BIBLIOGRAPHY

BANARIO, DARIO JR A. MARCH 2012. Intercropping Garden pea (*Pisum sativum* L.) Entries with Potato Under Organic Production System in Balili, Mankayan, Benguet Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted to determine the effect of intercropping garden pea with potato; determine the best garden pea entry intercropped with potato; determine the interaction effect of intercropping and garden pea entries; determine the profitability of the garden pea entries intercropped with potato; and identify the most preferred garden pea entry of farmers in Balili, Mankayan, Benguet.

Based on the results of the study, growing of garden pea entries either as monocrop or intercropped with potato had similar maturity, resistance to pest, and yield. Among the garden pea entries, CGP 34 and Chinese 2 (local variety) were the best performing entries as exemplified by their high yield and moderate resistance to pod borer and leaf miner. Chinese 2 (local variety) either planted as monocropped or intercropped with potato had the highest ROCE. CGP 34 also had above 100% ROCE.

In addition, Betag, Chinese 1 and Chinese 2 (local variety) were the most preffered by the farmers due to their high yield, good plant stand and good quality pods.

INTRODUCTION

Garden pea (*Pisum sativum* L.) is a semi-temperate legume grown at about 1,500 meters above sea level. As a result, garden pea can be grown practically in all parts of Benguet with the central and southern towns as major production areas (MSAC, 1982).

Garden pea which is one of the most expensive vegetable legumes in the country is among the leguminous crops grown commercially by Benguet farmers. However, most farmers are spending for higher inputs such as inorganic fertilizers and pesticides. Application of these chemicals may destroy the soil structure and eliminate beneficial insects. In this regard, organic farming incorporated with intercropping appears to be a logical alternative in minimizing the harmful effect of inorganic fertilizer and chemical inputs (Dela Cruz, 2004).

Intercropping means growing of two or three crop species in mixed cultures on the same land by putting the crops in alternative strips of rows (Lantican, 2001). In the Philippines, landholdings are generally small due to the system of land inheritance resulting to the fragmentation of land areas. Hence, intercropping has grown out of necessity to increase farm income inspite of farm size. This practice makes more efficient use of the land area by increasing the yield per unit area and controlling erosion in hilly lands, especially if accompanied by proper fertilization and irrigation. Harvest is also spread over the year and makes supply available over an extended period as it provides genetic diversity to minimize pest incidence (Bautista, 1994). Thus, combining garden pea with potato, an important tuber crop in the Philippines, was done in this study.

The study was conducted to:

1. determine the effect of intercropping garden pea with potato;
2. determine the best garden pea entry intercropped with potato;
3. determine the interaction effect of intercropping and garden pea entries;
4. determine the profitability of the garden pea entries intercropped with potato; and
5. identify the most preferred garden pea entry by farmers.

The study was conducted in Balili, Mankayan, Benguet from October 2011 to February 2012.

REVIEW OF LITERATURE

Description and Production of Garden pea in the Philippines

Garden pea (*Pisum sativum* L.), locally known as 'Chinese pea', 'snow pea', 'sweet pea' or 'sitsaro', is the most expensive vegetable legumes in the country. It is grown for its edible pods or seeds. It grows very well in Benguet, where the climate is cool throughout the year. Garden pea seeds contain considerable amounts of digestible protein, carbohydrates, and minerals, while the green pods are rich sources of vitamin A. Garden pea is a popular ingredient in 'chop suey' and 'pancit'. It also makes an important addition in soups, sautés, and any dish with mushrooms, bamboo shoots, and shrimps. Recognizing its importance to the industry, PCARRD-DOST identified sweet pea, among others, as a priority crop under the National Vegetable R&D Program (PCARRD, 2011).

Garden pea grows well in humus-rich or volcanic soil and thrives best in areas at least 1,000 m above sea level. It favors a cool climate with a temperature range of 10-18°C. Organic garden pea is being produced in limited quantities (PCARRD, 2011).

In 2006, PCARRD stated that the production this year was 5,723 t, down by 1.5% from the output of the previous year at 5,808 t. The major producer was the Cordillera Administrative Region which accommodated 94.5% of the production and 5.5% to other. The area harvested in 2006 was 1,674 ha, down by 1.4% from 1,697 ha in 2005 and the yield per hectare was 3.4 t in 2006, the same level posted in 2005.

Description of intercropping

In 2001, Lantican stated that intercropping is the growing of two or three crop species in mixed cultures on the same land by putting the crops in alternative strips of rows. Normally, a short- and a tall-growing crop or quick and late-maturing crops are used as intercrops. Intercropping is also used to utilize the vacant or unused species in between rows of certain crops during the course of their growth.

In 2004, Beazley added that intercropping is done when two or more crops are grown together within the same area. Rows of one may alternate with rows of another, or plants of different crops may alternate within rows. Often fast- and slow-growing crops are paired: the fast-growing one is cleared before the slower one needs the space.

Effect of intercropping

In 1994, Bautista stated that intercropping provides genetic diversity to minimize pest increase. Variation in susceptibility among species or varieties to a particular disease is great. Given abundant host of a single species or variety, a pest could easily be dispersed from host to host. When the number of the host declines, the incidence will also decrease for lack the necessary food for the organism. In addition, intercropping a disease-susceptible variety with a resistant one in the vegetable plot is a technique that is also looking promising, on a field scale at least. Research trials have shown that lettuces susceptible to downy mildew can be protected if in the row, each plant alternates with one of a resistant lettuce variety (Kruger *et al*., 2008).

In some studies shown that intercropping of cabbage with tomato, white and corn has been found to reduce the population of larvae of the diamond back moth of cabbage.

Intercropping marigold and ‘Martha Washington’ asparagus among crop plants is good for the control of nematodes since these two plants have been found to have nematode depressant values (Lantican, 2001).

Other studies reported in the USA have shown that intercropping of corn and soybeans in double rows affected an increase of 30% in the yield of corn over that planted in pure stand. There was no change in the yield of soybeans. Interplanting of corn and soybean at every four rows of each and at every six rows of each, showed an increase in the yield of corn of 16% and 20%, respectively, in comparison with those in pure stand. Although a decrease of 20% in yield of soybeans observed in other case, total yield with intercropping were higher (Lantican, 2001).

Sugarcane and bananas are slow-growing and long-maturing crops. The rows are normally spaced widely at one meter or more and it takes about three to four months from planting before the leaves of the plants between rows over lap-puring this early stage of growth, there is ample space between rows on which to grow a quick-maturing crop like mungo, sweet potatoes, soybean, etc. Farmers in the sugarcane producing areas in Taiwan interplant peanuts, sweet potatoes, soybeans, cotton, rapeseed or onion during the early period of growth of sugarcane. If the weeds of the intercrops for fertilizers are adequately supplied, only very little decreases in the yield of sugarcane are intercrops for fertilizers are adequately supplied, only very little decreases in the yield of sugarcane are observed. In return, 1 ton per ha of soybeans, 974 kg of seed cotton, 2.4 to 3.0 ton of rape seed and 15 to 20 ton per ha of onions are obtained (Lantican, 2001).

Lantican further added that some farmers in Negros and Laguna who have practiced intercropping of sorghum, corn or mungo in between the rows of sugarcane have obtained

added income from these intercrops without getting any apparent losses in the yield of sugarcane. Weed population in the sugarcane field was even reduced.

Organic farming

Organic agriculture is a holistic production management system which promote and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system (FAO, 1999).

Organic farming is a modern, sustainable farming system which maintains the long-term fertility of the soil and uses less of the Earth's finite resources to produces high quality and nutritious food (OFRF, 2004).

In 2006, Kristiansen *et al.* stated that the purpose of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals, and people. In addition, soil care is a main principle in organic farming. It is, therefore, not surprising that the impacts of organic farming on soil properties have been researched comprehensively. Special focus in this research is on organic matter content, biological activity, nutrient cycles and soil erosion. Even though soil performance is very site specific, results of studies in different countries show that organic farming tends to conserve soil fertility and system stability better than conventional farming system.

On the other hand, according to Alfoldi *et al.* as cited by Kristiansen in 2006, as organic farmers cannot use synthetic substances, they pay particular attention to operating a sound rotational system to 'nourish the soil' in order to maintain organic matter content and keep it in good condition. Organic management focuses on nutrient cycling with the aim of maximizing agro ecosystem stability and homeostasis. To restore the natural ecological balance is seen as essential by organic farmers because ecosystem functions are considered to be the main productive "input".

MATERIALS AND METHODS

An area of 210 square meters was thoroughly prepared and treatments were laid-out following Split-plot Design (Figure 1). Each treatment was replicated three times.

The treatments were the following:

Main plot: Cropping System (CS)

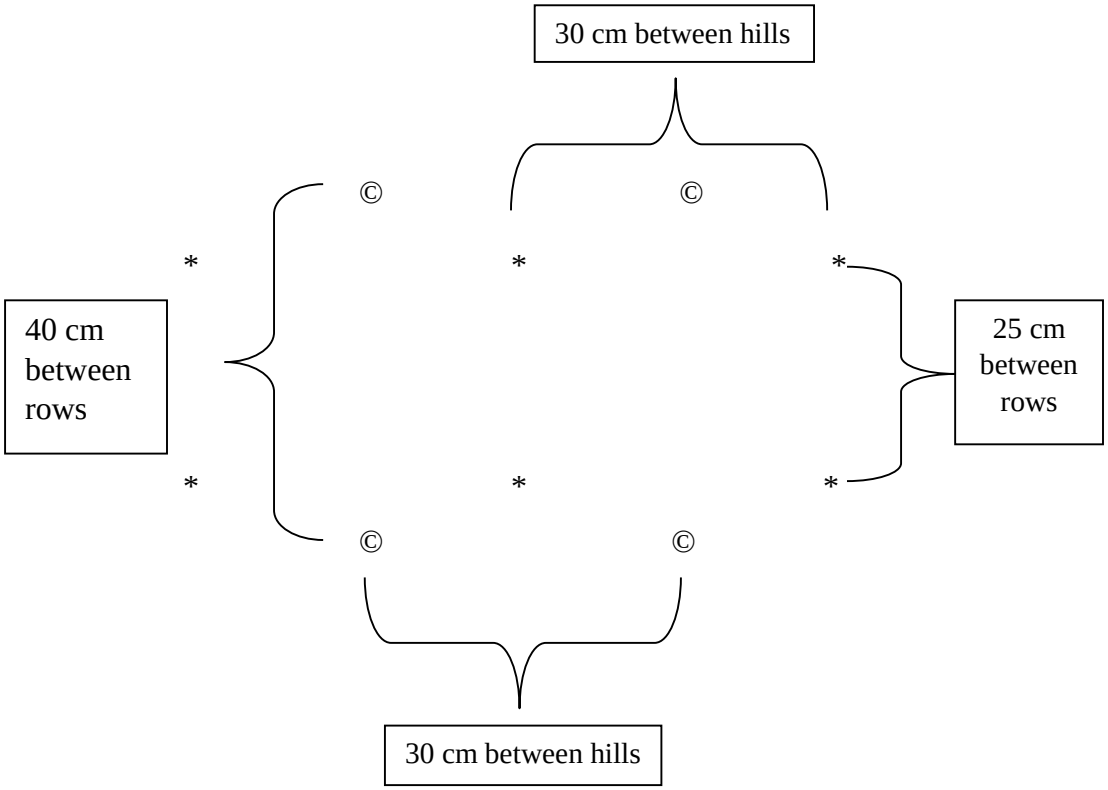
Code	Cropping System
CS_1	Garden pea alone
CS_2	Garden pea with potato

Sub plot: Garden Pea Entries (E)

Code	Entry	Source
E_1	CGP 13	BSU-IPB
E_2	CGP 34	BSU-IPB
E_3	CGP 59	BSU-IPB
E_4	BETAG	BSU-IPB
E_5	Chinese 1	ABC-Company
E_6	Chinese 2	Local variety

Each plot measuring 1 m × 5 m had two rows of garden pea plants. Seeds were sown at 2-3 seeds per hill to a depth of 2-5 cm with the distance of 30 cm between hills and 25 cm between rows. Potato tubers were sown in between hills of garden pea with a distance of 30 cm between hills and 40 cm between rows.

The following was a lay-out for planting garden pea with potato:



Legend:

* = garden pea

© = potato

Cultural Management Practices

Organic farming management was practiced from land preparation until harvesting (Figure 2-7). BSU compost was incorporated basally during land preparation. Irrigation was provided from sowing until the crop was harvested. Wind breaker crops (corn) were planted around the experimental area. Trellis was provided at 20 days after emergence and was bound with plastic twine allowing the crop to cling to the trellis. Inorganic fertilizers and pesticides were not used.

Figure 1. Overview of the production site

Figure 2. Land clearing

Figure 3. Plot preparation

Figure 4. Fertilizer (BSU compost) application

Figure 5. Planting

Figure 6. Training of plants with plastic twine

Figure 7. Harvesting

Data Gathered

1. Meteorological data. Relative humidity and temperature were taken by using a digital hygroscometer. Rainfall was collected and measured.

2. Percentage emergence. This was computed using the formula:

$$\% \text{ Emergence} = \frac{\text{Number of seed emerged}}{\text{Total no. of seed sown}} \times 100$$

3. Maturity data

a. Number of days from sowing to emergence. This was taken by counting the number of days from sowing to emergence.

b. Number of days from sowing to first flowering. This was recorded by counting the number of days from sowing to the time when at least 50% of the plants per plot had at least two fully opened flowers.

c. Number of days from emergence to last flowering. This was recorded by counting the number of days from emergence to last flowering when at least 50% of the plants per plot had stopped flowering.

d. Number of days from flowering to pod setting. This was obtained by counting the number of days from flowering until the pods begin to develop.

e. Number of days from pod setting to pod maturity. This was gathered when the last pod has set and 50% of leaves died.

f. Number of days from emergence to harvesting. This was recorded by counting the number of days from emergence to harvesting.

4. Flower and pod characters

a. Number of flowers per plant. This was gathered by counting the flowers per plant of ten sample plants per plot at the peak of flowering.

b. Number of flower clusters per plant. This was gathered by counting the flower clusters per treatment at 50 days after planting.

c. Number of flowers per cluster. This was gathered by counting the flowers per cluster per replication at the peak of flowering.

d. Number of pods per plant. This was recorded by counting the number of pods per plant of ten sample plant per plot.

5. Final plant height. This was measured from the base of the plant of the ten sample plants per plot.

6. Seed characters

a) Seed length (mm).This was obtained by measuring the seed parallel to the helium by the used of vernier caliper.

b) Seed width (mm). This was obtained by measuring the mid-portion of the ten sample seeds per plot by the used of vernier caliper.

7. Seed Yield

a. Number of seeds per pod. This was recorded by counting the number of seeds in ten sample plants per pod.

b. Number and weight of marketable seeds/plot (g/5m^2). This was obtained by counting and weighing the marketable seeds.

c. Number and weight of non-marketable seeds (g/5m^2). This was obtained by counting and weighing the non-marketable seed which are damaged, small size and infected with pod borer.

d. Total seed yield per plot (g/5m^2). This was obtained by getting the total seed yield per plot.

e. 100 dry seed weight (g). This was obtained by weighing randomly chosen 100 dry seeds per plot.

8. Reaction to pod borer. The reaction to infestation to seed/pod borer was obtained using the following scale used by Tandang *et al.* (2008):

Scale	Description	Remarks
1	No infestation per plot	Highly resistant
2	1-25% infestation per plot	Mildly resistant
3	25-50% infestation per plot	Moderately resistant
4	51-75% infestation per plot	Susceptible
5	76-100% infestation per plot	Very susceptible

9. Reaction to leaf miner infestation. This was gathered using the following scale used by Tandang *et al.* (2008):

Scale	Description	Remarks
1	No damage/infestation	Highly resistant
2	1-25% infestation	Moderately resistant
3	25-50% infestation	Resistant
4	51-75% infestation	Moderately Susceptible
5	76-100% infestation	Very susceptible

10. Reaction to powdery mildew. The susceptibility of the plant was evaluated using the following rating scale used by Tandang *et al.* (2008):

Scale	Description	Remarks
1	No damage/infestation	Highly resistant
2	1-25% of the total leaves per plant parts are infected	Moderately resistant
3	25-50% of the total leaves per plant parts are infected	Resistant
4	51-75% of the total leaves per plant parts are infected	Moderately susceptible

5 76-100% of the total leaves per plant parts are infected Very susceptible

11. General acceptability of the farmers on the garden pea entries. Thirteen farmers were invited to evaluate the garden pea entries at peak of pod setting. They were requested to make their own selection and express their reasons for choosing or not choosing the seven entries of garden pea. Selection was based on the plant growth.

12. Weight of marketable and non-marketable potato tuber (intercrop) (g/plot). This was the weight of marketable and non-marketable potato tuber taken at harvest.

13. Return on cash expenses (ROCE). This was computed using the formula:

$$\% \text{ ROCE} = \frac{\text{Gross Sale-Total Expenses}}{\text{Total Expenses}} \times 100$$

Data Analysis

All quantitative data was gathered and analyzed statistically using the Analysis of Variance (ANOVA) for Split-plot design. The significant differences among the treatment means were tested using the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Meteorological Data

The temperature, relative humidity, rainfall amount and light intensity during the conduct of the study are shown in Table 1. The average temperature range in the area is from 17°C to 25°C while relative humidity ranges from 77 to 82 %. PCARRD (2012) stated that garden pea grows well in an area where temperature ranges from 10°C to 18°C with an average relative humidity of 86% (GIAA, 2012). The temperature and relative humidity during the conduct of the study was observed to be within the required range for garden pea production.

The rainfall was continuous throughout the growing season, which may affect the occurrence of pest. A high amount of rainfall was recorded in the month of November (4.68 L) and decreased in the month of February with a recorded amount of 1.83 liters. A minimum of 400 to 500 mm rainfall per cropping season (about three months) is required for growing garden pea without supplementary irrigation (GIAA, 2012). Light intensity in the month of January was very low at 2133 foot candles compared to the month of November (2739 foot candles).

Table 1. Average temperature, relative humidity, rainfall, and light intensity from November 2011 to February 2012

MONTH	AVERAGE TEMPERATURE (°C)	RELATIVE HUMIDITY (%)	RAINFALL (L)	LIGHT INTENSITY (foot candle)
November	25	82	4.68	2739
December	22	81	4.34	2376
January	19	79	2.42	2133
February	17	77	1.83	2451

Table 2. Percentage emergence of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	EMERGENCE (%)
CROPPING SYSTEM (CS)	
Garden pea alone	90.74
Garden pea + potato	92.48
ENTRY (E)	
CGP 13	100.00[a]
CGP 34	99.64[a]
CGP 59	100.00[a]
Betag	89.76[b]
Chinese 1	63.89[c]
Chinese 2 (local variety)	96.36[a]
CS×E	ns
CV (a) (%)	5.91
CV (b) (%)	4.20

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

Percentage emergence

Effect of cropping system. There were no significant differences observed on the percentage emergence of garden pea plants subjected under the different cropping systems. However, garden pea intercropped with potato had the highest percentage emergence (Table 2).

Effect of entry. Highly significant differences were observed among the six entries on percentage emergence (Table 2). Entries CGP 13, CGP 34, CGP 59 and Chinese 2 (local variety) significantly had the highest percentage emergence. Lowest percentage emergence

was obtained from Chinese which might be due to the continuous rainfall prevailing in the site that resulted to severe rotting of seeds sown.

Interaction effect. No significant interaction was observed between the entries and the cropping system on percentage emergence.

Number of days from sowing to emergence

Effect of cropping system. Monocropped and intercropped garden pea plants emerged at six days after sowing (Table 3).

Effect of entry. Most of the entries emerged earlier (6 days from sowing) except Chinese 1 which emerged later at seven days after sowing. Vanderlinded (2005) stated that garden pea normally emerges from 6 to 10 days. The number of days from sowing to emergence of the garden pea entries was observed to be within the normal range of emergence for garden pea.

Interaction effect. No significant interaction was observed between the entries and the cropping system on the number of days from sowing to emergence.

Number of days from sowing to first flowering

Effect of cropping system. The monocropped and intercropped garden pea plants flowered at 44 days after sowing (Table 3).

Effect of entry. Entries CGP 13 and Betag produced first flowers earlier at 41 days from sowing (Figure 8) which may imply early pod setting and maturity.

Interaction effect. There were no significant interaction observed between the cropping systems and garden pea entries.

Table 3. Number of days from sowing to emergence, sowing to first flowering, emergence to last flowering and flowering to pod setting of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	NUMBER OF DAYS FROM			
	SOWING TO EMERGENCE	SOWING TO FIRST FLOWERING	EMERGENCE TO LAST FLOWERING	FLOWERING TO POD SETTING
CROPPING SYSTEM (CS)				
Garden pea alone	6	44	70	6
Garden pea + potato	6	44	70	6
ENTRY (E)				
CGP 13	6	41	66	5
CGP 34	6	48	68	8
CGP 59	6	44	70	5
Betag	6	41	67	7
Chinese 1	7	46	77	6
Chinese 2 (local variety)	6	45	74	6
CS × E	ns	ns	ns	ns
CV (a) (%)	0	0	0	0
CV (b) (%)	0	0	0	0

Figure 8. Six Garden pea entries at flowering

Number of days from emergence to last flowering

Effect of cropping system. The number days from emergence to last flowering of monocropped and intercropped garden plants was 70 days from emergence (Table 3).

Effect of entry. Entry CGP 13 was the earliest to stop producing flowers at 66 days after emergence. The result implies early maturity and harvesting of this entry.

Interaction effect. The garden pea entries did not significantly interact with cropping systems in terms of the number days from emergence to last flowering.

Number of days from flowering to pod setting

Effect of cropping system. The number of days from flowering to pod setting of monocropped and intercropped garden plants did not differ. Plants set pod at 6 days after flowering (Table 3).

Effect of entry. Entries CGP 13 and CGP 59 produced pods earlier at 5 days after flowering since both entries flowered earlier than the other entries.

Interaction effect. No significant interaction was observed between the cropping systems and the garden pea entries on the number of days from flowering to pod setting.

Number of days from pod setting to pod maturity

Effect of cropping system. The number of days from pod setting to pod maturity of monocropped and intercropped garden pea plants was 38 days. This result implies that the type of cropping system does not affect pod maturity (Table 4).

Effect of entry. Entries CGP 13, CGP 34 and Betag were the early maturing entries in terms of days from pod setting to pod maturity. The results might indicate early harvesting of the entries.

Interaction effect. There was no significant interaction between the cropping systems and garden pea entries on the number of days from pod setting to pod maturity.

Table 4. Number of days from pod setting to pod maturity and emergence to harvesting of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	NUMBER OF DAYS FROM	
	POD SETTING TO POD MATURITY	EMERGENCE TO HARVESTING
CROPPING SYSTEM (CS)		
Garden pea alone	38	96
Garden pea + potato	38	96
ENTRY (E)		
CGP 13	36	89
CGP 34	36	93
CGP 59	38	96
Betag	36	89
Chinese 1	40	104
Chinese 2 (local variety)	40	104
CS × E	ns	ns
CV (a) (%)	0	0
CV (b) (%)	0	0

Number of days from emergence to harvesting

Effect of cropping system. The number of days from emergence to harvesting of the garden pea plants as affected by the type of cropping system was 96 days. The cropping systems did not affect crop maturity (Table 4).

Effect of entry. Entries CGP 13 and Betag were harvested early at 89 days after emergence which might be due to their early flowering, pod setting and early maturity of the pods.

Interaction effect. There was no significant interaction between the cropping systems and the garden pea entries on the number of days from emergence to harvesting.

Number of flowers per plant

Effect of cropping system. Significant differences were observed on the number of flowers per plant as affected by different cropping systems (Table 5). Monocropped garden pea plants significantly produced the highest number of flowers per plant. This result might be due to the absence of competition on nutrients, moisture, space and other environmental resources (Sheaffer *et al*., 2009).

Effect of entry. A highly significant difference was observed on the number of flowers of the different entries (Table 5 and Figure 9). Entry Chinese 2 (local variety) significantly produced the highest number of flowers per plant which might lead to high number of pods and possibly high yield.

Interaction effect. No significant interaction was observed between the cropping system and the entries in terms of the number of flowers per plant.

Number of flower clusters per plant

Effect of cropping system. There were no significant differences observed on the number of flower clusters per plant (Table 5) of monocropped and intercropped garden pea. All the plants produced eight flower clusters per plant.

Effect of entry. Highly significant differences were observed among the garden pea entries in terms of the number of the flower clusters per plant (Table 5). Entry Chinese 2 (local variety) significantly produced the highest flower clusters per plant while the lowest number of flower clusters per plant was obtained from CGP 13. The results imply that the higher number of flower clusters produced may lead to higher number of pods or yield obtained.

Table 5. Number of flowers, flower clusters, flowers per cluster and pods per plant of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	NUMBER OF			
	FLOWERS PER PLANT	FLOWER CLUSTERS PER PLANT	FLOWERS PER CLUSTER	PODS PER PLANT
CROPPING SYSTEM (CS)				
Garden pea alone	12[a]	8	2	10
Garden pea + potato	11[b]	8	2	9
ENTRY (E)				
CGP 13	9[c]	7[c]	2	7[c]
CGP 34	14[b]	8[b]	2	11[b]
CGP 59	8[c]	8[b]	1	7[c]
Betag	8[c]	8[b]	1	7[c]
Chinese 1	14[ab]	9[a]	2	12[a]
Chinese 2 (local variety)	15[a]	9[a]	2	13[a]
CS×E	ns	ns	ns	ns
CV (a) (%)	5.11	24.45	0.00	11.47
CV (b) (%)	7.65	8.53	0.00	10.85

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

Figure 9. Pods and flowers of garden pea entries

Interaction effect. There was no significant interaction between the cropping system and the garden pea entries on the number of flower clusters per plant.

Number of flowers per cluster

Effect of cropping system. No significant differences were observed on the number of flowers per cluster as affected by the type of cropping system. All the plants produced two flowers per cluster.

Effect of entry. There were no significantly differences observed among the entries on the number of flowers per cluster. Entries CGP 13, CGP 34, Chinese and Chinese 2 (local variety) produced two flowers per cluster (Table 5).

Interaction effect. No significant interaction was observed between the cropping systems and the garden pea entries on the number of flowers per cluster.

Number of pods per plant

Effect of cropping system. The number of pods per plant was not significantly affected by the cropping system. The highest number of pods per plant was recorded from monocropped garden pea.

Effect of entry. A highly significant difference was observed on the number of pods per plant (Table 5) of the garden pea entries. The highest number of pods per plant was obtained from Chinese 2 (local variety) which might be due the high number of flowers produced by this entry.

Interaction effect. No interaction effect was observed between the cropping system and the entries in terms of the number of pods per plant.

Final plant height

Effect of cropping system. The type of cropping system did not significantly affect the final plant height of the entries. Numerically, monocropped garden pea plants were the tallest (Table 6).

Effect of entry. Table 6 showed that there were highly significant differences observed on the final height of the entries. CGP 34 and Chinese 2 (local variety) were significantly the tallest entries. However, Betag and CGP 13 were the shortest garden pea entries which might be due to early senescence since both entries matured early.

Interaction effect. There was no interaction effect observed between the cropping system and the entries on final plant height.

Table 6. Final plant height of the six garden pea entries as a monocrop and intercropped with potato

TREATMENT	FINAL PLANT HEIGHT AT 104 DAP (cm)
CROPPINGSYSTEM (CS)	
Garden pea alone	161.78
Garden pea + potato	160.14
ENTRY (E)	
CGP 13	143.42[c]
CGP 34	181.58[a]
CGP 59	159.00[b]
Betag	146.75[c]
Chinese 1	154.17[bc]
Chinese 2 (local variety)	180.83[a]
CS×E	ns
CV (a) (%)	4.10
CV (b) (%)	5.88

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

Seed length

Effect of cropping system. Table 7 showed that there were no significant differences on the seed length of monocropped and intercropped garden pea plants.

Effect of entry. There were highly significant differences observed on the seed length of the different entries (Table 7). The longest seeds were obtained from Betag that might be due to its genetic characteristics. Long seeds may lead to high dried seed weight.

Interaction effect. The seed length of the garden pea entries was not significantly interacting with cropping system.

Table 7. Seed length, seed width and number of seeds per pod of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	SEED LENGTH (mm)	SEED WIDTH (mm)	NUMBER OF SEEDS PER POD
CROPPING SYSTEM (CS)			
Garden pea alone	6.73	5.68	6
Garden pea + potato	6.76	5.78	6
ENTRY (E)			
CGP 13	6.98^{ab}	5.82^{ab}	6^{c}
CGP 34	6.92^{b}	5.98^{a}	8^{a}
CGP 59	6.98^{ab}	5.63^{bc}	6^{c}
Betag	7.20^{a}	5.82^{ab}	7^{b}
Chinese 1	6.22^{c}	5.52^{c}	5^{d}
Chinese 2 (local variety)	6.17^{c}	5.60^{bc}	5^{d}
CS×E	ns	ns	ns
CV (a) (%)	1.75	1.83	1.11
CV (b) (%)	2.73	3.20	2.74

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

Seed width

Effect of cropping system. The cropping systems did not significantly affect the seed width of the garden pea plants.

Effect of entry. A highly significant difference was observed on the seed width of the garden pea entries (Table 7). CGP 34 significantly produced the widest seed while Chinese 1 produced the narrowest seeds which might be due to its genetic characteristics.

Interaction effect. No interaction effect was observed between cropping system and entries in terms of seed width.

Number of seeds per pod

Effect of cropping system. There were no significant differences observed on the number of seeds per pod of monocropped and intercropped garden pea plants.

Effect of entry. Based on the results in Table 7, highly significant differences were observed on the number of seeds per pod of the different entries. CGP 34 significantly produced the highest number of seeds per pod. However, lesser number of seeds per pod was obtained from Chinese 1 and Chinese 2 (local variety). The higher number of seeds per pod implies higher number and weight of seed yield.

Interaction effect. The number of seed per pod of the entries was not significantly interacting with cropping system.

Number and weight of marketable seeds

Effect of cropping system. No significant effect of cropping system was observed on the number and weight of marketable seeds per plot of the garden pea plants (Table 8). Garden pea intercropped with potato had the highest number and weight of marketable seeds per plot.

Effect of entry. Highly significant differences were observed on the number and weight of marketable seeds per plot (Table 8). Chinese 2 (local variety) significantly produced the highest number and weight of marketable seeds per plot. This might be due to the high percentage of emergence, high number of flowers and pods produced.

Interaction effect. No interaction was observed between the cropping system and the entries in terms of number and weight of marketable seeds per plot.

Table 8. Number and weight of marketable and non-marketable seeds, and total seed yield of six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	MARKETABLE SEEDS (per $5m^2$)		NON-MARKETABLE SEEDS (per $5m^2$)		TOTAL SEED YIELD ($g/5m^2$)
	NUMBER	WEIGHT (g)	NUMBER	WEIGHT (g)	
CROPPING SYSTEM (CS)					
Garden pea alone	852	129.17	369	31.14	161.53
Garden pea + potato	912	140.73	351	32.73	173.46
ENTRY (E)					
CGP 13	604^{c}	100.75^{c}	434^{d}	40.22^{b}	140.97^{b}
CGP 34	1223^{b}	182.33^{b}	467^{d}	39.68^{b}	222.02^{a}
CGP 59	766^{c}	115.68^{c}	367^{cd}	28.57^{b}	144.25^{b}
Betag	616^{c}	106.07^{c}	278^{ab}	29.07^{b}	135.13^{b}
Chinese 1	564^{c}	76.43^{c}	216^{a}	17.17^{a}	97.27^{b}
Chinese 2 (local variety)	1520^{a}	228.45^{a}	397^{d}	36.90^{b}	265.35^{a}
CS×E	ns	ns	ns	ns	ns
CV (a) (%)	16.25	22.54	27.25	29.74	17.09
CV (b) (%)	25.37	27.46	21.83	27.59	24.88

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

Number and weight of non-marketable seeds

Effect of cropping system. There were no significant differences observed on the number and weight of non-marketable seeds per plot as affected by the cropping systems (Table 8).

Effect of entry. There was a highly significant difference on the number and weight of non-marketable seeds per plot (Table 8) of the different garden pea entries. Chinese 1 significantly had the least number and weight of non-marketable seeds. The results might be due to the resistance of this entry to pod borer and powdery mildew.

Interaction effect. There was no interaction observed between the cropping system and the entries on the number and weight of non-marketable seed per plot.

Total seed yield

Effect of cropping system. The total seed yield per plot was not significantly affected by the cropping systems. Garden pea intercropped with potato had higher total yield than monocropped garden pea.

Effect of entry. Based on the results in Table 8, there was a highly significant difference observed on the total seed yield per plot of the garden pea entries. Chinese 2 (local variety) significantly produced the highest total seed yield per plot (265.350 g) followed by CGP 34 (222.017 g). The results might be due to their high number of flowers and pods produced.

Interaction effect. The total seed yield per plot of the entries was not significantly interacting with cropping system.

100 dried seed weight per plot (g)

Effect of cropping system. The 100 dried seed weight per plot of the entries was not significantly affected by the cropping systems.

Effect of entry. There was a highly significant difference on the 100 dried seed weight per plot of the garden pea entries (Table 9 and Figure 10). Betag significantly produced the heaviest weight of 100 dried seeds which might be due to its high seed length and seed width.

Interaction effect. The cropping systems did not significantly interact with the garden pea entries in terms of 100 dried seed weight.

Table 9. One hundred dried seed weight of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	100 DRIED SEED WEIGHT (g)
CROPPING SYSTEM (CS)	
Garden pea alone	15.34
Garden pea + potato	16.14
ENTRY (E)	
CGP 13	16.76[ab]
CGP 34	15.03[c]
CGP 59	15.63[bc]
Betag	17.41[a]
Chinese 1	13.58[d]
Chinese 2 (local variety)	16.01[bc]
CS×E	ns
CV (a) (%)	10.24
CV (b) (%)	6.27

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

CGP 13

CGP 34

CGP 59

Betag

Chinese 1

Chinese 2 (local variety)

Figure 10. Seeds of six garden pea entries

Reaction to pod borer

Effect of cropping system. Monocropped and intercropped garden pea plants had moderate resistance to pod borer (Table 10). The cropping systems used had little effect on the response of plants to pod borer infestation.

Effect of entry. Entries CGP 34, Chinese 1 and Chinese 2 (local variety) were mildly resistant to pod borer which might be due to the genetic characteristics of the garden pea entries. The result implies lesser weight of non-marketable seeds produced by these garden pea entries.

Table 10. Reaction to pod borer, leaf miner and powdery mildew of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	REACTION TO		
	POD BORER	LEAF MINER	POWDERY MILDEW
CROPPING SYSTEM (CS)			
Garden pea alone	3	2	4
Garden pea + potato	3	2	4
ENTRY (E)			
CGP 13	4	2	4
CGP 34	2	2	4
CGP 59	3	2	4
Betag	3	2	4
Chinese 1	2	2	3
Chinese 2 (local variety)	2	2	3

Rating scale for pod borer: 1-highly resistant; 2-mildly resistant; 3-moderately resistant; 4-susceptible; 5-very susceptible

Rating scale for leaf miner and powdery mildew: 1- highly resistant; 2- moderately resistant; 3-resistant; 4-moderately susceptible; 5-very susceptible

Reaction to leaf miner

Effect of cropping system. The cropping systems did not affect the reaction of the garden pea plants to leaf miner (Table 10). The plants were moderately resistant to leaf miner.

Effect of entry. Table 10 showed that all garden pea entries were moderately resistant to leaf miner. The result might be due to the continuous rainfall prevailing in the site which may have controlled the occurrence of leaf miner.

Reaction to powdery mildew

Effect of cropping system. The different cropping systems apparently made no difference on the reaction of the garden pea entries to powdery mildew. The plants were moderately susceptible to the disease which might be due to continuous rainfall from November to February.

Effect of entry. There were no significant differences observed among the different garden pea plants on their reaction to powdery mildew. Chinese 1 and Chinese 2 (local variety) were resistant to powdery mildew (Table 10) which implies lesser number and weight of non-marketable seeds. Most of the entries were moderately susceptible to the disease.

Weight of potato tuber

Table 11 and Figure 11 showed the weight of marketable and non-marketable potato tubers used as intercrop to garden pea. The weight of marketable potato tubers was generally low which might be due to early infection of late blight. However, the heaviest marketable tubers were obtained from potato intercroped with Chinese 1.

The results imply that selection of a high yielding and more adaptable potato variety for organic production should be considered.

Table 11. Weight of marketable and non-marketable potato tuber

TREATMENT	WEIGHT OF TUBER (g/15m^2)	
	MARKETABLE	NON-MARKETABLE
Potato + CGP 13	74.33	22.67
Potato + CGP 34	114.67	26.33
Potato + CGP59	107.00	26.00
Potato + Betag	99.33	33.67
Potato + Chinese 1	130.00	23.67
Potato + Chinese 2 (local variety)	58.00	27.67

Figure 11. Yield of Potato intercropped with Garden pea

Farmers acceptability

Table 12 and Figure 12 showed that CGP 13 was liked slightly by seven farmers due to its short height and slightly low yield. On the other hand, CGP 34 and CGP 59 were liked very much by nine farmers due to its good growth stand and high yield. However, CGP 34 was liked slightly by one farmer due to its broad pods.

Betag was liked extremely by five farmers due to its good growth stand and slightly narrow but medium-sized pods. Chinese 1 was liked extremely by seven farmers while Chinese 2 (local variety) was liked extremely by ten farmers due to their high yield capacity, tall growth stand and good quality pods. However, both entries were like slightly by one farmer due to its small pods.

In addition, farmers express their observation that growing garden pea under organic production is also applicable in Balili, Mankayan with proper time of planting. However, they commented that the potato variety used was not a good intercrop for garden pea because of its low yield. The farmers suggested that leafy vegetables such as cabbage might be a good intercrop.

Table 12. Farmer acceptability of the six garden pea entries

ENTRY	NUMBER OF FARMERS					
	Dislike slightly	Neither like or dislike	Like slightly	Like moderately	Like very much	Like extremely
CGP 13	1	-	7	4	1	-
CGP 34	-	-	1	3	9	-
CGP 59	-	-	-	4	9	-
Betag	-	-	1	3	4	5
Chinese 1	-	-	1	-	5	7
Chinese 2 (local variety)	-	-	1	-	2	10

Figure 12. Farmers' evaluation on the Garden pea entries at the peak of pod setting

Return on Cash Expenses (ROCE)

Most of the garden pea entries grown as a monocropp and intercropped with potato had positive ROCE except monocropped Chinese 1 which had a negative ROCE. Chinese 1 had a very low yield.

Chinese 2 (local variety) had the highest positive ROCE (Table 13) in both cropping systems. However, Chinese 2 (local variety) intercropped with potato had higher ROCE than planting Chinese 2 (local variety) alone. The higher ROCE obtained came from the added profit from the intercrop (potato). In addition, CGP 34 had a high positive ROCE in both cropping systems.

The positive ROCE implies that producing these entries especially when intercropped with another plant is profitable.

Table 13. Return on cash expenses of the six garden pea entries grown as a monocrop and intercropped with potato

TREATMENT	MARKETABLE SEED YIELD PER 15m^2 (g)	POTATO YIELD (g /15m^2)	TOTAL COST OF PRODUCTION (Php.)	GROSS SALE (Php.)	NET INCOME (Php.)	ROCE (%)
GARDEN PEA ALONE						
CGP 13	280.4		235.26	336.48	101.22	43.02
CGP 34	535.3		235.26	642.36	407.1	173.04
CGP 59	394.4		235.26	473.28	238.02	101.17
Betag	358.7		235.26	430.44	195.18	82.96
Chinese 1	151.2		235.26	181.44	-53.82	-22.87
Chinese 2 (local variety)	605.1		235.26	726.12	490.86	208.64
MEAN						97.66
GARDEN PEA + POTATO						
CGP 13+P	324.1	233	295.26	412.22	116.96	39.61
CGP 34+P	558.7	344	295.26	704.84	409.58	138.71
CGP 59+P	299.7	321	295.26	391.74	96.48	32.67
Betag+P	277.7	298	295.26	363.04	67.78	22.95
Chinese 1+P	307.4	390	295.26	407.88	112.62	38.14
Chinese 2+P (local variety)	765.6	174	295.26	936.12	640.86	217.04
MEAN						81.52

*Total cost of production includes the cost of planting materials, trellis material and organic fertilizer.
*Selling price of garden pea seeds is based on Php. 1200.00 per kilo.
*Potato tubers was sold at a price of 100 per kilo (based on the LaTop organic market price)

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the effect of intercropping garden pea with potato; determine the best garden pea entry intercropped with potato; determine the interaction effect of intercropping and garden pea entries; determine the profitability of the garden pea entries intercropped with potato; and identify the most preferred garden pea entry of farmers.

The garden pea entries was not significantly affected by cropping system on percentage emergence, maturity, flower and pod character, seed characters, seed yield and reaction to pest. However, significant differences were observed on the number of flowers. Most of the entries intercropped with potato have a negative ROCE due to the high cost of production. Most of the monocropped garden pea entries had a positive ROCE due to their high yield and low cost of production.

Chinese 1 and Chinese 1 (local variety) entries significantly produced the highest number of pods per plant followed by CGP 34. Fewer pods were obtained from CGP 59 and Betag. CGP 34 and Chinese 2 (local variety) were significantly the tallest among the entries. On the other hand, CGP 34 had the highest number of seeds per pod.

The garden pea entries Chinese 2 (local variety) and CGP 34 produced the highest yield of marketable seeds and highest positive ROCE. On the other hand, monocropped Chinese 1 have a negative ROCE due to their low marketable seed yield.

Furthermore, CGP 34, Chinese 1 and Chinese 2 (local variety) were mildly resistant to pod borer while the rest were moderately resistant and susceptible to pod borer. All the

entries were moderately resistant to leaf miner. In addition, Chinese 1 and Chinese 2 (local variety) were resistant to powdery mildew while the rest were moderately susceptible.

There were no significant interaction between the cropping systems and the garden pea entries on percentage emergence, maturity, flower and pod characters, seed characters, seed yield and reaction to pest.

Conclusion

Based on the results of the study, growing of garden pea entries either as monocrop or intercropped with potato had similar maturity, resistance to pest, and yield. Among the garden pea entries, CGP 34 and Chinese 2 (local variety) were the best performing entries due to their high yield and moderate resistance to pod borer and leaf miner. Chinese 2 (local variety) either planted as a monocrop or intercropped with potato had the highest positive ROCE. CGP 34 also had above 100% ROCE.

In addition, Betag, Chinese 1 and Chinese 2 (local variety) were most preffered by the farmers due to their high yield, good plant stand and good quality pods.

Recommendation

Based on the findings, Chinese 2 (local variety) and CGP 34 planted as a monocrop or intercropped with potato are recommended for a more profitable organic seed production.

In addition, growing garden pea using organic production practices is recommended under Balili, Mankayan condition.

Further study on intercropping garden pea with other potato varieties or other crops is also recommended.

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