O, Silva CA, Muniz JA, Savian TV. Mineralização de nitrogênio em latossolos adubados com resíduos orgânicos. *Revista Brasileira de Ciencia do Solo.* 2013;37(3):715–25, DOI: 10.1590/S0100-068320130003000018.

[19] de Souza HA, Melo MD, Primo AA, Vieira LV, Pompeu RCFF, Guedes FL, et al. Use of organic compost containing waste from small ruminants in corn production. *Revista Brasileira de Ciencia do Solo*. 2016; 40:1–16, DOI: 10.1590/18069657rbcs20150385.

[20] Mourão I, Brito LM, Coutinho J. *Influência da dose e época de aplicação de um compostado na cultura de cebola biológica*. Rev de Ciências Agrárias [Internet]. 2011 [cited 2022 Jun 16];34(2):106–16. Available from: https://www.researchgate.net/publication/262594236_Influencia_da_dose_e_epoca_de_aplicacao_de_um_compostado_na_cultura_de_cebola_biologica

[21] R Core Team. *R: a language and environment for statistical computing* [Internet]. R Foundation for Statistical Computing, Vienna, Austria. 2020 [cited 2022 Jun 18]. p. www.gbif.org/pt/tool/81287/r-a-language-and-enviro. Available from: https://www.gbif.org/pt/tool/81287/r-a-language-and-environment-for-statistical-computing.

[22] Ali H, Shafeek M, Asmaa R, El-Desuki M. Effect of Various Levels of Organic Fertilizer and Humic Acid on the Growth and Roots Quality of Turnip Plants (Brassica rapa). *Current Science International*. 2014;3(1):7–14.

[23] Dikinya O, Mufwanzala N. Chicken manure-enhanced soil fertility and productivity: Effects of application rates. *Journal of Soil Science and Environmental Management.* 2010;1(3):46–54.

[24] Kopec´, MK, Gondek K, Mierzwa-Hersztek M, Antonkiewicz J. Factors influencing chemical quality of composted poultry waste Production and hosting by Elsevier. *Saudi Journal of Biological Sciences*. 2018; 25:1678–86, DOI: 10.1016/j.sjbs.2016.09.012.

[25] Yao L, Li G, Dang Z, He Z, Zhou C, Yang B. Arsenic speciation in turnip as affected by application of chicken manure bearing roxarsone and its metabolites. *Plant and Soil*. 2009 Mar 1;316(1–2):117–24, DOI: 10.1007/S11104-008-9764-4/TABLES/4.

[26] Huang LX, Yao LX, He ZH, Zhou CM, Li GL, Yang BM, et al. Uptake of arsenic species by turnip (Brassica rapa L.) and lettuce (Lactuca sativa L.) treated with roxarsone and its metabolites in chicken manure. *Food Additives and Contaminants - Part A.* 2013;30(9):1546–55, DOI: 10.1080/19440049.2013.812809.

[27] Lee J, Kim H, Lee S, Ro C. Evaluation of Composted Pig Manure and Organic Fertilizer for Organic Onion Production in Paddy Soil. *J Hort Sci Technol.* 2012;30(2):123–8, DOI: 10.7235/hort.2012.11086.

[28] Lee J, Hwang S, Min B, Kim H, Kim J, Hong K, et al. Effect of Compost and Mixed Oilseed Cake Application Rates on Soil Chemical Properties, Plant Growth, and Yield of Organic Bulb Onions. *Horticultural Science and Technology.* 2018;36(5):666–80, DOI: 10.12972/KJHST.20180067.

[29] Erkalo M, Nebiyu A, Daba G. Onion (Allium cepa L.) bulb yield in low input production systems can be sustained through combined application of chicken manure and blended fertilizer. *Journal of Plant Nutrition.* 2022.

[30] Boyhan GE, Hicks RJ, Torrance RL, Riner CM, Hill CR. Evaluation of Poultry Litter and Organic Fertilizer Rate and Source for Production of Organic Short-day Onions. *Horttechnology*. 2010 Apr 1;20(2):304–7, DOI: 10.21273/HORTTECH.20.2.304.

[31] Yoldas F, Ceylan S, Mordogan N, Esetlili BC. Effect of organic and inorganic fertilizers on yield and mineral content of onion (Allium cepa L.). *African Journal of Biotechnology*. 2011 Oct 31;10(55):11488–92, DOI: 10.4314/ajb.v10i55.