**COMPARISON OF YIELD POTENTIALITY AND CULTIVARS PERFORMANCE OF 20 COLLECTED PURSLANE (*PORTULACA OLERACEA* L.) ACCESSIONS USING SEEDS AND STEM CUTTINGS**

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**Abstract**

Purslane is a nutritious vegetable and a medicinal herb with high antioxidant properties and high mineral content. There are two types of purslane: common, or wild, and ornamental are found everywhere and both are safe for human consumption. Common purslane produces large numbers of seeds, while the ornamental type does not produce seeds and therefore is propagated by cuttings. Though the common purslane produce huge seeds but sometimes it shows dormancy resulting very little germination or no germination even for several years. To overcome these difficulties cuttings are the best alternatives. A glass house experiment was conducted in Universiti Putra Malaysia (UPM) to evaluate the regeneration and yield potentiality of both purslane using seeds and stem cutting of 20 collected accessions from different locations. To the best of our knowledge, this is the first attempt to evaluate and to compare any significant variation in morphological, physiological especially mineral nutritional variation in purslane propagated through cuttings and seeds. Significant variation (p<0.05) was observed for morphological traits viz., plant height, no. of main branches, no. of nodes, internodal distance, stem diameter, no. of leaves, leaf area, stem diameter, no. of flowers, root length, fresh and dry wt. but there were no significant variation observed in physiological traits viz., total chlorophyll, net photosynthesis, stomatal conductance, transpiration and water vapor deficit and for major micro and macro nutrients.

**Keywords:** Purslane (*Portulaca oleracea* L.), plant regeneration, stem cutting, morphological traits, physiological traits, mineral nutrition

**INTRODUCTION**

The genus *Portulaca* comprising about 70 species is characterized by conspicuously fleshy sessile leaves (Jonas et al. 1972). Many varieties of purslane under many names grow in a wide range of climates and regions. It can be found in Europe, Africa, North America, Australia and Asia (Liu et al. 2000, Rashed et al. 2003). It is a widespread weed, ranked among the eighth most common plants in the world. It is fast growing and self-fertile, with the ability to produce seeds even when close to death is the reason this plant is so prolific (Liu et al. 2000). The common purslane begins flowering 20 to 30 days after emergence and produces a single, five-petalled little yellow flower at the ends of its stems but the ornamental ones produces flowers of different colors. The blossom of common ones remains open only briefly, but the resultant seedpod is filled with tiny seeds. The plants produce 4 to 15 seeds/capsule depending on environmental conditions, with an average of 9.4 seeds per capsule (Galinato et al. 1999). Seed production of this weed ranges from 126 to 16,300 seeds/plant with an average of 6,940 seeds/plant (Galinato et al. 1999). Freshly collected seeds have no dormancy and germinate immediately after maturity (Balyan and Bhan, 1986a). Seeds of Purslane have the ability to remain dormant but fertile in soil for up to 40 years (Helen 2004). Its shiny, fleshy leaves have red margins, and are teardrop or wedge-shaped. Leaves are between 1/4 inch and 2 inch long, and 1/6 - 1/2 inch wide. Leaves are attached to stems without a stalk, and at the lower ends of stems, leaves are arranged alternately, but are produced in clusters at stem tips. Stems are smooth, branched and often pinkish or reddish. Stems radiate up to 20 inches outward from a central root. In Malaysia there are about 70 species of edible herbs, which are called by their local name ulam (Samy et al. 2004). Some of these herbs are claimed to have high antioxidant properties as well as medicinal properties (Uddin et al. 2012, Lim and Quah 2007), high in potassium and magnesium, as well as vitamins A, B and C and also high in oxalic acid, which binds with prevents the body from absorbing calcium and other minerals. Recent research demonstrates that purslane has better nutritional quality than the major cultivated vegetables, with higher β-carotene, ascorbic acid, and α-linolenic acid, an essential fatty acid, content (Liu et al. 2000). Additionally, purslane has been described as a ‘‘power food’’ because of its high nutritive and antioxidant properties (Simopoulos et al. 1995). Simopoulos et al. (1992) showed that purslane, which is largely consumed in the Mediterranean basin, is the richest source of α-linolenic acid (ALA) among green leafy vegetables and a rich source of antioxidants. It is listed in the World Health Organization as one of the most used medicinal plants and it has been given the term ‘Global Panacea’ (Dweck 2001, Samy et al. 2004). Different varieties, harvesting times, and environmental conditions can contribute to purslane nutritional composition and benefits (Liu et al. 2000), and possibly to its biological activity.

Purslane grows readily in soils that may be arid and saline. Hence, it is listed as halophyte in the Haloph database (Aronson 1989). Considering its tolerance to especially to the chlorine salinity, Grieve and Suarez (1997) suggested purslane as a promising candidate for use in drainage water reuse system, not only its survivability and water use, but also its usefulness as a vegetable and oil seed crop. The unique nutritive quality of purslane as well as its outstanding tolerance to chloride salinity makes this species a promising halophyte candidate for saline agriculture (Yazici et al. 2007). Grieve and Suarez (1997) showed that purslane reallocates resources and energy to counteract osmotic and/or ionic effects of salt stress, which enables it to resist salinity and thus to complete its life cycle and produce seeds. In Malaysia purslane is still being treated only as a weed and a very little is known about its production as a food crop and the effects of cultural conditions on its nutritional value. The ornamental purslane is propagated mainly by stem cutting due to their inability to produce seeds where as the common one can produce by both seeds and stem cutting but the performance of stem cutting is significantly lower regarding growth and development and ultimate yield. However, in this experiment the morphological, physiological and nutritional variation have been determined using both seeds and stem cutting of common purslane and ornamental ones using stem cutting as the growing media.

**MATERIALS AND METHODS**

**Experiment location and soil**

A pot (24x22cm) experiment was conducted during January 2012 to August 2012 in a glasshouse at the Faculty of Agriculture, University Putra Malaysia (3⁰00ʹ 21.34ʹʹ N, 101⁰42ʹ 15.06ʹʹ E, 37 m elevation). The plastic pots were filled with soil (39.51% sand, 9.03% silt and 51.35% clay) of pH 4.8 with 2.6% organic carbon, 1.24 g cc-1 bulk density and CEC of 7.07 me 100 g-1 soil. Soil nutrient status was 0.16% total N, 5.65 ppm available P, 15.3 ppm available K, 3295 ppm Ca and 321 ppm Mg. At field capacity, soil water retention was 31.18% (wet basis) and 45.31% (dry basis). The experimental soil belongs to the Serdang series.

**Plant Materials and Experimental Design**

Ten common purslane samples of 10-15 days young seedlings and 10 samples (cuttings) of different types of ornamental purslane were collected from different locations of West Peninsular Malaysia considering location and morphological variation of the plants divided into groups and transplanted into the pots and reared about 60 days for seed collection from common purslane and multiplication of the ornamental purslane. After that for the main experiment the plastic pots were filled up with prepared soils organized in a randomized complete block design with three replications. Brief descriptions of the collected samples and locations have been shown in Table 1. The propagation and cultivation through seeds of common purslane and stem cuttings of both ornamentals and common purslane are presented in Figure 1, 2 and 3.

Table 1. Brief description of collected 20 purslane samples with specific locations of West Peninsular Malaysia

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No. | Sample Code | State | Locations | Latitude (⁰N) | Longitude (⁰E) | Brief morphology of the plants |
| 1 | Slg-1 | Selangor | Sungai Buloh | 03⁰19ʹ | 101⁰59ʹ | Pink colored flower, wedge shaped margin red green leaf, red stem |
| 2 | Slg-2 | “ | Sungai Buloh | 03⁰19ʹ | 101⁰59ʹ | White-pink colored flower, wedge shaped green leaf, red stem |
| 3 | Slg-3 | “ | AgroBio. UPM | 02⁰98ʹ | 101⁰73ʹ | Yellow colored flower, red margin wedge shaped green leaf, red stem |
| 4 | Slg-4 |  | Nursery, Klang | 03⁰02ʹ | 101⁰26ʹ | Pink flower, wedge shaped green leaf, green red stem |
| 5 | Kdh-1 | Kedah | Nursery, Kedah | 06⁰11ʹ | 100⁰37ʹ | Yellow flower, wedge shaped green leaf, red stem |
| 6 | Kdh-2 | “ | Nursery, Kedah | 06⁰11ʹ | 100⁰37ʹ | Pink flower, wedge shaped green leaf, Red stem |
| 7 | Kdh-3 | “ | Nursery, Kedah | 06⁰11ʹ | 100⁰37ʹ | Purple flower, paddle shaped green leaf, red stem |
| 8 | Kdh-4 | “ | Kuala Kedah | 06⁰11ʹ | 100⁰29ʹ | Orange-yellow flower, green wedge shaped leaf, green stem |
| 9 | Png-1 | Penang | Seberang Perai, Pulau Penang | 05⁰54ʹ | 100⁰47ʹ | Yellow flower, paddle shaped, margin green red leaf, Red stem leaf |
| 10 | Png-2 | “ | Seberang Perai,  Pulau Penang | 05⁰54ʹ | 100⁰47ʹ | Pink flower, wedge shaped green red leaf, red stem |
| 11 | Slg-5 | Selangor | Seri Kembangan | 03⁰00ʹ | 101⁰713ʹ | Wild, yellow colored flower, small paddle shaped red-green leaf, red stem |
| 12 | Slg-6 | “ | Port Klang | 03⁰00ʹ | 101⁰36ʹ | Wild, yellow flower, wedge shaped green red leaf, red stem |
| 13 | Mlk-1 | Melaka | Kg. Pulau Gadong-1 | 02⁰24ʹ | 102⁰21ʹ | Wild, yellow flower, wedge shaped green leaf, red-green stem |
| 14 | PD-1 | N. Sembilan | Kg. Ayer Meleleh-1 | 02⁰54ʹ | 101⁰80ʹ | Wild, yellow flower, paddle shaped green leaf, red green stem |
| 15 | Kdh-5 | Kedah | Jitra-1 | 06⁰24ʹ | 100⁰43ʹ | Wild, yellow flower, green wedge shaped leaf, green-red stem |
| 16 | Kdh-6 | “ | Kota Setar | 06⁰16ʹ | 100⁰54ʹ | Wild, yellow flower, green wedge shaped leaf, green-red stem |
| 17 | Kdh-7 | “ | Jitra-3 | 06⁰33ʹ | 100⁰42ʹ | Wild, yellow flower, wedge shaped green-red leaf, red stem |
| 18 | Prk-1 | Perak | Kuala Kangsar | 04⁰77ʹ | 100⁰94ʹ | Wild, yellow flower, wedge shaped green-red leaf, red stem |
| 19 | Png-3 | Penang | Seberang Perai, Pulau Penang | 05⁰54ʹ | 100⁰47ʹ | Wild, yellow flower, wedge shaped green red leaf, red stem |
| 20 | Pls-1 | Perlis | Balai Baru Beseri | 06⁰51ʹ | 100⁰23ʹ | Wild, yellow flower, wedge shaped green leaf, red stem |

|  |  |
| --- | --- |
| http://upload.wikimedia.org/wikipedia/commons/thumb/1/10/6H-diGangi-Purslane-Seed-Pods.jpg/220px-6H-diGangi-Purslane-Seed-Pods.jpg  Seeds | Seedlings |
| C:\Users\user\Desktop\Pics\P1050029.jpg  Mature plant | C:\Users\user\Desktop\Pics\P3120025.jpg  Young plant |

Fig. 1. Regeneration of new plants from seeds of common purslane

|  |  |
| --- | --- |
| C:\Users\user\Desktop\Pics\P9080035-1.jpg  Stem cuttings | C:\Users\user\Desktop\Pics\P9260049.jpg  New shoots from cuttings |
| C:\Users\user\Desktop\Pics\PA060002-2.jpg  Mature plants | C:\Users\user\Desktop\Pics\PA110053.jpg  Young plants |

Fig. 2. Regeneration of new plants from stem cuttings of common purslane

|  |  |
| --- | --- |
| C:\Users\user\Desktop\Pics\P9080040-1.jpg  Stem cuttings | C:\Users\user\Desktop\Pics\P9260028-1.jpg  New shoots from cuttings |
| F:\Different re-sized photos\Yellow-1.jpg  Mature plants | C:\Users\user\Desktop\Pics\PC060013.jpg  Young plants |

Fig. 3. Regeneration of new plants from stem cuttings of ornamental purslane

**Plants rearing, Data collection and Analysis**

Four to five 10 days seedlings of common purslane and 8-10 cm stem cuttings from 15-20 days old common purslane plants as well as ornamentals were transplanted in each pot and were surface irrigated thrice a week (every alternate day) throughout the growing period using only tape water. All types of weeds or any other plant seedlings were uprooted just after emergence and regular observation continued up to harvesting. Purslane blooms everyday so total numbers of flowers were counted daily and recorded. Regarding morphological attributes plant height (cm), no. of nodes, average internodes distance (cm), average no. of main branch, stem diameter (mm), total no. of leaves, average leaf area (cm2), root length (cm), total fresh wt. (g) and total dry wt. (g) of the plants were determined. Leaf area was measured by leaf area meter (LI-Cor, Model LI-3100 Area Meter, LI-COR Inc. Lincoln, Nebraska, USA).

Regarding physiological data; the net photosynthesis rate (μmol CO2/m2/sec), Stomatal conductance (cm/sec), Transpiration rate (mol/m2/sec) and Water vapor deficit (mol H2O/m2/sec) were determined using LI-COR, LI 6400 Portable Photosynthesis System; LI-Cor, Inc., Lincoln, NE, USA. Relative chlorophyll content or greenness of leaves was measured at 60 days after transplanting (SPAD60) using portable chlorophyll meter or SPAD meter (MINOLTATM SPAD-502, Minolta Camera Co., Osaka, Japan). Five leaf SPAD readings were taken and then averaged to have mean SPAD reading for each replicate. Chlorophyll meter (Minolta) uses light sources and detects the light transmitted by a plant leaf at two wavelengths (at red and infrared region of the spectrum) (Biljana and Aca. 2009).

The purslane plants is very succulent and contain mucilaginous substances and water contents is about 90% or more so for initial drying just after harvesting the fresh samples were stored in a cool dry place for 3 days then kept in oven at 40⁰C temperature for 3 days (to make dry and preventing from sudden burning injury) and then transferred to70⁰C for another 3 days (72 h).

Oven-dried samples of purslane were ground and stored in plastic vials. For the measurement of macro nutrient (N, P, K, Na, Ca and Mg) and micro (Fe, Mn and Zn) nutrient contents were analyzed using the digestion method (Ma and Zua, 1984) and determined using an Atomic Absorption Spectrophotometer (AAS; Perkin Elmer, 5100, USA).

**Statistical analysis**

All data were subjected to analysis of variance using the SAS statistical software package version 9.2 (SAS 2013). Significant differences among means were calculated using Fisher’s protected Least Significant Difference (LSD) test at 5% level of significance.

**RESULTS**

**Morphological traits analysis of ornamental purslane propagated through cuttings**

The analysis of variance for 10 collected ornamental purslane accessions for morphological traits differed significantly (p<0.05) while compared one with another. The average performances of all the morphological traits viz., plant height (cm), no. of nodes, internodes distance (cm), no. of main branch, stem diameter (mm), total no. of leaves, leaf area (cm2), root length (cm), total fresh wt. (g) and total dry wt. (g) were determined and presented in Table 2. Results of Pearson’s correlation coefficient analysis show positive, negative significant relation and also non-significant relation among the evaluated morphological characters. Pearson’s correlation coefficient analysis of the morphological characters is presented in Table 3.

Table 2. Descriptive statistics of the evaluated morphological traits from 10 collected accessions of ornamental purslane

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Acc.no. | PH (cm) | Main brach | N. of nodes | Internode dis.(cm) | No. of leaves | Leaf area (cm2) | No. of flower | Stem dia (mm) | Root length (cm) | FW (g) | DW (g) |
| V1 | 32.5±2.0 ab | 1.4±0.1 d | 11.2±2.0 c | 3.10±0.30 a | 298.6±13.7 d | 1.91±0.33 ab | 324.4±17.1 bc | 2.98±0.15 a | 9.7±0.75 a-c | 130±15 c | 9.57±0.24 d |
| V2 | 28.6±3.7 a-c | 2±.0.3 c | 10.4±1.9 c | 2.90±0.20 ab | 190.4±25.1 e | 2.09±0.30 a | 227.6±59.7 cd | 2.52±0.32 a | 8.5±1.15 d | 70±12 d | 3.69±0.38 f |
| V3 | 28.6±3.7 a-c | 1.8±0.1 cd | 11.6±2.1 c | 2.80±0.30 a-c | 97±18 f | 1.71±0.28 d | 94.8±8.5 de | 2.88±0.31 a | 7.18±0.74 e | 50±3 d | 3.25±0.14 f |
| V4 | 23.4±3.6 cd | 1.8±0.1 cd | 10.8±1.5 c | 2.38±0.30 c | 435±47 c | 1.04±0.03 i | 441.8±73.9 a-c | 2.89±0.24 a | 9.9±0.29 ab | 75±8 d | 7.66±0.23 e |
| V5 | 28.4±3.9 a-c | 2.8±0.6 b | 11.8±1.6 bc | 3.14±0.08 a | 750.8±49.2 a | 1.67±0.46 a-c | 533.8±119.4 a | 2.86±0.29 a | 8.7±0.65 cd | 50±7 d | 3.66±0.45 f |
| V6 | 27±2.5 bc | 3.2±0.3 b | 15±2.5 ab | 2.98±0.53 ab | 579.4±43.8 b | 1.23±0.06 cd | 261.3±70.4 c-e | 2.72±0.11 a | 10.5±0.64 a | 80±9 d | 3.73±0.30 f |
| V7 | 20.6±2.7 d | 2.8±0.3 b | 16.8±3.0 a | 2.57±0.31 be | 433.8±20.2 c | 1.5±0.18 b-d | 395.8±35.9 a-c | 2.88±0.31 a | 10.56±0.67 a | 200±21 b | 12.2±0.11 c |
| V8 | 27.6±1.3 a-c | 1.8±0.3 cd | 11.6±2.1 c | 2.56±0.30 be | 612.4±99.6 b | 1.63±0.34 a-c | 551.2±282.82 a | 2.61±0.33 a | 6.5±0.60 e | 178±25 b | 9.81±0.32 d |
| V9 | 30±3.3 ab | 4.1±0.2 a | 11±2.3 c | 2.96±0.11 ab | 370±43 cd | 1.66±0.07 a-c | 479.4±16.9 ab | 2.81±0.17 a | 9.3±1.13 b-d | 180±40 b | 15.02±0.25 b |
| V10 | 33.2±2.0 a | 3.2±0.3 b | 10.8±1.9 c | 3.10±0.18 a | 192±53 e | 1.97±0.53 ab | 89.4±10.9 e | 2.95±0.22 a | 8.6±0.43 cd | 272±15 a | 26.17±0.94 a |
| LSD | 5.86 | 0.52 | 3.39 | 0.48 | 86.09 | 0.52 | 186.29 | 0.46 | 1.18 | 32.03 | 0.71 |
| CV | 12.21 | 12.14 | 16.34 | 9.99 | 12.67 | 18.64 | 31.48 | 9.58 | 7.69 | 14.53 | 4.34 |

Here, ± indicates mean value with standard deviation. Means followed by the same letter are not significantly different (Fisher’s LSD, p<0.05).

Table 3. Pearson’s correlation coefficient among different morphological traits of ornamental purslane

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | PH | MB | NN | ID | NL | LA | NF | SD | RL | FW | DW |
| PH | 1 |  |  |  |  |  |  |  |  |  |  |
| MB | -0.31 ns | 1 |  |  |  |  |  |  |  |  |  |
| NN | 0.21 ns | 0.57 ns | 1 |  |  |  |  |  |  |  |  |
| ID | -0.18 ns | 0.96 \*\*\* | 0.61 \* | 1 |  |  |  |  |  |  |  |
| NL | 0.39 ns | -0.31 ns | 0.24 ns | -0.31 ns | 1 |  |  |  |  |  |  |
| LA | -0.41 ns | 0.95 \*\*\* | 0.45 ns | 0.96 \*\*\* | -0.43 ns | 1 |  |  |  |  |  |
| NF | 0.28 ns | -0.38 ns | 0.01 ns | -0.39 ns | 0.84 \*\* | -0.47 ns | 1 |  |  |  |  |
| SD | -0.21 ns | 0.95 \*\*\* | 0.62 \* | 0.99 \*\*\* | -0.30 ns | 0.96 \*\*\* | -0.37 ns | 1 |  |  |  |
| RL | 0.63 \* | 0.14 ns | 0.74 \*\* | 0.21 ns | 0.42 ns | -0.02 ns | 0.26 ns | 0.22 ns | 1 |  |  |
| FW | 0.51 ns | -0.21 ns | 0.14 ns | -0.25 ns | 0.19 ns | -0.34 ns | 0.22 ns | -0.23 ns | 0.33 ns | 1 |  |
| DW | 0.49 ns | -0.01 ns | 0.13 ns | -0.04 ns | 0.02 ns | -0.14 ns | 0.03 ns | -0.03 ns | 0.34 ns | 0.92 \*\*\* | 1 |

Here, PH, MB, NN, ID, SD, NL, LA, NF, RL, FW and DW indicates; Plant height, Main branch, No. of nodes, Internodes distance, Stem dia, No. of leaves, Leaf area, No. of flowers, Root length, Fresh weight and Dry weight respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001, \*\*\*P<0.0001, ns not significant at P>0.05

**Physiological traits analysis of ornamental purslane propagated through cuttings**

The physiological characteristics regarding total chlorophyll content (SPAD value), net photosynthetic rate (μmol CO2/m2/sec), stomatal conductance (cm/sec), transpiration rate (mol/m2/sec) and water vapor deficit (mol H2O/m2/sec) were measured from 10 collected ornamental purslane accessions. Significant differences (p<0.05) were observed among the accessions and all the traits measured. The result is presented in Figure 4 along with the Pearson’s correlation coefficient analysis results of all the physiological traits in Table 4.

Figure 4.Figure showing different physiological traits value of ornamental purslane propagated through cuttings. Means with different letters are significantly different at P < 0.05

Table 4. Pearson’s correlation coefficient among different physiological traits of ornamental purslane

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factor | Chlorophyll | Photosynthesis | Stomatal cond. | Transpiration | Water Vap. Def. |
| Chlorophyll | 1 |  |  |  |  |
| Photosynthesis | -0.09 ns | 1 |  |  |  |
| Stomatal cond. | 0.26 ns | 0.07 ns | 1 |  |  |
| Transpiration | -0.02 ns | 0.08 ns | 0.93 \*\*\* | 1 |  |
| Water Vap. Def | 0.03 ns | 0.19 ns | -0.30 ns | -0.31 ns | 1 |

Here, \* 0.05>P>0.01, \*\*0.01>P>0.001, \*\*\*P<0.0001, ns not significant at P>0.05

**Mineral nutrition analysis of the collected 10 ornamental purslane accessions**

Results from statistical analyses of major macro (N, P, K, Na, Ca and Mg) and micro (Zn, Fe and Mn) minerals indicate the presence of significant (p<0.05) variation in all traits evaluated. Elemental composition of the dry samples, reported on dry weight basis, is given in Table 5 along with the Pearson’s correlation coefficient analysis among different mineral composition has been presented in Table 6.

Table 5. Macro and micro mineral composition in ornamental purslane propagated through cuttings

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Acc.no. | N | P | K | Na | Ca | Mg | Fe | Zn | Mn |
| V1 | 87.2±4 a | 5.28±0.4 c | 185±4 f | 3.99±0.12 f | 42.65±1.91 c | 32.07±1.61 a | 2.53±0.08 f | 0.75±0.12 d | 0.67±0.06 c |
| V2 | 90.56±2.81 a | 3.82±0.07 g | 228±8 bc | 1.52±0.07 i | 27.30±1.10 f | 8.70±1.20 e | 3.11±0.14 e | 1.26±0.05 a | 0.76±0.04 b |
| V3 | 80.6±1.1 b | 5.84±0.06 b | 237±6 b | 12.66±0.09 a | 24.05±1.02 f | 27.65±2.22 b | 2.17±0.06 g | 0.65±0.04 d | 0.21±0.04 d |
| V4 | 80.9±1.7 b | 6.20±0.05 a | 177±3 fg | 7.85±0.18 b | 62.20±1.27 a | 23.55±0.96 c | 1.07±0.04 h | 0.92±0.04 c | 0.85±0.04 a |
| V5 | 72.9±1.3 d | 4.38±0.03 e | 219±8 cd | 5.33±0.14 e | 34.55±0.89 d | 27.60±1.77 b | 5.50±0.13 b | 0.42±0.05 ef | 0.12±0.04 e |
| V6 | 78.2±1.2 bc | 3.03±0.06 h | 213±4 de | 6.48±0.13 d | 25.15±1.28 fg | 31.60±1.63 a | 2.98±0.07 e | 0.50±0.05 e | 0.21±0.02 d |
| V7 | 79.2±0.9 bc | 6.23±0.04 a | 171±5 g | 1.94±0.13 h | 23.05±1.28 f | 23.05±1.42 c | 3.41±0.04 d | 1.06±0.04 b | 0.80±0.07 ab |
| V8 | 75±7.33 cd | 3.24±0.04 h | 237±4 b | 6.82±0.20 c | 45.40±1.83 b | 31.75±1.92 a | 2.14±0.03 g | 0.46±0.05 ef | 0.14±0.03 e |
| V9 | 71.2±1.1 d | 4.8±0.04 d | 255±4 a | 2.37±0.10 g | 30.60±2.09 e | 26.55±0.74 b | 3.81±0.06 c | 0.47±0.06 ef | 0.09±0.06 e |
| V10 | 56.5±7 e | 4.06±0.04 f | 205±4 e | 4.11±0.15 f | 27.15±0.96 f | 18.75±1.77 d | 5.90±0.07 a | 0.37±0.05 f | 0.09±0.03 e |
| **LSD** | 5.01 | 0.23 | 9.36 | 0.23 | 2.53 | 2.7 | 0.14 | 0.11 | 0.05 |
| **CV** | 3.78 | 2.84 | 2.56 | 2.49 | 4.31 | 6.26 | 2.56 | 8.74 | 7.77 |

Here, ± indicates mean value with standard deviation. Means followed by the same letter are not significantly different (Fisher’s LSD, p<0.05).

Table 6. Pearson’s correlation coefficient among different mineral nutrients of 10 collected ornamental purslane propagated through cuttings

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | N | P | K | Na | Ca | Mg | Fe | Zn | Mn |
| N | 1 |  |  |  |  |  |  |  |  |
| P | 0.22 ns | 1 |  |  |  |  |  |  |  |
| K | -0.16 ns | -0.49 ns | 1 |  |  |  |  |  |  |
| Na | 0.01 ns | 0.16 ns | 0.15 ns | 1 |  |  |  |  |  |
| Ca | 0.16 ns | 0.21 ns | -0.30 ns | 0.19 ns | 1 |  |  |  |  |
| Mg | -0.07 ns | -0.02 ns | 0.03 ns | 0.43 ns | 0.22 ns | 1 |  |  |  |
| Fe | -0.67 \* | -0.30 ns | 0.14 ns | -0.42 ns | -0.51 ns | -0.22 ns | 1 |  |  |
| Zn | 0.74 \* | 0.41 ns | -0.41 ns | -0.29 ns | 0.04 ns | -0.60 ns | -0.43 ns | 1 |  |
| Mn | 0.68 \* | 0.53 ns | -0.70 \* | -0.26 ns | 0.32 ns | -0.38 ns | -0.51 ns | 0.91 \*\* | 1 |

Here N, P, K, Na, Ca, Mg, Zn, Fe and Mn indicates Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Zinc, Iron and Manganese respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001 and ns not significant at P>0.05

**Morphological traits analysis of common purslane propagated through cuttings**

Different morphological traits viz., plant height (cm), no. of nodes, internodes distance (cm), no. of main branch, stem diameter (mm), total no. of leaves, leaf area (cm2), root length (cm), total fresh wt. (g) and total dry wt. (g) were analyzed from the common purslane plants propagated through cuttings. There were significant variations (p<0.05) among those parameters and accessions. The analyzed results are presented in Table 7. The Pearson’s correlation coefficient analysis was also done for those morphological traits which represent positive, negative significant relation and also non-significant relation among the evaluated morphological characters have been shown in Table 8.

Table 7. Mean value of the evaluated morphological traits from 10 collected accessions of common purslane propagated through cuttings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Mean | Max | Min | CV | LSD (p<0.05) |
| Pl Ht. (cm) | 26.35±3.58 | 34.3 | 21.13 | 4.23 | 1.91 |
| Main Branch | 3.27±0.69 | 4.26 | 2.23 | 8.74 | 0.51 |
| No. of nodes | 14.31±3.63 | 19.8 | 9.16 | 12.02 | 2.96 |
| Internode dist. (cm) | 2.65±0.39 | 3.16 | 1.99 | 9.55 | 0.43 |
| Stem Dia (mm) | 2.74±0.24 | 3.21 | 2.24 | 11.11 | 0.52 |
| No. of leaves | 302.89±117.96 | 542 | 143.83 | 25.34 | 131.67 |
| Leaf area (cm2) | 1.42±0.33 | 1.68 | 1.05 | 16.29 | 0.39 |
| No. of flowers | 262.61±91.91 | 387.4 | 125.9 | 19.67 | 88.64 |
| Root length (cm) | 7.65±1.29 | 9.31 | 5.64 | 9.29 | 1.22 |
| Fresh Wt. (g) | 152.68±61.67 | 240 | 63.66 | 9.39 | 24.64 |
| Dry Wt. (g) | 11.05±4.45 | 18.67 | 5.94 | 8.51 | 1.61 |

Here, ± indicates mean value with standard deviation

Table 8. Pearson’s correlation coefficient among different morphological traits of common purslane propagated through cuttings

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | PH | MB | NN | ID | NL | LA | NF | SD | RL | FW | DW |
| PH | 1 |  |  |  |  |  |  |  |  |  |  |
| MB | -0.47 ns | 1 |  |  |  |  |  |  |  |  |  |
| NN | -0.09 ns | 0.22 ns | 1 |  |  |  |  |  |  |  |  |
| ID | 0.59 ns | -0.02 ns | 0.09 ns | 1 |  |  |  |  |  |  |  |
| NL | -0.08 ns | 0.45 ns | -0.15 ns | 0.02 ns | 1 |  |  |  |  |  |  |
| LA | 0.25 ns | -0.31 ns | 0.53 ns | -0.33 ns | -0.41 ns | 1 |  |  |  |  |  |
| NF | -0.04 ns | 0.29 ns | -0.51 ns | -0.26 ns | 0.74 \* | -0.40 ns | 1 |  |  |  |  |
| SD | -0.09 ns | 0.14 ns | 0.78 \*\* | -0.06 ns | -0.25 ns | 0.59 ns | -0.57 ns | 1 |  |  |  |
| RL | -0.23 ns | 0.63 ns | -0.22 ns | -0.29 ns | 0.73 \* | -0.28 ns | 0.82 \*\* | -0.30 ns | 1 |  |  |
| FW | 0.39 ns | -0.19 ns | 0.64 \* | 0.26 ns | -0.59 ns | 0.69 \* | -0.72 \* | 0.75 \* | -0.61 ns | 1 |  |
| DW | 0.44 ns | -0.20 ns | 0.43 ns | 0.39 ns | -0.60 ns | 0.42 ns | -0.52 ns | 0.49 ns | -0.59 ns | 0.87\*\* | 1 |

Here, PH, MB, NN, ID, SD, NL, LA, NF, RL, FW and DW indicates; Plant height, Main branch, No. of nodes, Internodes distance, Stem dia, No. of leaves, Leaf area, No. of flowers, Root length, Fresh weight and Dry weight respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001, \*\*\*P<0.0001, ns not significant at P>0.05

**Physiological traits analysis of common purslane propagated through cuttings**

The analyzed data obtained from 10 common purslane accessions propagated through stem cuttings showed significant (p<0.05) differences among all the physiological characteristics regarding total chlorophyll content (SPAD value), net photosynthetic rate (μmol CO2/m2/sec), stomatal conductance (cm/sec), transpiration rate (mol/m2/sec) and water vapor deficit (mol H2O/m2/sec). The result is presented in Figure 5. The positive, negative and non-significant correlation obtained from Pearson’s correlation coefficient analysis of physiological traits is also presented in Table 9.

Figure 5. Different physiological traits value of 10 common purslane accessions propagated through cuttings. Means with different letters are significantly different at P < 0.05

Table 9. Pearson’s correlation coefficient among different physiological traits of common purslane propagated through cuttings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factor | Chlorophyll | Photosynthesis | Stomatal cond. | Transpiration | Water Vap. Def. |
| Chlorophyll | 1 |  |  |  |  |
| Photosynthesis | 0.04 ns | 1 |  |  |  |
| Stomatal cond. | 0.49 ns | -0.01 ns | 1 |  |  |
| Transpiration | 0.52 ns | -0.54 ns | 0.62 ns | 1 |  |
| Water Vap. Def | -0.40 ns | -0.21 ns | 0.28 ns | 0.21 ns | 1 |

Here, ns not significant at P>0.05

**Mineral nutrition analysis of the collected 10 common purslane accessions propagated through cuttings**

Major macro (N, P, K, Na, Ca and Mg) and micro (Zn, Fe and Mn) minerals were determined from all the 10 accessions of common purslane and found significant (p<0.05) variation in all traits evaluated. Elemental composition of the dry samples, reported on dry weight basis, is given in Table 10 along with the Pearson’s correlation coefficient analysis among different mineral composition has been presented in Table 11.

Table 10. Mean value of the evaluated macro and micro minerals from 10 collected accessions of common purslane propagated through cuttings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Mean | Max | Min | CV | LSD (p<0.05) |
| N | 75.09±15.31 | 106.80 | 55.03 | 2.7 | 3.48 |
| P | 5.33±1.07 | 7.45 | 4.09 | 3.01 | 2.11 |
| K | 224.96±27.56 | 277 | 191.33 | 2.94 | 11.37 |
| Na | 15.84±15.96 | 49.39 | 1.03 | 4.35 | 1.18 |
| Ca | 24.13±9.34 | 39.61 | 12.16 | 8.05 | 3.33 |
| Mg | 24.36±3.79 | 30.67 | 20.34 | 7.25 | 3.03 |
| Fe | 2.07±1.06 | 4.72 | 1.11 | 4.75 | 0.16 |
| Zn | 0.63±0.16 | 0.94 | 0.41 | 7.94 | 0.08 |
| Mn | 0.30±0.24 | 0.78 | 0.06 | 12.61 | 0.06 |

Here; N, P, K, Na, Ca, Mg, Fe, Zn and Mn represents Nitrogen, Potassium, Sodium, Calcium, Magnesium, Iron, Zinc and Manganese respectively and ± indicates mean value with standard deviation

Table 11. Pearson’s correlation coefficient among different mineral nutrients of 10 collected common purslane propagated through cuttings

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | N | P | K | Na | Ca | Mg | Fe | Zn | Mn |
| N | 1 |  |  |  |  |  |  |  |  |
| P | 0.55 ns | 1 |  |  |  |  |  |  |  |
| K | 0.09 ns | 0.27 ns | 1 |  |  |  |  |  |  |
| Na | 0.30 ns | -0.22 ns | 0.04 ns | 1 |  |  |  |  |  |
| Ca | 0.36 ns | 0.15 ns | -0.17 ns | -0.12 ns | 1 |  |  |  |  |
| Mg | -0.20 ns | 0.08 ns | -0.51 ns | -0.48 ns | 0.70 \* | 1 |  |  |  |
| Fe | -0.04 ns | -0.13 ns | -0.17 ns | -0.26 ns | 0.46 ns | 0.59 ns | 1 |  |  |
| Zn | 0.50 ns | -0.06 ns | -0.18 ns | 0.64 ns | -0.32 ns | -0.61 ns | -0.56 ns | 1 |  |
| Mn | 0.78 ns | 0.45 ns | 0.10 ns | 0.34 ns | -0.17 ns | -0.62 \* | -0.53 ns | 0.83 \*\* | 1 |

Here N, P, K, Na, Ca, Mg, Zn, Fe and Mn indicates Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Zinc, Iron and Manganese respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001 and ns not significant at P>0.05

**Morphological traits analysis of 10 collected common purslane accessions propagated through seeds**

The average performances of all the morphological traits viz., plant height (cm), no. of nodes, internodes distance (cm), no. of main branch, stem diameter (mm), total no. of leaves, leaf area (cm2), root length (cm), total fresh wt. (g) and total dry wt. (g) were determined and significant (p<0.05) differences were found among accessions is presented in Table 12. Results of Pearson’s correlation coefficient analysis show positive, negative significant relation and also non-significant relation among the evaluated morphological characters is presented in Table 13.

Table 12. Mean value of the evaluated morphological traits from 10 collected accessions of common purslane propagated through seeds

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Mean | Max | Min | CV | LSD (p<0.05) |
| Pl Ht. (cm) | 31.84±3.53 | 37.16 | 27.14 | 1.59 | 0.84 |
| Main Branch | 3.28±0.71 | 4.0 | 1.90 | 11.35 | 0.54 |
| No. of nodes | 16.43±4.18 | 23.4 | 10.50 | 16.27 | 3.83 |
| Internode dist. (cm) | 2.85±0.37 | 2.12 | 1.05 | 10.04 | 0.47 |
| No. of leaves | 348.62±154.03 | 608 | 146.60 | 16.93 | 104.22 |
| Leaf area (cm2) | 1.48±0.37 | 2.12 | 1.05 | 18.02 | 0.46 |
| No. of flowers | 291.21±114.74 | 493 | 134.60 | 27.33 | 143.73 |
| Stem Dia (mm) | 2.95±0.35 | 3.78 | 2.38 | 10.24 | 0.48 |
| Root length (cm) | 8.03±1.27 | 9.74 | 5.90 | 7.89 | 1.11 |
| Fresh Wt. (g) | 159.3±59.42 | 240 | 70 | 11.21 | 26.67 |
| Dry Wt. (g) | 11.47±4.73 | 20.37 | 6.45 | 4.5 | 0.77 |

Here, ± indicates mean value with standard deviation

Table 13. Pearson’s correlation coefficient among different morphological traits of common purslane propagated through seeds

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | PH | MB | NN | ID | NL | LA | NF | SD | RL | FW | DW |
| PH | 1 |  |  |  |  |  |  |  |  |  |  |
| MB | 0.47 ns | 1 |  |  |  |  |  |  |  |  |  |
| NN | 0.01 ns | 0.01 ns | 1 |  |  |  |  |  |  |  |  |
| ID | -0.29 ns | 0.28 ns | 0.06 ns | 1 |  |  |  |  |  |  |  |
| NL | 0.10 ns | 0.19 ns | -0.43 ns | -0.02 ns | 1 |  |  |  |  |  |  |
| LA | 0.12 ns | -0.19 ns | 0.52 ns | 0.24 ns | -0.52 ns | 1 |  |  |  |  |  |
| NF | 0.42 ns | 0.20 ns | -0.49 ns | -0.34 ns | 0.82 \* | -0.33 ns | 1 |  |  |  |  |
| SD | 0.06 ns | 0.11 ns | 0.74 ns | -0.13 ns | -0.57 ns | 0.59 ns | -0.58 ns | 1 |  |  |  |
| RL | 0.19 ns | 0.36 ns | -0.16 ns | -0.39 ns | 0.72 \* | -0.21 ns | 0.78 \* | -0.28 ns | 1 |  |  |
| FW | 0.17 ns | 0.12 ns | 0.67 ns | 0.14 ns | -0.82 \* | 0.72 ns | -0.63 \* | 0.72 \* | -0.52 ns | 1 |  |
| DW | 0.42 ns | 0.16 ns | 0.49 ns | 0.16 ns | -0.76 \* | 0.48 ns | -0.48 ns | 0.46 ns | -0.56 ns | 0.88\*\* | 1 |

Here, PH, MB, NN, ID, SD, NL, LA, NF, RL, FW and DW indicates; Plant height, Main branch, No. of nodes, Internodes distance, Stem dia, No. of leaves, Leaf area, No. of flowers, Root length, Fresh weight and Dry weight respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001, \*\*\*P<0.0001, ns not significant at P>0.05

**Physiological traits analysis of 10 collected common purslane accessions propagated through seeds**

The physiological characteristics regarding total chlorophyll content (SPAD value), net photosynthetic rate (μmol CO2/m2/sec), stomatal conductance (cm/sec), transpiration rate (mol/m2/sec) and water vapor deficit (mol H2O/m2/sec) were analyzed the data obtained from 10 common purslane accessions propagated through seeds and revealed significant (p<0.05) differences among those accessions. The result is presented in Figure 6 and the Pearson’s correlation coefficient analysis of physiological traits is also presented in Table 14.

Figure 6. Different physiological traits value of 10 common purslane accessions propagated through seeds. Means with different letters are significantly different at p< 0.05

**Table 14.** Pearson’s correlation coefficient among different physiological traits of common purslane propagated through seeds

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Factor | Chlorophyll | Photosynthesis | Stomatal cond. | Transpiration | Water Vap. Def. |
| Chlorophyll | 1 |  |  |  |  |
| Photosynthesis | 0.08 ns | 1 |  |  |  |
| Stomatal cond. | 0.36 ns | 0.58 ns | 1 |  |  |
| Transpiration | -0.24 ns | 0.57 ns | -0.50 ns | 1 |  |
| Water Vap. Def | -0.21 ns | -0.22 ns | -0.47 ns | 0.09 ns | 1 |

Here, ns not significant at P>0.05

**Mineral nutrition analysis of the collected 10 common purslane accessions propagated through seeds**

Results from statistical analyses of major macro (N, P, K, Na, Ca and Mg) and micro (Zn, Fe and Mn) minerals showed significant (p<0.05) variation in all traits evaluated among accessions. Elemental composition of the dry samples, reported on dry weight basis, is given in Table 15 and the Pearson’s correlation coefficient analysis among different mineral composition has been presented in Table 16.

Table 15. Mean value of the evaluated morphological traits from 10 collected accessions of common purslane propagated through cuttings

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | Mean | Max | Min | CV | LSD (p<0.05) |
| N | 75.47±14.83 | 106 | 55.50 | 2.92 | 3.68 |
| P | 5.40±1.08 | 7.58 | 4.11 | 1.94 | 0.16 |
| K | 226.40±26.93 | 276 | 192 | 2.26 | 8.18 |
| Na | 16.43±16.75 | 57.17 | 1.04 | 2.37 | 0.43 |
| Ca | 24.24±9.47 | 39.65 | 12.50 | 5.38 | 0.26 |
| Mg | 24.54±3.87 | 30.60 | 20.25 | 6.11 | 2.51 |
| Fe | 2.02±1.06 | 4.69 | 1.08 | 2.75 | 0.12 |
| Zn | 0.63±0.17 | 0.96 | 0.41 | 8.16 | 0.08 |
| Mn | 0.29±0.24 | 0.77 | 0.06 | 11.72 | 0.07 |

Here; N, P, K, Na, Ca, Mg, Fe, Zn and Mn represents Nitrogen, Potassium, Sodium, Calcium, Magnesium, Iron, Zinc and Manganese respectively and ± indicates mean value with standard deviation

Table 16. Pearson’s correlation coefficient among different mineral nutrients of 10 collected common purslane propagated through cuttings

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Factor | N | P | K | Na | Ca | Mg | Fe | Zn | Mn |
| N | 1 |  |  |  |  |  |  |  |  |
| P | 0.58 ns | 1 |  |  |  |  |  |  |  |
| K | 0.08 ns | 0.45 ns | 1 |  |  |  |  |  |  |
| Na | 0.32 ns | -0.20 ns | 0.03 ns | 1 |  |  |  |  |  |
| Ca | 0.38 ns | 0.16 ns | -0.14 ns | -0.11 ns | 1 |  |  |  |  |
| Mg | -0.20 ns | -0.11 ns | -0.38 ns | -0.47 ns | 0.70 \* | 1 |  |  |  |
| Fe | -0.05 ns | -0.15 ns | -0.34 ns | -0.27 ns | 0.46 ns | 0.61 ns | 1 |  |  |
| Zn | 0.51 ns | 0.11 ns | -0.16 ns | 0.59 \* | -0.32 ns | -0.64 \* | -0.57 ns | 1 |  |
| Mn | 0.77 \* | 0.48 bs | 0.11 ns | 0.35 ns | -0.18 ns | -0.67 \* | -0.54 ns | 0.82 \* | 1 |

Here N, P, K, Na, Ca, Mg, Zn, Fe and Mn indicates Nitrogen, Phosphorus, Potassium, Sodium, Calcium, Magnesium, Zinc, Iron and Manganese respectively. \* 0.05>P>0.01, \*\*0.01>P>0.001 and ns not significant at P>0.05

The pair wise genetic distances obtained from morphological, physiological and mineral traits of all the 20 clones based on the Pearson’s similarity coefficients were employed for clustering the clones with the help of UPGMA method. Based on the tertiary branching, the clones were grouped into five clusters (Figure 7). The Pearson’s similarity coefficient obtained by morphological marker was ranged between 0.13 and 1.25.



**G5**

**G4**

**G3**

**G2**

**G1**

Figure 7. Dendrogram showing phenotypic relationship among the collected 20 accessions of purslane based on Pearson’s similarity coefficient generated by morphological, physiological and mineral markers. Slg: Selangor, PD: Port Dickson (Nigeri Sembilan), Prk: Perak, Png: Penang, Pls: Perlis, Kdh: Kedah, Mlk: Melaka

**DISCUSSIONS**

**Comparison among the morphological characteristics of purslane plants propagated through cuttings (both ornamental and common) and seeds (common purslane)**

The common purslane can be propagated easily through both seeds and cuttings but in case of ornamental purslane there is only way of propagation by cuttings. The ornamental purslane produces very vice and attractive flowers but due to self-incompatibility, which prevent self-fertilization resulting no seed are produced. In this study we have tried to draw a comparison among the measured morphological traits from 10 ornamental (V1-V10) and 10 common (V11-V20) purslane accessions. Among the two methods of plant propagation the highest significant variation was observed in case of plant height. The highest plant height (37.16±0.32 cm, V17, Table 12) was observed in common purslane propagated by seeds followed by common purslane cuttings (34.3±2.1 cm, V14, Table 7) and ornamental cuttings (33.2±2.0 cm, V10, Table 2) respectively. The highest no. of main branch (4.26±0.35, V17, Table 7) was produced by common purslane propagated by cuttings followed by ornamental cuttings (4.1±0.2, V9, Table 2) and common purslane (4±0.4, V17, Table 12) propagated by seeds respectively. That means there is no significant difference among ornamental cuttings and common purslane propagated by seeds for number of main branches. Number of nodes and internode distance is closely related with plant height. Seed propagated common purslane plants produced the highest number of nodes (23.4±4.0, V11, Table 7) and internode distances (3.43±0.17, V14, Table 7) followed by cutting of common purslane (19.8±2.09, V11; 3.16±0.06, V14, Table12) and by ornamental cuttings (16.8±3.0, V7; 3.14±0.08, V5, Table 2) respectively. Average number leaves were significantly different with ornamental purslane than both of the common purslane. The highest number of leaves (750.8±49) was produced by the accession V5; propagated through cuttings of ornamental purslane where as the 2nd highest (608±137) was produced by the seed propagated purslane V18 and the 3rd most leaves (542±179.13) were also produced by the accessions V18 but propagated through cuttings (Table 2, 7 and 12). There was very little different but not significant for stem diameter, leaf area and root length where as average number of flowers were differed significantly among both of the ornamentals and common purslane (Table 2, 7 and 12). The average highest amount of fresh weight (FW) production was achieved by those accessions of common purslane propagated through cuttings but dry matter production rate didn’t differ significantly (Table 2, 7 and 12).

The Pearson’s correlation coefficient analyses were done among different morphological traits of ornamental and common purslane propagated through cuttings and seeds. The fresh weight was highly correlated (P<0.001) with dry weight in all three conditions of purslane propagation (Table 3, 8 and 13). In case of ornamental cuttings the main branches was highly correlated with internode distance, leaf area and stem dia mneter but were negatively correlated in case of both seeds and cuttings of common purslane. Internode distance was highly correlated (P<0.001) with leaf area and stem diameter; leaf area was also highly correlated with stem dia meter for ornamental purslane (Table 3). But most of all the morphological parameters of common purslane (from both seeds and cuttings) were non-significantly correlated with each other (Table 8 and 13). Lokhande et al. (2009) conducted an experiment with 8 collected clones of sea purslane (*Sesuvium portulacastrum* L.) and described some important morphological traits those are closely related with our study.

**Comparison among the physiological parameters of purslane plants propagated through cuttings (both ornamental and common) and seeds (common purslane)**

According to the physiological traits analysis (Figure 4, 5 and 6) results from ornamental cuttings, common purslane cuttings and seeds the highest amount of total chlorophyll (37.16±0.32, SPAD value) was produced by the accessions V17 propagated from seeds of common purslane where as the 2nd highest amount of chlorophyll (35.94±0.48) was recorded in V3 propagated from ornamental cuttings and the seed propagated purslane V12 produced the 3rd most highest (35.6±2.78) amount of total chlorophyll (Figure 4, 5 and 6). These results proved that there has only significant variation in total amount of chlorophyll may be due to different morphological variation is growth and development of purslane plants but interestingly there was no significant differences among all other physiological traits perhaps due to equal environmental conditions in glass house.

From the Pearson’s correlation coefficient analysis (Table 4, 9 and 14) it is seen that Stomatal conductance is very significantly (P<0.0001) correlated with transpiration rate in case of ornamental purslane plants propagated through cuttings but it was non-significantly (P>0.05) correlated with all other traits. On the other hand all the physiological traits were also non-significantly correlated with each other in both cases of propagation from common purslane (Table 4, 9 and 14).

**Comparison among the mineral nutrient parameters of purslane plants propagated through cuttings (both ornamental and common) and seeds (common purslane)**

Vegetables are the fresh and edible portions of herbaceous plants having good source of vitamins and minerals. They are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. Minerals are naturally occurring inorganic substances with a definite chemical composition and an ordered atomic arrangement (Nudelman and Nudelman 1976).

From the mineral composition analysis results it is found that Potassium (K) content was the highest amount among all other minerals followed by Nitrogen (N), Calcium (Ca), Magnesium (Mg), Sodium (Na), Phosphorus (P), Iron (Fe) and Manganese (Mn) respectively (Table 5, 10 and 15). Hussain et al. (2011), Bangash et al. (2011), Muhamed and Hussein (1994) also reported their findings about the highest amount of Potassium (P) but got different results regarding other minerals. From the comparison of macro and micro mineral contents it is observed that both of the common purslane (cuttings and seeds) contains significantly higher amount than ornamentals but there was no significant difference between common purslane propagated by cuttings and seeds (Table 5, 10 and 15). That means common purslane contain more minerals than ornamental purslane.

The Pearson’s correlation coefficient analysis for minerals revealed that Zinc (Zn) was significantly correlated with Manganese (Mn) in all three cases of purslane propagation (Table 6, 11 and 16). Nitrogen (N) was also significantly correlated with Manganese (Mn) only in ornamental cuttings and common purslane seeds but was non-significant with common purslane cuttings. Calcium (Ca) was significantly correlated with Magnesium (Mg) for both of common purslane but was non-significant with ornamental cuttings. On the other hand Nitrogen (N) was found significantly correlated with Manganese (Mn), Iron (Fe) and Zinc (Zn) for ornamental purslane cuttings but only in case of seed propagated common purslane Nitrogen (N) was found significantly correlated with Manganese (Mn) where as for common purslane cuttings all these were non-significant. Regarding all other minerals mostly was positively non-significant but some were also with negative non-significant correlation (Table 6, 11 and 16). This finding is partially supported with the results described by Uddin et al. (2012).

The Pearson’s similarity coefficients were employed for clustering all those 20 collected purslane clones with the help of UPGMA method. Based on the tertiary branching, the clones were grouped into five clusters (Fig. 7).The first group (G1) included the clones Slg-1, Slg-4, Slg-6, , Kdh-3, Kdh-7, Png-1 and Pls-3; the second group (G2) included only kdh-2; while, the third group (G3) consisted of clones Kdh-1, Kdh-4, Kdh-5 and Prk-1. The fourth cluster (G4) included the clones Slg-2 and Slg-3 and finally the fifth group (G5) included Png-2, Slg-5, Mlk-1, PD-1, Kdh-6 and Pls-1. The Pearson’s similarity coefficient obtained by morphological marker was ranged between 0.13 and 1.25. The highest pair wise phenotypic similarity was observed for the clones PD-1 and Kdh-6 (0.13). Lokhande et al. (2009) has described the UPGMA dendrogram for morphological traits of collected Sea purslane (*Sesuvium portulacastrum* L.) clones.

**CONCLUSION**

Purslane is already well established as highly tolerant against salinity and drought stress with very good source of antioxidant properties and nutritionally potential vegetable especially contain very high amount of essential minerals and vitamins. But very unfortunately this potential vegetable is still treating as noxious weeds in most countries of the world due to its rapid growth and survivability even in unfavorable environments. The common purslane is usually grown using only seeds but worldwide many research findings already published regarding the long time dormancy of purslane seeds. Morphological variation in plants is very normal depending on variety, soil and environmental conditions. Plant physiological characteristics are also influenced by environmental situation. But nutritional quality is mainly controlled by genetic factors may be due to this we didn’t observe any significant variation among mineral nutrient contents of purslane propagated through seeds and cuttings. Hope our findings will appreciate readers to cultivate purslane vegetables very quickly and directly using cuttings rather than waiting for several weeks through seeds.

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