EVALUATION OF POTATO GENOTYPES GROWN FROM ROOTED STEM CUTTINGS UNDER MID-MOUNTAIN ZONE

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ABSTRACT

Rooted stem cuttings of six Potato genotypes; 5.19.2.2, 380241.17, 573275, 676070, 2.21.6.2, and MLUSA, and check varieties Granola and Igorota were evaluated for yield in mid-mountain zones.

It was observed that there were significant differences on plant survival, height, and weight of marketable tubers. Genotype 676070 had the highest plant survival of 100%, and Granola had the lowest survival of only 76%. Genotype 5.19.2.2 were the tallest plants at 75 DAP (28.45 cm). Genotype 380241.17 produced the highest marketable tuber weight (4.76kg/5m^2) with highest computed yield of 22.36t/ha, and the highest profit. Genotypes 5.19.2.2, and 2.21.6.2 produced comparable yield of 8.83t/ha and 8.2t/ha respectively. Granola produced the lowest yield and negative profit.

Genotype 380241.17, 5.19.2.2, and 2.21.6.2 grown from rooted cuttings are favorable in mid-mountain zone.

KEYWORDS: potato genotypes, rooted stem cutting, potato genotype evaluation, mid-mountain zone

INTRODUCTION

Potato is one of the cash crops grown by farmers in the Cordillera particularly in Benguet and Mountain Province. This crop has great importance in the business industry. Aside from the fact that potatoes contain high nutritive value, potato production has always been a source of cash income for the vegetable farmers in the highlands of Benguet and Mountain Province of the Philippines.

The demand for potatoes continues to increase due to rapid urbanization and because of the increasing demand for processed potato by fast food chains and snack industry in the country. Hence, selection of adaptable potato cultivars and healthy planting materials become critical (FRLD, 1985).

Seed supply is one of the problems of potato growers in the highlands. Producing quality potato seeds entail high cost coupled with the problem of seed borne diseases. Seed cost contributes more or less fifty percent of the production cost. To cope with the problem on tuber seeds, alternative planting materials is then suggested. Rooted stem cutting is the most economic planting material since it can rapidly multiply planting materials for faster selection of new cultivars and prevents the occurrence of tuber borne diseases (Escobar and Vander Zaag, 1985). Using rooted stem cuttings to produce potato seed tuber minimize seed borne-diseases. As reported by Bryan *et al.*, (1981) as cited by Tad-awan *et al.* (2008), there is a high potential of using rooted stem cuttings for potato production because rooted stem cuttings limits contact with tuber and soil – borne diseases such as potato rot (*Pecttobacterium* sp.), black scurf (*Rhizoctonia solani*), wart (*Syn chytrium*) and nematode disease (*Globodera rostochiensis*).

Proper management is necessary to increase yield, however wrong choice of variety leads to low yield hence selection of appropriate cultivars, high yielding, and adaptable to the locality is important in potato production. Likewise, proper selection of planting materials is important for a successful potato production and for increasing productivity and sustainability. Seed tubers are also costly and seed multiplication is very slow delaying the selection process in variety evaluation.

This study aims to evaluate the different potato genotypes grown from rooted stem cuttings and to

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identify high yielding genotypes under mid-mountain zone.

MATERIALS AND METHODS

An area of 130 m^2 was properly prepared before planting. The area was divided into 3 blocks. Each block composed of eight plots measuring 1m x 5m and each plot was planted with rooted stem cuttings of one potato genotype.

Rooted stem cuttings of six potato genotypes and cvs. Granola and Igorota were acquired from the Northern Philippine Root Crops and Research and Training Center (NPRCRTC). The different treatments were equally applied with a handful of chicken manure per hill together with ½ of the recommended rate of inorganic fertilizer (140-140-140 kg N-P2O5-K2O/ ha) applied as basal five days prior to planting. The remaining ½ of the recommended inorganic fertilizer were applied as side dress during hilling-up 30 days after transplanting. The potato stem cuttings were planted at a distance of 30cm × 25cm between hills and rows. The experiment was laid out following the Randomized Complete Block Design (RCBD) with three replications.

The treatments were as follows:

TREATMENT	GENOTYPE CODE	LOCALITY OF LOCATION
T1	5.19.2.2	Philippines
T2	380241.17	CIP
T3	573275	CIP
T4	676070	CIP
T5	2.21.6.2	Philippines
T6	MLUSA-3	Mainland USA
T9	Granola (Check)	CIP
T10	Igorota(Check)	Philippines

Cultural management such as hilling-up, irrigation, weeding, and spraying of insecticides and fungicides were equally employed as needed. At harvest, 500g of small to extra big tubers were taken per genotype for dry matter content analysis.

The data gathered were:

1. ***Percentage Survival (%).*** The plants that survived 30 days after transplanting (DAT) were noted and plant survival was computed using the formula:

$$\% \text{ Survival} = \frac{\text{Number of plants survived}}{\text{Total number of plants planted}} \times 100$$

2. ***Plant Vigor.*** This was taken one month DAT using the following rating scale 1-5 by Palomar and Sanico (1994).

RATING	DESCRIPTION
1	Very poor
3	Moderately vigorous
5	Highly vigorous

3. ***Initial plant height (cm).*** 30 DAT, initial plant height was measured from the base to the tip of the longest shoots of ten random sample plants.

4. ***Final plant height (cm).*** Final height of the plant was measured at maturity from the base to the tip of the longest shoot of ten sample plants that was taken at random.

5. ***Late blight incidence.*** This was observed and recorded 30, 45, and 60 DAT using the CIP Scale (Henfling, 1987).

(see next page of the Table 1...)

6. Number and weight of marketable tubers/ plot (kg). All tubers that were of marketable size, not malformed, free from cuts, cracks and with less than 10% greening of the total surface were counted and weighed at harvest.

7. Number and weight of non-marketable tubers/plot (kg). These were the tubers that were malformed, damaged by pest and disease, and those with more than 10% greening.

8. Total yield per plot (kg). The sum of the weight of marketable and non-marketable tubers were counted and weighed.

9. Computed yield (tons/ha). This was computed in hectare basis using the formula:

$$\text{Yield (tons/ha)} = \frac{\text{Total yield/plot} \times 10,000}{\text{Plot size (m2)}}$$

10. Return of Cash on Expense (ROCE). This was computed by dividing the net profit over the total cost of production multiplied by 100.

$$\text{ROCE} = \frac{\text{Net profit}}{\text{Total cost of production}} \times 100$$

11. Dry matter content (DMC). Tubers were weighed into fifty grams per sample. Sliced into cubes, and oven dried at 80°C for 72 hours. This was recorded and computed using the following formula:

Table 1. CIP Scale by Henfling (1987)

CIP SCALE VALUE	BLIGHT (%) MEAN	LIMITS	SYMPTOMS*
1	0		No late blight observable
2	2.5	Traces - < 5	Late blight present. Maximum 10 lesions per plant
3	10	5 - < 15	Plants look healthy, but lesions are easily seen at closer distance. Maximum foliage area affected by lesions or destroyed corresponds to no more than 20 leaflets.
4	25	15 -< 35	Late blight easily seen on most plants. About 25% of foliages is covered with lesions or destroyed.
5	50	35 -< 65	Plot looks green; however, all plants are affected. Lower leaves are dead. About half the foliage area is destroyed.
6	75	65 -< 85	Plots look green with brown flecks. About 75% of each plant is affected. Leaves of the lower half of plants are destroyed.
7	90	85 -< 95	Plot neither predominantly green nor brown. Only top leaves are green. Many stems have large lesions.
8	97.5	95 - < 100	Plot is brown-colored. A few top leaves still have some green areas. Most stems have lesions or are dead.
9	100		All leaves and stem dead

**The description of symptoms is based on plants with 4 stems and 10 to 12 leaves per stem.*

$$\% \text{ Moisture Content (MC)} = \frac{\text{Fresh weight} - \text{Over dry weight}}{\text{Fresh Weight}} \times 100$$

% Dry matter content (DMC) = 100% - %MC

Analysis of data

All quantitative data was analyzed through analysis of variance (ANOVA) for randomized complete block design (RCBD) with three replication. Significance of difference among the treatment means was tested using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Percent Survival

As shown in Table 2, significant differences were observed on percentage survival of the six potato genotypes and cvs. Granola and Igorota grown from rooted stem cuttings. Percent survival of 76-100% was recorded. Highest percent survival of 100% was observed from genotype 676070, however it did not differ from genotype; 5.19.22, 380241.17, and 2.21.6.2, all the four potato genotype have comparable percent survival. Lowest percent survival of 76% was observed from cv. Granola but did not differ with MLUSA-3 that had a percent survival of 80%.

Table 2. Survival (%) of potato genotypes grown from rooted stem cuttings

GENOTYPES	SURVIVAL (%)*
5.19.2.2	98[a]
380241.17	98[a]
573275	89[b]
676070	100[a]
2.21.6.2	98[a]
MLUSA-3	80[c]
Granola (check)	76[c]
Igorota (check)	88[b]
CV (%)	4.41

**Means with the same letter are not significantly different at 5% level by DMRT.*

Plant vigor

Plant vigor were observed to be comparable among the genotypes and check varieties 30 days after planting All the potato genotypes and the two check varieties were rated moderately vigorous. At 45 days after planting all the potato genotypes and the check varieties Granola and Igorota were comparable in vigor. All the tested genotypes and varieties were rated moderately vigorous no differences were observed.

Late Blight Incidence

Late blight Resistance of the different potato genotypes and the two check varieties were rated 1-2 at 45 days after planting. As shown in Table 4, most of the potato genotypes were rated highly resistant except genotypes MLUSA-3, 676070 and Granola which were resistant. At 60 days after transplanting, genotypes 380241.17, 2.21.6.2, and MLUSA-3 exhibited high resistance to late blight while the other genotypes were resistant. The two check varieties Granola and Igorata were moderately resistant to late blight which is comparable with genotypes: 5.19.2.2, 573275, 676070. It can be noted that genotype 380241.17

Table 3. Plant vigor of potato genotypes grown from rooted stem cuttings at 30 and 45 DAT

GENOTYPES	DAYS AFTER TRANSPLANTING	
	30	45
5.19.2.2	3	3
380241.17	3	3
573275	3	3
2.21.6.2	3	3
676070	3	3
MLUSA-3	3	2
Ganza	3	3
Solibao	3	3
Granola (check)	3	3
Igorota (check)	3	3

Vigor Rating (Scale): 1–very poor; 2–less vigorous; 3–vigorous; 4–moderately vigorous; 5–highly vigorous

Table 4. Late blight incidence in potato genotypes grown from rooted stem cuttings at 45 and 60 DAT

GENOTYPES	LATE BLIGHT RATING DAYS AFTER TRANSPLANTING	
	45	60
5.19.2.2	1	2
380241.17	1	1
573275	1	2
676070	2	2
2.21.6.2	1	1
MLUSA-3	2	1
Granola (check)	2	2
Igorota (check)	1	2

Rating Scale: 1 –highly resistant; 2 – 3 – resistant; 4 – 5 – moderately resistant; 6 – 7 - moderately susceptible; 8 – 9 – susceptible

and 2.21.6.2 exhibited highly resistant reaction to late blight at 60 days after transplanting. Other genotypes 5.19.2.2, 573275 were highly resistant to late blight at 45 days after transplanting, however at 60 days after transplanting these exhibited resistance to late blight. MLUSA-3 was resistant to late blight at 45 days after transplanting but became highly resistant at 60 days after transplanting, and genotype 676070 was observed to be only resistant to late blight in both observation periods. Granola was resistant to late blight at 45 and 60 days after transplanting and Igorota was highly resistant to late blight at 45 days after transplanting but exhibited to be only resistant at 60 days after transplanting.

Initial and final plant height

Result showed that the plant height of the different genotypes and check varieties significantly varies (Table 5). Genotype 5.19.2.2 significantly had the tallest for the recorded initial and final height followed by MLUSA-3 and 2.21.6.2 respectively for the initial and final height measured. The shortest was cv. Granola for the initial and final height. The significant differences on the plant initial and final height of the different genotypes could be due to their genetic characteristics as affected by the photoperiod.

Table 5. Initial and final height (cm) of potato genotypes grown from rooted stem cuttings

GENOTYPES	HEIGHT (cm)*	
	INITIAL	FINAL
5.19.2.2	13.21^{a}	28.45^{a}
380241.17	12.30^{b}	22.36^{bc}
573275	10.19^{c}	20.90^{c}
676070	12.35^{b}	20.65^{c}
2.21.6.2	10.17^{c}	23.02^{b}
MLUSA-3	13.09^{a}	23.65^{b}
Granola (check)	11.68^{bc}	19.06^{d}
Igorota (check)	11.22^{bc}	20.92^{c}
CV (%)	7.07	1.86

**Means within a column with the same letter are not significantly different at 5% level by DMRT.*

Number and weight of Marketable Tubers

Significant differences were noted on the marketable tubers produced by the different potato genotypes and check varieties (Table 6). Potato genotypes 2.21.6.2, (was the numerous followed by genotype) 380241.17, and 5.19.2.2 produced comparable number of tubers of 129,120, and 105 tubers, respectively. It can be noted that the cv Granola produced the lowest tuber numbers of only 15.

It can be further noted that the weight of marketable tubers produced were significant. Potato genotype 380241.17 produced the heaviest tubers of 4.76 kg/5m^2, however this is comparable with the tubers produced by genotype 5.19.2.2. (3.78 kg/5m^2). The least for the marketable weight was realized from cv. Granola with the weight of 0.26 kilo/5m^2. This yield weight differences was considered as the effect of the tuber size differences.

Table 6. Number and weight (kg/5m²) of marketable potato tubers grown from rooted stem cuttings

GENOTYPES	MARKETABLE TUBERS (kg/ 5m²)	
	NUMBER	WEIGHT
5.19.2.2	105[a]	3.78[ab]
380241.17	120[b]	4.76[a]
573275	49[g]	1.93[c]
676070	117[bc]	3.025[b]
2.21.6.2	129[a]	3.42[b]
MLUSA-3	94[e]	2.65[bc]
Granola (check)	15[i]	0.26[d]
Igorota (check)	91[f]	3.13[b]
CV (%)	26.29	20.41

**Means within a column with the same letter are not significantly different at 5% level by DMRT.*

Number and weight of Non-marketable Potato Tubers

Table 7 shows the number and weight of non-marketable tubers. Genotype MLUSA-3 consistently produced the highest number and weight of non-marketable tubers out of six potato genotypes and two check varieties evaluated. The least was noted from check variety Granola.

Table 7. Number and weight (kg) of non-marketable potato tubers grown from rooted stem cuttings

GENOTYPES	NON-MARKETABLE TUBERS (kg/5m²)	
	NUMBER	WEIGHT
5.19.2.2	55[b]	0.59[ab]
380241.17	32[b]	0.35[bc]
573275	58[b]	0.42[bc]
676070	51[b]	0.45[bc]
2.21.6.2	102[a]	0.61[ab]
MLUSA-3	135[a]	0.90[a]
Granola (check)	50[b]	0.22[c]
Igorota (check)	42[b]	0.45[bc]
CV (%)	21.58	23.02

**Means within a column with the same letter are not significantly different at 5% level by DMRT.*

Total and computed yield

Significant differences on the total and computed yield were observed among the potato entries (Table 8). Genotype 380241.17 produced the heaviest total yield of 5.08kg/5m² and computed yield of 10.16tons/ha, but was comparable with the yield of 8.83, and 8.20tons/ha, respectively. These three genotypes outyielded the check variety Igorota. All of the potato genotypes outyielded check variety Granola which is one of the common variety planted in the area.

The low yield produced by the other genotypes could be due to their non-suitability or the unfavorable conditions during the conduct of the study.

Table 8. Total and computed tuber yield of potato genotypes grown from rooted stem cuttings

GENOTYPES	TOTAL YIELD (kg/5m²)	COMPUTED YIELD (tons/ha)
5.19.2.2	4.92[ab]	8.83[ab]
380241.17	5.08[ab]	10.16[a]
573275	2.35[c]	4.70[c]
676070	3.44[bc]	6.87[b]
2.21.6.2	4.03[ab]	8.20[ab]
MLUSA-3	3.48[bc]	6.97[b]
Granola (check)	0.47[d]	0.93[d]
Igorota (check)	3.58[b]	7.17[b]
CV (%)	18.59	18.38

**Means within a column with the same letter are not significantly different at 5% level by DMRT*

Return on Cash Expense

Cash expense of potato entries is shown in (Table 9). Genotype 380241.17 had the highest ROCE of 56.24% followed by Genotypes 5.19.2.2 and 2.21.6.2 with their ROCE of 23.18 and 12.23%, respectively. These results indicate that the Genotypes with the highest yield also gained the highest profit.

Dry Matter Content

Highly significant differences among the entries were observed in terms of percent dry matter content (Table 10). Genotypes 573275 and 5.19.2.2 had the highest dry matter content of tubers with identical mean dry matter content of 22% while genotype MLUSA-3 had the lowest dry matter content of 18%. The percent dry matter content indicates the soluble solid that comprises the tubers which is a very important composition of potatoes. It is mainly determined genetically and is dependent on the variety

Table 9. Return on cash expense of potato genotypes grown from rooted stem cuttings

GENOTYPES	COST OF PRODUCTION (Php)	MARKETABLE TUBERS (kg/5m2)	GROSS SALE (Php)	NET INCOME (Php)	ROCE
5.19.2.2	274	11.25	337	63.50	23.18
380241.17	274	14.27	428.10	154.10	56.24
573275	274	5.78	173.40	-100.6	-36.71
676070	274	9.18	275.40	1.40	0.51
2.21.6.2	274	10.25	307.50	33.50	12.23
MLUSA-3	274	7.95	238.50	-35.5	-12.96
Granola (check)	274	0.78	23.40	-250.6	-91.46
Igorota (check)	274	9.4	282.00	8.00	2.92

** Total cost of production includes cost of planting materials, insecticides, fertilizers and labor.*

** Selling price of potato tubers was based at Php30.00 per kilo for seed purposes.*

Table 10. Dry matter content of six potato genotypes and cvs. Granola and Igorota entries

ENTRY	DRY MATTER CONTENT(%)
5.19.2.2	22[a]
380241.17	21[ab]
573275	22[a]
676070	19[bc]
2.21.6.2	21[ab]
MLUSA-3	18[c]
Granola	20[b]
Igorota	20[b]
CV (%)	4.42

**Means with the same letter are not significantly different at 5% level by DMRT.*

(Hartman and Vanes, 1974). The differences in the dry matter content of potato tubers of the different genotypes and check varieties Granola and Igorota could be attributed to their genotypic characteristics.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study was conducted to evaluate the different potato genotypes and check varieties Granola and Igorota grown from rooted stem cuttings and to identify the highest yielding entries grown from rooted stem cuttings under mid-mountain zone. This was conducted on October 2007 to January 2008.

Results showed that majority of the genotypes had significantly higher plant survival compared to Granola. All the potato genotypes were vigorous except for genotype MLUSA-3 that was less vigorous at 45 DAP.

On tuber yield performance, all the potato genotypes outyielded the check variety Granola. Highest tuber yielded was gathered from genotype 380.241.17 followed by 5.19.2.2 and 2.21.6.2. These three genotypes even outyielded check variety Igorota. Genotype 380241.17 which had the highest computed tuber yield also gained the highest ROCE.

On the other hand, genotypes 5.19.2.2 which had the second highest fresh tuber yield showed a significantly highest percent dry matter content together with 573275 MLUSA -3 had the lowest.

Conclusion

There are some genotypes which can be adapted to the mid-mountain zone. Genotype 380241.17 is best among the six genotypes tested. This genotype yielded the highest and consequently the ROCE. Genotypes 5.19.2.2 and 573275 are also suited for this zone as shown by their high tuber yields.

These three genotypes even outyielded the check varieties Igorota and Granola.

Recommendation

Findings indicated that Genotype 380241.17

is recommended for mid-mountain zone. his genotype had the highest computed yield per hectare resulting to a high ROCE. Hence, this variety is recommended for potato growers in the mid-mountain zone.

Genotypes 5.19.2.2 and 2.21.6.2 are also recommended for this zone, considering that they gave comparable yield to the highest yielder (380241.17) and for being resistant to late blight.

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