Research Journal of Soil Biology, 2015
ISSN 1819-3498 / DOI: 10.3923/rjsb.2015.

Effects of Cultivation of Gerbera on some Physical and Chemical Properties of Different Growing Substrates

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ABSTRACT

This study was carried out in the research greenhouse of Islamic Azad University, Isfahan (Khorasgan) branch, to explore the effect cultivation of Gerbera on some physical and chemical properties of growing substrates. The experimental design was randomized complete, using different organic growing substrates including raw date palm waste, spent date palm waste, spent date palm waste+perlite (60+40%) in three sizes (0-0.5, 0.5-1 and 1-2 cm) and coco peat+perlite (50+50%) with 5 replications. The results indicated that cultivation of gerbera on spent date palm waste and spent date palm waste+perlite resulted in significant increases in bulk density of these substrates. The results indicated that cultivation of gerbera on coco peat+perlite and spent date palm waste+perlite resulted in significant increases in particle density of these substrates. However, there were no significant differences between treatments in porosity except in spent date palm waste treatments that had significant decrease in porosity after cultivation. The results indicated that cultivation of gerbera on the raw date palm waste and spent date palm waste with the particle size of 1-2 cm resulted in significant increases in water holding capacity. The cultivation of gerbera on growing substrates resulted in significant increase in pH. Although the EC of coco peat+perlite was also significantly greater in after cultivation than in before cultivation, the cultivation of gerbera on other growing substrates (in most cases) resulted in significant decrease in EC.

Key words: Date palm waste, coco peat, growing substrate, cultivation, gerbera

INTRODUCTION

In recent years, different formulations of alternative materials for potting horticultural plants are being developed. Suitable growing substrates are necessary for gaseous exchange between roots and atmosphere, quality flower production, sufficient anchorage of plant as well as provision of nutrients and water (Abad *et al*., 2002; Awang *et al*., 2009). Nutrient availability is one of the important factors influencing the suitability of organic substrates for plant growth and development (Caballero *et al*., 2007). However, different growing substrates have several materials which could have effects on plant production. Thus, selecting the best substrate among the various materials is imperative to the plant productivity (Olympios, 1992). Ali (2008) showed that total number of seeds germinated, rate of seed germination, plant height, number of leaves per plant and the dry-biomass per plant was better in the Date Palm Leaves Compost (DPLC) relative to the peat

moss. The application of alternative growing substrates requires knowledge of their physical and chemical characteristics responsible for providing suitable support and a reservoir for air, water and nutrients. Nkongolo *et al*. (2007) suggest that measurements of pore space characteristics (τ and Ds/Do) in top of storage properties (water and air contents) of media may be useful in understanding the relationship between plant growth and the physical properties of growing media. The effect of the alternative substrates on plant growth and ornamental traits needs to be evaluated during the entire cultivation period. To date, there is little available information about the effects of cultivation on some physical and chemical parameters of growing substrates. Accordingly, the purpose of this study was to examine the influence of cultivation of gerbera on the physical-chemical properties of substrates, including Water Holding Capacity (WHC), Bulk Density (BD), Particle Density (PD), porosity, Electrical Conductivity (EC) and pH at before and after planting.

MATERIALS AND METHODS

This study was performed in the greenhouse research site of Isfahan Azad University (Khorasgan) to explore the effect cultivation of gerbera on some physical and chemical properties of growing substrates. The experiment was conducted in a randomized complete design with 10 treatments and 5 replications. Date palm wastes were chopped into smaller sizes and chopped wastes are separated in three sizes (0-0.5, 0.5-1 and 1-2 cm) by sieve. In 2013, a part of raw palm wastes was used for cultivation of tomato and in this research these material are called as spent date palm waste. Then, these date palm wastes were used as culture media for gerbera cultivation.

Then treatments were including:

- Coco peat+perlite (50+50%) as control
- Raw date palm waste size 0-0.5 cm (RDP 0-0.5)
- Raw date palm waste size 0.5-1 cm (RDP 0.5-1)
- Raw date palm waste size 1-2 cm (RDP 1-2)
- Spent date palm waste size 0-0.5 cm (SDP 0-0.5)
- Spent date palm waste size 0.5-1 cm (SDP 0.5-1)
- Spent date palm waste size 1-2 cm (SDP 1-2)
- SDP (0-0.5) +perlite (60+40%) (SDPP 0-0.5)
- SDP (0.5-1) +perlite (60+40%) (SDPP 0.5-1)
- SDP (1-2) +perlite (60+40%) (SDPP 1-2)

The studied gerbera cultivar was dune. Plants were grown in 4 L pots (one pot per replication); each of the pots was filled with one growing medium at its bulk density. Hoagland solution was applied during plant growth period. During growth period, irrigation rate, humidity and temperature were similar. The growth characteristics of gerbera plant were determined at the end of growth period. Average temperature of day and night were 29 and 17°C, respectively during growth period. Physical and chemical characteristics of the culture media including water holding capacity (Verdonck and Gabriels, 1992), bulk density and particle density (Daifullah *et al*., 2003), porosity (Baruah and Barthakur, 1997), Electrical Conductivity (EC) and pH were measured before and after planting.

Statistical analyses: Experimental data normality was verified and then data was submitted to analysis of variance, using SAS 9.1 software package for Windows. Means were compared using Least Significant Difference (LSD) test at $p<0.05$.

RESULTS AND DISCUSSION

Physical properties

Bulk density: The results indicated that cultivation of gerbera on spent date palm waste and spent date palm waste+perlite resulted in significant increases in bulk density of these substrates (Fig. 1). However, there were no significant differences between before and after cultivation in coco peat+perlite and raw date palm waste with the particle size of 0.5-1 and 1-2 cm (Fig. 1). The highest amount of bulk density was obtained in spent date palm waste with the particle size of 0-0.5 cm at after cultivation (0.31 g cm^{-3}). Generally, the results showed that bulk density in spent date palm waste and spent date palm waste+perlite substrates was significantly greater than that in coco peat+perlite and raw date palm waste (Fig. 1). Before cultivation, the highest bulk density value was recorded in the spent date palm waste and spent date palm waste+perlite with the particle size of 0-0.5 cm. It was because of more entered dust in this size during the crashing and sieving. The results illustrated that with increasing size particles, bulk density decreased. It could be due to bigger pores and higher porosity in bigger sizes. Higher values of bulk density by cultivation of plant could be attributed to this reason that Organic Carbon (OC) present in the organic substrates is used by microorganisms. At the planting period, as OC is lost from the organic substrates, the substrates become more compacted and air spaces within the organic substrates become smaller (Hirrel and Riley, 2012) and consequently bulk density was increased. Bulk density is a physical propriety of growing substrate, because this allows easier transportation of plant units in the greenhouse (Abad *et al*., 2004).

Particle density: The results indicated that cultivation of gerbera on coco peat+perlite and spent date palm waste+perlite resulted in significant increases in particle density of these substrates (Fig. 2). Generally, the results showed that particle density in date palm waste substrates was significantly greater than that in coco peat+perlite (Fig. 2).

Porosity: The highest amount of porosity were observed in raw date palm waste substrates because of lower bulk density and bigger pores between them. Also, the results indicated a

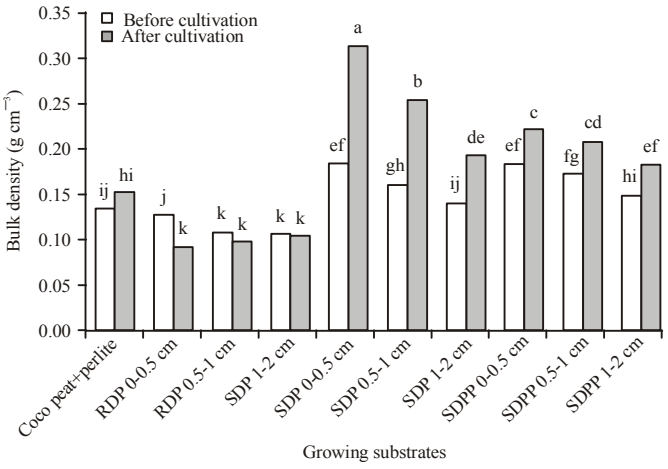

Fig. 1: Effect of different substrates and cultivation on bulk density of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 0.019)

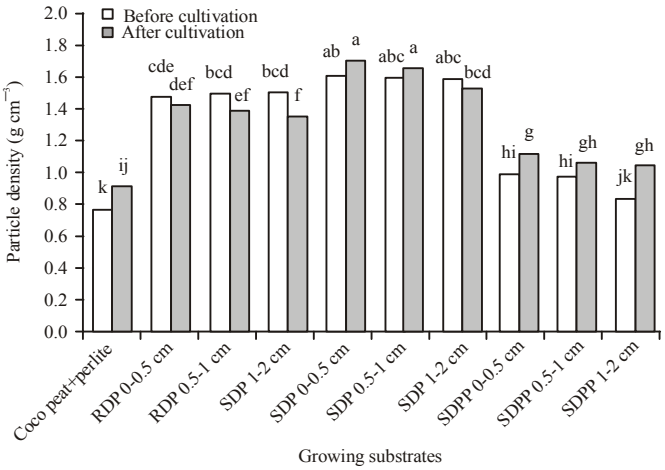

Fig. 2: Effect of different substrates and cultivation on particle density of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 0.117)

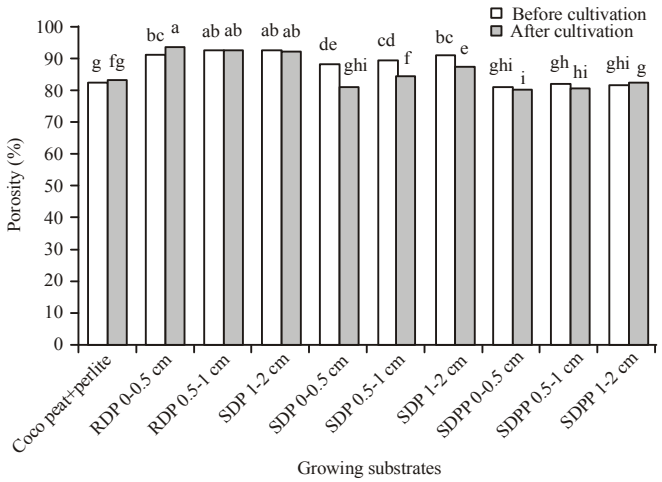

Fig. 3: Effect of different substrates and cultivation on porosity of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 0.19)

significant decrease in values of porosity by cultivation of gerbera in spent date palm waste substrates because in effect of decomposition process particles be small and sit in large pores and led to increasing density, reducing porosity and increasing bulk density (Fig. 3). Low porosity can cause poor aeration and higher resistance to root penetration, limiting nutrition minerals and water uptake by plants and consequently inhibiting plant growth (Forbes and Watson, 1992). However, Nowak and Strojny (2004) demonstrated that the total porosity, bulk density and air capacity of the growing substrates had significant effects on growth of gerbera. Masaka *et al*. (2007) showed that media particle size distribution, combinations of pine bark and coal rubble media components had a comparatively significant effect on the total porosity of media blends while their influence on bulk density was largely insignificant.

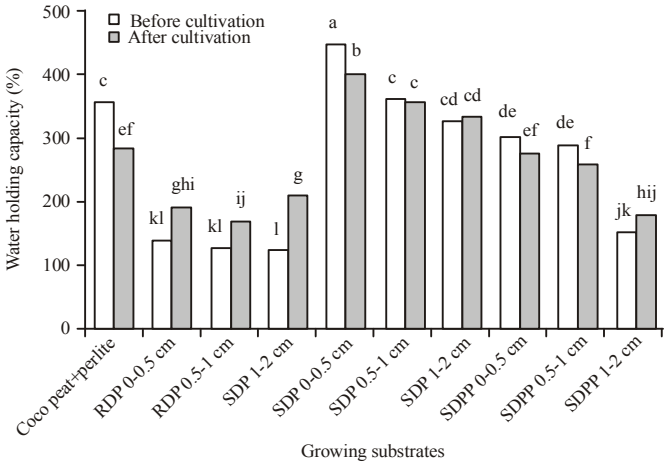

Fig. 4: Effect of different substrates and cultivation on water holding capacity of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 28.37)

Water holding capacity: The results indicated that cultivation of gerbera on the raw date palm waste resulted in significant increases in water holding capacity (Fig. 4). However, in some cases, a marginal decrease in water holding capacity by cultivation of gerbera was obtained. The highest amount of water holding capacity was obtained in the spent date palm waste with the particle size of 0-0.5 cm at before cultivation (449.56%) because smaller particles have a larger surface area than those with larger particles; a large surface area allows a media to hold more moisture and to increase WHC. In spent date palm waste and spent date palm waste+perlite substrates, a decrease in water holding capacity was noted as the size classes increased. Generally, the results showed that water holding capacity in spent date palm waste and spent date palm waste+perlite substrates was significantly greater than that in raw date palm waste (Fig. 4). Samiei *et al*. (2005) found that palm peat and coco peat were similar in some characteristics (CEC, pH, EC and organic carbon). However, water holding capacity was higher in coco peat than in palm peat. They also reported that if water holding capacity of palm peat is improved, it would be a proper substitute for peat moss.

Chemical properties

Electrical conductivity: The cultivation of gerbera on growing substrates significantly affected the EC. Although the EC of coco peat+perlite was also significantly greater in after cultivation than in before cultivation, the cultivation of gerbera on other growing substrates (in most cases) resulted in significant decrease in EC but this decrease was much more in raw date palm waste (Fig. 5). The use of irrigation water led to leaching of soluble salts from growing substrates, therefore, substrates EC was substantially decreases by cultivation of gerbera. Another reason for EC decline could be due to nutrients absorption by plants during the experiment. Also, Abad *et al*. (2005) suggested that leaching the composts with water decreased significantly the salinity and the concentration of soluble mineral elements. Highest amount of EC (3.79 dS m^{-1}) was significantly observed in spent date palm waste with the particle size of 0-0.5 cm at before cultivation. High EC in this palm waste was due to that solution salt particles and dust had covered date palm leaves and when date palm wastes were chopped and sieved, these fractions were

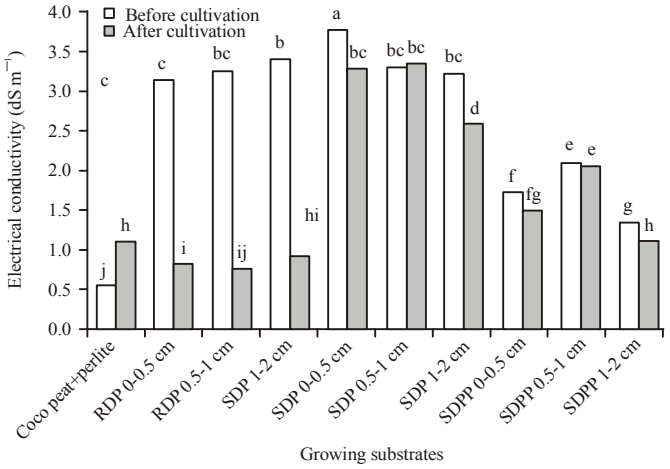

Fig. 5: Effect of different substrates and cultivation on electrical conductivity (EC) of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 0.24)

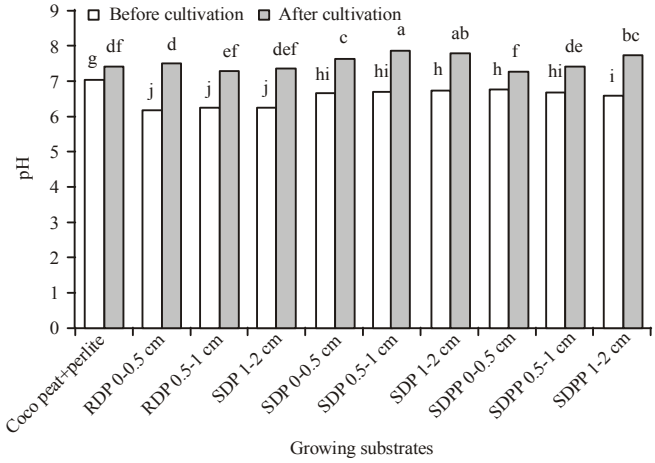

Fig. 6: Effect of different substrates and cultivation on pH of substrates. The means followed by the same letter are not significantly different according to LSD test at $p<0.05$, (LSD = 0.15)

released. However, these results are not agreed with the findings of Larcher and Scariot (2009) that found an increase in EC and in the amount of available nutrients was detectable in all substrates at the end of cultivation of *Camellia japonica.*

pH: Figure 6 shows effect of different substrates and cultivation on pH of substrates. The cultivation of gerbera on growing substrates resulted in significant increase in pH (Fig. 6). It may be due to continuous composting process in all culture media. In fact, the composition of these materials leads to major changes in materials and their pH. On the other hand, the increases in the content of substrates pH by cultivation were mainly related to volatilization of organic acids and accumulation of ammonia in these materials (Hellmann *et al*., 1997). Hernando *et al*. (1989) demonstrated that compost products commonly have a near to neutral or partly alkaline pH with

a high buffering capacity. However, Hachicha *et al*. (2008) found that higher surface area in smaller particles caused more decomposition of organic matter and more production of organic acids and more reduces of pH.

CONCLUSION

Based on the results obtained in this study, date palm waste can be partially substituted by coco peat and perlite. The cultivation of gerbera on growing substrates significantly affected the physical and chemical properties of different growing substrates.

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