Effect of different media on the growth, yield and quality of water spinach under container gardening

Preetesh Pandey, Jitendra Singh, Omesh Thakur, Ritika Bhattacharjee
Dept. of Vegetable Science, Dept. of Plant Pathology, I.G.K.V, Raipur, C.G.
Corresponding Author's email- preeteshpandey312@gmail.com

Abstract

The increasing use of chemical fertilizers to grow vegetables such as spinach has caused numerous problems related to the environment and human health. Hence, using organic fertilizers including compost and vermicompost can be a more suitable alternative. Making use of agricultural waste and returning them to the cycle of nature rather than burying or burning them is an effective approach to help the environment. Soil organic matter. affects the chemical and physical properties of the soil and its overall health. Its composition and breakdown rate affect: the soil structure and porosity; the water infiltration rate and moisture holding capacity of soils; the diversity and biological activity of soil organisms; and plant nutrient availability. Few foliage or flowering plants are grown in field soil. Most are produced in a soilless growing medium which consists of components such as peat moss, wood residues, sand, etc. These media are designed to provide the necessary aeration, drainage and water holding properties required for plant growth in a container. An ideal potting medium should be free of weeds and diseases, heavy enough to avoid frequent tipping over and yet light enough to facilitate handling and shipping. The media should also be well drained and yet retain sufficient water to reduce the frequency of watering.

Introduction

Water spinach (*Ipomoea aquatica* Forsk) locally known as *Karmatha bhaji* belongs to family convolvulaceae. It has a short growth period and can be cultivated either in marshy land or flooded soils. Moreover, it has been found that water spinach has a high potential to convert nitrogen from biodigester effluent into edible biomass with high protein content (Sophea and Preston, 2001).

Water spinach is an herbaceous aquatic or semi-aquatic perennial plant of the tropics or subtropics. It's leaves are flat, and vary in shape depending on genotype, from heart-shaped to long, narrow and arrow-shaped. Narrow leaves are 1-2.5 cm wide and 20-30 cm long. The large,

attractive flowers have the typical open, trumpet shape of convolvulus or bindweed flowers. There are two major cultivars of water spinach,

- Ching Quat (known as "green stem") – this has a narrow, pointed leaves and white flowers and is adapted for moist soils. This can be grown in beds, provided there is always plenty of moisture.
- Pak Quat (known as "white stem") – this has broad, arrow-shaped leaves and pink flowers. It is adapted to aquatic conditions and also called "Water Ipomea".

A container in gardening is a small, enclosed and usually portable object used for displaying live flowers or plants. It may take the form of a pot, box, tub, pot, basket, tin, barrel or hanging basket.

Effect of different media on growth parameters of water spinach

Lal *et al.* (2002) studied the effects of farmyard manure (FYM; 0, 50 and 100 t/ha^{-1}) and irrigation (4, 5, 6 and 7 cm) on the growth and yield of onion cv. Hisar-2. Plant height, number of leaves plant^{-1}, bulb size and bulb yield increased with increasing rates of farmyard manure and irrigation. The interaction effects between FYM and irrigation were significant only for bulb size and yield.

Magnani *et al.* (2003) evaluated the growth rate and qualitative characteristics of 3 vegetable (lettuce, cabbage and cauliflower) seedlings, grown with an organic method, were evaluated. The organic method consisted of using coco-peat as the growth medium and organic fertilizer for fertigation. This method was compared with a traditional one based on a peat growth medium and synthetic fertilizers for fertigation. The results showed different responses among the vegetables, regarding growth rate and quality. Lettuce grown with organic method presented an increase of growth rate, fresh weight, leaf number and area, height, root/shoot ratio and nutrient content compared to the traditional method. On the contrary, cabbage and cauliflower, grown with organic method, showed a reduction of growth rate, dry weight, leaf number and area, chlorophyll content, height and nutrient content.

Reddy and Mallareddy (2004) studied the acclimatization of 4 parwal (*Trichosanthes dioica*) genotypes, *i.e.* Swarna Alaukik, elite selection-1, Swarna Rekha and male, studied in different substrates, i.e. vermiculite, soilrite, coco-peat, coco-peat+sand in 3:1 and 2:2 ratio, and sand+vermiculite+coco-peat in 1:1:1 ratio, in the greenhouse. Swarna Alaukik

recorded the highest survival percentage (89.94%), followed by elite Selection-1 (85.71%) and Swarna Rekha (81.42%), in coco-peat, whereas Male survived better in vermiculite (64.28%). Shoot length (10.06 cm) and number of leaves (7.97) were higher in coco-peat than in any other substrate after 28 of growing period.

Anshebo *et al.* (2004) observed high heritability estimates for vine traits viz., length of vine, number of branches plant^{-1} and weight of foliage plant^{-1}. The least estimate of heritability was observed for number of tubers plant^{-1}. The characters such as number of branches plant^{-1}, weight of single tuber, girth of tuber and length of tuber showed high heritability estimates associated with high genetic advance indicating the presence of additive gene effect.

Arcidiacono *et al. (*2005) conduct trial on different substrates for soilless cultivation in an open system were compared. The experimental protocol includes three randomized blocks made of six rows of pots filled with six different substrates: Etna lapillus, expanded clay, perlite, peat, cocopeat, and sand. Then, tomato plants were planted in each pot. In the central pot of each row, thermoresistance probes were installed at different locations in the substrates in order to monitor the temperature of the media. The total solar radiation, the air temperature and relative humidity were measured inside and outside the greenhouse. The net radiation was also measured inside the greenhouse just above the substrates. The effect of the nature of the different substrates on their thermal regimes was examined on the basis of the collected data. Moreover, the connections between the substrate temperatures and the microclimatic variables were analysed.

Botrini *et al.* (2006) studied the growth rate and quality of tomato seedlings grown on 2 cocopeat growth media, with organic fertirrigation, and the effects of these techniques on seedling development after transplanting were evaluated. The daily increase in fresh weight and height of seedlings grown on cocopeat supplemented with borlanda and natural fertilizers were similar to those of seedlings grown with a traditional system based on peat and synthetic fertilizers. At the time of transplanting, the qualitative parameters of the seedlings were the same for the traditional growth system and the organic system based on cocopeat with borlanda and natural fertilizers.

Engida *et al.* (2007) studied high heritability and expected genetic advances

were recorded for vine length, vine inter node length, leaf area, above ground fresh and dry weights, number of storage root plant^{-1}, individual storage root weight, storage root fresh yield plant^{-1}.

Singh *et al.* (2008) reported significant increase in vine length, number of branches per plant and fruit yield with the application of FYM and gypsum during the two years of experimentation. Maximum fruit yield (195.2 qha^{-1}) was observed at 20 t FYM and with the application of gypsum @ 100% GR (gypsum requirement). The yield under canal irrigated check was found to be 214.6 q ha^{-1}.

Bhat *et al.* (2013) studied on a suitable growing substrate for organic greenhouse vegetable production. A number of combinations of vermicompost, coco-peat, sphagnum peatmoss, perlite, farm yard manure and avicumus were compared with ready-to-use organic substrate for producing tomato, cucumber and capsicum under greenhouse conditions. Vegetative growth parameters (average plant height, number of leaves, chlorophyll index) and fruit yield plant^{-1} were used to evaluate various growing substrates. overall, substrates containing vermicompost, coco-peat, perlite and sphagnum peat moss (2:1:1:1 or 1:1:1:1 v/v) produced significantly better growth, yield and quality in tomato, cucumber and capsicum than other substrate combinations and in some cases were better than ready to use mixes and conventional soil based growing system.

Khan *et al.* (2013) found that growth parameters including number of flowers plant^{-1}, number of fruits plant^{-1} and fruit diameter were also found significantly different by the application of FYM and K fertilizer. The mineral nutrition of tomato showed significant effect of FYM and K levels on plant P and K. FYM and K levels also significantly improved soil K content. It may be concluded that the Potassium applied @ 120 kg/ha along with the FYM was effective in improving the tomatoes attributes as well soil K content.

Luo *et al.* (2015) reported that the germination rates of water spinach decreased with increasing biochar rates when biochar was added alone (76.9%–83.7%), whereas the rates increased to 83.6%–85.8% when biochar was added in combination with sap. Growth parameters of water spinach and nutrient uptake by shoots and roots increased with increasing biochar rates and reached the maximum values at the biochar rate of 100 ml litter. There were significant cubic relationships between the

uptake of nutrients (N, P, and K) and biochar rates, both with and without SAP addition. In order to avoid negative effects on plant growth, the biochar application rate should be controlled at an optimal level (100 ml litter). The SAP addition not only enhanced the positive effects of biochar application on the properties of the substrate, but also inhibited the excessive rise of pH and EC following biochar additions, which led to better plant growth and enhanced nutrient uptakes by water spinach.

Effect on different media on yield water spinach

Sophea and Preston (2001) conducted experiment to evaluate the effect of different fertilizing practices on water spinach (*Ipomoea aquatica, var. reptans*) yield. The crop was located on a sandy, poor soil derived from alluvial deposits (pH 5.45, N 0.13%). There was no difference in fresh biomass yield of water spinach between the two treatments with bio digester effluent (17.6 and 18.6 t ha $^{-1}$, for total N and ammonia N, respectively).

Hoang *et al.* (2005) studied to evaluate the response of water spinach to fertilization with increasing levels of nitrogen (0, 10, 20, 30, 40, 50, 60 kg N/ha over 28 days) in the form of earthworm compost or urea. The biomass yield response to fertilizer N was positive and curvilinear and was greater for the earthworm compost at the higher levels of application of N. Increasing application of fertilizer N provoked linear responses in DM content, which decreased, and in crude protein content, which increased. Soil fertility was improved by the worm compost, but not by urea, as measured by the organic matter, phosphorus and potassium contents of the soil at the end of the trial. It appears that the most economical level of N is 40 kg/ha applied over the 28 day growth period.

Dixit and Kumar (2006) studied the effect of farmyard manure (FYM) and macronutrients on the yield and nutrients uptake by garlic. The treatments include: absolute control, control (FYM alone), 100% N, 100% NP, 100% NPK, 100% NPKS, 100% NPKSMg, 125% N, 125% NP, 125% NPK, 125% NPKS, 125% NPKSMg, 150% N, 150% NP, 150% NPK, 150% NPKS and 150% NPKSMg. Results showed that in general, the 150% N.P.K.S.Mg recorded the maximum garlic bulb yield and increased nutrients (N, P, K, S and Mg) uptake.

Bohme *et al*. (2014) reported that the spinach yield was in average approximately 20% higher on rockwool than on coco-peat mainly due to a higher number of fruits harvested but the fruits on rockwool were also longer than on coco-peat. Regarding the quality in the fruits grown on coco-peat a higher mineral content, in particular K, P and Mg, was determined. In both substrates significant differences between the genotypes of bitter gourd.

Nunal *et al.* 2014. conducted the effectiveness of cocopeat and rice hull powder obtained from agricultural wastes as biocarriers for an oil-degrading bacterial consortium. Scanning electron microscopy revealed colonization and strong attachment of bacterial cells on the surface of both carriers. Results of a 60-day in vitro seawater bioremediation trial showed significant oil reduction and high cultivable bacterial counts in treatments augmented with the carrier-attached bacterial consortia compared to treatments supplemented with the same consortium in free living and encapsulated forms. Significant degradations in both aliphatic and aromatic fractions were obtained in treatments augmented with carrier-immobilized consortia. The developed immobilized cells showed sustained activities and viabilities during storage for six months. Results of this study demonstrated that inexpensive waste materials can be utilized as biocarriers of an oil-degrading consortium and that immobilization on biocarriers can enhance the bioremediation of oil-contaminated seawater.

Surrage *et al.* (2010) revealed that Forterra Royal GRO 1 (GRO 1; coconut coir/vermicompost) and Forterra Royal GRO 2 (GRO 2 aged pine bark/ coconut coir/vermicompost) attained significantly higher marketable yields plant^{-1} compared with the plants grown in RW. A similar trend was seen in the incidence of Blossom End Rot (BER) with GRO 1 and GRO 2 having reduced numbers of BER incidences per plant when compared with RW. In conclusion, the addition of vermicompost to organic growing substrates is beneficial for tomato growth and yield.

Hegde and Reddy (2012) study the rapid regeneration protocol of brinjal was conducted. The shoot tip and hypocotyl explants from the in vitro grown sterile seedling were used for regeneration. In hardening, highest survival percentage (100%) and healthy growth of plantlets were observed in mixture of vermiculite, farmyard manure and coco-peat in 1:1:1 ratio.

Khan *et al.* (2013) In vestigate the results indicated that application of FYM and various K levels had significant effect on the growth, yield and nutrient content of tomatoes. The highest yield of tomatoes was (39.05 t/ha) observed in the pots receiving FYM and 41.97 t ha^{-1} was found in the treatment receiving K @ 120 kg/ha^{-1}.

Sharma *et al.* (2014) studied the treatments consisting of two levels of vermicompost (0, 2.5 t ha^{-1}), three levels of potassium (0, 10 kg ha^{-1}, 20 kg ha^{-1}) and three levels of iron (0, 20 kg ha^{-1}, 40 kg ha^{-1}) were applied to crop *Trigonella foenum-graecum* var Rmt-1 as soil application. Results showed that application of vermicompost, potassium and iron individually and in combination significantly influenced the yield attributes and yield of the crop during both the years.

Effect on different media on Economic of water spinach

Umar *et al*. (2007) carried out analysis of the nutritional composition of water spinach (*Ipomoea aquatica* Forsk) leaves were carried out using standard methods of food analysis. The proximate composition as well as mineral elements was determined. The leaves were found on dry weight basis to have high moisture (72.83+or-0.29%), ash (10.83+or-0.80%), crude lipid (11.00+or-0.50%), crude fibre (17.67+or-0.35%) and available carbohydrate (54.20+or-0.68%), but low in crude protein content (6.30+or-0.27%). The leaves also have energy value (300.94+or-5.31 kcal/100 g) that is within the range reported in some Nigerian leafy vegetables. The mineral element contents were high with remarkable concentration of K (5,458.33+or-954.70 mg/100 g) and Fe (210.30+or-2.47 mg/100 g). Also the leaves content moderate concentrations of Na (135.00+or-2.50 mg/100 g), calcium (416.70+or-5.77 mg/100 g), Magnesium (301.64+or-12.69 mg/100 g) and P (109.29+or-0.55 mg/100 g), with low Cu (0.36+or-0.01 mg/100 g), Mn (2.14+or-0.22 mg/100 g) and Zn (2.47+or-0.27 mg/100 g) contents. Comparing the mineral content with recommended dietary allowance, it was showed that the plant leaves is good sources of K, Mn and Fe for all categories of people, while Mg is adequate enough for adult female and children. From the result, Ipomoea aquatica Forsk leaves could be used for nutritional purposes, due to the amount and diversity of nutrients it contains.

Qiuzhuo *et al.* (2014) studied on water spinach which was grown on aquatic eco-nomic crops floating bed which harvested at regular time intervals. The total

harvest weight of water spinach was 11,907 kg, which could achieve good economic benefits. A small parts of the water spinach were transplanted to crab ponds. The transplanted water spinach could not only serve as food source for crab, but also purify the water quality in crab ponds. Based on efficient utilization and recycling of natural resources and harmless discharge of wastes, the concept of circular economy was applied to agriculture system, and a recycling and utilization mode of solid waste in ecological agricultural park was realized, which could provide a good sample for sustainable development in ecological agricultural park.

Malakar *et al.* (2015) reported that human race is dependent on the use of traditional plant-based medicines as well as poly herbal preparations. And from the last few decades several research works are carried out which confirms the potentiality of these natural sources as a good source of medications. *Ipomoea aquatica* was among such plant having good nutraceutical applications and is commonly consumed as a vegetable and is commonly found in tropical Asia, India, Africa and Australia, etc. The plant is considered to be a good source of vitamins, minerals, plant proteins, fibers, etc. as well as the plant is supposed to have tremendous pharmacological importance. The present review aims to present a brief overview of the medicinal use as well pharmacological value of the plant.

Shamli and Chandra (2015) studied the natural products, such as plant extract, either as pure compounds or as standardized extracts, provide unlimited opportunities for new drug discoveries because of the unmatched availability of chemical diversity. *Ipomoea aquatica* Forsk (IAF), commonly called water spinach, belongs to the family Convolvulaceae. The present study reveals the antibacterial and phytochemical analysis of various organic extracts (acetone and petroleum ether) of leaves of plant of *Ipomoea aquatica* forsk. Acetone and Petroleum ether extracts of *Ipomoea aquatica* Forsk were tested against four common bacteria of medical importance using Disc Diffusion (DD) and Well Diffusion (WD) assay. Acetone extract showed the maximum zone of inhibition when compared with petroleum ether extract in both disc diffusion and well diffusion method. Phytochemical analysis of both the extracts showed the presence of carbohydrates, phenols, tannins, proteins and terpenoids. The results obtained in the present study indicate that *Ipomoea aquatica*

could be a good source of anti-bacterial drug, relatively safe for consumption.

Southavong *et al.* (2016) investigated the effect of biochar, charcoal and biodigester effluent on growth of water spinach soil amender (biochar or charcoal or none) at 40 t ha^{-1} and level of effluent (0, 25, 50, 75 or 100 kg N ha^{-1}) applied to samples of soil held in fifteen litre capacity plastic baskets. Sixty seeds of water spinach were planted in each basket. After germination, some seedlings were removed to balance the number in each basket (40 seedlings) for the rest of the experiment. The plants were irrigated every morning and evening. Measurements were made of height, number of leaves, and weight of aboveground biomass after 28 days and again (regrowth) after a further 28 days. Both soil menders (biochar and charcoal) gave similar improvements in water holding capacity, from 27.4% to 39.0 and 37.6, respectively. Soil pH was increased from 4.7 to 6.6 due to addition of biochar and to 6.3 with charcoal. Biochar increased foliage yield of the water spinach in both the first and second harvests, but there was no apparent effect on foliage growth from application of charcoal. In the first harvest, there were curvilinear responses to biodigester effluent for biochar and charcoal amenders, with the peak occurring at between 50 and 75 kg N ha^{-1}. For the unamended soil the response was linear with the highest yield at 100 kg N ha^{-1}. In the second harvest, the response to effluent for the biochar amender was again curvilinear with the peak at 5075 kg N ha^{-1} by contrast the response to effluent with the charcoal amender was linear with maximum yield requiring 100 kg N ha^{-1}. On the un amended soil there was no relationship between effluent level and biomass yield.

Conclusion:

Growing media are used in smaller quantities and have a great role in the fertilizer program to achieve higher and sustainable crop yields. There is enormous potential for container gargening systems to utilize organic waste products from other industries and, atthe same time, recycle valuable nutrients.

References

Ahmadi, F. and Jarapour, M.2015. The Functional Effect of Different Organic Matter on Spinach (*Spinacia oleracea*).Journal of earth, environment and health sciences, 1(1):1-4.

Anshebo, T., Veeraragavathatham, D. and Kannan, M. 2004. Genetic variability and correlation studies in sweet potato [*Ipomoea*

batatas (L.) Lam.]. *Madras Agric. J*. **91** (7): 420-424.

Arcidiacono, C., Emilio, D., Francesco, A. and Mazzarella, A.D. 2005. Analysis of thermal behaviour of the pot-substrate system for soilless cultivation. *J. Rivista di Ingegneria Agraria* 36(1): 1-6.

Bhat, N., Albaho, M., Suleiman, M., Thomas, B., George, P. and Ali, S.I. 2013. Growing substrate composition influences growth, productivity and quality of organic vegetables. *Asian Journal of Agricultural Sciences* 5(4): 62-66.

Bohme, M. H., Pinker, I. and Edenharter, S. 2014. Greenhouse cultivation of bitter gourd (*Momordica charantia* L.) in mineral and organic substrate .*J. Acta Horticulturae* (1034): 227-232.

Botrini, L., Magnani, G., Graifenberg, A., and Marchetti, L. 2006. The organic production of tomato seedlings. *J. Colture Protette* 35(3): 77-84.

Dixit, S. P. and Kumar, S. 2006. Effect of FYM and macro nutrients on yield and nutrient uptake by garlic. *Journal of the Indian Society of Soil Science* 54(3): 372-374.

Engida, T., Sastry, D. and Dechassa, N. 2007. Genetic variability for yield and other agronomic traits in Sweet Potato [*Ipomoea batatas* (L.) Lam.] *Indian J. Hort*. 64(2): 237-240.

Hegde, V. and Reddy, R. 2012. Studies on in vitro plant regeneration in brinjal (*Solanum melongena* L.). *International Journal of Plant-Sciences Muzaffarnagar* 7(1): 126-129.

Hoang., T. C., Dung, N. T., Binh, D. V. and Preston, T. R. 2005. Effect on yield and composition of water spinach (Ipomoea aquatica), and on soil fertility, of fertilization with worm compost or urea. *J.Livestock Research for Rural Development* 17(10): 108.

Khan, Q.U., Ahmad, R., Jamil, M., Obaidullah, S., Latif, A., Khakwani, A., Khan, G., Hashim, M. M., Muhammad, M. R. and Muhammad, P. 2013. Assessment of various growth, yield and nutritional parameters of tomatoes as affected by farmyard manure fortified with potassium fertilizer. *Pakistan Journal of Nutrition* 12(12): 1066-1069.

Lal, S., Yadav, A. C., Mangal, J. L., Singh, A. and Batra, V. K. 2002. Effect of FYM and irrigation levels on growth and yield of onion cv. Hisar - 2. *Haryana-Journal of Horticultural Sciences.* 31(3/4): 256-258.

Luo, J., Yan, S., Zhou, Y. and Zhang, Z. 2015. Effects of biochar and super absorbent polymer on substrate properties and water

spinach growth. *FAN Ruqin1, Elsevier B.V. and Science Press* 25(5): 737–748.

Magnani, G., Botrini, L. and Graifenberg. 2003. A growth rate and quality of the seedlings of lettuce (*Lactuca sativa* L.) and cabbage (*Brassica oleracea* L.) for the organic horticulture. *J. Italus Hortus*. 10(4, Supplemento): 80-87.

Nunal, S. N., Leon, S. D., Bacolod, S. M. S., Koyama, E. J., Uno, S. Hidaka., M. Yoshikawa . and Maeda, T. H. 2014. Bioremediation of heavily oil polluted seawater by a bacterial consortium immobilized in cocopeat and rice hull powder. J. *Biocontrol Science*. 19(1): 11-22.

Qiuzhuo, Z., Varenyam, A., Tong., X. Y. and WeiNing, X. 2014. Aquaculture wastewater quality improvement by water spinach (*Ipomoea aquatica* Forsskal) floating bed and ecological benefit assessment in ecological agriculture district. *J. Aquacultural Engineering* 60: 48-55.

Reddy, K. R. and Mallareddy, K. 2004. Studies on acclimatization of in vitro produced plantlets of four genotypes of parwal (*Trichosanthes dioica* Roxb.). *Journal of Research ANGRAU*. 32(4): 48-53.

Shamli, M. and Chandra, J. H. 2015. Evaluation of antibacterial activity of different solvent extracts of medicinal plant I*pomoea aquatica* forsk. *Journal of Chemical and Pharmaceutical Sciences* 0974-2115.

Sharma, P., Majumdar, S. P.and Sharma, S. R. 2014. Impact of vermicompost, potassium and iron on yield attributes and yield of fenugreek in topic-ustipsamments. *J. Environment and Ecology* 32(2): 439-443.

Singh, A., Yadav, A. C., Brar, J. S., Sharma, S. K. and Phogat, V. 2008 . Effect of FYM and gypsum on production of bottle gourd under sodic water conditions. *Haryana Journal of Horticultural Sciences* 37(3/4): 297-298.

Sophea, K. and Preston, T. R. 2001. Comparison of biodigester effluent and urea as fertilizer for water spinach vegetable. *Livestock Research for Rural Development* 13(6): 125-127.

Surrage, V. A., Claudia., L. Dixon, M. and Zheng, Y. 2010. Benefits of Vermicompost as a constituent of growing substrates used in the production of organic greenhouse tomatoes. *Hortscience* 45(10):1510–1515.

Umar, K. J., Hassan, L. G,. Dangoggo, S. M. and Ladan, M. J. 2007. Nutritional composition of water spinach (*Ipomoea aquatica Forsk*.) leaves. *Journal of Applied Sciences* 7(6): 803-809.