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GROWTH AND FLOWERING RESPONSE OF *Tagetes erecta* L. (Asteraceae) GROWN IN DIFFERENT NURSERY MEDIA MIXTURES

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Abstract
Marigold (*Tagetes erecta* L.) is an annual ornamental bedding and pot plant of the family Asteraceae. This study on growth and flowering response of *T. erecta* grown on different locally sourced nursery media was conducted at the floriculture nursery of the Teaching and Research Farm, Federal College of Agriculture, Ishaigu Ebonyi State Nigeria. Six treatments comprised of mixtures of different growth media, namely topsoil + cured poultry manure + river sand, at varied ratios: T_1 (M3:2:1), T_2 (M2:3:1), T_3(M1:3:2), T_4 (M1:2:3), T_5 (M0:3:3), and T_6 – control (M6:0:0), respectively, were used. The screen house pot experiment was laid out in completely randomised design six replicates. Data on Plant Height-PH (cm), Number of Leaves (NL), Number of Branches (NB), Stem Diameter-SD (mm), Days to 50% Flowering (DF), Number of Flower (NF); including Root Length-RL (cm) and Dry Matter-DM (g) at 12 weeks after planting (WAP) were collected. Data were analysed using descriptive statistics and ANOVA . Results showed that the PH, NL, NF and DM of *T. erecta* at 12 WAP ranged 95.2 (T_1) to 71.1 (T_5), 85.0 (T_1) to 61.0 (T_6-control), 6.0 (T_1) to 5.0 (T_6-control), and 16.2 (T_1) to 8.4 (T_6-control), respectively; while NB, SD, RL and DF ranged from 21.0 (T_2) to 11.0 (T_6-control), 6.2 (T_4) to 3.5 (T_5), 12.8 (T_4) to 10.4 (T_6-control), and 58.2 (T_4) to 65.6 (T_5), respectively. The T_1 showed significantly ($P \leq 0.05$) higher values in PH, NL and DM than other growth media combinations; in addition to NF, although differences were non-signoficant among the treatments. Results from nursery medium T_1 (M3:2:1) conbination showed remarkably improved growth and yield of *Tagetes erecta* than the control growth medium (M6:0:0; topsoil only) and other growth media evaluated.

Keywords: *Tagetes erecta*, growth substrates, floriculture, topsoil, nursery media, propagation

Introduction

Marigold (*Tagetes erecta* L.) is an annual, herbaceous plant, and a member of the family Asteraceae The original home of marigold could be traced to the new world (Americas) and sacred flowers of the Aztecs, as it journeyed across the Atlantic ocean eastward to spread to other parts of the world where it is being cultivated today (Mulley *et al*., 2009). *Tagetes erecta* is the third most important cut flower in the global market after roses and carnations. The flowers of the plant come in different colours. They are in high demand, and mostly cherished during Easter and mothers' Day (Blonde and Noland, 2000). Flowering of *T. erecta* are best achieved under short photo-periods (Ref.) (Acharya and Dashora, 2004; Rahbarl *et al*., 2013). The plants can be used in various situations in the home garden, since it has a longer flowering period (Golestani *et al.,* 2013). *Tagetes erecta* flowers are a rich source of a natural yellow to orange dye, helenien (dipalmitar extract of axanthophylls) which is in high request by national and international companies (Acharya and Dashora, 2004; Ali and Hassan, 2013). The leave of the *T. erecta* can also be used as a spice and tea (Cetkovic *et al.,* 2003; Isaac, 1994). *Tagetes erecta* can be used in various situations in the home garden and in landscaping. It is one of the best plants for rock gardens, flower beds and balcony plantings. The plant is also reputed to be a snake repellant when situated in the garden, in addition to possession of pesticidal properties against nematodes and some common garden insect pests (Golestani *et al.,* 2013). Growing medium can be described as a material on which plant roots grow, find anchorage and extract

water and nutrients (ref.) (Baiyeri, 2002). Selecting a good growing medium is fundamental to good nursery management and is the foundation of a healthy root system. Growing media for use in container nurseries is available in two basic forms: soil based and organic based (Ref.) (Hartmann *et al*., 2007, Rahbarl *et al*., 2013). Compared with soil based media that has field soil as a major component, organic based media (a base of organic materials that may be compost, peat, saw dust, rice husk, coconut coir, poultry droppings etc. or other organic materials, mixed with inorganic ingredients) promotes better root development. In temperate areas, nurseries can choose from a wide range of commercial products for their growing media, including peat moss, vermiculite, and perlite, and premixed blends of these ingredients. Most nurseries in the tropics, however, do not have easy and affordable access to these materials, and even nurseries in temperate areas are seeking to replace some of these ingredients with more local and sustainable materials. In the tropics, growers often create their own media using locally available ingredients. A favorable growing medium consists of two or more ingredients. Growers must be familiar with the positive and negative characteristics of the various ingredients and how they will affect plant growth when creating a suitable growing medium, or even when purchasing a commercial one where available (Shadanpour *et al.,* 2011; Hartmann *et al*., 2007). It is essential to characterize the growing media which greatly affect plant growth, development and use/application in the garden environment (Yasari and Patwardhan, 2007; Razzaq, 2014). *Tagetes erecta* is one of the most important flowering annual crops in the international flower trade and is grown at large scale for the beautification of landscape gardens, indoor decoration and for making garlands. However, few studies have focused on growth and productivity of this ornamental plant in locally formulated potting media in Nigeria (Ekwu and Mbah, 2001a; Abiola *et al.,* 2005). Also there is need to identify suitable growth media formulation that will enhance early establishment and growth of the ornamental annual, *T. erecta*, in southeast Nigeria agroecology. Therefore, the objective of this present study was to evaluate the efficacies of six different nursery media from locally available materials (composed of varying ratios of topsoil/poultry manure/river sand) on some growth and yield parameters of *T. erecta*).

Materials and Methods

This research was conducted at the Floriculture nursery of the Department of Horticulture and Landscape Technology, Federal College of Agriculture (FCA), Ishiagu, Ebonyi State Nigeria, during 2918 cropping season. The College lies along 05°55'N latitude, 07°33'E longitude and altitude of 59 m above sea level, with average annual rainfall of about 1735.7 mm and average annual temperature of about 29.4 °C. Certified seed pack of *T. erecta* was obtained from ShopRite Departmental Stores, Umuahia, Abia State, Nigeria. Seeds of *T. erecta* were initially raised on a nursery tray filled with mixed river sand and saw dust substrate for germination. The seeds were nurtured to seedlings stage for three weeks in the pre-nursery before transplanting to main nursery growth media in pots for establishment and monitoring. Each nursery pot (15 cm by 30 cm dimension) was filled 12 Kg of the growth medium and planted with three healthy seedlings. The experiment was laid out in a Completely Randomized Design (CRD) with six treatments comprised of mixtures of top soil, cured poultry and river sand in varied ratios (namely: M3:2:1, M2:3:1, M1:3:2, M1:2:3, M0:3:3, M6:0:0, respectively), and five replications. Standard cultural nursery practices, including daily watering, weeding at six week after planting (WAP), staking at eight (WAP), and insect pest control as at when due were carried out. Physico-chemical soil analysis of the different nursery growth media samples before transplanting was carried out at Soil laboratory of the National Root Crop Research Institute (NRCRI), Umudike Abia State Nigeria. growth and yield parameters collected for assessment of treatment effects included: plant height (cm), number of leaves, number of branches, stem diameter (mm) using digital caliper, day to 50% flowering, number of flower per plant; root length (cm) and dry matter (g) both at 12 weeks after planting (WAP). Data collected were analysed using analysis of variance, (ANOVA) whereas, comparison of treatment means was carried out using Fisher's Least Significant Difference (F-LSD) at $P \leq 0.05$.

Results and Discussion

The nursery growth media and local soil sample used were made up of three different textural classes namely: sandy clay loam (M3:2:1, i.e. topsoil/poultry manure/river sand respectively), sandy loam (M2:3:1, M1:3:2, M6:0:0) and loamy sand (M1:2:3, M0:3:3); where M6:0:0 was topsoil from the locality which also served as control (Table 1). The media pH range showed that M3:2:1, M1:2:3 and M0:3:3 were moderately acidic, M 2:3:1 and M1:3:2 were slightly acidic; while the local topsoil was very strongly acidic. Available phosphorus (P) was high in most of the media, except in local topsoil 6:0:0 which had least 5.02 mg/kg soil. Similarly, the Cation Exchange Capacity (CEC) was low in local topsoil with 10.50 cmol/kg soil, but high in the other nursery media. The physical composition of nursery growth medium could have profound impact on the supply of water and air to the growing plant, in addition to root anchorage, nutrient and water holding capacity of the medium. Such physical properties of growth medium could indirectly impact seed germination, but directly influence the emergence and vigour of seedling with subsequent effect on quality of seedlings produced. In fact, quality of seedling produced from well formulated growth medium is known to influence their success rate of establishment in the field, as well as the future productivity of permanent crops (Baiyeri, 2002; Ahmadloo *et al*., 2012). In this present study, media used differed in sand/clay proportions and organic matter content, and invariably the quantity and availability of air, moisture and nutrient to the seedlings. This could explain the reason for the

remarkable effect of the different media on growth parameters (including number of leaf, stem diameter, root length, and dry matter production) that were monitored.

Effect of growth media on some growth parameters of marigold (Tagetes erecta)

The response of *T. erecta* growth parameters to different nursery growth media is shown in Table 2. The T_1 (M3:2:1) grown *T. erecta* plant height (95.1±7.20) were significantly ($P \leq 0.05$) higher than control T_6 (78.0±15.70), while the plant height ranged from 95.1±7.20 to 71.1±22.90 in T_1 (M3:2:1) to T_5 (M0:3:3), respectively and mean of 85.1 cm. Table 2 also showed the effect of nursery media on the number of leaves of marigold (*Tagetes erecta*) at 12WAP. The T_1 (M3:2:1) grown marigold had more photosynthetic capacity in terms of number of leaves per plant (85.0±14.4) than the other growth media, including control T_6 (M6:0:0) which had (61.0±16.00). Moreover *T. erecta* grown on T_1 (M3:2:1) had significantly ($P \leq 0.05$) more number of leaves than those of T_5 and T_6. The present results corroborated the report of Abiola *et al*. (2005) which indicated that similar growth media mixes of poultry manure and top soil (2:1; v/v) used gave remarkably highest plant height, number of branches and number of leaves than both control (topsoil alone) and poultry + top soil (1:1;v/v). Remarkably, T_2 (M2:3:1) grown marigolds produced significantly ($P \leq 0.05$) more number of branches (21.0±2.87) ($p<0.05$) than control (M6:0:0) (11.0±3.16) among other growth media. In addition, T_2 (M2:3:1) plants had longer root length (12.8±2.14) than other treated marigolds including the control medium grown ones (10.4±1.50), although the difference was non-significant. Stem diameter was greater in T_4 (M1:2:3) grown marigolds than control medium T_6 (M6:0:0) plants among others, but the difference was non-significant as well.

Effect of growth media on some yield parameters of marigold (Tagetes erecta) at 12 WAP

The result obtained in Table 3 showed the effect of nursery media on days to 50% flowering of marigold (*Tagetes erecta*). Mean days to 50% flowering among the marigolds was 63.5 DAP, with the range of 58.2±5.90 to 64.6±7.70 in T_4 (M1:2:3) and T_1 (M3:2:1), respectively. The T_4 (M1:2:3) which recorded least number of days (i.e. earliest day) to 50% flowering was significantly ($P \leq 0.05$) different from the other growth media, including the control T_6 (M6:0:0). Similarly, the mean number of flowers produced per marigold stand at 12 WAP was 5.6 flowers. The difference between least 5.0±0.98 (in T_6 (M6:0:0)) and highest 6.0±2.76 (in T_1 (M3:2:1)) number of flowers was non-significant. In terms of dry matter production, the T_1 (M3:2:1) grown marigolds gave remarkable highest (16.2±2.79 g) dry matter among all the growth media, while the least (8.4±1.36 g) was obtained in the control growth medium plants. In the same vein, T_1 (M3:2:1) had significantly ($P \leq 0.05$) higher dry matter production than T_2 (M2:3:1) and control T_6 (M6:0:0) Abiola *et al.* (2005) also reported similar trend where poultry manure and topsoil growth media mixes (2:1;v/v) gave highest number of flowers than the control (topsoil alone) and poultry manure + topsoil (1:1;v/v). This is also in agreement with the findings of Ekwu and Mbah (2001b). Of noteworthy also is the relative appreciable performance of T_4 (M1:2:3) in thicker stem diameter of *T. erecta* seedlings and earliest days to flowering which merited further investigation as to its suitability as alternative nursery medium for pot plants generally, and florist crops in particular (Baiyeri, 2002).

Conclusion

results revealed that tested growth media influenced *Tagetes erecta* growth and yield parameters, it is obvious that T_1(M3:2:1) (topsoil +cured poultry manure + river sand) performed better in critical growth and yield indices (plant height, number of leaves, number of flower and dry matter production) than the control (T_6 – M6:0:0) topsoil alone and other media evaluated; although T_4 (M1:2:3) grown plants possessed thicker stem diameter and showed earliest days to flowering which may also be of interest to the commercial flower gardener.

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Table 1: Physico-chemical properties of select nursery media and soil samples tested for growth and yield parameters of *T.erecta*

Parameters	Growth media mixes (topsoil : poultry manure : river sand)					
	M3:2:1	**M2:3:1**	**M1:3:2**	**M1:2:3**	**M0:3:3**	**M6:0:0**
pH water	5.8	6.3	6.2	5.9	5.6	4.8
Available P (mg/kg)	64.7	63.3	70.6	81.4	65.8	5.02
Organic matter (%)	5.41	2.76	3.64	5.50	5.50	0.33
Carbon (%)	3.14	1.6	2.11	3.19	3.19	3.76
Nitrogen (%)	0.271	0.138	0.182	0.225	0.275	0.190
Exch. Bases (cmol/kg) Ca	23.6	21.2	14.8	17.6	19.2	6.00
Mg	10.8	15.6	14.4	8.4	10.8	2.0
K	0.644	0.434	0.082	0.10	0.105	0.105
Na	0.768	0.610	0.416	0.624	0.718	0.639
Exch. Acidity (cmol/kg) Al^{3+}	0.08	0.32	0.16	0.24	0.16	0.40
H^{+}	0.40	0.56	1.04	0.56	0.48	1.36
Cation exch. Capacity (cmol/kg)	36.29	38.72	30.89	27.52	31.46	10.50
Base saturation (%)	98.67	97.30	96.11	97.09	97.96	83.23
Particle size (%) : Sand	64.6	64.6	68.6	80.6	80.6	74.6
Silt	14.8	16.8	16.8	8.8	8.8	10.8
Clay	20.6	18.6	14.6	10.6	10.6	14.6
Textural class	SCL	SL	SL	LS	LS	SL

SCL = sandy clay loam; SL= sandy loam; LS = loamy sand

Table 2: Responses of some growth parameters of *Tagetes erecta* to different nursery growth media at 12 WAP†

Treatments	Plant height (cm)	Number of leaves	Number of branches	Stem diameter (mm)	Root length (cm)
T_1 (M3:2:1)	95.1±7.20	85.0±14.4	19.0±5.16	5.6±1.43	12.6±1.74
T_2 (M2:3:1)	91.4±8.40	82.0±13.10	21.0±2.87	5.4±1.75	12.8±2.14
T_3 (M1:3:2)	85.0±17.40	84.0±19.40	20.0±3.54	5.4±1.11	12.0±3.10
T_4 (M1:2:3)	89.9±19.3	75.0±16.80	18.0±5.61	6.2±0.80	12.8±1.94
T_5 (M0:3:3)	71.1±22.90	65.0±13.70	13.0±1.17	3.5±1.50	11.6±1.83
T_6 (M6:0:0)	78.0±15.70	61.0±16.00	11.0±3.16	4.1±2.12	10.4±1.50
Mean	85.1	75.4	16.9	5.1	12.0
F- LSD 0.05	11.61	12.62	5.65	NS	NS

†Values are mean ± SD (n = 15) (n=30); N/B: the treatment comprised of top soil, cured poultry manure and river sand mixed in varied ratios as listed. WAP = week after planting; NS = non-significant

Table 3: Responses of *Tagetes erecta* yield parameters to different nursery media at 12WAP †

Treatments	Day to 50% flowering	Number of flower	Dry matter (g)
T_1 (M3:2:1)	64.6±7.70	6.0±2.76	16.2±2.79
T_2 (M2:3:1)	65.2±8.10	6.0±0.80	12.2±1.33
T_3 (M1:3:2)	63.2±8.00	6.0±1.49	16.0±2.76
T_4 (M1:2:3)	58.2±5.90	6.0±1.55	14.4±2.24
T_5 (M0:3:3)	65.6±1.60	5.0±2.12	14.2±2.4
T_6 (M6:0:0)	64.0±4.60	5.0±0.98	8.4±1.36
Mean	63.5	5.6	13.6
F- LSD (0.05)	4.05	NS	3.25

†Values are mean ± SD (n = 30); N/B: the treatment comprised of top soil, cured poultry manure and river sand mixed in varied ratios as listed. NS = non-significant