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Establishment and Early Regeneration of Stem Cuttings from Chicken Weed (*Portulaca quadrifida* L.) as Influenced by Soil Types

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ABSTRACT: Differences in the ability of soil are a requirement for early regeneration of a plant. It was a pot experiment carried out at Sokoto in the Sudano Sahelian agro-ecological Zone of Nigeria. The objective was to investigate the regenerative ability of stem cuttings of Chicken weed on different soil type as a strategy for the weed control. The experimental set up was 3 × 7 factorial arrangement in a Completely Randomized Design. The treatments consisted of seven stem cuttings types namely (NLA-D - node leaf attached at distal stem location, NLR-D - node leaf removed from distal stem location, NLA-P- node leaf attached at proximal stem location, NLR-P- node leaf removed from proximal stem location, IN-D - internodes at distal stem location, IN-P- internodes from proximal stem location and SRA- stem roots attached) and three soil textural class (Sandy, Silty clay and Loamy sand). Result revealed that Silty clay recorded highest number of survived plants. Plant height, number of leaves, nodes, internodes and internodes length were greatly favoured by sandy soil. Loamy sand supported the earliness to leaf emergence and flowering. NLA-D supported the early regeneration of the plant in all stem cuttings tested, but earliness to leaf emergence and flowering was better with NLA-P. This finding gave information that Chicken weed regenerate profusely and control measures should be administers to save target crop from yield losses.

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Portulaca quadrifida originates from India, and has been widely distributed in other temperate and tropical areas of the world (Lie *et al*., 2015 and Zhou, 2015). Netala *et al*. (2014) reported that the botanical name is derived from the Latin *Potare*, meaning to "carry," and *Lac* or "milk", referring to the milky sap of the plant. *Portulaca quadrifida* belongs to the family *Portulacaceae*. (Nyffeler and Eggli, 2010). The weed has been known by a number of other synonyms (*Illecebrum verticillatum L., Portulaca formosana* (Hayatta)*, Portulaca meridiana* L.f., *Portulaca microphylla* A. Rich. *and Portulaca walteriana*), but the original Linnean name persists and there is no confusion with any closely related species. Therefore, it is regarded as a variable species and occurs in a number of different ploidy forms (2n= 18, 36, 48) (PROTA, 2014). Gilbert and Phillips (2000) described the *P. quadrifida* as mat-forming habit and prostrate stems which can root from the nodes. It can easily be distinguished from other members of the genus. The flowers are said to open promptly at 10:00am, hence the English name ten O'clock plants (Grubben and Derton 2004), but is most preferably called Chicken weed (PROTA, 2014). The group of *Portulaca* that is particularly with alternate leaves is taxonomically difficult to control compared with *P. quadrifida* that is rather unique with its mat-formation habit, although, it varies particularly in stamen number and flower size (PROTA, 2014). *Portulaca quadrifida* is an annual weed that causes significant damage to a variety of crops. Subbulakshmi (2009) reported that in its native India, *P. quadrifida* is a significant weed in maize (*Zea mays*) and onions (*Allium cepa*) (Kachare *et al*., 2005). The plant is reported to be a major weed of green gram (*Vigna radiata*) in the 'summer' season in India but less significant in black gram (*V. mungo*) in the monsoon season (Singh *et al.*, 1991). Pigeon pea (*Cajanus cajan*), cabbage (*Brassica oleracea* var. *capitata*), cauliflower (*Brassica oleracea* var. *botrytis*), cucurbits (Cucurbitaceae family) and teosinte (*Zea* species) in India, coffee (*Coffea* species) in Kenya, and sorghum (*Sorghum bicolor*) in Sudan are variety host species of *P. quadrifida* (Singh *et al.*, 1991). It is also a common weed in garden land crops

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like banana (Srinivasan *et al*., 2009).The genus *Portulaca* comprised of about 150 species, mostly distributed in arid tropical and subtropical regions, particularly Africa and South America, with a few species extending into temperate regions with some of them cultivated for medicinal or horticultural uses (Chung *et al*., 2008). According to Nyananyo and Mensah (1990), the family Portulacaceae is virtually cosmopolitan in distribution and its component genera show interesting patterns of distribution, which may shed some light on its history and origins.

Portulaca quadrifida is widely distributed in Africa and tropical Asia and has also been introduced into the warmer areas of the Americans. It was also reported that the weed is found in all countries in Africa usually as a weed and it is rarely cultivated (Jansen, 2004). *P. quadrifida* is found in the wild from sea-level up to 2000m altitude on the bare patches of ground and among rocks, on sandy or stony soils. They are involuntarily introduced by man in to new areas where it never existed; like the compost, rubbish heaps and fields. It is tolerant of a wide range of soils but prefers sand or sandy loams (PROTA, 2014). The objective of the present study was to investigate the regenerative ability of Chicken weed through propagation by stem cuttings under different soil type which will aid in mapping out strategies for the control of the weed.

MATERIALS AND METHODS

Experimental Site, Soil and collection of plant material: The experiment was conducted at the Biological garden of the Department of Biological Science of the Usmanu Danfodiyo University Sokoto, Nigeria (Latitude 12^0 01′ N and 13^0 58′ N and Longitude 4^0 8′ E and 6^0 54′ E) during the2017 and 2018 rainy seasons. The aim of this study is to investigate the early regeneration from stem cuttings of Chicken weed (*Portulaca quadrifida*) under different soil types. Sokoto is characterized by a long dry season from November to May, comprising of cool dry air (harmattan) between November to February and hot dry air between March and May (Ahmed *et al*., 2007).

Soils (Sand, silt clay and loamy sand) were randomly collected at the depth of 0 – 15 cm from the Fadama Research farm and Dry land Research Farm of the Usmanu Danfodiyo University Sokoto. Soil was analyzed for its physical properties and contents of Nitrogen, phosphorus and potassium at the laboratory using standard procedures. Matured stem of Chicken weed were collected in an onion farm at Birnin-Kebbi during the rainy season of 2017 and 2018. Seven different cuttings were made from the stem of the plant which serves as the treatments. Plastic pots measuring 25cm diameter × 24cm height was filled with 10 kg of the soil sample from the three soil textural class and irrigated prior before planting. Three stem cuttings of the Chicken weed were planted in the pots according to the laid down treatments.

Treatments and Experimental Design: The experiment consisted of two factors namely; three Soil Types (Sand, Silty clay and loamy sand) and seven stem cuttings of Chicken weed (NLA-D - node leaf attached at distal stem location, NLR-D - node leaf removed from distal stem location, NLA-P - node leaf attached at proximal stem location, NLR-P- node leaf removed from proximal stem location, IN-D internodes at distal stem location, IN-P- internodes from proximal stem location and SRA- stem roots attached). The experiment was laid out in a Completely Randomized Design (CRD) and replicated three times. The pots were planted with three stem cuttings each and the pots were surface irrigated every other day throughout the growing period.

Data Collection and Analysis: Data collection on the growth parameters of the plants was taken at intervals of 15 and 30 days after planting (DAP) which includes percentage establishment count, plant height, number of leaves/plant, number of nodes/plants, number of internodes/plant, internodes length, days to leaf emergence and days to first flowering. Data collected was subjected to analysis of variance (ANOVA) using GenStat 17^{th} Edition. Fisher's least significant difference test was used to separate treatment means at 5% levels of probability.

RESULTS AND DISCUSSION

Soil characteristics: Three different agricultural soils were used for the study with different textural class (Sand, Silty clay and Loamy sand)and soil nutrient content (NPK) was presented in Table 1 and 2 respectively. The analysis of the physical properties (Table 1) soil content of NPK (Table 2) showed that soil sample collected in 2017 revealed that, sample A, B and C was Sand, Clay and Loamy soil with pH level of 7.7, 6.8 and 7.3 respectively, while result observed during the 2018 showed that sample A, B and C has the pH of 7.6, 6.8 and 6.9 respectively.

The result indicated here showed that farming activities among farmers in the study area resulted to low nutrient composition of the soil types used for this research with pH ranges between 6.8 –7.7. This result corroborate the report of Olabode *et al*. (2007) and Babajide *et al*. (2008) who stated that most tropical soils are acidic and low in nutrients and can no effectively sustain vegetative and reproductive growth of tropical vegetables.

Table 1. pH and soil Textural Class used for pot experiment during the 2017 and 2018 rainy seasons at Sokoto

pH and Soil Textural Class										
	2017					2018				
Soil sample	Sandy %	Silt %	Clay %	pH in H_{2O}	Soil Textural class	Sand %	Silt %	Clay %	pH inH_{2O}	Soil Textural class
A	92.2	5.8	2.0	7.7	Sandy	91.6	6.2	2.2	7.6	Sandy
B	17.4	44.3	38.3	6.8	Silty clay	19.2	46.3	34.5	6.8	Silty clay
C	72.3	17.5	10.2	7.3	Loamy sand	77.2	15.3	7.2	6.9	Loamy sand

Table 2. Soil nutrient contents of Nitrogen (N), Phosphorus (P) and Potassium (P) in soil sample collected during the 2017 and 2018 rainy seasons at Sokoto, Nigeria

Soil content						
	2017			2018		
Soil Textural Class	Total N %	Available P mg kg^{-1}	Potassium K^+	Total N %	Available P mg kg^{-1}	Potassium K^+
Sandy	0.025	0.41	0.26	0.074	0.70	0.15
Silty clay	0.081	0.82	1.08	0.116	0.77	0.69
Loamy sand	0.039	0.51	0.74	0.123	0.84	0.79

Response of establishment count, plant height and number of leaves of Chicken weed on soil textural class and stem cutting effects at Sokoto: Tables 3 showed the effect of soil and stem cuttings on establishment count, plant height and number leaves of Chicken weed. The result showed that in 2017 Silty clay recorded the highest number of plant that survived at 30 DAP. Plant height and number of leaves at 15 DAP in both years significantly ($p<0.05$) recorded the tallest plant and highest number of leaves respectively under the influence of sandy soil, though the result was at par with those obtained when loamy sand was used. This indicates that good number of the plants have thrives better in sandy soil, even though sandy soil has its disadvantage as a growth medium, it usually exists with some percentage of silt particles which increases its ability to hold water and retain nutrients. In response to this, an experiment conducted by Pahla *et al*. (2014) on the effect of seedling emergence and vigour of *Acacia sieberana* indicated that sandy soil recorded the shortest time to emergence across all other treatments compared to clay soil.

Table 3: Effect of Soil Textural Classes and Stem Cuttings on establishment count, plant height and number of leaves of *P. quadrifida* during the 2017 and 2018 rainy seasons at Sokoto

	Establishment count				Plant height				Number of leaves			
	2017		2018		2017		2018		2017		2018	
	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP
Soil Textural Classes												
Sand	61.90	61.90b	63.64	63.64	4.72a	13.59	4.41a	17.40	10.62a	16.72	9.33a	17.52
Silty Clay	65.08	69.84a	60.32	57.14	2.07b	10.90	3.05b	15.97	7.29b	13.10	7.24b	16.67
Loamy sand	61.90	60.32b	68.25	63.49	3.37ab	9.39	3.31ab	15.46	9.95ab	13.76	7.91ab	17.48
SE±	2.92	2.60	3.84	3.05	0.74	1.93	0.40	1.90	0.97	1.38	0.61	0.97
Stem Cuttings												
NLA-D	100.00a	100.00a	100.00a	96.30a	7.92a	23.56a	8.06a	27.98a	16.89a	26.44a	16.00a	27.33a
NLR-D	100.00a	100.00a	92.59a	81.48b	4.03bc	16.38ab	4.20b	19.30ab	12.67b	21.33ab	10.44b	23.78a
NLA-P	96.30a	96.30a	100.00a	100.00a	5.88ab	14.88ab	7.30a	27.24b	14.89ab	20.89ab	14.44a	27.11a
NLR-P	62.96c	62.96b	63.30b	59.26c	1.84cd	7.76b	2.00c	17.51b	6.67c	13.56b	6.89c	18.67b
IN-D	0.00d	0.00c	0.00c	0.00d	0.00c	0.00c	0.00d	0.00c	0.00d	0.00c	0.00d	0.00c
IN-P	0.00d	0.00c	0.00c	0.00d	0.00c	0.00c	0.00d	0.00c	0.00d	0.00c	0.00d	0.00c
SRA	81.48b	88.89a	92.59a	92.59ab	4.02bc	16.49ab	3.56c	21.90ab	13.89ab	19.56b	9.33bc	23.67a
SE±	4.49	3.97	5.86	4.65	1.13	2.95	0.62	2.90	1.47	2.10	0.93	1.48
Interaction												
ST × SC	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) in a treatment column are not significantly different at 5 % level of probability using Fisher's least significant difference test. NS = not significant.

African plant database (2014) also described *P. quadrifida* as a plant of sandy river banks. All the stem cuttings sprouted and developed into new plant in all the soils tested during the experiment except IN-D and IN-P. Stem cuttings with NLA-D consistently recorded the highest plant survival, tallest plants and highest number of leaves. Similar highest number of plants survival was observed when stem cuttings with

NLR-D and NLA-P was used at 15 and 30 DAP in both years. SRA at 30 DAP and 15 DAP in 2017 and 2018 respectively produced similar highest number of plant survival. NLA-D which supported higher plant survival, tallest plant and highest number of leaves might be that the top cutting of stem of Chicken weed has better propagation ability than other portions of the plant. This result is in agreement with the findings of Wassner and Ravetta (2000) who reported that good propagation ability from top cuttings was better than from the basal cuttings in *Grindelia chiloensis*. Interaction on soil textural class and stem cuttings on establishment count at 30 DAP was observed (Table 3).The interaction of soil textural classes and stem cuttings on the establishment count of *P. quadrifida* at 30 DAP is presented in Table 4. The result showed that stem cuttings with NLA-D, NLR – D and NLA – P produced similar highest establishment count in all the soil textural class, except NLA – P in silty clay. NLR – P and SRA under silty clay produced similar highest plant establishment count. NLR – P produced the lowest establishment count under sandy and loamy sand respectively and IN-D and IN-P did not regenerate.

Table 4: Interaction of soil textural class and stem cuttings on percentage establishment count of *P. quadrifida* at 30 DAP during 2017 rainy season in Sokoto.

Treatment	**Soil textural class**		
Stem Cuttings (SC)	Sandy	Silty clay	Loamy sand
NLA – D	100.00a	100.00a	100.00a
NLR – D	100.00a	100.00a	100.00a
NLA – P	100.00a	88.89ab	100.00a
NLR – P	44.44c	100.00a	44.44c
IN – D	0.00d	0.00d	0.00d
IN – P	0.00d	0.00d	0.00ed
SRA (control)	88.89ab	100.00a	77.78b
SE±		6.88	

*Means followed by same letter (s) in a column are not significantly different at 5% level of probability using Fisher's least significant difference test. NS= not significant, **= significant at 1% level.*

Response of number of nodes, internodes and length of internodes/plant of Chicken weed on soil textural class and stem cutting effects at Sokoto: Number of nodes, internodes and length of internodes/plant of Chicken weed are presented in Table 5. The result indicated that highest number of nodes and internodes/plant was recorded at 15 and 30 DAP in 2017 when sandy soil was used, though similar number of nodes/plant was obtained under loamy sand at 15 DAP and number of internodes at 30 DAP under silty clay in 2017.Growing vigorously and healthier could be as a result of the weed's suitability to sandy soil. Dreyer, (1993) reported that Bearberry (*Arctostaphyllous uva-ursi*) thrives in sand, poor soils forming a dense mat of foliage. Stem cuttings with NLA-D significantly ($p<0.05$) recorded the highest number of nodes, internodes and length of internodes/plant at 15 and 30 DAP in both years. Likewise, similar highest number of nodes, internodes and length of internodes was also obtained when NLR-D and NLA-P was used at 15 DAP in 2017 and 30 DAP in 2018 in terms of number of internodes/plant. Stem cuttings with SRA also produced similar highest number of nodes at 15 DAP in 2017 and 30 DAP in 2018 and internodes/plants at 30 DAP in 2018. The lowest number of nodes, internodes and length of internodes/plant was noticed when stem cuttings with NLR-P was used. Having good response from NLA-D in terms of higher number of nodes, internodes and internodes length might be that it is the top part of the plant facing towards the sunlight with more chlorophyll content and hence grow faster. Beemnet and Solomon (2012) reported the advantage of top cutting on propagation ability and growth of *Stevia rebaudiana*.

Table 5: Effect of Soil Textural Classes and Stem Cuttings on number of nodes, internodes Length of internodes per plant of Chicken weed (*Portulaca quadrifida*) at Sokoto in 2017 and 2018 rainy seasons

	Number of nodes/plant				Number of internodes/plant				Length of internodes/plant			
	2017		2018		2017		2018		2017		2018	
	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP	15 DAP	30 DAP
Soil Textural Classes												
Sand	3.81a	7.10a	5.10	8.76	4.48a	7.33a	3.95	8.10	0.68	1.57	0.96	1.77
Silty Clay	2.52b	5.05b	4.00	8.33	3.14ab	5.33a	3.29	7.62	0.40	1.21	0.66	1.62
Loamy sand	3.90a	5.62ab	3.95	8.76	4.19ab	5.86ab	3.24	8.05	0.52	1.21	0.69	1.33
SE±	0.44	0.61	0.12	0.18	0.45	0.61	0.32	0.46	0.11	0.21	0.12	0.17
Stem Cuttings												
NLA-D	6.41a	11.11a	8.11a	13.67a	7.00a	11.67a	7.00a	12.67a	0.98a	2.19a	1.21ab	2.62a
NLR-D	4.56a	8.56ab	5.67bc	11.89a	5.56a	9.00ab	4.67b	10.89a	0.94a	2.12a	1.06bc	1.89ab
NLA-P	5.44a	8.22b	7.33ab	13.56a	6.44a	8.33b	6.33a	12.56a	0.64ab	1.92a	1.66a	2.59ab
NLR-P	2.00b	5.11c	3.56d	9.33b	2.56b	5.33c	2.67c	8.44b	0.43b	1.14b	0.53cd	1.77b
IN-D	0.00c	0.00d	0.00e	0.00c	0.00c	0.00d	0.00d	0.00c	0.00c	0.00c	0.00e	0.00c
IN-P	0.00c	0.00d	0.00e	0.00c	0.00c	0.00d	0.00d	0.00c	0.00c	0.00c	0.00e	0.00c
SRA	5.00a	8.44ab	4.78cd	11.89a	6.00a	8.89ab	3.78bc	10.89a	0.74ab	1.93ab	0.93bc	2.16ab
SE±	0.67	0.94	0.64	0.74	0.69	0.93	0.45	0.71	0.16	0.32	0.18	0.27

Interaction												
ST × SC	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) in a treatment column are not significantly different at 5 % level of probability using Fisher's least significant difference test. NS = not significant.

Influence of soil textural class and stem cuttings on days to leaf emergence and days to first flowering of leaves of Chicken weed: Table 6 represent days to leaf emergence and days to first flowering of Chicken weed in 2017 and 2018 at Sokoto. The result revealed that significant ($p<0.05$) difference was noticed when different soil textural class was used. The earliness to leaf emergence was influenced with the use of loamy sand in both years and the result was at par when silty clay was used, while the use of sand produced the lateness to leaf emergence. The early emergence of the leaves of the weed could be as a result of adaptation of the weed to sandy soil. Ramamoorthy *et al.* (2004) asserted that many weeds can adapt and grow well in soils having poor soil fertility status. For example, thatch grass *(Imperata cylindrica* Beauv.) grows well in low fertile soils and can also adapt well to soils of high fertility, while *Commelina benghalensis* L. thrives better in both moist and dry soil conditions. Stem cuttings of Chicken weed has significant ($p<0.05$) influence on the leaf emergence of the weed. In 2018, the use of NLA-D, NLR-D, NLA-P and SRA recorded the earliness to leaf emergence with similar earliness to leaf emergence been observed in 2017 with the use of NLR-P. All other treatments in 2017 recorded lateness to flowering, but IN-D and IN-P did not regenerate. Table 6 indicates that Days to first flowering of Chicken weed was not affected with use of different soil textural classes, but the use of stem cuttings has significant ($p<0.05$) differences been observed. The use of NLA-D, NLR-D, NLA-P and SRA in 2018 significantly ($p<0.05$) recorded the earliness to flowering with similar earliness to leaf emergence been observed in 2017 with the use of NLR-D, NLR-P and SRA. The lateness to flowering of product of stem cuttings was observed in 2017 when NLA-D and NLA-P was used, while IN-D and IN-P did not regenerate (Table 6).Loamy sand greatly enhanced the growth of Chicken weed in terms of days to leaf emergence. Early leaf emergence of the plant may be due the role played by loamy sand soil which was characterized with the ability of water holding capacity which must have retained much soil moisture for plant to grow faster, though *P. quadrifida* can survive in a wide range of soils (PROTA, 2014).Days to leaf emergence were earlier when NLR-P was used and days to first flowering were favored with the use of NLR-D. In this regard, Kim and Carr (1990) reported that flowers of *Portulaca* exhibit sequential maturation throughout the growing season and the development of mature capsules from flowering usually required 13-14 days in most species and all flowers examined lasted only 1 day. Vengris *et al.* (1972) stated that Purslane will continue flowering under favorable conditions.

Table 6. Effect of Soil Textural Classes and Stem Cuttings on number of nodes, number of internodes and length of internodes Chicken weed at Sokoto in 2017 and 2018rainy seasons

	Days to leaf emergence		Days to flowering	
	2017	2018	2017	2018
SOIL TEXTUTRAL CLASSES				
Sand	3.81b	3.43b	10.76	10.29
Silty Clay	4.43ab	4.29ab	10.81	10.95
Loamy sand	4.71a	5.05a	11.05	11.24
SE±	0.29	0.35	0.22	0.52
STEM CUTTINGS				
NLA-D	5.00b	5.33a	13.89b	14.67a
NLR-D	5.22b	5.33a	15.56a	15.78a
NLA-P	5.89b	6.00a	14.44b	15.33a
NLR-P	8.22a	6.78a	16.44a	14.33a
IN-D	0.00c	0.00b	0.00c	0.00c
IN-P	0.00c	0.00b	0.00c	0.00c
SRA	5.89b	6.33a	15.78a	15.67
SE±	0.45	0.53	0.33	0.79
INTERACTION				
ST × SC	NS	NS	NS	NS

Means with the same letter (s) in a treatment column are not significantly different at 5 % level of probability using Fisher's least significant difference test. NS = not significant.

Conclusion: This study elaborates more light on the knowledge of regeneration ability of Chicken weed (*Portulaca quadrifida*) on different soil textural class. All stem cutting of the weed regenerated except IN-D and IN-P. Irrespective of location, Chicken weed can adapt and survive in a wide range of soil. To further elucidate on the regeneration and copious nature of the weed, it is therefore recommended that, strategies for the control of *P. quadrifida* earlier than none using integrated weed management methods are essential for optimum crop yield.

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