

EVALUATION FOR YIELD AND ADAPTATION OF PATHOGEN-TESTED POTATO ACCESSIONS GROWN FROM APICAL CUTTINGS AT LOW MOUNTAIN ZONE ENVIRONMENT

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ABSTRACT

Sets of germplasm from apical cuttings produced at BSU were evaluated in low mountain zone environment. The trial was conducted to determine the yield and adaptation of 32 accessions in low mountain zone environment and to select promising accessions for further evaluation in different agro-ecological zones in the Philippine highlands.

Tuber yield of selected accessions and cvs. 'Ganza,' 'Igorota' and 'Granola' ranged from 1.25 to 23.29t/ha. A total of 14 accessions were selected both by the researchers and farmers for their good yield, desirable tuber shape, skin color, and shallow eyes. Most of these selected accessions were resistant to late blight.

It is recommended that these selected accessions be screened further for their adaptability in different agro-ecological zones in the Philippine highlands. Selected accessions will be included in the National Testing Center for final evaluation. Outstanding accessions will be recommended to the Philippine Seed Board for variety release.

KEYWORDS: apical cuttings, evaluation of pathogen-tested, potato accessions, low mountain zone

INTRODUCTION

The Philippine highlands have four agro-ecological zones classified according to elevation such as: high hill zone (500-1000 masl); low mountain zone (1001-1500 masl); mid-mountain zone (1501-2000 masl) and high mountain zone (above 2000 masl) (DA, 1988 as cited by Tadawan, 2007). Benguet is composed of these agro-ecological zones that are suited for the production of high value crops like potato and cabbage. The unique climate of the province favors the production of temperate crops which are globally competitive. Furthermore, Benguet is a major potato producer contributing 62% of the total volume produced in the country (BAS, 2008).

Potato is traditionally grown from seed tuber. With this method, multiplication is slow and requires at least 80 to 90 days to harvest (Demonteverde *et al.*, 1991). An alternative measure to this predicament is to grow them from apical cuttings which is a rapid multiplication technique allowing the timely increase of new accessions for propagation.

The production of quality potato seeds is based on the use of the rapid multiplication technique which starts with the production of the *in vitro* plantlets that are used as source of mother plants for rooted stem cuttings. The advantage of the use of stem cuttings is that tuber-borne and soil-borne non-systemic diseases and nematodes can be effectively eliminated because only above-ground parts are used for multiplication (Struik and Wiersema, 1999). Thus, the use of rooted

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stem cuttings as planting materials is being used for the multiplication of clean planting materials.

Germplasm with wide range of genotypic characteristics are continuously maintained in *in vitro* and in the green house at the Northern Philippine Root Crop Research and Training Center (NPRCRTC) of the Benguet State University (BSU). Selections made need further evaluation for eventual variety release. Hence, this study was conducted to evaluate the yield and adaptation of 32 accessions grown from apical cuttings in low mountain zone environment and to select promising accessions that are resistant to late blight infection.

MATERIALS AND METHODS

Thirty five entries with diverse genetic background were grown from cuttings from August 1 to November 15, 2004 at Bektey, La Trinidad, Benguet (1500masl). Pathogen-tested clones/cultivars were maintained at the *in vitro* gene bank of the NPRCRTC. These were acquired as tubers from the International Potato Center (CIP), Lima, USA, Japan, China, and the Philippines from farmers' selections.

The trial was laid out in a randomized complete block design with three replications. Varieties Igorota, Granola and Ganza were used as control check. Plot size was 1m x 3m with 20 plants per treatment. The recommended rate of inorganic fertilizer for potato (140-140-140kg N-P-K/ha) was applied as side dressing and chicken manure at 5 t/ha as basal. All other cultural management practices were carried out as recommended.

At harvest, tubers of small to big size with about 200 grams of the selected accessions including check variety Ganza were reserved per sample for dry matter content analysis.

Data gathered were the following:

A. Growth parameters

□ **Plant vigor.** This was evaluated at 45 and 75 days after planting (DAP) using the rating scale as follows:

SCALE	DESCRIPTION	REACTION
5	Plants are strong with robust stems and leaves; light to dark green in color	Highly vigorous
4	Plants are moderately strong with robust stems and leaves; are light green in color	Moderately vigorous
3	Better than less vigorous	Vigorous
2	Plants are weak with few thin stems and leaves; pale color	Less vigorous
1	Plants are weak with few stems and leaves; very pale color	Poor vigor

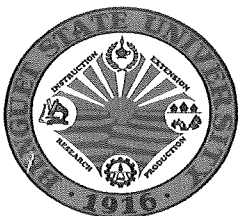
□ **Plant survival.** This was determined by counting the number of harvested plants and computed as:

$$\% \text{ Plant Survival} = \frac{\text{No. of plants survived}}{\text{No. of plants planted}} \times 100\%$$

C. Late blight incidence

□ Late blight (*Phytophthora infestans*) was assessed and recorded at 45, 60, and 75 DAP using the rating scale:

SCALE	DESCRIPTION	REACTION
1	Lesions none or very few	HR
3	2% but not more than 25% infection	R
5	25% but not more than 50% of the foliage destroyed	MR
7	50% but not more than 75% of the foliage destroyed	S
9	75-100% or foliage completely destroyed	HS



B. Plant harvested. This was determined by counting the number of harvested plants and computed as:

$$\% \text{ Plant Survival} = \frac{\text{No. of plants harvested} \times 100}{\text{No. of plants planted}}$$

D. Tuber yield parameters

□ **Marketable tuber (kg/plot).** These are tubers with marketable size ranging from 15 to 60 grams and above, free from defects and more than 10% greening.

□ **Non-marketable (kg/plot).** Marble size, decayed, rat damaged, and more than 10% greening were considered non-marketable.

□ **Dry matter content (%).** This was determined by oven drying sliced tubers for 48 hours at 100°C and computed using the formula:

$$\text{DMC} = \frac{\text{Oven-dry weight}}{\text{Fresh weight}} \times 100\%$$

RESULTS AND DISCUSSION

Plant Vigor

Results show that all the selected accessions had a good growth stand (Table 1). It was observed that their stems were strong with robust stems and leaves were light to dark green in color. The check variety Granola had a rating of 3 (moderately vigorous) while all the other entries had highly vigorous (5) growth. This might be associated with their genetic characteristics as affected by the environmental factors during the conduct of the study.

Late Blight Incidence

Table 1 shows the incidence of late blight gathered at 45, 60, and 70 days after transplanting (DAT). Results show that there was no late blight infection at 45 DAT. Nevertheless, at 60 DAT, signs and symptoms of late blight were observed

Table 1. Plant vigor and late blight incidence of 17 potato accessions grown in Lacaan, Bonglo, Atok

ENTRY	PLANT VIGOR ¹	LATE BLIGHT INCIDENCE ²		
		45 DAT	60 DAT	75 DAT
1. IP84004.67	5	1	1	1
2. Alchip	5	1	1	1
3. 384558.10	5	1	2	4
4. 720071	5	1	1	2
5. 387164.4	5	1	1	1
6. Alpha	5	1	2	6
7. 720097	5	1	1	1
8. GT	5	1	2	2
9. 387410.7	5	1	1	1
10. 285378.27	5	1	4	6
11. Monona	5	1	1	1
12. 523275	5	1	1	1
13. 380241.17	5	1	1	1
14. 676070	5	1	1	2
15. Ganza	5	1	1	1
16. Igorota	5	1	1	3
17. Granola	3	1	3	9

¹Rating scale: 1- poor; 2 - less vigorous; 3 - Vigorous; 4 - moderately vigorous; 5 - highly vigorous

²Rating scale: 1-highly resistant; 3- resistant; 5-moderately resistant; 7-susceptible; 9- highly resistant

in some of the entries, which had progressed up to 75 DAT. However, it was observed that the entries IP84004.67, Alchip, 387164.4, 720097, 387410.7, Monona, 523275, Ganza and 380241.17 were resistant to late blight with a rating of 1 (none or few lesions) up to 75 DAT.

Plant Survival (%)

Table 2 shows the percentage plant survival. The total number of rooted cuttings planted is 20 per entry. Plant survival ranged from 75% to 100% however, their differences were not significant. Accessions IP84004.67, 384558.10, 720097, 387410.7, 523275, and var. Igorota had a 100% survival. On the other hand, the accessions Alpha and 387164.4 had the lowest plant survival of 75%. The lower plant survival of these two entries could be due to their sensitivity to photoperiod and temperature associated to the genetic makeup of the plants.

Hills Harvested

The number of hills harvested from variety Granola was significantly lower than the other accessions (Table 2). Only 47% of the plants survived and harvested which is very low compared to the 73-100% hills harvested in the other accessions. There were no significant differences on the number of plants harvested between the other 16 accessions. The lower survival rate in some of the entries might be due to their sensitivity to stress caused by the transport of the planting materials from Bektey, La Trinidad to Lacaan, Bonglo, Atok (about 40km from apical production to planting site).

Number and Weight of Marketable Tubers

The number and weight of marketable tubers varied significantly among the accessions evaluated (Table 2). Accession IP84007.67 had the highest number of marketable tubers (101pcs) significantly outnumbering check varieties Igorota and Granola with mean marketable tuber numbers of 51 and 13 pcs, respectively. However it is significantly comparable with Ganza having a marketable tuber number of 95 pieces.

The accessions 387410.7 and IP84007.67 with respective marketable mean tuber weights of 7.31 and 6.32kg which significantly outranked cv Granola and Igorota with tuber mean weight of 0.36 and 2.57kg, respectively. However these are significantly comparable with cv Ganza with tuber mean weight of 7.30kg. The marketable weight of the other accessions ranged from 2.58 to 5.7% either comparable or outyielding the check varieties Igorota and Granola. This shows that these two accessions are adopted to the low mountain zone environment of Benguet Province.

Number and Weight of Non-marketable Tubers

Table 2 shows the non-marketable mean tuber number and weight of 14 accessions and cvs. Ganza, Igorota and Granola. Accessions IP84007.67 significantly had the highest non-marketable tuber mean number of 94 pieces followed by 380241.17 with 72 pieces while accession Alchip and cv. Granola had the least with identical mean of 16 pcs. Likewise accessions IP84007.67 significantly had the highest non-marketable tuber mean weight of 1.07kg while cv. Granola had the lowest non-marketable tuber mean weight of 0.10kg. This result is similar to the observation in the marketable tubers wherein these accessions/cultivars produced the highest and lowest marketable yield. It follows that accessions or cultivars with the highest marketable yield also had the highest non-marketable yield.

Total Yield per Plot

Statistical analysis showed significant differences among the accessions evaluated on their total yield (Table 2). Accession IP84007.67 had the highest mean total yield of 8.38kg, significantly out yielding cvs Igorota (2.83kg) and Granola (0.45kg). However, this is significantly comparable with cv. Ganza with mean total yield of 7.72 kg. It can be noted that the accessions/cultivars that yielded the highest are the late blight resistant ones. On the other hand, cv. Granola, 285378.27, Igorota, and Alpha which yielded the lowest were the ones infected with late blight at 75 DAT (Table 1) could have affected their tuber yield.



Table 2. Growth and yield of 17 potato accessions grown in Lacaan, Bonglo, Atok.

ACCESSION	PLANT SURV	PLANT HARV	MARKETABLE TUBER		NON-MARKETABLE TUBER		TOTAL TUBER YIELD (kg/5m ² plot)	TUBER YIELD (t/ha)
			#	Weight (kg)	#	Weight (kg)		
1. IP84004.67	100 ^a	100 ^a	101 ^a	6.32 ^{ab}	94 ^a	1.07 ^b	8.38 ^a	23.29 ^a
2. Alchip	93 ^a	82 ^{ab}	44 ^{efghijkl}	5.30 ^{abc}	16 ^{ghij}	0.13 ^{de}	5.43 ^{abcdef}	15.09 ^{abcdef}
3. 384558.10	100 ^a	100 ^a	85 ^{abcde}	5.57 ^{abc}	44 ^{bcdefghi}	0.60 ^{bcde}	5.98 ^{abcd}	16.62 ^{abcd}
4. 720071	98 ^a	90 ^a	70 ^{abcdefg}	4.17 ^{bcde}	51 ^{bcdefgh}	0.42 ^{cde}	4.58 ^{cdefgh}	12.92 ^{cdefgh}
5. 387164.4	75 ^{ab}	75 ^{ab}	54 ^{bcdefghi}	5.38 ^{abc}	23 ^{fg hij}	0.20 ^{de}	5.60 ^{abcde}	15.86 ^{abcde}
6. Alpha	75 ^{ab}	70 ^{abcde}	59 ^{bcdefgh}	3.42 ^{bcdefgh}	31 ^{cdefghij}	0.28 ^{cde}	3.70 ^{defghij}	10.28 ^{defghij}
7. 720097	100 ^a	100 ^a	88 ^{abcd}	5.18 ^{abcd}	61 ^{abcdef}	0.53 ^{bcde}	5.73 ^{abcde}	15.88 ^{abcde}
8. GT	97 ^a	87 ^{ab}	71 ^{abcdef}	3.07 ^{cdefghi}	29 ^{defghij}	0.30 ^{cde}	3.37 ^{defghijk}	9.35 ^{defghijk}
9. 387410.7	100 ^a	97 ^a	91 ^{abc}	7.31 ^a	19 ^{ghij}	0.23 ^{cde}	7.54 ^{abc}	20.94 ^{abc}
10. 285378.27	98 ^a	90 ^a	41 ^{efghijkl}	2.17 ^{efghi}	37 ^{cdefghij}	0.23 ^{cde}	2.40 ^{fghijklm}	6.67 ^{fghijklm}
11. Monona	82 ^{ab}	73 ^{abcd}	45 ^{defghijk}	3.92 ^{bcdef}	28 ^{defghij}	0.40 ^{cde}	4.32 ^{defghi}	12.01 ^{defghi}
12. 523275	100 ^a	100 ^a	81 ^{abcde}	3.70 ^{bcdefgh}	67 ^{abcde}	1.73 ^a	5.43 ^{abcdef}	15.09 ^{abcdef}
13. 380241.17	92 ^a	98 ^a	93 ^{abc}	5.30 ^{abc}	72 ^{abc}	0.73 ^{bcd}	6.03 ^{abcd}	16.76 ^{abcd}
14. 676070	80 ^{ab}	73 ^{abcd}	52 ^{bcdefghij}	2.58 ^{cdefghi}	21 ^{ghij}	0.27 ^{cde}	2.95 ^{defghijklm}	8.19 ^{defghijklm}
15. Ganza	93 ^a	90 ^a	95 ^{ab}	7.30 ^a	44 ^{bcdefghi}	0.42 ^{cde}	7.72 ^{ab}	21.44 ^{ab}
16. Igorota	100 ^a	83 ^{ab}	51 ^{cdefghij}	2.57 ^{cdefghi}	30 ^{defghij}	0.27 ^{cde}	2.83 ^{efghijklm}	7.87 ^{efghijklm}
17. Granola	92 ^a	47 ^{bcdef}	13 ^{ijkl}	0.36 ^j	16 ^{ghij}	0.10 ^{de}	0.45 ^{klm}	1.25 ^{klm}
CV %	22.57	26.62	26.91	23.59	28.65	14.70	25.95	27.88

Yield per Hectare

Result showed significant variation on the yield (tons/ha) among the accessions evaluated (Table 2). Accession IP84007.67 had the highest tuber mean yield of 23.29t/ha significantly out yielding check varieties Granola and Igorota with tuber mean yield of 1.25 and 7.87t/ha respectively. Nevertheless, the mean yield of IP84007.67 is significantly comparable with cv Ganza (21.44 t/ha). On the other hand accessions 387410.7, 380241.17, 384558.10, 720097, 387164.4, Alchip, 523275, 720071, Monona and Alpha had a mean yield of 20.94, 16.76, 16.62, 15.88, 15.86, 15.09, 12.92, 12.01 and 10.28 t/ha respectively significantly out yielded cv Granola. Accessions GT, 676070 and 285378.27 with a mean yield of 9.35, 8.19 and 6.67t/ha were significantly comparable with cvs Igorota and Granola with mean yield of 7.87 and 1.25t/ha respectively.

Tuber Characteristics of Selected Entries

The tuber characteristics of selected accessions are presented in Table 3. The tuber shape varied among the selected accessions. In terms of tuber skin color, most of selected accessions had yellow skin; accessions 720097 and 676070 had pinkish skin; accessions 285378.27 had purple and 380241.17 had white-cream tuber skin color. It was observed that all the selected entries had smooth texture. Likewise tuber flesh color of selected entries varied from light yellow, yellow to deep yellow except for Monona and 380241.17 which had a flesh color, defined as all flesh-yellow while the medulla is cream and cream respectively. Their depth of eyes ranges from shallow to shallow-depth.

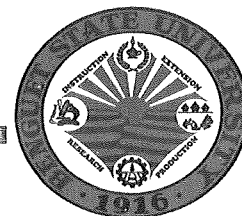


Table 3. Tuber characteristics of selected potato accessions grown in Lacaan, Bonglo, Atok.

ENTRY	TUBER SHAPE	TUBER SKIN COLOR	TUBER TEXTURE	TUBER FLESH COLOR	DEPTH OF EYES
1. IP84004.67	Round	Yellow	Smooth	Yellow	Shallow
2. Alchip	Oval-oblong	Yellow	Smooth	Yellow	Shallow
3. 384558.10	Oval	Yellow	Smooth	Light yellow	Shallow-depth
4. 720071	Oval	Yellow	Smooth	Yellow	Shallow-depth
5. 387164.4	Round-oval	Yellow	Smooth	Yellow	Shallow
6. Alpha	Oval-oblong	Yellow	Smooth	Yellow	Shallow
7. 720097	Obovate-oblong	Pinkish	Smooth	Deep Yellow	Shallow
8. GT	Oblong	Yellow	Smooth	Yellow	Shallow
9. 387410.7	Long-oblong	Yellow	Smooth	Yellow	Shallow-depth
10. 285378.27	Round-oblong	Purple	Smooth	Yellow	Shallow-depth
11. Monona	Round-oblong	Yellow	Smooth	All flesh yellow Medulla-cream	Shallow -depth
12. 523275	Oval-oblong	Yellow	Smooth	Light yellow	Shallow-depth
13. 380241.17	Oval to oblong	White-cream	Smooth	Cream	Shallow - depth
14. 676070	Oval-oblong	Pinkish	Smooth	Yellow	Shallow
15. Igorota	Round-oval	Yellow	Smooth	Pale yellow	Shallow
16. Ganza	Oval-oblong	Cream	Smooth	Pale yellow	Medium
17. Granola	Round	Brown	Smooth	Yellow	Shallow

Dry Matter Content

Dry Matter Content (DMC) of the different accessions/varieties ranges from 16 to 22%. The acceptable dry matter content for processing is 20%. The accessions Monona, 720097, 676070, and the var. Granola which have DMC's lower than 20 (16-18%) would have low chip/fry recovery because of high water content.

Table 4. Dry matter content of selected accessions and check varieties Igorota, Granola and Ganza grown at Lacaan, Bonglo

ACCESSION	DRY MATTER CONTENT (%)
1. IP84004.67	22 ^a
2. Alchip	22 ^a
3. 384558.10	22 ^a
4. 720071	22 ^a
5. 387164.4	20 ^{ab}
6. Alpha	22 ^a
7. 720097	18 ^c
8. GT	22 ^a
9. 387410.7	20 ^{ab}
10. 285378.27	22 ^a
11. Monona	16 ^d
12. 523275	20 ^{ab}
13. 380241.17	20 ^{ab}
14. 676070	18 ^c
15. Ganza (check)	20 ^{ab}
16. Igorota (check)	21 ^b
17. Granola (check)	18 ^c
CV %	3.53



SUMMARY AND CONCLUSION

This study was conducted to determine the growth and yield of 17 accessions in low mountain zone environment grown from apical cuttings to select promising accessions for further evaluation in different agro-ecological zones in Philippine highlands.

Growth and yield varied among accessions. Tuber yield of selected accessions and cvs. Ganza, Igorota and Granola ranged from 1.25 to 23.29 t/ha. Some of the selected accessions such as IP84007.67, 387410.7, 380241.17 and 384258.10 with yield ranging from 16.62 to 23.29 t/ha outyielded cv Igorota but comparable with the yield of cv. Ganza with tuber yield of 21.44 t/ha. The other ten selected accessions outyielded cv. Granola which produced the lowest tuber yield of 1.25 t/ha.

All of the accessions tested and var. Ganza and Igorota have very vigorous growth (rating of 5). Only check variety Granola showed less vigorous growth with rating of 3 (vigorous). Their reaction to late blight differed from resistant to moderately susceptible at 75DAT. Eight of the accessions and the variety Ganza were resistant to late blight (rating of 1) even at 75 DAT while six accessions and the check varieties Igorota and Granola were infected with late blight. Variety Granola was severely infected or highly susceptible to LB having a rating of 9.

Most of the farmers selected the accessions based on the tuber quality and yield. Purple, pinkish and red skin and tuber shape of long-oblong was rejected by most of the farmers due to non-acceptability by consumers. Some farmers selected accessions with tuber skin color of purple and pinkish for home consumption production due to their perception of having good taste.

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