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Article

Effect of spent mushroom compost on yield and fruit quality of tomato

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Abstract: An experiment was conducted to observe the performance of the composted spent mushroom substrate (SMS) along with chemical fertilizers on the yield, fruit quality and nutrient uptake by tomato plant for using the mushroom waste through composting. The experiment was laid out in a randomized complete block design with seven replications. Treatments were T_1: no fertilizer and compost application (control), T_2: recommended dose of fertilizers (RFD), T_3: 25% SMC-N+ 75% fertilizer-N, T_4: RFD + 2.5 t ha^{-1} SMC, T_5: 50% SMC-N + 50% fertilizer-N, T_6: 100% SMC-N and T_7: 100% SMC-N + 50% fertilizer-N. Application of SMS compost at 2.5 t ha^{-1} along with recommended fertilizer dose showed the best performance for number of fruits, fruit yield, fruit quality (total protein, vitamin C, total sugar, reducing sugar) and nutrient uptake by tomato. This treatment showed significantly higher fruit yield, quality and nutrient uptake not only over control but also RFD, SMS compost alone and combination of SMS compost & RFD. Though SMS compost alone proved less effective, however combined application of SMS compost at 2.5 tha^{-1} with chemical fertilizer of recommended dose had shown to be more effective.

Keywords: spent mushroom compost; yield; fruit quality; tomato

1. Introduction

The use of agrowastes as sources of plant nutrients serve as environmental sanitation as well as reduction in craving for mineral fertilizers by farmers Ayeni (2014). The best alternative of the present day's environmental degradation is to make proper use of the available unutulized organic biodegradable wastes in order to convert them into compost within a short period (Chanda *et al*., 2011). Mushroom wastes are creating various problems as air pollution, ground water contamination and nuisance. Waste management program is not well organized in Bangladesh due to different causes. Many cities in Bangladesh are not able to manage it due to institutional, regulatory, financial, technical and public participation shortcomings. People use to pile it and then burn it, or just bury it in some out of-the-way place and forget about it. It is recognized that spent mushroom waste contains rich and valuable organic materials and is convenient for recycling in different forms (Danny, 1992; Szmidt and Convay, 1995). There is a good opportunity to reuse spent mushroom substrate through composting to produce vegetable crops.

Tomato (*Lycopersicon esculentum*) is a major horticultural crop with an estimated global production over 120 million metric tons (FAO, 2007). It is one of the most popular and versatile vegetables in the world, because of its taste, color, high nutritive value and its diversified use (Verma *et al*., 2015) and ranked among the top vegetables of economic importance. Tomatoes need high levels of nitrogen and phosphorus. It requires nutrients such as N, P, K, Mg, Ca, Na and S for good production. These nutrients are specific in function and must be supplied to the plant at the right time and in the right quantity (Shukla and Naik, 1993). Tomatoes need to grow in soil with heavy organic matter incorporated into it. Tomato plants have high requirement, are heavy feeders, for macro-nutrient elements including potassium and calcium and some micronutrients such as iron, manganese and zinc (Abbasi *et al*., 2002).

Research interest in tropical countries has shifted to the utilization of agro based industrial wastes and farm waste products which if not converted to other economic uses such as fertilizers might pose environmental hazards (Ayeni, 2014). Farmers spend generally excessive amounts of inorganic fertilizers to produce vegetables with high yield (Stewart *et al*., 2005). Continuous use of inorganic fertilizers cause imbalance in soil physicochemical properties and unsustainable crop production (Jeyathilake *et al*., 2006). Organic fertilization is important for providing plant with their nutritional requirements without having an undesirable impact on the environment (Njoroge and Manu, 1999). But organic manures alone are unable to give economic yield. Again huge quantity of organic wastes required for manuring.

It has become necessary to combine different types. It is also necessary to integrate chemical fertilizers into the organic sources to reduce the quantity and enhance nutrient release (Ayeni and Adetunji, 2010). Combination of organic and inorganic fertilizers could produce better yields than organic manure alone. These result agreed with previous findings obtained on onion (Abbey and Kanton, 2004; Gambo *et al*., 2008) and broccoli (Ouda and Mahadeen, 2008). Use of organic manure is limited by the huge quantities needed to meet crop nutritional need, while the use of chemical fertilizer is limited by cost and scarcity (Akanbi *et al.*, 2005). So, there is need to investigate the combined effects of organic fertilizer with inorganic fertilizers and also to find suitable ratio of inorganic fertilizers and compost, which could give an economic yield.

Therefore, the goal of the present study was to devise ways and means for utilization of spent mushroom substrates instead of disposing them as undesirable waste. The study was planned to evaluate the effects of SMS compost with different levels of inorganic fertilizer on tomato and finding out suitable ratio of them which could give an economic yield of tomato.

2. Materials and Methods

2.1. Location and time

Compost of spent mushroom substrate was prepared at the Field Laboratory of the Department of Soil Science, BAU, Mymensingh during April to July 2010. Field experiment was also conducted in the Field Laboratory of the Department of Soil Science, BAU, Mymensingh during November 2010 to March 2011.

2.2. Compost preparation

Spent mushroom substrate was heaped into piles under a cover shed over a 12-week period. The compost pile was turned twice a month for the first 10 weeks and then the materials were allowed to attain maturity over a period of 4 weeks, with no turning. Moisture content of the feed was kept at around 60 – 70% throughout the composting period by sprinkling adequate quantities of water. The composted material was allowed for curing over a minimum of one month to create more stable compost.

2.3. Treatments and experimental design

There were seven treatments in the experiment and each treatment was replicated 3 times. Treatments were defined according to the different levels of inorganic fertilizer and SMS compost as basal application.

The treatments were as follows:

T_1= No fertilizer and compost application (control)
T_2= Recommended dose of fertilizers (RFD)
T_3=25% SMC-N+ 75% fertilizer-N
T_4= RFD + 2.5 t ha^{-1} SMC
T_5= 50% SMC-N + 50% fertilizer-N
T_6= 100% SMC-N
T_7= 100% SMC-N + 50% fertilizer-N

Randomized complete block design (RCBD) with 3 replications of each treatment was laid out. Each plot size was 5 m^2 (2.5 m long and 2 m wide), with 1 m between blocks and 0.5 m between plots.

2.4. Tomato production

Healthy and uniform sized 25 days' old tomato (*Lycopersicon esculentum;* variety was Ruma) seedlings were transplanted to the experimental plots on 04 November 2010. Spacing of 50 cm between the rows and 50 cm between the plants were maintained. Urea, TSP, MoP, gypsum and zinc oxide were used as sources of N, P, K, S and Zn, respectively. All fertilizers except urea were applied as basal before sowing/planting of the crops. SMC and all fertilizers except urea were applied during final land preparation. Urea was applied in two split applications, the first split at seedling establishment stage and the second at flowering stage. Various intercultural operations were accomplished after seedling emergence for better growth and development of plants such as gap filling, weeding, staking, irrigation and plant protection. Tomato fruits were harvested when they became slightly red. Harvesting was done at 3-4 day intervals whenever necessary. After harvesting, data were collected on number of fruits per plant, fruit weight, fruit yield.

2.5. Chemical analysis

Plant analysis was accomplished to determine N, P, K and S contents. Further biochemical analysis was performed to measure protein, vitamin C and sugar contents.

Digestion of plant samples were done with sulphuric acid and then the digest was estimated by distilling the digest with 10N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4 (Page *et al*., 1982). Wet digestion of plant samples with nitric-perchloric acid was performed for the determination of phosphorous, potassium and sulphur. Phosphorus was determined colorometrically using molybdovanadate solution yellow colour method (Yoshida *et al*., 1976) and the S concentration by turbidity method (Chapman and Pratt, 1964). The K concentration in the acid digest was determined directly by flame photometer (Yoshida *et al*., 1976).

2.6. Biochemical analysis

Biochemical analysis for total protein, vitamin C, total sugar and reducing sugar was done following standard methods. The principle of protein estimation is based on estimating the nitrogen content of the material and then multiplying the nitrogen value by 6.25. The estimation of nitrogen was made by micro-kjeldahl method, as described by Jackson (1973). Total sugar content was determined by the Anthrone method as per Dubois *et al*. (1951). Reducing sugar content was determined by following the method of Miller (1972). L-ascorbic acid was extracted with 6% Metaphosphoric acid and was estimated by titrimetric method (Reo, 1954).

2.7. Statistical analysis

Data on the yield and other plant parameters were statistically analyzed using MStat-C computer programme. Means were computed following DMRT at 5% level using the same computer programme (Gomez and Gomez, 1984).

3. Results

3.1. Number of fruits per plant

Application of spent mushroom compost (SMC) with or without chemical fertilizers greatly affected the amount of fruits per plant (Table 1). The result revealed that the highest fruit number per plant in treatment T_3 (68) which was statistically identical to treatment T_2 (67), T_4 (65) and T_7 (65). The lowest fruit number per plant was obtained from control (T_1) treatment (23).

3.2. Fruit weight

Average fruit weight is presented in Table 1. The largest tomatoes were recorded in control (T_1) treatment (24.5 g) which was statistically similar to T_4 (RD+ 2.5 t ha^{-1} compost) treatment (22.2 g). The smallest tomato fruits were found in T_7 (Compost 100% + N 50%) treatment (15.5 g). Average fruit weight ranged from 15.5 to 24.5 g over the treatments.

3.3. Fruit yield

Fruit yield of tomato was significantly influenced by the application of spent mushroom compost (SMC) with or without chemical fertilizers (Table 1). Treatment T_4 (SMC at 2.5 t ha^{-1} along with RFD) recorded significantly higher fruit yield (46.0 t ha^{-1}) followed by the treatment T_3 (75% N through chemical fertilizer +

25% N through SMC) (42.6 t ha^{-1}) and T_2 (RFD) (41.5 t ha^{-1}). The lowest yield was recorded in control treatment (T_1) (20.5 t ha^{-1}). Fruit yield was found to vary from 20.5 t ha^{-1} to 46.0 t ha^{-1} across the treatments.

Table 1. Effects of spent mushroom compost on the growth and yield of tomato (field experiment).

Treatments	**Number of fruits (no. $plant^{-1}$)**	**Average weight of fruit (g)**	**Fruit yield (t ha^{-1})**
T_1: Control	23 c	24.5 a	20.5 f
T_2: RFD	67 a	19.1 cd	41.5 b
T_3: 25% SMC-N + 75% fertilizer-N	68 a	19.5 c	42.6 b
T_4: RFD + 2.5 t ha^{-1} compost	65 a	22.2 ab	46.0 a
T_5: 50% SMC-N + 50% fertilizer-N	59 ab	21.0 bc	37.2 c
T_6: 100% SMC-N	51 b	16.9 de	25.7 e
T_7: 100% SMC-N + 50% fertilizer-N	65 a	15.5 e	34.3 d
CV (%)	11.64	6.60	4.48
SE (±)	3.83	0.75	0.92

Values having same letters in a column do not differ significantly at 5% level by DMRT. **= Significant at 1% level. CV = Coefficient of variation

3.4. Fruit quality of tomato

From the data in Table 2, it appears that application of SMC at different amounts with different combinations positively influenced the fruit quality of tomato. Recommended dose of fertilizers application with 2.5 t ha^{-1} compost (T_4) showed the highest protein content (13.2%) and Vit C (25.4 mg Vit C $100g^{-1}$) with statistically similar Vit C content of T_3 (25.0 mg Vit C $100g^{-1}$). Total sugar and reducing sugar were found highest in treatment T_3 (4.08%) and T_5 (0.540%), respectively with statistically similar result of treatment T_4 (3.96%) for total sugar and T_2 (0.503%), T_3 (0.487%), T_4 (0.533%) and T_6 (0.492%) for reducing sugar.

Table 2. Effects of spent mushroom compost on tomato fruit quality (Field experiment).

Treatments	**Total protein (%)**	**Vit C (mg Vit C $100g^{-1}$)**	**Total sugar (%)**	**Reducing sugar (%)**
T_1: Control	10.2 c	15.6 d	3.28 c	0.430 b
T_2: RFD	11.2 bc	23.0 b	3.76 ab	0.503 a
T_3: 25% SMC-N + 75% fertilizer-N	10.9 bc	25.0 a	4.08 a	0.487 a
T_4: RFD + 2.5 t ha^{-1} compost	13.2 a	25.4 a	3.96 a	0.533 a
T_5: 50% SMC-N + 50% fertilizer-N	11.9 abc	21.2 bc	3.57 bc	0.540 a
T_6: 100% SMC-N	10.9 bc	19.7 c	3.38 c	0.492 a
T_7: 100% SMC-N + 50% fertilizer-N	12.5 ab	13.8 d	2.41 d	0.410 b
CV (%)	8.45	5.31	4.84	5.51
SE (±)	0.56	0.63	0.10	0.05

Values having same letters in a column do not differ significantly at 5% level by DMRT. *= Significant at 5% level and **= Significant at 1% level. CV = Coefficient of variation

3.5. Nutrient uptake by tomato fruit

Different treatments significantly affected the uptake of N, P, K and S by tomato (Table 3). The N uptake was increased due to the effects of different treatments of SMC. Among the treatments, significantly higher N uptake (136 kg ha^{-1}) was observed in T_4 treatment followed by T_3 and T_2 showing the values of 104 kg $ha^{-1}$and 104 kg ha^{-1}, respectively. The highest P uptake was with treatment T_6 (24.62 kg ha^{-1}) followed by treatment T_5 (23.73 kg ha^{-1}) and treatment T_4 (23.01 kg ha^{-1}). The highest K and S uptake were recorded in T_4 with the values of 191 kg ha^{-1} and 17.49 kg ha^{-1}, respectively. In all cases of nutrient uptake (N, P, K & S), the control treatment (T_1) showed the lowest uptake with the values of 47 kg ha^{-1}, 6.72 kg ha^{-1}, 83 kg ha^{-1} and 6.23 kg ha^{-1} for N, P, K and S, respectively.

Table 3. Effects of spent mushroom compost on nutrient concentration and uptake of tomato (field experiment).

Treatments	Nutrient uptake (kg ha^{-1})			
	N	P	K	S
T_1: Control	47 d	6.72 e	83 c	6.23 d
T_2: RFD	104 b	14.91 d	144 b	9.58 c
T_3: 25% SMC-N + 75% fertilizer-N	104 b	21.42 bc	181 a	15.64 ab
T_4: RFD + 2.5 t ha^{-1} compost	136 a	23.01 ab	191 a	17.49 a
T_5: 50% SMC-N + 50% fertilizer-N	99 b	23.73 ab	174 a	13.71 b
T_6: 100% SMC-N	62 c	24.62 a	133 b	9.11 c
T_7: 100% SMC-N + 50% fertilizer-N	96 b	19.74 c	145 b	9.36 c
CV (%)	6.69	8.20	6.68	12.72
SE ($\pm$)	3.579	0.907	5.794	0.852

Nutrient uptake was calculated on dry basis, tomato contained 86% water. Values having same letters in a column do not differ significantly at 5% level by DMRT. *= Significant at 5% level and **= Significant at 1% level. CV = Coefficient of variation

4. Discussion

The effects of SMS compost alone and combination with inorganic fertilizer at different levels on tomato were evaluated to find suitable ratio of them which could give an economic yield of tomato.

Application of SMS compost at 2.5 t ha^{-1} with RFD showed significantly higher fruit yield over control yield and also over RFD, combination of RFD with SMC and SMC. 2.5 t ha^{-1} SMC with RFD produced higher fruit yield along with higher number of fruits per plant. Baniuniene and Zekaite (2008) reported that application of enriched compost in conjunction with inorganic fertilizer increased rice productivity and enhanced soil fertility status than recommended fertilizer application alone. Addition of suitable organic manure improves the soil physical and chemical properties which encourage better root development, increased nutrient uptake and water holding capacity which leads higher fruit yield and better fruit quality (Suge *et al*., 2011). Organic manure activates many species of living organisms which release phytohormones and may stimulate the plant growth and absorption of nutrients (Arisha *et al.,* 2003). Organic inputs alone will not meet the nutritional needs of crops because they contain a comparatively less quantity of nutrients compared to inorganic fertilizers, the need to integrate the two forms in order to achieve better crop yield. Organic manure alone is unable to give higher economic yield (Seran *et al*. 2010).

SMS compost possesses the quality of good soil amendment for raising healthy vegetable crops tomato when applied with recommended dose of chemical fertilizers. When organic manure was applied with chemical fertilizer more nutrient uptake occurred in the plant system and so more plant biomass was recorded (Kavita and Subramanian, 2007). Jonathan *et al*. (2011) reported that SMS compost of *Pleurotus pulmonarius* mixed with depleted garden soil generally enhanced all the variables of growth considered when compared with control and significantly promoted height, stem girth, number of leaves, flowers and fruit production in all the vegetables investigated. Integrated use of organic manure and chemical fertilizers resulted in higher yield of onion in comparison with the exclusive application of chemical fertilizers (Jeyathilake *et al*., 2006). Seran *et al*. (2010) also reported that combination of organic and inorganic fertilizers could produce better yields than organic manure alone. Akanbi *et al*. (2005) observed a great increase in yield of tomato when nitrogen fertilizer was combined with compost manure.

Application of SMS compost at 2.5 t ha^{-1} plus RFD also produced higher quality tomato fruit. Total protein, vitamin C, total sugar and reducing sugar contents of tomato fruit and potato tuber were found the highest in this treatment. This result is supported by the result of Ahlawat and Sagar (2007) who stated that composted SMS improved the firmness and ascorbic acid content. They also reported that mixing of soil with recomposted SMS enhanced the tomato quality with respect to higher fruit weight, ascorbic acid content, dry matter, total soluble solids and acidity. The composted SMS has been found to be a good growing medium for the vegetables and field crops and has shown multifaceted utilities in improving the yield and quality of the crop.

Organic fertilizer supplemented with chemical fertilizer treated plants exhibited better results than the plants treated separately with different fertilizers treated plants (Chanda *et al*., 2011). Integrated use of organic and inorganic nutrient source of N is advantageous over the use of inorganic fertilizer alone. Use of organics could enhance efficiency of chemical fertilizer (Dulal and Roy, 1995). Combination of organic and inorganic nutrient sources result into synergy and improved conservation and synchronization of nutrient release and crop demand, leading to increased fertilizer efficiency and higher yields (Vanlauwe *et al*., 2002). Integration of organic and inorganic nutrient inputs could be considered as a better option instead of only inorganic fertilizer to increase fertilizer use efficiency and to maintain more balanced nutrient supply.

5. Conclusions

It can be concluded from the study that the reuse of spent mushroom substrate can be a value-added process, manuring vegetable crops. Combined application of SMS compost at the rate of 2.5 t ha^{-1} and recommended inorganic fertilizer could give higher yield of tomato along with high quality. The inorganic fertilizers appear to have compensated with slow release of nutrients from the compost and their combined effects would have increased the yield.

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Conflict of interest

None to declare

References

Abbasi PA, J Al-Dahmani, F Sahin, HAJ Hoitink and SA Miller, 2002. Effect of compost amendments on disease severity and yield of tomato in conventional and organic production systems. Plant Dis., 86: 156-161.

Abbey L and RAL Kanton, 2004. Fertilizer type, but not time of cessation of irrigation, affect onion development and yield in a semi arid region. Journal of Vegetable Crop Production, 9: 41-48.

Ahlawat OP and MP Sagar, 2007. Management of spent mushroom substrate. Technical Bulletin, National; Rsearch Centre for Mushroom (ICAR), Chambaghat, Solan, India.

Akanbi WB, MO Akande and JA Adediran, 2005. Suitability of composted maize straw and mineral nitrogen fertilizer for tomato production. Journal of Vegetable Science, 11: 57-65.

Arisha HME, AA Gad and SE Younes, 2003. Response of somew pepper cultivars to organic and mineral nitrogen fertilizer under sandy soil conditions. Zagazig Journal Agriculture Research, 30: 1875-1899.

Ayeni LS, 2014. Effect of manufactured organic fertilizers on soil chemical properties and yield of tomato (Lycopersicum lycopersicon) in Alfisol, Southwestern Nigeria. Molecular Soil Biology, 5: 1-6.

Ayeni LS and MT Adetunji, 2010. Integrated application of poultry manure and mineral fertilizer on soil chemical properties, nutrient uptake, yield and growth components of maize. Nature and Science, 8: 60-67.

Baniuniene A and V Zekaite, 2008. The effect of mineral and organic fertilizers on potato tuber yield and quality. Latvian Journal of Agronomy, 11: 202-206.

Chanda GK, G Bhunia and SK Chakraborty, 2011. The effect of vermicompost and other fertilizers on cultivation of tomato plants. Journal of Horticulture and Forestry, 3: 42-45.

Chapman CA and PF Pratt, 1964. Methods of Analysis for Soil, Plant and Water. Division of Agricultural Science, University of California, USA.

Danny LR, 1992. Commercial mushroom production. Horticultural Research Institute of Ontario Vineland Station. Ontario Ministry of Agriculture and Food Publication, 350: 37-38.

Dubois M, KA Gills, JK Hamilton, PA Robers and F Smith, 1951. A colorimetric method for the determination of sugars. Nature, 168: 167.

Dulal R and R Roy, 1995. Integrated nutrition systems. Report of an expert consultation held in Rome Italy, 13-15 Dec. 1993. FAO Fertilizer and Plant Nutrition Bulletin.

FAO (Food and Agriculture Organization), 2007. FAOStat, core production 2005. Available at http://faostat.fao.org/site/340/default.aspx accessed on 26.01.2012.

Gambo BA, MD Magaji, AI Yakubu and AU Dikko, 2008. Effects of farmyard manure, nitrogen and weed interference on the growth and yield of onion (Allium cepa L.) at the Sokoto Rima valley. Journal of Sustainable Development in Agriculture and Environment, 3: 87-92.

Gomez KA and AA Gomez, 1984. Statistical Procedures for Agricultural Research, 2nd (ed). John Wiley & Son's. Inc. New York. pp. 141-177.

Jackson ML, 1973. Soil Chemical Analysis. Prentice Hall of India, Private Limited, New Delhi, India.

Jeyathilake PKS, IP Reddy, D Srihari and KR Reddy, 2006. Productivity and soil fertility status as influenced integrated use of N-fixing Biofertilizers, organic manures and inorganic fertilizers in onion. Journal of Agricultural Sciences, 2: 46-58.

Jonathan SG, MM Lawal and OJ Oyetunji, 2011. Effect of spent mushroom compost of Pleurotus pulmonarius on growth performance of four Nigerian vegetables. Mycobiology, 39:164-169.

Kavita R and Subramanian, 2007. Effect of enriched municipal solid waste compost application on growth, plant nutrient uptake and yield of rice. Journal of Agronomy, 6: 586-592.

Miller GL, 1972. Use of dinitrosalicyclic acid reagent for determination of reducing sugar. Analytical Chemistry, 31: 426-428.

Njoroge WJ and C Manu, 1999. Organic Farming. A Textbook for Post-Secondary Education. Kenya Institute of Organic Farming, Nairobi, Kenya.

Ouda BA and AY Mahadeen, 2008. Effect of fertilizers on growth, yield, yield components, quality and certain nutrient contents in broccoli (Brassica oleracea). International Journal of Agriculture and Biology, 10: 627-632.

Page AL, RH Miller and DR Keeney, 1982. In Methods of Soil Analysis, Part2: Chemical and Microbiological Properties. 2nd Ed. SSSA, Madison, Wisconsin.

Reo JH, 1954. Chemical determination of ascorbic acid dehydroascorbic acid and diketogluconic acid. Method of Biochemical Analysis, 1: 115-139.

Seran TH, S Srikrishnah and MMZ Ahmed, 2010. Effect of different levels of inorganic fertilizers and compost as basal application on the growth and yield of onion (Allium cepa L.). The Journal of Agricultural Sciences, 5: 64-70.

Shukla V and LB Naik, 1993. Agro-Technique for Solanaceous Vegetables, In: Advance in horticulture, vol. 5. Malhotra publishing house, New Delhi, India, pp 364-399.

Stewart MW, WD Dibb, EA Johnston and JT Smyth, 2005. The contribution of commercial fertilizer nutrients to food production. Agronomy Journal, 97: 1-6.

Suge JK, ME Omunyin and EN Omami, 2011. Effect of organic and inorganic sources of fertilizer on growth, yield and fruit quality of eggplant (Solanum Melongena L). Archives of Applied Science Research, 3: 470-479.

Szmidt RAK and PA Convay, 1995. Leaching of recomposted spent mushroom substrates (SMS). Science and Cultivation of Edible Fungi, II: 901-905.

Vanlauwe B, J Diels, N Sanginga and R Merckx, 2002. Integrated plant nutrient management in Sub-saharan Africa: From concept to practice. CABI Publishing. Oxon, U.K. 352 pp.

Verma S, A Sharma, R Kumar, C Kaur, A Arora, R Shah and L Nain, 2015. Improvement of antioxidant and defense properties of Tomato (var. Pusa Rohini) by application of bioaugmented compost. Saudi Journal of Biological Sciences, 22: 256-264.

Yoshida SD, A Forno, JH Cock and KA Gomez, 1976. Laboratory manual for physiological studies of rice. 3rd edition, 14-22. International Rice Research Institutuion, Manila, Philippines.