Vegetative Reproduction Potential of Common Purslane (*Portulaca oleracea*)

Author(s) :Christopher A. Proctor, Roch E. Gaussoin, and Zachary J. Reicher

Source: Weed Technology, 25(4):694-697. 2011.
Published By: Weed Science Society of America
DOI:
URL: http://www.bioone.org/doi/full/10.1614/WT-D-11-00045.1

Weed Technology 2011 25:694–697

Vegetative Reproduction Potential of Common Purslane (*Portulaca oleracea*)

Christopher A. Proctor, Roch E. Gaussoin, and Zachary J. Reicher*

Common purslane is a widely distributed summer annual weed. It can reproduce vegetatively from stem cuttings by forming adventitious roots from the cut end of the stem. Apart from large stem cuttings, it is unclear whether purslane cuttings of various plant tissues differ in their ability to reproduce asexually. The objective of the study was to determine the survival and asexual reproductive capacity of purslane cuttings. A greenhouse study evaluated three cuttings from two stem locations and a leaf from one stem location for their survival and new leaf growth after 21 d. Cuttings included a stem node with either leaves attached or removed and a stem internode, all from proximal and distal stem locations relative to the root crown, and a leaf from a proximal stem node. Stem node cuttings had ≥ 70% survival, whereas internodes had 0% survival. Nodes with leaves attached further increased survival by > 20%. The location of the cutting on the main stem did not affect survival. Only noded cuttings produced new leaves, and cuttings with leaves attached produced the most new leaves. For purslane to vegetatively reproduce, nodes on stem cuttings are required, and the presence of leaves on the cutting improves the survival and new leaf growth of cuttings. Therefore, mechanical methods of weed control that chop and spread purslane leaves and stems might not be effective and could ultimately increase weed populations.
Nomenclature: Common purslane, *Portulaca oleracea* L. POROL.
Key words: Adventitious roots, weed control, stem cuttings, summer annual, asexual reproduction.

La *Portulaca oleracea* es una maleza anual de verano ampliamente diseminada. Se puede reproducir vegetativamente a partir de cortes de tallos o esquejes formando raíces adventicias al extremo del corte del tallo. Con excepción de tallos muy grandes, no está claro si cortes de *P. oleracea* tomados de varios tejidos de la planta difieren en sus habilidades de reproducción asexual. El objetivo de este estudio fue determinar la supervivencia y la capacidad reproductiva asexual de cortes de tallos de *P. oleracea*. Un estudio de invernadero evalúo tres cortes tomados de dos sitios diferentes en el tallo y de un sitio con hoja, en cuanto a su supervivencia y nuevo crecimiento de hojas después de 21 días. Los cortes incluyeron un tallo con nudo ya sea con hojas o removidas, un entrenudo, todo con tallos con sitios proximales y distales relativo a la corona radical, y una hoja en un nudo proximal en un tallo. Los cortes de los tallos con nudo tuvieron ≥70% de supervivencia, mientras que los entrenudos tuvieron 0% de supervivencia. Los nudos con hojas tuvieron una supervivencia adicional >20%. La ubicación de los cortes en el tallo principal no afectó la supervivencia. Únicamente los cortes con nudo produjeron nuevas hojas y los cortes con hojas produjeron el mayor número de nuevas hojas. Para que *P. oleracea* se reproduzca vegetativamente se requieren nudos en los cortes o esquejes, y la presencia de hojas en los esquejes mejora la supervivencia y el crecimiento de nuevas hojas. Por lo tanto, los métodos mecánicos de control de maleza que cortan y dispersan las hojas y tallos de *P. oleracea* podrían no ser efectivos y pueden al final, incrementar su población.

Common purslane (referred to hereafter as purslane) is a succulent summer annual weed. The origin of purslane is uncertain but has been reported as native to South America (Rydberg 1932), North Africa (Holm et al. 1977), and western Asia and Europe (Mitich 1997). Although purslane was thought to have been imported by post-Columbian immigrants (Vengris et al. 1972), seeds and pollen have been found in the sediment of Crawford Lake, Ontario, from AD 1350, and seeds from southern Louisiana, Illinois, and Kentucky date from 1000 BC to AD 750 (Kaplan 1973; Walker 1936; Watson 1969). Within North America, the spread of purslane is attributed, in part, to American Indians (Chapman et al. 1974).

Purslane has a prostrate growth habit, a thick taproot, and abundant fibrous secondary roots. Leaves are alternate, often clustered around the branch tip, succulent, with smooth margins; stems are glabrous, succulent, often reddish with primary and secondary branching, forming a mat up to 60 cm in diameter. Stems and leaves both contain a watery sap. Purslane produces small yellow-petaled flowers that only open on sunny mornings producing spherical, many-seeded capsules that open around the middle with the top coming off like a lid (Mitich 1997; Miyanishi and Cavers 1980). Purslane produces rapid vegetative growth under a long-day photoperiod and flowers within a month of germination; seeds ripen within 2 wk of flowering (Holm et al. 1977; Miyanishi and Cavers 1980). A single purslane plant can produce > 100,000 seeds in a growing season (Holm 1977; Matthews et al. 1993; Zimmerman 1976). Purslane will continue flowering under favorable conditions until the first killing frost in fall (Vengris et al. 1972), and plants growing in the tropics will senesce naturally after 3 to 4 mo (Singh 1973). Optimal seed germination occurs at air temperatures > 30 C and poor germination at temperatures < 24 C (Miyanishi and Cavers 1980; Zimmerman 1976). Purslane is highly adaptive, growing in temperate and tropical environments from 58° N latitude in Alberta, Canada, to 40° S latitude (Matthews et al. 1993) and has been found on six continents and in 81 different countries (Holm et al. 1977). Gorske et al. (1979) classified 44 ecotypes of *Portulaca oleracea* from 18 different countries based on 36 plant characteristics; as a result, the plants were differentiated into four major groups: cool

DOI: 10.1614/WT-D-11-00045.1
* Graduate Research Assistant, Professor, and Professor, Department of Agronomy and Horticulture, University of Nebraska–Lincoln, Lincoln, NE 68583-0724. Corresponding author's E-mail: caproctor@huskers.unl.edu

temperate, warm temperate to wet dry subtropic, humid subtropic to tropic, and cultivated. Purslane is a unique C_4 plant that is able to induce crassulacean acid metabolism (CAM) photosynthesis under drought stress conditions (Koch and Kennedy 1980; Lara et al. 2003). Historically, purslane has been used medicinally and as a blue dye, cultivated as a vegetable or potherb, and, more recently, fed as fodder for hogs (Mitich 1997). As a weed, purslane is commonly found in bare soil areas along sidewalks, planting beds, marginal lands, or recently tilled soil for agricultural and horticultural crop production or turfgrass establishment (Holm et al. 1977; Hopen 1972; Zimmerman 1976).

In addition to reproducing by seed, purslane will reproduce vegetatively from cut stems left in contact with the soil (Holm et al. 1977; Miyanishi and Cavers 1980; Muenscher 1980). Control of purslane by hoeing or through light cultivation has been effective for plants < 3 wk old (Haar and Fennimore 2003; Muenscher 1980). It is recommended that mature plants are removed after uprooting to prevent stems from rooting or seed production from occurring (Haar and Fennimore 2003; Holm et al. 1977; Miyanishi and Cavers 1980; Muenscher 1980). Severed purslane stems produce adventitious roots from the cut end of the stem (Connard and Zimmerman 1931) and can regrow from stem and intact root segments after hoeing or rototilling (Miyanishi and Cavers 1981). Adventitious roots will only form from the cut end of the stem, not from nodes of a buried section of an attached stem (Vengris et al. 1972). Although whole purslane stems have been shown to reproduce vegetatively, it is unclear whether cuttings of individual plant parts (e.g. node, internode, leaf) will reproduce similarly. This study was part of a larger project examining the biology and control of common purslane. The objectives were to identify effective and reliable methods for vegetatively reproducing common purslane and to determine the survival and new leaf growth potential of cuttings from various plant tissues under controlled greenhouse conditions.

Materials and Methods

A greenhouse study was conducted in 2010 at the University of Nebraska in Lincoln. Vegetative plant material used in this study was grown from purslane seed purchased from England.[1] The seed source was a noncultivated variety and showed no obvious phenotypic differences when compared with local wild-type plants. To produce plant material for two runs of the study, seed was sown May 26 and June 8 in 6.35-cm square pots with approximately 5 to 10 seeds per pot and thinned to one plant per pot after emergence. Potting soil consisted of 35% peatmoss, 33% vermiculite, 9% soil, and 12% sand by volume, with 2.3 mg cm^{-3} dolomitic lime and 9.8 mg cm^{-3} micronutrient fertilizer.[2] Pots were placed on a greenhouse bench and misted for 10 s every 6 min from dawn to dusk. Purslane plants from the June 8 seeding were treated for aphids on July 15 with 0.01 g ai per pot imidacloprid.[3]

The study began on June 25 (run 1) and was repeated beginning July 19 (run 2). Plant cuttings were harvested from purslane plants, with main stem length ranging from 7.5 to 20 cm and 8 to 12 nodes. Because plants used to harvest cuttings were started from seed, natural variation in size between plants existed. On the basis of results from a pilot study (Proctor and Reicher 2011), cuttings from four vegetative tissues at two stem locations relative to the root crown were selected; seeded purslane was also included as a control. The cuttings included internode from proximal (IN-P) and distal (IN-D) locations on the stem, node with leaves attached from proximal (NLA-P) and distal (NLA-D) locations on the stem, node with leaves removed from proximal (NLR-P) and distal (NLR-D) locations on the stem, and a leaf from a proximal (L-P) node (Figure 1). Two whole plants of similar size were used to collect cuttings so the same node location was used for both NLA and NLR. The proximal end of each cutting was inserted into the soil. The seeded control was sown, as described previously, on the same day vegetative cuttings were planted. Identical pots, growing media, and irrigation were used as those to establish plant material. Pots were fertilized weekly with 20–20–20 N–P–K plus trace elements[4] at a rate of 100 kg N ha^{-1} with a pressurized sprayer.[5] Air temperature, relative humidity, and photosynthetically active radiation were measured in two locations at bench height every hour during the study with a data logger[6] (Table 1). After 21 d, data were collected to calculate percent survival. For cuttings that survived, increase in leaf number (Δleaf) was also collected.

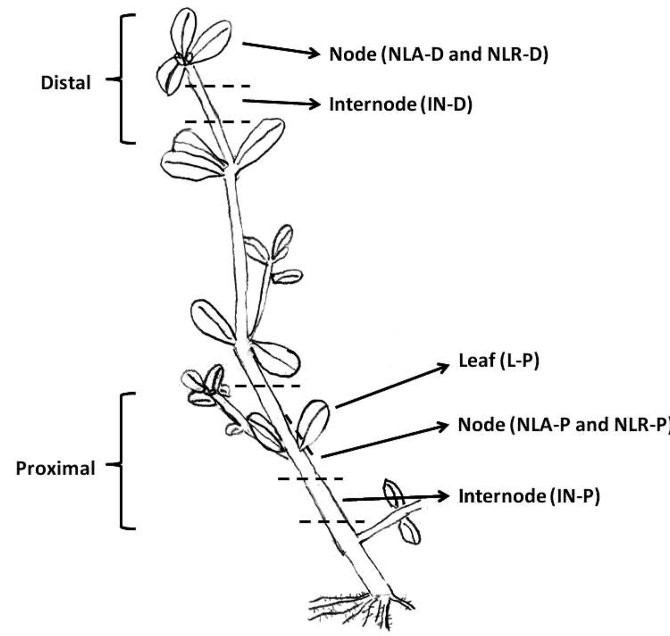

Figure 1. Location of cuttings on stem for common purslane vegetative reproduction. Node leaf attached distal stem location (NLA-D), node leaf removed distal stem location (NLR-D), internode distal stem location (IN-D), leaf proximal stem location (L-P), node leaf attached proximal stem location (NLA-P), node leaf removed proximal stem location (NLR-P), and internode proximal stem location (IN-P).

Survival data were binomial and defined by the presence of both roots and pigmented turgid plant tissue. Each run was arranged as a randomized complete block with 48 replications. Cuttings within a block were harvested from plants of the same

Table 1. Greenhouse air temperature, relative humidity and PAR data for run 1 and run 2 of common purslane vegetative reproduction study.

	Air temperature[a]			
	Maximum	Minimum	Relative humidity[b]	PAR[c]
	C		%	W m^{-2}
Run 1	39.6	22.3	73.6	26.3
Run 2	39.9	21.4	69.6	27.9

[a] Mean daily maximum and minimum air temperature from June 25 to July 16, 2010 (run 1), and July 19 to August 12, 2010 (run 2).

[b] Mean relative humidity from June 25 to July 16, 2010 (run 1), and July 19 to August 12, 2010 (run 2).

[c] Mean photosynthetically active radiation (PAR) from June 25 to July 16, 2010 (run 1), and July 19 to August 12, 2010 (run 2).

size. Survival data were fit using a generalized linear model. ANOVA was performed in SAS using PROC GLIMMIX and the logit link function (SAS 2009). Treatment comparisons were made using Fisher's LSD ($P \leq 0.05$). Treatment estimates for the binomial data were converted back to the scale of measure using the ilink function (SAS 2009). The Δleaf data were normally distributed and analyzed separately from survival data. ANOVA was performed with PROC GLIMMIX, and treatment comparisons were made using Fisher's LSD test.

Results and Discussion

The run by treatment interaction was not significant for either survival or Δleaf, therefore data were pooled across runs. Cuttings with the highest survival were NLA-P and NLA-D at 98 and 97%, respectively (Table 2). Comparatively, seeded plants resulted in 89% survival, whereas L-P, IN-P, and IN-D resulted in ≤ 7% survival. Percent survival for seeded treatments was the percentage that germinated and survived. The 7% of the L-P cuttings that survived were likely a result of the petiole being cut too close to the stem, and part of the node was removed along with the leaf. On the cuttings where this occurred, the node tissue resulted in the formation of adventitious roots and survival of the cutting. If the L-P cuttings had only consisted of leaf tissue, we expect that survival would not have occurred, as was the case for 93% of the L-P cuttings. For noded cuttings, presence of leaves increased survival by 21 to 27%. Location of the cutting on the main stem had no effect on percent survival in our study. However, Vengris et al. (1972) found that purslane stem cuttings from the distal end of the stem did not survive, whereas mature cuttings from the proximal end of the stem did survive when rooting hormones were not used. Purslane has previously been shown to survive if severed by hand-pulling, hoeing, or cultivation and left in contact with the soil (Miyanishi and Cavers 1981; Vengris et al. 1972). Furthermore, Connard and Zimmerman (1931) described the formation of adventitious roots originating from the end of purslane stem cuttings cut parallel to the main axis of the stem, resulting in the survival of the cuttings. Our study agrees with their research that severed purslane stems form adventitious roots from the cut end of the stem. Additionally, we noted that the presence of a node on the stem was necessary for root formation and survival. Similarly, *Portulaca grandiflora* Hook. requires leaves on stem cuttings for the formation of adventitious roots, and new leaf growth increases with the number of original leaves on the cutting (Yamdagni and Sen 1973).

Table 2. Percent survival and change in leaf number (Δleaf) of common purslane when vegetatively reproduced from different plant cuttings or seed.

Treatment[a]	Stem location	Leaf attached	Node included	Survival[b]	Δleaf[c]
				%	No. leaves
IN-D	Distal	No	No	0 e[d]	0.1 d
IN-P	Proximal	No	No	0 e	0.0 d
NLA-D	Distal	Yes	Yes	97 a	41.3 a
NLA-P	Proximal	Yes	Yes	98 a	41.0 a
NLR-D	Distal	No	Yes	70 c	13.7 b
NLR-P	Proximal	No	Yes	77 c	16.4 b
L-P	Distal	Yes	No	7 d	−0.9 d
Seed	—	—	—	89 b	6.8 d
ANOVA					
				P value	
Treatment (T)				< 0.0001	< 0.0001
Run (R)[e]				0.9779	0.5770
T × R				0.1176	0.3192

[a] Internode at distal stem location (IN-D), internode at proximal stem location (IN-P), node with leaf attached at distal stem location (NLA-D), node with leaf attached at proximal stem location (NLA-P), node with leaf removed at distal stem location (NLR-D), node with leaf removed at proximal stem location (NLR-P), leaf from proximal node (L-P).

[b] Percentage of cuttings with adventitious roots and pigmented turgid tissue after 21 d.

[c] Increase in leaf number after 21 d.

[d] Means followed by the same letter are not significantly different ($P \leq 0.05$) using Fisher's LSD test.

In addition to survival, both noded cuttings with or without leaves attached had a higher Δleaf than the seeded plants. However, nodes with leaves attached had at least two times higher Δleaf than all other cuttings (Table 2). While leaves on the cutting were not required to form new leaves, a node was required because the IN-P, IN-D, or L-P cuttings did not form new leaves (Table 2).

The growth of purslane has been shown to increase with nutrient levels, and soil phosphorus plays a significant role during establishment (Hopen 1972; Miyanishi and Cavers 1980). Fertilization during this study most likely had a positive effect on the growth of surviving plants.

We confirmed that purslane is able to reproduce vegetatively from cuttings under greenhouse conditions in our study. Although naturally occurring ecotypes of purslane might respond slightly different under field conditions, we found that vegetative reproduction from stem cuttings only occurs when nodes are present. We substantiated that control methods resulting in severing and distribution of mature stem cuttings (> 3 wk old), such as mowing or cultivation, might not be an effective means of control when left in contact with the soil, particularly if nodes and leaves remain intact on the stem.

Sources of Materials

[1] Herbiseed, New Farm, Mire Lane, West End, Twyford RG100NJ, U.K.

[2] Micromax micronutrients, The Scotts Company. Marysville, OH 43041.

[3] Marathon®, OHP Inc., Mainland, PA 19451.

[4] Jack's Professional, J. R. Peters Inc., Allentown, PA 18106.

[5] RL Flo-Master, Lowell, MI 49331.

[6] Hobo data logger, model U12-012, Onset Computer Corp., Bourne, MA 02532.

Literature Cited

Chapman, J., R. B. Stewart, and R. A. Yarnell. 1974. Archaeological evidence for pre-Columbian introduction of *Portulaca oleracea* and *Mollugo verticillata* into eastern North America. Econ. Bot. 28:411–412.

Connard, M. H. and P. W. Zimmerman. 1931. The origins of adventitious roots in cuttings of *Portulaca oleracea* L. Contrib. Boyce Thompson Inst. 3:337–346.

Gorske, S. F., A. M. Rhodes, and H. J. Hopen. 1979. A numerical taxonomic study of *Portulaca oleracea*. Weed Sci. 27:96–102.

Haar, M. J. and S. J. Fennimore. 2003. Evaluation of integrated practices for common purslane (*Portulaca oleracea*) management in lettuce (*Lactuca sativa*). Weed Technol. 17:229–233.

Holm, L. G., D. L. Plucknett, J. V. Pancho, and J. P. Herberger. 1977. The world's worst weeds: distribution and biology. Honolulu, HI: Published for the East-West Center by the University Press of Hawaii.

Hopen, H. J. 1972. Growth of common purslane as influencing control and importance as a weed. Weed Sci. 20:20–23.

Kaplan, L. 1973. Ethnobotany of the Apple Creek archaeological site, southern Illinois. Am. J. Bot. 60:39.

Koch, K. and R. A. Kennedy. 1982. Crassulacean acid metabolism in the succulent C_4 dicot, *Portulaca oleracea* L. under natural environmental conditions. Plant Physiol. 69:757–761.

Lara, M. V., K. B. Disante, F. E. Podesta, C. S. Andreo, and M. F. Drincovich. 2003. Induction of a crassulacean acid like metabolism in the C_4 succulent plant, *Portulaca oleracea* L.: physiological and morphological changes are accompanied by specific modifications in phosphoenolpyruvate carboxylase. Photosynth. Res. 77:241–254.

Matthews, J. F., D. W. Ketron, and S. F. Zane. 1993. The biology and taxonomy of the *Portulaca oleracea* L. (portulacaceae) complex in North America. Rhodora 95:166–183.

Mitich, L. W. 1997. Common purslane (*Portulaca oleracea*). Weed Technol. 11:394–397.

Miyanishi, K. and P. B. Cavers. 1980. The biology of Canadian weeds. 40. *Portulaca oleracea* L. Can. J. Plant Sci. 60:953–963.

Miyanishi, K. and P. B. Cavers. 1981. Effects of hoeing and rototilling on some aspects of the population dynamics of pure stands of *Portulaca oleracea* L. (purslane). Weed Res. 21:47–58.

Muenscher, W. C. 1980. Weeds. 2nd ed. Ithaca, NY: Cornell University Press Comstock Publishing Assoc.

Proctor, C. A. and Z. J. Reicher. 2011. Pilot Study: Vegetative Reproduction of Common Purslane (*Portulaca oleracea*). Lincoln, NE: UNL Turfgrass, University of Nebraska, http://turf.unl.edu/ResearchReports/PurslaneVegReproductionPilot2010.pdf. Accessed: February 14, 2011.

Rydberg, P. A. 1932. Portulacaceae. N. Am. Flora 21:279–336.

SAS Institute. 2009. SAS Users Guide. Version 9.2. 2nd ed. Cary, NC: Statistical Analysis Systems Institute.

Singh, K. P. 1973. Effect of temperature and light on seed germination of two ecotypes of *Portulaca oleracea* L. New Phytol. 72:289–295.

Vengris, J., S. Dunn, and M. Stacewicz-Sapuncakis. 1972. Life history studies as related to weed control in the northeast. 7. Common purslane. Res. Bull. Agric. Exp. Sta. University of Massachusetts. No. 598, Amherst. 44 p.

Walker, W. M. 1936. The Troyville Mounds Catahoula Parish, Lousiana. Bureau Am. Ethnol. Bull. 113. 73 p.

Watson, P. J. 1969. The Prehistory of Salts Cave, Kentucky. Reports of Investigations, No. 16. Springfield, IL: Illinois State Museum. 86 p.

Yamdagni, N. and D. N. Sen. 1973. Role of leaves present on the stem cuttings for vegetative propagation in *Portulaca grandiflora* L. Biochem. Physiol. Pflanz. 164:447–449.

Zimmerman, C. A. 1976. Growth characteristics of weediness in *Portulaca oleracea* L. Ecology 57:964–974.

Received April 4, 2011, and approved July 11, 2011.