Research Reports

Good Yields of Common Purslane with a High Fatty Acid Content Can Be Obtained in a Peat-based Floating System

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Additional index words. alpha-linolenic acid, baby-leaf, irrigation system, linoleic acid, new crops, *Portulaca oleracea*, substrates

Summary. Interest in cultivating common purslane (*Portulaca oleracea*) as a food crop has grown since its identification as an exceptionally rich source of bioprotective substances considered essential for normal human growth, health promotion, and disease prevention. However, little is known about the suitable cultural systems, substrates, and irrigation systems for common purslane's commercial production. In this study, we examined the effects of various substrates in a floating system on common purslane's yield and fatty acid content during 2003 and 2004. We carried out three experiments using peat, vermiculite, coir, perlite, and mixtures of peat and perlite (3:1 and 1:1 v/v). In 2003, highest yields were obtained in plants grown in either peat (1806 g·m^{-2}) or vermiculite (1982 g·m^{-2}) and far exceeded those grown in coir (1254 g·m^{-2}) or perlite (834 g·m^{-2}). In 2004, plants grown in peat or 3 peat:1 perlite mixture yielded the best (2000 g·m^{-2}), whereas the lowest yields were obtained in plants grown in either coir or perlite (534 and 601 g·m^{-2}, respectively). Plants grown in peat substrate had the highest total fatty acid content, alpha-linolenic acid, and linoleic acid, whereas the highest proportion of alpha-linolenic acid to total fatty acids was obtained in plants when grown in either coir or perlite.

Common purslane is a member of the Portulacaceae family, which consists of more than 120 species of often succulent herbs and shrubs. It is an annual plant, which grows in many areas of the world, including Mediterranean countries, Africa, and Asia. Common purslane has a long history of use for human food, animal feed, and medicinal purposes (Liu et al., 2000; Salisbury, 1961). However, interest in cultivating common purslane as a food crop has been stimulated since its identification as a rich source of bioprotective nutrients: fatty acid ω3, antioxidants, vitamins, and essential amino acids (Miller et al., 1984; Simopoulos and Salem, 1986; Simopoulos et al., 1992), glutathione, and alpha-tocopherol (Liu et al., 2000; Palaniswamy et al., 2001, 2002; Simopoulos, 1991, 2001; Simopoulos et al., 1992), together with the catecholamines, as noradrenaline and dopamine (Chen et al., 2003).

Recent studies have shown that the consumption of these substances helps reduce the incidence of coronary heart disease; they also have anticarcinogenic (Chen et al., 2003; Palaniswamy et al., 2000; Simopoulos, 1991, 2001), analgesic and antiinflammatory (Chan et al., 2000; Simopoulos 1999a, 1999b; Simopoulos et al., 1992), diuretic, antiascorbic and antipyretic (Chan et al., 2000; Simopoulos et al., 1995), bronchodilatory (Malek et al., 2004), and neuropharmacologic properties (Radhakrishnan et al., 2001).

Common purslane has been listed as a "commercially cultivated vegetable of the world" (Kays and Dias, 1995). Some varieties such as Golden Gerber, Garden (The Netherlands), and Golden (England) are grown as such; however, in many parts of the world, it is regarded as a weed (Mitich, 1997; Whitson, 2001). Common purslane is now cultivated only on a small scale in France and Holland. In the U.S., common purslane is a minor crop because of its use in ethnic cooking and its reported health benefits. However, this species is now receiving attention for cultivation by the U.S.

We thank Fundación Séneca de la Región de Murcia and the Comisión Interministerial de Ciencia y Tecnología (CICYT) for their help in financing this study (projects PI-27/00753/FS/01 and AGL 2000-0521, respectively).

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Unit

To convert U.S. to SI, multiply by	U.S unit	SI unit	To convert SI to U.S., multiply by
0.3048	ft	m	3.2808
0.0929	ft^2	m^2	10.7639
3.7854	gal	L	0.2642
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
6.4516	inch^2	cm^2	0.1550
1	micron	µm	1
1	mmho/cm	dS·m^{-1}	1
28.3495	oz	g	0.0353
28,350	oz	mg	3.5274×10^{-5}
305.1517	oz/ft^2	g·m^{-2}	0.0033
0.1	ppm	mg/100 g	10
1	ppm	mg·L^{-1}	1
(°F – 32) ÷ 1.8	°F	°C	(1.8 × °C) + 32

Department of Agriculture as part of their effort to modify the "Western" diet with the increased intake of fresh fruits and vegetables. Indeed, several internal reports of the University of Florida and the University of California describe common purslane as a succulent herb with good nutritional and health properties, whereas in recent years, scientists at the University of Connecticut have investigated several factors that might affect the nutritional content of the same plant, common purslane (Palaniswamy et al., 2000, 2001, 2002, 2004). However, very little is known about culture systems, substrates, and irrigation systems suitable for its production as a commercial food crop. It is therefore important to carry out studies to determine the most suitable techniques for growing this species, which should be directed at its production and presentation as a ready-to-eat or ready-to-cook small leafy vegetable.

Among hydroponic methods used to produce baby-leaf vegetables, the "floating system" is the easiest and cheapest (Gonnella et al., 2003). This system shortens the cultivation cycle compared with soil-based culture and is very interesting for growers because of the low installation and manpower costs; weeds are avoided and harvesting is straightforward. Plants can be grown at high densities and the resulting products (leaf vegetables) are clean and ready to be packed. In a comparison of the yields of common purslane obtained in earth and in a floating system, Graifenberg et al. (2003) found similar values but that the growth cycle was considerably shorter in the floating system. It is therefore worth looking at this technique in greater depth. Our own experiments led to the rejection of growing common purslane in soil to obtain a baby-leaf plant resulting from the rapid formation of mucilage in leaves and stem and the difficulty of harvesting (unpublished data).

On the other hand, in floating systems, important parameters such as the nitrates that tend to accumulate in some species, for example, rocket (*Eruca vesicaria*) (Elia et al., 2001; Santamaria and Elia, 1997), can be controlled.

Although different substrates and mixtures are commercially available for use in floating systems (Carrasco et al., 2000, 2003), it is not clear which is the best for obtaining high-quality common purslane plants (adequate for consumption as baby-leaf and also with high fatty acid contents). Given that one of the main reasons for growing this species is its high fatty acid content, it would seem essential to take into account the effect of different substrates on this parameter.

There are, then, two objectives in this study: 1) to determine the most suitable substrate for a floating system designed to grow common purslane for retail as a baby-leaf vegetable and 2) to assess the possible influence of the substrate used on the fatty acid content.

Materials and methods

Study site and greenhouse conditions. The experiments were conducted in July to Aug. 2003 (Expt. 1 and Expt. 2) and Sept. 2004 (Expt. 3) in the "Tomás Ferro" Experimental Agro-Food Station of the Polytechnic University of Cartagena (UPCT) on the Mediterranean coast of Spain (lat. 37°36′52″N, long. 0°58′07″W) in an unheated greenhouse covered with polycarbonate. The weather conditions during greenhouse culture in Expt. 1 and Expt. 2, respectively, were as follows: average air temperature 25.9 and 26.3 °C with minimum air temperature 21.1 and 19.8 °C, maximum air temperature 40.4 and 41.5 °C, minimum relative humidity (RH) 19% and 22%, maximum RH 89% and 91%. The weather conditions during the greenhouse culture in Expt. 3 were: average air temperature 26 °C, minimum air temperature 14.5 °C, maximum air temperature 43.9 °C, minimum RH 10%, maximum RH 85%. In all the experiments, the greenhouse received only natural light with an average midd *PAR* (*PAR*) of 690, 660, and 620 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in Expt. 1, Expt. 2, and Expt. 3, respectively.

Plant material and substrates. The common purslane seeds tested in this study were provided by the germplasm bank of UPCT registered as accession 01–215 (Cartagena, Murcia). These seeds were collected in July 2001 and stored at 4 °C until used.

Expts. 1 and 2. Sowing was carried out manually on 12 July 2003 (Expt. 1) and on 27 July 2003 (Expt. 2) in polystyrene trays with 176 cells (2.9-cm diameter, 4-cm deep, 26.43-cm^3 volume) and filled with different media: 1) peat (type S, fine texture; Floragard Vertriebs, GmbH, Oldenburg, Germany); 2) vermiculite (Asfaltex no. 3, particles ≤4 mm; Asfaltex S.A., Barcelona, Spain); or 3) coir (Cocopeat, fine texture; Projar S.A., San Javier, Spain). In Expt. 2, we also used a substrate: 4) perlite (A13, particles 3–5 mm; Projar S.A.).

Expt. 3. To confirm the results obtained in Expt. 1 and Expt. 2, we carried out a third experiment in Sept. 2004 (Expt. 3), in which the number of substrates was increased and the growth parameters compared with the previous findings, analyzing at the same time root development and fatty acid content. In this experiment, sowing was carried out manually on 11 Sept. 2004 in similar polystyrene trays as used in Expt. 1 and Expt. 2 and filled with one of the following: 1) peat, 2) vermiculite, 3) coir, 4) perlite, 5) a mixture of 3 peat:1 perlite (by volume), or 6) 1 peat:1 perlite (by volume).

Plant growth environment. In all the experiments, the trays were kept in the greenhouse and irrigated as needed with tap water until germination. After emergence (3–4 d after sowing), the seedlings were thinned to retain only three seedlings in each cell (2200 plants/m^2). Beds were constructed inside the greenhouse using galvanized metal troughs (3 × 1.5 × 0.15 m) lined with 1.2-mm-thick clear PVC film (Alkorplan A 35279; Renolit Ibérica S.A., Barcelona, Spain). Trays were transferred to these flotation beds and maintained on fresh tap water. After the appearance of one leaf pair (7–8 d after sowing), the fresh water in the beds was replaced with nutrient solution. This solution was made up using fresh water with an EC (EC_w) of 0.9 $dS \cdot m^{-1}$ and pH 7.7. The composition of the base nutrient was: 3200 $\mu mol \cdot L^{-1}$ nitrate (NO_3^-), 2000 $\mu mol \cdot L^{-1}$ dihydrogen phosphate ($H_2PO_4^-$), 4800 $\mu mol \cdot L^{-1}$ sulphate (SO_4^{2-}), 1000 $\mu mol \cdot L^{-1}$ calcium (Ca^{2+}), 6000 $\mu mol \cdot L^{-1}$ potassium (K^+), 2000 $\mu mol \cdot L^{-1}$ magnesium (Mg^{2+}), 4800 $\mu mol \cdot L^{-1}$ ammonium (NH_4^+) prepared with the following compounds: ammonium sulphate, ammonium phosphate, potassium sulphate, calcium hydroxide, potassium phosphate, magnesium sulphate, and ammonium nitrate, whereas micronutrients were added using Nutromix 10 (3 $mg \cdot L^{-1}$; Biagro S.L., Valencia, Spain). EC (EC) and pH of solution were monitored during the experimental period with values of EC of 2.2 to 2.45 $dS \cdot m^{-1}$ and values of pH of 5.5 to 6.5. The solution temperature during the culture period was monitored with a temperature recorder (Escort Junior Temperature Recorder EJ-1E; Escort Data Loggers, New Lynn, New Zealand). The average solution temperatures in Expt. 1 and Expt. 2 were 26.6 and 26.3 °C with minimum and maximum of 21.9 and 21 °C and 40.1 and 40.7 °C, respectively. The average solution temperature of Expt. 3 was 24.6 °C with minimum and maximum of 15.0 and 42.4 °C. Besides, water consumption was measured for each flotation bed (six trays per bed) with a mean water consumption of 56 ± 2.57 L.

EXPERIMENTAL DESIGN AND DATA COLLECTION. For Expt. 1 and Expt. 2, two trays of each substrate were randomly placed in each of the floating beds described (three replicates). The plants were harvested when most of the plants in all the substrates had five leaf pairs (14 and 13 d after sowing in Expt. 1 and Expt. 2, respectively). The height and number of leaf pairs per plant and the fresh and dry weight of the aerial part were measured.

In Expt. 3, in each of the three floating beds described (replicates), six trays, each containing a different substrate, were randomly placed. The plants were harvested when most of the plants in all the substrates had five leaf pairs (18 d after sowing). The height and number of leaf pairs per plant, fresh and dry weight of the aerial part, leaf area, total root length, number of tips and forks, and average root diameter were measured.

Besides these morphologic parameters, the fatty acid content of the plants grown on peat, vermiculite, coir, and perlite was assessed in Expt. 3.

To study height and the leaf pairs per plant, three replicates of 10 plants per substrate were picked, whereas the other parameters were analyzed in relation with the area of the crop taking three samples from each substrate. Each sample contained the plant material of five cells (70 cm^2 in total) taken randomly from each tray. The root part was separated from the aerial part and the roots were analyzed individually for each of the five cells of each sample. A two-stage washing process separated the roots from growing media. In the first stage, they were immersed in water and shaken carefully to clean the roots. In the second stage, they were gently washed on a screen with a low-pressure stream of water applied through a flat nozzle (Franco et al., 2002a, 2002b). The fresh and dry weights of leaves, stems, and roots were measured with a 0.1-mg precision balance (BP221S; Sartorius, Goettingen, Germany). To determine the dry weights, the samples were dried in a forced air oven at 65 °C until the weight was constant (48 h). To measure leaf area, leaves were separated manually from stems and then screened using a Delta-T gauge (Delta-T Devices, Cambridge, U.K.).

Total root length, number of tips and forks, and average root diameter were measured using Digital Image Analysis System WinRhizo LA 1600 (Régent Instruments Inc., Québec) (Franco and Leskovar, 2002).

To quantify the fatty acids, three samples (100 g each) of fresh weight [FW (leaves and stems)] were taken from the plants grown in peat, vermiculite, coir, and perlite. Fatty acids were extracted with methanol and determined by gas chromatography, according to the method described by Palaniswamy et al. (2001), using a gas chromatograph (Varian 3800; Varian, Palo Alto, Calif.) with a flame ionization detector and a Supelcowax capillary column [10 stationary phase, 1-µm film thickness, 0.53 mm i.d. × 30 m (Supelco, Bellefonte, Pa.)]. Fatty acid peak areas were determined with a gas chromatograph–mass spectrometer (Varian Saturn 2000, Palo Alto, Calif).

STATISTICAL ANALYSIS. All data sets were subjected to analysis of variance (ANOVA) using SPSS (version 12; SPSS Inc., Chicago). Data are presented as mean ± standard error; separation of means for the relative values was performed using Tukey's test at 95% of confidence.

The fatty acids percentages were arcsine transformed (Zar, 1984) before statistical analysis (ANOVA and Tukey's test at 95% of confidence).

Results

PLANT PRODUCTION—EXPTS. 1 AND 2. Plant height was greater in the plants grown in peat and vermiculite than in those grown in coir in Expt. 1. In Expt. 2, plant height was greater in peat and vermiculite than in coir or perlite (Table 1).

There was no difference in leaf pair per plant between the substrates in Expt. 1, whereas in Expt. 2, the number of leaf pairs was greater with peat compared with coir or perlite (Table 1).

The highest yields were obtained in peat and vermiculite (1818 and 1982 $g \cdot m^{-2}$, respectively, in Expt. 1), which were greater than coir. In Expt. 2, common purslane, when grown in either peat or vermiculite substrate, had almost twofold higher yields than those grown in coir or perlite (Table 1). Water constituted 95.77 ± 0.37% of fresh common purslane weight.

PLANT PRODUCTION—EXPT. 3. In Expt. 3, plant height was greater in plants grown in peat and the peat–perlite mixtures, followed by plants grown in vermiculite, followed by plants grown in coir and perlite (Table 2). The number of leaf pairs per plant

Table 1. Values of height, leaf pairs, and production of plants of common purslane grown in different substrates (peat, vermiculite, and coir) in July 2003 (Expt. 1) and (peat, vermiculite, coir, and perlite) in Aug. 2003 (Expt. 2).[z]

	Vegetative parameters		
Substrates	Plant ht (cm)[y]	Leaf pairs (no./plant)	Yield ($g \cdot m^{-2}$)[x]
Expt. 1			
Peat	8.32 a	5.0	1818 a
Vermiculite	8.73 a	4.83	1982 a
Coir	6.12 b	4.85	1254 b
Expt. 2			
Peat	8.0 a	4.76 a	1806 a
Vermiculite	8.18 a	4.28 ab	1864 a
Coir	5.18 b	3.8 b	789 b
Perlite	5.16 b	3.67 b	834 b

[z]For each experiment, different letters denote significantly differences ($P = 0.05$) according to Tukey's multiple range test.
[y]1 cm = 0.3937 inch.
[x]1 $g \cdot m^{-2}$ = 0.0033 oz/ft^2.

was also greater in peat and the peat–perlite mixture (7.98–7.18) than in coir and perlite (4.13–4.66). (Table 2).

Fresh weight of leaves and stems were significantly affected by the substrate used (Fig. 1). The best results for leaf and stem fresh weights were obtained in peat (2240 $g \cdot m^{-2}$) and the 3 peat:1 perlite mixture (2132 $g \cdot m^{-2}$) (Fig. 1). The 1 peat:1 perlite mixture was significantly less than peat or the 3 peat:1 perlite mixture. The lowest yields were with coir and perlite with 534 and 601 $g \cdot m^{-2}$, respectively (Fig. 1). In addition, the stems appeared thinner on these substrates compared with the others.

The leaf dry weight of the plants grown in peat and the 3 peat:1 perlite mixture was greater than in the plants grown in the other substrates, the lowest weights being obtained with coir and perlite alone. In general terms, the dry weight of the stems showed similar behavior with no differences between the results obtained in vermiculite, perlite, and coir, which had the lowest values, whereas peat-grown plants produced the highest weight. The average water content across all treatments was of 94.77 ± 0.34%.

Leaf area was greater in peat-grown plants than in those grown in peat–perlite (3:1 and 1:1). The same parameter was substantially lower when coir and perlite were used (Table 2).

Root system. Root fresh weight of plants grown in peat and the mixture of 3 peat:1 perlite was substantially greater than in plants grown in the other substrates with the lowest root fresh weight obtained in coir (Table 3).

Similarly, total root length and the number of tips and forks were lower in plants grown in coir and perlite, whereas the highest values were obtained in peat and the 3 peat:1 perlite mixture. The plants grown in perlite and both peat–perlite mixtures showed the highest root diameter values with the lowest values occurring with peat and coir (Table 3).

Fatty acid content. The highest content was obtained in peat (85.61 mg/100 g FW) and the lowest values in coir and perlite (27.26 and 21.46 mg/100 g FW, respectively) (Table 4). In general, the major fatty acids presents were alpha-linolenic acid (LNA) (13.5–48.1 mg/100 g FW), linoleic acid (LA) (1.5–6.5 mg/100 g FW), palmitic acid (4.5–26.1 mg/100 g FW), and stearic acid (0.8–3.2 mg/100 g FW). Smaller amounts of myristic acid, arachidic acid, gondoic acid, heneicosanoic acid, erucic acid, behenic acid, tricosanoic acid, and lignoceric acid were also detected (Table 4).

Regarding the major fatty acids found, the highest values for LNA, LA, stearic acid, and palmitic acid were observed in the peat-grown plants. In the case of the last mentioned acid (palmitic acid), the plants grown in vermiculite did not show significant differences from those grown in peat. The highest proportion of LNA with respect to total fatty acids was observed in plants grown in coir and perlite (64.99% and 63.57%, respectively), whereas the plants grown in vermiculite showed considerably lower values (37.42%); peat-grown plants showed intermediate levels for this parameter. The LNA:LA ratio was significantly higher in the plants grown in vermiculite, coir, and perlite with values in the range of 8.5 to 8.9 compared with the 7.3 obtained in peat.

The longer-chain omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were not detected in any of the plant samples grown in any of the substrates used.

Discussion

Plant production. The results obtained for the three experiments show that common purslane is a species that adapts well to a floating cultivation system, because it produces a high yield in a short period of time. The yields obtained with peat and the peat–perlite mixtures were between 1818 and 2240 $g \cdot m^{-2}$. However, to the best of our knowledge, there is nothing in the literature concerning the production of common purslane as a food crop. We can compare the results obtained with those for other small leafy vegetables. Dellacecca and Calegari (2001), for example, obtained yields of 1800 to 2900 $g \cdot m^{-2}$ for corn salad (*Valerianella locusta*), wild rocket (*Diplotaxis tenuifolia*), and spinach (*Spinacea oleracea*) using a floating system, which is very close to our results.

Common purslane production fell in the mixture containing less peat (1 peat : 1 perlite), reflecting the observations made by Papafotiou et al. (2004) for poinsettia plants (*Euphorbia pulcherrima)* even when only 25% of the peat was replaced. Because of its texture, it has good water-holding capacity and cation exchange capacity (Evans and Stamps, 1996). In addition, the water retention of the trays filled with peat and 3 peat:1 perlite were greater than those filled with 1 peat : 1 perlite (data no shown), which could influence the amount of nutrient solution by cell and therefore in the seedlings' growth.

Vermiculite in the first two experiments differed from Expt. 3. In Expt. 1 and Expt. 2, the results

Table 2. Vegetative parameters of plants of common purslane grown in different substrates in Sept. 2004 (Expt. 3).

	Vegetative parameters				
Substrates	Plant ht (cm)[z]	Leaf fresh wt ($g \cdot m^{-2}$)[y]	Stem fresh wt ($g \cdot m^{-2}$)[y]	Leaf pairs (no./plant)	Leaf area ($cm^2 \cdot m^{-2}$)[x]
Peat	14.7a[w]	1,275.7 a	964.9 a	7.9 a	28,964.9 a
Peat–perlite (3 : 1)	14.2 a	1,262.6 a	869.8 ab	7.9 a	25,814.3 b
Peat–perlite (1 : 1)	13.6 a	1,134.9 b	787.8 b	7.1 ab	23,761.3 b
Vermiculite	9.3 b	625.2 c	317.5 c	5.5 bc	13,915.9 c
Coir	6.3 c	369.1 d	164.9 d	4.2 c	8,373.8 d
Perlite	6.2 c	432.5 d	168.1 d	4.7 c	9,785.5 d

[z]1 cm = 0.3937 inch.
[y]1 $g \cdot m^{-2}$ = 0.0033 oz/ft².
[x]1 $cm^2 \cdot m^{-2}$ = 0.01439 inch²/ft².
[w]Within column means followed by different letters are significantly difference by Tukey's multiple range test ($P = 0.05$).

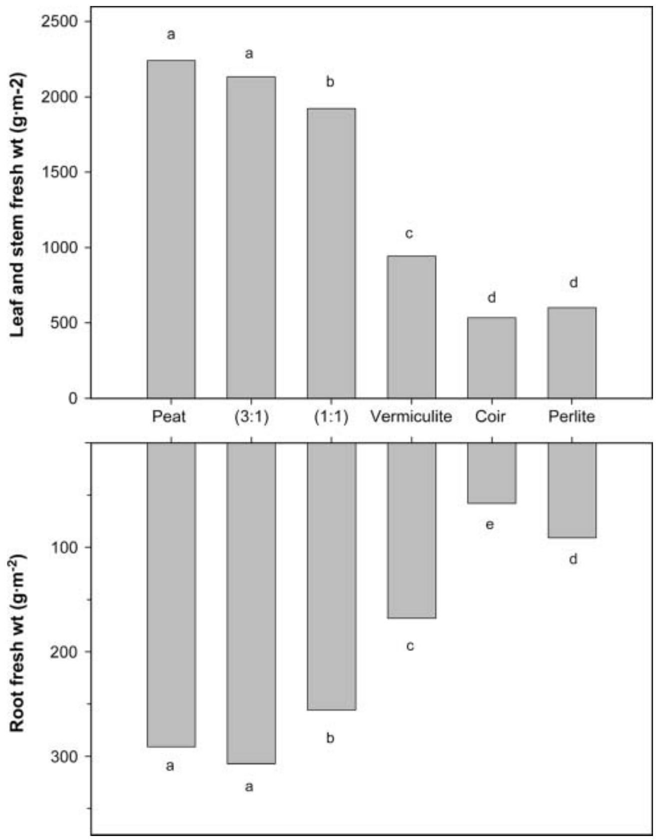

Fig. 1. Values of root and leaf and stem fresh weight of plants of common purslane grown in different substrates [peat, peat:perlite (3:1) and (1:1) (by volume), vermiculite, coir, and perlite] in Sept. 2004 (Expt. 3). Different letters denote significantly differences ($P \leq 0.05$) according to Tukey's multiple range test; 1 g·m^{-2} = 0.0033 oz/ft^2.

were similar to those obtained with peat, whereas in Expt. 3, they were substantially lower with vermiculite. It is unclear why vermiculite performed so poorly in Expt. 3 compared with the peat and peat mixtures; however, differences in temperatures during September production compared with July and August may have played a role.

The production data for plants grown in perlite were always significantly lower than for those grown in vermiculite. The differences in growth observed between these inorganic substrates could be attributed to the cationic exchange capacity of the vermiculite, which perlite does not have and which encourages better growth during the first few days of cultivation, a factor that would be of great importance in short growth cycles such as that of common purslane. Indeed, it has been suggested that an adequate cation exchange capacity is desired in a soilless medium to buffer it from sudden changes in pH and nutrient concentrations (Biernbaum, 1992).

The low yield of common purslane frequently obtained in coir is interesting because this material has been tested as a horticultural medium for several ornamental and agronomic crops with acceptable results (Evans and Stamps, 1996; Meerow, 1994; Pill and Ridley, 1998). However, fertilization frequently has to be adjusted to provide more nutrients to growing plants when coir is used (Guérin and Charpentier, 1997; Noguera et al., 1997, 2000), and in our experiment, no such adjustments were made because the aim was to assess the behavior of all the substrates used with minimal fertilization.

ROOT PARAMETERS. The physical properties of the different substrates strongly influenced the root system of common purslane plantlets, reflecting more or less the effect they had on aerial growth (Fig. 1). Root morphology was also affected by the substrate. The greater mean diameter of the roots and the lower root length and number of root tips and forks observed in the plants grown with perlite suggest that these are mostly primary roots with few secondary roots. Similar results were obtained by Kreen et al. (2002) and Ochoa et al. (2003), although in ornamental plants. The greater root length and high number of root tips and forks observed in the plants grown in peat and the two peat–perlite mixtures reflect greater growth, which increased capacity to capture more water and nutrients as shown by the higher production values. The lower yields obtained in vermiculite, coir, and perlite can be explained by a diminution in root length and a lower number of tips and forks, which emphasizes the relationship between root development and good production.

FATTY ACID CONTENT. The results show that by far, the highest total fatty acid content was obtained in the peat-grown plants with the lowest values being obtained in perlite and coir. The value obtained in peat was below that recorded by Palaniswamy et al. (2000, 2001) for common purslane plants. These differences may have been the result of differences in the age and growth stage of the plants at harvest, because we collected the plants at 18 d, whereas the previous authors did so at 30, 49, and 59 d after sowing. Similarly, Palaniswamy et al. (2001) found higher levels of fatty acids in the oldest plants compared with the other two stages. Furthermore, we extracted fatty acids from the whole plant (stems and leaves), whereas Palaniswamy et al., (2000, 2001, 2002) extracted them from leaves alone. Liu et al. (2000) observed differences between the total fatty acid content of stems and leaves, the former showing one third the level of the latter, which might also be a factor in our lower values.

Therefore, the differences observed in the total fatty acid content between the plants grown in different substrates may have been the result of the different growth stages they had reached when harvested rather than the different substrates. The plants grown in peat showed the greatest development and the greatest number of leaf pairs, leaf area, and FW (Table 2) and, therefore, the highest fatty acid content. The

Table 3. Root parameters of plants of common purslane grown in different substrates in Sept. 2004 (Expt. 3).

	Root parameters				
Substrates	Root fresh wt ($g \cdot m^{-2}$)[z]	Root length (cm)[y]	Avg root diameter (mm)[x]	Tips (no.)	Forks (no.)
Peat	290.98 a[w]	440.5 a	0.283 bc	874 a	1,790 ab
Peat–perlite (3 : 1)	307.3 a	408.7 ab	0.316 a	981 a	2,181 a
Peat–perlite (1 : 1)	255.87 b	308.7 bc	0.296 ab	730 ab	1,514 bc
Vermiculite	167.68 c	274.8 c	0.296 ab	529 b	1,048 cd
Coir	58.13 e	126.5 d	0.264 c	263 c	410 e
Perlite	90.94 d	101.1 d	0.320 c	251 c	446 de

[z]1 $g \cdot m^{-2}$ = 0.0033 oz/ft^2.
[y]1 cm = 0.3937 inch.
[x]1 mm = 0.0394 inch.
[w]Within column means followed by different letters are significantly difference by Tukey's multiple range test ($P = 0.05$).

Table 4. Mean values of fatty acid content in plants of common purslane grown in different substrates in Sept. 2004 (Expt. 3).

	Fatty acid content (mg/100 g FW)[z] Substrates			
Fatty acid	Peat	Vermiculite	Coir	Perlite
Alpha-linolenic acid (LNA)	48.116 a[y]	15.813 b	17.729 b	13.595 b
Linoleic acid (LA)	6.525 a	1.767 b	2.003 b	1.594 b
Palmitic acid	26.057 a	23.136 a	4.595 b	4.716 b
Stearic acid	3.208 a	1.004 c	1.320 b	0.843 c
Myristic acid	0.042 a	0.016 b	0.032 a	0.033 a
Gondoic acid	0.003 b	ND	0.003 b	0.0424 a
Arachidic acid	0.285 a	0.059 b	0.080 b	0.075 b
Heneicosanoic acid	ND	ND	0.014	0.017
Erucic acid	0.211 b	0.029 c	0.554 a	0.229 b
Behenic acid	0.605 a	0.154 c	0.477 b	0.228 c
Tricosanoic acid	0.073 b	0.129 a	0.007 c	ND
Lignoceric acid	0.492 a	0.145 b	0.446 a	0.084 b
Total fatty acids	85.61 a	42.25 b	27.26 c	21.46 c
LNA:LA ratio	7.368 b	8.966 a	8.834 a	8.517 a
LNA (%)	56.18 b	37.42 c	64.99 a	63.57 a

[z]1 mg/100 g = 10 ppm.
[y]Within line means followed by different letters are significantly difference by Tukey's multiple range test ($P = 0.05$).
ND = not detected.

plants grown in the other substrates showed no significant differences in the number of leaf pairs (5.5–4.13) per plant, but did show differences in leaf fresh weight and leaf area, the highest values being obtained in vermiculite, which may explain the results obtained.

Regarding the major fatty acids identified, there were differences between the levels recorded in the plants grown in peat and those grown in the other substrates, except in the case of palmitic acid, for which similar levels were recorded in peat-grown and vermiculite-grown plants. The most abundant fatty acid was LNA, for which the range recorded (13.6–47.7 mg/100 g FW) is comparable to that reported by Ezekwe et al. (1999) (18–30 mg/100 g FW) and Omara-Alwala et al. (1991), (10–29 mg/100 g FW). LNA in common purslane has been differentially quantified by several authors, who obtained values much above ours, 67 to 400 mg/100 g FW (Liu et al., 2000; Palaniswamy et al., 2001; Simopoulos et al., 1992). The range of LA recorded (1.5–6.5 mg/100 g FW) is comparable to that reported by Ezekwe et al. (1999) (1.2–6.0 mg/100 g FW), whereas values obtained of palmitic and stearic fatty acid were similar to those obtained by Palaniswamy et al. (2001). However, such differences may well be the result of differences in plant varieties or environmental and developmental factors, plant growth stage, sample material, or sampling procedures (Palaniswamy et al., 2001; Simopoulos et al., 1992).

Although the plants grown in peat showed the highest LNA and LA content, those grown in the other substrates also showed a very good nutritional index as seen from the LNA : LA ratio obtained (8.5–8.9), values that are very similar to those obtained by Ezekwe et al. (1999) (5–22.3), whereas Palaniswamy et al., (2001) found slightly lower values (3.9–5.2).

We could not detect the longer-chain omega-3 fatty acids such as EPA and DHA in any of the plant samples of common purslane grown in the substrates used, which was similar to other studies (Liu et al., 2000; Palaniswamy et al., 2001). However, Omara-Alwala et al. (1991), Simopoulos (2001), and Simopoulos and Salem (1986) did find very small quantities of EPA in wild common purslane plants (1 mg/100 g FW), although both EPA and DHA are almost exclusively confined to fish and fish oil.

In conclusion, common purslane is a species that adapts well to a peat-based floating cultivation system, producing a high yield in a short period of time and being rich in fatty acids, principally in LNA, LA, palmitic acid, and stearic acid.

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