INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 11, No. 2, p. 54-59, 2017

RESEARCH PAPER OPEN ACCESS

Effect of different concentrations of zeolite incorporating into Kenaf core fibre on growth and flowering of Marigold

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Article published on August 30, 2017

Key words: Kenaf Core Fiber, Marigold, Zeolite, Growing media

Abstract

The objective of this research was to determine the effect of different concentrations of zeolite incorporating into Kenaf Core Fibre on growth and flowering of Marigold. The study was conducted with five concentrations of zeolite 0, 10, 20, 30 and 40g/L into growing media KCF using marigold plant at Taman Pertanian, Universiti Putra Malaysia, Serdang, Selangor, Malaysia. The experiment was conducted using randomized complete block design (RCBD) with four replications. Each plot consists of 6 plants. The data were analyzed using SAS software (Ver. 9.1) (SAS institute, Inc., Cary, MC, USA). The treatments means were compared by using DMRT at $p<0.05$ level of probability. The results showed that different concentration of zeolite incorporating into KCF significantly affected the growth of marigold plant. The growth and flowering on concentrations of 30 and 40g/L had the fastest and greatest growth rate and could probably be used for a successful production of horticultural crops.

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Introduction

Using topsoil is essential for producing of top horticultural crops. Topsoil provides sufficient nutrients and water for plants good growth. Supplying suitable soil for horticultural crops has been declined due to increased demands of productive land. However, using soilless growing media has advanced the production of horticultural crops (Yahya *et al.*, 2009).

Another soilless material that has been recently researched and used is kenaf core fiber (KCF). It's also easily grown as it is tolerant to most type of soil conditions. Kenaf is a highly productive annual plant and using its core fiber as growing media is an environment-friendly strategy.

Kenaf core fiber as the new substitute of soilless media is produced from kenaf (*Hibiscus cannabinus* L.). Kenaf stems have two types of fiber which are coarse and fine. The coarse and fine fibers produced by kenaf stems are located in the outer layer (bast fiber) and in the core, respectively. The core with the amount of 5600kg/ha produces KCF that could be used as a soilless medium. The core made up 60-65% of the stem dry weight (Chuni *et al.*, 2012).

The main advantage of KCF over other soilless media are good physical, chemical and biological properties for plants, readily available, easy to handle, lightweight, low cost, and free from pathogens, weed seeds, and foreign materials (Chuni *et al.*, 2012).

Previous studies have shown that incorporation zeolites into soil enhances long-term soil quality and hold nutrients by improving its nutrient absorption ability. Zeolite increased capability of soil to retain important plant nutrients such as N, P, K, Ca, Mg, and many kinds of micro-elements (Li *et al.*, 2013). The use of KCF as soilless medium and zeolite for growth and flowering of marigold has not been studied in this country. The objective of this experiment was to determine the suitable concentration of zeolite and its effect on the growth and development of marigold grown on KCF-based substrates.

Materials and methods

Plant material and experimental treatments

This study was carried out at Taman Pertanian University (TPU) University Putra Malaysia (UPM), Serdang, Selangor, Malaysia. The substrate was KCF with equal proportion of coarse (93-6mm) and fine (1-2mm) particular size. The treatments comprised of five different concentrations of zeolite incorporate into KCF (0, 10, 20, 30, and 40g zeolite/L media) which were thoroughly mixed with KCF before planting.

Five g of complete fertilizer of 8:8:8 N, P_2O_5 and K_2O, 2.0% of ground magnesium limestone (GML), and 1 g of ready-mix micronutrients were incorporated into every 1.0L of media as a base fertilizer.

African marigold c.v Taishan orange was used as an indicator plant in this experiment. The seeds were germinated and raised in plug trays (200 cells/ray) containing media composing of 50% peat moss and 50% cocopeat. The seedlings of 2-3 true leaves (10 days old) were transplanted into the (1 litter) pots consisting of KCF growing media. A multipurpose liquid fertilizer containing (mg L^{-1}): 232 N, 67P, 239K, 120Ca, 30Mg, 3Fe, 0.62Mn, 0.44B, 0.02Cu, 0.11Zn and 0.048Mo (IMPRA®, Mega Prima Resources Sdn bhd., Shah Alam, Selangor, Malaysia) was sprayed into the leaves directly after transplanting. The plants were watered using overhead micro-sprayer irrigation 10 and 15 ml /L first and second weeks, respectively.

Fig. 1. Marigold plants grown in KCF substrate media at Taman Pertanian University, UPM.

Plant growth and flowering

Medium characteristics and plant growth data on various aspects were collected. To measure marigold plant growth and flowering, the plants were monitored 5-6 weeks after transplanting, by measuring of plant height from the base to the top of the plants, stem width diameter, and flower number. The number of flowers was calculated from the flower appearance. Three samples were selected out of six plants.

Dry weight

At the end of the experiment, three samples out of six plants per block were harvested in order to measure dry weights of roots, stems, leaves, and flowers. The leaves, stems, flowers and roots were cut out, and then dried in an oven at 80°C for 72h.

Leaf nutrients analysis

At the end of the experiment, 0.25g of finely ground dried mature leaves samples were digested for 2 hours in 5ml concentrated sulphuric acid (H_2SO_4), Then 2ml of hydrogen peroxide (H_2O_2) was added into the mixture, then heated on hot plate at 285°C in a fume chamber for 45 minutes. The solutions were then made up to 100mL by adding distilled water. N and P contents were determined using an auto-analyzer (Model Lachat 8000 series). K, Ca and Mg were measured using spectrophotometer (Automatic Absorption 3110 Perkin Elmer) (Yahya *et al*., 2009).

Experimental design and data analysis

The experiment was conducted using randomized complete block design (RCBD) with four replications. Each plot consists of 6 plants. The data were analyzed using SAS software (Ver. 9.1) (SAS institute, Inc., Cary, MC, USA). The treatments means were compared by using DMRT at $p<0.05$ level of probability.

Results

Effects of Zeolite Concentrations on Plant Growth and Development Plant height

Plant height means at week five had no significant effect among the treatments (Table 1). Even though the plants grown in media of KCF with the concentration of 40g/L zeolite were the highest among the others but there was no significant effect among the treatments during growing period.

Table 1. Effects of kenaf core fiber with different concentrations of zeolite on growth and flowering of marigold plant.

Zeolite Conc. (g/L)	Plant height (cm)			Stem width (mm)			Flower No			Flower size (cm)
	Week 5	Week 6	Week 7	Week 5	Week 6	Week 7	Week 5	Week 6	Week 7	Week 7
0	15.20a	26.37a	31.41a	0.23ab	0.44ab	0.45ab	0.25a	2.83ab	3.66ab	2.00a
10	15.00a	26.33a	31.41a	0.19b	0.37b	0.37b	0.25a	2.25b	2.75ab	2.00a
20	14.70a	25.79a	30.50a	0.21ab	0.37b	0.35b	0.33a	1.91b	2.50b	1.87a
30	15.70a	27.62a	32.4 a	0.22ab	0.45ab	0.49a	0.33a	2.25b	3.75a	2.33a
40	16.29a	29.12a	33.33a	0.27a	0.50a	0.54a	0.58a	3.25a	3.83a	2.54a

Values in column with the same letter did not differ significantly at $p< 0.05$ according to DMRT.

Stem width

Corresponding effects of changing the concentrations of zeolite in the media of KCF were studied for stem width. Results in (Table 1) indicate that differences in zeolite concentrations significantly affected the stem width. The width of the plant stems grown in media KCF containing 30 and 40g/L zeolite at six weeks were 0.45 and 0.50mm respectively. The stem width of the plants grown in media of KCF at seven weeks with the concentrations of zeolite at 30 and 40g/L zeolite had no significant effect with their respective value of 0.49 and 0.54mm.

Flower number

Corresponding effects of changing zeolite in KCF were studied for flower number. Results indicate that differences in zeolite concentrations significantly affected the flower number (Table 1). There was a significant effect in flower number between 30 and 40g/L zeolite incorporated in KCF at six week.

However there was no significant effect when comparing them at seven week.

Flower size

Flower sizes were measured at the end of the experiment and it shows that different concentrations of zeolite incorporated to KCF substrate media have no significant effects among the treatments (Table 1), while the biggest flower size was found on the plants treated with 40g/L zeolite compare to others.

Plant dry weight

Root dry weight

The effects of various concentrations of zeolite in KCF substrate media on dry weights of plant components is shown in (Table. 2). Data show that among the treatments there was no significant effect on root dry weights of the plants.

Stem dry weight

As it is seen in the Table 2, there was no significant effect using different concentrations of zeolite incorporate to KCF substrate media on the stem dry weight of the marigold plants.

Leave dry weight

There was no significant effect on leaves dry weight of the plant grown in different concentrations of zeolite incorporated to KCF substrate media (Table 2). However leaves of the plant grow in the media containing 30 and 40g/L zeolite treated to be heavier with their dry weights.

Flower dry weight

The data at Table 2 show that there was a significant effect on flower dry weights of marigold plant among all treatments. However the plants that grown in concentration of 40g/L incorporated to KCF had heaviest flower dry weight at 6.77g compared to other treatments.

Leaf nutrient contents

The effects of different concentrations of zeolite mixed with KCF substrate media on selected macronutrients contents in marigold leaves is shown in Table 3. The values recorded in this study were on healthy mature leaf tissue as suggested by (Jobin *et al.*, 2004).

Table 2. Effects of kenaf core fiber with different concentrations of zeolite on dry weight of roots, stems, leaves and flowers of marigold plant.

Zeolite Conc. (g/L)	Roots (g)	Stem (g)	Leaves (g)	Flowers (g)
0	1.75 a	2.32 a	2.35 a	5.60 ab
10	1.55 a	1.67 a	1.60 a	3.37 b
20	1.42 a	1.70 a	1.67 a	4.07 ab
30	1.72 a	2.00 a	2.12 a	4.00 ab
40	2.22 a	2.37 a	2.35 a	6.77 a

Values in column with the same letter did not differ significantly at $p< 0.05$ according to DMRT.

Result showed that using KCF as substrate media with different concentrations of zeolite had no significant effect on nitrogen, phosphorus, and calcium content. On the other hand, it is clearly seen there was a significant effect on potassium and magnesium. However, results shown that variation in growth and flowering of marigold determined in this study were primarily associated with the differences in K and Mg macronutrients plant leaves properties of KCF, and different concentrations of zeolite. The level of Mg had reciprocal relation with K, high level of Mg provide low level of K.

The maximum level of potassium in the plant leave was found to be on the plant grown in KCF substrate media with the zeolite level of 20 and 40g/L, since there was no significant effect between both of them, while the concentration of 0g/L had the lowest level at 1.63%. There was a significant effect of KCF substrate media on magnesium level of the plant, however, the highest value of magnesium was found to be on plant grown in KCF with zero level of zeolite since the lowest value was on level of 40g/L at 0.23 and 0.16%, respectively. There was no significant effect among zeolite level of 10 and 20g/L, and 30 and 40g/L.

Table 3. The amount of leaf nutrient contents (%) in the leaves of marigold plants grown in kenaf core fiber substrate media containing different concentrations of zeolite.

Zeolite Conc. (g/L)	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)
0	5.62a	0.21a	1.63b	1.37a	0.23a
10	5.61a	0.17a	1.89ab	1.51a	0.20b
20	6.12a	0.21a	1.95a	1.42a	0.20b
30	6.10a	0.19a	1.81ab	1.44a	0.18bc
40	5.68a	0.18a	1.97a	1.40a	0.16c

Values in column with same letter did not differ significantly at $p < 0.05$ according to DMRT.

Discussion

The plant height, stem width, flower numbers and flower sizes of marigold plants grown on KCF as a substrate media and treated with different levels of zeolite were different among the treatments. High concentrations of zeolite incorporated to KCF substrate media improved a growth performance of marigold plant.

Since marigold is an annual plant, the most important part to be used is the flowers. High concentration of zeolite incorporated to KCF substrate media resulted to no significant effect among the treatments. The best yield of rose flower variety Bianca was achieved when zeolite was incorporated into perlite (1:3 ratio) (Maloupa *et al*., 2000). However, dry weight of root did not differ markedly in all treatments, but affected the stem dry weight. There was a significant effect on flower dry weight. Results show that among the treatments, concentrations of 30 and 40g/L zeolite were better than other concentrations.

In term of plant tissue mineral content, different concentrations of zeolite incorporated to KCF had no significant effects on N, P, and C. In case of K and Mg, there was a significant effect of using concentrations 30 g/L zeolite which had a good result in K, using concentration of 0g/L zeolite resulted in high level of Mg. The nutrients holding capacity of zeolite is one of the positive properties to the plants. However, this point makes the required nutrients available to plants. The values of P, and K were almost in the normal range, i.e. 0.3-0.5% for P, and 3.5-5.5% for K (Kessler, 2015). It was reported that the ability of the plants to absorb and decreases leaching of potassium of the growth medium it would be handled by zeolite. Then zeolite releases potassium gradually as available to plants (Karami *et al*., 2011). Therefore, variation in the growth and flowering of marigold determined in this study were associated with the different concentrations of zeolite in the substrate media.

Conclusion

The results showed that different concentrations of zeolite into KCF significantly affected the stem width, and flower number of marigold plant. The growth and flowering of the marigold plant grown on KFC substrate media with concentrations of 30 and 40g/L of zeolite had good performance. Results achieved that KCF with 30or 40g/L of zeolite could be used for successful production of horticultural crops, but using concentration of 30g/L zeolite would be recommended in term of economic compared to concentration of 40g/L zeolite.

Acknowledgement

The authors would like to thanks University Malaysia Terengganu and University Putra Malaysia for giving permission to publish this paper

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