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EVALUATION OF COMMERCIAL ROOT YIELD OF ARRACACHA (*Arracacia xanthorrhiza* Banc.) FROM BRAZILIAN GERMPLASM COLLECTION.

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ABSTRACT

Characterization and evaluation of germplasm collections is considered an achievement as important as maintaining the collection. The objective of this work was to evaluate quantitative yield traits of a collection of Brazilian arracacha to identify high yielding, early and duplicated accessions. All 67 accessions of the arracacha collection were planted in an experiment at the Horticultural Research Station of Public University of Viçosa, MG, Brazil. A randomized complete block design with two replications was used. Each plot contained 15 plants in three rows spaced one m apart and with 0.40 m between plants. After eight months of planting, only 38 accessions presented three or more competitive plants in both replications. Yield of four commercial class root (Extra A, Extra, Special and First) and total commercial root yield were evaluated in three competitive plants of each plot. Sixteen accessions did not produce Extra A roots and eight accessions did not produced Extra roots. Accession BGH 6525 showed the highest total commercial root yield. Accession BGH 4551 showed highest Extra A root yield. Accession BGH 5747 showed highest Extra root yield.

Keywords: *Arracacia xanthorrhiza*, yield, germplasm, selection, root class.

INTRODUCTION

Arracacha *(Arracacia xanthorrhiza* Bancroft) belongs to family Apiaceae (Umbelliferae) which includes about 300 genera and 3000 species (Mathias 1971). The genus *Arracacia* includes about 30 species among them *Arracacia xanthorrhiza* is the only cultivated. This crop an asexually propagate and perennial plant (Blas *et al.* 2007). Although the diversity of genus *Arracacia* is particularly high in Mexico, Andean South America is considered the place of domestication of arracacha. Arracacha is produced mainly in four countries; Brazil, Colombia, Ecuador and Venezuela with total production area over 30 thousand hectares (Blas and Arbizu, 1999; Hermann, 2005). Edible part are tuberous roots which after cooking become an essentially starchy food with small portions of β-carotene, ascorbic acid and calcium and its utilization is intimately related to its high starch content, about 95% (Hermann, 1997).

Three Andean horticultural forms could be found these forms were yellow-rooted, white-rooted and purplish-rooted (Hermann, 2005). Morphological variation in Brazilian cultivated gene pool of arracacha is small. Yellow-root cultivar is commercially grown in Brazil named ‘Amarelo de Carandai’ its accession number in germplasm collection is BGH 5746. It has intensive yellow root pigmentation and purplish petiole bases, yielding from

8.74 t ha^{-1} at 10 months after planting (Madeira *et al.*, 2002) to 15.69 t ha^{-1} at eight months (Granate *et al*, 2004) or a bit more as in this experiment (Table 3). When compared with common commercial cultivars planted in Andean countries it has stronger flavor. Intensive yellow color and strong flavor are required by Brazilian fresh market and processing industry.

Usually arracacha remains in the field during 11 to 12 months and the main objective of breeding is to reduce this period. Commercial roots are classified in four classes (Extra A, Extra, Special and First). Prices range from one to four fold from the smallest (First) to the largest root class (Extra A) (CEASAMINAS, 2007). Accessions high yield with high percent of the two largest roots classes (Extra A and Extra) after less than 10 months in the field needed to be identified.

The optimal utilization of germplasm collections depends on its informations from characterization and evaluation process. There are several arracacha collections at Ecuador, Peru, Colombia and Brazil. Most arracacha collections are well documented in terms of passport data but characterization and evaluation of arracacha germplasm collections is still uncompleted (Blas and Arbizu, 1999; Hermann, 1997; Rosso *et al*, 2004). Public University of Viçosa (UFV) began collecting arracacha germplasm in 1974 when the Horticulture Germplasm Bank (BGH) established arracacha field collection (Silva *et al.*, 2001).

The aim of this investigation was to present first quantitative data of UFV - BGH arracacha collection: total commercial roots yield and four classes root yield of arracacha accessions in an attempt to identify high yielding accessions with high percent of the two Extra root yield classes after eight months in the field.

MATERIALS AND METHODS

At Viçosa, Minas Gerais State (MG), Brazil (latitude: 20º45'14" S, longitude: 42º52'55" E, altitude: 650 m'' average temperature: 19ºC, average precipitation: 1.240 mm, subtropical highland climate and cambic red-yellow podzolic terrace phase soil), were planted 67 accessions from BGH-UFV. Experiment was conducted at Horticultural Research Station of UFV, in the growing seasons of 2007and 2008. A randomized complete blocks design with 67 treatments and two replications and 15 plants per plot was applied. Total area was 1212 m^2. Intra-row distance was 0.40 m and inter-row distance 1.00 m. According to soil analysis result it was necessary to add calcium, N-P-K, potassium chloride and organic matter at following rates: 128 Kg of dolomite (30 % Ca, 12.1 % Mg), 408 g m^{-2} of cattle manure both by throwing in all the field and 16g m^{-1} of N-P-K (0-25-15) in the row at planting time; at 90 days after planting were applied 2 g $plant^{-1}$ of potassium chloride fertilizer (58 % K) in each plant. At planting time Nematicide "Furadan" was applied in the row.

Cormels were selected from healthy, ripe and productive plants, separated from crowns. Their apex and base were cut leaving four centimeters long propagules. Root productivity depends mainly on this

correct cutting of cormels (Hermann, 1997; Sediyama and Casali, 1997). Since nematodes and soil diseases threaten root productivity a preventive treatment was applied to cormels. They were immersed for 5-10 mints in 10 % sodium hypochlorite solution and after let dry in shade for one day according to Sediyama and Casali (1997). Irrigation was made with conventional aspersion and manual weed control was done when necessary. In this study the harvest was at eight months after planting in order to identify early yielding accessions. In each plot were picked up three competitive plants randomly sampled. Only competitive plants should be picked up because plants not surrounded by other four plants produce much more and are not representative of commercial plantations. Roots were washed with tap water and dried in open air during one day and evaluated the day after.

Fig 1. Experimental field with eight months old arracacha clones being picked up at random. Viçosa, January 2008.

Fig 2. Arracacha accession BGH 6525 had highest total yield in this experiment.

Fig 3. Arracacha accession BGH 5746 'Amarelo de Carandaí' is the most commercially planted clone in Brazil.

ıe following traits: total commercial yield
(T ‡ than 5 cm long and more than 1 cm of
la A): yield of roots 16 to 18 cm long and 4
to (EXT): yield of roots 13 to 16 cm long
ar cial yield (ESP.): yield of roots 10 to 13 cm long and at least 3 cm largest diameter; First yield (FIR): yield of roots

that did not belong to other classes. Percent of Extra A, Extra, Special and First roots in total commercial yield of each accession was computed. Analysis of variance and comparison of means using Tukey's test at 5% probability was applied. Computation utilized Software ''GENES'' program version 2007.6.1 developed at UFV (Cruz, 2001).

RESULTS AND DISCUSSION

There were losses of plants in emergency and during early growth which is a major constraint of this culture on which it is usual 10 to 15% emergency losses (Granate *et al.*, 2003). Mean of percent of lost plants per plot was 22.67%. This loss of stand higher than usual was supposed mainly due to weeds that had germinated at the same time of arracacha. At the harvest time the mean of plant number/plot was 11.60 but mean of number of competitive plant/plot was 5.00. From the 67 accessions planted only 38 accessions presented three or more competitive plants in both replications and only these 38 were evaluated. The other 29 accessions will be planted in another experiment with more plants in each plot. Neither nematode nor disease symptoms were observed on harvested roots.

The results of variance showed highly significant at 1% for traits total commercial roots yield of classes; Extra A roots yield, Special roots yield and First root yield and at 5% probability level for Extra roots yield was only significant (Table 1) meaning that there are differences between accessions for these traits as expected.

Table 1: Summary of analysis of variance (mean squares) of total commercial roots and four-classes of arracacha yield (tha^{-1}) evaluated after eight months of planting.

S.V.	D.F.	Mean Squares				
		TCY[1]	EXT A	EXT	SPE	FIR
Blocs	1	94.63	4.70	6.48	6.55	6.03
Genotype	37	124.11**	6.64**	9.60*	17.61**	23.07**
Error	37	16.86	2.08	5.44	4.80	4.81

Environmental variance was lower than those genotype variance for all studied traits except Extra A roots yield (Table 2) suggesting this trait is more influenced by environment than others. Coefficient of variance of Extra A roots yield and Extra roots yield are greater than those of others traits (Table 2) since 16 accessions did not give Extra A roots and 8 accessions did not produce Extra roots (Table 3).

Table 2: Parameters estimation of commercial roots yield and four-classes of arracacha roots yield (tha^{-1}) evaluated after eight months of planting.

Parameter[1]	Trait				
	TCY	EXT A	EXT	SPE	FIR
Phv	62.06	3.318	4.80	8.81	11.53
Env	8.43	1.038	2.72	2.40	2.40
Genv	53.63	2.28	2.079	6.41	9.13
Coef	51.42	103.69	49.05	64.39	51.09
Mean	14.24	1.46	2.94	3.93	5.91

[1]Phv: phenotypic variance; Env: Environmental variance; Genv: genotypic variance; Coef: genetic covariance

Table 3: Total commercial yield and four classes roots yield means (Extra A, Extra, Special and First) evaluated in arracacha accessions harvested at eight months after planting.

Clone (BGH)	TCY[1]	Extra A		Extra		Special		First	
	Yield	Yield		Yield		Yield		Yield	
	t ha^{-1}	t ha^{-1}	%[2]	t ha^{-1}	%[2]	t ha^{-1}	%[2]	t ha^{-1}	%[2]
4551	20.63abcdefg	5.83a	28.28	6.15[a]	29.8	3.48abcd	16.9	5.17abcdef	25.1
4552	7.73defghi	--	--	1.96[a]	25.3	2.56abcd	33.2	3.21cdef	41.5
4553	19.13abcdefgh	1.48a	7.73	3.36[a]	17.5	6.83abcd	35.7	7.46abcdef	39.0
4555	15.56abcdefghi	4.05a	26.02	2.35[a]	15.1	4.73abcd	30.4	4.43cdef	28.5
4556	15.34abcdefghi	0.83a	5.43	4.07[a]	26.5	3.67abcd	23.9	6.77abcdef	44.1
4557	21.73abcdef	4.21a	19.37	5.63[a]	25.9	5.65abcd	26.0	6.25abcdef	28.8
4559	20.13abcdefgh	5.48a	27.22	3.00a	14.9	3.33abcd	16.6	8.31abcdef	41.3
4560	21.58abcdef	0.51a	2.38	4.60[a]	21.3	9.06abcd	42.0	7.40abcdef	34.3
4579	13.79abcdefghi	0.46a	3.32	1.23[a]	8.9	3.10abcd	22.5	9.00abcdef	65.3
4580	1.33 i	--	--	--	-	-	-	1.33ef	100.0
5741	23.60abcd	1.85a	7.86	3.81[a]	16.2	3.61abcd	15.3	14.32[a]	60.7
5742	15.27abcdefghi	1.75a	11.46	1.87[a]	12.2	2.89abcd	18.9	8.77abcdef	57.4
5746	16.15abcdefghi	1.00a	6.19	4.09[a]	25.3	3.92abcd	24.2	7.15abcdef	44.2
5747	22.54abcde	1.79a	7.95	6.39[a]	28.4	5.94abcd	26.3	8.42abcdef	37.3
6311	19.51abcdefgh	--	--	1.61[a]	8.3	10.73ab	55.0	7.17abcdef	36.7
6403	--	--	--	--	--	--	--	--	--
6411	6.81defghi	--	--	--	--	1.83bcd	26.9	4.98bcdef	73.1
6417	20.62abcdefg	5.75a	27.86	6.02[a]	29.2	2.58abcd	12.5	6.27abcdef	30.4
6423	17.05abcdefghi	4.00a	23.46	3.35[a]	19.7	3.79abcd	22.2	5.91abcdef	34.7
6429	5.27fghi	--	--	2.94[a]	55.7	0.67cd	12.6	1.67ef	31.6
6436	9.79bcdefghi	--	--	1.81[a]	18.5	1.98bcd	20.2	6abcdef	61.3
6445	9.35cdefghi	1.65a	17.60	2.36[a]	25.2	1.71bcd	18.3	3.65cdef	39.0
6458	4.14ghi	--	--	--	0.0	0.77cd	18.6	3.37cdef	81.4
6467	17.19abcdefghi	1.17a	6.79	5.85[a]	34.1	5.40abcd	31.4	4.77bcdef	27.8
6480	4.23ghi	--	--	--	0.0	2.81abcd	66.5	1.42ef	33.5
6490	13.98abcdefghi	3.83a	27.43	1.82[a]	13.0	3.56abcd	25.5	4.76cdef	34.1
6494	7.40defghi	--	--	1.35[a]	18.3	3.54Abcd	47.9	2.5cdef	33.8
6507	11.21abcdefghi	--	--	5.58[a]	49.8	3.61abcd	32.2	2.02def	18.0
6518	5.13fghi	--	--	--	0.0	1.35cd	26.3	3.78cdef	73.7
6525	28.38a	3.46a	12.20	4.6[a]	16.2	6.35bcd	22.4	13.96ab	49.2
6529	2.96hi	--	--	--	--	--	--	2.96cdef	100.0
6538	6.05efghi	0.75a	12.39	2.06[a]	34.0	--	--	3.25cdef	53.6
7605	4.16ghi	--	--	--	--	1.83bcd	44.0	2.33cdef	56.0
7606	17.05abcdefghi	1.50a	8.82	2.13[a]	12.5	2.38abcd	13.9	11.04abcd	64.7
7607	22.89abcde	2.54a	11.10	3.78[a]	16.5	9.69abc	42.3	6.88abcdef	30.0
7610	21.88abcdef	--	--	7.27[a]	33.2	7.69abcd	35.1	6.92abcdef	31.6
7609	24.95abc	1.44a	5.76	5.07[a]	20.3	6.93abcd	27.8	11.5abc	46.1
7608	26.65ab	--	--	5.56[a]	20.9	11.42a	42.8	9.67abcde	36.3

[1]TCY: root length 5 to 18 cm or more and 1 to 5 cm or more in diameter; EXT A: root length 16 to 18 cm and 4 to 5 cm in diameter; EXT root length of 13 to 16 cm and 3 to 4 cm in diameter; SPE: root length 10 to 13 cm and at least 3 cm in diameter; First: root length of 10 to 15 cm or more than 18 cm and 1 to 3 cm in diameter or more than 5 cm in diameter. 2 %: of total commercial yield of each accession.

Total commercial roots yield mean of all accessions (Table 2) was greater than that obtained by Madeira *et al.* (2002) at 10 months after planting for accession BGH 5746 and for its other 17 high yielding accessions experiment mean of 9.82 t ha^{-1}. This was an unexpected result since accessions in this experiment are a mixture of commercial and non-

commercial accessions. This experiment mean was lower than Granate *et al.* (2004) 29 high yielding accessions experiment mean of 17.88 t ha^{-1}. Clone BGH 6403 can be eliminated from germplasm bank because it did not produce commercial roots in any plant of both replications.

Twenty four accessions cleared in significant different in total commercial yield according to Tukey test at 5% probability (Table 3). Their total commercial yield was greater than 10.95 t ha^{-1}, the Minas Gerais State mean for 12 months in the field (Torres, 1997). Six accessions yielded 22.00 tha^{-1} or over which is considered very high yield specially because it was obtained four months earlier than usual. Accession BGH 6525 was the more productive. This accession was originated at Viçosa from seed which is a very rare achievement and is a new genotype (Sediyama, 1988). However its percent of Extra A and Extra roots is not one of the highest (Table 3). The 22 accessions that produced Extra A roots do not differ according to Tukey test (Table 3) and five of them reached more than 25 % of Extra A roots. The greatest Extra A yielding clone is inferior to Madeira *et al.* (2002) bests but those were picked up at 10 months after planting. Thirty accessions produced Extra roots and from these eight presented Extra root yield above 5.50 t ha^{-1} overgrowing Madeira *et al.* (2002) highest Extra root yield of 5.11 t ha^{-1}. Any accession showed the three desired characteristics of high total commercial yield and high Extra A and Extra root percent. Accession BGH 5747 was considered the best because its total commercial yield was more than twice Minas Gerais mean and its Extra root yield is almost one third of total commercial yield. It may be recommended as a new commercial cultivar after experiments in other regions of the State.

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تقييم المحصولِ الاقتصادى للجذور لمجموعة من جيرمبلازم الآراكاتشا البرازيلية (*Arracacia xanthorrhiza* Banc.).

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يُعتَبر توصييف وتقييم مجموعاتِ الجيرمبلازم من الامورالضرورية لإيجاد توازنٍ أفضل بين صيانة التنوع المحصولي واستخدامه فى استنباط أصنافٍ محسنة تلائم الظروف البيئية والتغيرات المناخية و تحمل الإجهادات في المناطق التي كثيراً ما تكون الأسمدة والمواد الكيماوية والري فيها باهظة التكاليف أو غير متاحة. لذا كان الهدف من هذه الدراسة هو تقييم الصفات الكمّيةِ للمحصولِ لمجموعة من جيرمبلازم الآراكاتشا البرازيلية بهدف الانتخاب للمحصول و التبكير بجانب عمل تضاعف و تجديد للمدخلات. تم زراعة ٦٧ مدخل بمحطة بحوث البستانين- جامعةِ فيزوسا. إحتوتْ كُلّ قطعة تجريبية على ١٥ نبات. بعد ثمانية شهورٍ مِنْ الزراعة ، وجد ٣٨ مدخل انطبق عليهم شروط التقييم وقد أختير ثلاثة نباتاتِ تنافسيةٍ من كل مدخل. تم تدريج المحصول الاقتصادى الى الاربع درجات المعروفة. ١٦ مدخل لم يُنتجْ جذور درجة اكسترا A وثمانية مدخلات لَمْ تنتجُ جذوراكسترا. اظهرت كل من المدخلات BGH 6525, BGH 5747 و BGH 4551 اعلى محصول كليّ , اكسترا A و اكسترا على الترتيب.