EFFECTS OF DIFFERENT FERTILIZERS ON YIELD AND YIELD COMPONENTS OF *ZEA MAYS.var amylacea*

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Abstract

The growing of *Zea mays var. amylacea* in the field experiment was carried out using different fertilizers conducted in the Vegetables, Fruits Research and Development Center (VFRDC), Yemon, Hlegu Township, Yangon Region from March to July, 2019. The experiment was laid out in completely randomized designs with three replications. The data were analyzed using Statistics 8.0. In this study, the maize plants treated with EM (Effective microorganism suspension) and cow-dung. The results of yield components showed that the, plant height, number of leaves, leaf area, stem girth, node length and ear length, ear diameter, grains yields, total dry matter per plant and harvest index were significantly influenced in maize variety treated with EM organic fertilizer than the other treatments.

Key words: *Zea mays var. amylacea*, EM, cow-dung, yield and yield components

INTRODUCTION

Maize or corn (*Zea mays* L.) is a plant belonging to the family Poaceae. It is cultivated globally being one of the most important cereal crops worldwide. Major countries growing maize are USA, Argentina, Canada, Brazil, South Africa, Philippines, Chile, Egypt, Honduras, China and Myanmar (Dowswell, 1996).

Maize, also known as corn, is one of the most extensively cultivated cereal crops on earth. Almost every country of the world cultivates and produces maize commercially. Maize is a staple crop, and many people rely on it as a primary source of nutrition. In addition to playing a major role in the human diet and it is also used as livestock fodder. Maize is processed to make an assortment of products ranging from high fructose corn syrup to bio-fuel, all of which play the important roles in human society (Smith, 2008).

Maize is a tall, determinate annual plant with a height of about 1 - 4 m. It has a jointed stem with solid pith at the nodes. The plant bears unisexual flowers, the male flowers are borne in tassel at the upper end, while, the female flowers are borne in a cob, in the axil of the leaf at lower end. The female flowers are arranged in a spike on short branch and are characterized by long and feathery style, which emerge out of the cob. The grain is typically a single seeded dry fruit, caryopsis, having two kinds of endosperm, the outer yellow and hard while the inner white and soft (AGBIOS, 2005 a).

Corn is classified as sweet, pop, flour, silage or feed corn, depending on the type of carbohydrate stored in the ear. The average chemical composition of the grain is starch 68%-70%, protein 5-11% and oil 3.5-5% respectively. In addition, the grains contain appreciable amount of Ca, Fe and Vitamin A, B and C (Chaudhary, 1983).

Now, maize plants grown all over the world both on the hills and plains under hot and cold climates. Myanmar is a maize producing and exporting country among 163 maize producing countries in the world. Maize crop are produced regularly in Northern Shan State, Mandalay Region and Ayeyarwady Region. Nowadays, quality seeds have been changed in production. Maize is not only an important human nutrient but also a basic element of animal feed and raw material for manufacture of many industrial products.

The efficiency of EM (Effective recommended Microorganisms) as a bio-fertilizer is attributed to its role in accelerating the mineralization processes of organic matter and helping the release of nutrients resulting in enhancing the utility

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Therefore, bio-fertilizers are gaining importance as they are eco-friendly, nonhazardous and nontoxic products (Bashan, 2004 and Sharma, 2007).

Cow-dung is an important source of nitrogen for crop production in the small holder sector. It helps framers reduce inputs of commercial fertilizer, thereby increasing the profit margin of the framer.

Fertilizers are essential part of modern farming. Fertilizers may be organic or inorganic, and their effect on plant growth depends upon the necessary nutrients. Organic farming is eco-friendly, improves soil fertility, and sustains higher yield.

In this study, the application of organic fertilizer is very important not only for promoting the organic farming system but also for the production of high yield. The objectives of the present research works are to determine the effects of different types of organic fertilizers, to evaluate and compare the growth and yield of maize plants treated with organic fertilizers such as EM and cow-dung and to achieve the valuable information to upgrade the organic farming system of maize plants.

MATERIALS AND METHODS

Experimental place and plant materials

The field experiment was conducted at the Vegetables and Fruits Research and Development Center, Hlegu Township, Yangon Region from March to July, 2019. Sweet violet (glutinous maize) was treated with organic fertilizers such as EM and cow-dung and each treatment had 4 replications are arranged in completely randomized designs (CRD).

There were three plots for the study. Each plot was (4×8) feet. Plant spacing was 12 inches and row spacing was 18 inches. The total experiment area was 160 sq feet.

The soil for growing plants was prepared by mixing thoroughly soil with EM bokarshi suspension (1 liter) for plot one, cow-dung (3.0 kg) for plot two and plot three was without fertilizer respectively. The prepared soil was wet by the enough amount of water about two weeks before sowing seeds to retain their soil moisture.

The seeds were sown in rows with uniform depth of 1 to 2 cm. During the growth of maize plants the cultural management such as, irrigation, pests, diseases and weeds control were had done when it was necessary. The physical and chemical analysis of soil samples were carried out at Soil Analysis Laboratory of Myanmar Agricultural Service (Land Use) before and after planting the maize plants.

Morphological Study

The morphological characters of the collected plant specimens were identified according to the observations and based on the available literatures Hooker (1879), Backers *et al.* (1963), and Dassanayake (1996). The morphological characters were observed using a disserting set and under a microscope. The fresh plants specimens were recorded by taking the photographs.

Data collection

The data for plant height, leaf number, leaf area, node length, stem girth, were collected at weekly intervals. Date of 25% ear formation, 50% ear formation, 75% ear full maturity, ear harvest (days after sowing to harvest) were also recorded. The 50% tasseling and 50% earing time, ear number, ear weight, ear length, ear diameter, number of seed per row, number of row per ear, 100% grains weight, grain yields, total dry matter per plant and harvest index (HI) were also collected at final harvesting time.

Methods

Leaf Area (LA)

Leaf area was calculated according to (Montgomery, 1911).

Leaf area (LA) cm^2 = K x length (cm) x width (cm) (k = 0.75)

Harvest Index (HI) (%)

The determination of harvest index is usually based on a harvest at maturity. Mature plants are cut at ground level, weighed to given total yield of plant material and the harvest index is ratio of the yield of grain to the biological yield (Reddy, 2001).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Experimental Design and Statistical Analysis

The experiment was carried out using Completely Randomized Design (CRD) in field. The totals of five maize varieties were carried out in the study. Each treatment consisted of four replications. Each replication included 3 samples plants. The data were subjected for analysis of variance according to CRD designs and all calculation was performed using Statistic-8 package and Least Significance Differences (LSD) was used to compare treatment means (Gomez and Gomez, 1984).

RESULTS

***Zea mays.* L.var. *amylacea* (Sturter). L.H. Bailey**.

***Zea amylacea* Sturter.**

Family	:	Poaceae
English name	:	Flour corn
Varietal name	:	Meilan
Flowering period	:	at 40DAS after sowing

Tall annual, monoecious, erect, robust. Culms solid, 65.0 - 235.0 cm tall,, stout, frequently developing stilt roots from the lower nodes, glabrous, tinged with pale purple and pale green; nodes 3.0 – 6.0 cm long, glabrous; internodes 8.0 - 20.0 cm long, glabrous. Leaf-sheaths 10.0 – 16.0 cm long, overlapping; ligules membranous, 1.0 - 2.0 mm long; leaf-blades linear-lanceolate 35.0 – 103.0 cm long, 6.0 – 11.0 cm wide, flat, rough, rounded at the base, acuminate at the apex, entire along the margin, sparsely hairy above, glabrous in beneath, many-nerved. Male inflorescences terminal large, paniculateraceme, 30.0 - 55.0 cm long, 18.0 – 30.0 cm wide, composed of 1 - many spike arranged on all sides of the main axis; spikelets oblong, finely short-hairy, usually tinged with purple, awnless. Glumes lanceolate, 1.0 cm long, 2.0 - 3.0 mm wide, acute at the apex, long ciliate along the margin, hyaline a few tinged with purple. Lemma and palea ovate-lanceolate or elliptic lanceolate, hyaline, glabrous, ciliate and acute at the apex, inflexed at the margins. Stamens 3+3; filaments 3 long and 3 short, filiform; anthers versatile, dithecous, yellow in coloured. Female inflorescences produce in the axils of mid-culm leaves; 16.0 – 30.0 cm long, 6.0 – 10.0 cm wide, tightly enclosed in numerous foliaceousspathes; rachis stout, hairy at the base of spikelets. Glumes broadly obovate or cuneate, 3.0 - 4.0 mm long, 4.0 - 5.0 mm wide, membranous, glabrous, entire along the margin. Lemma and palea 3.0 – 4.0 mm long, 4.0 - 5.0 mm wide, membranous and hyaline, glabrous, entire, along the margin. Ovary superior, unilocular; silky style protruding from the apex, filiform, creamy coloured, these withering persistent and becoming brown, 14.0 – 25.0 cm long ; stigmas bifid. Grains medium flat, winkled on the surface, 7.0 mm long, 7.0 mm wide, glabrous, purple in coloured (Figure 1).

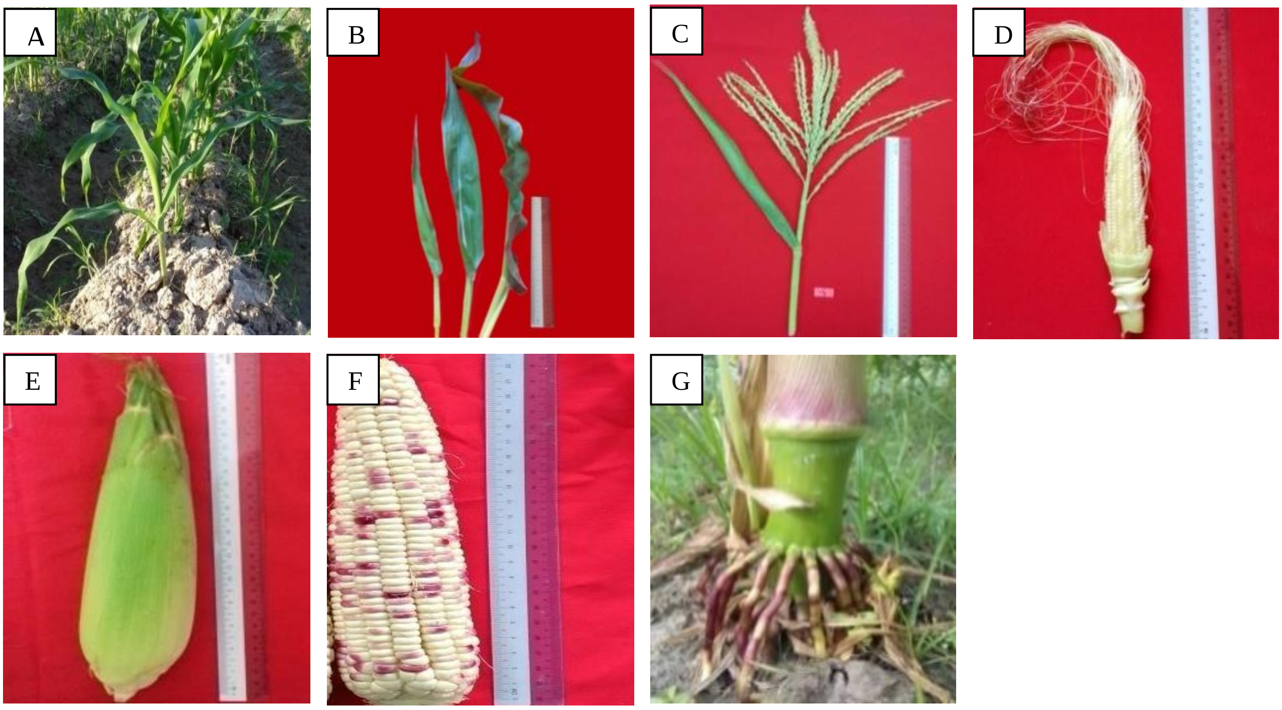

Figure. 1 ***Zea mays.* L.var. *amylacea* (Sturter). L.H. Bailey**.

A. Habit, B. Leaves, C. Male inflorescence, D. Female inflorescence, E. Cob with husk, F. Cob without husk, G. Slit root

Plant height, Number of leaves, Leaf area, Girth and Node length at 63 DAS

At 63 days after sowing, the effect of EM on plant height, number of leaves, leaf area, girth and node length show highly significant among the treatments. In plant height, it was 225.3 cm pt^{-1} in the plant treated with EM, 203.4 cm pt^{-1} in cow-dung and 185.7 cm pt^{-1} in control (LSD 7.67). For number of leaves, it was 13.0 pt^{-1} in the plant treated with EM, 12.6 pt^{-1} in cow-dung and 12.3 pt^{-1} in control (LSD 0.38). The leaf area was 685.5 cm^2 pt^{-1} in EM, 657.3 cm^2 pt^{-1} in cow-dung and 630.2 cm^2 pt^{-1} in control (LSD 7.10). In girth, it was 8.6 cm in EM, 8.6 cm in cow-dung and 8.0 cm in control (LSD 0.23). The node length, it was 15.2 cm in EM, 14.3 cm in cow-dung and 13.0 cm in control respectively (LSD 0.19) (Table 2).

Table 1. Effect of fertilizers plant height, number of leaves, leaf area, girth and node length of *Zea mays var. amylacea* at 63DAS

Treatments	PH (cm pt^{-1})	No. of leaves	Leaf area (cm^2)	Girth (cm)	Node length (cm)
Cow-dung (T1)	203.4	12.6	657.3	8.3	14.3
EM (T2)	225.3	13.0	685.5	8.6	15.2
Control (T3)	185.7	12.3	630.2	8.0	13.0
F-test	**	*	**	Ns	*
$LSD_{0.05}$	7.67	0.38	7.10	0.23	0.19
CV%	9.04	5.31	9.90	4.90	13.64

** = Correlation is significant at the 0.01% level, * = Correlation is significant at the 0.05% level

Correlation Coefficient (Pearson method)

The correlation between plant height with number of leaves, leaf area and girth and node length were closely related with each other with the R^2 value of 0.9216, 0.8362, 0.7365 and 0.7710 respectively. The regression correlation analysis between number of leaves with leaf area, girth and node length were closely related with each other with the R^2 value of 0.210, 0.7959 and 0.8721 respectively. The relationship between leaf area with girth and node length were closely related with each other by the R^2 value of 0.6621 and 0.7348 respectively. The girth with node length was closely related with each other with the R^2 value of 0.7310 (Table 2).

Table 2. Correlation matrix in Plant height, Number of leaves, Leaf area, Girth and Node length

Parameters	PH (cm pt^{-1})	No. of L	LA (cm^2)	S G (cm)	NL (cm)
PH (cm pt^{-1})	1				
No. of leaves	0.9216**	1			
Leaf area (cm^2)	0.8362*	0.9210**	1		
Girth (cm)	0.7365	0.7959	0.6621	1	
Node length (cm)	0.7710	0.8712*	0.7348	0.7310	1

Each value represents the r value of correlation relationship, ** = 1% level of significance, * = 5% level of significance, PH = Plant height, No. of L = number of leaves, LA = Leaf area, S G = stem girth and NL = node length

Effects on Yield and Yield Components of *Zea mays L.var amylacea* (Table 3)

Ear length (EL) (cm)

The maximum number of ear length was found in T_2 (EM) treatment with 32.53 cm and followed by T_1 (cow-dung) 30.16 cm and control was 28 cm.

Ear diameter (ED) (cm)

The highest means value of ear diameter T_2 (EM) has obtained the highest value of 19.53 cm and followed by T_1 (cow-dung) 17.6 cm and control 15.4 cm.

Number of row ear^{-1}

Among the treatments T_2 (EM) has obtained the highest value of 16.0 and followed by T_1 (cow-dung) 14.0 and control 13.3.

Number of seed row^{-1}

The highest mean total plant dry matter per plant was found in T_2 (EM) 43.0 and followed by T_1 (cow-dung) 38.3 and control 33.0.

100 grains dry weight (g)

The highest value of grains dry weight was found in T_2 (EM) 17.04 g and followed by T_1 (cow-dung) 13.45 g and control 12.88 g.

Seeds Yield (g)

It was observed that the maximum seed yield in T_2 (EM) 86.4 g and followed by T_1 (cow-dung) 78.1 g. The minimum seed yield was found in control 60.3 g.

Total dry matter per plant (g)

The maximum number of total dry matter per plant was found in T_2 (EM) treatment with 135.7 g followed by T_1 (cow-dung) 123.4 g and control was 117.3 g

Harvest index (g)

The highly maximum value of harvest index was observed in T_2 (EM) treatment with 0.62 g, followed by T_1 (cow-dung) 0.58 g and control was 0.42 g.

Table. 3 Effects on Yield and Yield Components of *Zea mays L.var amylacea*

Treatments	EL (cm)	ED(cm)	NRO	SPR	SDW (g)	Y (g)	TDM (pt^{-1})	HI (g)
Cow-dung (T1)	30.16	17.6	14.0	38.3	13.45	78.1	123.4	0.58
EM (T2)	32.53	19.53	16.0	43.0	17.04	86.4	135.7	0.62
Control (T3)	28.00	15.4	13.3	33.0	12.88	60.3	117.3	0.42
F-test	*	*	**	*	*	*	*	*
$LSD_{0.05}$	1.32	0.56	0.38	0.83	1.10	0.86	1.42	0.30
CV%	7.42	5.39	4.62	3.81	13.27	4.36	2.03	7.10

** = Correlation is significant at the 0.01% level, * = Correlation is significant at the 0.05% level

Correlation Coefficient (Pearson method)

Each parameter was highly significantly correlated to each other owing to the R2 values which was greater than 0.9, except yield and harvest index their correlation was significant that is R2 of 0.86 (Table 4).

Table 4. Correlation matrix in ear length, ear diameter, number of row ear^{-1}, number of seed row^{-1}, 100 grains weight, yield, total dry matter per plant and harvest index

Parameters	EL (cm)	ED(cm)	NRO	SPR	100W (g)	Y (g)	TDM(pt^{-1})	HI(g)
EL (cm)	1							
EW (cm)	0.9989**	1						
NRO	0.9837**	0.9744**	1					
SPR	0.9990**	1.0000**	0.9749**	1				
100 W (g)	0.9611**	0.9474**	0.9951**	0.9481**	1			
Yield (g)	0.9861**	0.9927**	0.9402**	0.9925**	0.9019**	1		
TDM (pt^{-1})	0.9927**	0.9861**	0.9982**	0.9864**	0.9874**	0.9589**	1	
HI	0.9669**	0.9777**	0.9054**	0.9772**	0.8590*	0.9959**	0.9291**	1

Each value represents the r value of correlation relationship, ** = 1% level of significance, * = 5% level of significance, ns = non significance, EL = ear length, ED = ear diameter, R/E = number of kernel row per ear, K/R = number of kernel per row, EW = ear weight, 100 SW = 100 grains weight, Yield = grains yield, TDM = total dry matter and HI = harvest index

Figure 2. ***Zea mays.* L.var. *amylacea* (Sturter). L.H. Bailey**. at 63 DAS in the field experiment (A) T1: Cow-dung, (B) T2: EM and (C) T3: Control

Figure 3. ***Zea mays.* L.var. *amylacea* (Sturter). L.H. Bailey**. after harvest with and without husk (A & B) T1: Cow-dung, (C & D) T2: EM and (E & F) T3: Control

DISCUSSION AND CONCLUSION

In the present study, maize variety treated with organic fertilizers EM, cow-dung and compared with control (without fertilizer). It was found that the EM suspension provided more effect than the plants treated with cow-dung and control.

According to the results, maize plants treated with organic fertilizers have significantly effective on the vegetative and reproductive growth than the plants treated with control.

The maize plants treated with organic fertilizer EM was attained the highest value in plant height 225.3 $cmpt^{-1}$, number of leaves 13.0 pt^{-1}, leaf area 685.5 cm^2pt^{-1}, stem girth 8.6 and node length 15.2 cm respectively. In contrast, the maize plants treated with cow-dung organic fertilizer showed that the plant height 203.4 $cmpt^{-1}$, number of leaves 12.6 pt^{-1}, leaf area 657.3cm^2pt^{-1}, stem girth 8.3 and node length 14.3 cm respectively. In control (without fertilizer), it was occurred that 185.7 $cmpt^{-1}$, number of leaves 12.3 pt^{-1}, leaf area 630.2 cm^2pt^{-1}, stem girth 8.0 and node length 13.0 cm respectively.

The correlation matrix among yield growth, yield and yield components for the effect of maize showed that grain yield development in maize is dependent on the direct or indirect contribution of various agronomic traits such as: ear length, ear diameter, number of kernel row per ear, number of kernel per row, 100 grain weight, grains yield, total dry matter per plant and harvest index.. These contributions had been reported by several authors Gallagher (1978).

The maize plants treated with organic fertilizer were observed positively and highly significant ($p \leq 0.01$) correlation with grain yield and 100 grain weight. The results were agreed with the findings of Kurmar (1997) who reported that the variety of maize had a significant effect on yield and yield components of each other. Growth and yield traits in maize are often linked or associated with each other.

EM has been used on many different soils and crops over a wide range of conditions. Results show that in most cases EM gives positive results. EM technology is an added dimension for optimizing our best soil. If used properly EM enhances soil fertility and promotes growth, flowering, fruit development and ripening in crops. EM suspensions can increase yields of maize and improve quality of maize (Portal, 2013).

Organic fertilizers have played an important role in agricultural for sustainability of soil quality and improving crop production. The value of organic fertilizers as a source of humus, macro and micro-nutrients, as well as increase the activity of the useful microorganisms has been reviewed by El-Gizy (1994).

As the maize is ranked as the third major cereal crop after wheat and rice, the growers always try to find out the source to increased yield and produced quality seeds. According to the present study, the used of organic fertilizers can promote the growth and yield of maize cultivation that benefits for both human and their environment. The resulting data are applicable to promote the organic farming system and enhance to sustain soil quality.

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