

BIBLIOGRAPHY

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ABSTRACT

The study was conducted to determine the highest yielding and resistant potato entries determine the effect of location on the growth and yield of the potato entries; determine the interaction of potato entries and location; and determine the profitability of growing potatoes at Mankayan and Atok, Benguet.

Based on the results, Bonglo, Atok is the best site for potato production due to the high yield and positive ROCE obtained from the potato entries. Among the potato entries, Tawid, 676070, 2.21.6.2 and Igorota (check) were the best performing entries due to high yield, wide canopy and ROCE.

On other hand, potatoes harvested at Cada, Mankayan had the lowest yield and negative ROCE except entry 2.21.6.2 that obtained high yield and ROCE. Further evaluation of the potato entries should be conducted in different planting months to determine the stability and adaptability of the plants to different production sites.



INTRODUCTION

Potato (*Solanum tuberosum L.*) is one of the primary crops grown in Northern Luzon Provinces and serves as a major source of income among farmers in Benguet and in some municipalities of Mountain Province (NPRCRTC, 1998).

At present, farmers in Benguet commonly grow one variety of potato namely “granola” every year. As a result, the variety becomes more prone to pest and diseases such as late blight and leaf miner (Perez *et al.*, 2006) leading to much economic loss.

This scenario necessitates selection of other potato varieties which are high yielding, early maturing and provides higher profit to farmers. Furthermore, evaluation of different potato varieties may provide a wide range of traits which could guide farmers to select their preferred varieties (Baidu-Forson, 1997).

Evaluation and introduction of suitable potato varieties for a particular locality is also an important aspect in increasing yield. Varietal evaluation in multi-elevations is one way of assessing the performance of different varieties suited to a particular place (Baidu-Forson, 1997).

The study was conducted to:

1. identify the highest yielding and resistant potato entries at Atok and Mankayan, Benguet;
2. determine the effect of location on the growth and yield of the potato entries;
3. determine the interaction of potato entries and location; and
4. determine the profitability of growing potatoes at Mankayan and Atok, Benguet.

This study was conducted at Atok and Mankayan, Benguet from November 2010 until February 2011.



REVIEW OF LITERATURE

The Plant

Potato (*Solanum tuberosum* L.) is usually grown at higher elevations such as northern Luzon provinces and cultivated by planting tubers. Purity of the cultivars, healthy seed tubers, selection of resistant varieties and a good crop performance over a wide geographic region under variable climatic and environmental conditions are the primary requirements for a successful crop (Singh, 1999).

Varietal Evaluation

Varietal evaluation is ultimately measured in terms of variety that passed the evaluation process by the end users. Varietal trial can be done indirectly by assessing available the product and characteristics perceived to be relevant evaluation objective (Gonzales *et al.*, 2004).

Many of the agricultural experiment station conducting varietal evaluation of economical crops recommended those that appears to be the best ,but the farmers needs to test those recommended varieties in order to determine if they are adaptable in the particular area or condition (Bay an, 2001).

Importance of Elevation in Potato Production

Production system in temperate and high elevations, particularly over 2,000 meters, is more common with each other than with lowland production systems. For example, temperate and high elevation areas have cold winters, so farmers usually grow potatoes in summer. Lowland zones have hot summers, so farmers usually grow potatoes in the winter. In mid-elevation and Mediterranean zones, farmers grow potatoes at various time of the



year, depending on the climate and market conditions. Storage is easier in temperate and highland zones, where potatoes are harvested at the beginning of the season (Horton, 1987).

Fertilizer Application and Hilling Up

New selected varieties have greater yield compared to a variety that reached fourth generation. Using chicken dung and complete fertilizers like 14-14-14 increase yield in new varieties than the old ones. To maintain new varieties to produce higher yield, proper fertilization should be based on soil analysis. Too much nutrient application delays maturity, promotes skinning and black spot bruising. In an area where bacterial wilt is a problem, early hilling up is necessary to prevent root injury (Vergara, 1991).

Soil and Climate Requirements

Potato can be grown to almost any type of soil except saline soil and alkaline soil. The most preferred are loose soils which offer least resistance to the enlargement of the tubers; loamy and sandy loam soils high in organic matter with good drainage and aeration are most suitable for cultivation. The soil pH range of 5.2 to 6.4 is ideal. Although a temperate crop, potato can also be grown in a wide range of climatic conditions depending on the variety. It grows best with an average relative humidity of 86%. The vegetative growth of the plant is best at temperature of 20 to 24 degrees Celsius while tuber development is favored at 20 degree Celsius (NPRCRTC, 1998).

In areas such as Benguet, the months of March to April and October to November are the best month for planting time but from June to September are not preferable because its rainy season where that due to the presence of too much moisture and high relative humidity occurrence of late blight is favorable (Perez, 2008).



Multi-Location Trials

The climate which involves temperature, moisture, and light is the summation of condition in a location. These can determine when, where, and what plants will grow. Some varieties of potato are adaptable and thus profitable and other varieties, which are non-adaptable to the area's conditions, are relatively unprofitable to the needs of the farmers (Bang-as, 1999).

At present, most farmers in Benguet commonly grow the Granola cultivar. The farmers prefer this variety because it is adaptable to wet and dry cropping seasons and warm and cold weather conditions (Ayangdan, 1998).



MATERIALS AND METHODS

Land Preparation

An area of 150 m² in Atok and Mankayan was thoroughly prepared before planting and divided into three blocks which corresponds to eight plots (Figure 1). Each block was divided into eight plots measuring 1m x 5m each.

The following treatments were:

LOCATION (L)

<u>Code</u>	<u>LOCATION</u>
L1	Atok
L2	Mankayan

POTATO ENTRY (E)

<u>Code</u>	<u>ENTRY (E)</u>
E1	Tawid
E2	Watwat
E3	676070
E4	2.21.6.2
E5	Omega
E6	Jelly
E7	Eurotango
E8	Igorota(Check)



Experiment Layout

The experiment was laid out following the Randomized Complete Block Design (RCBD) with three replications in each location.

Planting Materials and Management Practices

The potato seed tubers with equal length of sprouts were planted at a distance of 30cm x 30cm between hills and rows at a depth of 2 inches. Other cultural management practices such as hilling-up (Figure 2), fertilizer application, pest control, etc. were equally done on both sites.

Data Gathered

1. Temperature, relative humidity and rainfall. This data was taken every two weeks after planting. Temperature and relative humidity was taken using a digital psychrometer. Rainfall amount was taken by placing three cans within the field to collect water when precipitations occur. The volume of water collected was measured using a graduated cylinder. Rainfall was recorded getting the average volume of water from the three cans.

2. Percentage survival. This was taken by counting the numbers of plants that survived 30 and 75 days after planting using the following formula:

$$\% \text{ survival} = \frac{\text{Total Number of Plants Survived}}{\text{Total Number of Tubers Planted}} \times 100$$

Per Plot

3. Initial plant height (cm). Initial plant height was taken by measuring ten samples from the base to the tip of the longest shoots one week after hilling up.

4. Plant vigor. This was recorded at 30 and 75 days after planting using the CIP rating scale (Gonzales *et al.*, 2004):



<u>Rating</u>	<u>Description</u>
1	Very poor vigor
2	Poor vigorous
3	Moderate vigorous
4	Vigorous
5	Highly vigorous

5. Final height (cm). Ten sample plants per plot were measured from the base to the tip of the plant one week before harvest.

6. Canopy cover. This was gathered 30 days after planting and one week before harvesting using a wooden frame which measured 120cm x 60cm with equal-sized grids of 12cm x 6cm (CIP, 2000).

7. Leaf miner infestation. This was observed at 30, 45 and 60 DAP using the following scale (CIP, 2000).

<u>Scale</u>	<u>Description</u>	<u>Remarks</u>
1	less infested (1-20 %)	highly resistant
2	infested	moderately resistant
3	moderately infested (41-60%)	intermediate
4	severely infested	moderate susceptibility
5	most serious	susceptible

8. Late blight infection. Rating was done at 30, 45 and 60 DAP using the CIP rating scale (Henfling, 1987):



Late Blight (%)	CIP scale	Description of corresponding symptoms
0	1	No late blight observed.
Trace <5	2	Late blight present. Maximum 10 lesions per plant.
5-<25	3	Plants look healthy, but lesions are easily seen at a closer distance. Maximum foliage area is affected by lesions or destroyed. It corresponds to no more than 20 leaflets.
15-<35	4	Late blight is easily seen on most plants. About 25% of foliage is covered with lesions
35-<65	5	Treatments look green; however all plants are affected leaves are dead. About half the foliage is destroyed.
65-<85	6	Treatments look green with brown flecks. About 75% of each plant is affected. Leaves of the lower half of the plants are destroyed.
85-<95	7	Treatments are neither predominantly green nor brown. Only top leaves are green. Many have large lesions.
95-, 100	8	Treatments are brown-colored. A few top leaves still have green areas. Most stems have lesions or are dead.
100	9	All leaves and stems are dead.

Descriptions: 1= highly resistant; 2-3 = resistant; 4-5 = moderately resistant; 6-7 = moderately susceptible; 8-9 = susceptible

9. Number and weight of marketable tubers (kg/ 5m²). The tubers that were extra large to marble sized, not malformed and free from natural cracks and with no more than 10% greening of the total surface at harvest was counted and weighed.

10. Number and weight of non-marketable tubers (kg/ 5m²). This was obtained by counting and weighing all tubers that had natural cracks, malformed and damaged by pest and diseases.

11. Total yield per plot (kg/ 5m²).. This was the sum of the weight of marketable and non-marketable tubers per plot.



12. Dry matter content (DMC). This was obtained by slicing each sample tubers of every entry weighing 30g (fresh weight) and oven dried in 24 hours at 80 degrees Celsius. This dry matter content was computed using the formula:

$$\% \text{ Moisture content (MC)} = \frac{\text{Fresh Weight} - \text{Oven Dry Weight}}{\text{Fresh Weight}} \times 100$$

$$\% \text{ Dry matter content} = 100\% - \text{MC}$$

13. Computed yield (ton/ha). This was obtained by using the formula:

$$\text{Yield (ton/ha)} = \frac{\text{Total yield per plot}}{10,000 \text{ m square/Plot Size (5 m}^2\text{)}} \times 100$$

14. Return on Cash Expense (ROCE). This was computed using the formula:

$$\text{ROCE} = \frac{\text{Net Income}}{\text{Total Cost of Production}} \times 100$$

Data Analysis

All quantitative data were analyzed using the Analysis of Variance for Randomized Complete Block Design with three replications. The significance of differences among the treatment means was determined using the Duncan's Multiple Range Test (DMRT) at 5% level of significance.





a. Bonglo, Atok



b. Cada, Mankayan

Figure 1. Overview of potato entries at 75 DAP



Figure 2. Hilling up of plots at 30 DAP

RESULTS AND DISCUSSION

Meteorological Data

Table 1 shows the temperature, relative humidity, and rainfall at Bonglo, Atok and Cada, Mankayan from November to February 2011. The temperature in Bonglo, Atok ranged from 18 °C to 22 °C while the temperature at Cada, Mankayan was 16 °C to 21 °C. Relative humidity was observed to be at 64% to 82% at Bonglo, Atok and 65% to 85% at Cada, Mankayan. Rainfall amount of 11 ml to 293 ml was recorded at Bonglo, Atok in the months of November to February while at Cada, Mankayan rainfall amount was 3 ml to 99ml.

The temperature and relative humidity during the conduct of the study was observed to be favorable for the growth and development of potatoes in Cada, Mankayan and Bonglo, Atok but not during the months of December and January. The best temperature for potato production is from 20 to 24 °C with an average relative humidity of 86% (NPRCTC, 1998). Large volume of rainfall was gathered in Bonglo, Atok during the months of December and January. Too much rainfall is not preferable for potatoes because of the occurrence of late blight (Perez, 2008).

Plant Survival

Effect of location. No significant differences were observed on the plant survival of the potato plants grown at Cada, Mankayan and Bonglo, Atok due to the prevailing favorable climatic condition during the first two months of growth. However at 75 DAP, plant survival decreased in both locations (Table 2).



Table 1. Air temperature (T°), relative humidity (RH) and rainfall (RF) at Bonglo, Atok and Cada, Mankayan, Benguet during the conduct of the study

MONTH	BONGLO, ATOK			CADA, MANKAYAN		
	T° (°C)	RH (%)	RF (ml)	T° (°C)	RH (%)	RF (ml)
November	21	82	138	21	65	83
December	19	80	225	20	85	87
January	18	64	293	16	68	99
February	22	65	11	20	67	3

Effect of entry. There were significant differences observed on the plant survival of the eight potato entries grown (Table 2). Most of the entries had 100% plant survival except Jelly and Eurotango at 30 DAP. At 75 DAP, entries 2.21.6.2, Igorota and 676070 had the highest survival while Eurotango had the lowest. The differences in plant survival of the different entries might be attributed to its genetic characteristics.

Interaction effect. No significant interaction was observed between the potato entries and locations on plant survival at 30 DAP. Significant interaction, however was observed on plant survival at 75 DAP (Figure 3). Entries, Omega, Jelly, and Eurotango planted at Bonglo, Atok and Cada Mankayan have the lowest plant survival. This result may be attributed to the high amount of rainfall in the sites. Entry 2.21.6.2 grown in either location had the highest plant survival which may translate to high yield.



Table 2. Plant survival at 30 and 75 days after planting (DAP) of the different potato entries grown in two locations of Benguet

TREATMENT	PLANT SURVIVAL (%)	
	30 DAP	75 DAP
<u>LOCATION (A)</u>		
Bonglo, Atok	99	66
Cada, Mankayan	100	66
<u>ENTRY (B)</u>		
TAWID	100 ^a	69 ^{bc}
WATWAT	100 ^a	74 ^{bc}
676070	100 ^a	85 ^{abc}
2.21.6.2	100 ^a	93 ^a
OMEGA	100 ^a	67 ^c
JELLY	99 ^b	32 ^d
EUROTANGGO	98 ^b	25 ^d
IGOROTA	100 ^a	86 ^{ab}
A X B	ns	**
CV (%)	1.43	14.71

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



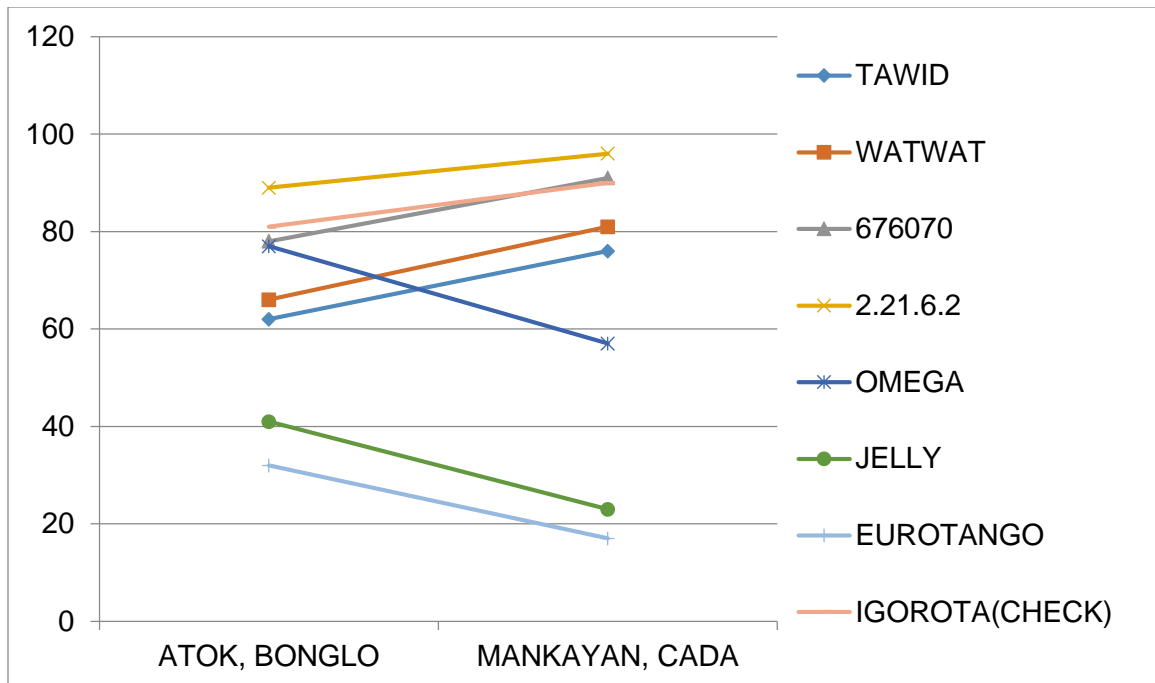


Figure 3. Plant survival at 75 days after planting (DAP) of the different potato entries grown in two locations of Benguet

Plant Height

Effect of locations. Table 3 shows the height of potato entries grown across locations at 30 and 75 DAP. Highly significant differences were observed on the height of potato plants grown in Bonglo, Atok and Cada, Mankayan at 30 DAP. Potatoes grown at Cada, Mankayan were the shortest at 5.64 cm at 30 DAP and the tallest plants at 47.94 cm at 75 DAP. The result may be due to favorable conditions in the area.

Effect of entries. No significant differences were observed on the plant height of the entries at 30 DAP but highly significant differences were observed at 75 DAP. Potato entries at 30 DAP had varying heights ranging from 5 to 6 cm. At 75 DAP, entry 2.21.6.2 were the tallest plants. This result may indicate adaptability to the environmental conditions in the area.



Interaction effect. No significant interaction was observed between the entries and locations on plant height at 30 and 75 DAP. The potato entries 2.21.6.2 and Igorota planted in Cada, Mankayan at 75 DAP were the tallest among all the entries.

Plant Vigor

Effect of locations. There were no significant differences observed on the plant vigor of potato plants grown at Bonglo, Atok and Cada, Mankayan at 30 and 75 DAP (Table 4). The potato entries evaluated at Bonglo, Atok and Cada, Mankayan had moderate to highly vigorous growth.

Effect of entries. Most of the potato entries remained vigorous to highly vigorous except Jelly and Eurotango at 30 and 75 DAP (Table 4). The highly significant differences observed on plant vigor might be attributed to the genetic characteristics of the entries and may indicate resistance to pest.

Interaction effect. No significant interaction was observed on plant vigor at 30 to 75 DAP of potato entries grown in two locations of Benguet.



Table 3. Initial and final height of different potato entries grown into two locations of Benguet

TREATMENT	HEIGHT (cm)	
	30 DAP	75 DAP
<u>LOCATION (A)</u>		
Bonglo, Atok	6.33 ^a	46.85
Cada, Mankayan	5.64 ^b	47.94
<u>ENTRY (B)</u>		
TAWID	5.70	49.55
WATWAT	5.73	48.47
676070	6.28	52.63
2.21.6.2	6.40	56.64
OMEGA	5.67	45.13
JELLY	6.14	36.68
EUROTANGGO	5.75	35.29
IGOROTA	6.22	54.77
A X B	ns	ns
CV (%)	8.34	10.56

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

Canopy Cover

Effect of locations. There were highly significant differences observed on the canopy cover of potato plants at Bonglo, Atok and Cada, Mankayan at 30 to 75 days after planting (Table 5). The potato entries grown at Bonglo, Atok had a wider canopy cover than those that were evaluated at Cada, Mankayan. This wider canopy cover may be due to the favorable temperature at Bonglo, Atok which was within the required temperature



of 17°C to 22°C for growing potatoes. Canopy cover is usually correlated to resistance to disease and high yield.

Table 4. Plant vigor at 30 and 75 days after planting of different potato entries grown in two locations of Benguet

TREATMENT	PLANT VIGOR	
	30 DAP	75 DAP
<u>LOCATION (A)</u>		
Bonglo, Atok	5	3
Cada, Mankayan	4	4
<u>ENTRY (B)</u>		
TAWID	4 ^{ab}	4 ^{ab}
WATWAT	4 ^{ab}	3 ^{bc}
676070	5 ^a	4 ^{ab}
2.21.6.2	5 ^a	5 ^a
OMEGA	4 ^{ab}	4 ^{ab}
JELLY	3 ^c	2 ^c
EUROTANGGO	4 ^{ab}	3 ^c
IGOROTA	5 ^a	4 ^{ab}
A X B	ns	ns
CV (%)	17.41	20.90

*Means with the same letter are not significantly different at 5 % level of DMRT
 Rating Scale: 1=very poor vigor, 2=poor vigor, 3=moderate vigor, 4=vigorous, 5=highly vigor



Effect of entries. Highly significant differences were observed among the eight potato entries at 30 and 75 DAP (Table 5). Entry Igorota significantly had the widest canopy of 40 and 64 at 30 and 75 DAP, respectively. Eurotango had the lowest canopy cover. The wide canopy cover of the plant might be attributed to its genetic characteristics and may indicate its resistance to pest and disease infection.

Interaction effects. Highly significant interactions of the canopy cover of the entries grown across locations at 30 to 75 DAP were observed (Figures 4 and 5). Entry Igorota significantly obtained the widest canopy of 64. Wide canopy among the potato entries may indicate adaptability to the location.



Table 5. Canopy cover at 30 and 75 days after planting of different potato entries grown in two locations of Benguet

TREATMENT	CANOPY COVER	
	30 DAP	75 DAP
<u>LOCATION (A)</u>		
Bonglo, Atok	41 ^a	69 ^a
Cada, Mankayan	22 ^b	31 ^b
<u>ENTRY (B)</u>		
TAWID	28 ^b	55 ^a
WATWAT	36 ^{ab}	56 ^a
676070	35 ^{ab}	62 ^a
2.21.6.2	43 ^a	56 ^a
OMEGA	36 ^{ab}	55 ^a
JELLY	17 ^c	30 ^b
EUROTANGGO	19 ^c	22 ^b
IGOROTA	40 ^a	64 ^a
A X B	**	**
CV (%)	17.63	23.62

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



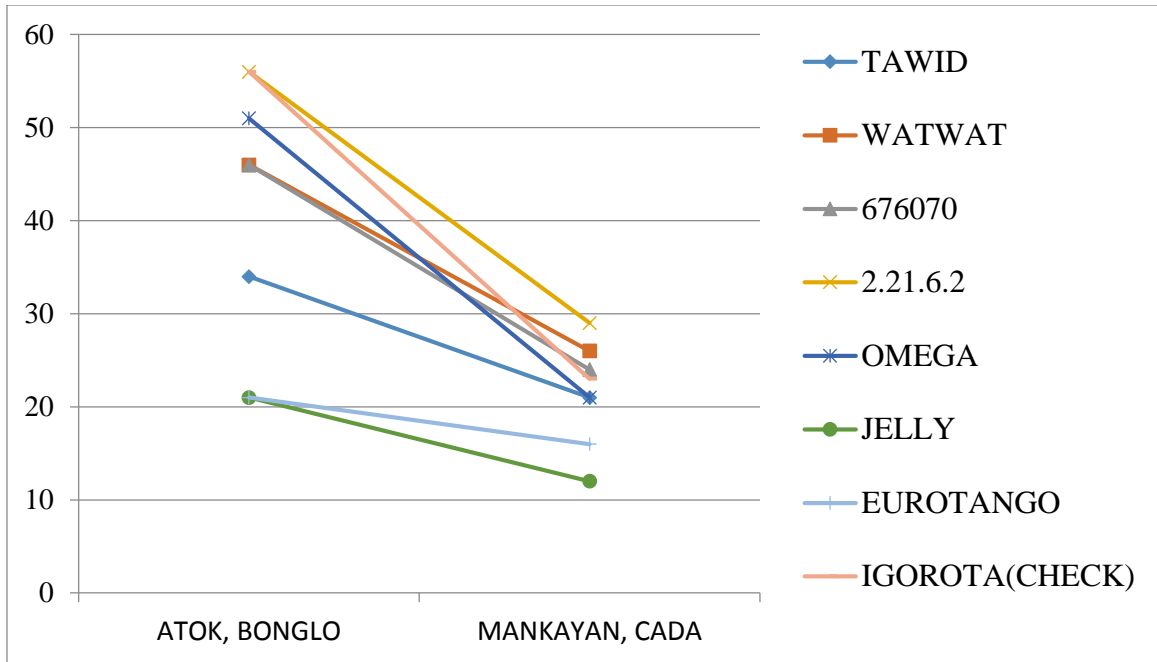


Figure 4. Canopy cover at 30 days after planting of different potato entries grown in two locations of Benguet

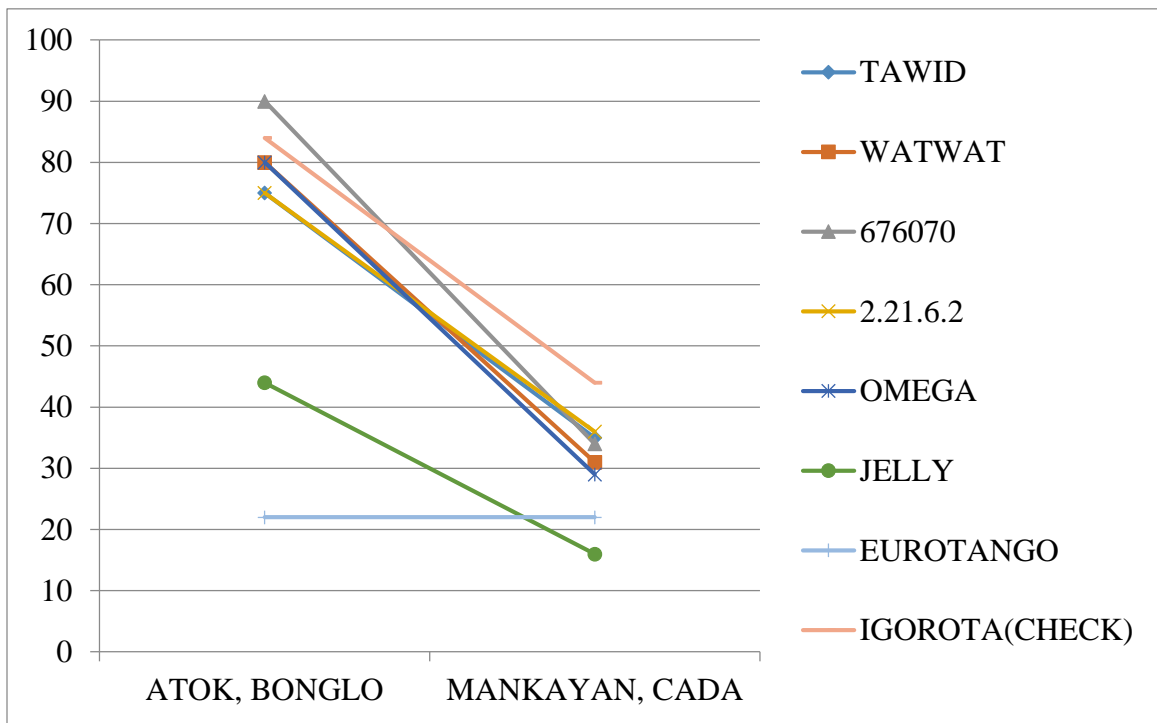


Figure 5. Canopy cover at 75 days after planting of the different potato entries grown in two locations of Benguet



Response to Late Blight

Effect of location. Potato entries evaluated in Bonglo, Atok and Cada, Mankayan had greater resistance to late blight at 30 and 45 DAP. Lower resistance of plant in Bonglo, Atok might be due to higher incidence of rainfall in the site. No differences were observed on the response of plants to late blight infection at 60 DAP.

Effect of entries. Most of the entries except Eurotango were resistant to late blight at 30 to 60 DAP. Eurotango was moderately resistant at 60 DAP. This result might be due to the genetic characteristics of the entries.



Table 6. Response to late blight at 30, 45 and 60 days after planting of different potato entries grown in two locations of Benguet.

TREATMENT	LATE BLIGHT		
	30 DAP	45 DAP	60 DAP
<u>LOCATION (A)</u>			
Bonglo, Atok	1	2	3
Cada, Mankayan	1	1	3
<u>ENTRY (B)</u>			
TAWID	1	2	2
WATWAT	1	2	3
676070	1	1	3
2.21.6.2	1	1	2
OMEGA	1	2	3
JELLY	2	3	3
EUROTANGGO	2	3	4
IGOROTA	1	1	2

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

Number of Marketable Tubers

Effect of location. Highly significant differences were observed on the number of medium and extra-large marketable tubers harvested in both locations (Table 7). More medium and extra-large tubers were harvested at Bonglo, Atok which might be due to the



high percentage of plant survival, wide plant canopy, and favorable condition prevailing during the conduct of study.

Effect of entries. Significant differences were observed on the number of extra-large, large, medium, small and marble tubers harvested in both locations (Table 7). Entry 2.21.6.2 produced the highest number of marketable tubers (in all sizes) while Eurotango produced the lowest number of tubers. The result might be attributed to the high percentage of plant survival, wide canopy, high vigor and late blight resistance of entry 2.21.6.2.

Interaction effect. No significant interaction was observed between the entries and location on the number of marketable tubers.

Weight of Marketable Tubers

Effect of locations. Highly significant differences were observed on the weight of medium marketable tubers in Bonglo, Atok and Cada, Mankayan. Potato entries evaluated in Bonglo, Atok produced the heaviest weight of marketable tubers.

High volume of marketable tubers produced might be attributed to more number of medium tubers, high percentage of plant survival, wide canopy and favorable climatic condition prevailing in the site during the conduct of the study.

Effect of entries. A significant difference was observed on the weight of marketable tubers of the potato entries evaluated. Entry 2.21.6.2 produced the heaviest marketable tubers. The weight of marketable tubers obtained from this entry might be attributed to more tubers produced, wide canopy, vigorous growth, and high percentage of plant survival. Most of the entries except Tawid, Watwat, Omega, Jelly and Eurotango significantly out yielded the check variety Igorota.



Table 7. Number of marble, small, medium, large and extra large potato tubers grown in two locations of Benguet

TREATMENT	NUMBER OF TUBER (per 5m ²)				
	MARBLE	SMALL	MEDIUM	LARGE	EXTRA LARGE
<u>LOCATION (A)</u>					
Bonglo, Atok	35	49	46 ^a	23	12 ^a
Cada, Mankayan	40	50	26 ^b	18	8 ^b
<u>ENTRY (B)</u>					
TAWID	26 ^b	28 ^{bc}	44 ^b	31 ^{ab}	13 ^{ab}
WATWAT	16 ^b	23 ^{bc}	27 ^b	13 ^{bc}	9 ^{ab}
676070	45 ^{ab}	48 ^{bc}	34 ^b	23 ^{bc}	14 ^{ab}
2.21.6.2	80 ^a	91 ^a	82 ^a	47 ^a	19 ^a
OMEGA	55 ^{ab}	68 ^{ab}	27 ^b	22 ^{bc}	10 ^{ab}
JELLY	22 ^b	27 ^{bc}	21 ^b	9 ^c	4 ^b
EUROTANGGO	15 ^b	14 ^c	15 ^b	3 ^c	1 ^b
IGOROTA	43 ^{ab}	58 ^{abc}	40 ^b	19 ^{bc}	12 ^{ab}
A X B	ns	ns	ns	ns	ns
CV (%)	26.67	21.64	19.07	25.39	25.88

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



Interaction effect. No significant interaction was observed between the entries and location on the weight of marketable tubers. However, plants grown in Bonglo, Atok produced the highest volume of marketable tubers.

Table 8. Weight of marble, small, medium, large and extra-large potato tubers grown in two locations of Benguet

TREATMENT	WEIGHT OF TUBER (kg/5m ²)				
	SMALL	MARBLE	MEDIUM	LARGE	EXTRA LARGE
<u>LOCATION (A)</u>					
Bonglo, Atok	0.75	0.23	1.29 ^a	1.23	1.23
Cada, Mankayan	0.57	0.19	0.75 ^b	0.98	0.84
<u>ENTRY (B)</u>					
TAWID	0.49 ^b	0.13 ^{ab}	1.35 ^{abc}	1.59 ^a	1.42 ^a
WATWAT	0.39 ^b	0.13 ^{ab}	0.95 ^{abcd}	1.05 ^{ab}	1.10 ^{ab}
676070	0.82 ^b	0.25 ^{ab}	1.13 ^{abc}	1.34 ^{ab}	1.54 ^a
2.21.6.2	1.29 ^a	0.53 ^{ab}	1.70 ^a	1.92 ^a	1.45 ^a
OMEGA	0.95 ^b	0.20 ^{ab}	0.84 ^{bcd}	1.07 ^b	0.95 ^{ab}
JELLY	0.28 ^b	0.18 ^{ab}	0.52 ^{cd}	0.42 ^{bc}	0.31 ^{ab}
EUROTANGGO	0.18 ^b	0.11 ^{ab}	0.24 ^d	0.15 ^c	0.08 ^b
IGOROTA	0.90 ^b	0.19 ^{ab}	1.45 ^{ab}	1.30 ^{ab}	1.44 ^a
A X B	ns	ns	ns	ns	ns
CV (%)	17.94	10.33	13.02	14.91	21.83

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



Number and Weight of Non-marketable Tubers

Effect of location. Plants grown in Bonglo, Atok significantly produced more number and weight of non-marketable tubers. High number and weight of non-marketable tubers might be due to the high total yield obtained and higher volume of rainfall in the site.

Effect of entries. No significant differences were observed on the number and weight of non-marketable tubers of the potato entries. Entries 2.21.6.2 produced highest number but lowest weight of non-marketable tubers. The lowest number of non-marketable tubers was produced by Eurotango which was affected early by late blight.

Interaction effect. No significant interaction between entries and location was observed in terms of weight and number of non-marketable tubers. Potato entries grown in Bonglo, Atok produced the highest number and weight of non-marketable tubers. This might be due to the high incidence of rainfall in the site.

Response to Leaf Miner

All of the potato entries at 30, 45 and 60 DAP grown in Bonglo, Atok and Cada, Mankayan Benguet were moderately resistant to leaf miner.



Table 9. Number and weight of non-marketable potato tubers grown in two locations of Benguet

TREATMENT	NON-MARKETABLE TUBER	
	NUMBER (per 5m ²)	WEIGHT (kg/5m ²)
<u>LOCATION (A)</u>		
Bonglo, Atok	30 ^a	0.40 ^a
Cada, Mankayan	9 ^b	0.08 ^b
<u>ENTRY (B)</u>		
TAWID	12	0.27
WATWAT	20	0.46
676070	26	0.48
2.21.6.2	40	0.09
OMEGA	19	0.18
JELLY	16	0.15
EUROTANGGO	9	0.11
IGOROTA	16	0.20
A X B	ns	ns
CV (%)	27.65	15.14

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

Total and Computed Yield

Effect of location. Potatoes grown in Bonglo, Atok significantly produced the highest total and computed yield of 4.75 kg/5m² and 9.51 tons/ha, respectively (Table 10). Entries grown at Cada Mankayan produced a lower total and computed yield. This result might be attributed to the differences in temperature and rainfall of the production sites. In



addition, potatoes harvested from Bonglo, Atok had higher number and weight of marketable and non-marketable tubers.

Effect of entries. There were highly significant differences observed on the total and computed yield of the eight potato entries evaluated. Entry 2.21.6.2 produced the highest total yield of 6.97 kg/5m² and highest computed yield of 13.93 tons/ha (Table 10). The high yield might be attributed to the high number and weight of marketable and non-marketable tubers harvested.

Interaction effect. Statistical analysis showed no significant interaction between location and the entries in terms total and computed yield.



Table 10. Total and computed yield of potato entries grown in two locations of Benguet

TREATMENT	TOTAL YIELD (kg/5m ²)	COMPUTED YIELD (tons/ha)
<u>LOCATION (A)</u>		
Bonglo, Atok	4.75 ^a	9.51 ^a
Cada, Mankayan	3.43 ^b	6.87 ^b
<u>ENTRY (B)</u>		
TAWID	5.17 ^a	10.33 ^a
WATWAT	4.03 ^{ab}	8.07 ^{ab}
676070	5.53 ^a	11.05 ^a
2.21.6.2	6.97 ^a	13.93 ^a
OMEGA	4.28 ^{ab}	5.75 ^{ab}
JELLY	1.84 ^{bc}	3.67 ^{ab}
EUROTANGGO	0.86 ^c	1.69 ^c
IGOROTA	5.49 ^a	10.97 ^a
A X B	ns	ns
CV (%)	17.34	19.46

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

Dry Matter Content

Effect of location. Highly significant differences were observed on dry matter content of the tubers harvested from Bonglo, Atok and Cada, Mankayan (Table 11). Tubers harvested from Bonglo, Atok gave the highest dry matter which may be due to the low relative humidity in the site. All the potato tubers harvested from the two locations are suitable for processing due to their high dry matter content.



Effect of entries. The tuber dry matter content of the different entries ranged from 18% to 22% (Table 11). The highest dry matter content of 24% was obtained from entry Omega. All the potato entries are suitable for processing.

Interaction effect. A high significant interaction was observed between entries and location on tuber dry matter content (Figure 6). Entries evaluated in Bonglo, Atok gained the highest dry matter content (figure 6). This result indicates that both location and entries must be considered in selecting potato entries for high dry matter content.

Sugar Content

Effect of location. No significant differences were observed on the sugar content of potato tubers harvested from Bonglo, Atok and Cada, Mankayan (Table 11). However, potatoes harvested from Cada, Mankayan gave the lowest tuber sugar content.

Effect of entries. No significant differences were observed on the sugar content of the eight potato entries. Entries Jelly and Eurotango obtained the lowest tuber sugar content (Table 11) which might be attributed to the cultivar, growing season, fertilizer application, disease infusion and other practices during the growth of the plant. Low sugar content is preferable for processing.

Interaction effect. No interaction existed between the entries and locations in terms of tuber sugar content. Entries Jelly and Eurotango harvested in Cada, Mankayan gained the lowest sugar content.



Table 11. Dry matter and sugar content of potato tubers grown in two locations of Benguet

TREATMENT	DRY MATTER CONTENT (%)	SUGAR CONTENT (°Brix)
<u>LOCATION (A)</u>		
Bonglo, Atok	21.75 ^a	6.13
Cada, Mankayan	21.00 ^b	5.69
<u>ENTRY (B)</u>		
TAWID	21.00 ^{bcd}	5.50
WATWAT	20.00 ^{cd}	5.50
676070	19.00 ^d	6.50
2.21.6.2	22.50 ^{ab}	6.50
OMEGA	24.00 ^a	6.00
JELLY	18.00 ^d	5.00
EUROTANGGO	21.50 ^{abc}	5.00
IGOROTA	21.50 ^{abc}	5.50
A X B	**	ns
CV (%)	6.59	14.28

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



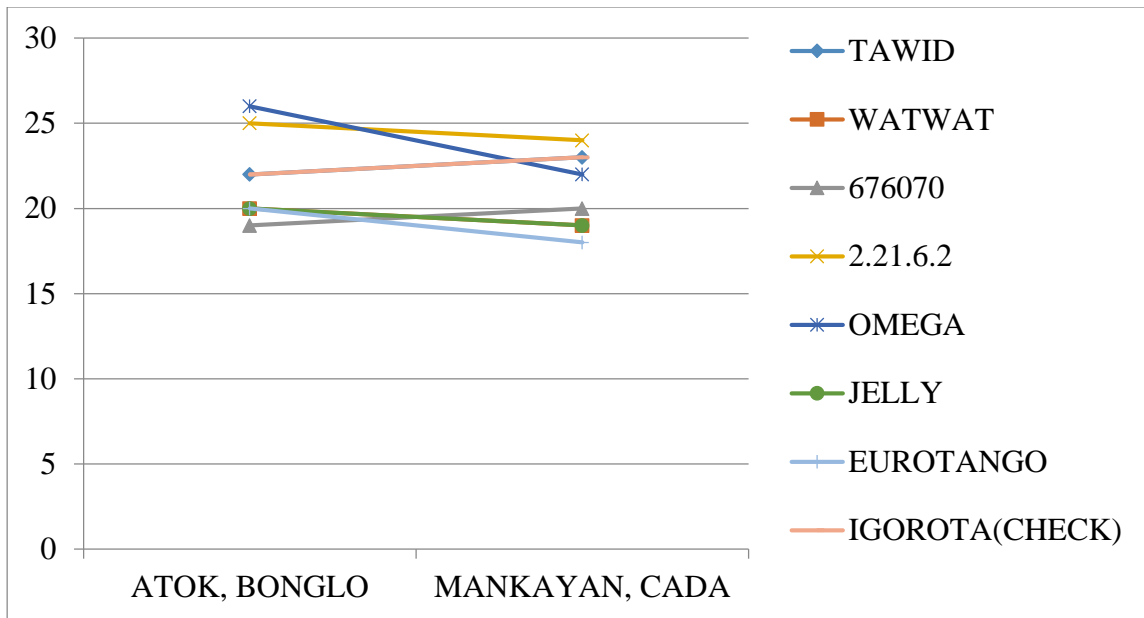


Figure 6. Dry matter content of potato entries grown in two locations of Benguet

Return on Cash Expense (ROCE)

Entries Tawid, Watwat, 676070, 2.21.6.2 and Igorota obtained positive ROCE in Bonglo, Atok Benguet while only entry 2.21.6.2 obtained a positive ROCE at Cada, Mankayan. The negative ROCE of the entries may be due to the low canopy cover and yield of the plants. Entry 676070 gained the highest ROCE at Bonglo, Atok while entry 2.21.6.2 gained the highest ROCE at Cada, Mankayan due to high total and computed yield.



Table 12. Return on cash expense of the eight potato entries grown in two locations of Benguet.

TREATMENT	COST OF PRODUCTION (Php)	MARKETABLE TUBERS YIELD (kg/15m ²)	GROSS SALES (Php)	NET INCOME (Php)	ROCE (%)
BONGLO, ATOK					
TAWID	570.00	19	760.00	640.00	33.33
WATWAT	570.00	16	640.00	70.00	12.28
676070	570.00	21	840.00	270.00	47.37
2.21.6.2	570.00	19	760.00	190.00	33.33
OMEGA	570.00	10	400.00	-170.00	-29.82
JELLY	570.00	7	280.00	-290.00	-50.88
EUROTANGO	570.00	3	120.00	-450.00	-78.95
IGOROTA	570.00	19	760.00	184.00	32.28
CADA, MANKAYAN					
TAWID	550.00	12.35	494.00	-56.00	-10.18
WATWAT	550.00	8.05	326.00	-228.00	-41.45
676070	550.00	12.55	502.00	-48.00	-8.73
2.21.6.2	550.00	22.31	892.40	342.00	62.18
OMEGA	550.00	7	280.00	-270.00	-49.10
JELLY	550.00	4.01	192.48	-357.52	-65.00
EUROTANGO	550.00	2.61	104.80	-445.20	-80.90
IGOROTA	550.00	13.50	540.00	-10.00	-1.82

*Total cost of production includes cost of planting materials, insecticides, fertilizers and labor, and selling price of potato tubers is based in Php 40.00 per kilo.



SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study was conducted to identify the highest yielding and resistant potato entries at Atok and Mankayan, determine the effect of location on the growth and yield of the potato entries, determine the interaction of potato entries and location, and determine the profitability of growing the potato entries in Bonglo, Atok and Cada, Mankayan.

The potato entries grown in Bonglo, Atok significantly attained the highest plant survival, highest initial and final height and widest canopy. The entries in Bonglo, Atok also attained positive return on cash expenses due to higher total and computed yield.

The potato entries 2.21.6.2, 676070, Tawid and Igorota significantly produced high yield of marketable tubers. Most of the potato entries produced high yield of marketable tubers resulting to positive ROCE except for entries Jelly and Eurotango that had low yield resulting to negative ROCE.

Entries 2.21.6.2, 676070 and Tawid were highly resistant to late blight while the rest of the entries were moderately resistant to the disease.

There were no significant interaction effect between location and entries on plant survival at 30 DAP, plant height, plant vigor, number of marketable tubers, weight of marketable tubers, number and weight of non marketable tubers, total and computed yield and sugar content of potato tubers grown.

High significant interaction effect was observed on plant survival at 75 DAP, canopy cover at 30 and 75 DAP, and tuber dry matter content.



Conclusions

Based on the results, Tawid, 676070, 2.21.6.2, and Igorota were the best performing potato entries due to their high yielding capacity and resistance to pest. Among the locations, Bonglo, Atok was the best site for growing the potato entries due to favorable environmental factors that resulted to the high percentage of plant survival, high plant vigor, wider canopy and high yield of the plants.

For wider canopy cover and higher tuber dry matter content, the potato entries may be grown at Bonglo, Atok. In addition, for higher profit (positive ROCE), entries 2.21.6.2 and 676070 may be grown in Cada, Mankayan and Bonglo, Atok, respectively.

Recommendations

Based on the results of the study, Bonglo, Atok is recommended for potato production. Entries 2.21.6.2, Tawid, 676070 and Igorota are recommended for a more profitable potato production.

Production of potatoes at Cada, Mankayan is less profitable due to its unfavorable environmental condition.



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