ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 6 No. 2 June 2020*

Effect of Rabbit Urine Application Rate as a Bio-Fertilizer on Agro-Mophorlogical Traits Of UC82B Tomato (*Lycopersicon Esculentum* Mill*)* Variety in Zaria, Nigeria

***Indabo, S. S. and Abubakar, A. A.**

Department of Biology,
Faculty of Life Sciences,
Ahmadu Bello University, Zaria

Email: sadambiologist@gmail.com

Abstract

The demand for tomato and its by-products far outweighs the supply, inherent low soil fertility has necessitated the use of chemical fertilizers in quest for an increased production. However, the use of chemical fertilizers poses significant threat on agricultural ecosystems. Therefore, this study aimed at determining the effect of rabbit urine supplemented with NPK fertilizer on the agro-morphological traits of UC82B tomato variety. The study was conducted in the green house of the experimental garden, Department of Botany, Ahmadu Bello University, Zaria, Nigeria. The experimental treatments consisted of seven groups (T_1toT_7)which are various combinations of NPK fertilizer and rabbit urine. The NPK fertilizer rate was adopted as a range of recommended 250: 250: 250kg of NPK ha^{-1}. The treatments were made in triplicates. The treatments were used as basal application which were then top-dressed by application of urea. Standard cultural practices of sowing, spacing, thinning, watering, pruning and staking were followed. Data on plant height, number of leaves and number of branches were taken after 2, 3, 4 and 6 weeks of treatment application. Data obtained revealed that T_5(recommended fertilizer + ¼ litre of rabbit urine)had the best performance in terms of number of branches with 6.57±0.24, 6.61±0.13, 6.63±0.51 and 6.66±0.18 number of branches at 2, 3, 4 and 6 weeks respectively, indicating that rabbit urine has indirect effect on tomato yield. Highest number of leaves was recorded in T_2 (18.44±0.04 leaves), a treatment which also contained rabbit urine. In terms of plant height, the highest values were recorded in T_1(8.59±0.21cm).T_5had a maximum height of8.33±0.03cm immediately following T_1. Improvement in crop morphological parameters was therefore found in treatment containing rabbit urine. It is recommended that rabbit urine should be applied to tomato in addition to recommended dose of NPK fertilizer.

Keywords: Agro-morphological, Bio-fertilizer, Tomato, Rabbit Urine

**Author for Correspondence*

INTRODUCTION

Tomato (*Lycopersicon esculentum*) because of its wide adaptation, high yielding potential and suitability for variety of uses both in fresh and processed food industries, is one of the most important vegetable crops grown globally (Nwosu *et al.,* 2018). The popularity of the crop originates from its acceptable flavour, great nutritive value, short life cycle and high productivity rate (Adil *et al*., 2003). The best area for tomato production in Nigeria is the Savannah agro-ecological zone where tomato diseases and pests are uncommon. The crop, tomato is known to grow in most parts of Nigeria. These areas include Bauchi, Benue, Borno, Kano, Kaduna, Plateau, Jigawa, Delta, Kwara and Oyo states(FAO, 2010; Ugonna *et al*., 2015).
Tomato is considered as an important cash and industrial crop in many parts of the world (Ajagbe *et al.,* 2014) as it gives a high yield and is economically attractive (Ugonna *et al.,* 2015).However, low soil fertility and unfavourable soil physical properties are some of the major flaws of tomato production in Nigeria (Adekiya and Ojeniyi, 2002). Tomato plant requires nutrients such as N, P, K, Mg, Ca and Na which are necessary for proper plant production, these nutrients must be available to the plant at the right time and quantity needed to exert their specific functions (Shuka and Naik, 1993; John *et al*., 2004). Proper fertilizer and manure application can be linked to an unprecedented boost in tomato production (Nnabude *et al.,* 2015).

Organic fertilizers/organic materials have been shown to have important chemical functions such as the provision of macro and micro-nutrients (N, P, K, Ca, Zn, Cu and Mo) in relative amounts (Izaurralde *et al.,* 2000; Abustam *et al.,* 2018). In general, the application of organic fertilizers improve root system and plant stems better than chemical compounds (Benchasri and Simla, 2017). Organic ingredients in livestock waste serve as raw materials for fertilizer being an alternative to increase the added value of the waste (Said *et al*., 2018). Thus, the recent initiative of livestock waste management makes the development of livestock business more recognizable. Comprehensive test carried out on both livestock waste and chemical fertilizer revealed that the former is more efficient, more effective and environmentally friendly. Livestock waste increases the availability of nutrients in food crops, thereby increasing yield (Leite *et al.,* 2010; Wildayana, 2017; Vasileva *et al.,* 2017).

Rabbit urine has been shown by Said *et al*. (2018) to contain essential nutrients such as nitrogen, potassium and phosphates for plant growth. Carbon-organic content, a very important factor in organic fertilizer that distinguishes it from an inorganic fertilizer, has also been shown to be present in rabbit urine (Stark *et al.* 2008). According to Atia *et al*. (2005), rabbit urine contains high levels of nitrogen since their major food preference is forage and drink little water. Rabbits can produce 100ml of urine which contains ammonia (NH_3), a colourless gas, strong in odour and lighter than air. Ammonia and other nitrogenous gases are by-products of protein digestion, some of which are lost in manure and urine. This liquid animal waste can be used as liquid organic fertilizer (Salisbury and Ross, 1995). Rabbit urine may be a suitable alternative to chemical fertilizers since it poses minimal risks to the ecosystem while still providing the essential nutrients needed for adequate plant growth. In addition, the economic advantage is that rabbits can be farmed for meat and the urine which was hitherto considered livestock waste is easily used as an organic fertilizer without the need of further treatment. In this light, the study was conducted to determine the effects of rabbit urine on agro-morphological traits of tomato plant.

MATERIALS AND METHODS

Study Area

The research was conducted at the Experimental Garden, Department of Botany, Ahmadu Bello University, Zaria in polythene bags under greenhouse conditions. Zaria is located in Kaduna at Latitude 11°4'0'' North, 7°42'0'' East. Zaria is situated in the Northern Guinea Savanna Zone with a tropical continental climate possessing distinct rainy and dry seasons.

Source of Plant Material and Rabbit Urine Used

Seeds of Tomato (UC82B variety) were obtained from Institute for Agricultural Research (IAR), Ahmadu Bello University. Rabbit urine was obtained from Rabbitry Unit of National Animal Production Research Institute (NAPRI), Ahmadu Bello University.

Sowing of Seed, Experimental Design and Maintenance of Seedlings

Five seeds of UC82B tomato variety were planted in labelled polythene bags and thinned to three seedlings after germination. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. The experimental treatments consisted of seven various applications of NPK fertilizer supplemented with rabbit urine. The quantity of each experimental treatment was calculated based on the recommended 250: 250: 250 kg of NPK ha^{-1} (Yogeeshappa and Srinivasamurthy, 2017). Application rate of fertilizer ranged between high dose (higher than recommended) and low dose (lower than recommended). The seven treatments included; T_1(control): recommended dose of NPK fertilizer with no rabbit urine, T_2 :1.5 times recommended dose of NPK fertilizer plus ½ litre of rabbit urine, T_3 :1.5 times recommended dose of NPK fertilizer plus ¼ litre of rabbit urine, T_4 : recommended dose of NPK fertilizer plus ½ litre of rabbit urine, T_5 : recommended dose of NPK fertilizer plus ¼ litre of rabbit urine, T_6 : ½ times recommended dose of NPK fertilizer plus ½ litre of rabbit urine, T_7 : ½ times recommended dose of NPK fertilizer plus ¼ litre of rabbit urine. The treatments were used as basal application, which were then top-dressed by application of urea at the onset of flowering. Recommended cultural practices for tomato suggested by Hanson *et al*. (2000) were followed; crop spacing were maintained at 50 x 50cm and thinned to one seedling after germination. Daily watering was done to ensure better seedling establishment and moisture availability. Weeding was done manually after every two weeks. Fungicide (Chlorothalonil) was applied when symptoms of fungal infection appeared. Side shoots were pruned and the crop staked with 1m stake (Hanson *et al*., 2000; Ilupeju *et al*., 2015).

Data Collection

Data on plant height, number of leaves and number of branches per plant were recorded as follows; plant heights were determined by measuring the height of three randomly sampled plants per treatment from soil surface to the tip of the apex using a meter rule. The average height was calculated and recorded. Number of leaves on randomly sampled plants were counted and recorded. Primary branches borne on the main shoot of randomly sampled plants from each treatment were also counted and recorded. All parameters were taken at 2nd, 3rd, 4thand 6th week after application of experimental treatment (fertilizer plus rabbit urine).

Data Analyses

The data obtained from the growth parameters were subjected to One-way Analysis of Variance (ANOVA) to determine the significant difference ($p \leq 0.05$) among the treatment means using Statistical Analysis Software (SAS) 2007 (version 9.0). Duncan's Multiple Range Test (DMRT) was used to separate the means, where significant differences are observed.

RESULTS AND DISCUSSION

Effect of application of NPK fertilizer supplemented with rabbit urine on plant height of UC82B tomato variety is presented in table 1. There is significant difference ($p<0.05$) in plant heights among the treatments. The experimental groups responded differently to the treatments applied. T_1, which is the control group had the highest plant height with 8.43±0.04cm, 8.54±0.30cm and 8.59±0.21cm at 3, 4 and 6 weeks after rabbit urine application (WAU) respectively. However, at 2 WAU, T_5 had highest plant height (8.21±0.14cm). In similar trend, T_1 was the second in terms of plant height (8.15±0.09cm) at 2 WAU, whereas at 3, 4 and 6 WAU, T_5 was the second in terms of plant height with 8.23±0.48cm, 8.27±0.28cm and 8.33±0.03cm respectively. The lowest plant height at 2 and 3 WAU, was in T_6 with 7.17±0.14cm and 7.19±0.15cm respectively whereas the lowest plant height at 4 and 6 WAU was in T_4 with 7.5±0.14cm and 7.57±0.13cm respectively. T_1 and T_5 proved more effective in terms of plant height, this could be as a result of the recommended dose contained in T_1. For T_5, the improvement in plant height could be attributed to the addition of large quantity of the rabbit urine to the recommended dose, hence the crop responded by increasing height in consequence to the additional nutrients available through the rabbit urine.

Table 1: Tomato plant height measured after rabbit urine application

TREATMENT	PH			
	2 WAU	3 WAU	4 WAU	6 WAU
T_1	8.15± 0.09^a	8.43± 0.04^a	8.54± 0.30^a	8.59± 0.21^a
T_2	8.12± 0.03^a	8.16± 0.31^a	8.18± 0.31^a	8.28± 0.18^a
T_3	8.51± 0.15^a	7.55± 0.50^b	7.75± 0.25^b	7.78± 0.12^b
T_4	7.52± 0.15^b	7.54± 0.28^b	7.55± 0.14^b	7.57± 0.13^b
T_5	8.21± 0.14^a	8.23± 0.48^a	8.27± 0.28^a	8.33± 0.03^a
T_6	7.17± 0.15^b	7.19± 0.15^b	8.00± 0.20^a	8.24± 0.20^a
T_7	7.79± 0.13^a	7.85± 0.10^b	7.87± 0.04^b	7.91± 0.21^b

Means with different superscripts along columns are significantly different ($p \leq 0.05$)

Key: PH- Plant height, **WAU**- Weeks after rabbit urine application T_1(control): recommended dose of NPK fertilizer with no rabbit urine, T_2 :1.5 times recommended dose of NPK fertilizer plus ½ litres of rabbit urine, T_3 :1.5 times recommended dose of NPK fertilizer plus ¼ litres of rabbit urine, T_4 : recommended dose of NPK fertilizer plus ½ litres of rabbit urine, T_5 : recommended dose of NPK fertilizer plus ¼ litres of rabbit urine, T_6 : ½ times recommended dose of NPK fertilizer plus ½ litres of rabbit urine, T_7 : ½ times recommended dose of NPK fertilizer plus ¼ litres of rabbit urine

Number of tomato leaves per plant are presented in table 2. There is significant difference ($p<0.05$) in number of leaves among the treatments. Interestingly, the highest number of leaves per plant at 2, 3, 4 and 6 WAU were all recorded in T_2 with 18.37±0.07, 18.23±0.20, 18.41±0.31 and 18.44±0.04 leaves respectively. Even though T_2 had fertilizer above the recommended dose, it could be the additional influence of the rabbit urine that neutralize it and ensure adequate supply of nitrogen. This can be confirmed from the trend observed in T_7 which had the lowest number of leaves at 2, 3, 4 and 6 WAU with 17.07±0.18, 17.10±0.23, 17.13±0.01 and 17.18±0.14 leaves respectively.

Table 2: Number of tomato leaves per plant counted after rabbit urine application

TREATMENT	NLP			
	2 WAU	3 WAU	4 WAU	6 WAU
T_1	$17.13±0.02^{c}$	$17.35±0.12^{ab}$	$17.36±0.13^{bc}$	$18.40±0.13^{a}$
T_2	$18.37±0.07^{a}$	$18.23±0.20^{ab}$	$18.41±0.31^{a}$	$18.44±0.04^{a}$
T_3	$16.80±0.04^{abc}$	$16.91±0.02^{abc}$	$16.93±0.05^{abc}$	$16.97±0.04^{a}$
T_4	$18.22±0.01^{ab}$	$18.23±0.03^{ab}$	$18.26±0.21^{ab}$	$18.29±0.11^{a}$
T_5	$17.21±0.12^{bc}$	$17.24±0.32^{bc}$	$17.27±0.14^{bc}$	$17.28±0.08^{a}$
T_6	$16.73±0.08^{abc}$	$16.77±0.11^{abc}$	$16.79±0.12^{abc}$	$16.82±0.15^{a}$
T_7	$17.07±0.18^{c}$	$17.10±0.23^{c}$	$17.13±0.01^{c}$	$17.18±0.14^{a}$

Means with different superscripts along columns are significantly different ($p \leq 0.05$)
Key: NLP- Number of leaves per plant, **WAU**- Weeks after rabbit urine application

Number of tomato branches per plant are presented in table 3. Number of branches differed significantly ($p <0.05$) among the treatments. Number of branches recorded at 2, 3, 4 and 6 WAU were highest in T_5 with 6.57±0.24, 6.61±0.13, 6.63±0.51 and 6.66±0.18 branches respectively. Number of branches bear significant correlation with crop yield, hence, the treatment with highest supply of nutrients (supplemented through large quantity of rabbit urine) had highest number of branches. The trend observed in T_1 was that they had the lowest number of branches with 2.51±0.31, 2.63±0.01, 2.69±0.33 and 2.74±0.12 branches at 2, 3, 4 and 6 WAU respectively.

Table 3: Number of tomato branches per plant after rabbit urine application

TREAMENT	NBP			
	2 WAU	3 WAU	4 WAU	6 WAU
T_1	2.51 ± 0.31^c	2.63 ± 0.01^c	2.69 ± 0.33^c	2.74 ± 0.12^c
T_2	2.56 ± 0.23^c	2.62 ± 0.04^c	2.67 ± 0.34^c	2.70 ± 0.23^c
T_3	5.71 ± 0.01^b	5.74 ± 0.23^b	5.77 ± 0.05^b	5.81 ± 0.03^b
T_4	5.60 ± 0.12^b	5.70 ± 0.04^b	5.73 ± 0.16^b	5.76 ± 0.34^b
T_5	6.57 ± 0.24^a	6.61 ± 0.13^a	6.63 ± 0.51^a	6.66 ± 0.18^a
T_6	5.81 ± 0.03^b	5.84 ± 0.06^b	5.88 ± 0.15^b	5.91 ± 0.01^b
T_7	6.07 ± 0.20^a	6.05 ± 0.42^a	6.12 ± 0.65^a	6.18 ± 0.22^a

Means with different superscripts along columns are significantly different ($p \leq 0.05$)
Key: NBP- Number of branches per plant, **WAU**- Weeks after rabbit urine application

Even though T_4 had the recommended fertilizer dose but the plant height was low just like T_6 with fertilizer below the recommended dose and low quantity of rabbit urine. Urine in fertilizer was reported by Yogeeshappa and Srinivasamurthy (2017) to undergo evaporation. The evaporation of urine create air-filled pore spaces in the soil leading to improved soil aeration, nitrification and dominance of N_2O production. These processes could be responsible for the improved plant height recorded in T_1 and T_5. However, Yogeeshappa and Srinivasamurthy (2017) conducted a research on effect of human urine and cattle urine on growth and yield of tomato in India. Their study, reported a contrasting result where there was significantly lower plant height (85.7cm) with recommended dose of fertilizer compared to the treatment where human urine was applied, in which case, the plant height was 87.2cm. Chandra *et al*. (2019) opined that liquid bio-fertilizer is a natural organic product, relatively slow acting but supply available nitrogen for a longer period. Liquid bio-fertilizer is effective in enhancing significant increase in morphological parameters.

T_7 with low number of leaves, had low fertilizer and rabbit urine and therefore low nitrogen supply. The findings of this study, is in contrast to the report by Lamidi *et al*. (2018) who reported that there was no significant difference in number of leaves of tomatoes on organic manure buffered lateritic soils. Yogeeshappa and Srinivasamurthy (2017) reported significantly maximum number of leaves per plant (40.8) in tomato treated with human urine compared to the application of recommended chemical fertilizer, where 29.6 leaves were recorded.

Low number of branches could be an indication of low yield. These results corroborates the findings of Yogeeshappa and Srinivasamurthy (2017) who reported maximum number of branches (5.90 branches per plant) of tomato crop treated with 2 times recommended dose of nitrogen through human urine compared to the low number of branches (5.15 branches per plant) in tomato treated with recommended fertilizer dose. The use of livestock urine is a form of integrated farming system and serves as a better supplement for nutrient management (Pradhan *et al*., 2018). Use of different urine sources from livestock as fertilizer for crops has been reported by several authors(Patil *et al*., 2012; Singh *et al*., 2015; Yogeeshappa and Srinivasamurthy, 2017). Nwite *et al*. (2015) opined that different urine sources were responsible for enhanced soil nutrient status and agronomic yield parameters of maize when applied to the soil as a fertilizer. Application of cow urine on chickpea at the rate of 10% was tightly linked to higher plant height (35.78cm) and number of pod per plant (60.86) as compared to control (Patil *et al*., 2012). Singh *et al*. (2015) also reported higher plant height (116.2cm), leaves per plant (13.5), root length (12.6cm) and other agronomic parameters of buckwheat after cow urine application.

CONCLUSION

Rabbit urine had effect on the morphological parameters(plant height, number of leaves and number of branches) of tomato grown under treatment containing recommended doses of NPK fertilizer plus rabbit urine. Maximum mean number of branches (6.66±0.18) and mean number of leaves (18.44±0.04) were found in treatments containing ¼ litre of rabbit urine, an indication of adequate supply of additional nitrogen through the urine. For plant height, there was also a high value in treatment containing rabbit urine. It is recommended that farmers should apply rabbit urine (¼ litre)in addition to the recommended fertilizer dose(250: 250: 250 kg of NPK ha^{-1}), for improved agronomic parameters and yield.

REFERENCES

Abustam, E., Said, M. I. and Yusuf, M. (2018). The Effect of Antioxidant Activity of Liquid Smoke in Feed Supplement Block on Meat Functional of Muscle *Longissimus dorsi*. IOP Conference Series: *Earth and Environmental Science*, **119**:1-7.

Adekiya, A. O. and Ojeniyi, S. O. (2002). Evaluation of Tomato Growth and Soil Properties under Method of Seedling Bed Preparation in an Alfisol in the Rainforest Zone of Southwest Nigeria. *Soil Tillage Research*, **64**:275 – 279.

Adil, H. A., Gruda, N. and Geyer, B. (2003). Effect of High Temperature and Heat Shock on Tomato (*Lycopersicon esculentum* Mill) Genotypes under Controlled Condition. Conference for International Agricultural Research for Development.Pp.1-7. https://www.semanticsscholar.org.

Ajagbe, B. O., Oyediran, W. O., Omoare, A. M. and Sofowora, O. O. (2014). Assessment of Post-Harvest Practices among Tomato (*Solanum lycopersicum*) Farmers/Processors in Abeokuta North Local Government Area of Ogun State, Nigeria. *International Journal of Education and Research,* Vol. 2(3). Retrieved 26th June, 2015 from www.ijern.com.

Atia, A., Haugen-Kozyra, K. and Amrani, M. (2005). "Ammonia and hydrogen sulfide emissions from livestock production." Manure research findings and technologies: From science to social issues [Online]. Alberta Agriculture, Food and Rural Development. Pp. 47. Available atwww.agric.gov.ab.ca/$department/deptdocs.

Benchasri, S. and Simla, S. (2017). Potential of Chilli Varieties under Chemical and Organic Agricultural Systems in Thailand. *Bulgarian Journal of Agricultural Sciences*, 23(1): 58-70.

Chandra, M. S., Naresh, R. K., Lavanja, N., Varsha, N., Chand, S. W.,Chandana, P., Shivangi, Kumar, B. N., Kumar, R. and Navsare, R. I. (2019). Production and Potential of Ancient Liquid Organics Panchagavya and Kunapajala to Improve Soil Health and Crop Productivity: A Review. *Journal of Pharmacognosy and Phytochemistry*, **8**(6): 702-713.

F.A.O. (2010). Statistical Division, http//faostat. Fao.org. pp 16-21.

Hanson, P., Chen, J. T., Kuo, C. G., Morris, R. and Opena, R. T. (2000). *Suggested Cultural Practices for Tomato*. Asian Vegetable Research and Development Center (AVRDC). Pp 1-8.

Ilupeju, E. A. O., Akanbi, W. B., Olaniyi, J. O., Lawal, B. A., Ojo, M. A. and Akintokun, P. O. (2015). Impact of Organic and Inorganic Fertilizer on Growth, Fruit Yield, Nutritional and Lycopene Content of Three Varieties of Tomato (*Lycopersicon esculentum* (L.) Mill) in Ogbomoso, Nigeria. *African Journal of Biotechnology*, **14** (31): 2424-2433.

Izaurralde, R.C., McGill, W.B. and Rosenberg, N.J.(2000). Carbon Cost of Applying Nitrogen Fertilizer. *Science*, **288**: 811–812.

John, L.W., Jamer, D.B., Samuel, L.T. and Warner, L.W. (2004). Soil Fertility and Fertilizers. AnIntroduction to Nutrient Management. *Pearson Education*, India, Pp. 106 – 153.

Lamidi, W. A., Shittu, K. A. and Adeyeye, A. S. (2018). Yield Performance of Tomatoes (*Lycopersicum esculentum*) on Organic Manure Buffered Lateritic Soils. *Journal of Applied Sciences and Environmental Management*, **22**(8): 1207-1212.

Leite, L.F.C., Oliveira, F.C., Arau, A.S.F, ´jo, S.R.,Galvao, S. and Lemos, J.O.(2010). Soil Organic Carbon and Biological Indicators in an Acrisol under Tillage Systems and Organic Management in North-eastern Brazil. *Soil Research*, **48**: 258–265.

Nnabude, P. C., Nweke, I. A. and Nsoanya, L. N. (2015). Response of Three Varieties of Tomatoes (*Lycopersicon esculentum*) to Liquid Organic Fertilizer (NPK: 20:10:10) and for Soil Improvements. *European Journal of Physical and Agricultural Sciences*, **3**(2): 28-35.

Nwite, J. N. (2015). Effect of Different Urine Sources on Soil Chemical Properties and Maize Yield in Abakaliki, Southeastern Nigeria. *International Journal of Advanced Agricultural Research*, **3**: 31-36.

Nwosu, D. J., Nwadike, C., Afolayan, G.,Aladele, S., Okere, A.U. and Omonomo, P (2018). Genetic and Agronomic Evaluation of Rainfed Tomato (*Solanum lycopersicum* L.) Accessions in Ibadan, Nigeria. *Journal of Plant Development*, **25**: 43-57.

Patil, S. V., Halikatti, S. I., Hiremath, S. M., Babalad, H. B., Sreenivasa, M. N., Hebsur, N. S. and Somanagouda, G. (2012). Effect of Organics on Growth and Yield of Chickpea (*Cicer arietinum* L.) in Vertisols. *Karnataka Journal of Agricultural Sciences*, **25** (3): 326-331.

Pradhan, S. S., Verma, S., Kumari, S. and Singh, Y. (2018). Bio-efficacy of Cow Urine on Crop Production: A Review. *International Journal of Chemical Studies*, **6**(3): 298-301.

Said, M. I., Asriany, A., Sirajuddin, S. N., Abustam, I. E., Rasyid, R., and Al-Tawaha, A. R. M. (2018). Evaluation of Quality of Liquid Organic Fertilizer from Rabbit's Urine Waste Fermented Using Local Microorganisms as Decomposers. *Iraqi Journal of Agricultural Sciences*, **49**(6):990-1003.

Salisbury, F. and Ross, C. (1995). *Fisiologitumbuhan. Jilid* 3. Terjemahan DR Lukmandan Sumaryono, Penerbit ITB Press, Bandung.

Shuka, V. and Naik, L. B. (1993). *Agro-technique for Solanaceous Vegetables*, In: Advance in horticulture, Vol. 5. Malhotra publishing house, New Delhi, India, Pp. 364 – 399.

Singh, R., Babu, S., Avasthe, R. K., Yadav, G. S., Chettri, T. K., Phempunadi, C. D. and Chatterjee, T. (2012). Bacterial Inoculation Effect on Soil, Biological Properties, Growth, Grain Yield, Total Phenolic and Flavonoids Contents of Common Buckweed (*Fagopyrum* *esculentum* Moench) Under Hilly Ecosystems of North-East, India. *African Journal of Microbiology Research*, **9** (15): 1110-1117.

Stark, C. H., Condron, L. M., O'Callaghan, M., Stewart, A. and Di, H. J. (2008). Differences in Soil Enzyme Activities, Microbial Community Structure and Short-Term Nitrogen Mineralization Resulting From Farm Management History and Organic Matter Amendments. *Soil Biology and Biochemistry*, **40**: 1352– 1363.

Ugonna, C.U., Jolaoso, M. A. and Onwualu, A. P. (2015). Tomato Value Chain in Nigeria: Issues, Challenges and Strategies. *Journal of Scientific Research and Reports.* **7**(7): 501-515.

Vasileva, V., Kertikov, T. and Ilieva, A. (2017). Dry Mass Yield and Amount of fixed Nitrogen in Some Forage Legume Crops after Treatment with Organic Fertilizer Humustim. *Bulgarian Journal of Agricultural Sciences,* **23** (5): 816–819.

Wildayana, E. (2017). Challenging Constraints of Livelihoods for Farmers in the South Sumatra Peatlands, Indonesia. *Bulgarian Journal of Agricultural Sciences,***23** (6): 894–905.

Yogeeshappa, H. and Srinivasamurthy, C. A. (2017). Effect of Human Urine and Cattle Urine on Growth and Yield of Tomato (*Solanum lycopersicum*) in Red, Lateritic and Black Soil of Karnataka, India. *International Journal of Current Microbiology and Applied Sciences*, **6**(12): 1597-1605.