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Evaluation and Performance of Different Bush Snap Beans (*Phaseolus vulgaris* L.) Varieties under Organic Farming System in La Trinidad, Benguet

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Abstract

More people are advocating organic farming and products for food safety, wellness and nutrition, as well as to favor balance and ecologically-sound environment. With few crops being evaluated under organic farming system, this study was conducted to evaluate the performance of seven bush snap bean varieties ('Bokod', 'Sablan', 'French Bean', 'FB Claudine', 'Landmark', 'Pencil Bean', and 'Blue Lake 274' as the check variety) under organic farming system in La Trinidad, Benguet. Parameters such as maturity, pods and seeds size were evaluated. 'Blue Lake 274' produced the biggest pods and seeds in terms of length and width, while 'Landmark' had the heaviest seeds. Marketable seed yield and ROI was highest in 'Bokod' and 'Sablan' varieties, thus, show potential for organic production.

KEYWORDS

seed production
conventional
organic
agri-business
livelihood

Introduction

Snap beans (*Phaseolus vulgaris* L.) is an important world crop. It was originally a crop of the New World, but is now grown extensively in all major continental areas. Its production spans from 52°N to 32°S latitude, and from near sea level in the continental USA and Europe, to elevations of more than 3000 masl in Andean South America (Schoonhoven & Voysest, 1991). Its widespread cultivation is attributed to the benefits it offers including being a rich source of vitamins, minerals and dietary fiber (Kelly & Scott, 1992), its nitrogen fixing association that minimize nitrogen fertilizer input (Piha et al., 1987) and its ability to improve soil condition (Nason & Myrold, 1992). In 2012, about 23.9 metric ton (Mt) of dry bean, 20.7 MT of green (faba) bean, and 1.9 MT of string or snap bean were produced worldwide (FAOSTAT, 2014). This makes snap beans as one of the most important legume vegetable crops.

In the Philippines, snap bean is locally know as 'habitchuelas' or 'Baguio beans'. It is commonly grown in the northern highlands of Benguet, Mountain Province and Nueva Vizcaya, and other mid-elevation areas in the country like Bukidnon, Quezon, and Laguna (Tandang, 2017). In 2013, snap bean production covered around 3,502 ha with an estimated 15,413 Mt production.

Snap bean is a leading crop in Benguet but in 2004 and 2009, the land area planted with

snap bean decreased from 1,798.23 to 817.94 ha and consequently drop the production from 13,098.70 MT to 6,594.58 MT (Commodity Production Profile of Benguet Province, 2004-2009). This is an alarming drop that required intervention by concerned authorities. Like any intervention, researches had to be conducted to gather data as basis for improving production. Unfortunately, researches on snap bean in the locality were relatively few amidst its importance. These include the works of Rai and Alipit (1989) who determined the dry-matter and nitrogen accumulation effected by nitrogen fertilization, Tabangin et al. (1980) on thrips affecting snap beans and their control, Bayogan et al. (1980) on market quality profile assessment, Tandang et al. (2010) on characterization of new NSIC-approved varieties of snap beans, and recently the work of Tandang et al. (2017) on the development and performance of these new NSIC-approves varieties.

Majority of the abovementioned studies were conducted under conventional farming, in which application of synthetic fertilizers and pesticides were rampant. These synthetic inputs were known to cause adverse soil condition (Roy et al., 2010) and majority of soil series in the locality were documented to be degraded (Calubaquib et al., 2016). All major soil series from Luzon (which include Benguet) were found acidic, have low organic matter, total N, available P, and low to moderate exchangeable cations. This degraded soil condition in the locality probably contributed in the drop of snap beans production.

Organic farming system is now being advocated to curb the problem of soil degradation. Organic amendment to soil contributes substantial residual effect on succeeding crops besides supplying nutrients to the target crops (Nambiar & Abrol, 1989). It helps to improve soil physical properties and increase the absorption capacity of soil for cations and anions leading to higher yield (Singh et al., 1981). Also, organic produce are being patronize by government and private entities including private practitioners who recognize the value of food safety, wellness, and nutrition. The productions of organically grown vegetables ensure safe consumption of produce, promote health and favor balance and ecologically sound environment.

Moreover, organic agriculture was documented to be more adaptable to climate change compared to conventional agriculture (Niggli, 2008). However, greater recognition on the potential of organic agriculture in mitigating climate change is needed. More research is needed for improving organic yields in developed countries and in realizing the potential of organic agriculture in mitigating climate change (Kuan, 2009).

One factor that is critical to the success of organic vegetable industry in the upland Cordillera is the availability of varieties adapted to organic production (Tandang, 2017). In the locality, organic farmers are clamoring for snap bean varieties that require low input and with stable yield under local conditions. Since most varieties available commercially are conventionally produced, there is a need to develop or select varieties and produce seeds of bush and pole snap beans under local and organic conditions. Previous studies of Tandang et al. (2009), Suyam (2006), Gapad (2010) and Tandang (2017) had already identified bush and pole snap bean varieties suited for local conditions. However, these varieties were not tested yet under organic system. This is where the study aimed to contribute. In this study, the performance of different bush snap bean varieties were evaluated in terms of maturity, yield, pod and seed length, width, weight and return of investement (ROI) under organic production system. The study hoped to guide farmers in making organic snap bean production viable and profitable.

Materials and Methods

Bush snap bean varieties. Varieties of bush snap beans cultivated under organic production systems were 'Bokod', 'Sablan', 'French beans', 'FB Claudine', 'Landmark', 'Pencil beans' and 'Blue Lake 274'. 'Blue Lake 274' served as the check variety as established in the locality by previous studies (Mulchino, 2007; Tandang et al., 2011).

Experimental plot set-up. The experiment was conducted in Benguet State University Experimental Farm in La Trinidad, Benguet. Organic compost was applied to the plots before planting at 5kg per plot and were mixed with the soil. The bean seeds were planted at 3 seeds per hill with a distance of 30cm between hills and 30cm between rows. Randomized Complete Block Design (RCBD) was used in the experimental

area measuring 210m² which was thoroughly prepared and divided into three blocks. Each block contained 7 plots, one variety per plot, each measuring 1x10m². Each block has a distance of 1x10m² from each other.

At the end of the experiment period, the matures pods were harvested at yellowing state. The harvested pods were properly sun-dried for about a month. After a week from pod drying, the seed were extracted from the pericarp the sun-dried daily for about a month. The seeds were weighed and moisture content was taken simultaneously. The small and undeveloped seed were removed before weighing and packaging. The seeds were packed in plastic bottle containers.

Data gathered. In the study, the data gathered were days to flowering, days to first harvest of mature pods, days to last harvest, pod and seed size (length, width), seed weight, total seed yield and marketable seed weight and (ROI). Pod length was measured from the base to the tip while width at the widest part of ten sample pods taken randomly per plot. Seed length was measures by using a Vernier caliper from the base to the tip while seed width at the widest portion of the ten randomly sampled seeds per plot. To determine the average seed weight, 100 randomly selected seeds were weighed right after drying. Seed yield per hectare (kg) and ROI were determined using the formula:

$$\text{Yield (ton/ha)} = \frac{\text{Total Yield Per Plot}}{\text{Plot Size}} \text{x } 10{,}000 \text{ m2}$$

$$\text{ROI} = \frac{\text{Gross Sales} - \text{Total Expenses}}{\text{Total Expenses}} \text{ x } 100\%$$

Additionally, the susceptibility of bush snap bean varieties to bean rust was rated after flowering and after pod formation. The reaction of variety to bean rust was rated based on the scale in Table 1. All quantitative data were analyzed using LSD with three replications.

Cultural management. Weeding was done three times a month to avoid competition, prevent occurrence of pests and diseased, and maintain the productivity of plants. Hilling-up was done once, irrigation was done twice a week and spraying was done once a week.

Results and Discussion

Pod and Seed Characteristics of Bush Snap Bean Varieties

'Pencil bean' was the fastest to produce flowers among the seven entries of bush snap beans at 33 days after sowing (DAS) as shown in Table 2. 'Blue Lake 274', the check variety, has the longest days to produce flowers at 46 DAS. The number of days form sowing to first and last harvesting significantly differ among the varieties evaluated. Dried pods of 'Blue Lake 274', were the first to be harvested at 85 DAS, comparable to that of 'Pencil Bean' and 'Sablan'. The longest to first harvest were observed in 'French Beans' at 104 DAS; thus consequently also took the longest to produce the last harvestable pods at 115 days. 'Sablan' and 'Landmark' had the shortest day to produce the last harvestable pods at 98 days and 99 days, respectively. The DAS to first and last harvesting in the study were much longer compared to those recorded by Tandang (2017) where 'Blue Lake 274', 'Bokod', 'Sablan' and 'Landmark' varieties had 50 DAS to first harvest and 74-76 DAS to last harvest. This could be attributed to the synthetic fertilizer and pesticide input employed through conventional farming in the study of Tandang (2017).

Table 1

Scale used rating bean rust infection in bush snap bean varieties

Scale	Description	Remarks
1	No infection	High resistance
2	11-25% of the total plant/plot is infected	Mild resistance
3	25-50% of the total plant/plot is infected	Moderate resistance
4	51-75% of the total plant/plot is infected	Susceptible
5	76-100% of the total plant/plot is infected	Very susceptible

"Adopted from: BSU-IPB"

The pod size differ significantly among the seven varieties tested. 'Blue Lake 274' and 'Pencil Bean' registered the longest pods at 13cm while 'FB Claudine' recorded the shortest at 9cm, comparable to that of 'French Bean' at 10cm. 'Blue Lake 274' also recorded the thickest pods at 0.92cm while 'FB Claudine' produced the thinnest at 0.5cm respectively. The pod length and width of Blue Lake 274, 'Bokod', 'Sablan', and 'Landmark' varieties in the study were slightly lower but still comparable with those conventional farmed counterparts in the study of Tandang (2017). In our study, pod length and width of the abovementioned varieties ranged from 9-13cm and 0.6-0.9cm respectively. In addition, the seed lenth of the different varieties differed significantly, ranging from 1.09-1.46cm with 'Pencil Bean having the longest seed at 1.46cm, comparable to that from 'Blue Lake 274' (1.43cm). 'FB Claudine' seeds were the shortest at 1.09cm, comparable to that from 'French Bean' at 1.13cm. In terms of seed width, 'Blue Lake 274' had the thickest seed and 'FB Claudine' was the thinnest at 0.69 and 0.49cm, respectively.

Resistance of Bush Snap Bean Varieties to Bean Rust

Table 3 shows the susceptibility of the tested bush snap bean varieties to bean rust during flowering and pod formation stages. On the onset of flowering, 'Bokod', 'French Beans' and 'Pencil Beans' exhibited mild resistance to bean rust. The rest of the varieties had moderately resistance to bean rust. However, at pod formation stage, only 'Bokod' remained mildly resistant to bean rust while the rest had moderate resistance. This shows that all varieties are viable under organic production in terms of resistance to bean rust.

The result of the study is consistent with the result from Tandang (2017) who determined 'Bokod' variety to be more resistant to bean rust than 'Sablan' and 'Blue Lake 274' under conventional farming. This shows that 'Bokod' variety is the most desirable in terms of bean resistance either under conventional or organic production.

Bean rust is caused by *Uromyces phaseoli typica*, and it affects common dry and snap, lima, and scarlet runner beans. It is a worldwide disease, and can destroy an entire crop if conditions are favorable early in the season. It is more severe in humid areas, and is favored by moderate temperatures. It can cause defoliation early in the season, which reduces yield. If only the leaves are infected later in the season, there is little yield loss, and the need for a chemical defoliant may be eliminated (Sherf & MacNab, 1986; Stavely Rust, 1991).

Table 2

Days to flowering, days to first and last harvest, pod length and width, 100 seeds weight (g), seed length, seed width, seed thickness of seven bush snap bean varieties under organic production.

Bush Snap Bean Varieties	Days to Flowering	Days to 1st Harvest	Days to Last Harvest	Pod Length (cm)	Pod Width (cm)	Seed Weight (g)	Seed length (cm)	Seed width (cm)	Seed Thickness (cm)
Bokod	35.00^{e}	86.33^{d}	99.00^{d}	10.67^{c}	0.71^{cd}	26.33c	1.20^{b}	0.56^{e}	0.51^{b}
Sablan	36.00^{d}	86.00^{e}	98.33^{e}	12.27^{b}	0.73^{bc}	26.33c	1.22^{b}	0.57^{e}	0.45^{d}
FB Claudine	41.00^{d}	92.00^{b}	113.66^{b}	9.37^{d}	0.55^{f}	22.00^{ed}	1.09^{c}	0.49^{f}	0.41^{e}
Landmark	42.33^{c}	89.33^{c}	98.67^{de}	11.53^{b}	0.75^{b}	36.00^{a}	1.21^{b}	0.61^{d}	0.53^{b}
French Beans	42.67^{b}	104.00^{a}	114.67^{a}	10.07^{cd}	0.63^{e}	18.67^{d}	1.13^{cd}	0.59c	0.48c
Pencil Beans	33.00^{f}	85.67^{e}	105.33^{c}	12.97^{a}	0.69^{d}	26.00c	1.46^{a}	0.62^{a}	0.53^{b}
Blue Lake 274*	46.00^{a}	85.33^{e}	98.00^{e}	13.30^{a}	0.92^{a}	30.33^{b}	1.43^{a}	0.69^{b}	0.58^{a}
LSD	0.388	1.297	0.633	0.706	0.028	0.258	0.077	0.027	0.024

Means with the same letter in a column are not significantly different at 5% LSD
** - check variety*

Seed Yield and Return of Investment (ROI) of Bush Snap Bean Varieties

Among the bush snap bean varieties evaluated, 'Bokod' had the highest seed yield at 1.28 kg/10m² plot and ROI of 107.79% when sold at Php470 per kg (Table 4). This was followed by 'Sablan', 'Pencil beans' and 'Landmark' with total yields of 1.21, 1.02 and 0.93 kg per plot with corresponding ROI of 96.43%, 65.59%, 62.99% respectively. 'French beans' variety gave the lowest return on investment at 18.82%.

The ROI of seed yield for 'Bokod' and 'Sablan' in this study was slightly higher than those recorded by Tandang (2017) at 98% and 84%, respectively, but as green pods under conventional farming. Our result could imply than organic production is more profitable than conventional ones or that seed production is more profitable than green pods. Nonetheless, our results clearly showed the better performance of 'Bokod' and 'Sablan' bush snap bean varieties under organic system not just in terms of seed yield and ROI but also in terms of resistance to bean rust. Their performance were twice greater than that of the check variety, Blue Lake 274.

Table 3

Reaction of the seven snap bean varieties to bean rust under organic cultivation

	BEAN RUST RATING	
Varieties	Flowering Stage	Pod Formation
Bokod	Mildly resistant	Mildly resistant
Sablan	Moderately resistant	Moderately resistant
French Beans Claudine	Moderately resistant	Moderately resistant
Landmark	Moderately resistant	Moderately resistant
French Beans	Mildly resistant	Moderately resistant
Pencil Beans	Mildly resistant	Moderately resistant
Blue Lake 274*	Moderately resistant	Moderately resistant

** - check variety*

According to Tandang (2017), Bokod variety has high resistance to bean weevil and moderate resistance to bean rust with an average green pod yield of 9.29 metric tons (MT) ha-¹. It is very much liked by farmers and consumers alike and could be profitably grown both in upland and lowland areas in the country. 'Sablan' variety, on the other hand, also has high resistance to bean weevil and moderate resistance to bean rust with a relatively lower average green pod yield of 8.57 metric tons (MT) ha-¹. These characters of 'Bokod' and 'Sablan' varieties were verified in the study and found consistent even under organic production system.

In this study, the ROI of 'Blue Lake 274', at 51%, was much lower than those recorded by Tandang (2017) at 98% for green pod production under conventional farming. This implies that 'Blue Lake 274' may not be recommended for organic production. This contradicts the finding of Muchino (2007) that 'Blue Lake 274' had the best performance in pod characters and ROI among other varieties examined but this is under conventional farming. This may suggest that 'Blue Lake 274' is most profitable under conventional farming but not in organic farming, as our result suggested.

Comparing the pod and seed characters with seed yield and ROI in the study, it appears that there is no correlation or observable coherence between these characters. Pod length and width and even seed length, width or weight did not translate to seed yield (kg) and ROI. For example, 'Blue Lake 274' had consistently longer, wider pod and bigger, heavier seeds but this not translate to higher seed yield (kg) and ROI. Instead, it is 'Bokod' and 'Sablan' that had the highest seed yield (kg) and ROI while having average pod length and width and seed length, width and weight. This observation is opposite with those observed in the study of Tandang (2017). Bush snap bean varieties with the largest pods tends to have the largest green pod yield. This contrasting results could suggest that pod characters (length and width) may directly correspond with green pod yield but not with seed yield.

Table 4

Average seed yield, cost of production, gross sales, net income and return of investment of bush snap beans cultivated in the organic production system

Bush Snap Bean Varieties	Marketable Seed Yield (kg/10m² plot)	Total Cost of Production (Php)	Gross Sales (PhP)*	Net Income (Php)	Return of Investment (ROI) (%)
Bokod	1.28	289.51	601.60	312.09	107.79
Sablan	1.21	289.51	568.70	279.19	96.43
French Beans Claudine	0.56	289.51	448.00	158.49	54.74
Landmark	0.75	289.51	352.50	62.99	62.99
French Beans	0.43	289.51	344.00	54.49	18.82
Pencil Beans	1.02	289.51	479.40	189.89	65.59
Blue Lake 274*	0.93	289.51	437.10	147.59	50.97

** - prices for all varieties is at Php 470/kg except for French beans at 800/kg*

Conclusions

This study evaluated the performance of seven bush snap bean varieties namely 'Bokod', 'Sablan', 'FB Claudine', 'Landmark', 'Pencil beans', 'French beans', and 'Blue Lake 274' for seed production under organic production system in La Trinidad, Benguet. 'Blue Lake 274' had consistently longer, wider pod and bigger seeds. 'Landmark' had the heaviest seeds. 'French beans' and 'FB Claudine' have consistently smaller pods and seeds. The large pods and seeds of 'Blue Lake 274' and 'Landmark' did not translate to higher seed yield (kg) and return of investment. Instead, it is 'Bokod' and 'Sablan' that had the highest seed yield and ROI. These results confirmed 'Bokod' and 'Sablan' varieties as potential cultivars of bush snap bean for organic production.

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