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Effect of Soil Organic Ameliorants with Carbonized Rice Hull on the Growth and Yield of Shallot Onion (*Allium ascalonicum L*) on Salt Affected Soil

Dave L. Naungayan[1], Judy M. Sorsano[2] and Elizabeth N. Farin[3*]

[1]Department of Agriculture- Local Government Unit, San Narciso, Zambales, Philippines.
[2]Tarlac Agricultural University, Tarlac, Philippines.
[3]President Ramon Magsaysay State University, Iba, Zambales, Philippines.

Authors' contributions

This work was carried out in collaboration among all authors. Author DN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors JS and EF managed the analyses of the study finalized and approved the final manuscript.

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ABSTRACT

A pot experiment was conducted to test the potential of different soil organic ameliorants in salt affected soils reclamation; to test the effect of soil organic ameliorants on the growth and yield of shallot onion (*Allium ascalonicum L.*) planted in salt affected soil; determine the most effective soil organic ameliorants on salt affected soil Treatments prepared were; T1- Control Salt affected soil (1.57 kg/pot^{-1}), T2- Vermi-cast (197.40 g/pot^{-1}) with CRH (30 grams/pot^{-1}),T3- Guano dung (39.40 g pot^{-1} with CRH (30 grams/pot^{-1}), T4- Dried Goat Manure (115.40 g/pot^{-1}) with CRH (30 grams/pot^{-1}), T5- Dried Chicken Dung (94.94 g pot^{-1}) with CRH (30 grams/pot^{-1}), T6- Dried Cattle Manure (214.30 g/pot^{-1}) with CRH (30 grams/pot^{-1}). The study was laid out using Randomized complete block design with treatments and three replications. All organic ameliorants applied to the salt affected soil significantly improved on average bulb diameter, average height, average number of leaves, average bulb fresh weight, average number of tillers and average yield per hectare. It can be concluded that application of organic ameliorants is effective means to address the problem in saline affected soils.

**Corresponding author: Email: Elizabeth_farin@yahoo.com;*

Keywords: Soil organic ameliorants; shallot onion; salt affected soil.

1. BACKGROUND OF THE STUDY

The response of plant to saline environment is of interest to people of many disciplines. In agriculture the problem of salinity becomes more and more severe every year as the non-saline soils and the non-saline waters become more extensively exploited [1].

According to [2] saline soil can be defined as soil with high content of soluble salts that are harmful to plants and causing the reduction of growth, yield and its quality.

Salinity became one of the major soil problems in many rice-growing areas in the world. The United Nations Environment Program estimates that approximately 20 % of agricultural land and 50 % of cropland in the world is salt-stressed. Soil salinization is reducing the area that can be used for agriculture by 1–2 % every year, hitting hardest in the arid and semi-arid regions. Salinity decreases the yield of many crops because salt inhibits plant photosynthesis, protein synthesis and lipid metabolism. About 48 million hectares of land in the humid regions of South and Southeast Asia are technically suited to rice production but remain idle or are grown with poor results due to salinity. Studies show, however, that sustained and profitable production of crops specifically rice on salt-affected soils is possible, if appropriate farm management practices are implemented.

There are 400,000 ha of coastal saline soils in the Philippines, of which 100,000 ha are in mangroves, 175,000 ha are in fishponds and 125,000 ha are idle. The province of Zambales has 344.2 hectares of salt affected soil and it is expanded every year (PAO, 2016). In Central Luzon, some provinces like Aurora and Bataan are also affected by salt since these provinces are located in the coastal areas.

The effect of salinity on plant growth and water quality lower crop yields and reduced agricultural production. As soil salinity increases, most plants find it increasingly difficult to extract water from the soil. Increased levels of salt can disturb the balance of plant nutrients in the soil and some salts are toxic to certain plants. Although there is a wide range of salt tolerance in plants, most normal crop and pasture plants are not highly salt-tolerant and will eventually die out under saline conditions. Other crops may be grown in saline soil such as onion, tomato, eggplant and other vegetables where application of organic fertilizer had been done.

The main problem in saline soil is high NaCl content in the soil. NaCl when dissolved in water dissociate into their constituent ions, there are Na + and Cl. The abundance of Na + and Cl content can lead to inequality ion which cause metabolic activity in plants being distracted [3]. Saline soil is less conducive to plant growth; therefore, it needs necessary improvement of soil fertility by giving ameliorant treatment. The purpose of ameliorant is to reduce levels of Electrical Conductivity (EC) in saline soil; therefore, it will not inhibit the growth of plants [4].

Many studies indicated that organic soil ameliorants could improve soil physical and chemical characteristic. Remediation of salt-affected soils depends upon the degree of salinity and specific salination processes through engineering and agronomic management approach which includes leaching and drainage, land leveling, deep plowing, surface mulching, use of organic amendments, selection of salt tolerant species or varieties and integrated management practices. Previous researches indicate that crops can be grown in saline soil provided application of organic amelioration is done. In this study, soil amelioration will be conducted in onion.

2. METHODOLOGY

2.1 Research Design

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each treatment was assigned to the plots randomly. The treatments were arranged randomly which includes the following:

2.1.1 Treatments

Treatment1- Control Salt affected soil (1.57 kg/pot^{-1}) (no organic fertilizer)
Treatment2- Vermi-cast (197.40 g/pot^{-1}) with CRH (30 grams/pot^{-1})
Treatment3- Guano dung (39.40 g/pot^{-1} with CRH (30 grams/pot^{-1})
Treatment4- Dried Goat Manure (115.40 g/pot^{-1}) with CRH (30grams/pot^{-1})
Treatment5- Dried Chicken Dung (94.94 g/pot^{-1}) with CRH (30 grams/pot^{-1})

Treatment6- Dried Cattle Manure (214.30 g/pot^{-1}) with CRH (30 grams/pot^{-1})

2.2 Data Collection

Data on growth and yield components of onion were recorded and collected from the entire plot.

1. Average Bulb diameter (mm) – The mean bulb diameter of all sample bulbs was measured at the maximum wider portion of matured bulbs using calipers.
2. Average height (cm) – data gathered from 15 days after planting - (DAP), 30 DAP, 45 DAP, 60 DAP and 75 DAP. This was measured from the ground to the tip of the leave
3. Average Number of leaves - The total number of leaves per plant was counted from 15 DAP, 30 DAP, 45 DAP, 60 DAP and 75 DAP.
4. Chlorophyll content (470 nm) - data was gathered 5 days before harvesting.
5. Average Bulb fresh weight (gram) – The average fresh weight of all sample taken mature bulbs measured by using sensitive balance and finally then expressed in grams.
6. Average Root Length (cm) – the data was gathered after harvest in expressed centimeter.
7. Average Number of Tillers: The total number of tillers per plant was counted from 15 DAP, 30 DAP, 45 DAP, 60 DAP and 75 DAP.
8. Total bulb yield (t/ha-1): The total bulb yield was measured from the total harvest of net pot as a sum weight of marketable and unmarketable yields that was measured in kg per plot and finally converted into t/ha-1.

2.3 Cultural Preparation

2.3.1 Soil sampling

The soil sample taken from the salt affected soil site was done in Integrated Laboratories Division (ILD), Department of Agriculture, Regional Soils Laboratory, City of San Fernando Pampanga. Soil samples were collected randomly from the entire salt affected soil field following a zigzag fashion from 0 to 20 cm depth using an augur. The soil samples were collected from the entire field and it was made one (1) kg composite sample. Determinations of some selected soil chemical properties were carried out based on the composite sample. The composite soil sample was air dried, crushed with wooden pestle and mortar to pass through a 2 mm sieve size for the analysis of physical and chemical properties; (1) pH, (2) electrical conductivity (EC), (3) Potassium (K+), (4) Calcium (Ca2+), (5) Magnesium (Mg2+), and (6) Sodium (Na^+) was determined in the laboratory from the sample submitted.

2.3.2 Collection of saline soil and potting

The salt affected soil was collected in near the sea in Barangay San Isidro, Municipality of Cabangan, Zambales.

2.3.3 Application of manure/nutrients management

The soil organic ameliorants which are vermi-cast at 197.40 grams per pot plus 30 grams carbonized rice hull, guano dung at 39.40 grams per pot plus 30 grams carbonized rice hull, dried goat manure at 115.40 grams per pot plus 30 grams carbonized rice hull, dried chicken dung at 94.94 grams per pot plus 30 grams carbonized rice hull and dried cattle manure at 214.30 grams per pot plus 30 grams carbonized rice hull. Application of soil organic ameliorants on the salt affected soil is two (2) weeks before the planting to make sure that they were readily available for the growth and development of the plants.

2.4 Planting

Onion was planted at one bulb per pot. The bulb has an average diameter of two (2) inches.

2.5 Water Management

The crops were irrigated every other day with 100 millilitres of water per pot. Irrigation should be applied after planting. More frequent watering when the bulbs are developing and stop irrigating 7-10 days before harvesting or when 20-30% of the plant tops fall over naturally.

3. RESULTS AND DISCUSSION

3.1 Average Bulb Diameter

Table 1 shows the average bulb diameter of onion in salt affected soil as affected by different organic ameliorants.

Onion average bulb diameter was significantly increased by the application of different organic ameliorants with carbonized rice hull except vermi-cast. The highest bulb diameter of 25.69 mm was recorded in onion applied with cattle manure. Followed by those applied with goat manure with 24.04 mm. The increase in bulb

diameter was 13.69 mm compared to control. According to [2] cow manure improves soil fertility well while rice husk would cut down brine from below to surface of the soil of saline soil. This might be attributed to the role of nitrogen on chlorophyll, enzymes and protein synthesizes and the role of phosphorous on root growth and development as well as the role of potassium on promotion of enzymes activity and enhancing the translocation of assimilates which resulted bigger bulb diameter than other organic ameliorants [5]. The lowest average bulb diameter was obtained in onion applied with vermi-cast.

All organic ameliorants computed the same amount of nitrogen applied except Potassium, Phosphorus and other micro nutrients. As per observation, data revealed until 30 days after planting with the growth parameters from vermi-cast had shown slow growth and development which has an effect on the diameter of the bulb produce. The development of bulb diameter influenced by organic ameliorants could be associated with promoting nature of nitrogen in cell elongation, above ground vegetative growth and synthesis of chlorophyll to impart dark green color of leaves. This may be linked to metabolic processes which increase dry matter production and translocation to the bulbs.

Result from the analysis of variance revealed that the effects of organic ameliorants significantly influenced bulb diameter of onion. However, there was no significant difference in bulb diameter between the two kinds of samples. The average plant height was significantly increased by the application of different organic ameliorants with carbonized rice hull in both soil samples taken from Santa Cruz and Cabangan, Zambales from 45 to 75 DAP (Table 2). The highest diameter of 37.83 cm was recorded in onion applied with guano in soil sample taken from Santa Cruz, Zambales and 37.83 cm in soil sample 2. The increase in plant height compared to control was 18.83 cm and 15.83 cm respectively. Similarly to the result of average bulb diameter, guano has the highest phosphorus content (Appendices Table 2). Phosphorus is one of the most essential plant nutrients. Salinity and sodicity can affect forms and dynamics of phosphorus in soil (Dominguez et al., 2001) as cited by [6]. The increase of NaHCO3 - extractable P with guano may be attributed to the release of humic acid during organic matter decomposition, results in a convert's unavailable soil phosphate into available forms. Marinari et al. (2000) as cited by [6] found similar increases in phosphates in the soil after the application of organic amendments.

The lowest average plant height was obtained in onion applied with vermi-cast. Data revealed that from 15 to 45 days after planting vermi-cast shown slow growth and development but starting from 60 DAP it was observed gradual increase of 12.17 cm and 10.00 cm compared to control.

Generally, the effect of organic ameliorant on the growth of shallot onion has shown highly significant difference between controls. Data revealed that at 60 days after planting, the height of the onion plants shows gradual decrease due to ripening of the leaves.

Cattle manure with carbonized rice hull shows early response at 15 to 45 days after planting, [7] cited by [4] stated cow manure significantly affected the length of cucumber plants. In accordance with the research [8] cited by [4], in saline soil organic material effects on water binding, so the plant roots can easily absorb nutrients that available for plant growth. Organic ameliorant on cucumber varieties Monza and Metavy could increase the plant growth better than treatment without ameliorant. Cow manure as ameliorant treatment on the varieties Monza and Metavy could increase the length of the plant, number of leaves, leaf area, shoot dry weight and root dry weight higher compared with ameliorant from gypsum, rice straw and C. juncea [4]. The increase in plant height with the addition of higher nitrogen fertilizer level could be attributed to more availability of the nutrient which enhances protein synthesis which lead to increased accumulation of carbohydrates and this in turn, may have resulted in increased plant growth such as leaf number and leaf length.

Result from the analysis of variance revealed that the effects of organic ameliorants significantly influenced average plant height of onion. However, there was no significant difference in average plant height of onion between the two kinds of samples but the interaction between soil sample and organic ameliorants revealed significant from 15 to 30 DAP.

Table 1. Average Bulb Diameter of Onion in Salt-Affected Soils Treated with Organic Ameliorants

Organic Ameliorant	Average Bulb Diameter (mm)	Computed Mean Difference	LSD at 5%	LSD at 1%
Control	12.00 a			
Vermi-cast + CRH	17.81 a	5.81^{ns}	5.96	8.13
Guano + CRH	20.75 b	8.75**	5.96	8.13
Goat Manure + CRH	24.04 b	12.04**	5.96	8.13
Chicken Manure + CRH	20.63 b	8.63**	5.96	8.13
Cattle Manure + CRH	25.69 b	13.69**	5.96	8.13
Mean	20.15	9.78		

Table 2. Average plant height from 15 to 75 DAP in salt-affected soils treated with organic ameliorants

Treatments / Character	Ave plant Height 15 DAP (cm)	Computed Mean Difference	Ave Plant Height 30 DAP (cm)	Computed Mean Difference	Ave Plant Height 45 DAP (cm)	Computed Mean Difference	Ave Plant Height 60 DAP (cm)	Computed Mean Difference	Ave Plant Height 75 DAP (cm)	Computed Mean Difference
Control	3.67		11.67		16.5		21.17		22	
Vermi-cast + CRH	7	3.33^{ns}	15.67	4.00^{ns}	22.67	6.17^{ns}	31.17	10.00**	31.17	9.17**
Guano + CRH	5.33	1.67^{ns}	17.33	5.67^{ns}	25.17	8.67*	37	15.83**	37.83	15.83**
Goat Manure + CRH	13.5	9.83**	20	8.33*	31.83	15.33**	37	15.83**	35.83	13.83**
Chicken Manure + CRH	7.33	3.67^{ns}	12.83	1.17^{ns}	23.67	7.17*	35.67	14.50**	37.67	15.67**
Cattle Manure + CRH	11.33	7.67**	25.17	13.50**	33.67	17.17**	35	13.83**	35.83	13.83**
Mean	8.03	5.23	17.11	6.53	25.59	10.90	32.84	14.00	33.39	13.67

ns - Not significant at the 0.05 alpha level of significance; - Significant at the 0.05 alpha level of significance;** - Significant at the 0.01 alpha level of significance*

Table 3. Average Number of Leaves from 15 to 75 DAP in Salt-Affected Soils Treated with Organic Ameliorants

Treatments/ Character	Ave no. of Leaves DAP	Computed Mean Difference	Ave no. of Leaves 45 DAP	Computed Mean Difference	Ave no.of Leaves 75 DAP	Computed Mean Difference
Control	12.67		9.00		11.00	
Vermi-cast + CRH	14.00	1.33^{ns}	23.00	14.00^{ns}	20.33	9.33^{ns}
Guano + CRH	12.00	-0.67^{ns}	15.00	6.00^{ns}	21.33	10.33^{ns}
Goat Manure + CRH	18.67	6.00^{ns}	44.33	35.33**	31.33	20.33**
Chicken Manure + CRH	13.00	0.33^{ns}	27.00	18.00*	43.33	32.33**
Cattle Manure + CRH	18.00	5.33^{ns}	42.33	33.33**	29.00	18.00*
Mean	14.72	2.46	26.78	21.33	26.05	18.06

ns - Not significant at the 0.05 alpha level of significance; - Significant at the 0.05 alpha level of significance;** - Significant at the 0.01 alpha level of significance*

Onion average number of leaves was significantly increased by the application of different organic ameliorants with carbonized rice hull from 15 to 75 days after planting. The highest number of leaves obtained 15 DAP were those applied with goat manure with carbonized rice hull with 18.67 leaves. Plants with the highest number of leaves were recorded in response to chicken manure with carbonized rice hull of 47.33. The increase in number of leaves compared to control was 43.33 at 45 DAP. The lowest average number of leaves was obtained in onion applied with vermi-cast next to control on the 75 DAP.

Analysis of variance revealed that the effects of chicken manure highly significantly influenced the average number of leaves of onion plants at 75 DAP in both soil sample 1 and 2 with 32.33 and 26.67 compared to control.

According to Rizk (2012) cited by [9], nitrogen mainly related to production of new shoots and vigor in vegetative growth of plants which is directly responsible for increasing leaf number. The maximum numbers of leaves per plant of onion obtained at 45 DAP whereas numbers of leaves decreased from 60 to 75 DAP due to the development bulb. According to Wiles (1994) cited by [10] a significant increase in bulb development lead to decrease in leaf area on the main shoot and the decrease in leaf production is the first indication of the initiation of storage scales. The higher number of leaves and leaf area could help the photosynthesis process to produce higher photosynthate. Arifin (2014) cited by [4] stated leaf area interconnected with the production of plant biomass that is going through the process of photosynthesis. The research of Wulandari et al (2014) cited by [4] also stated that leaf area will affect the quantity of light absorption in plants that increase the production of plant biomass in photosynthesis process.

Result from the analysis of variance revealed that the effects of organic ameliorants significantly influenced average number of leaves of onion. However, there was no significant difference in average number of leaves of onion between the two kinds of samples but the interaction between soil sample and organic ameliorants revealed significant at 30 days after planting.

Table 4 shows the average Bulb Fresh Weight of onion in salt affected soil as affected by different organic ameliorants.

Onion average bulb fresh weight was significantly increased by the application of different organic ameliorants with carbonized rice hull. The highest bulb fresh weight of 50.67 grams was measured in onion applied with cattle manure. The increase in bulb fresh weight was 43.67 grams compared to control. According to [2] cow manure seems to improve soil fertility well while rice husk would cut down brine from below to surface of the soil of saline soil.

Also the increment of 39.33 grams was observed in onion applied with cattle manure. Apparently, chicken manure recorded increase with 22.33 grams.

The lowest average bulb fresh weight was obtained in onion applied with vermi-cast.

In connection with the growth and development parameters of the onion plant, the main effect of organic ameliorants produce higher number of leaves resulting to higher bulb fresh weight whereas goat manure, chicken manure and cattle manure responded the highest number of leaves produced. The higher number of leaves and leaf area could help the photosynthesis process to produce higher photosynthate which affects the quantity of light absorption in plants that increase the production of plant biomass in photosynthesis process.

Table 5 shows the Average Bulb Fresh Weight of shallot onion applied with different organic amelorants.

Table 5 shows the Average Root Length of onion in salt affected soil as affected by different organic ameliorants.

The application of organic ameliorant has no significant difference in average root length of onion between the two kinds of soil sample. However, organic ameliorants slightly improved the average root length of onion.

Base on observation, in connection with the root applied with organic ameliorants are more fibrous and thicker than control. In accordance with the research of [8], in saline soil organic material effects on water binding, so the plant roots can easily absorb nutrients that available for plant growth.

Table 7 shows the Analysis of Variance of the Average Root Length from a 2x 6 Factorial Experiment in a Split-Plot Design.

Result from the analysis of variance revealed that the effect of organic ameliorants has no significance differences influencing the average root length of onion. Therefore, there was no significance difference in average root length of onion between the two kinds of samples.

Table 6 shows the Average Number of Tillers from 15 to 75 DAP of onion in salt affected soil as affected by different organic ameliorants.

Onion average number of tillers was significantly increased by the application of goat manure, chicken manure and cattle manure with carbonized rice hull from 45 to 75 days after planting. Plants with the highest number of tillers were recorded in response to chicken manure with carbonized rice hull of 11 from soil sample 1 taken from Sta. Cruz, Zambales and cattle manure of 8.33 in soil sample 2. The increase in number of tillers compared to control was 8.33 and 5.33 respectively at 60 DAP.

The lowest average number of tillers was obtained in onion applied with vermi-cast and guano in soil samples.

The average number of tillers gradually up at 15 DAP but then gradually stop at 60 DAP indicating that translocation of photosynthates had taken place and possibly fresh bulb weight increased gradually thereafter. A gradual stop of number of tillers, also in accordance with the number of leaves and growth rate results an indication of the initiation of storage scales.

Result from the analysis of variance revealed that the effects of organic ameliorants significantly influenced the average number of tillers of onion. However, there was no significant difference in average number of tillers of onion between the two kinds of samples.

Table 7 shows the Average Yield per Hectare of onion in salt affected soil as affected by different organic ameliorants.

The highest increment of 4.60 t/ha^{-1} was observed in onion applied with goat manure. Therefore, plant height and number of leaves per plant could be compensated for the yield due to higher possibility of photosynthesis. Thus, the average yield of onion per unit area does completely depend upon the performance of individual plants. It also related with the total number of plants per unit area and yield contributing parameters.

Organic manure has been found effective in increasing the crop yield and good physical health of soil. The organic amendments could provide plant growth influencing materials such as auxin, amino acids and vitamins which will be released to the soil following decaying (Melo & De-Oliveira, 1999 cited by [11]. It also promotes flocculation of clay minerals, which is an essential condition for the aggregation of soil particles. It also plays an important role in increasing biopores spaces, which increase Na+ leaching.

Based on the above mentioned findings of the present investigations, goat manure, chicken manure and cattle manure might be associated with the average number of leaves and plant growth rate resulting higher bulb fresh weight and yield. In study, [11] found that organic manure is a potential source of plant nutrients and chemical conditioner. The results indicate an increase of plant yield and better nutritional quality with the addition of commercial manure or poultry manure separately or in combination. Organic treatments may help to alleviate the negative effect of salinity on the growth and nutrient content of plants.

The increase in yield with the addition of organic manures is consistent with several other studies. The addition of organic manures buffer or offset the severity of crop damage caused by soil salinity [12]. Saline soil induces physiological and metabolic disturbances in plants, affecting growth development, yield, and quality of plants. Photosynthesis and respiration rate of plants are also decreased by salt stress.

Another study cited by [13] organic manures activate many species of living organisms which release phytohormones and may stimulate the plant growth and absorption of nutrients and such organisms need nitrogen for multiplication. Similar result was also reported. They found that animal manure applications increased onion yield.

Result from the analysis of variance revealed that the effects of organic ameliorants significantly influenced the average yield per hectare of onion. However, there was no significant difference in average yield per hectare of onion between the two kinds of samples.

Table 4. Average bulb fresh weight in salt-affected soils treated with organic ameliorants

Organic ameliorant	Average bulb fresh weight (grams)	Computed mean difference	LSD at 5%	LSD at 1%
Control	4.67			
Vermi-cast + CRH	20.00	15.33^{ns}	17.01	23.20
Guano + CRH	22.67	18.00*	17.01	23.20
Goat Manure + CRH	50.67	46.00**	17.01	23.20
Chicken Manure + CRH	27.00	22.33*	17.01	23.20
Cattle Manure + CRH	45.67	41.00**	17.01	23.20
28.45		28.53		

Table 5. Average root length in salt-affected soils treated with organic ameliorants

Organic Ameliorant	Average Root Length (cm)	Computed Mean Difference	LSD at 5%	LSD at 1%
Control	18.00			
Vermi-cast + CRH	25.67	7.67^{ns}	7.84	10.69
Guano + CRH	18.67	0.67^{ns}	7.84	10.69
Goat Manure + CRH	23.33	5.33^{ns}	7.84	10.69
Chicken Manure + CRH	21.00	3.00^{ns}	7.84	10.69
Cattle Manure + CRH	25.67	7.67^{ns}	7.84	10.69
Mean	20.06	4.87		

Table 6. Average number of tillers from 15 to 75 daps in salt-affected soils treated with organic ameliorants

Treatments/ Character	Ave no. of Tillers 15 DAP	Computed Mean Difference	Ave no. Tillers 45 DAP	Computed Mean Difference	Ave no. Tillers 75 DAP	Computed Mean Difference
Control	4.67		3.33		3.00	
Vermi-cast + CRH	5.67	1.00^{ns}	6.67	3.33^{ns}	6.33	3.33^{ns}
Guano + CRH	3.00	-1.67^{ns}	3.67	0.33^{ns}	3.33	0.33^{ns}
Goat Manure + CRH	6.67	2.00^{ns}	8.00	4.67*	7.67	4.67^{ns}
Chicken Manure + CRH	4.00	-0.67^{ns}	7.67	4.33^{ns}	8.33	5.33*
Cattle Manure + CRH	5.67	1.00^{ns}	8.33	5.00*	8.33	5.33*
Mean	4.95	0.33	6.28	3.53	6.17	3.80

ns - Not significant at the 0.05 alpha level of significance; - Significant at the 0.05 alpha level of significance;** - Significant at the 0.01 alpha level of significance*

Table 7. Average yield per hectare in salt-affected soils treated with organic ameliorants

Organic Ameliorant	Average Yield (t/ha)	Computed Mean Difference	LSD at 5%	LSD at 1%
Control	0.60			
Vermi-cast + CRH	1.60	1.00^{ns}	1.31	1.78
Guano + CRH	3.47	2.87^{**}	1.31	1.78
Goat Manure + CRH	5.57	4.97^{**}	1.31	1.78
Chicken Manure + CRH	4.93	4.33^{**}	1.31	1.78
Cattle Manure + CRH	4.60	4.00^{**}	1.31	1.78
3.46	3.43			

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusions

1. The application of soil ameliorants with carbonized rice hull significantly increase the diameter of bulb, plant height, number of leaves, number of tillers, bulb weight, chlorophyll content and average yield per hectare**.**
2. Growing of shallot onion in salt affected soil was possible with the right application of organic ameliorants. Application of ameliorant on shallot onion could increase the plant growth better than treatment without ameliorant. Goat manure with carbonized rice hull as ameliorant could increase the average weight and yield of the plant.
3. The period between 45 to 60 days after planting is the most decisive period for onion plant to fix the number of tillers, bulb weight, bulb diameter and ultimately the yield. Yield contributing characters like bulb weight, bulb diameter, plant height, number of leaves and number of tillers are the most dependable characters and could be effectively used improving production.
4. In connection with the interaction between two levels of salt affected soil, the findings revealed that there is no significant difference.
5. The application of cattle manure provides the highest profit in onion.

4.2 Recommendations

Based on the findings and conclusions of this study, the following recommendations are posited**:**

1. Since this study yielded positive result as to improving the yield and eventually income, the application of organic fertilizers as ameliorants is recommended.
2. It is recommended that farmers may use goat manure if this is available. However, the use of cattle manure is also recommended.
3. The study may be validated under field condition to verify the result of this pot experiment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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