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Proportion of Sawdust as Carbon Sources in Rabbit Manure Compost for Increasing the Growth of *Pennisetum purpureum* cv Mott

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ABSTRACT

The right proportion of carbon in high N organic matter source in composting process will result good decomposition process. In this study, rabbit manure was composted with different portion of sawdust, and then the chemical properties were evaluated. The compost then applied to determine the growth response of dwarf elephant grass (*Pennisetum purpureum* cv. Mott) in terms of plant height, number of leaves, root and shoot dry matter, shoot and shoot ratio, and N content in shoot. The results showed that compost consisted of rabbit manure + sawdust with the ratio of 3:1 and 1:1 had good chemical properties (pH around 7.56 - 7.94, C/N ratio 17 – 19, C-organic 19 – 24%, Nitrogen 0.84 – 1.31%, Phosphor 0.43 – 0.82%, and Potassium 0.27 – 0.37%) as well as sole rabbit manure compost. Applying compost to Mott grass resulted a good growth response which reflected in plant height (78.29 - 83.46 cm/plant), leaves number (53.50 - 57.92 blades), shoot dry matter (39.69 – 54.56 g DM/plant), root dry matter (16.50 – 18.16 g DM/plant), shoot : root ratios (2.52 - 3.20), and shoot N content (37.14 - 48.55 g DM/plant). The study concluded that compost rabbit manure + sawdust with ratio of 3:1 resulted the same growth response with sole rabbit manure compost.

Keywords: Carbon source, Dwarf elephant grass, Nitrogen content, Plant growth

Introduction

Compost is the result of the natural process of recycling organic matter, such as animal manure, sludge, agricultural waste, energy crops into valuable biofertilizer that would reduce its environmental impact (Barik, 2019; Li-li *et al.*, 2013) and it contributes in maintaining or improving soil fertility both chemical and physical (Hubbe *et al.*, 2010; Bianchi *et al.*, 2015; Barik, 2019).Animal manure which potential to be used as compost material one of which is rabbit manure. Rabbit is a promising animal to breed in Indonesia and some tropical countries nowadays, since rabbit has been raised for fancy pet and meat producer and it also contributes in improving the nutrition and the economy of smallholder families (Wina *et al.*, 2009; Luyen and Preston, 2012). As a prolific animal, rabbit is able to give birth a large litter with 4 – 7 kits of a single litter size (Ilès, 2018; Belabbas *et al.*, 2021) and allow a female to deliver up to 40 kit a year. One adult rabbit produces 100-120 g manure a day. This might become an environmental contaminant due to bulky material and gas emission if not handled properly (Estellés *et al.*, 2014).

Rabbit manure contain high N compared to others animal manure (Li-li *et al.*, 2013; Adi *et al.*, 2020). Therefore, it is needed additional carbon sources to adjust initial C/N ratio for the normal composting process (Hao *et al.*, 2004; Belete and Ayza, 2015). Formulation of the balanced mixture in composting by-product will activate the metabolism of thermophilic bacteria and obtain high quality of soil composted amendment (Bianchi *et al.*, 2015). Mixing sawdust with the right proportion of nitrogen-rich agro-waste during composting process will produce a good soil conditioner (Oluchukwu *et al.*, 2018). The other study reported that additional sawdust in the form of ash with help of microorganisms produces a compost mixture of chicken manure with rice straw which is rich in potassium (Ubaidillah *et al.*, 2018).

Microorganism plays an important role in decomposition process. Various microorganisms that can be present in composting process, such as fungi, bacteria, yeast and actinomycetes (Hubbe *et al.*, 2010). The principal organisms in effective microorganism (EM) are usually five viz. photosynthetic bacteria, lactic acid bacteria, yeasts, actinomycetes and fermenting fungi (Joshi *et al.*, 2019). EM may improve or accelerate the composting process and improved the compost product (Ab Muttalib *et al.*, 2016).

The resultant compost can be used for planting crops or forages to increase their

productivity. Compost can be an excellent source of nitrogen, organic matter, and other types of nutrients (Belete and Ayza, 2015) for plant growth such as *Pennisetum purpureum* cv. Mott (dwarf elephant grass). Application of sole cattle manure compost or in combination with urea and SP at rates indicated the potential in improving yield and quality of *P. purpureum* (Katuromunda *et al.*, 2011). Thus, this study conducted to determine the response of Mott grass growth toward different portion of sawdust in rabbit manure compost.

Materials and Methods

Materials and experimental procedures

A study has been carried out in a greenhouse at Crops and Forages Laboratory, the Faculty of Animal Science, University of Jambi, Indonesia. Rabbit manure as the main compost material are taken from Jambi's rabbit community. It was obtained from local rabbit species at 6 – 12 months age. The sawdust is derived from Medang Putih (*Litsea* spp) wood waste. Compost making started with mixing the rabbit manure and sawdust based on the proportion according to the treatments, and then added with 1% (w/w) of effective microorganisms-4 (EM-4) and molasses to accelerate decomposition process. The compost was harvested at 21 days. Then, the samples were taken for chemical properties analyses.

Compost application for growing *P. purpureum* cv. Mott (Mott grass) as the treatments were conducted by using 8 kg (w/w) ultisol soils (soil analyses in Table 1) placed in polybags. The planting material used were stem which cut at 20 cm length (contained 11 nodes) from 1 year old of Mott grass. CaMg $(CO_3)_2$ was added and mixed into soils before planting to increase the pH of the soils. The compost dosage was 20 t/ ha (80 g/polybag); calculated based on soils weight). Due to the characteristic of Ultisol soils that are easily compacted with continuous watering, in the middle of the polybag placed perforated PVC pipe to flow the water during watering the plant. The plant was harvested at 8 weeks. The plants were divided into shoot and roots, then dried in an oven at 60ºC for 48 hours. Samples were taken 1 g for dry matter analyses at 105ºC. Shoot sample was also taken for N content analyses (Kjeldahl Method).

Experimental design

The experiment was arranged in completely randomized design with 3 treatments and 6 replications. There were 2 polybags for each unit of experiment, , therefore the overall experiment units were 36 units. The treatment was C1= rabbit manure (100%), C2= 75% rabbit manure + 25% sawdust (3:1) and C3= 50% rabbit manure + 50% sawdust (1:1).

Data analyses

The data for Mott grass growth response was analysed with ANOVA program of the SPSS with a significance level of 5%. The difference between mean tested with Duncan Multiple Range Test. Data for soil chemical properties was done in descriptive.

Results and Discussion

Chemical properties of compost

Additional carbon source of sawdust in rabbit manure compost lowering pH, C-organic, nitrogen, phosphorous and potassium content, however increase C/N ratio of resultant compost (Table 2). Physical and chemical properties of compost are considerably influenced by additional different bulking material like sawdust, straw, dry horse ordure (Li-li *et al.*, 2013) Lowering pH in compost rabbit manure + sawdust with ratio of 3:1 and 1:1 compared to 100% rabbit manure as the effect of additional carbon source. The pH gradually increased at the 15th day because of the presence of NH_3 formed during mineralization of the organic materials (Li-li *et al.*, 2013; Oluchukwu *et al.*, 2018). pH values of matured compost from bovine, swine, and poultry manure combined with untreated sawdust in a range of 6.5 to 8.2 (Strapazzon *et al.*, 2021).

The final C/N ratio was less than 25 and this was an indication of maturity of compost (Hwang *et al.*, 2020). The increase sawdust ratio resulted an in increasing C/N ratio of compost due to organisms that drive the compost work harder in breaking down the compost material due to

Table 1. Ultisol soil analyses

PH (1:1) H_2O	Available P (ppm)	P. HCl 25 % (ppm)	N (%)	Ca	Mg (Me/100g)	K	Cation Exchange Capacity (Me/100g)
4.80	3.5	34.6	0.08	0.39	0.24	0.10	4.90

Results of the Faculty of Agriculture Laboratory analyses.

Table 2. Chemical properties of compost

Parameters	Treatments		
	Rabbit manure (100 %)	Rabbit manure + Sawdust (3:1)	Rabbit Manure + Sawdust (1:1)
pH	8.19	7.94	7.56
C/N	16	17	19
C-Organic (%)	22.50	24.77	19.48
Nitrogen (%)	1.53	1.31	0.84
Phosphorous (%)	1.02	0.82	0.43
Potassium (%)	0.51	0.37	0.27

Results of Laboratory of Faculty of Agriculture, University of Jambi analyses.

lower of nitrogen content (Oluchukwu *et al.*, 2018). Sawdust as a bulking agent in chicken manure compost increased total carbon concentration slightly (Hwang *et al.*, 2020). The difference in total carbon reductions reflects the characteristics of the bedding materials-wood chip bedded manure and fresh straw bedded manure (Hao *et al.*, 2004). The decrease percentage of organic carbon in a range of 33-44% (El-Haggar, 2007).

Nitrogen, phosphorous and potassium content tended to decrease with the increasing proportion of sawdust in rabbit manure compost. Sawdust contains 44% organic matter, 38.5% total carbon, 0.38% nitrogen, 17.9% ash, with pH 5.9, C/N 101. and 45% of moisture content (Oluchukwu *et al.*, 2018). Sawdust used along with the selected waste as a volume agent positively affect the decomposition rate (Strapazzon *et al.*, 2021). Rabbit manure contained excellent nutrient which consisted of 2.5% of nitrogen, 1.4% phosphoric acid and 0.6% potassium. When it mixed with rice straw and mushroom residue after composting process resulted 0.61% of phosphorous, 1.65% potassium and 0.41% of phosphorous and 0.76% potassium, respectively (Li-li *et al.*, 2013). Mixing rabbit manure with carbon source tended to decrease phosphorous content in compost.

The growth response of dwarf elephant grass (Mott grass)

High proportion of sawdust in rabbit manure compost decreased ($p<0.5$) plant height and the increase of Mott grass height (Figure 1).

The decreased of plant height occurs around 4.82-10.71% in the compost of rabbit manure + sawdust with the ratio of 3:1 and 1:1 treatment. Even though similar height ($p>0.5$) was achieved with compost of rabbit manure + sawdust with ratio of 3:1 and 100% rabbit manure treatment. Plant height is one of the indicators of plant vitality and a measure of plant respiratory and photosynthetic capacity, and it depends on the growth habit and vitality of plants (Zhang *et al.*, 2021). The similar result reported that Mott grass grown solely, with Calopo and Centro and also fertilized with compost (3 t/ha) and bio urine (450 l/ha) at the age of 10 weeks reached similar height was 89.33, 89.67 and 93.00 cm, respectively (Kaca *et al.*, 2017), and 96.3 cm (Sirait, 2017). However, higher plant height (124.80 cm) was found with the application of 20/t ha farm manure at 8 weeks (Bilal *et al.*, 2000).

Table 3 showed that Mott grass leaves number which applied rabbit manure + sawdust compost with the ratio of 3:1 did not differ with 100% rabbit manure, but differ with rabbit manure + sawdust compost with the ratio of 1:1 treatment. In different study found that leaves number of Mott grass was only 37.7 and 45.3 leave blades with the application of goat urine fertilizer and NPK inorganic fertilizer at 8 weeks (Bahar *et al.*, 2020), and leaves number of Mott grass reached 34.50 blades with 20 t/ha cattle bio-slurry application at 6 weeks (Turusy *et al.*, 2019). Number of leaves in this study higher than other studies because nitrogen content in compost treatments were higher (0.84-1.53%) than other studies (0.43-0.69%). Nitrogen is required in formation of leaves as vegetative part of the plant.

Rabbit manure (100%) compost yielded the highest shoot dry matter than rabbit manure with sawdust compost (Table 3). The shoot and root ratio showed that application of 100% rabbit manure compost yielded more shoot, but the result was the same ($p>0.05$) with rabbit manure +

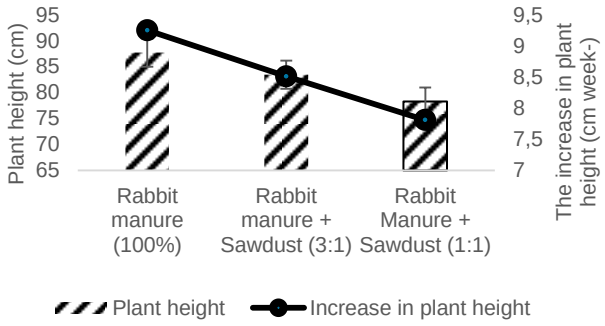

Figure 1. Plant height due to treatments of compost rabbit manure and sawdust.

Tabel 3. Growth response of Mott grass as effect of rabbit manure and sawdust compost

Treatments	Number of leaves (blade)	Shoot (g DM/plant)	Root (g DM/plant)	Shoot : Root Ratio	Shoot N content (g DM/plant)
Rabbit manure (100%)	60.00[a]	59.28[a]	13.34	4.68[a]	52.69[a]
Rabbit manure + Sawdust (3:1)	57.92[a]	54.56[b]	18.16	3.20[a]	48.55[a]
Rabbit Manure + Sawdust (1:1)	53.50[b]	39.69[c]	16.50	2.52[b]	37.14[b]
SEM	1.09	2.09	1.07	0.29	2.26
p	<0.034	<0.0000	<0.18	<0.0025	<0.0056

[abc] Means within the same column with different superscripts differ at $p<0.05$

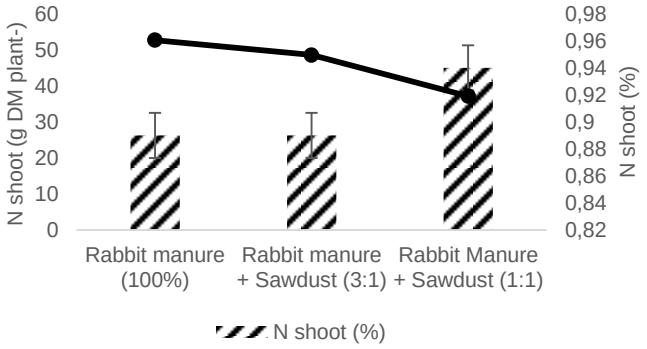

Figure 2. Nitrogen content in Mott grass shoot.

sawdust compost with the ratio of 3:1. The shoot yielded 3.20 up to 4.68 times than root for 100% rabbit manure and rabbit manure + sawdust (3:1), meanwhile rabbit manure + sawdust (1:1) yielded 2.52 times than root. The other study found that Mott grass fertilized with cattle slurry and bio-slurry yielded shoot 1.51 – 1.86 times than root *(*Turusy *et al.*, 2019). An increase in green fodder yield of Mott grass in response to nitrogen/farmyard manure fertilizations ascribed to the greater number of tillers per plant and heavier plants (Bilal *et al.*, 2000). Maize growth and production which are applied with NPK fertilizer and compost fertilizer response similar result because compost fertilizer can stimulate root growth by the presence of humic substance with mineralization process and benefit for root proliferation and overall plant growth (Zaki *et al.*, 2018).

Nitrogen content in the shoot (leaves and stem) of Mott grass treated with rabbit manure + sawdust compost with ratio 3:1 showed the same result ($p>0.05$) with compost of 100% rabbit manure, however, N content decreased ($p<0.05$) as 29.52% in rabbit manure compost + sawdust with ratio 1:1 compared to 100% of rabbit manure compost. However, the nitrogen concentration of Mott grass higher in treatment of rabbit manure + sawdust with the ratio of 1:1 compared to 100% rabbit manure and rabbit manure + sawdust with the ratio of 3:1 (Figure 2). This might be related to N availability in soils. Nitrogen uptake of *P. purpureum* treated with compost manure 10 t/ha yielded 149.89 kg/ha (Rahetlah *et al.*, 2014). The low C/N ratio of organic compost affects the release of N and consequently it might be lost by leaching, thus reduce N availability in soils and uptake by the plant (Pereira *et al.*, 2020). The digestibility and nutrient composition of different fractions (leaf, stem and whole plant) of grass is different with plant maturity within the same species and varieties (Ansah *et al.*, 2013).

Conclusions

Rabbit manure + sawdust with ratio 3:1 and 1:1 provided good chemical properties as well as sole rabbit manure compost. The higher proportion of sawdust as carbon sources in the high N rabbit manure decreases the macronutrients slightly such as nitrogen, phosphorous and potassium. Application of compost rabbit manure + sawdust with the ratio of 3:1 resulted in the same growth response of Mott grass which was treated with compost of rabbit manure alone.

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References

Ab Muttalib, S. A., S. N. S. Ismail, and A. M. Praveena. 2016. Application of effective microorganism (EM) in food waste composting: A Review. Asia Pacific Environ. Occupational Health J. 2: 37–47.

Adi, I. P. T. S., M. S. Yuliartini, and I. G. B. Udayana. 2020. Effect of rabbit compost and NPK on the growth and yield of zucchini (*Cucurbita Pepo* L.). SEAS 4: 151–156. http://ejournal.warmadewa.ac.id/index.php/seas

Ansah, T., E. L. K. Osafo, and H. H. Hansen. 2013. Variety, harvest date after planting and plant fraction of Napier grass influence in vitro gas production. Livestock Research for Rural Development 25. http://www.lrrd.org/lrrd25/5/ansa25078.htm . Accessed 25 July 2020.

Bahar, S., A. Saenab, and N. R. Sudolar. 2020. Growth Odot grass (*Pennisetum purpureum* cv Mott) on sandy marginal land on Payung Island Kepulauan Seribu Jakarta. Jurnal Sains dan Teknologi Peternakan 2: 1–5. https://ojs.unsulbar.ac.id/index.php/jstp

Barik, D. 2019. Energy extraction from toxic waste originating from food processing industries.

In: Energy from toxic organic waste for heat and power generation. Barik D (Ed.). Woodhead Publishing. pp. 17–42. https://doi.org/10.1016/B978-0-08-102528-4.00003-1

Belabbas, R., M. L. Garcia, H. Ainbaziz, A. Berbar, and M. J. Argente. 2021. Litter size component traits in two Algerian rabbit lines. World Rabbit Sci. 29: 51–58. https://doi.org/10.4995/wrs.2021.14247

Belete, F. and A. Ayza. 2015. A review on alternative technologies to manage manure: Cost effective and environmentally beneficial. Livestock Research for Rural Development 27. http://www.lrrd.org/lrrd27/10/bele27192.htm. Accessed 25 July 2020.

Bianchi B., I. Papajova, R. Tamborrino, D. Ventrella, and C. Vitti. 2015. Characterization of composting mixtures and compost of rabbit by-products to obtain a quality product and plant proposal for industrial production. Veterinaria Italiana 51: 51–61. https://www.izs.it/vet_italiana/2015/51_1/VetIt_138_388_1.pdf

Bilal, M. Q., M. Saeed, and M. Sarwar. 2000. Effect of varying level of nitrogen and farm yard manure application on tillering and height of Mott grass. Int. J. Agri. Biol. 2: 21–23.

El-Haggar, S. M. 2007. Sustainability of agricultural and rural waste management. Academic Press. https://doi.org/10.1016/B978-012373623-9/50009-5

Estellés, F., M. Cambra-López, A. Jiménez-Belenguer, and S. Calvet. 2014. Evaluation of calcium superphosphate as an additive to reduce gas emissions from rabbit manure. World Rabbit Sci. 22: 279–286. https://doi.org/10.4995/wrs.2014.3223

Hao, H., C. Chang, and F. J. Larney. 2004. Nitrogen balances and greenhouse gas emission during cattle feedlot manure composting. J. Environ. Quality 33: 37–44. https://doi.org/10.2134/jeq2004.3700

Hubbe, N. A., M. Nazhad, and C. Sanchez. 2010. Composting as a way to convert cellulosic biomass and organic waste into high-value soil amendments: a review. Bio Resources 5: 2808–2854.

Hwang, H. Y., S. H. Kim, M. S. Kim, S. J. Park, and C. H. Lee. 2020. Co-composting of chicken manure with organic wastes: characterization of gases emissions and compost quality. Appl. Biol. Chem. 63: 1-10. https://doi.org/10.1186/s13765-019-0483-8

Ilès, I. 2018. Vocalizations as an indicator of pregnancy in local domestic rabbit does: preliminary study. Livestock Research for Rural Development 30. . http://www.lrrd.org/lrrd30/5/iles30084.html. Accessed 30 July 2021.

Joshi, H., Somduttand, P. Choudhary, and S. L. Mundra. 2019. Role of effective microorganisms (EM) in sustainable agriculture. Int. J. Curr. Microbiol. App. Sci. 8: 172–181. https://doi.org/10.20546/ijcmas.2019.803.024

Kaca, I. N., I. G. Sutapa, L. Suariani, Y. Tonga, N. M. Yudiastari, and N. K. E. Suwitari. 2017. Production and quality of dwarf elephant grass ((*Pennisetum purpureum* cv. Mott) cultivated in mixed cropping-grass and legume at the first harvest. Pastura 6: 78–84. https://ojs.unud.ac.id/index.php/pastura/article/view/45448/27560 article/view/45448/27560

Katuromunda, S., E. N. Sabiiti, and M. A. Bekunda. 2011. Effect of combined application of cattle manure and mineral fertilisers on the growth characteristics and quality of *Pennisetum purpureum* fodder. Livestock Research for Rural Development 23. http://www.lrrd.org/lrrd23/12/katu23251.htm. Accessed 31 Juni 2021.

Li-li, B., Y. Tie-Jun, W. Bin, B. Lin, T. De-Gui, and F. Xiang-Chao. 2013. Evaluation and comparison of composting rabbit manure mixed with mushroom residue and rice straw. JAST 15: 1069–1081. http://jast.modares.ac.ir/article-23-8361-en.html

Luyen, L. T. and T. R. Preston. 2012. Growth performance of New Zealand White rabbits fed sweet potato (*Ipomoea batatas*) vines supplemented with paddy rice or Guinea grass supplemented with commercial concentrate. Livestock Research for Rural Development 24. http://www.lrrd.org/lrrd24/7/luye24127.htm. Accessed 25 June 2020.

Oluchukwu, A. C., A. G. Nebechukwu, and S. O. Egbuna. 2018. Enrichment of nutritional contents of sawdust by composting with other nitrogen rich agro-wastes for bio-fertilizer synthesis. J. Chem. Tech. Metallurgy 53: 430–436. https://dl.uctm.edu/journal/node/j2018-3/5_17-154_p_430-436.pdf

Pereira, G. A. C., A. A. Primo, A. J. G. Meneses, M. D. M. Araújo, R. C. F. F. Araújo, F. L. Guedes, and H. A. Souza. 2020. Soil fertility and nutritional status of elephant grass fertilized with organic compost from small ruminant production and slaughter systems. Rev. Bras. Cienc. Solo. 44: 1-15. http://doi.org/10.36783/18069657rbcs20200031.

Rahetlah, V. B., J. M. Randrianaivoarivony, B. Andrianarisoa, and V. L. Ramalanjaona. 2014. Yield response of Elephant grass (*Pennisetum purpureum*) to guano organic fertilizer in the Highlands of Madagascar. Livestock Research for Rural Development 26.

http://www.lrrd.org/lrrd26/1/rahe26003.htm. Accessed 25 June 2020.

Sirait J. 2017. Dwarf elephant grass (*Pennisetum purpureum* cv. Mott) as forage for ruminant. Wartazoa 27: 167–176. http://dx.doi.org/10.14334/wartazoa.v27i4.1569

Strapazzon, A. J., F. A. B. Theves, P. G. Wiesel, and E. A. Lobo. 2021. Efficiency in the treatment of three livestock manures through a composting process with mechanized turning. J. Agriculture Natural Res. 4: 140–153. https://doi.org/10.3126/janr.v4i1.33247

Turusy, R. D. P., I. K. M. Budiasa, and I. G. Suranjana. 2019. The growth and production of dwarf elephant grass (*Pennisetum purpureum* cv. Mott) towards various slurry and bio slurry fertilizer levels. J. Tropical Anim. Sci. 7: 51–65. https://ojs.unud.ac.id/index.php/tropika/article/view/45538/27644.

Ubaidillah, M. Maryadi, and R. Dianita. 2018. Physical and chemical characteristics of phospho-compost enriched with sawdust ash as potassium source. Jurnal Ilmiah Ilmu-Ilmu Peternakan 21: 98–109. https://doi.org/10.22437/jiiip.v21i2.6774

Wina, E., I. W. R. Susana, and B. Tangendjaja. 2009. Detannification of *Calliandra calothyrsus*: the effect on digestibility and performance of rabbits. Livestock Research for Rural Development 21. http://www.lrrd.org/lrrd21/6/wina21087.htm. Accessed 30 Juni 2020.

Zaki, M., Komariah, R. Ali, and P. Bambang. 2018. Organic amendment and fertilizer effect on soil chemical properties and yield of maize (*Zea mays* l.) in rainfed condition. Agricultural Tech. Biological Sci. 17: 11–17. DOI: https://doi.org/10.48048/wjst.2020.4590

Zhang, J., Z. Liang, C. Wang, and S. Li. 2021. Compound effective microorganisms treatment increases growth and yield of vegetables. JAST 23: 943–954.