

Full Length Research

Effect of Soil Media on Growth of Tomato Seedlings (*Solanum lycopersicum* L.) under nursery (Greenhouse) Conditions

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Production of healthy and vigorous tomato seedling is most important factor in successful commercial production and yield of quality tomato fruits. Moreover, germination of the seed is a critical stage, because the rest of the plant life is directly dependent upon the rate of its germination. Therefore, this experiment was conducted to investigate the effect of soil media on seedling growth of two tomato cultivars (Makis F1 and Nirvana F1) on different soil media. Soil media treatments were used either alone or in combination (Farm Yard Manure—FYM, compost, canal silt, FYM + compost, FYM + canal silt, compost + silt and FYM + compost +silt). Comparatively, both cultivars 'Makis F1' and 'Nirvana F1' exhibited highest plant height for soil media (T6, T7, T2 and T3) and lowest for T4, T5, and T1. Soil media had profound effect on seedling girth. T7, T8, T6, T3, T2 record the highest seedling girth while T1, T4 and T5 had the lowest. Although cultivar 'Nirvana F1' maintained higher seedling girth in all the soil treatments, cultivar 'Makis F1' had the highest seedling girth under soil media T7 and T8. T7 registered the highest dry weight (DW) followed by T6. While soil media T2, T3, scored slightly lower DW than T7, the lowest DW obtained for T1 and T4. Cultivar 'Nirvana F1' had the highest germination percentage than cultivar Makis F1 that showed unsteady pattern of germination percentage. FYM alone was found to have the lowest growth characteristics due to its highly concentrated nutrients which lower the osmotic potential of soil media that limit the absorption of water by the roots of seedlings hence leading to reduced seedling growth. Soil media containing mixture of equal proportion of FYM, compost and canal silt are recommended for raising tomatoes seedling as their combination improved both germination and subsequently growth compared to soil media used alone. FYM is not recommended to be used alone in raising tomatoes seedlings since it has high concentrated nutrients which lower seedling growth.

Keywords: Tomato, *Solanum lycopersicum* L., soil media, growth, seedling establishment

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a high-value vegetable crop that is widely consumed fresh or processed and grown in almost every country of the world (Naika *et al.*, 2005). The increase in area of production and value has increased the economic significance of the crop worldwide (Bodunde *et al.*, 1993). Rao *et al.* (1998) found that tomatoes and tomato products have numerous health benefits and also contribute to a well-balanced diet. They are a key source of essential nutrients including vitamin A, C and E

(Beecher, 1998), providing approximately 20 mg of vitamin C per 100 grams of edible product (Wilcox *et al.*, 2003). The production of healthy and vigorous tomato seedling is most important factor in successful production and yield of tomato fruits. Germination of the seed is a critical stage, because the rest of the plant life is directly dependent upon the rate of its germination (Qadir and Shahzadi, 1969). Growth medium is known to have effect on value of potted ornamental plants (Vendrame *et al.*, 2005) and plays an important role in

germination rate, and many other physiological parameters including plant height, number of leaves, spike length, number of florets per spike, spike diameter and yield, etc. (Vendrame *et al.*, 2005). A best Growing media should have proper aeration, water holding capacity and adequate nutrition supply; different manures provide good nutrition to plants when applied in combination with soil less substrates (Khobragade *et al.*, 1997; Hartmann *et al.*, 2011). Different vegetative and reproductive growth parameters produced best results favoured by different soil less media are observed in rose (Ahmad, 1989). Neelam *et al.* (2001) conducted an experiment on response of *Eucalyptus comaldulensis* seedlings to different soil media and found the maximum plant height (90.41 cm), more number of leaves per plant (31.89) and stem thickness (0.521 cm) were observed in silt +clay media. Vineeta *et al.* (2005) reported that soil structural stability increased due to straw addition with better aggregate size distribution and reduction in soil disturbance. He further added that soil organic matter acts as a reservoir for plant nutrients and prevents leaching of elements necessary for plants growth. Keeping in view the response of seedling growth to various soil and climatic conditions, this trial was conducted to study the effect of different soil media on tomato seedling growth under climatic condition of South Sudan.

Tomato is an annual plant, in the solanaceae family, typically growing to 1-3 m tall, with a weakly woody stem that usually scrambles over other plants. The fruit is edible; brightly colored (usually red, from the pigment lycopene) its diameter ranges between 1-2 cm in wild plants and cultivated forms. Botanically, it is a berry, with a subset of fruits. Furthermore, the tomato fruit is of nutritional importance with essential food value. In South Sudan, tomato is grown under rain fed condition however, in Double Harvesting Farm drip irrigation was used to supplement the rainfall.

Several soil media have been investigated to enhance seedling growth at an early stage. Farm yard manure (FYM) is one of the components of soil mixtures in seedling establishment.

Farm Yard Manure (FYM) is one of the oldest manure used by the farmers in growing crops because of its easy availability and presence of all the nutrients required by the plants. Farmyard manure refers to the decomposed mixture of dung and urine of farm animals along with their litter and left over material from roughages or fodder fed to the cattle. Application of this source of organic manure improves physical, chemical and biological condition of the soils. FYM can supply all the nutrients required by the plant, however with low quantity.

Compost manure is the product resulting from the controlled biological decomposition of organic material. More specifically, compost is the stable, humus-like product resulting from the biological decomposition of organic matter under controlled conditions. A wide range

of materials may be composted, but they must consist of principally organic components (i.e. carbon-containing remnants or residues of life processes). The starting materials for composting are commonly referred to as feedstocks. Feedstocks such as yard trimmings, wood chips, vegetable scraps, paper products, sorted municipal solid waste (MSW), animal carcasses, manures and wastewater sludges (biosolids) have all been composted successfully. Mixtures of organic materials may be more or less heterogeneous, but are rendered more physically homogenous through the composting process. Particles are made smaller and the total volume of the original materials is reduced (usually by 30 to 50 percent). Volume reduction is one of the benefits of composting

Silt soil is similar to loam soil but contains smaller ratios of both sand and clay particles. Silt soil feels smooth and silky. Silt soil retains water well but may drain slowly depending on the exact clay-silt-sand ratio. Silt is commonly found in floodplains and is the soil component that makes mud. Soils with a lot of silt make excellent farm land, but erode easily. This is the soil blown away in dust storms and carried downstream in floods

Objectives of the study

Therefore, the objectives of the study were twofold:

- 1) To investigate the effect of different soils media on tomato seedling growth.
- 2) To find a suitable soil media for raising tomato seedlings in nursery.

MATERIALS AND METHODS

Experimental site and location

Field experiment was conducted at Double Harvesting Farm located in Gumbo area south west of Gumbo market, Rajaf Payam, Juba County, Central Equatoria State, South Sudan near the freedom bridge across the River Nile. The farm, owned by South Sudanese, lies on latitude 4°48.595"N and longitude 31°36.375" E and altitude 1480ft above sea level. The soil characteristics at the experimental site were moderately drained sandy loam. This location places the site in the tropical humid climate. The experiment was conducted between February 12th 2015 and March 4th 2015 to find out the effect of soil media on tomato seedling growth under climatic conditions of South Sudan.

Plant materials

Two tomato (*Solanum lycopersicum* L) cultivars "A" Makis F1 and "B" Nirvana F1 were used in this experiment.

The materials used during the experiment were: ruler, tape measure, hoe, sowing crates, electric weighing scale, tomato seeds, different soil media and water. The data collected were for plant height, seedling girth, number of leaves, germination percentage and dry weight of plant for some selected tomato plants randomly from each plot. The seed were kindly provided by Double Harvesting Farm. Fresh, uniform and healthy certified seed from East – West International LTD for both varieties were selected for this purpose. The seeds were sown in medium size plastic sowing crates having length of 50 centimetre (cm) and width 25 centimetres (cm) each containing 72 holds. The size of the hold in sowing crate is 5.5 cm in depth and has two opens on the top it has an area of 12.25 cm² and on the bottom it has 6.25 cm² containing different types of soil media. One sowing crate with three replications was arranged in randomized complete block design. In total, eight sowing crates per variety in each replication were arranged in randomized complete block design with three replications. Four plants in each treatment per replication were selected to obtain the data required.

Experimental design

The experiments were laid out in randomized complete block design (RCBD) consisting of eight treatments, three replicates and three blocks and two varieties were used for this experiment. The treatments used for this experiment were based on soil media alone and in combinations. All nursery management practices were carried out as usual. The following soil media were used:

T1 Farm yard manure: 100%

T2 compost manure: 100%

T3 Canal silt: 100%

T4 Farm yard manure + compost manure: 50%+50%

T5 Farm yard manure + Silt: 50%+50%

T6 compost manure + Silt: 50%+50%

T7 Farm yard manure + compost manure + Silt: 33%+33%+33%

T8 Control: Ordinary soil*.

* Soil samples collected from the experimental site.

Growth parameters

The growth parameters such as plant height (cm), number of leaves, seedling girth (cm), dry weight (DW)/plant per replication was simultaneously recorded days after seed emergence (DAS) whilst obtaining the data for other parameters. Germination percentage (%) was taken after four days of seed emergence (DAS).

Management and experimental data

Management of data included information on planting date, stages in nursery, crop variety and irrigation. The data were needed for both evaluation and analysis. Crop type and cultivar (Two tomato cultivars namely A “Makis F1” and variety B “Nirvana F1”) were utilized in this experiment as mentioned in the plant material section above. Planting date was performed at a 2 cm depth on 12/02/2015; seedling emergence was recorded 4 days after planting (DAP) (16/02/2015). There were three (3) stages; stage one and two were in the open green house and stage three outside the green house (hardening stage).

Plants spacing of one plant per a hold was maintained in the sowing crate of medium size having length of 50 centimetres (cm) and width of 25 centimetres (cm) each containing 72 holds. The size of the hold in sowing crate was 5.5 cm in depth.

Irrigation was carried out with the nozzle using carefully adjusted to allow reduced strong droplets at the first stage of the seedling. Irrigation interval was determined by the weather conditions of day but in average is done in every two hours

Planting equipment included plastic sowing crate, medium in size having length of 50 centimetre (cm) and width of 25 centimetres (cm) each containing 72 holds. The size of the hold in sowing crate is 5.5 cm in depth and had two openings on the top it has an area of 12.25cm² and on the bottom it has 6.25cm² containing different types of soil media.

Soil appearance of control treatment (T8) was loam soil, black in color with enough humus content.

Data analysis

The data collected for all parameters measured were analyzed by analysis of variance (ANOVA) using a randomized complete block design (RCBD) of 3 replicates and means differences were separated by their DMRT (Duncan's multiple range test) 5% level of significance.

RESULTS

The statistical analysis of the data revealed the following findings:

The data obtained from the both cultivars A (Makis F1) and B (Nirvana F2) were for plant height(cm), seedling girth (cm), number of leaves, dry weight in gram and germination percentage(%) and there mean values were entered in table 1. and illustrated in graphs below

Comparatively, both cultivars ‘Makis F1’ and ‘Nirvana F1’ exhibited plant height for soil media (T6, T7, T2 and T3) and lowest for T4, T5, and T1 (Figure 1.)

The observation on the effect of soil media on seedling girth of two tomato cultivars showed that soil media has profound effect on seedling girth. T7, T8, T6, T3, T2

Table I: Effect of different soil media, on plant height, seedling girth, number of leaves, dry weight (DW) and germination percentages tomato under nursery (greenhouse) conditions

Treatments Cultivars	Plant height (cm)		Seedling girth (cm)		Number of leaves		Dry weight g/plant		Germination (%)	
	Makis F1	Nirvana F1	Makis F1	Nirvana F1	Makis F1	Nirvana F1	Makis F1	Nirvana F1	Makis F1	Nirvana F1
T1	4.63 c	4.72 c	0.36 b	0.40 c	4.08	3.83	0.025 bc	0.025 c	63.88	85.18
T2	6.59 a	5.98 b	0.68 ab	0.65 ab	4.42	5.92	0.042 bc	0.058 ab	81.48	86.11
T3	6.33 ab	6.72 ab	0.54 b	0.68 a	4.58	5.33	0.050 ab	0.058 ab	73.14	87.03
T4	4.58 c	5.14 c	0.37 b	0.48 c	4.25	4.42	0.025 bc	0.025 c	51.84	77.77
T5	4.88 c	5.33 c	0.38 b	0.48 c	4.08	4.50	0.025 bc	0.050 b	71.29	83.33
T6	5.98 ab	6.93 a	0.56 b	0.82 a	5.08	5.83	0.066 a	0.066 a	87.03	86.11
T7	6.75 a	6.58 ab	0.84 a	0.68 a	5.33	5.25	0.058 a	0.075 a	71.29	85.18
T8	5.74 bc	5.74 bc	0.65 b	0.58 c	4.75	5.50	0.050 ab	0.042 bc	70.36	80.55
% CV	16.9	11.02	22.8	5.75	7.56	15.68	30.32	23.60	12.25	22.23
SE	0.26	0.22	0.042	0.032	0.12	0.99	0.0043	0.0039	2.91	6.22
F-test	*	*	*	*	NS	NS	*	*	NS	NS

DMRT (Duncan's multiple range test) of treatment means in columns followed with the same letter are not significantly different from each other at 5% level of significance, (NS) not significant (NS), (*) significant at 5% level of significance ($P < 0.05$).

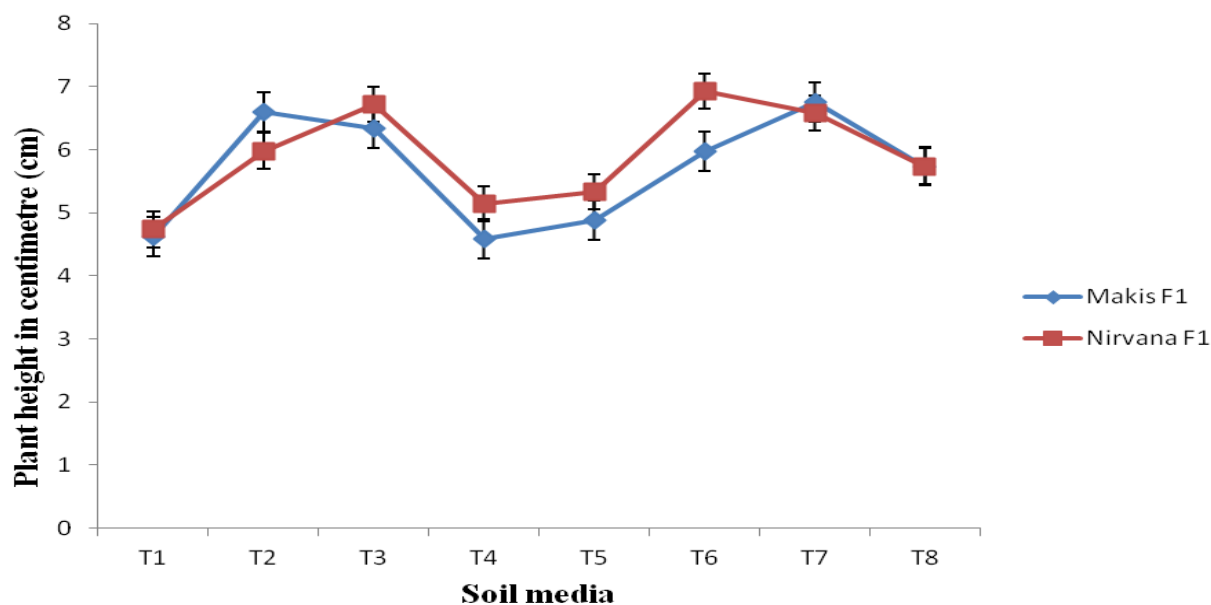


Figure 1: Effect of different soil media on the plant height (cm^2) of two tomato cultivars (Makis F₁ and Nirvana F₁). Means separated by DMRT (Duncan's multiple range test) at 5% level of significance ($p < 0.05$).

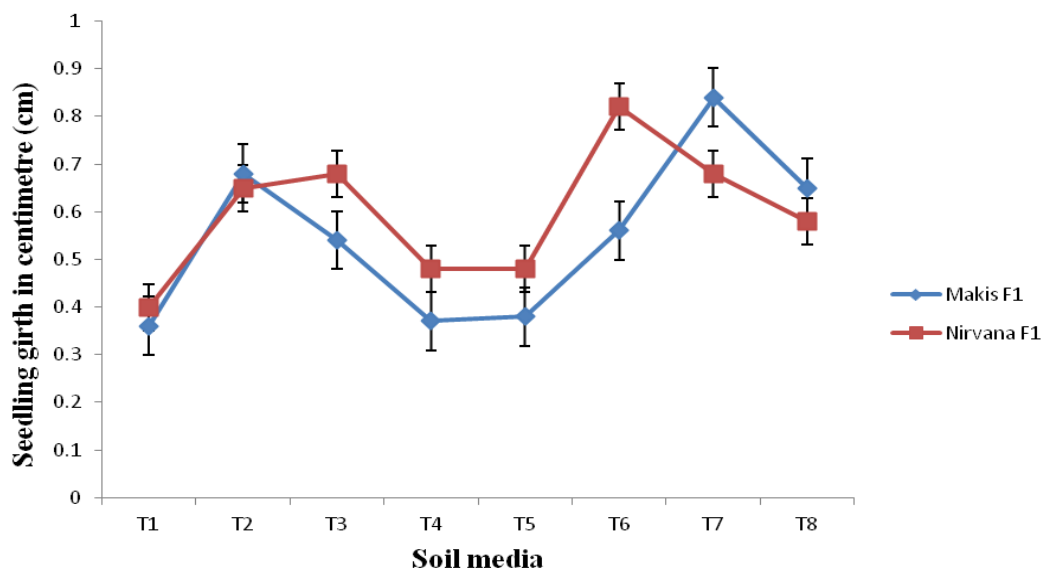


Figure 2: Effect of different soil media on seedling girth of two tomato cultivars (Makis F1 and Nirvana F1). Means separated by DMRT (Duncan's multiple range test) at 5% level of significance ($p < 0.05$).

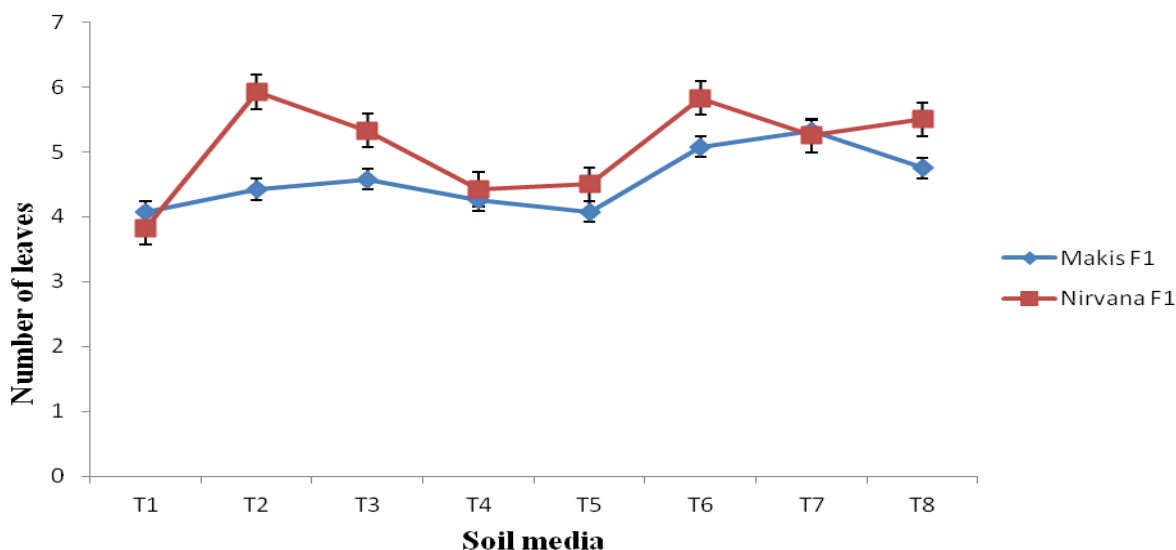


Figure 3: Effect of different soil media on number of leaves of two tomato cultivars (Makis F1 and Nirvana F1). Means separated by DMRT (Duncan's multiple range test) at 5% level of significance ($p < 0.05$).

record the highest seedling girth while T1, T4 and T5 had the lowest (Figure 2.). Although cultivar 'Nirvana F1' maintained higher seedling girth in all the soil treatments, cultivar 'Makis F1' had the highest seedling girth under soil media T7 and T8 (Figure 2.).

In regards to the effect of different soil media investigated, cultivars 'Nirvana F1' showed the same pattern of growth in seedling girth (Figure 2.). In other word, cultivar 'Nirvana F1' scored the highest number of leaves in all the soil media investigated (Figure 3.).

Soil media, T7 registered the highest dry weight followed by T6. Although soil media T2, T3, scored slightly lower dry weight than T7, the lowest dry weight obtained for T1 and T4 (Figure 4.).

In all the soil media investigated, cultivar 'Nirvana F1' had the highest germination percentage. However, it was observed that pattern of germination percentage for cultivar 'Makis F1' was not steadily (Figure 5.).

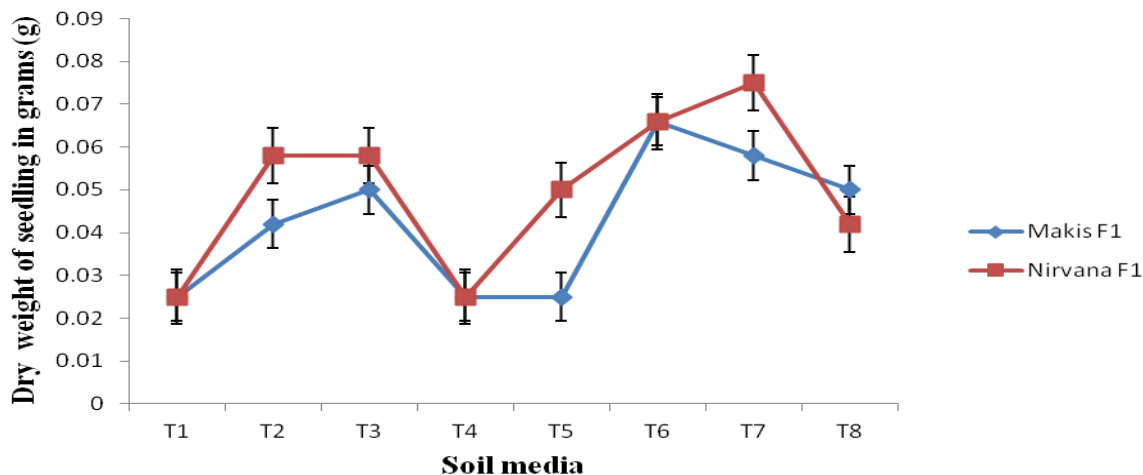


Figure 4: Effect of different soil media on dry weight of two tomato cultivars (Makis F1 and Nirvana F1). Means separated by DMRT (Duncan's multiple range test) at 5% level of significance ($p < 0.05$).

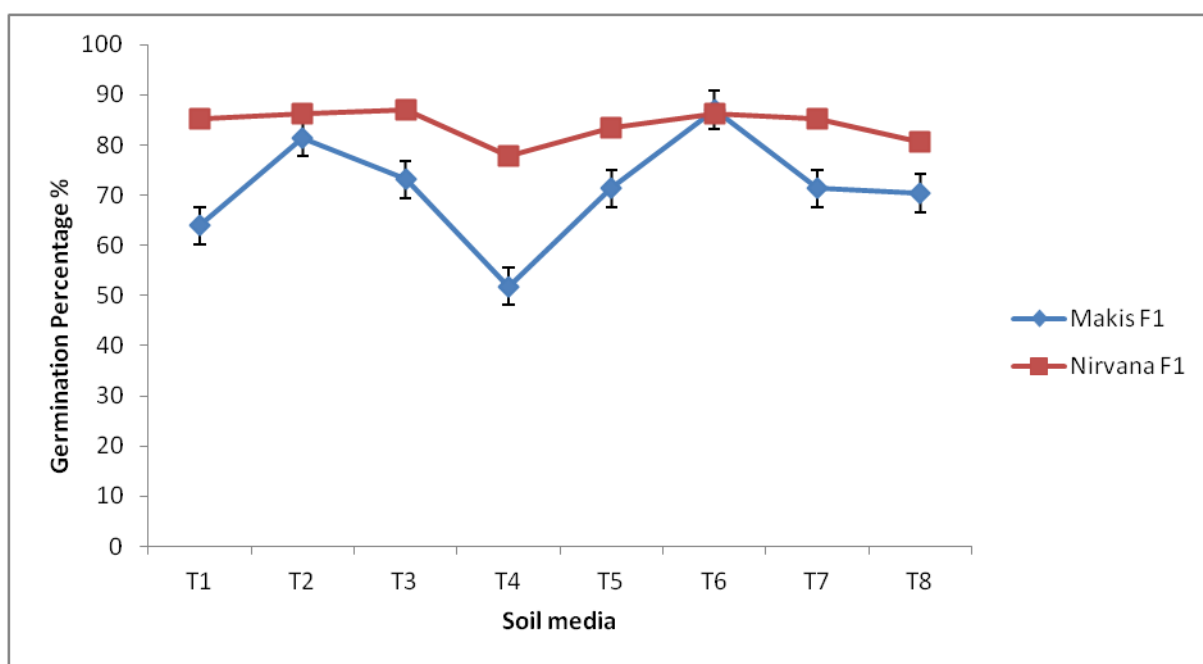


Figure 5: Effect of different soil media on germination percentage of two tomato cultivars (Makis F1 and Nirvana F1). Means separated by DMRT (Duncan's multiple range test) at 5% level of significance ($p < 0.05$).

DISCUSSION

Plant height

The data observed for plant height (Table 1.) indicated that the two tomatoes cultivars, Makis F1 and Nirvana F1 showed maximum plant height of 6.75 cm obtained from T7 (farm yard manure + composite manure + silt 33% + 33% + 33%) followed by T2 (composite manure 100%) by produced height of 6.59 cm and 6.33 cm plant

height produced by T3 (canal silt 100%). The lowest plant height of 4.58cm contributed by T4 (farm yard manure + composite 50% + 50%). while cultivar 'Nirvana F1' obtained maximum plant height of 6.93 cm was observed in T6 (composite manure + silt 50% + 50%) followed by T3 (canal silt 100%) producing a plant height of 6.72 cm and 6.58cm contributed by T7 (farm yard manure + composite manure + silt 33% + 33% + 33%). The least plant height obtained in Nirvana F₁ cultivar was 4.72 cm observed in T1 (farm yard manure 100%). The

results are in line with the work of Ahmad *et al.* (2004) and Turhan *et al.* (2007). They found that the best medium for the growth of saffron was mixture containing manure with its double application, above and below the corms. Our findings were in agreement with Yusef (1997) who reported that application of organic fertilizers had the best effects on growth of four annual flowers petunia (*Petunia hybrida* L.), snapdragon (*Antirrhinum majus* L.) and marigold (*Tagetes erecta* L.) and organic fertilizer increased plant height, flower diameter and number of flowers.

Seedling girth

The data showed that different soil media had a significant ($p < 0.05$) effect on seedling girth. Mean values given in table for two tomato cultivars showed that, Makis F1 cultivar has a highest girth of 0.84cm was recorded in T7 (farm yard manure + composite manure + silt 33% + 33% + 33%) followed by T2 (composite manure 100%) produced a seedling girth of 0.68cm, 0.65cm were observed in T8 and 0.56 cm was recorded in T6. A minimum value for seedling girth of 0.36cm was observed in T1 (farm yard manure 100%). While Nirvana F1 cultivar recorded a highest seedling girth of 0.82 cm in T6 followed by 0.68cm seedling girth was recorded in both T7 (farm yard manure + composite manure + silt 33% + 33% + 33%) and T3 (canal silt 100%) and 0.65 cm was recorded in T2 (composite manure 100%). The least seedling girth was 0.4cm recorded in T1 (farm yard manure 100%). The best performance of Farm yard manure was observed in combination with other soil media (compost and silt) might be attributed to its richer nutritional status which enhanced photosynthetic activity resulted in more plant stored material, thereby increasing seedling girth. Similarly minimum seedling girth observed in T1 (farm yard manure 100%) may be due high concentrated nutrients in farm yard manure alone which lower the osmotic potential of the media which restricted water up take for seedling growth.

Germination percentage

The data pertaining to germination percentage (Table 1.) revealed that different soil media did not affect the germination of seed significantly ($p < 0.05$) especially Nirvana F1 cultivar that showed maximum mean value of 87.03% recorded in T3, followed by 86.11% observed in both T2 and T6. The least mean value was 77.77% recorded in T4. While Makis F1 cultivar showed maximum of 87.03% recorded in T6 followed by 81.48% produced by T2, 73.14% was observed in T3. The least mean value was 51.84% recorded in T4. Mean values given in the table showed that all the treatments included in the trial proved their superiority over use of farm yard manure alone not in combination. This superiority can be

attributed to the fact that in mixed soil media, the soil structure and texture was improved which in turn increases the metabolic activity in germinating seed leading to better germination of seed while low germination percentage in Makis F1 cultivar it may be due low seed viability. These results are in agreement with the finding of Neelam *et al.* (2001) who reported that media improved soil physical and chemical properties, aeration and resulted luxurious plant growth.

Number of leaves

The data obtained for number of leaves (Table 1.) showed that different soil media do not affect number of leaves significantly for both cultivars ($p < 0.05$). However Makis F1 has a maximum number of leaves 5.33 was counted in T7 followed by 5.08 counted in T6, 4.75 counted in T8 and 4.58 was counted in T3. The least number of leaves counted was 4.08 and was observed in both T5 and T1. While Nirvana F1 has the maximum leaves count of 5.92 produce by T2 followed by 5.83 counted in T6 and 5.5 counted in T8 and 5.33 counted in T3. The least number of leaves count was 3.83 obtained by T1. These results were supported by the findings of Raiz *et al.* (2008) who counted maximum number of leaves in leaf compost mixture. The possible reason was nutritional contribution of the treatment that produced maximum number of leaves

Dry weight (DW)

The data indicated that seedling dry weight (DW) was significantly ($P < 0.05$) affected by different soil media for both cultivars. For Makis F1, mean values given in table revealed that maximum seedling dry weight of 0.066 grams was observed in T6 (composite manure + silt 50% + 50%) followed by T7 (farm yard manure + composite manure + silt 33% + 33% + 33%) produced a dry weight of 0.058 grams, 0.05 grams was observed from both T3 and T8. The minimum seedling dry weight of 0.025 grams was recorded in T1 (farm yard manure 100%), T4 (farmyard manure + composite manure 50% + 50%) and T5 (farm yard manure + silt 50% + 50%). While in Nirvana F1 cultivar recorded maximum dry weight of 0.075 grams observed in T7 (farm yard manure + composite manure + silt 33% + 33% + 33%) followed by 0.066 grams recorded in T6 (composite manure + silt 50% + 50%), 0.058 grams of dry weight was observed in both T2 and T3 and 0.05 grams was observed in T5 (farm yard manure + silt 50% + 50%). The least seedling dry weight recorded in both T1 (farm yard manure 100%) and T4 (farm yard manure + composite manure 50% + 50%).

Therefore, the data in table revealed that the differences between the two tomatoes cultivars Makis F₁ and Nirvana F1 in all the growth parameters were not

significant. However, 'Nirvana F1' cultivar had the high growth compared to 'Makis F1' cultivar.

The growth characteristics of two tomatoes cultivars Makis F1 and Nirvana F1 were significantly affected by the mixture of soil media containing farm yard manure, compost and canal silt because, it is rich in minerals that are required for the efficient growth for crop plant (Zhou *et al*, 2009; Hartmann *et al.*, 2011). The maximum contribution to the plant height, seedling girth, and dry weight was observed in soil media containing compost manure and canal silt and compost manure alone because compost is obtained by controlled biological decomposition of organic material (mainly plant) which are well decomposed and all the required nutrients were readily available to the plant. However the low growth characteristics observed in farm yard manure alone is due to its highly concentrated nutrients which lower the osmotic potential of soil media that limit the absorption of water by the roots of seedlings hence leading to reduced seedling growth. The ordinary soil obtained from the experimental recorded an average growth characteristics but its sticking ability to the sowing crates creates difficulties in transplanting.

It can be recommended that soil media containing mixture of equal proportion of farm yard manure, compost and canal silt can be used for raising tomatoes seedling as their combination improved both germination and subsequently growth compared to soil media used alone. Farm yard manure is not recommended to be use alone in raising tomatoes seedling since it has a high concentrated nutrients which lower seedling growth.

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