Advanced Research Journal of Plant and Animal Sciences, Vol. 1(1) pp 7-13, November 2013

Review

Effect of Flower Bud Removal on Growth and Yield of Anchote Root (*Coccinia abyssinica* (Lam.) Cogn.) Accessions at Bishoftu

Hassen Yassin[1], Ali Mohammed[2], Desta Fekadu[3], Seid Hussen[1]*

[1,2]Wollo University, Department of plant Sciences, Dessie, P.0.Box 1145, Ethiopia
[2] Jimma University Colleges of Agriculture and Veterinary Medicine, Jimma, P.0.Box 307, Ethiopia
[3]Debre Zeit Agricultural Research Center, Bishoftu, P.0.Box 32, Ethiopia
Corresponding Author E-mail: habebehass@gmail.com

Accepted 7th November

Anchote (Coccinia abyssinica (Lam.) Cogn.) is a tuberous root crop grown mainly in western and south western parts of Ethiopia for its edible root and tender leaves, in order of importance. Though anchote is underutilized, it has nutritional, socio-cultural and socioeconomic importance for the growers. Assimilate distribution in root and tuber crops to the reproductive parts affect the expected yield and quality of tubers and/or roots. Regardless of this fact, most growers practically leave fruits to grow until the harvest of the roots, diverting the ***photosynthates***. However, t**here is no research attempt made so far that assess the effect of flower bud removal on anchote growth and root yield. Therefore this** research was conducted **at DZARC field in 2011/2012 with the objective of assessing the effect of flower bud removal on growth and yield of roots of different anchote accessions. The experiment consisted of two factors vis-à-vis Factor A: anchote accessions (90801, 220563, 240407B, 240407G, 90802, 223090, and Kuwe) and Factor B: flower bud removal (with and without removal). A 2x7 factorial arrangement was laid with RCBD and replicated three times. Data pertaining to growth yield and yield component parameters were collected and analyzed using SAS statistical package with 9.2 versions (SAS 9.2 version Institute Inc., 2008). As per the results, internode length, percentage of ground cover and leaf area were highly significantly ($p<0.01$) affected due to accession. Flower bud removal treatment increased internode length and leaf area by 1.97% and 6.69% respectively. Highly significant ($p<0.01$) differences were observed in respect of root yield, root weight per plant, root length, root diameter and root number per plant among accessions. With this, accession kuwe had highest root yield (94.37t/ha) as compared to the rest of accessions. Flower bud removal treatment increased root yield, weight per plant, length and diameter by 15.87, 15.24, 5.21 and 7.99 in percent respectively. The study revealed that flower bud removal had a pronounced effect on growth and root yield of anchote and accessions differed significantly for all parameters examined. Accession kuwe is the best from the rest of the accessions. In general, this research put imperative information pertinent to the influence of developing fruits on the main consumable part, the root.**

Keywords: anchote accessions; flower bud removal; yield; growth

INTRODUCTION

Anchote (*Coccinia abyssinica*) is an endemic species which is annual trailing vine found in both cultivated and wild in Ethiopia with more than eight taxa recorded, distributed throughout the country (PGRC, 1995). According to Endashaw (2007), *Coccinia abyssinica* is a member of the family cucurbitacea, a tuberous annual, with shoots having simple tendrils. There are about ten species of Coccinia in Ethiopia; however, only *C. abyssinica* is cultivated for human consumption and also for cattle feed.

In Ethiopia, the cultivation of anchote is sporadic but widespread in the Western and Southwestern provinces of Wollega, Kaffa, Sidamo, and Illubabor, where other tuberous species of Colocosia, Dioscorea and Musa are also extensively cultivated. In these provinces, anchote is cultivated at elevation varying

Table 1 Anchote accessions used in the experiment

Accession	Collection area		
	Region	Zone	District
90801	Oromia	Horro GuduruWollega	Abbay Chomen
220563	Oromia	West Shoa	Bako Tibe
240407B	SNNPRS	Keficho Shekicho	Decha
240407G	SNNPRS	Keficho Shekicho	Decha
90802	Oromia	Horro GuduruWollega	Abbay Chomen
223090	Oromia	West Wollega	Gimbi
Kuwe	Oromia	East Wollega	Sibu Sire

from 1,300 m to 2,800 m above sea level where the rainfall ranges from 762 mm to 1,016 mm; it also occurs in the wild state in more arid regions (Amare, 1974). The area covered in 1998/99 in East Wollega and West Wollega zones were 440.75ha and 440 ha respectively (Weyessa *et al*., 2008).

Anchote is a valuable food source and grown for its high content of protein and calcium (Amare, 1974). According to Amsalu *et al*. (2008), tubers of anchote boiled and prepared with local butter, in addition, the crop consumed during special ceremonies. It regarded as medicinal as well as an important dietary item in Southern and Southwestern Ethiopia, it helps in fast mending of broken bones due to its good content of calcium (Endashaw, 2007). Unlike other cucurbits floral nature; monoecious, the male and female flowers do not occur separately on the same plant and the term monoecious could not be used in anchote. The length of the fruits ranges from 5.00 to 9.03 cm, diameter ranges 26.94 to 60.83 mm, and the fruit shape is heterogeneous; plum shaped, round, round oval, spherical and round elongated. Predominant root flesh color of different accessions varies from white to strongly pigment. Round, round elliptic, a slightly circular outline with acute and obovate root shapes were observed in the studied accessions.

Developing flowers and fruit are strong sinks for mineral nutrients, sugar and amino acids, and there is a corresponding decrease in the amounts available for the growth of other plant parts. Depending on the strength of the sinks, potato plants allocate assimilates to the developing fruit, tubers and other vegetative structures. Under conditions of assimilate limitation competition among sink organs is imperative. Pruning of reproductive parts allow assimilates to distribute to vegetative parts (Hasani et *al*., 2003).

Since anchote produces both fruit and root parts, competition for assimilates might be aggressive. The issue is further pronounced because it produces large fruits at the expense of root growth; the principal consumable part. However, to date, farmers are producing anchote without removing flower buds, and allowing fruits to grow until the tuberous root are harvested. Moreover, yield of anchote accessions is different so that selecting accession/s with highest yield is important to producers. Therefore, it is timely and pertinent to investigate the presence of flower bud effect on growth and root yield. Hence the present study is initiated to determine the effect of flower bud removal on growth and root yield of anchote and to select best performing accession(s) with respect to root yield.

RESEARCH METHODOLOGY

Description of the Experimental Site

The study was conducted at Debre Zeit Agricultural Research Center (DZARC) research Site, 47 km east of Addis Ababa in the year 2011/2012 cropping season. The study area is located approximately 08°44' N latitudes and 38°58' E longitudes geographic coordinates with altitude of 1860 meters above sea level. The area receives an annual average rainfall of 851 mm and has mean minimum and maximum temperatures of 8.9°C and 24.3°C, respectively. The experiment was conducted on heavy (*koticha*) soil site.

Experimental Material

Seeds of seven anchote accessions were obtained from Debre Zeit Agricultural Research Center (DZARC). The detailed information with regard to the seven anchote accessions is listed in Table 1 above.

Table 2. Mean square of growth parameters

Source of Variation	Df	Mean squares		
		Internode length (cm)	Percentage of ground cover (%)	Leaf area (cm^2)
Block	2	0.12	0.17	86.12
Accession	6	11.63**	5.91**	1796.42**
Flower bud removal	1	0.39*	0.095ns	564.67**
Accession x Flower bud removal	6	0.058ns	0.37ns	27.29ns
Error	26	0.07	0.24	43.35
SE±		0.26	0.49	6.58
CV		2.59	15.47	6.22

**= significant, **= highly significant, ns= non significant at p>0.05, Df=degree of freedom*

Table 3 Internode length, percentage of ground cover and leaf area of anchote as influenced by accessions and flower bud removal treatment

	Internode length (cm)	Ground Cover (%)	Leaf area (cm^2)
Accession			
90801	9.30e	1.83b	87.63e
220563	11.28b	3.66a	101.33cd
240407B	10.65c	3.83a	110.33b
240407G	9.95d	3.667a	102.99bc
90802	12.08a	1.67b	93.74de
223090	8.15g	3.666a	103.84bc
Kuwe	8.85f	4.00a	141.42a
LSD(0.05)	**0.3087**	**0.5857**	**7.8135**
Flower bud removal			
Removed	10.14a	3.24a	109.56a
Not Removed	9.94b	3.14a	102.23b
LSD(0.05)	**0.165**	**0.3131**	**4.1765**
CV (%)	**2.59**	**15.47**	**6.22**

Means followed by the same letter per column are not significantly different at p > 0.05

Treatment and Experimental Design

The experiment consisted of two factors vis-à-vis Factor A: Anchote accessions (90801, 220563, 240407B, 240407G, 90802, 223090, and *Kuwe*) and Factor B: Flower bud removal (With and without removal). A 2x7 factorial arrangement was laid out using Randomized Complete Block Design (RCBD) and replicated three times. Therefore, there were a total of 42 experimental units used for the whole study plot.

Data Collected

The data pertaining to growth and root yield were collected from each plot at predetermined schedule from sample plants taken in each plot. Parameters

Table 4. Mean square of yield and yield component parameters

Mean square						
Source of Variation	**Df**	**Root yield**	**Root Weight per plant (g)**	**Root length (cm)**	**Root diameter (mm)**	**Root number Per plant**
Block	2	6.70	607.31	0.18	0.67	0.006
Accession	6	2705.64**	175912.67**	4.069**	1898.46**	0.0975**
Flower bud removal	1	998.06**	58907.35**	3.37**	329.62*	0.00774ns
Accession x Flower bud removal	6	48.18ns	3021.73ns	0.239ns	4.67ns	0.00351ns
Error	26	19.83	1264.89	0.12	70.98	0.002
SE±		4.45	35.57	0.35	8.43	0.05
CV		7.87	7.83	3.32	11.89	2.43

**= significant, **= highly significant, ns= non significant at p>0.05, Df=degree of freedom*

Table 5 Yield and yield components of anchote root as influenced by accessions and flower bud removal treatment

	Root yield (t/ha)	**Root weight per plant (g)**	**Root number Per plant**	**Root length (cm)**	**Root diameter (mm)**
Accession					
90801	44.38^{d}	361.55^{d}	3.82(2.08^{b})	9.98^{b}	50.50^{c}
220563	44.88^{d}	358.09^{d}	2.92(1.85^{e})	10.18^{b}	72.60^{b}
240407B	37.54^{e}	294.39^{e}	3.92(2.10^{b})	9.52^{c}	49.58^{c}
240407G	78.46^{b}	629.97^{b}	3.17(1.93^{d})	11.5^{a}	91.13^{a}
90802	45.96^{cd}	367.71^{dc}	4.44(2.23^{a})	10.08^{b}	67.41^{b}
223090	50.42^{c}	408.17^{c}	3.47(1.99^{c})	10.28^{b}	69.22^{b}
Kuwe	94.37^{a}	758.07^{a}	3.58(1.96^{cd})	11.73^{a}	95.42^{a}
LSD(0.05)	**5.2854**	**42.21**	**0.058**	**0.413**	**9.9987**
Flower bud removal					
Removed	61.45^{a}	491.68^{a}	3.63(2.029^{a})	10.75^{a}	73.64^{a}
Not Removed	51.69^{b}	416.77^{b}	3.60(2.002^{a})	10.19^{b}	68.03^{b}
LSD(0.05)	**2.8252**	**22.56**	**0.031**	**0.221**	**5.3446**
CV (%)	**7.87**	**7.83**	**2.43**	**3.32**	**11.89**

Means followed by the same letter per column are not significantly different at p > 0.05. Values in parenthesis are square root transformed (√x+0.5).

related to growth were internode length (cm), leaf area (cm^2) and percentage of ground cover. Whereas total root yield (t/ha), root weight per plant (g), root number per plant, average root length (cm) and average root diameter (mm) were a yield and yield component parameters taken.

Data Analysis

First, data collected on growth, yield and quality parameters were checked for normality and meeting all ANOVA assumptions. Then data were subjected to the Analysis of Variance (ANOVA) and correlation using SAS statistical package with 9.2 versions (SAS 9.2 version Institute Inc., 2008). Least Significant Difference (LSD) was used to separate mean values of the treatments with significance level of 5%.

RESULT AND DISCUSSION

Growth Parameters

Internode length

According to Table 2 above internode length was significant due to accession ($P<0.01$) and treatment ($P<0.05$). A perusal use of Table 3 above showed that highest internode length recorded in accession 90802 (12.08cm) followed by 220563 (11.28cm) and the lowest was accession 223090 (8.15cm). This is in agreement with research on sweetpotato in which varieties were varied in internode length (Nedunchezhiyan *et al*., 2007). Flower bud removal caused to increased internode length by 1.97%, this may be due to availability of assimilates that increase the vegetative growth.

Percentage of ground cover

The canopy of anchote accessions was in the range of medium to total coverage. Based on Table 2, highly significant ($p<0.01$) variation observed due to accessions. According to Table 3, the highest in percentage of ground cover observed in *kuwe* (total, >90%) which however was statically at par with accession 223090, 240407G, 220563 and 240407B. The lowest in percentage of ground cover potential was noticed in accession 90802 (medium, 50-74%) and no significant difference with accession 90801. The leaf area is one of the determined factors for percentage ground cover potential.

Leaf area

As it is indicated in Table 3, anchote accessions and flower bud removal treatments had highly significant ($p<0.01$) effect on leaf area of anchote. Referring to Table 3, accession *Kuwe* ($141.42cm^2$) had highest leaf area followed by accession 240407B ($110.33cm^2$) as par with accession 223090 ($103.84cm^2$) and 240407G ($102.99cm^2$). Whereas accession 90801 ($87.63cm^2$) showed the lowest leaf area measurement compared to the rest. This work is in the same fashion with the previous research on anchote accessions (Daba *et al*., 2012). The differences in leaf area may be due to genotypic difference among anchote accessions. Leaf area was positively correlated with root yield ($r=0.68^{**}$). Flower bud removal increased leaf area by 6.69%. This result is in agreement with (Valantin *et al*., 1998) worked on antelope.

Yield and Yield Component Parameters

Parameters for yield and yield component were root yield (t/ha), root weight per plant (g), root number per plant, root length (cm) and root diameter (mm). The result obtained is presented (Table 4 above and 5 below) and discussed as follows.

Root yield

In this study, there was highly significant ($p<0.01$) difference between accessions and the treatments (Table 4). As presented in Table 5, the highest root yield was recorded in *Kuwe* (94.37t/ha) followed by 240407G (78.46t/ha) and the lowest in root yield recorded in accession 240407B (37.54t/ha). Variation in root yield also reported in investigation done on root yield of sweet potato varieties (Osiru *et al*., 2009) and cassava (Chaisri *et al*., 2011). Root yield was positively and significantly ($r=0.98^{**}$), ($r=0.91^{**}$) and ($r=0.92^{**}$) correlated with root weight per plant, root length and root diameter in that order. Regardless of accessions, flower bud removal treatment alone increased root yield by 15.87%. This is due to the strong competition exists between the reproductive and root part. The result is in agreement with research done on potato (Jansky and Thompson, 1990).

Root weight per plant

Result shown in Table 4 verify, variation in root weight per plant was observed. There was highly significant ($p<0.01$) difference in root weight per plant noticed in accession and the treatments. From Table 5, it is vivid that the highest root weights per plant observed in accession *kuwe* (758.07g) followed by accession 240407G (629.97g) and the lowest root weight per plant found in accession 240407B (294.39g). Irrespective of accessions, flower bud removal alone increased root weight per plant by 15.24%. This result is in parallel with the work on yam bean tuber fresh weight (Hasani and Karuniawan, 2010).

Root number per plant

The result shown in Table 4 verify, significant ($p<0.01$) difference observed between accessions. However, treatment and interaction was not significant ($p<0.05$). Data presented in Table 5 depict that, the highest number of roots found in accession 90802 (4.44) followed by accession 240407B (3.92) and lowest recorded in accession 220563 (2.92). The difference in root number between accessions might be the output of genotypic variation among accession.

Root length

As it shown in Table 4, highly significant ($p<0.01$) variation observed in root length of accession and the treatments. Referring to Table 5, accession *kuwe* had highest root length (11.73cm) followed by 240407G (11.50cm) and lowest root length (9.52cm) obtained in accession 240407B. In spite of accessions, flower bud removal, increased tuberous root length by 5.21%. Absence of reproductive parts contribute for enhanced growth of tuberous root in anchote because assimilates diverted to vegetative parts.

Root diameter

As it is indicated in Table 4, highly significant ($p<0.01$) and significant ($p<0.05$) variation observed in accessions and treatments respectively. Like root length, the highest and the lowest root diameter observed in *Kuwe* (95.42mm) and 240407B (49.58mm) respectively (Table 5). In parallel research done on sweet potato Nedunchezhiyan *et al*. (2007) and on cassava Ntawuruhunga and Dixon (2010) reported, cultivars showed significantly different in root diameter. Regardless of accessions, flower bud removal alone caused for increment of 7.62% of root diameter.

CONCLUSION AND RECOMMENDATION

Variation was observed among accessions in respect of growth, root yield and yield component parameters examined and the presence of developing fruits negatively affected the studied parameters of anchote. This may be due to strong competition between reproductive and vegetative parts for assimilates. However, flower bud removal treatment had no appreciable effect on percentage of ground cover and root number per plant. Anchote accessions significantly varied for yield and yield component parameters. The highest and lowest root yield was registered for accession *kuwe* (94.37t/ha) and 240407B (37.54t/ha), respectively. Irrespective of accessions, flower bud removal treatment alone, increased root yield, root weight per plant, root length and root diameter by 15.87, 15.24, 5.21 and 7.99 in percent respectively, from un-treated. This may be due to the absence of depressing effect of developing fruits.

It is advisable to use accession kuwe because it has highest productivity compare to the rest of the accessions. In addition removal of flower bud before development of fruits helps to gain more root yield due to the absence of strong sink. However, as the study was conducted under irrigated condition, it would be wise to revisit the findings of the present study under rain-fed conditions to come up with sound recommendation. In addition it is better to assess the effect of flower bud removal on nutritional quality of anchote.

ACKNOWLEDGMENT

Jimma and Wollo Universities are acknowledged for funding partial research costs.

REFERENCE

Plant Genetic Resources Center. (1995). Indigenous Plant Genetic Resources. In: Country Report to the FAO International Technical Conference on Plant Genetic Resources. April, 1995, Addis Ababa. p9.

Endashaw B (2007). Study on Actual Situation of Medicinal Plants in Ethiopia. http://www.endashaw.com. Accessed on July 30, 2011.

Amare G (1974). Developmental Anatomy of Tuber of Anchote; A Potential Dry Land Crop. (2):313-323. First Ethiopian Horticultural Workshop, 20-23 February 1985, Addis Ababa, Ethiopia.

Weyessa G, Girma A, Amsalu N, Wubishet A (2008). Socioeconomics and Technology Transfer. Pp.323-326. In: Gebremedhine W, Endale G, Berga L (eds.). (2008). Root and Tuber Crops: Untapped Resources. Ethiopian Institute of Agriculture Research, Addis Ababa, Ethiopia.

Amsalu N, Weyessa G, Assefa T, Wubishet A, Asfaw K, Edossa E (2008). Variety development in Taro, Cassava, Yam, Indigenous root and tuber crops. Pp.303-315. In: Gebremedhin, W., Endale, G. and Berga, L.(eds). Root and Tuber Crops: The Untapped

Resources. EIAR, Addis Ababa, Ethiopia.
Hasani S, Karuniawan A (2010). Tuber Production of Yam Bean (Pachyrhizus Spp.) Due to Sink-Reproductive Pruning. International Seminar Biotechnology.
Leidi OE, Rodr´ıguez-Navarro DN, Fernández M, Sarmiento, Semedo RJ, Marques N, Matos A, Machado AP, Orting B, Sorensen M, Matos MC (2003). Factors Affecting Root and Seed Yield, In: Ahipa (*Pachyrhizus ahipa* (Wedd.) Parodi), A Multipurpose Legume Crop. *Europe Journal of Agronomy* 20: 395–403.
Nedunchezhiyan M, Byju G, Naskar SK (2007). Sweet Potato (Ipomoea batatas L.) as an Intercrop in a Coconut Plantation: Growth, Yield and Quality. *Journal of Root Crops,* 33(1):26-29.
Daba M, Derbew B, Wosene G, Waktole S (2012). Growth and Yield of Anchote [Cocccinia abyssinica (Lam.) Cogn.] in Response to Contrasting Environment. *Asian Journal of Plant Sciences,* 11(4): 172-181.
Valantin M, Gary C, Vaissiere BE, Frossard JS (1999). Effect of Fruit Load on Partitioning of Dry Matter and Energy in Cantaloupe (*Cucumis melo* L.). *Annals of Botany,* 84: 173-181.
[11] Osiru, M.O., Olanya, O.M., Adipala, E. Kapinga, R. and Lemaga, B. 2009. Yield Stability Analysis of *Ipomoea Batatus* L. Cultivars In Diverse Environments. *Australian Journal of Crop Science,* 3(4):213-220.
Chaisri S, Pacharada C, Kingkan P, Supranee N, Prapart C (2011). Yield Potential of KU Cassava Varieties Grown in Upper Central Part of Thailands. Thailand.
Jansky, Thompson (1990). The Effect of Flower Removal on Potato Tuber Yield. *Canadian Journal of Plant Science,* 70: 1223-1225.
Ntawuruhunga P, Dixon AGO (2010). Quantitative Variation and Interrelationship Between Factors Influencing Cassava Yield. *Journal of Applied Biosciences*, 26: 1594-1602.