Effect of Organic Potting Media on Growth Performance of Rose Stem Cuttings

M.S. Afrin[1], T.H. Seran[2] and K.N.D. Lakmali[3]

[1,2,3]*Department of Crop Science, Faculty of Agriculture, Eastern University, Chenkalady, Sri Lanka*

[1]seerinmarrikar@gmail.com, [2] thayaminis@esn.ac.lk, [3]lakmalidhanu5@gmail.com

Abstract

The pot experiment was carried out to study the effect of different organic potting media on the growth parameters of rose stem cuttings. It was carried out with five treatments with four replications comprised of different organic potting media, T1 (no organic manure), T2 (cow dung), T3 (sawdust), T4 (poultry manure), T5 (goat manure). in a Completely Randomized Design. The results confirmed that the different organic potting media had significant differences in the number of leaves, number of sprouts, length of internodes, length a diameter of the main root, root area and root volume, fresh and dry weights of shoot and fresh and dry weights of the root. According to the statistically analyzed results, T4 (Poultry manure) gave a higher growth in the tested growth parameters of rose cutting which could be used as potting media for vegetative plant propagation. Poultry manure is environmentally friendly organic manure and it contains high nutrients, thereby it could be used for enhancing the growth of rose stem cuttings.

Kewwords: Cow Dung, Poultry Manure, Sawdust, Goat Manure, Stem Cuttings

I. INTRODUCTION

Rose (*Rosa hybrida* L) belongs to the family Rosaceae and it is the most diverse flowering ornamental shrubs in the world. It occupies a special position in the floriculture industry. Many roses are grown for their beautiful flowers and most have a delightful fragrance, which differs according to the variety and climatic conditions (Britannica, 2023). Roses use for commercial perfume, bouquet industry and in herbal and folk medicines (Savita, 2016). Organic manures are used as various potting medium in plant propagation. Organic materials such as crop residues, animal manures, green manures to soils supply organic matters, soil fertility, soil physical characteristics, and increase microbial activities, in the soil (Suthamathy and Seran, 2011; Roy and Kashem, 2014). Microbes in the soil decide the plant nutrient availability (Viharnaa *et al*., 2013). Cow manure is not only an agricultural waste, but also an organic fertilizer resource and it. Mainly consist of lignin, cellulose, hemicellulose, and 24 various minerals like N, K and P along with low amount of S, Fe, Mg, Cu, Co and Mn (Guptha *et al.* (2016). In addition to providing of plant supplements, organic manures generally improve soil tilth, air circulation, and water holding capacity of the soil and advances development of beneficial soil life forms (Fulhage, 2000). Sawdust, a bulky waste generated by wood processing industries, has very few profitable and ecofriendly uses and poses a problem of proper disposal (Maboko et al., 2013). Sawdust revealed beneficial attributes to various types of soils to make them suitable for agricultural purposes. Positive physical properties such as biodegradability at an acceptable rate, low superficial specific gravity, high porosity, high water retention, moderate drainage and high bacterial tolerance elevated the usage of sawdust as a plant growth medium in manufacturing industries (Maharani et al., 2010).

Goat manure improves the effectiveness of fertilizer, and its co-application increases the growth. Organic manures from dairy goats contained adequate amounts of nutrients, especially higher contents of N and P for optimal growth of plants (Gichangi *et al*., 2010). Poultry manure is the feces of chickens used as an organic fertilizer, especially for soil containing low nitrogen. All animal manures, it has the highest amount of nitrogen, phosphorus, and potassium. Composted poultry manure provides a slow-release source of macro and micronutrients and acts as a soil amendment. Compared to other manures, poultry manure and the associated litter are higher in nitrogen, potassium, phosphorus and

e-ISBN: 978-955-627-022-8

calcium, and are also rich in organic matter (Zublena, 1993). The organic matter in poultry manure has another benefit and it gives food to soil microbes allowing organic nutrients to break down faster, which in turn makes them available to plants more quickly (Place *et al*., 2002). Organic farming provides several benefits to the growers (Viharnaa *et al*., 2013) and incorporation of animal manure with EM solution gave the healthy seeds as planting materials (Seran and Shahardeen, 2013). It reduces production cost and it is an environmentally friendly method of cultivation (Green, 2015). In all parts of Sri Lanka, poultry manure, cowdung, goat manure and sawdust are available and those can be used as an organic fertilizer. The present study shows influence of organic manure on growth of rose stem cuttings and select the suitable organic manure for better plant performance of rose stem cutting.

II. MATERIALS AND METHODS

A. Experimental Location

This study was carried out as a pot experiment of August to November in 2022 to study the influence of organic manure on growth of rose stem cuttings and to select the suitable organic manure for better plant performance of rose stem cutting. The experiment was done at home garden Mathale, Central province of Sri Lanka which is located in the latitude of 7.4675°N and the Longitude of 80.6234° E and it is part of the Sri Lankan mid-country wet zone. The average annual temperature at the experimental site is 24.1°C and annual mean rainfall is 1868 mm during the year. Soil type of the experiment site is sandy clay loam in texture and dark brown to reddish brown in color.

B. Agronomic Practices

Rose variety, Grand gala was used in this experiment which is not very sprawling, up to 80 cm wide, but rather tall, reaching up to 1.2 m with proper care. Shoots are straight, strong, abundantly covered with dark green foliage with a glossy surface. The variety Grand Gala itself belongs to the re-flowering. Flowers appear singly on the stem. The inflorescence consists of 40-60 rounded double petals, which slowly unfold and, when fully expanded, elegantly bend outward. For the experiment, black polybags (12 inches diameter, 12 inches height and 8 inches width) were used. Three holes were made at the bottom of each polybag to facilitate the drainage of water. The polybags were filled with treatments (organic manures): garden soil in the ratio of 1:2 and a distance of 3 cm was left unfilled from the top of the soil to facilitate irrigation. Organic manures were collected from farm household. The stem cuttings were planted in the center of the pots at the depth of 2-3 cm which were collected from home garden and pots were kept at the under shade. Watering was practiced by using watering can.

C. Measurements

Number of sprouts and number of newly formed leaves per plant in each replication of all treatments was counted at regular intervals. Length of internode (cm) in each replication of all treatments were measured at 9^{th} week. Length and diameter (cm) of main root, root area (cm^2) and root volume (cm^3) of each plant of each replication of all treatments was measured after destructing the plant after 9^{th} week. Fresh weights of shoot and root (g) were taken using an electronic balance after cutting into small pieces. Dry weights of shoot and root (g) were taken by using electronic balance after drying at 105^0C in oven until a constant weight is obtained. Fresh weight of shoot and root and dry weight of shoot and root were taken after destruction of plant.

D. Experiment Design

The pot experiment was laid out in a completely randomized design (CRD) with five treatments and four replications each having two plants. The treatments used in this experiment are no fertilizer (T1), cow manure (T2), saw dust (T3), poultry manure (T4) and goat manure (T5).

E. Statistical Analysis

The data were analyzed by using statistical software, SAS 9.1 version. Duncan's Multiple Range Test was used to compare the treatment means at a 5% significant level.

III. RESULTS AND DISCUSSION

A. Number of Leaves

Effect of different organic potting media on number of leaves per stem cutting of rose is shown in Table 01 from 3^{rd} week after planting (WAP) to 9^{th} WAP. The results showed that different organic manures significantly influenced the number of leaves per stem cutting at 3^{rd} ($p=0.001$), 6^{th} ($p=0.001$) and 9^{th} WAP ($p<0.0001$). The highest number of leaves was observed in T4 (3.3 ± 0.7) and lowest number of leaves was observed in T1 and T3 (1.3 ± 0.2) in 3^{rd} WAP. From

e-ISBN: 978-955-627-022-8

6th WAP to 9th WAP, highest numbers of leaves were noted in T4 (5.8±0.6 and 7.5±0.8) and lowest numbers of leaves were observed in T1 (2±0.7 and poultry manure showed significant differences on number of leaves than other treatments from 3rd nutrient status of the soil and boost crop productivity. Compared to other manures, poultry manure and the associated litter are higher in nitrogen, potassium, phosphorus and calcium, and are also rich in organic matter (Zublena, 1993) and Place et al. (2002) reported that organic matter in poultry manure help to soil microbes to breakdown organic nutrients faster which in turn makes them available to plants more quickly.

B. Length of Newly Developed Shoot

The data presented in Table 02 clearly indicates that there was significant effect on the average length of the newly developed shoot at the 9th WAP (P<0.0001). The maximum length of the newly developed shoot was recorded in T4 (21.25±1.89 cm) followed by T5 (13.50±0.65 cm) and the minimum length of the newly developed shoot was recorded in T1 (4.50±0.65 cm). Mean values in a column having a similar letter indicate that there is no considerable variation between the treatments. Therefore, there are no substantial differences in the length of newly developed shoots between T2 and T3 which significantly varied from T1. Dauda et al. (2008) found that organic manures promote vigorous growth, and

3±0.4). The results prove that stem cuttings which were treated with

WAP to 9th WAP. Ndubuaku *et al.* (2014) observed that poultry manure increased the increase meristematic and physiological activities in the plant due to the supply of plant essential nutrients and enhancing the soil properties. Thereby, resulting in the synthesis of more photo assimilates and also N play a vital role in cell proliferation and cell elongation during the vegetative stage of plant (Marchner, 1995).

C. Number Sprouts per Cutting

There was a significant difference in number of sprouts per cutting at 9th WAP (p = 0.0017) (Table 02). Maximum number of sprouts per cutting were recorded in T4 (3.5±0.3) followed by T2 and T3 (2.3±0.5 and 2.3±0.2) and the minimum was recorded in T3 (1.3±0.2). There were no any significant differences between T1, T2, T3, and T5 among treatments. The nutrients in the substrate can be activated by organic fertilizer, which can also enhance the soil's physical and chemical properties, encourage plant nutrient absorption, increase nutrient content (Xiao *et al*., 2018), supply the nutrients required for dry matter accumulation, and encourage both vegetative and reproductive growth (Zhou *et al.*,2020 and Yuan *et al*., 2021).

Table 01: Effect of Different Organic Potting Media on Number of Leaves of Stem Cutting of Rose Leaves

Treatments	Number of leaves at different weeks		
	3 WAP	6 WAP	9 WAP
T1	1.3±0.2c	2.0±0.7c	3.0±0.4d
T2	2.3±0.5b	3.8±0.8b	5.3±0.8b
T3	1.3±0.2c	2.8±0.5bc	3.5±0.5c
T4	3.3±0.7a	5.8±0.6a	7.5±0.8a
T5	2.0±0.4bc	2.3±0.5bc	4.5±0.6bc
P value (df = 4)	0.001	0.001	<0.0001

Value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Dunca's multiple range test 5% significant level.

e-ISBN: 978-955-627-022-8

Table 02: Effect of Different Organic Potting Media on Length of Newly Developed Shoot in Stem Cutting of Rose, Number of Sprouts per Cutting and Internode Length of Rose Cutting at 9th WAP.

Treatments	Length of newly developed shoot (cm)	Number of sprouts per cutting	Internode length (cm)
T1	4.50±0.65d	1.5±0.3b	4.03±0.22
T2	10.25±0.48c	2.3±0.5b	3.15±0.30
T3	9.75±0.86c	1.3±0.2b	3.70±0.34
T4	21.25±1.89a	3.5±0.3a	3.87±0.43
T5	13.5±0.65b	2.3±0.2b	3.35±0.44
P value (df=4)	P<0.0001	P=0.0017	P=0.4117

Value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Duncan's multiple range test 5% significant level.

D. Internode Length

Effects of different organic manure on internodes length of newly developed shoot in rose cutting at 9th WAP shows in Table 02. The statistical analysis showed that there were significantly differences (p=0.4117) in internode length between treatments. Maximum Internode length was recorded in T1 (4.03±0.22 cm) followed by T4 (3.87±0.43 cm) and T3 (3.70±0.34) and the minimum was recorded in T2 (3.15±0.30 cm). Stem length is determined both by number of internodes and internode lengths (Pearson *et al*, 1995).

E. Root Diameter

Effects of different organic manure on root diameter of rose cutting at 9th WAP shows in Table 03. According to the statistical analysis data, there was a significant difference (p<0.0001) on average root diameter. There were no any Significant differences between T1 and T4. Maximum root diameter was recorded in T5 (1.54±0.08 mm) followed by T2 (1.22±0.06 mm) and the minimum root diameter was recorded in T1(1.01±0.07 mm). Poultry manure enhances the soil's physical properties and conditions, as well as nutrient uptake and crop productivity (Mbah and Nnej 2011; Ojeniyi *et al*., 2013).

F. Root Length

The data presented in Table 03 shows that the different organic manure has significant effect on root length of rose cuttings at 9th WAP (p < 0.0001). Maximum root length was recorded in T4 (10.92±0.41 cm) followed by T2 (8.91±0.44 cm), and the minimum was recorded in T1 (6.35±0.29 cm). Desuki (2005) reported that average root length of radish increased with increase N due to higher availability of N in root zone area. Ali *et al*, (2010) reported P present in organic manure increase the root development of rose.

G. Root Area

Effects of different organic manure on area of root of rose cutting at 9th WAP shows in Table 04. There was significantly difference (P < 0.0001) in root area per plant at 9th WAP. Maximum tap root area was recorded in T4 (63.20±2.58 cm^2) followed by T5 (47.31±4.297248 cm^2), T2 (46.60±4.11 cm^2), T3 (26.44±3.14 cm^2), and the minimum was recorded in T1 (23.02±2.12 cm^2). The plant treated with poultry manure (T4) root area was increased compared to control treatment (T1) at 9th WAP.

H. Root volume

The data presented in Table 04 shows that the different organic manures have significant effect on root volume at 9th WAP (P=0.0018). There were no any significant differences between T1 and T3 as well as T2 and T5. Maximum root volume was recorded in T4 (0.325±0.03 cm^3) followed by T2 (0.320 ±0.03 cm^3) and the minimum was recorded in T1 (0.170±0.02 cm^3).

e-ISBN: 978-955-627-022-8

Table 03: Effect of Different Organic Potting Media on Root Length (cm) and Diameter (mm) in Shoot Newly Developed in Stem Cutting of Rose at 9th WAP

Treatments	Root diameter (mm)	Root length (cm)
T1	1.01±0.07c	6.35±0.29d
T2	1.22±0.06b	8.91±0.44b
T3	1.05±0.03bc	7.65±0.28c
T4	1.02±0.02c	10.92±0.41a
T5	1.54±0.08a	7.07±0.37cd
p value (df=4)	p<0.0001	p<0.0001

Value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Duncan's multiple range test 5% significant level.

I. Fresh and Dry Weight of Shoot

Effects of different organic manure on fresh and dry weights of shoot of stem cutting of rose shown in Table 05. The results showed that there was significant difference (p = 0.0428) in fresh weights of shoot but remarkable variation was not noted in dry weight of shoot. Maximum fresh and dry weights of the shoot were recorded in T2 (2.175±0.519 g and 1.01±0.314 g) and the minimum fresh and dry weights of the shoot (0.795±0.2331 g and 0.462±0.049 g) were recorded in T1. The addition of cow dung to damaged soil improves the organic carbon content, which may lead to increased activity of beneficial soil microorganisms as well as improved soil fertility by improving the availability of nutrients for plants. Cow manure improved plant growth and yield substantially (Mehedi *et al*., 2011; Gudugi, 2013).

J. Fresh and Dry Weights of Roots

Effects of different organic manure on fresh and dry weight of roots of stem cutting of rose shown in Table 06. The results showed that there were significant differences (P<0.0001) in the fresh and dry weights of roots of rose cutting. Maximum fresh and dry weights of roots were recorded in T4 (2.52±0.219 g and 1.335±0.131 g) and the minimum fresh and dry weights of roots were recorded in T1 (0.987±0.046 g and 0.357±0.014 g). It was believed that the mineralization process slowly released the nutrients in the chicken waste, maintaining their availability for plant growth.

This raised the number of leaves and plant height, which in turn increased the plant's fresh weight (Joseph *et al.*, 2017. Lawal and Girei (2013) stated organic manure has the ability to increase the nutrient content of soil, soil moisture holding capacity, reduction in soil pH physico-chemical properties of soil. This finding was in conformity with Kaplan *et al*. (2019) who stated that the addition of organic manure improves the soil's physical and biological condition. Also, by creating more favorable environments for root growth and nutrient availability, increased plant growth and dry matter (Trevisn *et al*., 2010).

Table 04: Effect of Different Organic Potting Media on Root Area and Volume of Stem Cutting of Rose at 9th WAP.

Treatments	Root area (cm^2)	Root volume (cm^3)
T1	23.02±2.12c	0.170±0.02b
T2	46.60±4.11b	0.320±0.03a
T3	26.44±3.14c	0.195±0.01b
T4	63.20±2.58a	0.325±0.03a
T5	47.31±4.297248b	0.227±0.034b
p value (df=4)	p<0.0001	p=0.0018

Value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Duncan's multiple range test 5% significant level.

e-ISBN: 978-955-627-022-8

Table 05: Effect of Different Organic Potting Media on Fresh and Dry Shoot Weights of Stem Cutting of Rose Shoot Weight at 9th WAP.

Treatments	Shoot weight (g) at 9th WAP	
	Fresh weight (g)	Dry weight (g)
T1	0.795±0.2331b	0.462±0.049
T2	2.175±0.519a	1.01±0.314
T3	1.343±0.320ab	0.662±0.152
T4	1.965±0.336a	0.965±0.362
T5	1.550±0.1728ab	0.785±0.081
p value (df=4)	p=0.0428	p=0.4568

Value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Duncan's multiple range test 5% significant level.

Table 06: Effect of Different Organic Potting Media on Growth Parameter of Stem Cutting of Rose Root Weight

Treatments	Root weight (g) at 9th WAP	
	Fresh weight (g)	Dry weight (g)
T1	0.987±0.046c	0.357±0.014b
T2	1.743±0.1049b	1.050±0.057a
T3	1.295±0.148bc	0.462±0.0217b
T4	2.520±0.219a	1.335±0.131a
T5	1.512±0.185b	0.527±0.205b
p value (df=4)	p<0.0001	p<0.0001

The value represents mean ± standard error of five replicates. Means followed by the same letter in each column are not significantly different according to Duncan's multiple range test 5% significant level.

IV. CONCLUSION

This investigation was conducted to find out the effects of different organic manure on the growth stem cutting of roses (Grand Gala). The potting media of 2:1 ratio is two parts soil and one part organic manure increased the growth of stem cutting rose. Treatments of different organic potting media had a significant effect on all tested growth parameters on stem cuttings of rose. The results confirmed that the poultry manure was given the best results than the other treatments. In the parameters such as number of leaves, number of sprouts, lengths of internodes (cm), length and diameter (cm) of main root, root area (cm^2) and root volume (cm^3), fresh and dry weight of root (g) were significantly higher in poultry manure treatment than other treatment. Accordingly, Poultry manure is the best treatment for best growth of the rose stem cuttings. Poultry manure could be recommended for the cultivation of stem cutting of rose in order to achieve ecologically sound and better growth in roses.

REFERENCES

Dauda, S. N., Ajayi, F. A., Ndor, E. (2008) "Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application", *Journal of Agriculture and Social Science*, 4(3), pp.121-124.

Fulhage, C.D. (2000) "Reduce environmental problems with proper land application of animal manure", *University of Missouri Extension*, 7(1), pp. 1-10.

Gichangi, M., Pearson N.S., Minkeni, N.S., Brookes, C. (2010) "Goat manure application improves phosphate fertilizer effectiveness through enhanced biological cycling of phosphorus", *Soil science and plant nutrition,*. 56(6), pp. 853-860.

Green, B.W. (2015) "Fertilizers in aquaculture. In: Davis, D. A., editor. Feed and Feeding Practices in Aquaculture. Sawston, Cambridge", *Woodhead Publishing Ltd*, 23(1), pp. 27-52.

Gudugi, I.A.S. (2013) "Effect of cowdung and variety on the growth and yield of okra (*Abelmoschus esculentus* L.)", *Europian Journal of Experimenatal Biology*, 3(2), pp. 495–498.

e-ISBN: 978-955-627-022-8

Gupta, K., Aneja, K., Rana, D. (2016) "Current status of cow dung as a bioresource for sustainable development", *Bioresources and Bioprocessing,* 3(2), pp. 28-36.

Joseph, P. O., Ojomah, F. O., Joseph, P. O. (2017) "Effect of poultry manure and NPK fertilizer on growth and yield of eggplant (*Solanum melongena*)", *Journal of Agriculture and Rural Research,* 10(2), pp. 112–117.

Kaplan, H., Ratering, S., Felix-Henningsen, P., Schnell, S. (2019) "Stability of in situ immobilization of trace metals with different amendments revealed by microbial 13C-labelled wheat root decomposition and efflux-mediated metal resistance of soil bacteria", *Science Total Environment,* 659(12), pp. 1082-1089.

Lawal, H. and Girei, H. (2013) "Infiltration and organic carbon pools under the long term use of farm yard manure and mineral fertilizer" *International Journal of Advanced Agricultural Reseaarch,* 12(5), pp. 92–101.

Maboko, M.M. and Du-Plooy, C.P. (2013) "High density planting of tomato cultivar's with early decapitation of growing point increased yield in a closed hydroponic system", *Acta Agriculturae Scandinavica, Section B-Soil & Plant Science,* 63(8), pp. 676-682.

Maharani, R., Tamai, Y., Takashi, Y., Terazawa, M. (2010) "Scrutiny of Physical Properties of Sawdust from Tropical Countries Wood Species: Effect of Different Mills and Sawdust Particle Size", *Journal of Forestry Research,* 7(1) pp. 20-32.

Marschner, H. (1995) "Mineral Nuttition of Higher Plants", *Academic Press Limited,* 12(88), pp. 864-869.

Mbah, C.N., Nnej, I.R. (2011) "Effect of different crop residue management technique on selected soil properties and grain production of maize", *African Journal of Agricultural Research,* 6(7), pp. 4149–4152.

Mehedi, T.A., Siddique, M.A. and Shahid, S.B. (2012) "Effect of urea and cow dung on growth and yield of carrot", *Journal of the Bangladesh Agricultural University,* 10(5), pp. 9–13.

Ndubuaku, U.M., Nwankwo, V.U., Baiyeri, K.P. (2014) "Influence of poultry manure application on the leaf amino acid profile, growth and yield of moringa (*Moringa oleifera* Lam)", *Albanian Journal of Agricultural Science Albania ,* 13(1) pp. 42-47.

Ojeniyi, S.O., Amusan, O.A., Adekiya, A.O. (2013) "Effect of poultry manure on soil physical properties, nutrient uptake and yield of cocoyam (*Xanthosoma saggitifolium*) in southwest Nigeria", *American-Eurasian Journal of Agriculture and Environmental Sciences,* 13(1), pp. 121–125.

Pearson, S., Hadley, P., Wheldon, A.E. (1995) "A model of the effect of day and night temperatures on the height of chrysanthemums", *Acta Horticulturae,* 378(15), pp. 71–79.

Place, F., Swallow, B.M., Wangila, J.W., Barrett, C.B. (2002) "Lessons for natural resource management technology adoption and research. In Barrett (Eds.). Natural Resources Management in African Agriculture: Understanding and Improving Current Practices", *Oxon and New York: CABI publishing,* 45(4), pp. 275-285.

Roy, S. and Kashem, M. D. (2014) "Effects of Organic Manures in Changes of Some Soil Properties at Different Incubation Periods", *Open Journal of Soil Science,* 04(03), pp. 81-86.

Savita, C. (2016) "Rose Ornamental As Well As Medicinal Plant", *Journal of Research in Agriculture and Animal Science,* 4(1), pp. 08-10.

Seran, T.H. and Shahardeen, R.N.M. (2013) "Effect of EM-Bokashi on vigorous seed production in vegetable cowpea (*Vigna Unguiculata* L.)", *Proceedings of 3rd International Symposium, Section: Biology, Agricultural Sciences and Environmental Sciences, South Eastern University, Sri Lanka,* 1(1), pp. 13-18.

Suthamathy, N. and Seran, T. H. (2011) "Influence of different rates of cattle manure application on the weed occurrence in groundnut (*Arachis hopogae* L.). Proceedings of the 10th Annual Research Session", Eastern University, Sri Lanka, 18(2), pp. 132-139.

Trevisan, S., Francioso, O., Quaggiotti, S., Nardi, S. (2010) "Humic substances biological activity at the plant-soil interface from environmental aspects to molecular factors", *Plant signal behavior,* 5(6), pp. 635-643.

Viharnaa, S., Seran T.H. and Hassaan, A.M. (2013) "Dry matter content of groundnut (*Arachis hypogaea* L.) fertilized with liquid organic fertilizer", *In Proceedings of 3rd International Symposium, Section: Chemistry, Physics and Earth Science, South Eastern University, Sri Lanka,* 1(1), pp. 5-10.

Xiao, Q., Wang, Q.Q., Wu, L., Cai, A.D., Wang, C.J., Zhang, W.J., Xu, M.G. (2018) "Fertilization impacts on soil microbial communities and enzyme activities across China's croplands: A meta-analysis", *Plant Nutrition and Fertilizer. Science,* 24(5), pp. 1598-1609.

Yuan, Q., Feng, B., Zhong, Y.H., Wang, J., Xu, X.J. and Ma, H.B. (2021) "Partial replacement of chemical

e-ISBN: 978-955-627-022-8

fertilizer with organic fertilizer: Effects on eggplant yield, quality and soil fertility", *Chinese Agricultural Science Bulletin*, 37(12), pp. 59-63.

Zhou, Y., Li, Y.M., Fan, M.P., Wang, Z.L., Xu, Z., Zhang, D. and Zhao, J.X. (2020) "Effects of different base fertilizer treatments on mountain red earth soil nutrition, enzyme activity, and crop yield", *Chinese Journal of Applied and Environmental Biology*, 26(2), pp. 603-611.

Zublena J. P., Barker J. C., Carter T. A. (1993) "Poultry manure as a fertilizer source", *Publication AG-439-5. North Carolina Cooperative Extension Service*, 45(1), pp. 45-96.

e-ISBN: 978-955-627-022-8