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Growth and Production of *Portulaca oleracea* L. at Different Plant Ages Affected By Poultry Manure

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ABSTRACT

The study was conducted to investigate the growth and production of *Portulaca oleracea* L. (purslane) at different plant ages affected by poultry manure dosages. The experiment was carried out in Darmaga, Bogor, Indonesia, from September 2006 to January 2007. This experiment was arranged in a randomized complete block design in ti[illegible] factors. The first factor was manure dosages (0, 5, 10, and 15 ton ha^{-1}) and the second factor was harvesting [illegible] months old; 1 and 2 months old; and 2 months old (representing harvest frequencies of three, two and one tim[illegible] results of the experiment showed that for the first harvests, 15 tons manure ha^{-1} and harvesting once at 2 [illegible] produced the highest fresh weight of shoot, i.e. 105.18 g plant^{-1}. For repeated harvests, 10 or 15 tons manure ha^{-1} with harvesting at 1, 1.5, 2 months old (two-week interval of harvest) yielded the highest total fresh weight of 61.35 and 76.86 g, respectively.

Keywords: purslane, vegetable, medicinal plant, weed

INTRODUCTION

Portulaca oleracea L. (Purslane or krokot) is an herbaceous weed. It has been used as a vegetable and as a medicinal plant. *P. oleracea* contains many biologically active compounds (Ezekwe *et al.* 1999). *P. oleracea* is a good source of Omega-3 fatty acids (α-linolenic) (Liu *et al.* 2000) and protein (Miller *et al.* 1984). Omega-3 fatty acids are beneficial in congenital heart disease (CHD) and certain cancers (Liu *et al.* 2000) Fresh leaves of *P. oleracea* contain high concentration of α-linolenic acid; this is not found in spinach. Every kilogram of fresh leaves of *P. oleracea* contain 300-400 mg α-linolenic acid (C18:3 omega3), 12.2 mg α-topopherol, 26.6 mg ascorbic acid, 1.9 mg beta carotene, and 14.8 mg glutathione (Liu *et al.* 2000).

As a medicinal plant, *P. oleracea* contains glycoside, alkaloids, sterols, triterpene, and flavonoids. This plant is also high in vitamin and mineral contents (Reid, 1986); hence it poses an antioxidant activity (Wijayakusuma *et al.* 1996).

The quantity of chemical compounds in *P. oleracea* varies with the growing conditions (e.g. planting date, soil quality, fertilization) (Ezekwe *et al.* 1999) and the age of the plant (Palaniswamy *et al.* 2001, 2004). Although Elmi *et al.* (1997) reported that planting date had no direct effect on yield and yield component of purslane, Ezekwe *et al.* (1999) found that planting date (12 days apart) affected quality of purslane, i.e. crude protein, lipid and ash levels or purslane plant. Total lipids varied from 4.0–5.8% and 3.7–5.1% for the first and second planting dates, respectively. Palaniswamy *et al.* (2001) found that three stages (6-, 10-, and 14-true-leaf stages) of harvest had significant effect on total lipids and fatty acid concentration of purslane leaves where the 14-true-leaf stage was ideal for harvest. In term of oxalic acid (OA) content of purslane, which becomes one of the obstacles for consuming purslane, Palaniswamy *et al.* (2004) showed that leaves harvested at 16-true leaf stage had ≈36-45% lower OA concentrations compared to leaves harvested at 8-true leaf stage.

As a medicinal plant, it might be beneficial if purslane is grown organically, for instance with the use of organic manure as nutrient sources. Chicken manure has been commonly used as organic fertilizer due to its higher content of nitrogen and phosphorus compared to other manures (Table 1), for instance as shown by Wijewardena (2000).

Table 1. Some chemical properties of various types of animal manure

Types of Manure	pH (1 :10 H_2O)	Plant Nutrient Content (%)		
		N	P	K
Cattle Manure	7.1	1.42	0.67	0.72
Poultry Manure	8.6	3.02	1.46	1.95
Poultry Droppings	8.2	2.85	1.34	1.77
Broiler Litter	8.0	2.61	1.22	1.49
Goat Manure	7.6	2.54	0.76	0.98
Pig Manure	6.9	1.10	0.43	0.98

Source: Wijewardena (2000)

Study of *P. oleracea* is very limited in Indonesia since this plant is still considered as weed or ornamental plant rather than as a vegetable, therefore cultivation of *P. olerace* to determine the ideal time for harvesting with the application of chicken manure was studied.

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MATERIALS AND METHODS

The experiment was carried out in Darmaga, Bogor, Indonesia, from September 2006 to January 2007. This experiment was arranged in a randomized complete block design in times with 2 factors. The first factor was manure dosages (0, 5, 10, and 15 ton ha^{-1}) and the second factor was harvesting at 1, 1.5, 2 months old; 1 and 2 months old; and 2 months old (representing harvest frequencies of three, two and one time(s)).

Data were analyzed by using analysis of variance followed by Duncan Multiple Range Test if necessary. Repeated measurement method was used to analyze data from repeated harvests.

Plant seedlings (1 month old) were planted in 40 cm x 50 cm polybags containing soil and chicken manure according to the treatments. Polybags were put on land surface with the distance of 50 cm x 50 cm. Schedule of planting and harvesting is shown in Figure 1. Plant shoots were harvested with 4 cm stems were left remained on the soil to allow them to rejuvenate. Observed variables were plants' performances, growths, productions, and bioactive compounds.

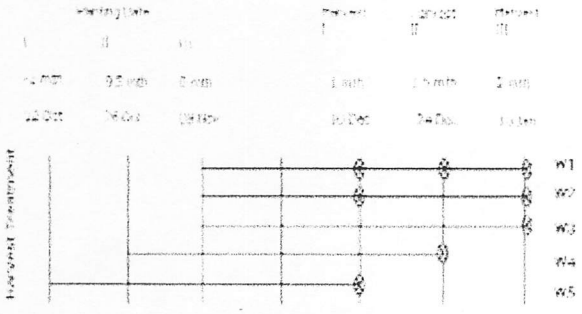

Figure **1.** Schedule of Planting and Harvesting *P. oleracea*

RESULTS AND DISCUSSION

Manure applications significantly increased linearly all plant growth components before first harvest (Table 2) including Relative Growth Rate (RGR) at 0-15 and 16-30 days after transplanting (DAT) (Figure 2). The application of 15 ton manure ha^{-1} resulted plant characteristics, at 4 weeks after transplanting, 1.9-4.0 fold to those without manure application. The results indicated that manure application increased the availability of soil nutrients and plants with the application of 15 ton manure ha^{-1} could absorb the available nutrient. There was a great concern related to the use of organic fertilizers as stated by Rosen and Allan (2007) that one of the problems in using organic fertilizers is the asynchrony of available nutrients with plant demand.

Table **2.** Plant performances with chicken manure application (before first harvest)

Manure Dosages (ton ha^{-1})	Weeks After Transplanting (WAT)			
	1	2	3	4
		Plant Height (cm)		
0	2.45 d	4.77 c	10.31 c	11.29 c
5	3.79 c	10.54 b	16.62 b	19.05 b
10	4.32 b	12.98 a	18.43 ab	20.64 b
15	5.15 a	14.69 a	20.65 a	23.97 a
		Length of Plant Surface (cm)		
0	2.59 c	6.31 c	14.60 c	17.27 c
5	5.66 b	17.08 b	26.38 b	31.96 b
10	6.36 ab	20.09 ab	28.57 b	32.89 b
15	6.99 a	22.81 a	33.39 a	38.72 a
		Width of Plant Surface (cm)		
0	1.89 c	5.56 c	11.02 c	13.13 c
5	3.18 b	16.40 b	22.61 b	26.80 b
10	3.31 b	18.18 b	24.68 b	28.91 ab
15	3.82 a	21.47 a	28.81 a	33.96 a
		Stem Diameter (cm)		
0	1.12 c	1.52 d	2.30 c	2.33 c
5	1.25 b	2.63 c	3.50 b	3.64 b
10	1.47 a	3.04 b	3.72 b	3.99 ab
15	1.48 a	3.48 a	4.29 a	4.41 a
		Branch Number		
0	1.4 b	7.0 c	20.3 c	22.3 c
5	4.6 a	31.0 b	53.7 b	62.0 b
10	5.1 a	37.6 a	57.3 b	65.6 b
15	5.4 a	41.9 a	77.0 a	89.4 a

Note : Same letters indicate numbers in the same column are not significantly different according to DMRT $p<0.05$

Positive linear of correlation between manure dosages and plant characteristic values meant that increasing amount of manure would increase the values. However, careful consideration must be taken regarding with the practical application of manure, the effect of manure on purslane qualities, and the environmental qualities. Applying large quantities of manure is time and economically consuming. Regarding with the quality of products, refers to the organic produce standard, USDA (2000) recommended that produce for human consumption cannot be harvested for at least 90 d after application for edible portions of the crop not in direct contact with the soil and 120 d for edible portions indirect contact with the soil. The impact of manure application to the environment had become a great concern, for example, by Rosen and Allan (2007). They highlighted the potential of surface water body degradation due to the accumulation of Phosphorus, brought by erosion, from manure as a result of high application of manure, which always be based on plant demand on nitrogen.

Manure application affected Relative growth rate (RGR) within the period of 0-15 and 16-30 DAT; however, in those two periods, the RGR patterns differed (Figure 2). In the period of 0-15 DAT, manure application increased the RGR, while in the period of 16-30 DAT the RGR decreased with manure application. The application of manure had increased plant growth since the beginning of growth phase therefore the RGR was higher in plants applied with manure than RGR in control plants.

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Treated plants probably had reached the maximum vegetative phase of growth within 2 weeks, and then the growth rate was nearly flat. On the contrary, there was a lack of plant nutrient in the control pots, therefore plants could not grow well in the early stage of growth. Although at 16-30 DAT the RGR of control plants was higher than those of treated plants, the values of plant characteristics were consistently the lowest; this meant that the control plants continued their vegetative growth while the treated plants might had switched their growth to the reproductive stage and the assimilate was transferred to reproductive organs including seeds.

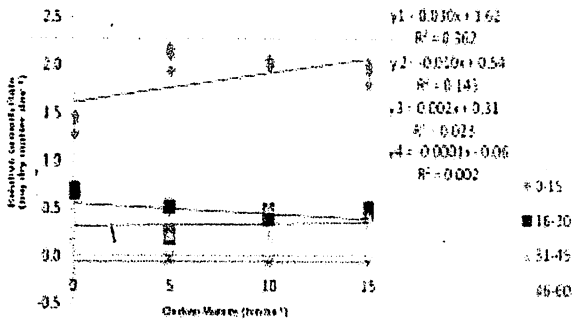

Figure 2. Relative growth rate every 2 weeks of *P. oleracea* with different chicken manure dosages

Net assimilation rate (NAR) is a measure of the photosynthetic efficiency of plant. The application of manure had increased NAR and it became double than that without manure (Table 3). NAR is higher during the period of 0-15 days after transplanting (DAT) than NAR in 16-30 DAT; this indicated that the vegetative growth phase of *P. oleracea* occur during the period of 0-15 DAT.

Table 3. Net assimilation rate of *P. oleracea* with chicken manure application

Manure Dosages (ton ha^{-1})	Days After Transplanting	
	0-15	16-30
	mg cm^{-2} day^{-1}	
0	0.053 b	0.035 c
5	0.11 a	0.079a
10	0.10 ab	0.069 a
15	0.12 a	0.057 ab

Note : Same letters indicate numbers in the same column are not significantly different according to DMRT $p<0.05$

The interaction between plant ages and manure dosages affected plant production (Table 4). For the first harvest, to obtain the largest amount of plant shoot (fresh weight), plant must be harvested at 2 month old and need 15 ton manure ha^{-1}. Fresh weight of shoot from 2-month-old plants was about triple that from 1-month-old plant. For repeated harvests, with the highest rate of manure (15 ton manure ha^{-1}), two-week interval of harvest could only produce 16-19 g of fresh shoot per plant.

Table 4. Plant production at different plant ages with various dosages of chicken manure

Plant Ages at Various Harvest Dates	Manure Dosages (ton ha^{-1}) 0	5	10	15	Means
Harvested on 10 Dec	Fresh Weight of Shoot (g)				
1 month (W1*, 1st harvest)	4.47 f	28.19 def	36.13 de	46.74 cd	28.88
1 month (W2, 1st harvest)	5.14 f	23.18 def	28.84 def	34.92 de	23.03
2 month (W5, 1st harvest)	18.52 ef	64.24 bc	75.73 b	105.18 a	65.92
Mean	9.38	38.54	46.90	62.29	
	Dry Weight of Shoot (g)				
1 month (W1, 1st harvest)	0.53	3.61	4.49	5.52	3.54 b
1 month (W2, 1st harvest)	0.66	3.39	4.21	5.41	3.42 b
2 month (W5, 1st harvest)	3.98	8.62	9.35	12.97	8.73 a
Mean	1.72 c	5.21b	6.02 b	7.97 a	
Harvested on 24 Dec	Fresh Weight of Shoot (g)				
1.5 month (W1, 2 wk interval)	3.26 f	8.67 ef	11.23 ef	19.68 e	9.21
2 month (W4, 1st harvest)	29.26 d	47.36 c	60.25 b	70.07 a	51.74
Mean	16.26	28.02	35.74	41.88	
	Dry Weight of Shoot (g)				
1.5 month (W1, 2 wk interval)	0.25 d	0.66 d	1.20 d	1.17 d	0.82
2 month (W4, 1st harvest)	4.11 c	6.61 b	7.60 a	8.18 a	6.69
Mean	2.18	3.64	4.40	4.80	
Harvested on 10 Jan	Fresh Weight of Shoot (g)				
2 month (W1, 2 wk interval)	4.41 e	11.67 cde	13.98 bcde	16.42 bcd	11.62
2 month (W2, 4 week interval)	7.90 de	14.04 bcde	14.41 bcde	18.52 bc	13.72
2 month (W3, 1st harvest)	6.40 de	21.88 bc	23.45 b	41.06 a	19.14
Mean	6.24	15.86	17.28	19.93	
	Dry Weight of Shoot (g)				
2 month (W1, 2 wk interval)	0.67 e	1.74 cde	2.00 cde	2.23 bcd	1.66
2 month (W2, 4 week interval)	1.17 de	2.16 bcd	2.12 bcde	2.71 bc	2.04
2 month (W3, 1st harvest)	1.01 de	3.04 bc	3.49 b	6.18 a	2.79
Mean	0.95	2.31	2.54	2.86	
Total harvest	Fresh Weight of Shoot (g)				
1, 1.5, 2 month (W1)	12.14 ij	48.54 cdef	61.35 bcd	76.86 b	49.72
1 & 2 month (W2)	13.04 ij	37.22 efgh	43.26 defg	53.48 cde	36.75
2 month (W3)	6.40 j	21.88 ghij	23.45 ghij	46.62 def	24.59
2 month (W4)	29.26 fghi	47.36 def	60.25 bcd	70.08 bc	51.74
2 month (W5)	18.53 hij	64.24 bcd	75.73 b	105.18 a	65.92
Mean	15.88	43.85	52.81	70.44	
	Dry Weight of Shoot (g)				
1, 1.5, 2 month (W1)	1.46 hi	6.01 cdef	7.69 bcd	8.93 bc	6.02
1 & 2 month (W2)	1.83 hi	5.55 defg	6.33 cdef	8.12 bcd	5.46
2 month (W3)	1.01 i	3.04 ghi	3.49 fghi	6.80 bcde	3.58
2 month (W4)	4.11 efgh	6.61 bcde	7.61 bcd	8.42 bcd	6.69
2 month (W5)	3.98 efgh	8.62 bc	9.35 b	12.97 a	8.73
Mean	2.48	5.97	6.89	9.05	

Note : *W1, W2, W3 = planted on 9 November; W4 = planted on 26 October; W5 = planted on 12 October. Same letters indicate numbers in the same variable are not significantly different according to DMRT $p<0.05$

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It was expected that 4-week interval would be enough for purslane to rejuvenate; however, there was only 18 g of fresh shoot at the second harvest or similar to that of 2-week interval. Pruning might have removed the apical dominance of the plant tips, hence it would prompt the plant to produce more branches rather than leaves; this was also reported by Sugiarto (2006).

The growth of plant might have been affected by increasing rainfall as indicated by the production of plant with the same ages but planted at different dates. When seedlings were planted on 12 October, 26 October, and 9 November 2006, the productions of fresh shoot per plant after 2 month were 105.18, 70.07, and 41.06 g, respectively.

Bioactive compounds found in purslane were alkaloid in all parts of plant, tannin in leaves and stems, and steroid in leaves (Table 5). Although the data were not statistically analyzed, there was an indication that steroid content increased with the application of 15 ton manure ha^{-1}, and tannin in leaves increased with manure application. Further study is needed to confirm the result.

Table 5. Bioactive compound of purslane with application of chicken manure (qualitative analysis)

Plant Parts	Chicken Manure (ton ha^{-1})	Alkaloid	Steroid	Saponin	Tannin	Flavo-noid
Leaves	0	++++	+++	-	+++	-
	5	++++	+++	-	++++	-
	10	++++	+++	-	++++	-
	15	++++	++++	-	++++	-
Stems	0	++++	-	-	++++	-
	5	++++	-	-	++++	-
	10	++++	-	-	++++	-
	15	++++	-	-	++++	-
Roots	0	++++	-	-	-	-
	5	++++	-	-	-	-
	10	++++	-	-	-	-
	15	++++	-	-	-	-

Note : ++++ = indicated very high content; +++ = high content - = not detectable

CONCLUSION

Interaction between plant ages and manure dosages affected production of *Portulaca oleracea*. Plants harvested at 2 month old with the application of 15 ton manure ha^{-1} yielded the highest amount of fresh weight of 105.18 g per plant. For repeated harvests, the highest yield was obtained with two-week interval of harvest with the application of 10 or 15 ton manure ha^{-1}, i.e. 61.35 and 76.86 g of fresh shoot per plant, respectively.

REFERENCES

Elmi, AA, Mebrahtu T, Omara-Alwala TR, and Ezekwe MO. 1997. Environmental effects on yield and agronomic traits of purslane (*Portulaca* sp.). *Virginia Journal of Science* 48(3):205-209.

Ezekwe, MO, Omara-Alwala TR, Mebrahtu T. 1999. Nutritive characterization of purslane accessions as influenced by planting date. *Journal of Plant Foods for Human Nutrition* 54(3):183-191.

Liu L, Howe P, Zhou YF, Xu ZQ, Hocart C, Zhan R. 2000. Fatty acids and beta-carotene in Australian purslane (*Portulaca oleracea*) varieties. *Australian Journal of Medical Herbalism* 893 (1):200-207.

Miller TE, Wing JS, Huete AR. 1984. The agricultural potential of selected C4 plants in arid environment. *Journal of Arid Environments* 7:275–286

Palaniswamy, UR, McAvoy RJ, and Bible BB. 2001. Stage of harvest and polyunsaturated essential fatty acid concentrations in purslane (*Portulaca oleracea*) leaves. *Journal of Agricultural and Food Chemistry* 49(7):3490-3493.

Palaniswamy, UR, Bible BB, and McAvoy RJ. 2004. Oxalic concentrations in purslane (*Portulaca oleracea* L.) is altered by the stage of harvest and the nitrate to ammonium ratios in hydroponics. *Scientia Horticulturae* 102(2):267-275.

Reid, D. 1986. Chinese Herbal Medicine . Boston, MA: Shambhala Publications, Inc.

Rosen, CJ and Allan DL. 2007. Exploring the benefits of organic nutrient sources for crop production and soil quality. *HortTechnology* 17(4):422-430.

Sugiarto NT. 2006. The effect of harvest dates and frequencies on shoot production of *Talinum triangulare* Wild (In Indonesia: Pengaruh umur dan frekuensi panen pada produksi pucuk kolesom (*Talinum triangulare* Wild)) [skripsi] Bogor: Fakultas Pertanian, Institut Pertanian Bogor.

U.S. Department of Agriculture. 2000. National organic program. Final Rule. 7 CRF. Part 205. 18 Apr. 2007. http://www.ams.usda.gov/ nop/NOP/ standards/ FullText.pdf.

Wijayakusuma H, Setiawan D, and Agustinus S. 1996. Tanaman Berkhasiat Obat Di Indonesia. Jilid 2. Jakarta: Pustaka Kartini.

Wijewardena, JDH. 2000. Comparison of animal manure sources on potato and vegetable cultivation in the upcountry. Annual Symposium of the Department of Agriculture, Sri Lanka, September 2000. 2:357-369.

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