OPEN ACCESS Asian Journal of Plant Sciences

ISSN 1682-3974
DOI: 10.3923/ajps.2022.XX.XX

Research Article
Effect of Vermicompost and NPK Application Techniques on Marigold Growth and Flowering on Vertical Pipes

Sitawati, M. Baskara and C.F. Wattimena

Department of Agronomy, Faculty of Agriculture, Brawijaya University, Jl. Veteran, Malang 65145, East Java, Indonesia

Abstract

Background and Objective: Verticulture is an effort to narrow land use for marigolds (*Tagetes erecta* L.) optimally. To obtain a good result, a plant needs suitable environmental conditions. Included in these factors are planting media and nutrient requirements. The purpose of this research was to determine the effect of planting media composition and fertilization techniques on the growth and flowering of marigolds in the verticulture system. **Materials and Methods:** The research was conducted on the 6th floor of the rooftop at Malang at 450 m.a.s.l from April-June, 2019. The materials used are yellow marigold seedlings planted in 5 dim vertical pipes, a mixture of media (soil, husk, cocopeat) and vermicompost as planting media, also NPK (6:13:25) 3 g/plant. We used a randomized block design with 6 treatments of Vermicompost (V) and Non-Parametric Kinetics (NPK) method application (Band Placement (BP) and Fertigation (F)), such as P_1= 0% V+NPK BP, P_2 = 50% V+NPK BP, P_3 = 100% V+NPK BP, P_4 = 0% V+NPK F, P_5 = 50% V+NPK F and P_6 = 100% V+NPK F. It performed 4 replications and was tested using 5% LSD. **Results:** The results showed that 50% vermicompost and band placement can increase the vegetative and generative growth of marigolds. Furthermore, it is known that plants grown with 50% vermicompost and fertilization techniques of the band placement flower faster than plants grown with other treatments. The number of flowers is 60% higher than 0% vermicompost with the NPK fertigation technique. **Conclusion:** Therefore, to obtain the optimal result for the growth and flowering of marigolds, it is suggested to apply 50% vermicompost media and use the NPK band placement technique.

Key words: Marigold, flowering, fertilizer dosage, fertilization technique, urban farming, vermicompost, verticulture

Citation: Sitawati, M. Baskara and C.F. Wattimena, 2022. Effect of vermicompost and NPK application techniques on Marigold growth and flowering on vertical pipes. Asian J. Plant Sci., 21: XX-XX.

Corresponding Author: Sitawati, Department of Agronomy, Faculty of Agriculture, Brawijaya University, Jl. Veteran, Malang 65145, East Java, Indonesia

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Verticulture is an effort to narrow land use optimally. It is believed that such a system will be able to overcome land limitedness, such as narrow yards in an urban area and sometimes no yard at all by Suwitra *et al.*[1]. Urban land limitedness could use the optimizing concept of narrow lands, such as verticulture, pot and pergola for creeping plants. Plants, which are mostly cultivated with a verticulture system are ornamental by Sumiasih and Ichniarsyah[2]. One of the ornamental plants that are used as an aesthetic enhancer is the marigold (*Tagetes erecta* L.).

Marigold is one of the ornamental plants, which is usually used for landscape, decoration and cut flowers. As an ornamental plant, which does not have a deep rooting system, marigold is cultivated by the verticulture system. Marigold produces a lot of flowers and it is expected that marigold will enhance the aesthetic value of an environment. To obtain a good result of the plant, it requires the suitability of environmental conditions. Factors that must be concerned are planting media and nutrient requirements by Oldroyd *et al.*[3]. On the verticulture system, excellent planting media and application of nutrients require the most effective and efficient method by Triyono *et al.*[4]. Excellent planting media should be able to be a foothold for plants, can bind water and supplies nutrients as required by plants, also be able to support air circulation. Planting media, which are mostly used nowadays for marigold, include a mixture of soil, husk and cocopeat. Alternative media, except soil that can be used as planting media are husk, coconut fibre and compost. One of the composts that can be applied is vermicompost. Vermicompost is compost, which is obtained through a process that involves worms in decomposing process. Based on research by researchers Khanzadeh *et al.*[5], the application of 50% vermicompost as planting media will be able to produce the best quantity and quality of Lochnera rosea flowers.

Nutrient requirements are not only provided by planting media but also the application of fertilizer. Fertilization is an important process in cultivating a plant. Such fertilization has a direct effect on soil maintenance to restore the nutrient condition to fulfil nutrient requirements for the plant to grow. Based on the result of the research by Grant *et al.*[6], they suggested that the application of the fertilization technique did not have a significant effect on the growth and production of *Chrysanthemum indicum*.

Therefore, it is assumed that the fertilizer application by band placement technique is more effective because the application is relatively more effective and efficient. It is hoped that the research will show the planting media composition and appropriate fertilizer application on marigolds. About 50% vermicompost and band placement technique will provide the best result toward growth and flowering of marigold by verticulture system.

The purpose of this research was to determine the effect of planting media composition and fertilization techniques on the growth and flowering of marigolds in the verticulture system.

MATERIALS AND METHODS

Study area: The research was conducted on the 6th floor of the rooftop at Malang with 450 m.a.s.l from April-June, 2019.

Equipment: Tools used to support the research include a ruler to measure plant height, a camera for documentation, PVC pipes 5 dim 120 cm high for media where the plant grows, an iron strut to support the PVC pipes and a watering can.

Materials: The materials used are yellow marigold seedlings, a mixture of planting media (consisting of soil, husk, cocopeat) and vermicompost as planting media as well as NPK (6:13:25) 3 g/plant.

Methodology: The research used randomized group design with P_1 = 0% vermicompost+band placement, P_2 = 50% vermicompost+band placement, P_3 = 100% vermicompost +band placement, P_4 = 0% vermicompost+fertigation, P_5 = 50% vermicompost+fertigation, P_6 = 100% vermicompost +fertigation. Band placement was applied once and fertigation is applied once a week. There were 6 combinations of treatment and 4 replications so that it had 24 combinations of treatment. Each treatment comprised 16 plants per pipe and totally 384 plants.

The observation included destructive observation (fresh weight of total plants, dry weight of total plants, root length, fresh weight of the plant roots, dry weight of the plant roots) and non-destructive observation (plant height, number of leaves, leaf area, age of flowering, number of flowers and flower diameter).

Statistical analysis: Data analysis used analysis of variance (F-test) on test level 5% to find out the effect of treatment and if the significant effect is obtained, it will be continued with honestly significant difference at level 5%.

RESULTS

Plant height: The result of observation on plant height of marigold showed significant effect as a result of planting media composition and fertilization technique at 28, 35 and 42 DAP. Treatment using 50% vermicompost by band placement technique and fertigation has significant difference and higher value than other treatments as presented in Fig. 1.

Number of leaves and leaf area: Parameter for the number of leaves is obtained by calculating the number of completely open-blade started from the base to the tip of the stem on each sample of the plant. On final observation at 42 DAP (Fig. 2a), the treatment of 50% vermicompost has more number of leaves, on average, than other treatments in which the average increases 47.80% in comparison with the treatment of 0% vermicompost and the average increases 24.34% in comparison with the treatment of 100% vermicompost. Parameter for leaf area showed a significant difference on average leaf area of the marigold due to treatment combination of planting media composition and fertilization technique. At 42 DAP (Fig. 2b) higher average leaf area was obtained from 50% vermicompost by band placement fertilization technique.

Fresh and dry weight of total plant: Parameter for the fresh weight of the total plant should be conducted to compare it with the parameter for dry weight of the total plant. These parameters were observed by weighing all parts of the plant, such as root, stem, leaf and flower on each sample plant at 42 DAP (Table 1). Parameter for the fresh weight of total plant showed that the treatment of planting media composition and fertilization technique has a significant effect on average fresh weight of total plant of marigold. Average fresh weight of total plant on 50% vermicompost, both fertilization technique of band placement and fertigation have a higher average of fresh weight than other treatments, in which the average increases 28.93% in comparison with the treatment on 100% vermicompost media and 64.77% in comparison with the treatment on 0% vermicompost media.

Parameter for dry weight of total plants is done to find out the result of photosynthate in a plant. Parameter for dry weight of total plant (Table 1) showed that planting media composition and fertilization technique has a significant effect on the average dry weight of total plant of marigold. The average dry weight of the total plant by 50% vermicompost media with band placement fertilization technique has a higher dry weight than other treatments.

Fresh and dry weight of the plant roots: The fresh weight of roots is observed by measuring the weight of the root of a plant, which has been cleaned up and remains of the planting media has been removed. The result for analysis of variance (Table 2) showed the average fresh weight of roots due to plant media composition and fertilization technique that have a significant effect on one another. The average fresh weight of roots is higher on media of 50% vermicompost with band placement in comparison with other treatments. Analysis of variance shows that the parameter for dry weight of the marigold's roots has a significant effect between plant media

Table 1: Average fresh weight and dry weight of total plant of marigold due to plant media composition and fertilization technique

Treatment	Fresh weight of total plant (g/plant)	Dry weight of total plant (g/plant)
0% V+NPK BP	6.87^{a}	1.05^{a}
50% V+NPK BP	11.32^{e}	1.96^{d}
100% V+NPK BP	8.78^{cd}	1.38^{bc}
0% V+NPK F (control)	7.40^{ab}	1.20^{ab}
50% V+NPK F	10.04^{de}	1.54^{c}
100% V+NPK F	8.27^{bc}	1.28^{abc}
LSD 5%	1.29	0.26

Number beside the same letter in the same column, does not have significant difference on LSD test 5%, BP: Band placement and F: Fertigation

Table 2: Average fresh and dry weight root of marigold due to plant media composition and fertilization technique

Plant media composition and fertilization technique	Root fresh weight (g/plant)	Root dry weight (g/plant)
0% V+NPK BP	1.82^{a}	0.63^{a}
50% V+NPK BP	3.09^{c}	1.18^{c}
100% V+NPK BP	2.26^{ab}	0.83^{ab}
0% V+NPK F (control)	1.88^{a}	0.67^{a}
50% V+NPK F	2.64^{bc}	0.93^{b}
100% V+NPK F	2.01^{a}	0.73^{ab}
LSD 5%	0.45	0.21

Number beside the same letter in the same column, does not have significant difference on LSD test 5%, BP: Band placement and F: Fertigation

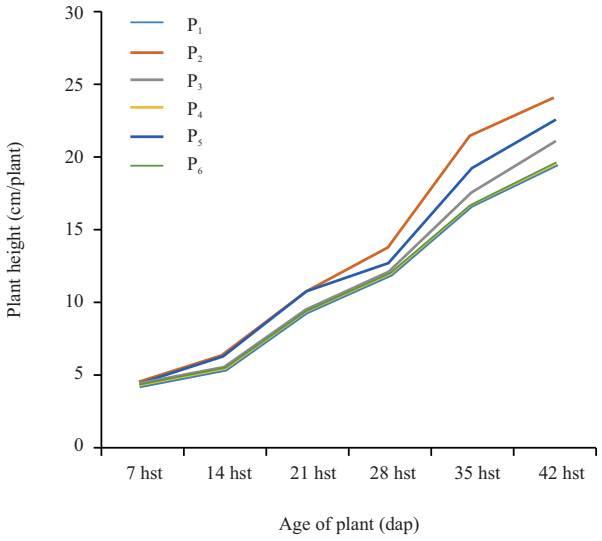

Fig. 1: Growth pattern on plant height of marigold due to planting media composition and fertilization technique at 7-42 DAP

V: Vermicompost, BP: Band placement, F: Fertigation, P_1: 0% V+NPK BP, P_2: 50% V+NPK BP, P_3: 100% V+NPK BP, P_4: 0% V+NPK F, P_5: 50% V+NPK F and P_6: 100% V+NPK F

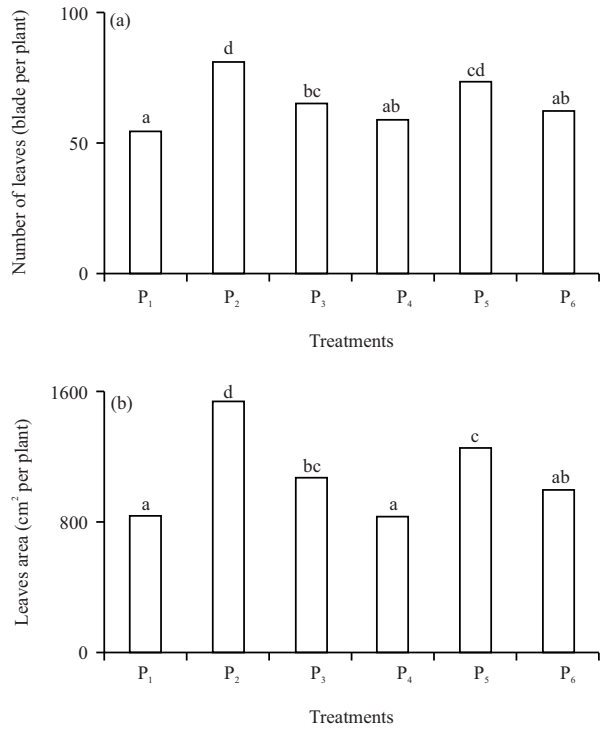

Fig. 2(a-b): Leaf observation on planting media composition and fertilization technique at 42 DAP, (a) Number of leaves and (b) Leaf area of marigold

P_1: 0% V+NPK BP, P_2: 50% V+NPK BP, P_3: 100% V+NPK BP, P_4: 0% V+NPK F, P_5: 50% V+NPK F, P_6: 100% V+NPK F, V: Vermicompost, BP: Band placement and F: Fertigation

Fig. 3: Differences in the appearance of marigold plants 42 DAP at each treatment

V: Vermicompost, BP: Band placement, F: Fertigation, P_1: 0% V+NPK BP, P_2: 50% V+NPK BP, P_3: 100% V+NPK BP, P_4: 0% V+NPK F, P_5: 50% V+NPK F, P_6: 100% V+NPK F)

composition and fertilization technique (Table 2). Plant in media of 50% vermicompost with fertilization technique of band placement has a higher average of the dry weight of roots.

Time of flowering, number of flower and flower diameter: Analysis of variance on the number of flowers showed that plant media composition and fertilization technique have a significant effect on the number of flowers on marigolds. An average number of flowers by the application of 50% vermicompost with NPK band placement (P_2) has a higher average and is significantly different with the treatments of 100% (P_3) and 0% (P_1 (Fig. 3). Other than 50% vermicompost media with band placement fertilization technique even has an average number of flowers <7 buds per plant (Fig. 3 and 4a-c).

Parameter for early flowering (Fig. 4a) is obtained by calculating the time when the first flower emerges in each treatment as it reaches 50% of the population. Based on analysis of variance, it showed a significant effect between plant media composition and fertilization technique. Plant, which is grown in 50% vermicompost and fertilization technique of band placement, has been flowering faster than other treatments, 26.83 DAP on average, followed by 50% vermicompost with fertigation, while the application of 100% vermicompost and 0% vermicompost have relatively equal age of flowering. In the experiment, marigold started flowering at 4 weeks after planting due to other factors, which also affect the age of flowering, such as the altitude of the location from the sea level and temperature.

Parameter of flower diameter was obtained through measurement using vernier callipers on the flower in fresh condition for each treatment. Average of the biggest flower

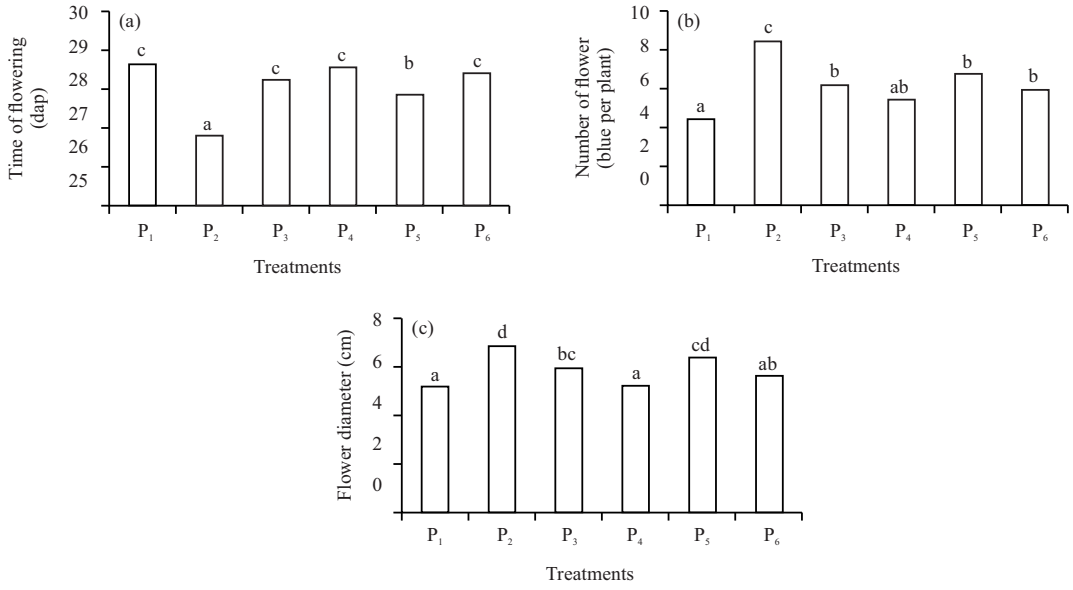

Fig. 4(a-c): Graphic for flowering observation on marigolds due to plant media composition and fertilization technique, (a) Time of flowering on marigold due to plant media composition and fertilization technique, (b) Number of flowers on marigold due to plant media composition and fertilization technique and (c) Flower diameter on marigold due to plant media composition and fertilization technique

P_1: 0% V+NPK BP, P_2: 50% V+NPK BP, P_3: 100% V+NPK BP, P_4: 0% V+NPK F, P_5: 50% V+NPK F, P_6: 100% V+NPK F, V: Vermicompost, BP: Band placement and F: Fertigation

diameter was found on the plant that was treated with 50% vermicompost, either fertilization of band replacement or fertigation with average diameter >6 cm per plant (Fig. 4a-c). The application of 100% vermicompost and 0% vermicompost with fertilization of band placement as well as fertigation resulted from a relatively smaller flower diameter <6 cm per plant.

DISCUSSION

The highest marigold plant height was obtained using the band placement technique in conjunction with a treatment effect of 50% vermicompost+NPK. Meanwhile, the number and leaf area parameters yielded the same results as the plant height parameter, namely, marigold plants treated with 50% vermicompost+NPK using the band placement technique had significantly higher numbers and leaf area than other treatments. From these two, it can be said that plant height is directly proportional to the number of leaves, i.e., the higher the plant, the greater the number of leaves will be produced. Plant height is directly proportional to the number of leaves, in which the higher the plant, the greater number of leaves will be produced. It is due to leaves being organs located in the stem node by Saribu *et al.*[7]. Francioli *et al.*[8] described that nutrient availability in the soil closely relate to vegetative growth. It correlates with the fulfilment of the nutrient supplies of the plant, which increase the number of leaves. The research showed that the greater number of leaves, the wider the leaf area will be produced. Leaf area increases and it means that ability of the plant to intercept light will increase as well. Allel *et al.*[9] suggested that the leaf as the place of photosynthesis highly determines absorption and the change of light energy for the formation of both vegetative and generative organs.

The increase of fresh weight relates to the increased number of leaves and wider leaf area. According to Indah *et al.*[10], the organic content in planting media will optimize the nutrient absorption process to produce more photosynthate. Parameter for dry weight of total plants is done to find out the result of photosynthate in a plant. Huang *et al.*[11] suggested that the dry weight of the plant is used to describe the biomass of the plant and to study the plant growth. The excellent and rapid growth of the plant will increase the biomass of the plant. It is due to sufficient nutrient availability will affect the plant growth, which can be gained by adding the nutrient from outside such as fertilizer application by Havlin[12].

The average fresh weight of roots is higher on media of 50% vermicompost with band placement in comparison with other treatments. The roots grow well because they are

supported by planting media and fertilizer application, which contains macronutrients and micronutrients. It conforms to the suggestions by Kranz *et al.*[13] that compost does not only provide nutrients but also affect the physical properties of the soil. The structure of the soil becomes looser, therefore it smoothens aeration inside the soil. Also, the existence of the organisms have assisted in decomposing organic material in the compost and acted as adhesive and bound soil grains and turned them into bigger ones. Bigger grains will be able to retain water so that it will always be available for the plant. Roots tend to form more branches in fertile soil, which have a good structure.

Plant in media of 50% vermicompost with fertilization technique of band placement has a higher average of the dry weight of roots. According to Cai *et al.*[14], inhibited growth of roots in high density of soil can be seen from the dry weight of the roots, the denser of the soil, the lower dry weight of the roots. According to Malshe *et al.*[15], in general, marigold starts to flowering at 5 weeks after planting. In the experiment, marigold started flowering at 4 weeks after planting due to other factors, which also affect the age of flowering, such as the altitude of the location from the sea level and temperature. It conforms to opinions by Hasibuan *et al.*[16], who suggested that the shift from vegetative to generative, in which partly determined by internal factors such as genetic and external factors such as temperature and light intensity. According to Priyadarshini *et al.*[17], nitrogen in vermicompost will linearly increase the flowering period and flower opening along with the increasing nitrogen absorbed by the plant. Besides that, vermicompost will accelerate the flowering time by increasing soil fertility and soil retention capacity. The number of flowers per plant also relates to a parameter of leaf area.

The application of 100% vermicompost and 0% vermicompost with fertilization of band placement as well as fertigation resulted in a relatively smaller flower diameter <6 cm per plant. It has been proven that vermicompost has a positive effect on the growth and flowering of marigolds. In the research by Kovshov and Iconnicov[18], the application of vermicompost as planting media for marigold affect stem diameter, flower diameter and the number of flowers. The yield of photosynthesis (photosynthate) affects flower diameter. Leaf functions as a source, where photosynthesis takes place. According to Ahmad *et al.*[19], nutrients absorbed by the plant may affect the photosynthesis process and leaf area. The photosynthesis process on the leaf will produce photosynthate. Photosynthate will be translocated and accumulated in diverse organs of the plant during vegetative and generative growths. After the vegetative phase has been completed, the resulting photosynthate will be transported to generative organs. The flower is one of the plant's organs, which acts as a sink organ. Therefore, the wider the leaf area, the greater photosynthate will result, which will be transported to generative organs.

CONCLUSION

Based on the result of the research, plant media composition and fertilization technique have significant effects on growth of plant height, number of leaves, leaf area, early flowering, number of flowers, flower diameter, fresh weight of total plants, dry weight of total plants, fresh weight of total roots, dry weight of total roots on marigold with verticulture system. To obtain the optimal result on growth and flowering of marigold, it is suggested to apply 50% vermicompost media and NPK band placement technique, which the number of flower 60% higher than 0% vermicompost with NPK fertigation technique.

SIGNIFICANCE STATEMENT

This study discovers the possible synergistic effect of vermicompost and NPK application techniques on marigold growth and flowering on vertical pipes that can be beneficial for narrow yards owner or farmers in an urban area. This study will help the researcher to uncover the critical areas of optimizing the concept of narrow lands that many researchers were not able to explore. Thus a new theory on vermicompost and NPK application techniques on vertical pipes may be arrived at.

REFERENCES

1. Suwitra, I.K., A.F. Amalia, J. Firdaus, A. Dalapati and N. Fadhilah, 2021. Study of ABMix nutrition concentration and water concentration in hydroponics with deep film technique (DFT) system in central Sulawesi. IOP Conf. Ser. Earth Environ. Sci., Vol. 807. 10.1088/1755-1315/807/4/042009.
2. Sumiasih, I.H. and A.N. Ichniarsyah, 2021. The design and concept of agro-edutourism park using sustainable agriculture principle at attaqie farm. IOP Conf. Ser.: Earth Environ. Sci., Vol. 709. 10.1088/1755-1315/709/1/012016.
3. Oldroyd, G.E.D. and O. Leyser, 2020. A plant's diet, surviving in a variable nutrient environment. Science, Vol. 368. 10.1126/science.aba0196.
4. Triyono, S., R. Putra, S. Waluyo and M. Amin, 2019. The effect of three different containers of nutrient solution on the growth of vegetables cultured in DFT hydroponics. IOP Conf. Ser. Earth Environ. Sci., Vol. 355. 10.1088/1755-1315/355/1/012092.

5. Khanzadeh, A. and D. Naderi, 2015. Different growing substrates affect periwinkle's (*Catharanthus roseus* L.) growth and flowering. J. Biodivers. Environ. Sci., 6: 179-186.
6. Grant, K.N., M.L. Macrae, F. Rezanezhad and W.V. Lam, 2019. Nutrient leaching in soil affected by fertilizer application and frozen ground. Vadose Zone J., 18: 1-13.
7. Saribu, I.D., C. Chairani and S. Safruddin, 2018. Growth response and yield of sweet corn (*Zea mays saccharata* Sturt.) against vermicompost fertilizer and SP-36 fertilizer aplication. Bernas: J. Penelitian Pertanian, 14: 60-73.
8. Francioli, D., E. Schulz, F. Buscot and T. Reitz, 2018. Dynamics of soil bacterial communities over a vegetation season relate to both soil nutrient status and plant growth phenology. Microb. Ecol., 75: 216-227.
9. Allel, D., A. Ben-Amar and C. Abdelly, 2018. Leaf photosynthesis, chlorophyll fluorescence and ion content of barley (*Hordeum vulgare*) in response to salinity. J. Plant Nutr., 41: 497-508.
10. Indah, S.P., H. Hermansyah, H. Hasanudin and M. Marwanto, 2017. Effect of oil-palm-empty-fruit-bunch granular organic fertilizer on the yield of oil palm fruit. Akta Agrosia, 20: 61-65.
11. Huang, W., D.A. Ratkowsky, C. Hui, P. Wang, J. Su and P. Shi, 2019. Leaf fresh weight versus dry weight: Which is better for describing the scaling relationship between leaf biomass and leaf area for broad-leaved plants? Forest, Vol. 10. 10.3390/f 10030256.
12. Havlin, J.L., 2020. Soil: Fertility and Nutrient Management. In: Landscape and Land Capacity, Wang, Y. (Ed.)., CRC Press, Boca Raton, Florida, United States, pp: 251-265.
13. Kranz, C.N., R.A. McLaughlin, A. Johnson, G. Miller and J.L. Heitman, 2020. The effects of compost incorporation on soil physical properties in urban soils-A concise review. J. Environ. Manag., Vol. 261. 10.1016/j.jenvman.2020.110209.
14. Cai, H., F. Li and G. Jin, 2019. Fine root biomass, production and turnover rates in plantations versus natural forests: Effects of stand characteristics and soil properties. Plant Soil, 436: 463-474.
15. Malshe, K.V., B.R. Salvi and V.V. Sagvekar, 2021. Flowering and yield in marigold (*Tagetes* spp) cv. pusa basanti gainda as influenced by mulching and pinching practices. J. Eco-Friendly Agric., 16: 133-136.
16. Hasibuan, S., S. Hasibuan and E.L. Panggabean, 2019. The effectiveness of castration and seed sources on the growth and production of strawberry plants (*Fragaria x ananassa* var. duchesne). Budapest Int. Res. Exact Sci. J., 1: 42-53.
17. Priyadarshini, A., S.K. Palai and M.R. Nath, 2018. Effect of source of nitrogen on growth and yield of African marigold (*Tagetes erecta* L.). Pharma Innovation J., 7: 917-921.
18. Kovshov, S.V. and D.A. Iconnicov, 2017. Growing of grass, radish, onion and marigolds in vermicompost made from pig manure and wheat straw. Indian J. Agric. Res., 51: 327-332.
19. Ahmad, B., A. Shabbir, H. Jaleel, M.M.A. Khan and Y. Sadiq, 2018. Efficacy of titanium dioxide nanoparticles in modulating photosynthesis, peltate glandular trichomes and essential oil production and quality in *Mentha piperita* L. Curr. Plant Biol., 13: 6-15.