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The Effects of Top Coat Substrates on Seedling Growth of Marigold

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Abstract

Seed germination and seedling growth of bedding plants are affected by various environmental conditions and cultivation techniques. In seedling cultivation of many bedding plants, a top coat is used to maintain sufficient moisture content around the seeds and to obtain high germination rate and rapid emerging. Therefore, the effect of some different top coat materials was investigated on seedling growth of marigold (*Tagetes erecta* L.) in this study. For this purpose, vermiculite, coarse river sand, quartz sand and sewage sludge were used as a top coat in seedling cultivation of two marigold cultivars (Discovery Yellow and Discovery Orange). Furthermore, uncovered treatment was defined as control. In the study, the effects of different top coat treatment on the parameters of seed emerging and the characteristics of seedling were evaluated. Emerging percentage, mean emerging time, mean daily emerging, speed of emerging and peak value of emerging were determined as a parameters of seed emerging. Plant height , compactness value, hypocotyl length, epicotyl length , hypocotyl thickness, epicotyl thickness, root length , stem length, canopy height, leaf length , number of leaf, fresh and dry weights (root, shoot and plant), and root/shoot ratio were evaluated as a plant characteristics. At the end of the experiment, maximum emerging percentage on both cultivars was recorded by vermiculite treatment. Besides, emerging percentage in sewage sludge was determined to be taken into consideration. As a consequence of the study, it was found that coarse river sand; quartz sand and vermiculite had an importance to obtain taller and higher quality seedlings. On the other hand, sewage sludge were found remarkable alternative for stunted seedlings.

Key words: Bedding plant, *Tagetes erecta,* top coat, sewage sludge.

INTRODUCTION

Bedding plants represent a diffuse class of ornamental plants which are significant to the world's floriculture production. Since they could be economically viable, bedding plants are generally cultivated with special techniques [1]**.** Quality of seedling, which is induced by cultivation techniques, is important for sales of bedding plants. Size, shape, compactness and freedom from defects are major indicators of seedling quality on bedding plants. Plant size is particularly important because it is often the first trait that registers with potential consumers or buyers. On the other hand, bedding plant producers should consider market's demand to sell their products. The lower recommended rates are suitable for growers who desire a larger plant for retail sales whereas higher rates are suitable for wholesale growers who require smaller diameter plants for shipping [2].

Both seed germination and seedling growth are affected by various environmental conditions and cultivation techniques, applied during the greenhouse production, such as temperature, light, fertilization and growth media [2, 3, 4, 5, 6]. In seedling production of many bedding plants, a top coat material (casing soil) is used to maintain adequate moisture around the seeds and to exclude light [7]. In this way, it is possible to obtain high germination rate and rapid germination [8]. Therefore, a top coat is a lightweight substrate component used in seedling production. The seeds are typically placed on a substrate such as peat and then the seeds are covered with a layer of the top coating substrate [7]. Vermiculite is preferred for most of plant species by growers [9]. Besides, using of some different materials such as coarse river sand and quartz sand also are present. Sewage sludge also might be one of the other alternatives.

As urban water supplies have recently improved considerably in the worldwide, the problem of waste water disposal and sewage sludge has also increased [10, 11]. Reuse of sewage sludge in agriculture seems attractive owing to the positive effects of sewage sludge on both plant and soil. Sewage sludge contains a lot of organic matter and is very rich in nutrients [12, 13]. Nevertheless, the elevated pH, excessive salinity and high proportion of certain heavy metals limit their use in the cultivation of some plants [13]. However, ornamental plants contain a very high potential related to the use of sewage sludge. Sewage sludge in agricultural production is used as a plant growth media [14, 15] and a fertilizer [16]. Using of sewage sludge as a component of substrates for the cultivation of ornamental plants has ecological and economic aspects, as it creates a nuisance to dispose of waste, while limiting the use of mineral fertilizers [13]. But there is limited research on the effectiveness of sewage sludge as a top coat material [17]. Therefore, in the current study, the effects of not only conventional material but also sewage sludge were investigated as a top coat on seedling growing of marigold.

Marigold is one of the most valuable annual ornamental plant species, which is preferred for landscape arrangement and also used as cut flowers [18]. It belongs to the family Compositae [19]. Marigold has two main types: one of them is American or African marigold (*Tagetes erecta*) which has large-flower and the other one is French marigold (*Tagetes patula*) which has small-flower [20]. *T. erecta* is used as a bedding plants and cut flower whereas *T. patula* is used just as bedding plants.

There is limited research related to the cultivation techniques on seedling growth of marigold. As far as we know, this study is considered as the first one related to the effects of top coat substrates on marigold. The aim of this study was to examine the influence of top coat materials on growth and quality of marigold seedling. For this purpose the effects of different top coat substrates were evaluated on the parameters of seed emerging and the characteristics of seedling.

MATERIAL AND METHODS

This study was conducted in greenhouses at the Department of Horticulture, Cukurova University in Adana/Turkey. In this study, two marigold cultivars (cv. Discovery Orange and cv. Discovery Yellow) were used as a plant material. Four different substrates (sewage sludge, quartz sand, vermiculite and coarse river sand) were used as a top coat to seedling cultivation. Cultivation of without top coat was accepted control treatment. Sewage sludge which was used as a top coat was obtained from The West Adana Wastewater Purification Facility of Adana Municipality. Seeds of marigold were germinated in tray plugs (each cell; ∅-3cm, h-4.5cm) containing peat on April, 2015. After the sowing, the seeds were covered with a layer of different casing materials (1 mm thickness) on tray plugs. The experiment was conducted three replicates and each treatment included 24 seeds. The study was terminated when seedling reached to the transplanting stage. In the study, the effects of different top coat substrates were determined by means of different quantity and quality parameters. For this purpose, parameters of seed emerging and quality of seedling were evaluated. Daily observations were carried out to determine parameters associated emerging in the study. Emerging percentage, mean emerging time, mean daily emerging, speed of emerging and peak value of emerging were determined according to Gairola et al. [21]. Seed emerging parameters were calculated using the following formulas (1, 2, 3, 4 and 5).

Emerging percentage % = Number of emerged seeds / Total number of seeds × 100 (1).

Mean emerging time = n1 x d1 + n2 x d2 + n3 x d3 + -------- / Total number of days (2).

Mean daily emerging = Total number of emerged seeds / Total number of days (3).

Speed of emerging = n1/d1+n2/d2+n3/d3+---------- (4).

Peak value of emerging = Highest emerged seed numbers / Number of days (5).

Where, n = number of emerged seeds, d = number of days.

At the end of the experiment, after the harvesting, some plant growth parameters were determined. Plant height (cm), hypocotyl length (cm), epicotyl length (cm), root length (cm), stem length (cm), canopy length (cm), and leaf length (cm) parameters were determined using ruler. Hypocotyl thickness (mm) and epicotyl thickness (mm) properties were determined using digital caliper. Number of leaf (unit) was estimated by counting.

The distance from the roots to cotyledon leaves was evaluated as hypocotyl part whereas the distance from cotyledon leaves to the first real leaves was accepted as epicotyl part [22].

After harvesting, the plants were uprooted and washed thoroughly in running tap water to remove soil particles. The plants were divided into roots and shoots. Samples were weighed using a digital top loading weighing balance (Mettler AE 100) to determine the fresh weights-FW (Root, shoot and total plant). The relative fresh weights of root and shoot were estimated according to Uzun [23] using the formula (6 and 7).

Relative Root-FW = Root-FW/Plant weight (6).

Relative Shoot-FW = Shoot-FW/Plant weight (7).

The plant parts (root and shoot) were dried at 65°C for 4 days. The dry samples were weighed to determine the dry weights (Root, shoot and total plant). The root/shoot ratio of dry weight was also calculated.

The compactness of the seedling was calculated by formula 8 according to Valdez et al. [24].

Compactness (mg cm^{-1}) = shoot DW/plant height (8).

Data were subjected to ANOVA and means were separated by using the LSD (least significant difference test) at $P \leq 0.05$. All the statistical analyses were performed by using JMP 8 software packages.

RESULTS

The data associated with parameters of seed emerging on marigold cultivated by using different top coat substrate are given in Table 1. Maximum emerging percentage was recorded on cv. Discovery Orange (92%) and cv. Discovery Yellow (100%) by vermiculite treatment. Moreover, emerging percentage of sewage sludge on both cultivars was determined to be taken into consideration. Nevertheless, mean emerging time of marigold cultivars in sewage sludge was found to be higher than that in the other treatments. On the other hand, daily emerging values of marigold cultivars in all top coat treatments were higher than one in control. In terms of emerging speed, maximum values were obtained in vermiculite and coarse river sand treatments on both marigold cultivars. The emerging speed values by vermiculite and coarse river sand treatments were determined 4.67 and 3.67, respectively for cv. Discovery Orange. Besides, these values were found as 4.93 and 3.00, respectively on cv. Discovery Yellow. Vermiculite treatment encouraged higher emerging peak value on cv. Discovery Orange while quartz sand exhibited the highest value on cv. Discovery Yellow.

In the study, it was found that top coat treatments effected the growth of marigold seedling. The results of plant height of marigold cultivars related to the top coat treatments are presented in Figure 1. At the end of the seedling growth period, the highest plant height (16.13±0.21 cm) was determined in coarse river sand whereas the lowest value (10.50±0.62 cm) was found in sewage sludge on cv. Discovery Orange (Figure 1A). The effects of different top coat material on seedling growth of cv. Discovery Orange can be also seen in Figure 2A. Compared to control, sewage sludge treatment exhibited 13 % decrease in plant height. In contrast, plant height on 'Discovery Orange' increased at the respective rates of 22, 17 and 34 % by quartz sand, vermiculite, and coarse river sand treatments, compared with the control. A similar trend was also detected for cv. Discovery Yellow (Figure 1B). While the highest plant height (13.90±0.36 cm) was determined in coarse river sand, the lowest values were found in sewage sludge (10.37±1.04 cm) and control (10.77±0.49 cm) treatments on cv. Discovery Yellow. The effects of top coat treatments on cv. Discovery Yellow can be also seen in general aspect of plants (Figure 2B). The change of plant height between the control and sewage sludge treatments was not significant on cv. Discovery Yellow, but plant height significantly increased when quartz sand, vermiculite, and coarse river sand were applied. Plant height increased at the respective rates of 4, 12 and 29 % in quartz sand, vermiculite, and coarse river sand treatments, compared to the control.

In general, in the compactness of marigold cultivars, the increasing trends were found depending upon the top coat treatments (Figure 3). Despite the fact that the compactness (ranges between 4.50 and 5.43 mg cm^{-1}) of cv. Discovery Orange in all top coat treatments increased compare to control, this increase was not significant (Figure 3A). On the other hand, the compactness of cv. Discovery

Table 1. Seed emerging parameters of marigold using different top coat material.

Cultivar	*Top Coat Substrate*	*Emerging Percentage*	*Emerging Time*	*Daily Emerging*	*Speed of Emerging*	*Emerging Peak Value*
D. Orange	*Control*	58	2.4	0.6	3.08	1.5
	Sewage sludge	75	2.7	1.5	2.75	1.3
	Quartz sand	58	1.3	1.2	1.83	1.0
	Vermiculite	92	2.4	1.8	4.67	3.5
	C-River sand	58	1.3	1.2	3.67	2.0
D. Yellow	*Control*	58	3.0	0.6	2.04	1.0
	Sewage sludge	83	4.7	1.0	2.10	0.7
	Quartz sand	83	2.6	1.7	2.42	3.0
	Vermiculite	100	3.0	1.5	4.93	2.0
	C-River sand	58	2.5	1.8	3.00	2.0

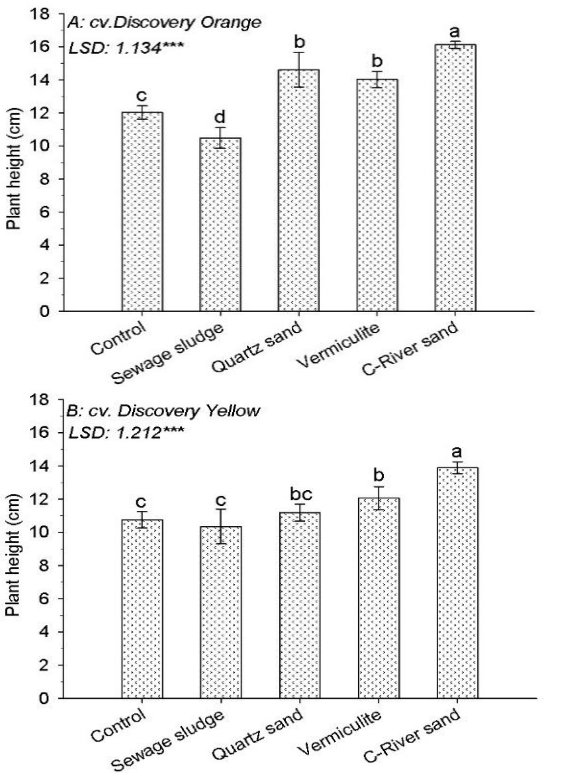

Figure 1. The plant height of marigold seedling. A: cv. Discovery Orange, B: Discovery Yellow. Different letters represent statistical differences at P≤0.05 (least significant difference test). ***: P≤0.001.

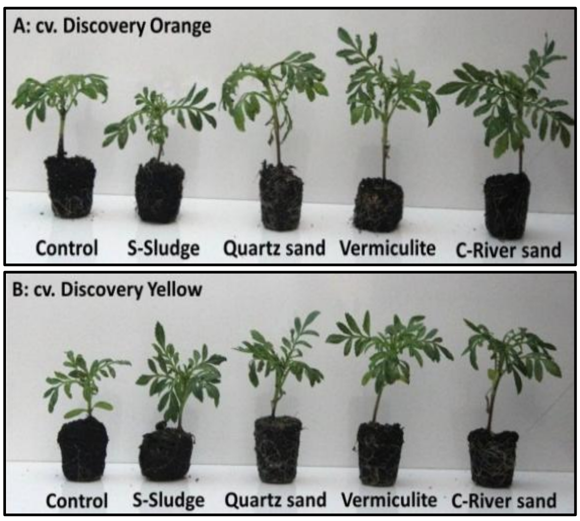

Figure 2. The marigold seedlings grown with different top coat materials. A: cv. Discovery Orange, B: Discovery Yellow.

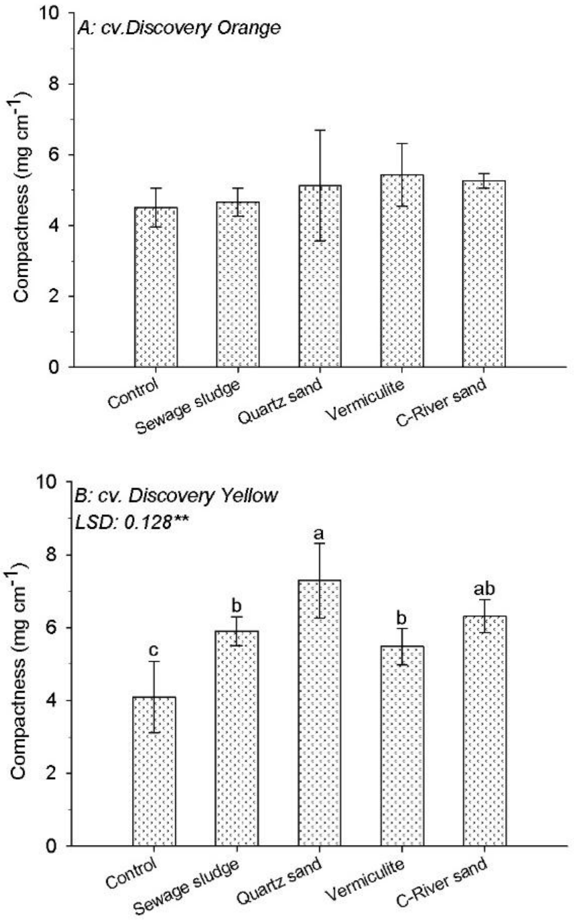

Figure 3. The compactness of marigold seedling. A: cv. Discovery Orange, B: Discovery Yellow.
Different letters represent statistical differences at P≤0.05 (least significant difference test). **: P≤0.01.

Yellow estimated in control, sewage sludge, quartz sand, vermiculite, and coarse river sand treatments were 4.09, 5.90, 7.29, 5.48 and 6.31 mg cm^{-1}, respectively (Figure 3B). The compactness on cv. Discovery Yellow significantly increased at the respective rates of 44, 78, 34 and 54 % in sewage sludge, quartz sand, vermiculite and coarse river sand treatments, compared to the control.

Various plant growth and quality characteristics of marigold seedling depending on different top coat materials are given in Table 2. Regarding the hypocotyl length, there was no significant difference among the top coat treatments on 'Discovery Orange'. On the other hand, the highest hypocotyl length was measured in the coarse river sand and vermiculite treatments while, the lowest value was determined in quartz sand on 'Discovery Yellow'. Top coat treatments affected the epicotyl length on both marigold cultivars. The highest epicotyl length on both cultivars was obtained by coarse river sand treatment. 'Discovery Orange' exhibited the lowest value (2.20 cm) deal with epicotyl length in sewage sludge while 'Discovery Yellow' presented the lowest epicotyl length (2.10 cm) in control treatment. In terms of the hypocotyl thickness, the effects of top coat materials on both marigold cultivars were found statistically insignificant. On the other hand, some changes were determined on epicotyl thickness of marigold cultivars. The change deal with epicotyl thickness of cv. Discovery Orange in the control, quartz sand, vermiculite and coarse river sand treatments were not statistically significant but the epicotyl thickness significantly decreased when sewage sludge was applied. The highest epicotyl thickness (2.80 mm) of cv. Discovery Yellow was found in coarse river sand, followed by quartz sand, vermiculite and control but the lowest one (2.12 mm) was measured in sewage sludge.

In the study, the changes of root length on both cultivars depending on treatments were not significant (Table 2). Top coat treatments affected the stem length on both marigold cultivars. The highest stem length (5.80 cm) on cv. Discovery Orange was found in coarse river sand whereas the lowest value (3.50 cm) was measured in sewage sludge. The stem length significantly increased at the respective rates of 9, 13 and 23 % in quartz sand, vermiculite and coarse river sand while it decreased in sewage sludge at rate of 26 % compared to the control. Similarly, the highest stem length (5.40 cm) on cv. Discovery Yellow was found in coarse river sand whereas the lowest value (3.93 cm) was obtained by sewage sludge. The stem length significantly increased at the respective rates of 2, 13 and 29 % by quartz sand, vermiculite and coarse river sand treatments when it was compared to the control, but in sewage sludge was found 6 % decrease in stem length. At the end of the study, it was found that the top coat treatments affected the canopy height on both marigold cultivars. The highest canopy height (10.33 cm) on cv. Discovery Orange was found in coarse river sand, followed by quartz sand and vermiculite. The lowest value on canopy height was obtained in control (7.33 cm) and sewage sludge (7.00 cm) treatments for cv. Discovery Orange. On the other hand, canopy heights of cv. Discovery Yellow in the control, sewage sludge, quartz sand and vermiculite were not significantly different, but the canopy height was on the highest value when coarse river sand was used as a top coat material.

The change of leaf length on cv. Discovery Orange depending on treatments was not significant (Table 2). On the other hand, the highest leaf length values of cv. Discovery Yellow were obtained via coarse river sand (4.77 cm) and quartz sand (4.60 cm) while the lowest values were found in control (3.67 cm) and sewage sludge (3.80 cm). The maximum number of leaf was determined by coarse river sand while the minimum one was found in control and sewage sludge on cv. Discovery Orange. Nevertheless, the change of leaf number depending on treatments was not significant on cv. Discovery Yellow.

At the end of the study, it was found that the top coat treatments affected fresh weight (FW) and dry weight (DW) parameters on both marigold cultivars (Table 3). The highest plant fresh weight of each marigold cultivar was obtained in coarse river sand, whereas, the lowest plant-FW was determined in control and sewage sludge treatments. Furthermore, plant fresh weight in quartz sand, vermiculite and coarse river sand were found to be 1.6, 1.4 and 2.0 times higher than in control, respectively cv. Discovery Orange. Otherwise plant-FW decreased 0.8 times in sewage sludge compared to the control. According to top coat treatments, the increasing trend was determined on plant-FW of 'Discovery Yellow'. Plant-FW in sewage sludge, quartz sand, vermiculite and coarse river sand were found to be 1.2, 2.1, 1.9 and 2.7 times higher than in control, respectively. In terms of root fresh weight, it was determined similar trend, like plant-FW, on both cultivars; the highest root-FW was in coarse river sand while the lowest one was in control and sewage sludge. Shoot fresh weight of cv. Discovery Orange was not statistically different in quartz sand, vermiculite and coarse river sand but shoot-FW significantly decreased when sewage sludge was applied. The highest shoot-FW was in coarse river sand whereas, the lowest one in control and sewage sludge on cv. Discovery Yellow. In terms of the relative root fresh weight, the highest value was estimated in coarse river sand but the lowest one was found in control and sewage sludge on cv. Discovery Orange. Contrary to these results, the highest value of relative shoot-FW was in control and sewage sludge whereas the lowest one was in coarse river sand. It was found that the relative root-FW in quartz sand, vermiculite and coarse river sand was higher than one in control and sewage sludge on cv. Discovery Yellow. In contrast to relative shoot-FW in quartz sand, vermiculite and coarse river sand was lower than one in control and sewage sludge treatments.

In terms of plant dry weight, the highest value was obtained in coarse river sand and quartz sand on each marigold cultivar (Table 3). The lowest plant-DW on each marigold cultivar was in control and sewage sludge. Furthermore, plant dry weight of cv. Discovery Orange in quartz sand, vermiculite and coarse river sand were found to be 1.4, 1.3 and 1.5 times higher than one in control, respectively, or else plant-DW decreased 0.8 times in sewage sludge compared to the control. According to top coat treatments, the increasing trend was determined on plant-DW of 'Discovery Yellow'. Plant-DW in sewage sludge, quartz sand, vermiculite and coarse river sand were found to be 1.6, 2.4, 1.9 and 2.8 times higher than that in control, respectively. Root dry weight of cv. Discovery Orange in all treatments, except sewage sludge, was not significantly different, but the lowest value was found when sewage sludge was used. On the other hand, the highest and the lowest root-DW were measured in coarse river sand and in control, respectively on cv. Discovery Yellow. In terms of the shoot-DW, coarse river sand exhibited higher results than the other top coat materials on cv. Discovery Orange. Besides coarse river sand and quartz sand demonstrated the highest shoot-DW on cv. Discovery Yellow. Sewage sludge treatment presented the lowest shoot-DW for cv. D. Orange and, control treatment exhibited the lowest value for cv. Discovery Yellow. The change on root to shoot ratio based on dry weight was not significant on cv. Discovery Orange. Despite that, this parameter was significant on cv. Discovery Yellow. The highest root/shoot ratio was obtained by coarse river sand and the lowest one was determined in control treatment.

Table 2. Plant characteristics of marigold seedling grown with different top coat substrates

Cultivar	*Top Coat Substrate*	*Hypocotyl Length (cm)*	*Epicotyl Length (cm)*	*Hypocotyl Thick. (mm)*	*Epicotyl Thick. (mm)*	*Root Length (cm)*	*Stem Length (cm)*	*Canopy Height (cm)*	*Leaf Length (cm)*	*Leaf Numb. (unit)*
D. Orange	*Control*	2.00	2.70^{bc}	2.30	2.51^{a}	6.50	4.70^{b}	7.33^{c}	4.10	6.0^{c}
	Sewage sludge	1.30	2.20^{c}	1.90	2.09^{b}	4.97	3.50^{c}	7.00^{c}	4.43	6.0^{c}
	Quartz sand	2.10	3.03^{ab}	2.32	2.67^{a}	7.40	5.13^{ab}	9.50^{ab}	4.90	7.7^{ab}
	Vermiculite	2.27	3.07^{ab}	2.31	2.50^{a}	7.00	5.33^{ab}	8.70^{b}	4.50	7.3^{b}
	C-River sand	2.47	3.33^{a}	2.24	2.75^{a}	8.73	5.80^{a}	10.33^{a}	5.20	8.3^{a}
	LSD	*ns*	*0.603**	*ns*	*0.323***	*ns*	*1.078***	*1.147****	*ns*	*0.814****
D. Yellow	*Control*	2.10^{ab}	2.10^{c}	2.08	2.42^{b}	6.00	4.20^{bc}	6.57^{b}	3.67^{b}	7.0
	Sewage sludge	1.67^{bc}	2.27^{bc}	2.26	2.12^{c}	5.07	3.93^{c}	6.43^{b}	3.80^{b}	7.7
	Quartz sand	1.60^{c}	2.67^{ab}	2.25	2.65^{ab}	7.17	4.27^{bc}	6.93^{b}	4.60^{a}	8.0
	Vermiculite	2.13^{a}	2.60^{bc}	2.37	2.57^{ab}	6.17	4.73^{b}	7.33^{b}	4.20^{ab}	7.0
	C-River sand	2.27^{a}	3.13^{a}	2.62	2.80^{a}	7.17	5.40^{a}	8.50^{a}	4.77^{a}	8.3
	LSD	*0.460**	*0.502***	*ns*	*0.297***	*ns*	*0.614***	*1.068***	*0.779**	*ns*

Different letters represent statically differences at P≤0.05 (least significant difference test). ***: P≤0.001, **: P≤0.01, *: P≤0.05, ns: not significant.

Table 3. Plant weight parameters (fresh weight-FW and dry weight-DW) of marigold seedling grown with different top coat substrates

Cultivar	*Top Coat Substrate*	*Plant-FW (mg)*	*Root-FW (mg)*	*Shoot-FW (mg)*	*Relative Root-FW*	*Relative Shoot-FW*	*Plant-DW (mg)*	*Root-DW (mg)*	*Shoot-DW (mg)*	*Root/Shoot DW-ratio*
D. Orange	*Control*	781^{c}	93^{d}	687^{ab}	0.12^{c}	0.88^{a}	83^{bc}	29^{a}	54^{bc}	0.54
	Sewage sludge	612^{c}	105^{d}	507^{b}	0.17^{c}	0.83^{a}	64^{c}	15^{b}	49^{c}	0.31
	Quartz sand	1270^{b}	338^{b}	932^{a}	0.28^{b}	0.72^{b}	112^{a}	37^{a}	75^{ab}	0.55
	Vermiculite	1083^{b}	200^{c}	883^{a}	0.18^{bc}	0.82^{ab}	107^{ab}	31^{a}	76^{ab}	0.41
	C-River sand	1582^{a}	618^{a}	963^{a}	0.39^{a}	0.61^{c}	124^{a}	39^{a}	85^{a}	0.46
	LSD	*295.735****	*92.750****	*293.606**	*0.096****	*0.096****	*26.673***	*11.382***	*24.158**	*ns*
D. Yellow	*Control*	663^{c}	140^{c}	522^{c}	0.22^{b}	0.78^{a}	49^{c}	5^{d}	44^{c}	0.13^{c}
	Sewage sludge	775^{c}	117^{c}	658^{c}	0.15^{b}	0.85^{a}	81^{c}	20^{c}	61^{b}	0.33^{b}
	Quartz sand	1387^{b}	551^{b}	835^{b}	0.39^{a}	0.61^{b}	117^{a}	36^{ab}	81^{a}	0.44^{ab}
	Vermiculite	1237^{b}	410^{b}	828^{b}	0.33^{a}	0.67^{b}	93^{b}	27^{bc}	66^{bc}	0.40^{b}
	C-River sand	1792^{a}	732^{a}	1060^{a}	0.41^{a}	0.59^{b}	135^{a}	47^{a}	88^{a}	0.54^{a}
	LSD	*281.229****	*166.958****	*167.423****	*0.083****	*0.083****	*21.872****	*11.224****	*14.573****	*1.314****

Different letters represent statistical differences at P≤0.05 (least significant difference test). ***: P≤0.001, **: P≤0.01, *: P≤0.05, ns: not significant.

DISCUSSION

In the study, the maximum values deal with most of emerging paremeters on marigold were obtained by vermiculite treatment. Similarly, Taylor et al. [8] indicated that use of vermiculite on tomato resulted in better germination than leaving the seeds uncovered. Besides, in our study, emerging percentage of sewage sludge on both cultivars was determined to be taken into consideration. Similarly, Demirkan et al. [17] stated that there were higher emerging percentage on three grass species, as a single and equal ratio mixed amount, when sewage sludge, mixing with soil or alone, were used as a cover material. They also found shorter emerging time with sewage sludge treatments compare to control. In contrast, in our study, mean emerging time of marigold cultivars in sewage sludge was found to be higher than in the other treatments. Prolongation of emerging time of seeds had led to decrease in the plant growth performance.

At the end of the study, using of top coat material affected seedling qualitiy of marigold. Correspondingly, it was determined that increasing on plant height was observed by quartz sand, vermiculite and coarse river sand treatments on marigold. This result was accompanied by an increase in the hypocotyl length, epicotyl length, stem length and canopy height of plants. It is concluded that to obtain quality seedling on marigold need to top coat substrate. However sewage sludge led to obtain shorter seedling which has a decrease in hypocotyl length, epicotyl length, stem length and canopy height. Therefore, sewage sludge were found remarkable alternative for stunted seedlings in the current study. It is well known that plant size in seedling production of bedding plant is determined according to the market demand. The taller and larger plants are suitable for retail sales whereas, smaller diameter plants are suitable for shipping [2]. On the other hand excessive elongation of bedding plants during greenhouse is common and results in low-quality plants. In general, excessively tall seedlings are generally considered to be low quality due to increased shipping costs of these plants and their increased susceptibility to lodging [25]**.** After germination, some plants, like marigold (*Tagetes* sp. L.), tend to stretch early, especially if they are grown under low light environments [4]. To limit elongation, some methods such as limited watering [25] and applying plant growth regulators [22, 26, 27] are used. On the other hand, if the bedding plant is slightly shorter, it could be generally acceptable for landscape applications [24]. In the current study, top coat treatments led to more compact plants on cv. Discovery Yellow. Although there was not detected statistical diffrence on compactness of cv. Discovery Orange, somewhat increasing on the compactness value was found. The increasing trend of compactness that was found in the current study is in agreement with previous studies. Shorter plants may not always compact. The relation between reduction of plant height and compactness was recorded previously [24]. Moreover, van Iersel and Nemali [25] stated that plants grown at high moisture content were more compact, but also taller. It is known that top coat on seed germination is a good tool to maintain moisture content [7]. In paralel, in our study, It is thought that using top coat material may have provided more compact seedling through preserving soil moisture content for a long time.

In the current study, quartz sand, vermiculite and coarse river sand provided increase in both root and shoot weights, compared with control. This result was accompanied by an increase in the plant growth parameters such as plant height, canopy height, root length, epicotyl thickness, and leaf length. Somewhat increase was also detected in leaf number. van Iersel and Nemali [25] indicated that weight of plant grown at lower moisture level was less than weight of plant grown at higher moisture content. In our study, reduction of plant weight on control group may have stemmed from momentary loss of the moisture content around the seeds. In contrast the top coat materials may have served to maintain moisture content. On the other hand, sewage sludge led to decrease in both root and shoot weights as well as decrease in the plant growth characteristics such as plant height, canopy height, root length, hypocotyl thickness, and epicotyl thickness. As a result sewage sludge was led to obtain stunted seedlings. The relation between limited root volume and stunting is previously reported [28]. Similarly, in our study we found restriction of root growth in sewage sludge treatment. On the other hand, due to the negative effects of sewage sludge, plant growth may have been limited. Some negative properties of sewage sludge like elevated pH, excessive salinity and certain heavy metals limit the use of sewage sludge in plant cultivation [13].

CONCLUSION

In conclusion, in the current study, the maximum values deal with most of emerging paremeters on marigold were determined by vermiculite treatment. Besides, emerging percentage of sewage sludge on both cultivars was determined to be taken into consideration. In this study, it was found the highest values deal with various seedling growth and quality parameters in coarse river sand treatment and followed by quartz sand and vermiculite. On the other hand, the results of sewage sludge on plant growth parameters were same level or slightly below, compare with control. As a consequence of the study, it was found that coarse river sand; quartz sand and vermiculite had an importance for obtaining taller and high quality seedlings. On the other hand, sewage sludge were found remarkable alternative for stunted seedlings. Accordingly, sewage sludge as an alternative top coat substrate could be used to obtain stunted plants in the seedling production. In addition, the new studies using with different bedding plants, will be useful for further research.

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