IJCRM
International Journal of Contemporary Research In Multidisciplinary

Research Article

Reducing the Effect of Salinity with the Application of Vermicompost on Biochemicals and Inorganic Constituents of *Arachis hypogaea* L.

Debasish Dikshit[1]*, Topi Karga[2], A. Venkatesan[3]

[1]Ph.D. Research Scholar, Department of Botany, Annamalai University, Tamil Nadu, India
[2]Ph.D. Research Scholar, Department of Botany, Annamalai University, Tamil Nadu, India
[3]Associate Professor, Department of Botany, Annamalai University, Tamil Nadu, India

Corresponding Author: * Debasish Dikshit

DOI: https://doi.org/10.5281/zenodo.10723524

Abstract

The present study was made to the effect of different concentrations of sodium chloride (NaCl) with the application of vermicompost on germination and biochemical constituents of *Arachis hypogaea* L. The germination study was conducted with various concentrations of NaCl (mM) with vermicompost (%) (0, 10, 25, 50, 10mM+5%, 25mM+10%, 50mM+25% and 100%VC) and the data were assessed 25th day after germination. The photosynthetic pigment, carotenoid, protein and starch content decreased with increasing concentration of NaCl upto 50mM and increase in addition with vermicompost. The maximum increase in this shown in 50 mM + 25%VC. The accumulation of Macro and micro nutrient content increased at extreme level of 100%VC but in NaCl stress with application of vermicompost the nutrient contents increase upto 50 mM + 25%VC.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 22-01-2023
- **Accepted:** 25-02-2023
- **Published:** 28-02-2024
- **IJCRM:**3(1);2024:215-221

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Manuscript

Debasish Dikshit, Topi Karga, A. Venkatesan. Reducing The Effect of Salinity with the Application of Vermicompost on Biochemicals and Inorganic Constituents of *Arachis hypogaea* L.. International Journal of Contemporary Research in Multidisciplinary. 2024; 3(1): 215-221.

Keyword: *Arachis Hypogaea* L, Salinity, Vermicompost, Macronutrients, Micronutrients

1. Introduction

In particular, in arid and semiarid regions around the world, salinity is a problem. Salinity affects about one third of arable land in variable degrees [1]. Osmotic stress and its particular effects especially induce plant development retardation when exposed to salt stress. The salt stress mainly inhibited photosynthesis and or reduced plant growth, according to Shu *et al.*, [2]. This inhibition, as shown, is associated with osmotic stress, decreased efficiency of ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco) [3], and photosynthetic system may result from stomatal closure due to disruption of the Chloroplast structure and function or by disassembly of the thylakoid membrane. In addition, salt stress results in disruption of thylakoids, an increase in the amount and size of plastid pellets, a decrease in starch content, chloroplast aggregation, grana swelling, fretting compartments, and lipid droplet accumulation [4, 5]. The issue of salinity in the world affects about 77 million hectares of farmland and 20 to 33 % of irrigated land.

Salts affect about 13% of Mexico's agricultural land, mostly in the country's north. Consequently, it is necessary to examine plants that have commercial agronomic characteristics, which enable them to thrive in salty areas without losing their capacity for the use of freshwater [6]. Vermicompost is a soil and organic fertiliser produced when earthworms convert various organic waste into humus conditioner like substances with high levels of enzymes, humic acids and fulvic acids. Vermicompost, by reducing the harmful effects of toxic components under salt stress and fostering antistress environments, improves soil quality and has beneficial effects on plant growth, but it also helps plants to cope with stress [7]. Together with leaf area index, leaf chlorophyll concentration has been demonstrated to be a crucial measure of agricultural productivity and photosynthetic capacity. In *Solanum melongiana* [8], *Oryza sativa* [9], and sorghums [10], the amount of chlorophyll reduced significantly at higher NaCl concentrations. Vermicompost has been shown to improve the chlorophyll index by 16% compared to the control when used at 20% concentration, according to a study by Akhzari *et al.*,[11], Carotenoids, which are critical to the protection of plant tissues, are biological antioxidants. The absence of carotenoids can lead to a severe photooxidative stress in plant tissues. Carotenoids have been attributed to a strong influence of salt stress and while the carotenoids decreased in salinity, their levels were not as high as that of chlorophyll. Chlorophyll a, Chlorophyll b, total chlorophyll, and carotenoids levels increased when soil vermicompost was added; the biggest increase was seen at the fourth level of vermicompost (18.39%) in comparison to the control [12]. Al-huraby and Bafeel [13] found that, in comparison to the control, the content of soluble protein increased, peaked, and then decreased. It has also been demonstrated that insolubleness alters the various processes of N metabolism such as uptake, decrease and protein synthesis, which can have direct or indirect effects on plant development. Slower growth and higher concentrations of salt in the tissues have been observed in plants that are under Salt Stress. In [7], according to Jabeen and Ahmad, an appreciable increase in nitrate and protein amino acid content under the nonsalinity condition, a small difference of salinity with respect to total amino acid decrease were observed when organic manure was applied. There was no significant difference in starch or sugar content between the control and salt treated plants, although an excessive accumulation of starch, sucrose, and total soluble sugars had been greatly reduced as well as glucose levels markedly increased following treatment with salt treatments [14]. According to Pérez-Gómez, *et al.*, [15], the application of vermicompost and vermiwash possibly increase the activity of sucrose phosphate synthase accumulating more starch. Salinity dominated by Na and Cl ions decreased the concentrations of essential macro and microelements in several vegetable crops [16]. The interactions between salinity and micronutrients are said to be difficult. Variations can be attributed to plant type, tissue, salt content and composition, concentration of micronutrients in medium grown conditions and duration of the study, as suggested by Gratan and Grieve. In addition, in plants that are exposed to salt stress, the treatment of Vermicompost significantly raises Fe, Mn and Zn levels. Vermicompost ensured that the soil was enriched in terms of Fe and Mn thanks to the helpful bacteria it contains, and it helped make the nutritional elements more useful by secreting plant growth regulators in the plant rhizospherep [16]. Consequently, it has significantly increased the capacity for Fe and Mn to be absorbed by plants, especially in cases of mild stress. According to Demir and Kiran's research from [17], Vermicompost increases the concentrations of P, K, Mg, Fe, Mn, and Zn, while decreasing the Na and the damaging effects of salt on the plant. There is a higher content of calcium in groundnut plants than in other plants. If the right quantities of essential components such as calcium are present, plant productivity is maximized. The cell wall binding sites with a high proportion of calcium may be to blame for the retention of calcium in the root [18].

2. Materials and Methods

Biochemical studies

Germinated seedlings of groundnut on 25th day were separated into root and shoot and they were used for biochemical analyses such as chlorophyll, carotenoid, starch and protein by using the following methods. The chlorophyll content was by the method of Arnon's, [19].The estimation of carotenoid content was carried out according to the protocol mentioned by Davis, [20]. The estimation of starch was carried out according to the protocol given by Summner and Somers, [21]. The protein content was estimated according to the protocol of Lowry *et al.*, [22]. The data were statistically analyzed by the method of complete randomized block design (ANOVA one-way method).

Estimation of macro and micronutrients

The estimation of Total nitrogen was carried out by Jackson, 1958 quoted by Yoshida *et al.*,[23]. The phosphorus content was estimated according to Black, [24] quoted by Yoshida *et al.*, [23]. The total Potassium was present estimated by Williams and Twine, [25]**.** Estimation of calcium and magnesium was carried out according to Yoshida *et al.*, [23] and the presence of Zinc was carried out according to the procedure given by De Vries & Tiller, [26].

3. Results & Discussion

Photosynthetic pigment

The data showed on the chlorophyll 'a', Chlorophyll 'b', Total chlorophyll and carotenoid content were estimated at various concentration of salinity in addition to vermicompost are given in Fig. I. The chlorophyll 'a' , Chlorophyll 'b' , Total chlorophyll and carotenoid content gradually decreased upto optimum level of 50mM NaCl (1.07,0.414, 1.484 and 0.59mg g^{-1} fr. wt.) and increased at 50mM NaCl + 25% vermicompost was (2.01, 1.47, 3.48 and 0.981 mg g^{-1} fr. wt) observed when compared to control.

Protein

The results on the protein control were estimated at various germination stages of seedling grown under different concentration of salinity and in addition of vermicompost are given in fig.II. The protein content gradually decreased upto optimum level of leaves, stem, and root of 50mm NaCl (3.312, 2.794, and 2.337mg g^{-1} fr. wt.) and increased in addition of vermicompost 50mM NaCl + 25% vermicompost (3.519, 3.104and 2.713mg g^{-1} fr.Wt.) was observed when compare in control.

Starch

The data on the starch content of various concentration of salinity with combined vermicompost are given in fig.III. the starch content gradually decreased with increasing concentration of salinity upto 50mm NaCl(0.325, 0.302 and 0.231mg g^{-1} fr. wt.) and moderately increased in starch contend in addition to vermicompost 50mm NaCl + 25% vermicompost (0.478, 0.409 and 0.331 mg g^{-1} fr. wt.) was observed when compared to control.

Macro and Micro Nutrients

Increases the NaCl concentration shows decreases in the nutrients content. In addition, with vermicompost shows gradually increase in the nutrient content upto 50mm NaCl + 25% vermicompost. The data shows the highest Nutrients (N, P, K, Ca, Mg, Zn) was observed in 100% vermicompost i.e Nitrogen- 4.88, Phosphorus- 3.911, Potassium- 2.015, Calcium- 0.869, Magnesium- 0.455, Zinc- 0.14. But it was also observed that with the NaCl concentration the highest nutrient content was found to be in 50mm NaCl + 25% vermicompost i.e. Nitrogen- 5.01, Phosphorus- 4.122, Potassium- 2.39, Calcium- 0.913, Magnesium- 0.481, Zinc- 0.125 (Figure. IV).

4. Discussion

According to Alamer *et al.,*[27] observed that the application of vermicompost in salinity stress increases the photosynthetic pigments in *Zea mays* L. studies have already documented the beneficial role of vermicompost application to plants grown under salinity, where the application of vermicompost helped the plants to grow and function normally under a salt stress environment[28], Medicago[11] and Marigold [29]. In AlAbdallah *et al.,*[30] experiment observed that the addition of biofertilizer increases the protein content in *Vigna unguiculata* L. under salt stress conditions. Vermicompost and vermiwash was increased the activity of sucrose phosphate synthase accumulating more starch in potato plants [31]. Belliturk *et al.,*[31] recorded the highest total N correlation coefficients between manure and vermicompost, measuring 0.736, but nitrogen 0.14 was found to be below the predicted amount. Additionally, it has been demonstrated that the addition of vermicompost promotes up to a one-week earlier flowering. This can be due to vermicompost's higher nutritional availability at the time of application. It also shows how vermicompost could be very helpful if the growing season is started earlier and with a higher emphasis. The vermicompost treatment has reportedly improved the quality and nutrient concentration of crops, including aromatic carbons, N, P, K, calcium, zinc, and manganese, according to Azarmi *et al*.,[32] and Kmetova and Kovacik [33] noted that vermicompost contains ten times as much total N as soil does. In addition to forcing the stomas to close, NaCl alters the structure of the proteins in chloroplast thylakoids, which affects the mobility of nitrogen into the leaves. In addition, by disrupting the ion balance of the cell, the NaCl salt used in the experiment may have contributed to the loss of P in the plant, as described by Parida and Das, [34]. In previous studies, vermicompost has been shown to improve phosphorus deposition and uptake, which in turn increases plant resilience to stress [35]. Organic materials in the soil is known to promote P mineralization. In a similar line, vermicompost treatment was reported to promote soil P mineralization during the trials. The salt stress considerably reduced the K concentration relative to the control, despite the vermicompost treatment increasing it. After receiving V treatments at a level of no more than 5%, the plant, which was experiencing severe salt stress, experienced a considerable rise in the contents of Fe, Mn, and Zn. Similar findings were noted by Abbaspour *et al.,* [36]. Vermicompost has an advantage over traditional compost in that it decreased Na concentrations while increasing Mg, Fe, Zn, and Cu concentrations in leaves. Various vegetables, strawberries, lettuce, and Chinese cabbage all had higher nutritional content after being treated with vermicompost [37]. By boosting the biological availability and transport of Zn and Cu by the plant, applications of V most likely facilitated plant growth. According to Demir and Kiran's research from [17], adding vermicompost to salt-stressed soil raised the concentrations of P, K, Mg, Fe, Mn, and Zn.

5. Conclusion

The experiment investigated the impact of the interaction between vermicompost (VC) and salinity on the biochemical and inorganic constituents of *Arachis hypogaea* L., commonly known as peanut plants. The study observed that the addition of vermicompost positively influenced both the growth parameters and the nutrient content of the plants, particularly up to a salinity level of 50 mM NaCl combined with 25% vermicompost.

One of the key findings highlighted that the incorporation of vermicompost led to an enhancement in the growth of *Arachis hypogaea* L. This improvement suggests that vermicompost may possess beneficial properties that facilitate the growth and development of the plants, even under conditions of salinity stress. Furthermore, the study noted that the nutrient value of the plants increased with the addition of vermicompost, particularly within the specified salinity range. This implies that vermicompost supplementation has the potential to enhance the nutritional quality of the plants, making them more resilient to salinity-induced stress. Overall, the findings of the study underscore the positive effects of vermicompost supplementation, particularly in mitigating the adverse impacts of salinity stress on the growth, nutrient content, and mineral composition of *Arachis hypogaea* L. These insights contribute to a better understanding of sustainable agricultural practices aimed at improving crop resilience and productivity in saline environments.

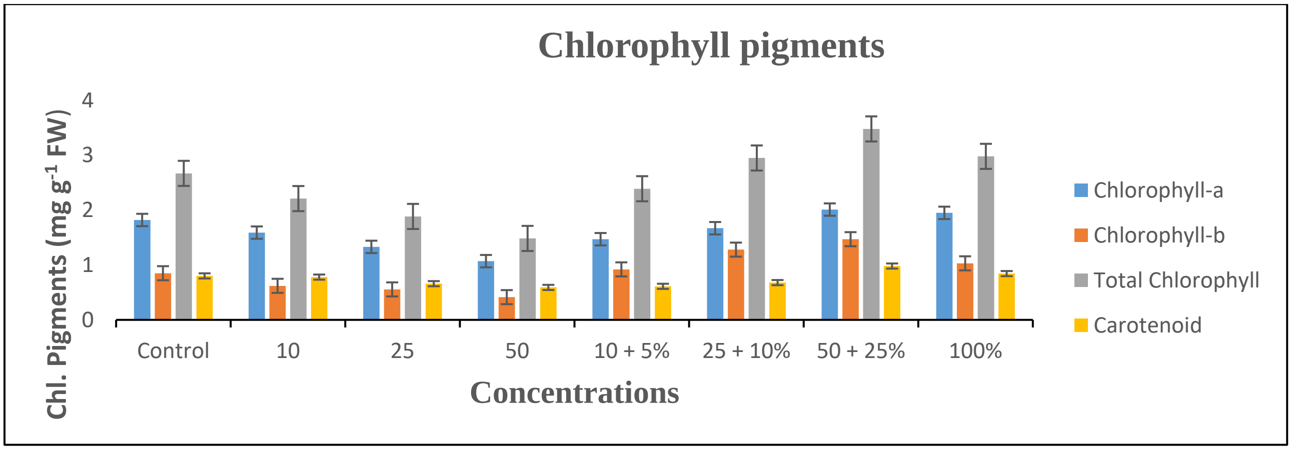
6. Acknowledgment
I record sincere thanks to **Dr. P Thamizhiniyan**, Head of the Department, for his generous help as providing me good library, fantastic internet connection, lab facilities, garden facility and timely supplying the chemicals to carry out my work effectively. I extend my thanks to all teaching and non-teaching faculty members, Department of Botany, Annamalai University, for their active support and encouragement throughout study.

References
1. Bahmani K, Noori SA, Darbandi AI, Akbari A. Molecular mechanisms of plant salinity tolerance: a review. Australian journal of crop science. 2015 Apr 1;9(4):321-36.
2. Shu S, Guo SR, Sun J, Yuan LY. Effects of salt stress on the structure and function of the photosynthetic apparatus in *Cucumis sativus* and its protection by exogenous putrescine. Physiologia plantarum. 2012 Nov;146(3):285-96.
3. Shu S, Yuan Y, Chen J, Sun J, Zhang W, Tang Y, Zhong M, Guo S. The role of putrescine in the regulation of proteins and fatty acids of thylakoid membranes under salt stress. Scientific reports. 2015 Oct 5;5(1):14390.
4. Hasan R, Kawasaki M, Taniguchi M, Miyake H. The damage of root, leaf and chloroplast ultrastructure on maize seedlings caused by salinity stress. InIOP Conference Series: Earth and Environmental Science 2018 Oct 1 (Vol. 197, No. 1, p. 012054). IOP Publishing.
5. Tammam A, El-Aggan W, Helaly A, Badr G, El-Dakak R. Proteomics and photosynthetic apparatus response to vermicompost attenuation of salinity stress *Vicia faba* leaves. Acta Physiologiae Plantarum. 2023 Jan;45(1):17.
6. García-Galindo E, Nieto-Garibay A, Troyo-Diéguez E, Lucero-Vega G, Murillo-Amador B, Ruiz-Espinoza FH, Fraga-Palomino HC. Germination of *Salicornia bigelovii* (Torr.) under shrimp culture effluents and the application of vermicompost leachate for mitigating salt stress. Agronomy. 2021 Feb 26;11(3):424.
7. Bidabadi SS, Dehghanipoodeh S, Wright GC. Vermicompost leachate reduces some negative effects of salt stress in pomegranate. International Journal of Recycling of Organic Waste in Agriculture. 2017 Sep;6:255-63.
8. Hannachi S, Steppe K, Eloudi M, Mechi L, Bahrini I, Van Labeke MC. Salt stress induced changes in photosynthesis and metabolic profiles of one tolerant ('Bonica') and one sensitive ('Black beauty') eggplant cultivars (*Solanum melongena* L.). Plants. 2022 Feb 22;11(5):590.
9. Cha-um S, Kirdmanee C, Supaibulwatana K. Biochemical and physiological responses of Thai jasmine rice (*Oryza sativa* L. ssp. indica cv. KDML105) to salt stress. Sci. Asia. 2004 Jan 1;30:247-53.
10. Netondo GW, Onyango JC, Beck E. Sorghum and salinity: II. Gas exchange and chlorophyll fluorescence of sorghum under salt stress. Crop science. 2004 May;44(3):806-11.
11. Akhzari D, Pessarakli M, Khedmati M. Effects of vermicompost and salinity stress on growth and physiological traits of *Medicago rigidula* L. Journal of Plant Nutrition. 2016 Dec 5;39(14):2106-14.
12. Afkari A. An investigation to the vermicompost efficacy on the activity level of antioxidant enzymes and photosynthetic pigments of borage (*Borago officinalis* L.) under salinity stress conditions. Russian Agricultural Sciences. 2018 Jul;44(4):310-7.
13. Al-huraby AI, Bafeel SO. The effect of salinity stress on the Phaseolus vulgaris L. plant. African Journal of Biological Sciences. 2022 Jan;4(1):94-107.
14. Shen JL, Wang Y, Shu S, Jahan MS, Zhong M, Wu JQ, Sun J, Guo SR. Exogenous putrescine regulates leaf starch overaccumulation in cucumber under salt stress. Scientia horticulturae. 2019 Jul 27;253:99-110.
15. Pérez-Gómez JD, Abud-Archila M, Villalobos-Maldonado JJ, Enciso-Saenz S, Hernández de León H, Ruiz-Valdiviezo VM, Gutiérrez-Miceli FA. Vermicompost and vermiwash minimized the influence of salinity stress on growth parameters in potato plants. Compost Science & Utilization. 2017 Oct 2;25(4):282-7.
16. Rangarajan A, Leonard B, Jack A. Cauliflower Transplant Production Using Organic Media, 2008.
17. Demir Z, Kiran S. Effect of vermicompost on macro and micro nutrients of lettuce (*Lactuca sativa* var. Crispa) under salt stress conditions. Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi. 2020 Feb 28;23(1):33-43.
18. Katyal JC, Datta SP. Role of micronutrients in ensuring optimum use of macronutrients. InIFA International Symposium on Micronutrients, New Delhi, India 2004 Feb (pp. 3-17).
19. Arnon DI. Copper enzymes in isolated chloroplasts. Polyphenoloxidase in *Beta vulgaris*. Plant physiology. 1949 Jan;24(1):1.
20. Davis RF. Salinity effects on the electrical and ionic parameters of *Atriplex gmelini*. Developments in plant biology. 1980.
21. Sumner JB, Somers GF. Laboratory experiments in biological chemistry. (No Title). 1949.
22. Classics Lowry O, Rosebrough N, Farr A, Randall R. Protein measurement with the Folin phenol reagent. J biol Chem. 1951;193(1):265-75.
23. Yoshida S. Laboratory manual for physiological studies of rice. Int Rice Res Ins, Philippines. 1976;23:61-6.
24. Black CA. Methods of Soil Analysis. Sponsored by the American Society of Agronomy and the American Society for Testing Materials. American Society for agronomy; 1965.
25. Williams V, Twine S. Flame photometric method for sodium, potassium and calcium. Modern methods of plant analysis. 1960; 5:3-5.
26. DE V. Routine procedures for determines Cu, Zn, Mn and Fe in plant materials.
27. Alamer KH, Perveen S, Khaliq A, Zia Ul Haq M, Ibrahim MU, Ijaz B. Mitigation of salinity stress in maize seedlings

by the application of vermicompost and sorghum water extracts. Plants. 2022 Sep 28;11(19):2548.
28. Tammam AA, Rabei Abdel Moez Shehata M, Pessarakli M, El-Aggan WH. Vermicompost and its role in alleviation of salt stress in plants–I. Impact of vermicompost on growth and nutrient uptake of salt-stressed plants. Journal of Plant Nutrition. 2023 Apr 21;46(7):1446-57.
29. Adamipour N, Heiderianpour MB, Zarei M. Application of vermicompost for reducing the destructive effects of salinity stress on tall fescue turfgrass (*Festuca arundinacea* Schreb.'Queen'). Journal of Soil and Plant Interactions-Isfahan University of Technology. 2016 Jun 10;7(1):35-47.
30. AlAbdallah NM, Basalah MO, Roushdy SS. The promotive effect of algal biofertilizers on growth and some metabolic activities of Vigna unguiculata L. under salt stress conditions. Egyptian Journal of Experimental Biology (Zoology). 2017 Jul 1;13(2).
31. Bellitürk K, Adiloğlu S, Solmaz Y, Zahmacıoğlu A, Adiloğlu A. Effects of increasing doses of vermicompost applications on P and K contents of pepper (*Capsicum annuum* L.) and eggplant (Solanum melongena L.). Journal of Advanced Agricultural Technologies Vol. 2017 Dec;4(4).
32. Azarmi R, Giglou MT, Taleshmikail RD. Influence of vermicompost on soil chemical and physical properties in tomato *(Lycopersicum esculentum*) field. African Journal of Biotechnology. 2008;7(14).
33. Kmeťová M, Kováčik P. The impact of vermicompost application on the yield parameters of maize (*Zea mays* L.) observed in selected phenological growth stages (BBCH-scale). Acta fytotechnica et zootechnica. 2014 Nov 24;17(4):100-8.
34. Parida AK, Das AB. Salt tolerance and salinity effects on plants: a review. Ecotoxicology and environmental safety. 2005 Mar 1;60(3):324-49.
35. Arancon NQ, Edwards CA, Bierman P. Influences of vermicomposts on field strawberries: Part 2. Effects on soil microbiological and chemical properties. Bioresource Technology. 2006 Apr 1;97(6):831-40.
36. Abbaspour H, Saeidi-Sar S, Afshari H, Abdel-Wahhab MA. Tolerance of mycorrhiza infected pistachio (*Pistacia vera* L.) seedling to drought stress under glasshouse conditions. Journal of Plant Physiology. 2012 May 1;169(7):704-9.
37. Wang D, Shi Q, Wang X, Wei M, Hu J, Liu J, Yang F. Influence of cow manure vermicompost on the growth, metabolite contents, and antioxidant activities of Chinese cabbage (*Brassica campestris* ssp. chinensis). Biology and fertility of soils. 2010 Sep;46:689-96.

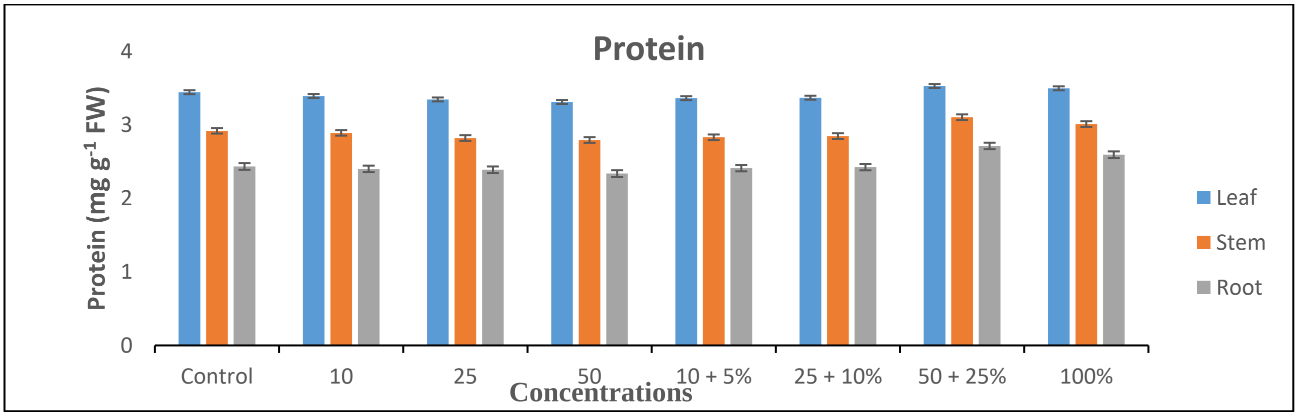
Appendix

Figure I: Effect of NaCl in addition with vermicompost on chlorophyll pigments (mgg^{-1}fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate



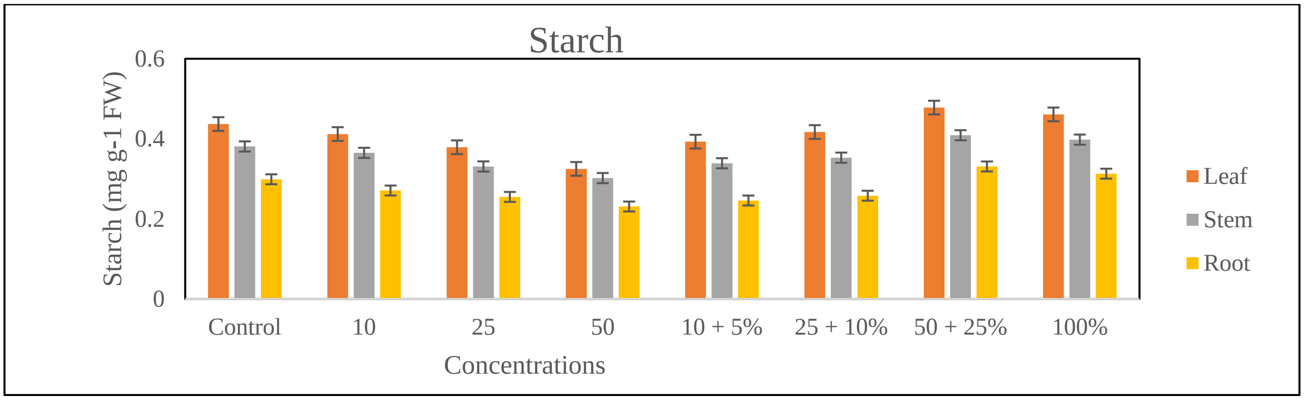
Chl. a - 8403.736*, Chl. b – 9400.208*, Total Chl. – 21899.903*, Carotenoid – 467.741*.The F values were significant at 1% level.

Figure II: Effect of NaCl in addition with vermicompost on protein (mg g^{-1}fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate.



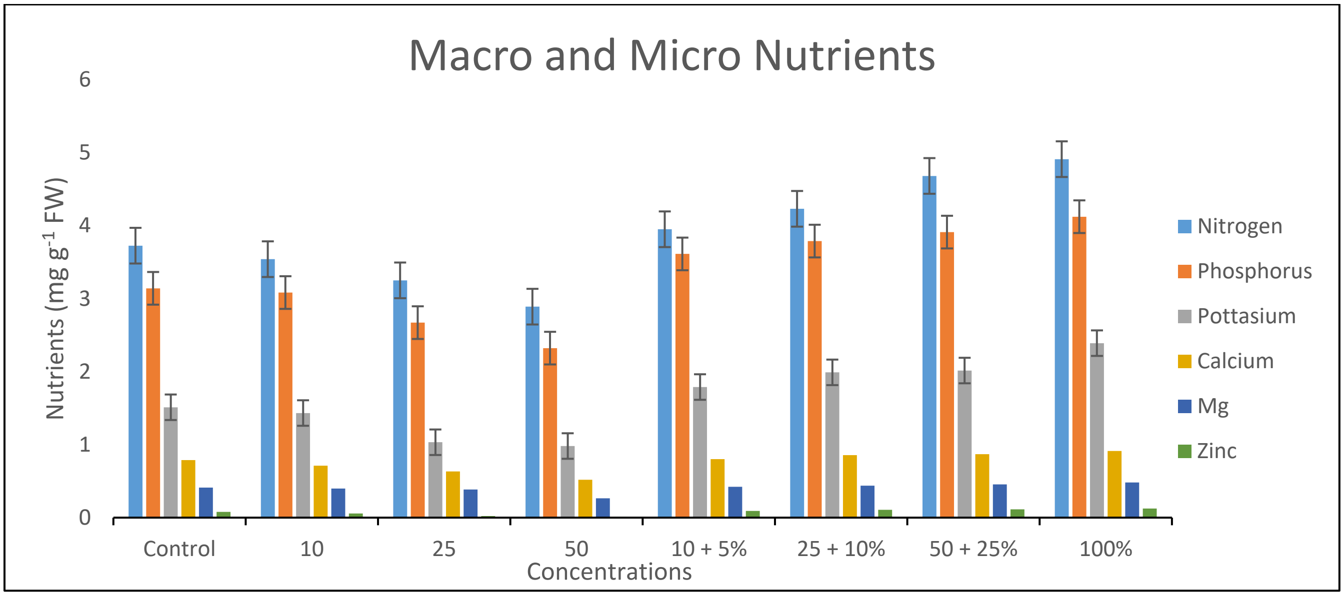
Leaf – 2119.829*, Stem – 1794.932*, Root – 1042.838*.The F values were significant at 1% level.

Figure III: Effect of NaCl in addition of vermicompost on starch (mgg^{-1}fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate



Leaf – 125.229*, Stem – 106.599*, Root – 98.833*. The F values were significant at 1% level.

Figure IV: Effect of NaCl in addition of vermicompost on Micro and macro nutrients (mgg^{-1}fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate



Nitrogen- 9034.16*, Phosphorus- 525.683*, Potassium- 343.524*, Calcium- 148.035*, Magnesium- 158.653*, Zinc- 266.197*. The F values were significant at 1% level.