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# Growth and Yield of White Corn (*Zea mays L.*) as Affected by Growth Enhancer

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## ABSTRACT

Seed priming is a beneficial technique to improve seed germination, uniformity and growth in many crops like corn. Effective Microorganisms (EM), a commercial concoction of microbes which include yeasts, fungi, bacteria and actinomycetes were found effective in enhancing crop growth. Effective Microorganisms as growth enhancer on stocked corn seeds was conducted under the laboratory and field conditions from January 27 to May 10, 2020 at San Isidro Sur, Luna Apayao, Cordillera Administrative Region. Five growth enhancers: Oriental Herbal Nutrient, Coconut Water, Lactic Acid Bacteria, Wood Vinegar and Effective Microorganism were used as seed primer under the laboratory experiment. Results showed that stocked seeds primed with any of the growth enhancers attained comparable length and weight of roots and shoots at 10 and 20 DAS. However, germination test showed that EM resulted in higher percentage germination thereby used under field conditions.

Results showed significant differences in terms of plant and ear heights, length and diameter of husked corn ear, heavier unhusked and husked ears per plant and per 6.75m$^2$ sampling area. Presoaking of seeds with EM plus the recommended rate of inorganic fertilizer significantly increased the yield and gave the highest return on investment of stocked corn seeds particularly at a level of 150%. Therefore, seed treatment using EM is proven to be an effective technique to increase germination as well as yield of white corn.

**Keywords:** Microorganisms; Growth enhancer; Promoter; Inoculant; Concoction

## INTRODUCTION

Seed quality plays an important role in the production of agronomic like corn and horticultural crops. Characteristics such as trueness to variety, germination percentage, purity, vigor, and appearance are important to the farmers. Priming allows some of the metabolic processes necessary for germination to occur without germination take place. In priming, seeds are soaked in different solutions with high osmotic potential [1]. This technique has become a common seed treatment that can improve rate, percentage and uniformity of germination or seedling emergence, mostly under unfavorable environmental circumstances. Corn production increases up to 612 thousand ha from 571 thousand ha [2]. Cagayan Valley contributes to significant increase including the Cordillera Administrative Region. Corn is one of the national banner programs of the Department of Agriculture with the increase of the production extension services such as providing farm machineries, irrigation system and seed support system. Thousands of bags of corn seeds from the regional centers are distributed to the corn farmers as seed support and to change the seeds for those who were affected by calamities. These are being delivered to Provincial Agriculture Office and redistributed to the Local Government Unit-Municipal Agriculture Offices and finally seed support will be awarded to the farmers. However, these seeds reached the end user with low germination percentage due to improper storage. Low germination of corn seed is an effect of complex scenarios like old stock from regional office, passes true many agencies, protocols of awarding, not planted after being awarded due to climate change and damage from pest and diseases in the warehouse. Growth Promoters/soil inoculants/growth enhancers such as Effective Microorganism (EM), Oriental Herbal Nutrient, Wood vinegar (Mokusako), Lactic Acid Bacteria and Coconut Water are some of the well-known growth promoters that increases the germination percentage of corn seeds. Since growth promoters are effective to improve the germination performance, seedling growth, and seed yield of corn it is necessary to determine the effect of the different growth enhancers on the percentage germination, growth and yield and highest return on investment [3].

However, these can be determined by keeping accurate records of production and by conducting field studies during the growing season, hence this study.

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# MATERIALS AND METHODS

## Source of seeds

The corn seeds (Var. IES White) were acquired from the Local Government Unit, Department of Agriculture Office, Luna, Apayao, Cordillera Administrative Region. These seeds are those left-over from the subsidized seeds given by the Department of Agriculture to the local farmers and stocked from the previous cropping season. The stocked seeds were not advisable for animal feeding as these were treated with chemical.

## Soaking of corn seeds

Plain tap water was used for seed soaking for the control treatment. Five growth enhancers were diluted into unchlorinated water and used for seed priming. The seeds were soaked for 12 hours using the different invigorating treatments.

## Experimental treatment (Study 1)

The dilution is based on the standard recommendation as follows:

Data gathered: After the corn seeds were soaked in the different growth enhancers, the highest germination percentage from among the treatment was selected. One hundred seeds were planted per treatment and replicated three times. Ten plants were used for destructive sampling on the 10th and 20th days after sowing to determine the length and weight of roots and shoots and the seedling vigor of the plants [4,5].

Seedling vigor test: Seed vigor is an important quality parameter which needs to be assessed to supplement germination and viability tests to gain insight into the performance of a seed lot in the field or in storage. It is an improved agronomic practices and seed handling which includes:

**Germination percentage:** The germination percentage was recorded using this formula:

$$Germination\% = \frac{(Number\ of\ Seeds\ Germinated)}{(Total\ Number\ of\ Seeds)} \times 100$$

**Root length:** Destructive sampling was done on the 10 and 20 days after planting. The roots were dunged up to collect the root system. The length of the root was measured using ruler in centimeter. Ten samples were measured per plot.

**Shoot length:** Shoot of the corn was measured on the day 10 and 20 days after planting using ruler.

**Fresh root weight:** The roots were extracted thoroughly washed and the weight was taken at 10 and 20 days after planting. Electronic weighing scale was used to weight the fresh roots of the white corn.

**Fresh shoot weight:** The shoots were weight on the 10 and 20 days after planting.

The treatment with the highest germination percentage was served as planting materials under field experiment.

## Study 2 (Field experiment)

**Soil analysis:** Soil samples were gathered prior to land preparation. One-kilogram composite soil was brought to the Bureau of Soils and Water Management for the nutrient analysis. Result of the analysis is shown in below.

**Land preparation:** The area was thoroughly plowed using tractor and harrowed twice before planting to attain good physical tilt of the soil and allowed proper decomposition of stables and to eliminate germination weeds seeds before planting.

**Experimental design and layout:** Three blocks were established in the prepared area in which each block was divided into six plots. Each plot measured 5 meters in width and 6 meters in length at 0.50 meter apart between rows. Alleyways of one meter between blocks were provided and numbered consecutively from left to right in any given replication/block.

## Experimental treatments

Among the seed enhancers used under the laboratory experiment, Effective microorganisms attained the highest seed germination percentage thereby this was combined to the inorganic fertilizer (Table 1).

## Application of fertilizer and effective microorganisms

The recommended rate of inorganic fertilizer based on the soil analysis was applied into two split applications. All the amount of P and K and half of nitrogen were applied as basal. The other half of nitrogen was side dressed at 30 days after planting.

Effective Microorganisms were activated using a ratio of 1:1:20, one liter of EM plus one liter molasses plus 20 liters unchlorinated water which were mixed and fermented for 5 days to increase good bacteria in the EM solution. The Table 1 below was used as guide in the preparation of activated EM and water applied to the plants as foliar spray and drenched at different time of applications.

## Planting

Corn seeds were soaked with Effective microorganisms. After which, corn seeds were planted at two to three seedlings per hill following the distance of 25 centimeters between hills and 75 centimeters between furrows. Thinning was done leaving one (1) healthy seedling per hill and replanting of missing hills was done seven days after planting.

## Care of the plants

**Cultivation:** Off-barring was done three weeks after planting to eliminate young weeds. Manual operation was done to cover the applied fertilizer in order to provide better anchorage of the plants towards increase roots aeration. Likewise, hand pulling of weeds was done to fully remove the weeds along the furrows.

**Irrigation:** Artificial irrigation was done to supplement the moisture requirements of the crop.

**Crop protection:** Appropriate pesticides following the recommendation of the manufacturer were applied as the need arises. Likewise, hand picking of insects was employed to totally eliminate in the area.

## Data gathered

**Plant height at 30, 60 DAP and at harvest:** The height of the ten randomly selected corn plants were measured from the ground level up to the tip of the collar leaf using meter stick at 30, 60 days after planting and at harvest from the ground level up to the tip of the tassel a day before harvest.

**Ear height:** The ear heights of the ten sample plants were measured a day before harvesting using measuring tape. Measurement was taken from the first node up to node bearing the ear of the plants.

**Length of husked ear:** The ten sample husked corn ears were measured from end to end using foot rule.

**Diameter of husked ear:** The diameter of the husked ears was measured from the ten sample plants. Measurement will be done at the central portion of the husked ear using caliper.

**Weight of unhusked and husked ear per plant:** The ten unhusked and husked corn ears were weighed using digital weighing balance.

**Ear weight per sampling area:** The unhusked and husked corn ears harvested from the sampling area was weighed using the digital weighing balance.

**Projected ear yield per hectare:** The projected ear yield per hectare of each treatment was computed based on the ear weight per sampling area using the formula:

$$Yield\ per\ Hectare = \frac{Yield\ per\ Sampling\ Area}{Sampling\ Area} \times 10,000\ sq.\ m$$

**Cost and return analysis:** The cost and return analysis was computed to determine the most economical treatment in terms of return on investment.

## Statistical analysis

All data gathered were analyzed using the Statistical Tool for Agricultural Research (STAR). The Duncan's Multiple Range test was used to compare significant treatment means.

# RESULTS AND DISCUSSION

## A. Seedling vigor (Study 1)

Germination test and germination responses after seed treatment: The germination percentage of corn seeds treated with different growth enhancers (Figure 1). It shows that regardless the seeds of corn were primed with any of the growth enhancers; no statistical differences were observed with means ranged from 68.67% to 77.00%. However, Effective microorganisms numerically registered the highest germination percentage.


**Figure 1:** Percentage germination of the stocked seeds using different growth enhancers.

**Length of roots (cm):** Vigor index of the corn plants is represented by the length of roots, shoots and the seed germination percentage. It shows that the root length of the seeds primed with the different growth enhancers 10 days after sowing exhibited non-significant difference with mean ranged from 12.57 cm to 13.98 cm. In like manner, the root length of the corn plants at 20 days after sowing showed trend of results as indicated by a non-significant difference among treatments with mean values that ranged from 16.82 cm to 18.29 cm.

**Length of shoots (cm):** The length of shoots at 10 days after planting as affected by the growth enhancers did not influenced the length of shoots with mean values means ranged from 18.63 cm to 21.51 cm. Similarly, at 20 days after planting, the length of shoots was not affected by the treatments imposed with mean values ranged from 25.61 cm to 29.50 centimeters.

**Weight of roots (g):** At 10 days after planting, no variation on the weight of roots was treatments existed. Mean weight of roots ranged from 8.00 grams to 9.00 grams, indicated that the neither growth enhancers nor inorganic fertilizer added to the plants did not influence the root mass.

Likewise, the weight of roots of the corn plants at 20 days after planting as influenced by the various growth enhancers did not show any significant differences (Figure 2). The mean weight that ranged from 14.67 cm to 20.00 cm showed that any of the growth enhancers had no effect to increase the weight of roots of the plants (Table 1).

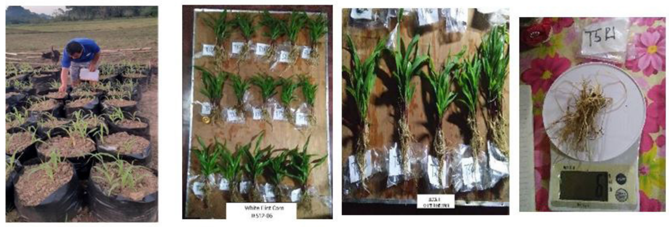

**Figure 2:** Destructive samples for the length and weight of shoots and roots 10 and 20 days after sowing.

**Table 1:** Control treatment experimental treatment of seeds (Study 1).

| Treatments | Solutions | Ratio |
|---|---|---|
| Treatment 1 | Oriental herbal nutrient | 1 ml:500 ml (OHN: Water) |
| Treatment 2 | Coconut water | 15 ml:500 ml (CW: Water) |
| Treatment 3 | Lactic acid bacteria serum | 1 ml:500 ml (LABS:Water) |
| Treatment 4 | Wood vinegar | 1 ml:200 ml (WV:Water) |
| Treatment 5 | Effective microorganism | 1 ml:500 ml (EM:Water) |

**Note:** OHN: Organic Herbal Nutrient; CW: Coconut Water; LABS: Lactic Acid Bacteria Serum; WV: Wood Vinegar; EM: Effective Microorganisms.

## B. Field experiment (Study 2)

**Growth and yield parameter:** Four levels of Effective Microorganisms (100% RR EM, 150% RR EM, 200% RR EM and 250% RR EM were combined to the recommended rate of inorganic fertilizer under field conditions. The results on the growth and yield attributes of white corn are as follows:

**Plant height (cm):** The initial growth of the corn crop was assessed in terms of the plant heights. At 30 days after planting, significant difference in heights were noted between the corn fertilized with the recommended rate of inorganic fertilizer and varying levels of EM. The plants applied with the recommended rate of 100-20-0 kg NPK with 100% EM ($T_2$), 150% EM ($T_3$), 200% EM ($T_4$), 250% EM ($T_5$) as well as the plants applied with pure EM ($T_6$) produced the tallest with a comparable mean values of 82.29 cm, 64.94 cm, 75.12 cm, 76.07 cm and 76.99 centimeters, respectively. The plants without fertilizer ($T_1$) produced the shortest with a mean of 61.49 centimeters.

Likewise, fertilization affected the height of the plants at 60 days after planting. Taller corn plants were noted by the application of 100-20-0 kg NPK $ha^{-1}$ in combination to the varying rates of Effective Microorganisms. Plants fertilized with EM alone ($T_6$), 100-20-0 kg NPK $ha^{-1}$+100% RR EM ($T_2$), $T_5$ (100-20-0 kg NPK $ha^{-1}$+250% RR EM), $T_4$ (100-20-0 kg NPK $ha^{-1}$+200% RR EM), $T_3$ (100-20-0 kg NPK $ha^{-1}$+150% RR EM) obtained corresponding mean values of 171.60 cm, 185.33 cm, 187.23 cm, 192.77 cm and 193.60 centimeters, respectively. The untreated plants had the smallest with a mean of 155.80 centimeters.

The same trend of results where variation was noted from the start of the observation period wherein the fertilized plants were taller over the unfertilized plants. Regardless of the levels of EM in combination to inorganic fertilizer attained taller plants with corresponding values of 204.43 cm ($T_3$), 202.60 cm ($T_2$), 198.91 ($T_4$) cm and 197.50 centimeters. However, the plants fertilized with EM alone obtained comparable height with a mean of 181.47 cm while the unfertilized plants had mean value of 163.13 centimeters.

Overall, there was a height increment of 102.60 percent ($T_2$), 104.43 percent ($T_3$), 97.5 percent ($T_4$), 98.97 percent ($T_5$) and 81.47 percent ($T_6$) over the control treatment was noted in terms of plant height at harvest. The increase on the height of the plants over the unfertilized plants is due to the amount of inorganic fertilizer in combination with Effective Microorganisms that resulted in taller plants and eventually promotes good vegetative growth. It shows that seed priming is beneficial technique to improve seed germination and growth in stress conditions in many crops like corn [6]. The supplementation of Effective Microorganisms (EM) that contains mixed cultures of beneficial and naturally-occurring microorganisms increase the microbial diversity of soils and improves soil quality as well as the health, growth, yield and quality of crops [7]. Effective Microorganisms contains particular taxa of microorganisms including populations of lactic acid bacteria, yeasts, and smaller numbers of photosynthetic bacteria, actinomycetes, and other types of organisms large number of beneficial microorganisms including photosynthetic bacteria and N-fixing bacteria that can enhance the plant's photosynthetic rate and efficiency and its N-fixing capacity as well [2]. On the other hand, smaller plants from the control plots are due to nitrogen deficiency thereby resulted in stunted growth and smaller leaves.

On the ear height of the plants, the non-uniform stands in corn resulted in lower yields because the smaller and late-emerging plants cannot capture enough sunlight. In this study, it was observed that there was a positive effect on the combination of inorganic fertilizer and Effective Microorganisms existed in increasing the ear height of corn as presented in Figure 3. The significant difference was noted in which taller ear height was obtained by the plants fertilized with the recommended rate of fertilizer (120-20-0 kg NPK $ha^{-1}$+150% RR EM) with 71.57 centimeters, yet comparable to the plants fertilized with 100-20-0 kg NPK ha+100% RR EM ($T_2$), 100-20-0 kg NPK ha+150% RR EM ($T_3$), 100-20-0 kg NPK ha+250% RR EM ($T_5$) and 100-20-0 kg NPK ha+200% RR EM ($T_4$) produced mean values of 71.57 cm, 71.07 cm and 69.97 centimeters, respectively. The smallest ear heights were noted at Treatment 6 (EM alone and the control plots ($T_1$) with both 47.63 centimeters (Figure 3).

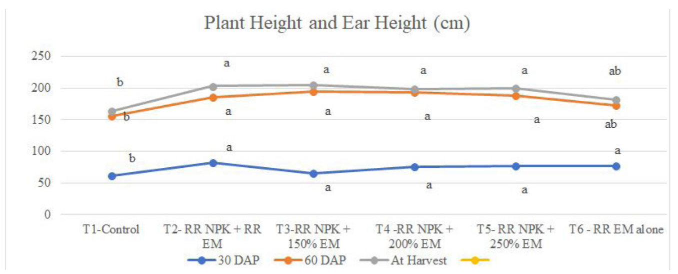


**Figure 3:** Plant and ear height of corn as affected by varying levels of effective microorganisms and inorganic fertilizer. Significance: (—•—) 30 DAP; (—•—) 60 DAP; (—•—) At Harvest; (—•—). **Note:** Means with a common letter are not significantly different with each other using DMRT.

The increase in the ear height of the plants is due to the application of fertilizer thus produced taller plants and ear heights. In cereal like corn, increase on the application of nitrogen also increases biomass particularly the above ground plant parts and stem elongation represents a period of rapid dry matter production and high nitrogen demand. Moreover, the increase in nitrogen rates extended vegetative growth period of corn that increases photosynthetic assimilate production and its partitioning to stems that might have favorable impacts on heights of corn [1]. In addition, EM can significantly enhance the soil fertility and promotes growth, flowering, fruit development and ripening in crops. It can increase crop yields and improve crop quality as well as accelerating the breakdown of organic matter from crop residues [8].

**Ear length and diameter (cm):** Irrespective of the levels of Effective Microorganisms in combination with the recommended rate of inorganic fertilizers as in Treatments 2, 3, 4, 5, 6, the corn plants produced longer husked ears with comparable mean values of 18.60, 18.90, 19.68, 19.45 and 16.68 centimeters. The plants fertilized with pure Effective Microorganism ($T_6$) and the unfertilized control plot ($T_1$) produced the shortest ears with comparable mean values of 16.65 and 16.49 cm. Possible reason is that EM cultures applied in soil stimulate the decomposition of organic matter thereby realizing inorganic nutrients for plant uptake and increase nutrition of the plants (Figure 4).

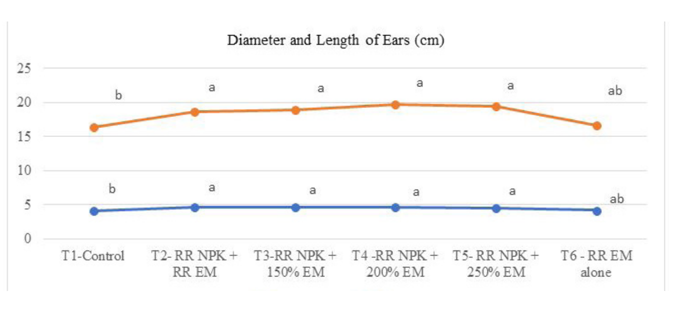


**Figure 4:** Ear diameter and length of ear of the plants (cm) as affected by varying levels of effective microorganisms and inorganic fertilizer. **Note:** Means with a common letter are not significantly different with each other using DMRT; **- significant at 1% level. Significance: (—•—) Diameter; (—•—) Length.

There is a positive response of corn to the combination of EM and inorganic fertilizer as indicated by longer ears which showed that the nutrients requirements by the crop are being supplied from these sources. On the other hand, EM alone is not an alternative to soil fertilization, but that it may be useful to supply part of the necessary nutrients and stimulate nutrient absorption by the root system. Effective Microorganisms are beneficial naturally occurring organisms that can be applied to increase the microbial diversity of the soil ecosystem and improve the quality of soil, plant growth and yield [9].

Fertilizer application significantly increased the ear diameter of the white corn. Generally, all the fertilized plants had bigger ear diameter with means ranging from 4.16 to 4.63 centimeters. However, the control plots ($T_1$) and the plants applied with EM alone had comparable ear diameter with 4.16 and 4.06 centimeters (Figure 4).

The effect of fertilizer combination can be traced in this parameter. Effective Microorganisms added to the inorganic fertilizer regardless of the levels resulted in bigger ears which mean that the nutrients derived were fully utilized by the plants. The combined use of inorganic fertilizer and EM in crop production has been widely recognized as a way of increasing farm yield and sustaining or improving the productivity of the soil. The decomposition of organic materials through the action of soil microorganism from EM must take place before nutrient can be available for the root absorption [10].

**Weight of unhusked and husked ear per plant (g):** The observed differences in treatment means with respect to the weight of husked and unhusked ears per plant shows that the application of the constant rate of inorganic fertilizer and varying levels of effective microorganisms had significant effect on the production of heavier unhusked ear per plant. The advantage of the fertilized plants over the unfertilized and sole EM alone produced heavier ears with mean weights of 288.53 grams ($T_3$), 275.60 grams ($T_4$), 274.00 grams ($T_5$) and 267.07 grams ($T_2$), respectively. The plants fertilized with EM alone ($T_6$) and unfertilized plants ($T_1$) had lighter ears with 197.47 and 180.73 grams.

Yield was significantly affected by the treatments employed primarily by the influence of inorganic fertilizer and supplemental effect of Effective Microorganisms. Heavier husked ear yield was produced by the plants in Treatments $T_4$, $T_3$, $T_5$ and $T_2$ with corresponding ear weight of 169.00 grams, 157.77 grams, 156.00 and 153.43 grams. The least in weight of husked ear per plant were produced from the EM applied plants ($T_6$) with a mean of 126.13 grams and the unfertilized plants with 103.53 grams (Figure 5).

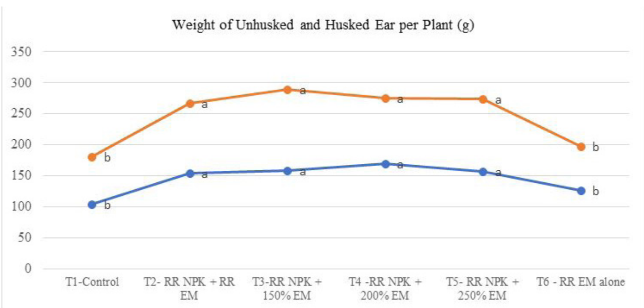


**Figure 5:** Weight of unhusked and husked ear per plants (g) as affected by varying levels of effective microorganisms and inorganic fertilizer. Significance: (—) Unhusked/EP; (—) Husked /EP. **Note:** Means with a common letter are not significantly different with each other using DMRT. **- significant at 1% level.

Such variation in the weight of ear per plants was attributed to the combined effects of EM and inorganic fertilizer that served as yield boosters and heavier ears. By observing the results, it is presumed the roles of EM increase the decomposition of organic materials and consequently the availability of mineral nutrients and important organic compounds to the plants. In addition, EM enhances the activities of beneficial indigenous microorganisms, fix atmospheric nitrogen thereby supplementing the use of chemical fertilizer. Moreover, the significant improvement in soil fertility has also had a positive effect on plant growth, flowering, fruit development (specifically yield) in crops [11].

**Weight of unhusked and husked ears per sampling area (kg/6.75 $m^2$):** The effect of inorganic fertilizer along with EM had a highly significant effect on the weight of ears per sampling area. It shows that unhusked ear yield was increased with the addition and combination of fertilizer. Corn treated with the constant rate of inorganic fertilizer regardless of the concentration of EM produced heavier unhusked ear yield with mean values that ranged from 7.10 kg to 10.38 kilograms, while plants in Treatment 6 was comparable to the control plants ($T_1$) with a mean of 6.50 kilograms.

As to the weight of husked ear per sampling area, mean comparison indicates that the recommended rate of inorganic and varying concentrations of EM (100, 150, 200 and 250 percent) produced the heavier yield with a mean of 6.08 kg comparable to the plants fertilized with 100-20-0 kg NPK $ha^{-1}$+150% RR EM ($T_3$) with 5.68 kg, 100-20-0 kg NPK $ha^{-1}$+250% RR EM ($T_5$) with 5.64 kg, 100-20-0 kg NPK $ha^{-1}$+100% RR EM ($T_2$) with 5.52 kg while the plants fertilized with EM alone had 4.54 kg and 3.72 kg from the untreated control plants (Figure 6).

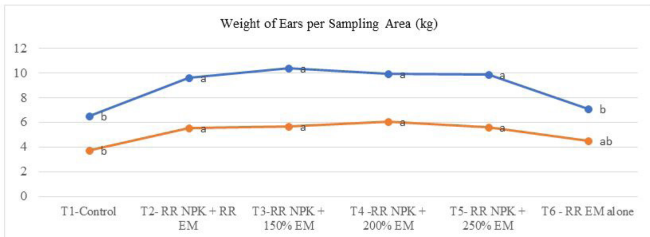


**Figure 6:** Weight of unhusked and husked ear per sampling area (kg/6.75 $m^2$) as affected by varying levels of effective microorganisms and inorganic fertilizer. Significance: (—) Unhusked/SA; (—) Husked /SA.

Such difference in the weight of husked ear was attributed to the applied EM in combination with inorganic fertilizer. Effective microorganisms increased soil microbial biomass C and N and soil respiration. Soil low in nitrogen increases soil respiration, while high nitrogen addition decrease soil respiration and the response of root biomass and soil abiotic factors to nitrogen addition is highly related with soil respiration [12]. Moreover, the accumulation of organic carbon as a result of organic nutrients additions not only results in increased microbial biomass but has also been linked to changes in microbial community structure and increased functional diversity. Increased microbial biomass and diversity are beneficial for soil quality because soil microorganisms play a key role in soil nutrient cycling.

**Projected yield hectare:** The unhusked and husked ear yield per hectare basis when projected and arranged in descending order are as follows: Plants applied with 100-20-0 kg NPK $ha^{-1}$+150% RR EM ($T_3$) yielded 15.37 tons per hectare, 100-20-0 kg NPK $ha^{-1}$+200% RR EM ($T_4$) with 14.59 tons, 100-20-0 kg NPK $ha^{-1}$+250% RR EM ($T_5$) with 14.60 tons, and 100-20-0 kg NPK $ha^{-1}$+100% RR EM ($T_2$) with 14.23 tons per hectare. The plots applied with EM alone had

10.51 tons and 9.62 tons from the untreated plots.

Fertilizer combination likewise out yielded the projected husked ear per hectare where the plants having the heaviest unhusked ear were likewise performed as best yielder (Figure 7). Plants in Treatment 2 to Treatment 5 yielded 8.17 to 9.00 tons per hectare while 6.72 on the EM treated plants and 5.51 to the unfertilized plants higher than the potential yield of IES 89-06 of 5.75 tons per hectare [13].

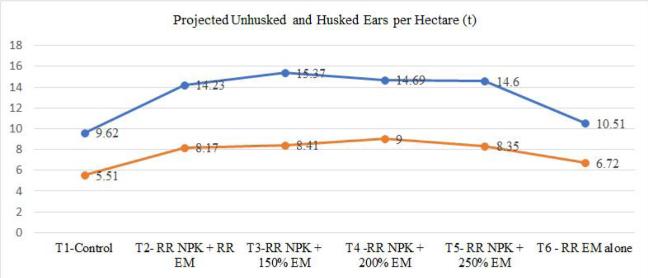


**Figure 7:** Projected Weight of Unhusked and Husked Ear per Hectare (t) as affected by Varying Levels of Effective Microorganisms and Inorganic Fertilizer. Significance: (—●—) Unhusked Yield Per Hectare (t); (—●—) Husked Yield Per Hectare (t).

**Cost and return analysis:** The projected cost and return analysis of producing one-hectare corn is shown in Table 1. It showed that Treatment 3 (100-20-0 kg NPK $ha^{-1}$+150% RR EM) had the highest return with 267.45% while $T_1$ (Control) had the lowest with 214.18% (Tables 2-4).

**Table 2:** Soils and water management for the nutrient analysis.

| Texture | Organic matter (%) | Phosphorus ppm | Potassium ppm | pH | Recommendation (NPK) |
|---|---|---|---|---|---|
| Medium | 4.02 | 20.70 | 100 | 4.85 | 120-20-0 |

**Table 3a:** The experimental treatments used under field study (Study 11).

| Treatments | Recommendation (NPK) |
|---|---|
| $T_{1-}$ | Control (No application) |
| $T_{2-}$ | 120-20-0 kg NPK $ha^{-1}$+100% RR EM |
| $T_{3-}$ | 120-20-0 kg NPK $ha^{-1}$+150% RR EM |
| $T_{4-}$ | 120-20-0 kg NPK $ha^{-1}$+200% RR EM |
| $T_{5-}$ | 120-20-0 kg NPK $ha^{-1}$+250% RR EM |
| $T_{6-}$ | EM alone |

**Table 3b:** Time and rate of effective microorganism's application.

| Time of application | Water Used/ drenching | | Activated EM used/drenching | | | | |
|---|---|---|---|---|---|---|---|
| | ml/ plant | ml/ plot | $T_{2(100\%\ EM)}$ | $T_{3\ (150\%\ EM)}$ | $T_{4\ (200\%\ EM)}$ | $T_{5\ (2500\%\ EM)}$ | $T_{6\ (EM)}$ |
| DAP | | | (1:500) | (1.5:500) | (2:500) | (2.5:500) | (1:500) |
| 14th | 50 | 7200 | 14.4 | 21.6 | 28.8 | 36 | 14.4 |
| 28th | 80 | 11520 | 23 | 34.6 | 46.1 | 57.6 | 23 |
| 42nd | 120 | 17280 | 34.6 | 51.8 | 69.1 | 86.4 | 34.6 |
| 56th | 235 | 33840 | 67.7 | 101.5 | 135.4 | 169.2 | 67.7 |
| 70th | 235 | 33840 | 67.7 | 101.5 | 135.4 | 169.2 | 67.7 |
| Total EM per plot (30 sq. m.) | | | 207.4 | 311 | 414.7 | 518.4 | 207.4 |
| Total EM per treatment | | | 622.1 | 933.1 | 1244.2 | 1555.2 | 622.1 |
| Total projected EM per hectare | | | 1866.24 | 2799.36 | 3732.48 | 4665.6 | 1866.24 |
| (Consumed Per Plot/30)* 10,000) | | | 69120 | 103680 | 138240 | 172800 | 69120 |
| Liters/ha | | | 69.12 | 103.68 | 138.24 | 172.8 | 69.12 |

DAP: Days After Planting.

**Table 3c:** Length and weight of shoots and roots using different growth enhancers.

| Treatment | Length of roots (cm) | | Length of shoots (cm) | | Weight of roots (g) | | Weight of shoots (g) | |
|---|---|---|---|---|---|---|---|---|
| | 10 DAP | 20 DAP | 10 DAP | 20 DAP | 10 DAP | 20 DAP | 10 DAP | 20 DAP |
| $T_{1-}$ OHN | 12.57 | 18.29 | 19.64 | 27.76 | 9 | 16 | 6.67 | 16 |
| $T_{2-}$ Coconut Water | 13.98 | 18.11 | 19.28 | 25.61 | 9.67 | 14.67 | 7 | 14.67 |
| $T_{3-}$LABS | 13.04 | 18.24 | 18.63 | 27.23 | 7.67 | 15.33 | 7.33 | 15.33 |
| $T_{4-}$Wood Vinegar | 13.54 | 16.82 | 20.96 | 27.78 | 8.67 | 16 | 7.67 | 16 |
| $T_{5-}$EM | 13.37 | 18.2 | 21.51 | 29.5 | 8 | 20 | 7.67 | 20 |
| RESULT | ns | ns | ns | ns | ns | ns | ns | ns |
| C. V. (%) | 9.38 | 11.77 | 6.99 | 7.39 | 21.44 | 16.21 | 7.11 | 6.21 |

DAP: Days After Planting.

**Table 4:** Projected return on investment of producing one hectare white corn (%).

| Treatments | Return On |
|---|---|
| $T_{1-}$Control (No application) | 214.18 |
| $T_{2-}$100-20-0 kg NPK $ha^{-1}$+ 100% RR EM | 247.46 |
| $T_{3-}$100-20-0 kg NPK $ha^{-1}$+150% RR EM | 267.45 |
| $T_{4-}$100-20-0 kg NPK $ha^{-1}$+200% RR EM | 244.98 |
| $T_{5-}$100-20-0 kg NPK $ha^{-1}$+250% RR EM | 234.27 |
| $T_{6-}$EM Alone | 224.9 |
| Cost of corn at P10/kg-Farm gate price | |

## CONCLUSION

Stock seeds of white corn were treated with different growth enhancers to determine which among the growth enhancers increases the percentage germination, seedling vigor as well as the yield under pot and field conditions.

Results of the pot experiment and a follow-up by the field study revealed that any of the growth enhancers primed to the stock seeds of white corn did not influenced the germination parameters such as the root length, shoot length as well as the root and shoot weights at 10 and 20 days after sowing.

Under field conditions, effective microorganisms as growth enhancer in combination to the recommended rate of inorganic fertilizer increased the plant heights, ear height, ear length and diameters as well as the weight of unhusked and husked ear yield per plant and per sampling area. Plants fertilized with EM alone and the unfertilized control showed significantly lower in the measured parameters. Moreover, the recommended rate of inorganic fertilizer+150% RR EM ($T_3$) significantly increased corn yield and increase the return on investment. This indicated that even stock seeds can be used as planting materials provided these will be fertilized with the recommended rate of inorganic fertilizer plus 150 percent increase of effective microorganisms. This strategy has proven a sound soil fertility management strategy. Moreover, the growth and yield of white corn do not only depend on the source of seeds but it could be possibly increase provided good combination of essential nutrients from inorganic fertilizer and effective microorganisms be applied to supply the nutrient requirements thus attaining higher yield. Hence the combination 150 percent EM plus the recommended rate of inorganic fertilizer in white corn production is recommended to attain higher yield.

## RECOMMENDATIONS

Based on the results of the study, the growth and yield of stocked seeds of white corn could be possibly increase provided good combination of essential nutrients from inorganic fertilizer and 150% of the recommended rate of effective microorganisms be applied to attain higher yield and highest return on investment.

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