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Effects of Swiftlet (*Aerodramus fuciphagus*) Manure and Methods of Crop Establishment on the Growth and Yield of Sweet Corn (*Zea mays* var. Saccharata) in Western Leyte, Philippines

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Abstract

Methods of crop establishment and fertilizer applications are crucial management practices that enhance the productivity of sweet corn farming. A field study was conducted for Macho F1 sweet corn at the experimental area of the Department of Agronomy, Visayas State University, Baybay City, Leyte to evaluate the agronomic responses of Macho F1 sweet corn to levels of swiftlet manure under different methods of crop establishment. The experiment was laid out in split plot in randomized complete block design with three replications with methods of crop establishment designated as the main plot and different levels of swiftlet manure as subplots. Transplanting method of crop establishment shortened the number of days from planting to green cob stage, produced higher net assimilation rate and crop growth rate value of Macho F1 sweet corn plant. However, direct seeding was found to be more economically favorable due to higher ROI and net income of 128% and PhP 133, 865.83, respectively. Application of 10 t/ha of swiftlet manure produced tallest plant, highest NAR and CGR of Macho F1 sweet corn plant. Swiftlet manure application at 5 and 10 t/ha surpassed the other treatments in terms of yield, LAI at 49 and 63 days after planting. These treatments also produced more marketable ear yield but the application of 5 t/ha of swiftlet manure proved to be more economically favorable with a net income of PhP 328,773.00 and higher ROI of 315%. Application of 5 t/ha of swiftlet manure is the appropriate rate for achieving better yield and profitability for Macho F1 sweet corn production under direct seeding method of crop establishment.

Keywords: Crop establishment; Direct seeding; Transplanting; Swiftlet manure

Introduction

Sweet corn is one of the well-loved staple crop next to rice. It has achieved a major success as important commercial cash crop in many tropical and semi-tropical countries. Production of sweet corn was found to be very promising livelihood for farmers. This is because sweet corn is simpler to grow, labor saving, and has high market demand for food than growing for grain [1]. Based on the assessment of the Department of Agriculture Region VIII [2], sufficiency level of Region VIII for sweet corn is consistently very low. Thus, sweet corn production is a very good source of motivation for discovering new ideas and inputs to increase productivity.

In the Philippines, sweet corn is conventionally grown through direct seeding method but new studies in University of Vermont, United States of America and Eastern Cape, South Africa showed that transplanting method of crop establishment resulted in better agronomic and economic productivity than the conventional method [3,4]. In fertilizer management, organic-based fertilizers are being encouraged due to benefits on soil properties. The excessive mismanagement of synthetic chemicals such as fertilizers and pesticides degraded the soil through time. A breakthrough in organic fertilizer is the discovery of the swiftlet manure (*Aerodramus fuciphagus* O.) locally known as *Balinsasayaw*. Researchers in Malaysia claimed that swiftlet manure has high nutritional value [5]. However, only limited studies were done on swiftlet manure and crop establishment on sweet corn production in the Philippines. Thus, findings of this research will serve as baseline information about swiftlet manure in sweet corn production under different methods of crop establishment.

This field experiment was conducted to compare the performance of Macho F1 sweet corn under direct and transplanting method of crop establishments; evaluate the effects of swiftlet manure on the growth and yield of Macho F1 sweet corn; determine the appropriate rate of swiftlet manure for optimum yield of Macho F1 sweet corn hybrid; and assess the profitability of using swiftlet manure in Macho F1 sweet corn production under two methods of crop establishment.

Materials and Methods

Time and place and design of the study

This study was conducted at the experimental area of Department of Agronomy, College of Agriculture and Food Science of the Visayas State University, Visca, Baybay City, Leyte from July 27, 2016 to November 19, 2016. The experiment was laid out in split plot arranged in randomized complete block design with three replications. Crop establishment was designated as the main plot (M1-direct seeding, M2-transplanting) while fertilizer management as the subplot (T_0-Control, no fertilizer applied; T_1-5 t/ha of swiftlet manure; T_2-10 t/ha of swiftlet manure; T_3-2 t/ha of swiftlet manure +30-30-30 kg/ha N,

P_2O_5, K_2O; T_4-2 t/ha of swiftlet manure +60-30-30 kg/ha N, P_2O_5, K_2O; T_5-Inorganic Fertilizer 120-60-60 kg/ha N, P_2O_5, K_2O).

Soil Sampling collection and analysis of the test site

Ten soil samples were randomly collected from the experimental area before application of treatments. These were composited, air-dried, and analyzed at the Central Analytical Service Laboratory (CASL) of the PhilRootcrops, VSU, Baybay City, Leyte for soil pH, organic matter content (%), total N (%), available phosphorous (mg/kg) and exchangeable potassium (me/100 g).

Land preparation

The area was plowed and harrowed twice at weekly interval. After the second harrowing, furrows were made at a distance of 0.75 m between rows. Alleyways of 1 m between replication and 0.50 m between subplot were done to facilitate farm operations and management as well as data gathering.

Swiftlet manure collection and nutrient analysis

The composted swiftlet manure was collected from Tabing, Tabango, Leyte and transported to the study site at Visayas State University while the inorganic fertilizers were secured from the nearest agricultural store in Baybay City, Leyte.

One kilogram of swiftlet manure samples was analyzed for pH, total N (%), P (%), K (%), and organic matter content (%) at the Central Analytical Service Laboratory (CASL) of Phil Root Crops, Visayas State University, Visca, Baybay City, Leyte. Results showed that the swiftlet manure was very slightly acidic with a pH of 6.88, had very high organic matter content (67.08%), high total nitrogen (9.96%), very low total P (1.15%) and total K (2.54%).

Application of fertilizer

Swi tlet manure was applied by equally distributing it in the furrows of each treatment plot two weeks before planting for T_1 (5 t/ha of swi tlet manure), T_2 (10 t/ha of swi tlet manure), T_3 (2 t/ha of swi tlet manure) and T_4 (2 t/ha of swi tlet manure) while the inorganic fertilizers (complete fertilizer at rate of 30-30-30 kg/ha N, P_2O_5, K_2O) was applied prior to planting by drilling it in the furrows for T_3, T_4 and T_5. Side dressed was applied 25 days a ter planting for T_4 (30 kg/ha of Urea) and T_5 (60-30-30 kg/ha N, P_2O_5).

Planting and thinning

The sweet corn variety used was Macho F1. This variety produced long cylindrical ears with 14-18 kernel rows and with good tip-filled kernels. Its green husk made it look fresh and more attractive to buyers. This variety is non-seasonal. Economically, it is a high yielding hybrid with wide market potential because it can be used for fresh and processed markets.

In transplanting method, seeds were sown in seedling trays a week before the field planting schedule. These were transplanted in the field seven days after at one seedling per hill simultaneously with the direct seeding. For direct seeding method, seeds were sown at the rate of 2 seeds per hill at the distance of 0.75 m between rows and 0.25 m between hills Thinning was done 15 days after planting leaving only one plant per hill to have the desired plant population of 53,333 plants per hectare. Only 70% under direct seeding method had germinated thus replanting of missing hills was done.

Cultivation and maintenance management

Off-barring was done 20 days after planting using a carabao-drawn implement. Hilling up was employed 30 DAP in order to cover the fertilizer during side dressing. Hand-weeding was employed at 7, 21 and 35 DAP. It was done to control weeds within the experimental area such as *Cyperus rotundos*, *Rottboella cochinchinensis*, *Amaranthus spinosus*, *Eleusine indica* and *Mimosa pudica*. Three weeding operations were employed during the conduct of the experiment due to the high rate of weed incidence. Drainage canals were constructed around the experimental area and between replications to avoid waterlogging during heavy rains.

Insect pests and diseases were controlled by application of Panyawan (*Tinosphora rumphii* B.) botanical pesticide biweekly starting V_3 of vegetative stage until ear formation stage. Daily monitoring of the experiment was done in order to assess the presence of insect pest infestations especially corn stem borers.

Harvesting

Sweet corn at green cob stage was harvested when 80% of the crop population reached R_4 stage or when it formed its dough grain and the kernel interior was similar to a dough. The corn silks at this stage also turned dry as indicated by their senesced brown color. All sample plants were taken from harvestable area excluding the end hills of each row and one row from each side.

Data gathered

Agronomic characteristics

Number of days from planting to tasseling stage: This was determined by counting the number of days from planting up to the time when 80% of the population in the plot tasseled.

Number of days from planting to silking stage: This was recorded by counting the number of days from planting up to the time when 80% of the crop population reached silking stage.

Number of days from planting to green cob stage: This was recorded by counting the number of days from planting up to the time when 80% of the crop population reached green cob stage.

Plant height (cm): This was determined by measuring 10 sample plants in each plot from ground level up to the tip of the highest plant part using a meter stick. This was done biweekly starting at two weeks after planting for a close monitoring of the growth and development of the crop.

Fresh stover yield (t/ha): This was determined by weighing the stalks of corn plants from the harvestable area in each treatment plot within the four inner rows after removing the ears.

Stover Yield (t/ha)=[Stover (kg)/Harvestable Area (13.125 m^2)] × [10,000 m^2/ha/1,000 kg/t]

Physiological parameters

Leaf area index: The measurement was done by randomly selecting ten (10) sample plants in each treatment plot. During the early vegetative stage where the number of fully expanded leaves was less than eight, the length and width of all the leaves were measured and LAI was calculated using the formula on the next page:

LAI=[Length × width × 0.75]/Ground area allotted per plant

During the stage where corn already consisted of eight or more fully-expanded leaves, LAI was computed by measuring the length of the flag leaf. Width was measured at the leaf's broadest part while the length was measured from the base to the tip. The leaf area index was calculated with the formula:

LAI=[Length × width × 0.75 × 9.39]/Ground area allotted per plant

Where, 9.39=correction factor for the 8^{th} leaf, 0.75=correction factor for the leaf area, L=Length of leaf no. 8, W=Width of leaf no. 8 measured at the broadest part.

Net assimilation rate (g/cm^2 day): This was gathered biweekly starting from the vegetative until early reproductive stage (56 days). Leaf samples were oven dried at 70°C for 3 days. This was calculated using the formula:

$NAR=[(W_2-W_1) \times (\ln LA_2-\ln LA_1)]/[(t_2-t_1) \times (LA_2-LA_1)]$

Where, ln=natural logarithm, W_1=total plant dry weight at time t_1, W_2=total plant dry weight at time t_2, LA_1=leaf area at time t_1, LA_2=leaf area at time t_2, t_1-t_2=time interval between the first and second measurement.

Crop growth rate (g/m^2 day): The crop growth rate (CGR) indicated the dry matter accumulated per unit land area per unit time. CGR of a species is closely related to interception of solar radiation. Data on total plant dry weight were collected from three weeks after planting until two weeks before the harvest period on biweekly interval. CGR was calculated using the formula:

$CGR=(W_2-W_1)/[(t_1-t_2) \times LA]$

Where, W_1=total plant dry weight at time T_1, W_2=total plant dry weight at time T_2, t_1-t_2=time interval between the first and second measurement, LA=Land Area.

Yield and yield components

Yield is the product of the combined or integrated effects of the environment and the genetic make-up of the plants given a well-defined human intervention. It is composed of several components each exerting specific influence on yield. Some of which affects the yield directly while others contribute indirectly. Below are some of the yield components of sweet corn that may affect its ear yield.

Ear length (cm): This was determined by measuring ten sample ears from base to tip using a ruler at harvest.

Ear diameter (cm): This was determined by measuring the diameter of the biggest portion of each ear (10 sample ears per plot) using a vernier caliper.

Number of kernel rows: This was determined by counting the number of rows per ear of the 10 sample ears.

Ear yield (t/ha): All cobs from the harvestable area of each treatment plot were harvested, husked and weighed to obtain the total yield using the formula:

Ear yield (t/ha)=[Plot yield (Kg)/Harvestable area (13.125 m^2)] × [(10,000 m^2/ha)/(1,000 Kg/ton)]

After harvesting, the ears were classified into marketable and non-marketable ears and weighed. Marketable ears had long cylindrical ears with good tip-filled kernels. The non-marketable ears had visible damages of corn borers, shorter ear length and unfilled kernel rows.

Total Ear yield (t/ha)=Marketable ears+Non-marketable ears

Profitability analysis

The production cost was determined by recording all the expenses incurred throughout the conduct of the study from land preparation up to harvesting. Total cost incurred for each activity was determined. These included the cost of fertilizers, materials and labor. Moreover, the imputed cost which was the value of land rental which is worth PhP 1,737.00 was based from Philippine Statistics Authority [6]. The returns was determined by multiplying the marketable yield with the current market price of sweet corn. The net return was determined by subtracting the total expenses from the return. Returns, costs and net returns were calculated using the following formulas:

- Returns=Marketable Yield (kilograms) × Current market price (Php)
- Total Cost=Total Fixed cost+Total variable cost
- Net Returns (Loss)=Returns-Total cost

Return on investment is another measure of farm profitability. It measures the percent (%) amount of returns earned with each peso of invested cost. It is calculated using the following formula:

ROI=[(Returns-Total Cost)/Total Cost] × 100

Statistical analysis

Data collected were statistically analyzed using Statistical Tool for Agricultural Research (STAR) version 2.0.1 2014, Biometrics and Breeding Informatics, Plant Breeding Genetics and Biotechnology Division, International Rice Research Institute, Los Baños, Laguna.

Results and Discussion

The soil used in this study was moderately acidic with a pH of 6 which is suitable for corn production. Optimum pH range for corn is 5.3-7.3 [7]. Organic matter was low as represented by organic carbon of 2.35%. It has medium total N (0.22%), very low in available P (3.84 mg/kg) and low in exchangeable K (0.20 me/100 g soil).

Agronomic characteristics of sweet corn

Corn is commonly direct seeded however, transplanting is done sometimes in hybrid sweet corn production when conditions are less favorable for direct seeding such as when heavy rainfall pose a threat to seeds and the emerging seedlings specifically in an area with Type IV climate like the Western Leyte. Hybrid sweet corn seeds are expensive hence, farmers need to devise strategy to obtain a good crop stand. Most studies conducted were on the response of direct seeded corn on fertilizer. Information is lacking on the response of transplanted sweet corn.

In this study, transplanting method produced taller sweet corn at 21 DAP only. This method of crop establishment enhanced earlier tasseling, silking and consequently earlier maturity than direct seeding method (Table 1). This observation was also reported by Fanadzo et al. [4] that transplanting seedlings had a good head start than the directly seeded plants resulting in better adaptation and transition in the outside environment leading to early maturity. In terms of fertilizer effects, unfertilized plants bore tassel, silk and matured earlier than the fertilized plants (Table 1). This could be due to inadequate nutrient supply resulting to early senescence of the crop. McKenzie [8] mentioned that unfertilized plants senesced faster and produced more non-marketable ears because of nutritional stress.

Treatment	Number of days from planting to tasseling	Number of days from planting to silking	Number of days from planting to green cob stage	Plant Height (cm)				
				21 DAP	35 DAP	49 DAP	63 DAP	Stover Yield (t/ha)
Crop Establishment								
Direct Seeding	55.78a	60.72a	81.89a	13.56b	111.83a	198.00a	226.67a	9.57a
Transplanting	51.67b	54.50b	73.94b	18.17a	114.89a	201.00a	230.53a	11.77a
Fertilizer								
T_0-Control (No fertilizer applied)	50.00b	53.33b	71.17b	9.00c	34.67d	53.83e	72.33e	6.51c
T_1-5 t/ha of Swiftlet manure	53.67a	57.33a	79.17a	17.50ab	124.17c	247.67b	274.17b	29.34a
T_2-10 t/ha of Swiftlet manure	54.17a	58.00a	79.00a	20.33a	138.17a	251.00a	282.00a	30.35a
T_3-2 t/ha of Swiftlet manure plus 30-30-30 kg/ha N, P_2O_5, K_20	54.83a	59.00a	78.83a	14.83b	123.67c	207.83d	239.67d	23.68b
T_4-2 t/ha of Swiftlet manure plus 60-30-30 kg/ha N, P_2O_5, K_2O	54.67a	58.33a	79.33a	16.00b	132.00b	203.83d	250.17d	22.50b
T_5-Inorganic Fertilizer: at 120-60-60 kg/ha N, P_2O_5, K_2O	55.50a	59.17a	80.00a	17.50ab	127.50b	232.83c	264.83c	22.08b
C.V. (a)%	2.03	4.55	1.5	10.51	16.72	9.84	4.43	12.68
C.V. (b)%	2.18	3.16	2.15	14.67	10.32	5.97	3.7	8.94
Means within column followed by the same letter are not significantly different at 5% level, HSD.								

Table 1: Agronomic characteristics of sweet corn (Macho F1) as influenced by levels of swiftlet manure under different methods of crop establishment.

At early growth stage (21 DAP), application of swiftlet manure at 5 and 10 t/ha produced taller plants comparable to those applied with inorganic fertilizer at 120-60-60 kg/ha N, P_2O_5, K_2O (T_5). As the plants grew and developed further, application of 10 t/ha of swiftlet manure (T_2) produced the tallest corn plants followed by plants applied with 5 t/ha swiftlet manure. This is because the plants at this stage were already big and it requires higher amount of nutrients since its rate of growth becomes faster. Swiftlet manure used in this study had high N content of 9.9%. In all growth stages considered, unfertilized plants were the shortest (Table 1).

For stover yield, similar trend was observed where the unfertilized corn plants gave the lowest stover yield while those applied with swiftlet manure (5 and 10 t/ha) produced highest stover yield suggesting that 5 t/ha is the rate of swiftlet manure enough to produce high stover yield for sweet corn. Corn plants applied with 2 t/ha of swiftlet manure+inorganic fertilizer gave stover yield statistically similar to those applied with inorganic fertilizer alone (Table 1).

Physiological parameters

Statistical analysis revealed that leaf area index of corn plants was not affected by method of crop establishment but significantly affected by levels of swiftlet manure (Table 2). Application of 10 t/ha swiftlet manure consistently gave higher leaf area index of corn from 21 DAP-63 DAP (Table 2).

This result could be possibly due to high nitrogen content of swiftlet manure. This was supported by findings of Farhad et al. [9] who stated that organic compost supply high amount of nutrition for better crop establishment thus, producing high leaf area index of the sweet corn plants. No significant difference was observed in crop establishment method in terms of LAI.

Generally, the net assimilation rate (NAR) of corn plants continued to increase from 14 until 42 days after planting and declined thereafter due to leaf shading. Total biomass decreased with decreasing irradiance reflecting reductions in dry mass of leaves, stems and roots. Highest NAR was observed under transplanting method of crop establishment because the sweet corn plants had a good head start making them efficient in terms of dry matter accumulation than the direct seeding method (Table 2). As regards the application of swiftlet fertilizer, high level of swiftlet manure (10 t/ha) had the highest NAR value followed by application of 5 t/ha of swiftlet manure alone which was statistically comparable to the application of inorganic fertilizer alone (120-60-60 kg/ha N, P_2O_5, K_2O).

Treatment	Leaf Area Index				NAR (g/cm^2 day)			CGR (g/m^2 day)		
	21 DAP	35 DAP	49 DAP	63 DAP	14-28 DAP	28-42 DAP	42-56 DAP	14-28 DAP	28-42 DAP	42-56 DAP
Crop Establishment										
Direct Seeding	1.78^a	2.63^a	3.48^a	4.03^a	6.32^b	14.64^b	12.95^b	6.49^a	16.96^b	33.56^b
Transplanting	1.87^a	2.58^a	3.71^a	4.35^a	7.68^a	17.63^a	15.85^a	7.06^a	22.07^a	40.34^a
Fertilizer										
T_0-Control (No fertilizer applied)	0.05^c	0.11d	0.18^e	0.21^c	4.62^e	9.02^e	7.34^e	5.11^c	10.71^e	27.77^e
T_1-5 t/ha of Swiftlet manure	2.33^{ab}	3.67^{ab}	4.93^{ab}	5.80^a	7.92^a	18.25^b	16.33^b	8.19^a	22.95^b	41.40^b
T_2-10 t/ha of Swiftlet manure	2.61^a	3.93^a	5.27^a	6.17^a	8.42^a	23.35^a	21.71^a	8.20^a	27.26^a	43.65^a
T_3-2 t/ha of Swiftlet manure plus 30-30-30 kg/ha N, P_2O_5, K_2O	1.85^b	2.31^c	3.27^d	4.03^b	6.44^d	12.84^d	11.33^d	6.03^b	15.73^d	34.02^d
T_4-2 t/ha of Swiftlet manure plus 60-30-30 kg/ha N, P_2O_5, K_20	1.96^b	2.58^c	3.68^{cd}	4.27^b	7.02^c	15.61^c	13.83^d	6.30^b	19.19^c	35.93^d
T_5-Inorganic Fertilizer: at 120-60-60 kg/ha N, P_2O_5, K_2O	2.14^{ab}	3.02^{bc}	4.25^{bc}	4.67^b	7.58^b	17.76^b	15.83^b	6.82^b	21.26^b	38.93^c
CV (a)%	20.29	19.54	5.82	6.72	6.81	8.4	12.14	16.18	16.77	8.73
CV (b)%	16.48	19	12.56	8.52	5.34	6.58	7.28	7.31	10.3	4.99
Means within column followed by the same letter are not significantly different at 5% level, HSD.										

Table 2: Physiological parameters of sweet corn (Macho F1) as influenced by levels of swiftlet manure under different methods of crop establishment.

Combination of lower rate of swiftlet manure (2 t/ha) and inorganic fertilizer gave lower NAR value than those applied with higher rate of swiftlet fertilizer alone. Lowest NAR was observed in the unfertilized plan.

In terms of crop growth rate (CGR), method of crop establishment failed to show significant difference at early growth stages (14-28 DAP). However, as the corn plant matures (28-42 DAP and 42-56 DAP), CGR also increased with transplanting method producing the highest CGR due to good head start (Table 2).

With regards to the effect of fertilizer treatments, application of 5 and 10 t/ha of swiftlet manure (T_1 and T_2) produced highest CGR at early growth stage (14-28 DAP). These were followed by the application of 2 t/ha swiftlet manure+inorganic fertilizers (T_3 and T_4) and application of inorganic fertilizer (120-60-60 kg/ha N, P_2O_5, K_2O). At later stage of crop growth (28-42 DAP and 42-56 DAP) application of high amount of swiftlet manure (10 t/ha) had higher CGR than the rest of the treatments. Plants without fertilizer (T_0) gave the lowest CGR (Table 2).

Yield and yield components

Results revealed that yield and yield components of Macho F1 sweet corn were not affected by crop establishment. However, all the parameters studied were significantly affected by swiftlet manure application (Table 3). Application of swiftlet manure at the rate of 10 t/ha (T_2) and 5 t/ha (T_1) gave the highest ear length and number of kernel rows.

Consequently, they gave the highest marketable and total ear yield but lowest in non-marketable yield. The high marketable and total yield of these two treatments could be attributed to longer and bigger ears and more kernel rows due to high nutrient content of swiftlet manure (Table 3).

Nkongolo et al. [10] found out that the application of organic fertilizer such as guano which is comparable to swiftlet manure produced 2.1 t/ha of corn higher than without fertilizer. Furthermore, these treatments gave the highest CGR in all growth stages which means that application of swiftlet manure at high level (5 & 10 t/ha) led to high crop productivity (Table 3).

This result supports the findings that organic manure application improves soil tilth, aeration, water holding capacity of the soil and encourages microbial and enzymatic activities that make nutrients available for plant use [11,12]. Application of inorganic fertilizer alone at 120-60-60 kg/ha N, P_2O_5, K_2O as well as those in combination of swiftlet manure and inorganic fertilizer produced lower marketable yield and higher non-marketable yield which apparently resulted from stem borer infestation.

Treatments	Ear length (cm)	Ear diameter (cm)	Number of kernel rows	Marketable Ear Yield (t/ha)	Non-Marketable Ear Yield (t/ha)	Total Ear Yield (t/ha)
Crop establishment						
Direct seeding	16.53[a]	4.25[a]	13.16[a]	4.42[a]	2.79[a]	7.21[a]
Transplanting	16.73[a]	4.18[a]	13.74[a]	4.47[a]	2.53[a]	7.00[a]
Fertilizer						
T_0	6.98[c]	1.36[c]	3.00[c]	0.01[d]	2.08[a]	2.09[c]
T_1	19.55[a]	5.00[ab]	16.67[a]	8.63[a]	0.55[b]	9.19[a]
T_2	21.55[a]	5.58[a]	17.73[a]	9.36[a]	0.47[b]	9.83[a]
T_3	17.27[b]	4.33[b]	14.53[b]	3.42[b]	3.92[a]	7.34[b]
T_4	17.37[b]	4.47[b]	14.00[b]	3.08[bc]	4.13[a]	7.21[b]
T_5	17.10[b]	4.55[b]	14.08[b]	2.21[c]	4.84[a]	7.05[b]
C.V. (a)%	10.6	11.73	5.39	4.96	21.88	7.07
C.V. (b)%	6.83	9.7	7.26	8.61	14.1	7.42

Means within column followed by the same letter are not significantly different at 5% level, HSD.

Legend:

T_0-Control (No fertilizer applied)

T_1-5 t/ha of swiftlet manure

T_2-10 t/ha of swiftlet manure

T_3-2 t/ha of swiftlet manure plus 30-30-30 kg/ha N, P_2O_5, K_2O

T_4-2 t/ha of swiftlet manure plus 60-30-30 kg/ha N, P_2O_5, K_2O

T_5-Inorganic Fertilizer: at 120-60-60 kg/ha N, P_2O_5, K_2O

Table 3: Yield and yield components of sweet corn (Macho F1) as influenced by levels of swiftlet manure under different methods of crop establishment.

Pest damage was minimized by the application of botanical pesticide (Panyawan-based extract), except in T_0 (control treatment) and T_5 (120-60-60 kg/ha N, P_2O_5, K_2O) where stem borer and stalk rot infestation was severe. Lowest yield was observed in the control plants (Table 3).

Profitability analysis

Direct seeding method of crop establishment had higher net returns of PhP 133,865.83 with an economically favorable ROI of 128% as compared to the transplanting method due to its lower cost of production (Table 4). Transplanting method incurred higher cost of production because of additional expenses such as purchase of seedling trays and labor for planting Macho F1 sweet corn seeds on seedling trays.

Application of 5 t/ha of swi tlet manure (T_1) gave a net income of PhP 326, 404.50 which is PhP 2,368.50 lower than the application of 10 t/ha. However, it was observed to be more economically favorable because it had a higher ROI of 315% which was 75% higher than the ROI obtained with the application of 10 t/ha of swi tlet manure (Table 4). This was due to the lower cost of production of the former treatment. Only the treatment with no fertilizer applied (T_0) had negative ROI of 99% and loss of PhP 67,227.00 which is attributed to low marketable ear yield (Table 4).

Treatments	Marketable Ear Yield (t/ha)	Gross Income (PhP/ha)	Production Cost (PhP/ha)	Net Returns (PhP/ha)	ROI (%)
Crop Establishment					
Direct Seeding	4.42	220,916.67	87,050.83	133,865.83	128
Transplanting	4.47	223,583.33	115,225.83	108,357.50	77
Fertilizer					
T_0	0.01	500	67,727.00	-67,227.00	-99

T_1	8.14	431,250.00	104,845.50	326,404.50	315
T_2	9.16	466,750.00	137,977.00	328,773.00	240
T_3	2.96	170,750.00	95,833.00	74,917.00	83
T_4	2.68	154,000.00	99,731.00	54,269.00	59
T_5	1.78	110,250.00	100,716.50	9,533.50	15

Market Price=PhP 50.00/kg

Legend:

T_0-Control (No fertilizer applied)

T_1-5 t/ha of swiftlet manure

T_2-10 t/ha of swiftlet manure

T_3-2 t/ha of swiftlet manure plus 30-30-30 kg/ha N, P_2O_5, K_2O

T_4-2 t/ha of swiftlet manure plus 60-30-30 kg/ha N, P_2O_5, K_2O

T_5-Inorganic Fertilizer: at 120-60-60 kg/ha N, P_2O_5, K_2O

Table 4: Profitability of sweet corn as influenced by levels of swiftlet manure under different methods of crop establishment.

Conclusion

Transplanting method of crop establishment shortened the number of days from planting to tasseling, silking and green cob stage in Macho F1 sweet corn. It resulted in higher net assimilation and crop growth rates of Macho F1 sweet corn. Transplanting and direct seeding method did not differ significantly in terms of ear yield, ear length and ear diameter as well as number of kernel rows. Both methods were able to produce good results. However, direct seeding method of crop establishment was more economically favorable due to higher ROI of 128% and net return of PhP 133,865.83.

Application of 10 t/ha of swiftlet manure produced the tallest plant, highest net assimilation and crop growth rate of Macho F1 sweet corn. Swiftlet manure at 5 t/ha and 10 t/ha of gave the highest leaf area index, marketable ear yield, longest and biggest ear and most number of kernel rows. But the application of 5 t/ha of swiftlet manure was the appropriate rate for optimum yield of Macho F1 sweet corn with a net return of PhP 328,773.00 and ROI of 315%.

Recommendation

For higher net returns and ROI of Macho F1 sweet corn production, direct seeding and application of 5 t/ha of swiftlet manure should be adapted.

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