Effect of Different Bio-Fertilizers Applied as Supplemental Foliar Spray on the Growth and Yield ff Corn (Zea Mays L.)

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Abstract - *Different bio-fertilizers like Fermented Plant Juice (FPJ), Indigenous Micro-Organisms (IMO) and Effective Microorganisms Activated Solution (EMAS) was prepared and applied as foliar spray to evaluate its effects on the growth and yield of corn at Conner, Apayao condition. Initial application was at 25 days after planting (DAP) and re-application after 7 days for 5 consecutive weeks.*

The different bio-fertilizers differed significantly in final plant height, ear height, number of leaves, ear length, ear diameter, weight of 1,000 seeds, yield per quadrant and computed yield. On the other hand, there was no significant difference on the number of rows per ear, shelling recovery and drying recovery.

EMAS produced the tallest plant, highest ear height, the most number of leaves, longest ear length, biggest ear diameter, heaviest weight of 1,000 seeds, and highest weight per quadrant and computed yield.

Furthermore, EMAS and IMO registered the highest ROCE while control was almost similar with the vermi tea and FPJ had the lowest.

Keywords: *bio-fertilizer, foliar spray, FPJ, IMO, EMAS*

INTRODUCTION

Along with rice and wheat, corn is one of the world's three major crops. In 2000, the major corn-producing countries include the USA and China although corn is also found in every country in the world and is planted more extensively than any other crop except wheat. Since 1950, worldwide production of corn has steadily increased from about 150 million to 550 million tons in industrialized countries, and from about 50 million to over 200 million tons in developing countries. Likewise in Asia, corn production has increased greatly as use of meat in the diets increases. Countries like Korea, does not only import millions of tons of corn as feed but also produces corn on extensively for both human and livestock consumption [1].

In the Philippines, corn along with rice is among the most important crops having about 14 million Filipinos preferring white corn as their main staple. Yellow corn on the other hand accounts for about 50% of livestock mixed feeds. Aside from the transport services, traders, processors and agricultural input suppliers who directly benefit from corn production, processing, marketing and distribution, there are about 600,000 farm households depending on corn as a major source of livelihood. In 2011, corn production in the country is recorded to be 6.97 million metric tons (MMT) [2].

In Apayao Province, corn as the second banner product is planted together with rice, banana timber and fruit bearing trees. In the municipality of Conner, most of the corn produce come from the barangays of Paddaoan, Ripang, Mawigue, Allangigan, Calafug and Sacpil which were identified as corn producing areas [3].

In a study conducted by the Apayao State College, most corn farmers rely on the use of inorganic fertilizers to increase their yield [4]. Although this modern agricultural practice have been observed to effect increased grain yield, the increasing cost of inorganic fertilizers negates the positive effects in yield or even sometimes resulting to negative return on cash expenses of farmers. In addition, there is the danger that with the long term and excessive use, it can lead to soil degradation which can result to decrease in crop yield in the long run.

To ensure maximum crop productivity while minimizing environmental risk, there is a need to apply the fundamental principles of sustainable

agriculture which include the use of renewable resources and organic inputs [5]. Furthermore, the introduction of integrated plant nutrients system which includes the application of organic and biofertilizers does not only help in maintaining and increasing the soil fertility but also aids in making the highly productive cereals mono cropping systems more sustainable [6]. Organic materials hold great promise due to their local availability as a source of multiple nutrients and ability to improve soil characteristics [7].

Biofertilizers has become an integral part of the integrated nutrient supply system; providing potentials for enhanced crop growth and yield.

The use of biofertilizers was introduced due to the presence of different types of microorganisms which can turn nutritionally important elements from unavailable to available forms [8, 9].

In another study conducted in Conner, it was found out that the use of organic fertilizers, particularly Vermi tea, was seen to have significantly improved the growth and yield of corn. This is due to the presence of plant growth regulators in vermi tea, and its ability to improve the condition of the soil [10].

Therefore, the objectives of this study is to investigate the efficacy of other biofertilizers like Fermented Plant Juice (FPJ), Indigenous Micro-Organisms (IMO), and Effective Microorganisms Activated Solution (EMAS) as supplemental or alternative forms of fertilizers for corn.

OBJECTIVES OF THE STUDY

This study was conducted to determine the effect of different bio-fertilizers applied as supplemental foliar spray on the growth and yield of corn.

Specifically it was conducted to determine which bio-fertilizer would give the most significant effect on the growth and yield of corn; to compare the occurrence of pests and diseases as affected by the application of the different bio-fertilizers; and to determine the Return on Capital Expense (ROCE) in using the different bio-fertilizers on corn.

METHOD

Experiment Area/Site

The study was conducted at Barangay Sacpil, Conner, Apayao starting December 2014 to April 2015. The soil is classified as Alemodian Clay Loam (MPDO-Conner. 2000) with a semi-rolling topography.

A hybrid F1 corn variety was planted using conventional method. The area was divided into five (5) plots as treatments, and each plot was subdivided into 3 sub-plots as replication. A 3 m x 3 m quadrant was determined in all the treatments where data was gathered.

Planting

Before planting, basal application of inorganic fertilizers at the rate 80-40-40 NPK per hectare was applied along the furrows. One seed per hill was planted with distance of 65-70 cm between furrows and 20-25 cm between hills.

Treatments

The different bio-fertilizers as treatments/ interventions were initially applied at 25 Days After Planting (DAP) and repeat application every 7 days for 5 applications. The treatments were the following:

T_0- Control-Farmers' Practice: No Foliar Application

T_1- Fermented Plant Juice (FPJ)

T_2- Indigenous Micro Organisms (IMO)

T_3- Effective Microorganism Active Solution (EMAS)

Application and Dosage

The different bio-fertilizers were applied five (5) times during the crop growth with the following dosages: FPJ- 200 ml/ 10 liters water; IMO- 200 ml/ 10 liters water; EMAS- 1 liter/ 10 liters water.

Preparation of the Bio- Fertilizers

The different bio-fertilizers were prepared through the following processes:

a. Fermented Plant Juice

Chop 2 kilos of green colored leaves such as kangkong , kamote, kalabasa, alugbati tops, young banana trunk and other fast growing plants and mix with 1 kilo of sugar. Place in a plastic container and let it to ferment for 7 days. Squeeze then filter the juice to separate sludge and put in a clean container for future use.

b. Indigenous Micro Organisms

Cooked rice was put in a box, tray or bamboo pole; covered with clean sheet of paper and was put on forested area until white molds appear on the rice. The moldy rice was mixed with brown sugar with a

ratio of 1:1. After 7 days, the resulting mud-like juice is collected and put into jars/bottles ready for use.

c. Effective Micro-organisms Activated Solution

Mix molasses with water and coconut juice. Add the EM 1 then add the yeast. Place the solution in an airtight plastic container but the cover will not be totally closed to let the gas escape during the fermentation. Ferment the material for 1 week in a cool, dark place and shaded area. Repack the fermented materials in smaller containers and store in room temperature for future use.

Pests and Disease Management

Since the variety used is RR/YG, there was minimal pest and disease damage on the corn plants which was assessed as way below the Economic Threshold Level (ETL), thus chemical application was not suggested.

Harvesting

Harvesting was done when the corn plants had exhibited the index of maturity.

DATA GATHERED

a. Occurrence Of Pests And Diseases

1. Occurrence of pests- the reaction to pests attack was obtained using the following rating scale:

Rating Scale	Description	Remarks
1	No infestation	High Resistance
2	1 - 25 % of plants infested	Mild Resistance
3	26 - 50 % of plants infested	Moderate Resistance
4	51- 75 % of plants infested	Susceptible
5	76 – 100 % of plants infested	Very Susceptible

2. Occurrence of diseases- the reaction to disease infection was obtained using the following rating scale:

Rating Scale	Description	Remarks
1	No infestation	High Resistance
2	1 - 25 % of plants infested	Mild Resistance
3	26 - 50 % of plants infested	Moderate Resistance
4	51- 75 % of plants infested	Susceptible
5	76 – 100 % of plants infested	Very Susceptible

b. Growth Parameters

1. Initial Plant Height (cm). It is the average height of 10 sample plants taken at the time of the first application of the bio-fertilizers at 25 days after planting (DAP) measured from the soil level to the longest extended leaf.
2. Final Plant height (m). The average height of 10 sample plants taken at the time of harvesting measured from the soil level to the base of the flag leaf.
3. Initial Number of Leaves- The number of leaves of the 10 sample plants per treatment were counted except the whorl leaves. This was taken at 25 DAP.
4. Final Number of Leaves. Average total number of leaves of 10 sample plants from planting to harvesting.
5. Ear Height (cm). Average height of 10 sample plants measured from the soil level to the base of the ear taken during harvesting.

c. Yield And Yield Components

1. Ear Length (cm). Average length of 10 sample husked ears taken from the base of the ear to the tip of the corn cob.
2. Ear Diameter (cm). The diameter of the 10 sample ears were measured at the biggest portion using a caliper.
3. Number of Rows per Ear. The average number of kernel rows on the ears of the 10 sample plants.
4. Shelling Recovery (%). It is the weight of the corn kernels after shelling. The recovery percentage is computed using the formula:

$$\text{Shelling Recovery (\%)} = \frac{\text{Weight of shelled kernels}}{\text{Weight of husked corn ears}} \text{ x } 100$$

5. Drying Recovery (%). It is the weight of corn kernels after drying. The recovery percentage is computed using the formula:

$$\text{Drying Recovery (\%)} = \frac{\text{Weight of dried corn kernels}}{\text{Weight of shelled kernels}} \text{ x } 100$$

6. Weight of 1,000 seeds (grams). It is the weight of 1,000 seeds taken from a composite sample after it has been sundried for 2 days.
7. Yield per Quadrant (kg). It is the total yield of the plants in the 3 m x 3 m quadrant.
8. Computed Yield (t/ha). It is the total yield of the plants in the 3 m x 3 m quadrant computed into tons per hectare using the formula:

$$\text{Computed Yield } \left(\frac{\text{t}}{\text{ha}}\right) = \frac{\text{Actual Yield (kg)}}{\text{Harvest area (m2)}} x \frac{1{,}000 \text{ kg}}{10{,}000 \text{ m } 2}$$

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Table 1. Reaction to pest infestation as affected by the different bio-fertilizer application

	Corn Plant Hoppers		Corn Aphids		Armyworms/ Cutworms		Corn Earworms	
	Rating	Remarks	Rating	Remarks	Rating	Remarks	Rating	Remarks
CONTROL	3	Moderate Resistance	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance
FPJ	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance	1	High Resistance
IMO	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance
EMAS	2	Mild Resistance	1	High Resistance	1	High Resistance	1	High Resistance

1. Diseases

Table 2. Reaction to disease infection as affected by the different bio-fertilizer application

	Downy Mildew		Leaf Rust		Leaf Spot	
	Rating	Remarks	Rating	Remarks	Rating	Remarks
CONTROL	2	Mild Resistance	3	Moderate Resistance	2	Mild Resistance
FPJ	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance
IMO	2	Mild Resistance	2	Mild Resistance	2	Mild Resistance
EMAS	1	High Resistance	2	Mild Resistance	1	High Resistance

DISCUSSION OF RESULTS

a. Occurrence Of Pests And Diseases

2. Pests

The reaction to pest infestation as affected by the different bio-fertilizer application was presented in Table 1.

For corn plant hoppers, the different bio-fertilizers had mild resistance as compared to the control which registered moderate resistance. EMAS produced high resistant corn to corn aphids while IMO, FPJ and control had mild resistance.

For the armyworms and cutworms, all the treatments had mild resistance while for corn earworms FPJ and EMAS had high resistance compared to IMO and control which registered mild resistance.

Corn plants sprayed with EMAS showed high resistance to downy mildew while the other treatments produced mild resistance. For leaf rust, all the bio-fertilizers registered mild resistance compared to control with moderate resistance. Lastly on leaf spot, EMAS had high resistance while FPJ, IMO and control had mild resistance.

3. Growth Parameters

Initial Plant Height and Number Of Leaves

The height and number of leaves of the corn plants at 25 Days After Planting (DAP) is presented in Table 3. The initial plant height of Control (70.00 cm.) is slightly higher than the other treatments. On the other hand, FPJ (7.23) had more leaves than the other treatments.

Analysis of Variation reveals that the means were significantly different at 5 % level DMRT. This shows that there were slight difference on the plant height and number of leaves before the different bio-fertilizers was applied.

Table 3. Plant height and number of leaves of the corn plants at 25 DAP

Treatments	Plant Height (Cm)*	Number of Leaves*
CONTROL	70.00[a]	6.87[b]
FPJ	65.77[b]	7.23[a]
IMO	63.67[b]	6.23[c]
EMAS	64.50[b]	6.47[b]
c.v.	4.03%	5.21%

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

**significant at 5 % level DMRT*

Table 4. Final plant height, total number of leaves and ear height of the plants at harvesting

Treatments	Final Plant Height (M)**	Final Number Of Leaves**	Ear Height (M)**
CONTROL	2.27[d]	16.73[d]	1.24[c]
FPJ	2.33[c]	17.43[c]	1.38[b]
IMO	2.39[b]	17.57[b]	1.36[b]
EMAS	2.54[a]	17.77[a]	1.48[a]
c.v.	1.49%	1.15%	3.65%

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

Final Plant Height (M)

As viewed from Table 4, EMAS had the tallest plants with mean of 2.54 meter. It is followed by FPJ (2.33 m), while control was shortest with a mean of 2.27 meters.

Analysis of Variation says the treatments were highly significant. This implies that the microorganisms and the enzymes in these different bio-fertilizers had a significant effect on the growth of the corn plants.

Final Number of Leaves

The treatment EMAS produced the most number of leaves with mean of 17.77, followed by IMO (17.57) and FPJ (17.43). Lastly, Control got the least number of leaves with mean of 16.73.

ANOVA reveals a highly significant difference between the treatments.

Ear Height (M)

With mean of 1.48 m, EMAS is significantly different from the other treatments while FPJ (1.38m) and IMO (1.36m) were almost similar from one another. Control is significantly lower than all the bio-fertilizers applied.

Analysis of Variation on the treatments means is highly significant.

4. Yield And Yield Components

The yield and yield components is presented in Table 5 and 6.

Ear Length (Cm)

The length of ears of the sample plants is presented in Table 5. It can be noted that all the interventions was significantly similar to one another with EMAS having the longest ear length with 80.83 cm followed by FPJ (79.63), and IMO (79.27) but were significantly different at 5 % level DMRT from the control.

Coefficient of variation for was computed at 2.83%.

Table 5. Ear length, Ear Diameter, Number of Rows per Ear, Shelling and Drying Recovery of corn

Treatments	Ear Length (Cm)*	Ear Diameter (Cm)*	Number Of Rows Per Ear Ns	Shelling Recovery (%)Ns	Drying Recovery (%)Ns
CONTROL	73.13[b]	4.01[b]	13.07	82.84	90.10
FPJ	79.63[a]	4.53[a]	14.00	86.70	91.42
IMO	79.27[a]	4.47[a]	13.47	84.17	90.89
EMAS	80.83[a]	4.57[a]	14.27	86.71	92.29
c.v.	2.83%	3.74%	3.85%	3.46%	2.31%

Means with the same letter/s are not significantly different at 5 % level DMRT
**significant at 5 % level DMRT*
ns not significant

Table 6. Weight of 1,000 seeds, yield per quadrant and computed yield of corn

Treatments	Weight Of 1,000 Seeds (Grams)**	Yield Per Quadrant (Kg)*	Computed Yield (T/ Ha)*
CONTROL	255.00[c]	4.45[c]	4.95[c]
FPJ	275.00[b]	4.86[c]	5.40[c]
IMO	286.67[a]	6.19[a]	6.88[a]
EMAS	290.00[a]	6.82[a]	7.58[a]
c.v.	2.07%	12.07%	12.12%

Means with the same letter/s are not significantly different at 5 % level DMRT
***highly significant*
**significant at 5 % level DMRT*

Ear Diameter (Cm)

Similar to ear length, the different bio-fertilizers were significantly similar to one another but were significantly different from the control at 5 % level DMRT. Coefficient of Variation was 3.74%.

Number Of Rows Per Ear, Shelling Recovery (%), Drying Recovery (%)

There was no significant difference on the treatments on number of rows per ear, shelling recovery (%) and drying recovery (%).

Weight of 1,000 seeds

As presented in Table 6, EMAS and IMO had the highest mean of 290.00 and 286.67 grams which are significantly similar, followed by FPJ with mean of

275.00 grams. Control registered the lowest weight with 255.00 grams.

Analysis of Variation revealed a highly significant difference between the different bio-fertilizers and control.

Yield per Quadrant (kg)

The treatments EMAS and IMO registered a significantly similar yield of 6.82 kg and 6.19 kg respectively. It is followed by FPJ with mean of 4.86 kg which is comparable to control with mean of 4.45 kg.

ANOVA reveals significance of the treatments at 5 % level DMRT.

Economic Analysis on Corn Production

ITEMS	AMOUNT
A. LABOR COST	
1. Land Preparation (Tractor)	1,500.00
2. Furrowing (3 MAD @ 300)	900.00
3. Basal Fertilizer Application (3 MD @ 150)	450.00
4. Planting (15 MD @ 150)	2,250.00
5. 1st Spraying of Herbicide (4 MD @ 200)	800.00
6. Side dressing of N Fertilizer (4 MD @ 150)	600.00
7. 2nd Spraying of Herbicide (4 MD @ 200)	800.00
8. Harvesting (15 MD @ 150)	2,250.00
9. Hauling	1,000.00
10. Shelling	1,800.00
11. Hauling to Drying Pavement	1,000.00
12. Drying (5 MD @ 150 x 2 days)	1,500.00
SUB-TOTAL	**14,850.00**
B. MATERIAL COST	
1. Seeds (2 bags @ 4,500)	9,000.00
2. Fertilizers : 2 bags 14-14-14 @ 1,050	2,100.00
3 bags urea @ 900	2,700.00
3. Herbicides :	1,780.00
4. Twine	440.00
5. Bio-fertilizers:	50.00
FPJ (0.5 L @ P 30/ L – for 27 m^2 area)	5,555.56
IMO (0.5 L @ P 40 / L – for 27 m^2 area)	7,407.40
EMAS (2 L @ P 15/ L – for 27 m^2 area)	11,111.11
SUB TOTAL	**16,170.00**

	CONTROL	FPJ	IMO	EMAS
YIELD (t/ha)	4.95	5.40	6.88	7.58
Price per Kg	11.5	11.5	11.5	11.5
Gross Income	56,925.00	61,920.00	79,120.00	86,970.00
Cost of Production	30,920.00	36,475.56	38,327.40	42,031.56
Net Income	**26,005.00**	**25,444.44**	**40,792.60**	**44,938.44**
ROCE	**84.10%**	**69.76%**	**106.43%**	**106.92%**

Computed Yield (t/ha)

The treatments EMAS and IMO had a significantly similar yield of 7.58 t/ha and 6.88 t/ha respectively. FPJ and Control had a significantly similar yield of 5.40 t/ha and 4.95 t/ha respectively.

Analysis of Variation says treatments were significant at 5 % level DMRT. The treatment means were higher to the Region 02 average yield of 5.05 t/ha on the same variety (Agri Pinoy Corn Technoguide, 2012).

The micro-organisms in the EMAS and IMO solutions might have resulted into higher yield as these micro-organisms facilitates in the decomposition of the organic matters in the soil. Further, the better root growth of the corn plants may have contributed to higher absorption of nutrients which leads to higher yield.

CONCLUSION AND RECOMMENDATIONS

The different bio-fertilizers had a very significant effect on the growth of the corn plants in terms of final plant height, ear height, number of leaves, ear length, ear diameter, weight of 1,000 seeds, yield per quadrant and computed yield of corn.

However, it had no significance on the number of rows per ear, shelling and drying recovery percentage.

EMAS had the best performance compared to the other bio-fertilizers in almost all the data gathered.

EMAS and IMO registered the highest ROCE with 106.92% and 106.43% respectively while FPJ had the lowest with 69.76 %.

It is highly recommended that The EMAS, IMO, and FPJ can be used as supplemental spray to improve the growth and increase the yield of corn; A follow-up study be conducted to evaluate the effect of the different bio-fertilizers during the wet season (July-November); and the bio-fertilizers may be applied on other crops to evaluate its efficiency.

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