UNESWA Journal of Agriculture. 2019. Volume 20, pp. 1-7 http://ojs.uniswa.sz/
ISSN: 1029-0873

THE EFFECTS OF DIFFERENT GROWING MEDIA ON THE GROWTH AND DEVELOPMENT OF WHITE ASTERS (*SYMPHYOTRICHUM ERICOIDES L.)*

Mandla M. Makhubela, Paul K. Wahome, Tajudeen O. Oseni and Michael T. Masarirambi

Department of Horticulture, Faculty of Agriculture, Luyengo Campus, University of Eswatini, Private Bag Luyengo, M205, Eswatini

Email address: wahome@uniswa.sz

Abstract

All good potting media should meet the needs of plant's root for air, water, nutrients and support. Satisfactory growth of annual transplants and nursery crops can occur in soilless media made up of a wide range of components. White asters are important flowering plants usually grown in gardens, as potted plants and bedding plants. The purpose of this research was to investigate the effects of different growing media on the growth and development of white asters. The different treatments combinations used included: garden soil; soil + sand (1:1); sand + kraal manure (1:1); soil + sand + compost (1:1:1), and soil + sand + shredded bark (1:1:3). The treatments were arranged in a Randomized Complete Block Design (RCBD). White asters grown in soil/sand/shredded bark mixture had the highest number of leaves (32.0), plant height (23.2 cm), leaf area (30.9 cm^2), leaf area index (0.35), number of flowers (18.8), flower diameter (4.8 cm), shoot fresh mass (27.3 g), shoot dry mass (5.8 g), root fresh mass (3.6 g), root dry mass (0.6 g), and root length (13.2 cm). Plants grown in soil/sand/shredded bark mixture had twice the shoot dry mass of those grown in soil/sand/ compost medium. The roots dry mass of plants grown in soil/sand/shredded bark mixture was more than double that of plants grown in soil/sand/compost mixture. Plants grown in soil/sand/compost mixture had the lowest number of leaves (17.3), plant height (18.5 cm), leaf area (17.2 cm^2), leaf area index (0.19), number of flowers (11.5), flower diameter (4.2 cm), shoot fresh mass (13.6 g), shoot dry mass (2.9 g), root fresh mass (1.3 g), and root dry mass (0.3 g). Therefore, it can be recommended that farmers or florists who want to grow white asters may use soil/sand/shredded bark mixture for optimum growth and development of the plants.

Keywords: Flower quality, flower yield, growing media, vegetative growth, white asters.

INTRODUCTION

White asters (*Symphyotrichum ericoides L.*) also commonly known as heath asters, are native to much of North America including the Northwestern, Central and Eastern United States, much of Canada, as well as Northern Mexico, and have also been introduced to many areas beyond their native origin (Anon., 2013a). They belong to the Asteraceae Family formerly known as the Compositae Family. The white asters can be found in many open habitats in dry to moist soils. They are characterised by their white or rarely pinkish rays with yellow centres that become brown in late summer through fall (Anon., 2013a). Distinctive features include: many small white flowers, closely crowded along the stems (Anon., 2013b).

Houseplants or potted plants are used indoors in places such as residences and offices, in containers or in hanging baskets containing growing media. There are various reasons for growing plants indoors which include: decorative purposes, positive psychological effects, or health reasons such as indoor air purification (Anon., 2012a). A growing medium is a mixture of various raw materials designed to be used in horticulture as a substrate to support the roots of plants. Media provide water, nutrients (nitrogen, phosphorus, potassium, calcium etc.) and support for the plant.

Successful greenhouse and nursery production of container-grown plants is largely dependent on the chemical and physical properties of the growing media (Agriculture and Natural Resources, 2013). An ideal medium should be free of weeds and diseases, heavy enough to avoid tipping-over of the plants and yet light enough to facilitate handling and shipping (Agriculture and Natural Resources, 2013). The media also should be well drained and yet retain sufficient water to reduce the frequency of watering. Other parameters to consider include cost, availability, consistency between batches, and stability in the media over time (Agriculture and Natural Resources, 2013).

In the past few decades, peat moss has become the main component of growing media in Europe and overseas (Schmilewski, 2013). Dependence on peat in modern, industrial business is undeniable. The trend in the production of growing media is definitely not away from peat based media but towards more use of other components. However, their heterogeneous properties restrict their use (Schmilewski, 2013). Reasons for intensified use of composts in horticulture are increasing amount of waste and shortage of landfills (Schmilewski, 2013).

Sphagnum peat moss has been the most important growing medium constituent for many decades because its properties are the best available (Schmilewski, 2008). The use of other organic or mineral-organic materials is being forced ahead by research and development against background of public favour for peat replacement, recycling and re-use of bio-degradable waste. Most materials are only slightly or not suitable for use as growing medium at all. The exceptions are compost, wood fibre, shredded bark, and coir (Schmilewski, 2008). Peat-vermiculite mixes have been popular for many crops, but the high cost of these components stimulated research for substitutes (Hemphill *et al*., 1984). Each geographical area produces waste products, which have potential use as medium components. Shredded bark, woodchips, sawdust, leaf mould, straw, cinders, nut shells, grain hulls, bagasse etc. have been incorporated successfully into growing media (Anon., 2013c; Hemphill *et al*., 1984).

Generally, houseplants are grown in substrate not in soil. A good potting mixture includes all elements necessary for plant growth to provide the plant with nutrients, support, adequate drainage, and proper aeration. To obtain a growing medium with almost all these properties, it is necessary to choose growing medium components that will complement each other on the properties (Anon., 2012c). Some plants require potting soil that is specific for their environment. For example, an African violet would grow better in potting soil containing extra peat moss while a cactus would thrive in potting soil that contains material for sufficient drainage, most commonly perlite or sand (Anon., 2012d). But potting soil is not ideal for all container gardening. Insectivorous plants, such as the Venus flytrap and the pitcher plant, prefer nutrient-poor soils common to bogs and ferns while water-based plants thrive in heavier topsoil mix (Anon., 2012d).

For many years, the trend in conventional growing has been towards soilless media (Kuepper, 2013). A major reason for this is concern about soil-borne diseases and the excess density of mixes where soil is a dominant ingredient. Clean topsoil is an acceptable natural ingredient provided it is sterilized before use (Kuepper, 2013). Field soils are generally unsatisfactory for the production of plants in containers (Anon., 2013d). This is primarily because soils do not provide the aeration, drainage and water holding capacity required (Anon., 2013d). To improve this situation, several soilless growing media have been developed.

Coarse sand (builder's sand) provides porosity to potting media. Clean, washed sand has a near neutral pH and has little if any nutrients (Kuepper, 2013). Sand is much heavier than any other potting ingredient. It is least expensive and most available medium component (Kuepper, 2013). Sand is a naturally occurring granular material composed of weathered rock particles. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. In terms of particle size as used by geologists, sand particles range in diameter from 0.05– 2.0 mm (Anon., 2012e).

A large variety of compost or animal manure products is available in the marketplace. Their advantages include the nutrient contribution and potential improvement in media physical properties. Their disadvantages include possible high salts, fine particle size and weed seeds. In some areas compost products provide a low-cost media amendment. Critical issues to consider are the availability and consistency of the product and the particle size. Particle sizes for plant-based compost can be either too large or too fine depending on the source material and composting process (Anon., 2012b). Compost is perhaps the most common potting-mix ingredient among organic producers (Kuepper, 2013). It is cheaper than peat moss and holds water well, provides nutrients and can be made on the farm (Kuepper, 2013). The quality of compost depends in part on how it is made, but especially on what is made from. As the pH value, salinity and K_2O content of compost are practically always incompatible with plants, compost must always be blended with material with lower pH and concentrations of these compounds in such a way that risks are avoided or reduced (Schmilewski, 2008). Compost is organic matter that has undergone partial thermophilic, aerobic decomposition (Raviv, 2005). Compost provides organic matter, nutrient (slow release fertilizer with 1.8% N or more) and suppresses diseases due to fungistatic chemicals it contains (Raviv, 2005). Compost is used for soil amendment and as a potting mixture (Raviv, 2005).

Shredded bark is primarily a bi-product of the pulp, paper and plywood industries. Suitable particle size is obtained by hammer milling and screening. This produces a material which is suitable for use in container media (Anon., 2012b). The type of shredded bark available varies from area to area.

The two types are softwood with a pH of 5.0-6.0 and hardwood with a higher pH around 7.0. Shredded bark can be used as the primary medium component for epiphytic plants such as orchids. Bark can have disease-suppressive properties (Dole and Wilkins, 2005). Adding bark to growing medium increases porosity, drainage, cation exchange capacity (CEC) and provide for pH buffering (Schmilewski, 2008). However, the pH and salt content of composted bark can be too high. Composted bark has low CEC. When using bark as medium component, pH and nutrient levels should be regularly monitored (Will and Faust, 2013).

Many potted plants are commonly grown using soil in Swaziland. This is attributed to the fact that some of the materials used as potting media are costly, therefore, making it difficult for most people in a nation whose majority live on less than a dollar per day. This limits the quality of the houseplants as well as the production. This research sought to determine the best growing medium for potted plants through mixing the various growing medium components available at lower prices in the country.

MATERIALS AND METHODS

This study was conducted in a lath house in the Horticulture Department, Faculty of Agriculture, Luyengo Campus at the University of Swaziland, between November 2012 and February 2013. The area is located at the Malkerns valley with the latitude of 26º 34' and longitude 31º 12' at an altitude of 750 m above sea level. The soils are Ultisol, red in colour and medium in mixture (FAO, 2006a, b).

Two hundred white aster seedlings were purchased from the local nursery, Vickery Seedlings, Malkerns, Swaziland, at four-leaf stage and transplanted into 30 cm-plastic pots in November 2012. Different growing media components: garden soil, sand, kraal manure, compost and shredded bark were used in different proportions and combinations. The different treatments combinations were: garden soil; soil + sand (1:1 v/v); sand + kraal manure (1:1 v/v); soil + sand + compost (1:1:1 v/v); and soil + sand + shredded bark (1:1:3 v/v). The treatments were arranged in a Randomized Complete Block Design (RCBD). The treatments were replicated four times with 10 plants per treatment. Irrigation was carried out throughout the research process when necessary. Weeds were removed upon emergence so as not to affect the objectives of the study. Pests including aphids, caterpillars and leaf miners were controlled using decis. Four weeks after planting, plants were top-dressed with 10 g of 2:3:2 (37) fertilizer per plant.

Data was collected from the following growth parameters: plant height; number of leaves; leaf length; and leaf breadth. Leaf area was calculated using the leaf length and breadth and a correction factor of 0.75 was used. The data was collected once a week, starting from four weeks after transplanting (WAT). Data from the number of flowers and flower diameter were also collected at the end of the experiment. Fresh and dry masses of shoots and roots, and length of the root system were determined at the end of the experiment. Collected data were subjected to analysis of variance (ANOVA) using MSTAT-C Programme (Nissen, 1989). The means that were significant were separated using Duncan's New Multiple Range Test (DNMRT) at 5% level of significance (Little and Hills, 1978).

RESULTS

Number of leaves

The highest number of leaves (32.0) was obtained from plants grown in the soil/sand/shredded bark medium and the lowest (27.3) from those grown in soil/sand/compost mixture at 8 WAT (Figure 1). The second highest number of leaves was obtained from white aster plants grown using garden soil.

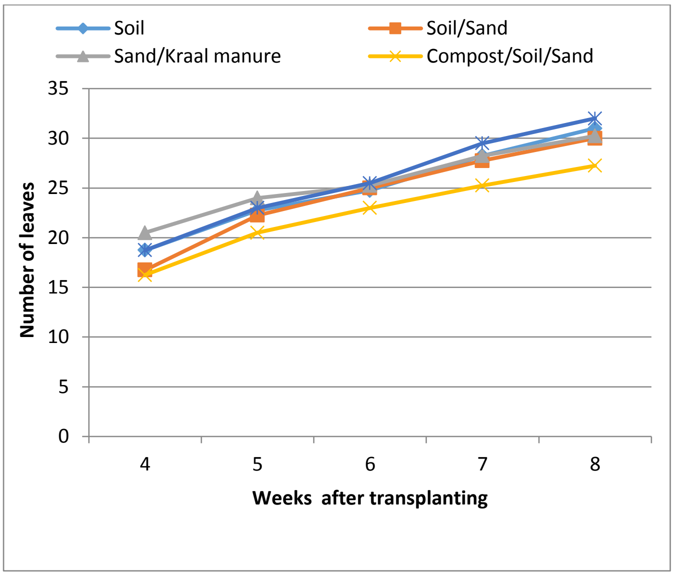

Figure 1: Effects of different growing media on the number of leaves of white asters.

Plant height

Similarly, white aster plants grown in soil/sand/shredded bark mixture showed the highest plant height (23.2 cm) while the lowest plant height (18.5 cm) was observed in plants grown in soil/sand/compost mixture at 9 WAT (Figure 2). The next highest plant height was obtained from those grown in sand/kraal manure mixture.

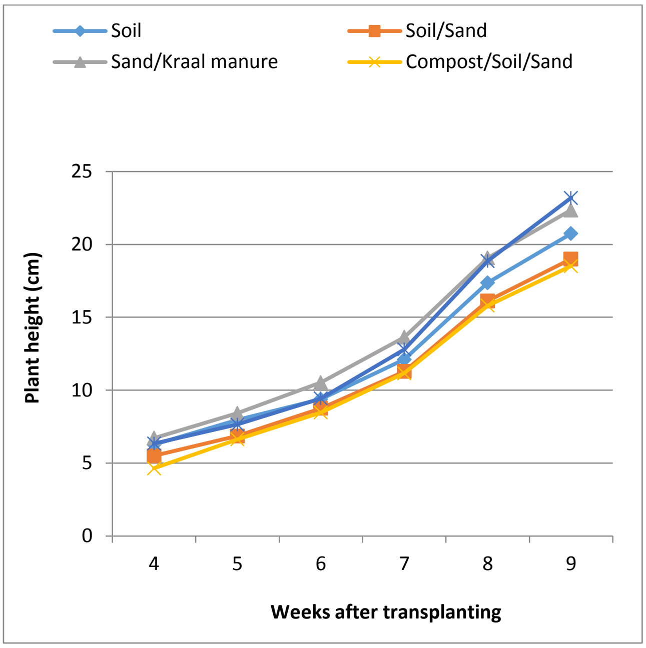

Figure 2: Effects of different growing media on plant height of white asters.

Leaf area and leaf area index

Plants grown in soil/sand/shredded bark mixture had the highest leaf area (30.9 cm^2) followed by those grown in sand/kraal manure medium at 8 WAT (Figure 3). The lowest leaf area (17.2 cm^2) was observed in those plants grown in soil/sand/compost mixture. The next highest leaf area was observed in plants grown using sand/kraal manure mixture. Growing white asters in soil/sand/compost mixture resulted in reduction in leaf area by almost a half when compared to those grown using soil/sand/shredded bark mixture.

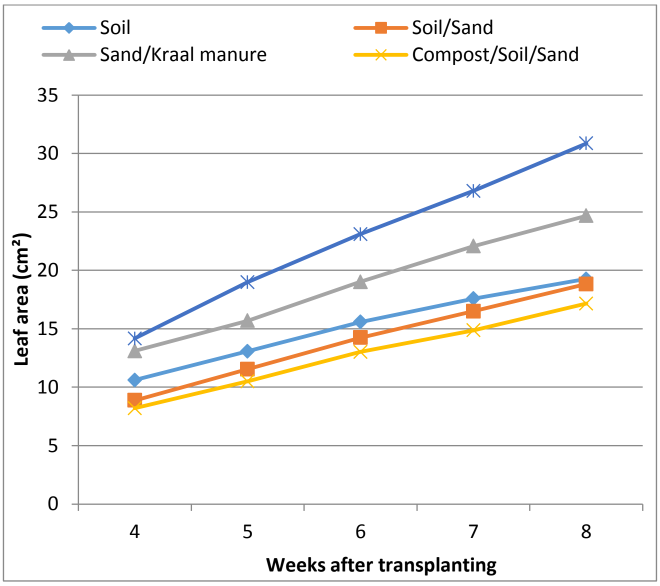

Figure 3: Effects of different growing media on leaf area of white asters.

Similarly, white aster plants grown in soil/sand/shredded bark had the highest leaf area index (0.35) followed by those in sand/kraal manure at 8 WAT (Figure 4). The lowest leaf area index (0.19) was observed in those plants grown in soil/sand/compost. A reduction in leaf area index by almost a half was observed between the plants grown in soil/sand/compost mixture and those grown using soil/sand/shredded bark mixture.

Number of flowers

There was a significant ($P<0.05$) difference in the number of flowers of white asters across all the five different growing media (Figure 5). The highest numbers of flowers (18.8) was observed in plants grown in soil/sand/shredded bark mixture but was not significantly different from those in sand/kraal manure and soil (Figure 5). The lowest number of flowers (11.5) was observed in those plants grown in soil/sand/compost but not significantly different from those in soil/sand medium.

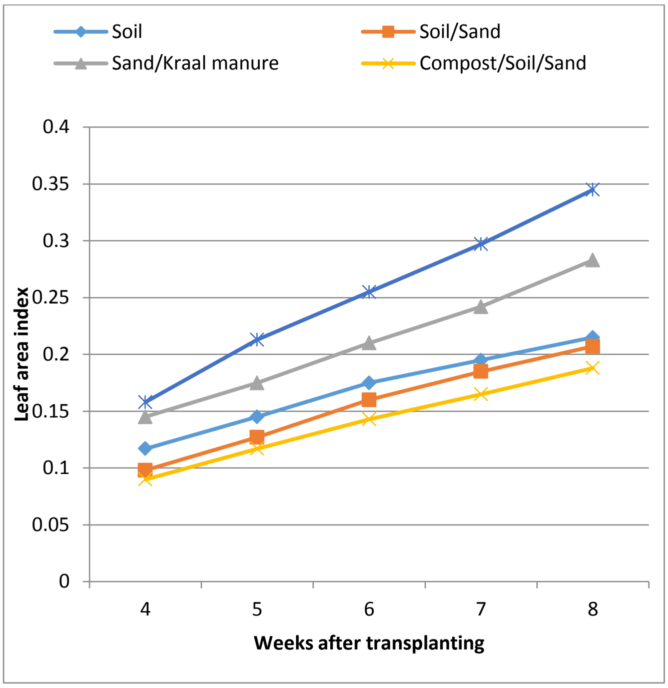

Figure 4: Effects of different growing media on leaf area index of white asters.

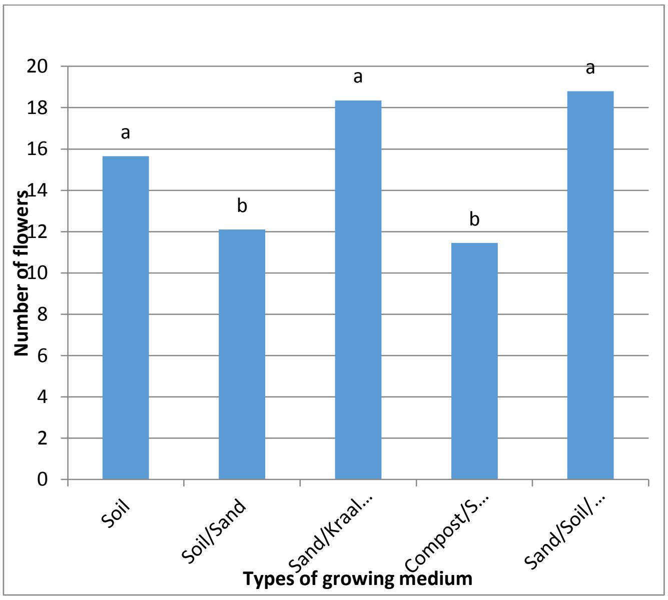

Figure 5: Effects of different growing media on the number of flowers of white asters. Bars followed by same letter not significantly different from each other at P = 0.005. Mean separation by DNMRT.

Flower diameter

There was no significant (P > 0.05) difference in flower diameter of white asters across all the five different growing media (Figure 6). The highest flower diameter (4.8 cm) was observed in plants grown in soil/sand/shredded bark mixture (Figure 6). The next highest flower diameter was recorded from plants grown in sand/kraal manure mixture. The lowest flower diameters was (4.2 cm) observed in plants grown in soil/sand/compost.

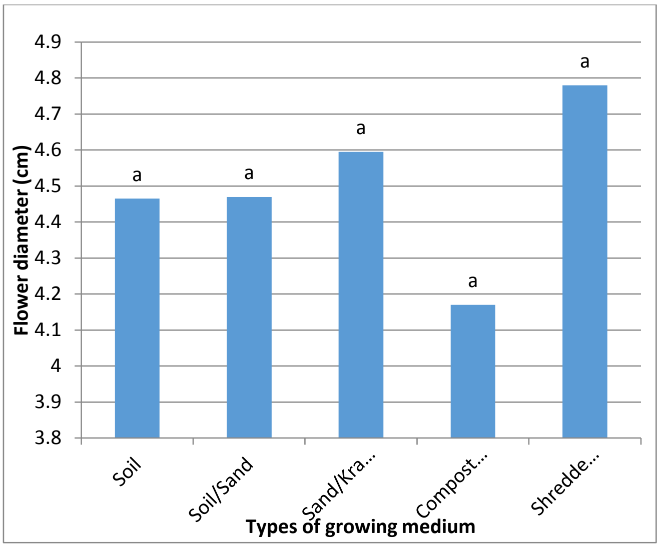

Figure 6: Effects of different growing media on the flower diameter of white asters. Bars followed by same letter not significantly different from each other at P = 0.005. Mean separation by DNMRT.

Shoot fresh and dry masses

There were significant (P<0.05) differences in the shoot fresh and dry masses of white asters across all the five different growing media (Figure 7). The highest shoot fresh mass (27.3 g) was obtained in plants grown using soil/sand/shredded bark medium followed by plants in sand/kraal manure mixture (Figure 7). The lowest shoot fresh mass (13.6 g) was recorded in those plants grown in soil/sand/compost medium. The highest shoot dry mass (5.8 g) was obtained in plants grown from soil/sand/shredded bark mixture followed by plants grown in sand/kraal manure mixture (Figure 7). The lowest shoot dry mass (2.9 g) was recorded in those plants grown in soil/sand/compost mixture. Plants grown in soil/sand/shredded bark mixture had twice the shoot dry mass of those grown in soil/sand/compost mixture.

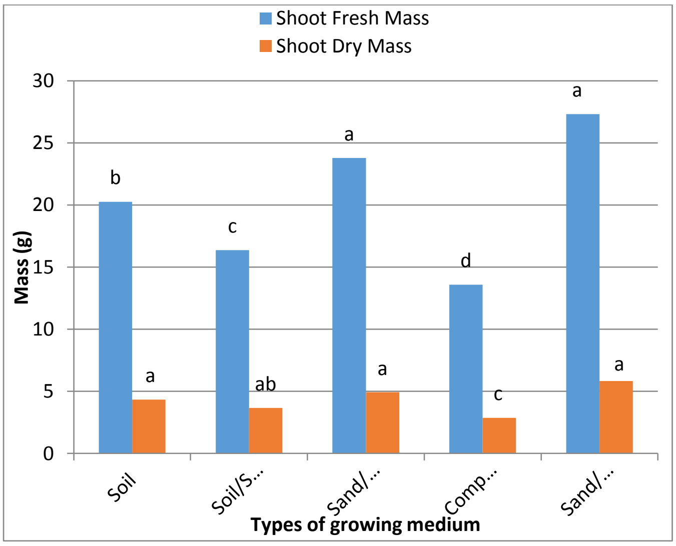

Figure 7: Shoot fresh and dry masses of white asters grown in different growing media. Bars for each parameter followed by same letter not significantly different from each other at P = 0.005. Mean separation by DNMRT.

Root fresh and dry masses

There were significant (P<0.05) differences in the root fresh and dry masses of white asters across all the five different growing media (Figure 8). The highest root fresh mass (3.6 g) was recorded in plants grown in soil/sand/shredded bark mixture followed by that of plants grown in sand/kraal manure medium (Figure 8). The lowest root fresh mass (1.3 g) was recorded in those plants grown in soil/sand/compost mixture. The root fresh mass of plants grown in soil/sand/shredded bark mixture was almost thrice that of plants grown in soil/sand/compost mixture.

Similarly, the highest root dry mass (0.7 g) was recorded in plants grown in soil/sand/shredded bark mixture followed by that of plants in sand/kraal manure medium (Figure 8). The lowest root fresh mass (0.3 g) was recorded in those plants grown in soil/sand/compost mixture. The root dry mass of plants grown in soil/sand/shredded bark mixture was more than double that of plants grown in soil/sand/compost mixture.

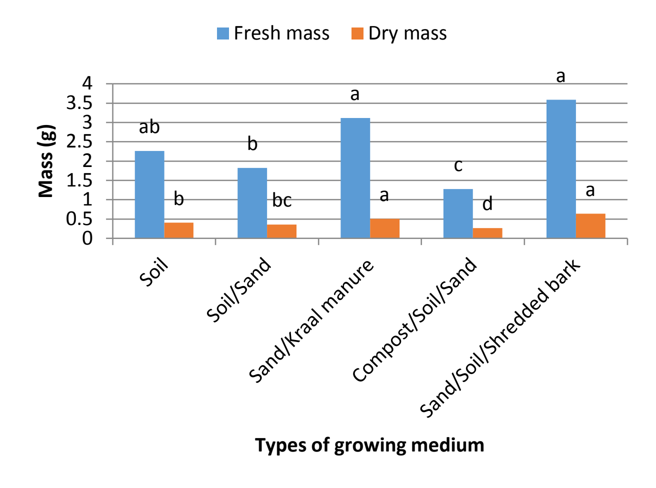

Figure 8: Root fresh and dry masses of white asters grown in different growing media. Bars for each parameter followed by same letter not significantly different from each other at P = 0.005. Mean separation by DNMRT.

Root length

There was a significant ($P<0.05$) difference in root length of white asters across all the five different growing media (Figure 9). The highest root length (13.2 cm) was recorded in plants grown in soil/sand/shredded bark mixture followed by that of plants in sand/kraal manure medium (Figure 9). The lowest root length (8.5 cm) was recorded in those plants grown in soil/sand mixture.

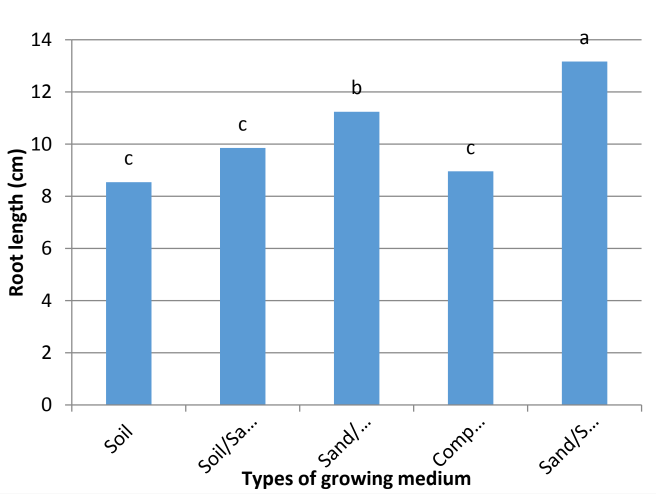

Figure 9: Effects of different growing media on the root length of white asters. Bars followed by same letter not significantly different from each other at P = 0.005. Mean separation by DNMRT.

DISCUSSION

White asters grown in the soil/sand/shredded bark mixture exhibited the highest number of leaves, plant height, leaf area, leaf area index number of flowers/plant, flower diameter, root length, shoot and root fresh masses, and biomass production: shoot and root dry masses. This was probably due to the fact that the medium had a high content of organic matter which improved the nutrient content in the medium. Nutrients such as nitrogen are well known for vegetative growth in plants. The medium was also probably more porous and better drained as compared to the other media. Similarly, (Schmilewski, (2008) and (Will and Faust, 2013) argued that addition of shredded bark to growing medium increases porosity, drainage, cation exchange capacity (CEC) and provide for pH buffering.

Plants grown in sand/kraal manure showed the next best results in all the parameters determined. The kraal manure probably provided the necessary nutrients essential for plant growth such as nitrogen, phosphorus, calcium etc. According to Christian *et al.* (2013), who studied the nutritive composition of kraal manure, found that kraal manure had all 13 essential nutrients. These essential plant nutrients are macro-nutrients: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and micro-nutrients: magnesium (Mg), sulphur (S) iron (Fe), boron (B), manganese (Mn), copper (Cu), molybdenum (Mo), zinc (Zn), and chloride (Cl). Inclusion of sand made the medium to be porous which made it easier for the plant roots to develop in the medium. El-Naggar and El-Nasharty (2009) reported that potting media as well as nutritional requirements are the most important factors affecting growth of ornamental plants.

Khayyat *et al*. (2007) observed that, the type of growing media and their characteristics are of utmost importance for the quality of rooted cuttings. Khayyat *et al*. (2007) attributed the improved root formation and growth in *Epipremnum aureum* cuttings rooted in medium mixtures containing leaf mould and sand to better aeration, drainage and water holding capacity. The higher root length in white asters grown in soil/sand/shredded bark mixture could probably be attributed to higher water holding capacity of the medium. Aeration also plays a very significant role in root elongation in plants (Anon., 2007). Shredded bark and sand could probably have contributed to the increased porosity in the medium. Similarly, Khayyat *et al*. (2007) reported that mechanical impedance and reduced porosity can reduce formation, growth and development of roots in cuttings.

The lowest values in most of the parameters measured were obtained from white asters grown using soil/compost/sand mixture. However, the quality of compost depends in part on how it is made, but especially on what it is made from. Compost contains low pH value, high salinity, fine particle size, and weed seeds, which poses risk to growth of plants (Anon., 2012b; Schmilewski, 2008). These negative attributes could probably have contributed to the reduction in growth and development of the white asters grown in compost containing medium in this investigation.

CONCLUSION

Growing white asters in soil/sand/shredded bark produced vigorously growing and well developed plants. In all the growth parameters determined in this experiment, plants grown in this medium had the highest response. Sand/kraal manure produced the next best results. Plants grown using soil/sand/compost showed the lowest results in all the parameters determined. Horticultural growers wishing to grow white aster in pots should use soil/sand/shredded bark medium to produce the best growth and development.

REFERENCES

Agriculture and Natural Resources. (2013). Growing media for container production in a greenhouse or nursery. Part 1- Components and mixes. http://www.uaex.edu/ other_Areas/Publication/pdf. 13/06/13.

Anonymous. (2007). Aeration. http://www.ecochem.com/t_soil_aeration.html. 23/05/07.

Anonymous. (2012a). Houseplants. http://en.wikipedia.org/wiki/Houseplants. 26 /02/12

Anonymous. (2012b).Choosing Potting Media. http://www.firstrays.com. 13/03/12

Anonymous. (2012c). Soil. http://en.wikipedia.org/wiki/Soil. 11/03/12

Anonymous. (2012d). Potting Soil.http://en.wikipedia.org/wiki/Pottingsoil. 24/02/12

Anonymous. (2012e). Sand. http://en.wikipedia.org/wiki/Sand. 03/03/12

Anonymous. (2013a). Heath Aster *(Symphyotrichum ericoides)* http://en.wikipedia.org/wiki/ Symphyotrichum_ericoides. 05/03/13

Anonymous. (2013b). White Asters. http://ontariowildflowers.com/main/species.php?id=11. 03/02/13

Anonymous. (2013c). *Symphyotrichum ericoides* (Heath Aster) http://www.minnesotawild flowers.info/flower/heath-asters. 19/02/ 13

Anonymous. (2013d). Ornamental production: growing media. http://aggie-horticulture.tamu. edu/ornamental/greenhouse-management/growing-media. 13/06/13.

Christian, J., Camberato, J. and Albrecht.J. (2013). Nutrient content of livestock and poultry manure. http://www.clemson.edu.cafls/department/biosystemseng/faculty_staff/research/ christian_nutrient_content_manure.pdf. 13/06/13.

Dole, J.M. and Wilkins, H.F. (2005). *Floriculture Principles and Species.* Pearson Education Inc., Upper Saddle River, New Jersey 07458, USA.

El-Naggar, A.H. and A.B. El-Nasharty, 2009. Effects of growing media and mineral fertilisation on growth, flowering, bulb productivity and chemical constituents of *Hippeastrum vittatum*, Herb. American-Eurasian J. Agric. & Environ. Sci. 6(3): 360-371.

Food and Agricultural Organisation (FAO), 2006a. Swaziland: Geography, population and water resources. http://www.fao.org/docrep/V8260B/ V8260B11.htm. 01/08/06.

Food and Agricultural Organisation (FAO), 2006b. Crop and food supply assessment mission to Swaziland. http://www.fao.org/docrep/007/j2678e/ j2678e00.htm. 01/08/06.

Hemphill, D.D., Tricknor, R.L. and Flower, D.J. (1984). Growth response of annual transplants and physical and chemical properties of growing media as influenced by composted sewage sludge amended with organic and inorganic materials. *Journal of Environmental Horticulture*. 2(4): 112-116.

Khayyat, M., F. Nazari and H. Salehi, 2007. Effects of different pot mixtures on Pothos (*Epipremnun aureum* Lindl. and Andre 'Golden Pothos') growth and development. American-Eurasian J. Agric. & Environ. Sci. 6(3): 360-371.

Kuepper, G. (2013). Potting mixes for certified organic production. http://www.calorinafarm stewards.org/wp-content/uploads/2012/12/pdf. 13/06/13.

Little, T. M. and Hills, F. J. (1978). Agricultural experimentation, design and analysis. John Wiley and Sons, Inc., New York.

Nissen, O. (1989). Mstat-C.A microcomputer programmed for the design and management and analysis of research experiments. Michigan State University. U.S.A.

Raviv, M. (2005). Production of high quality composts for horticultural purposes: A mini- review. *Hort Technology*. 15(1): 52-57.

Schmilewski, G. (2008). The role of peat in assuring the quality of growing media. *Mires and Peat*. 3: 1-8.

Schmilewski, G.K. (2013). Quality control and use of composted organic waste as components of growing media in the Federal Republic of Germany. http://www.actahort.org/books/294/294_9.htm. 13/06/13.

Will, E. and Faust, J.E. (2013). Growing media for greenhouse production. http://campus. extension.org/pluginfile/php. 13/06/13.

