IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 13, Issue 6 Ser. I (June. 2019), PP 56-61
www.iosrjournals.org

Comparative Studies on Different Methods of Applying Organic Fertilizer to Maize (Zea mays L) for Effective Plant Growth

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Abstract: *The experiment was split plot randomized block design involving planting of Zea mays L with eight replicates. Methods of application comprised: A-Land application, B-Broad casting, C-Organic tea preparation, D-No fertilizer (Control), E-Point application, F-Ring application and G-planting into water soaked fertilizer. Fertilizer was applied two weeks after planting.Agronomic parameters were determined from two weeks after organic fertilizer (OF) application and continued for four weeks. Data were analyzed using descriptive statistics, ANOVA at 5% level of significance and significant means were compared, using Duncan Multiple Range Test. Results at four weeks (cm) showed:* ***PH(A****-18.1±4.7;* ***B****-17.19±5.1;* ***C****-23.7±4.3;* ***D****-10.3±3.5;* ***E****-13.3±3.4;* ***F****-10.3±2.3;* ***G****-11.8±1.2),* ***NL(A****- 10.1±1.4;* ***B****- 10.0±2.0;* ***C****- 9.9±.8;* ***D****- 8.1±1.3;* ***E****-7.8±2.1****F****- 7.9±1.5;* ***G****-7.8±0.7),* ***SG(A****- 4.1±0.8;* ***B****-4.5±0.8;* ***C****-4.9±0.8;* ***D****-3.0±0.5;* ***E****-3.5±0.68;* ***F****-3.4±0.5;* ***G****-3.3±0.4 with significant differences across different methods of application. Also, B (8 days) and G (almost 6 days) methods delayed germination of the maize seed. The C method of organic fertilizer application was the best for maize followed by A and B which had same growth response.To get expected results from the use of organic fertilizer on maize, the fertilizer has to be applied with appropriate methods.*

Key Words: *Land application, Organic Fertilizer, Organic tea preparation, Plot experiments, Seed germination*

Date of Submission: 26-05-2019 Date of acceptance: 11-06-2019

I. Introduction

Many researches have been carried out on the use of organic fertilizer on different crops [14,16,3,7,9,12,4] but less attention is given on methods of fertilizer application to crops [17]. In view of the importance of organicfertilizer in corn production vis-à-vis its effects on crop development, strategies that enhanceefficacy of the fertilizer whilereducing phytotoxic impacts on plant should be explored.Some previous researchers on the similar study include [6] and [5] who studied the efficiency of different types of fertilizers, timing offertilizer application and seasonal trends.[10] assessed strategies to reduce nitrogen losses from organic fertilizer to improve fertilizer use efficiencies and concluded that consumption of slow release fertilizer,placement techniques and nitrification inhibitors have potential to reduce the nitrogen losses. In their findings on crop response to nitrogen fertilizer[13] revealed that soil type, crop sequence and thesupply of residual and mineralized nitrogen fertilizers influenced development of crops.

Some other previous studies on fertilizer application compare different forms and rates of organic fertilizer to be applied on plants for nutrient efficiency. In an experimental study design with laboratory analysis, [18] investigated the effect of locally fabricated pelletizingmachine on the chemical and microbialcomposition of organic fertilizer produced at a resource recovery facility in Ibadan, Nigeria, he found out that pelletizing improved the quality of organic fertilizer due to the significantreduction of heavy metals and bacterial.[15] assessed the effect of pellet fertilizer application on corn yieldand results showed that application of pellet fertilizer improved the quantity and quality of wheat yield owing to the pellet's slow nitrogen release to the plant. A similar study was conducted by [11] who also applied pelletized fertilizer to wheat and concluded that fertilizer has to be applied in correct form with correct dosage and methods in order to get expected results. Similar to pellet fertilizer [2] experimented a dual role of compost extract foliar sprays as source of nutrients and materials for controlling insect pests in plants and part of their findings was that plants that received nutrients inform of foliar spray performed similarly with those that werefertilized with soil applied NPK fertilizers. According to [1]fertilizercan also beinjected into a drip or overhead irrigation system (fertigation with a siphonmixer) however information has not yet be well documented with this practice in Nigeria and other African countries.

Maize ranks third in world production following wheat and rice. This represents 24% of the total cereal production as compared to 27 % for wheat and 25% for rice. Various studies have shown the importance of organic fertilizer in improving maize yields. [4]conducted study to test whether composted manure would improve growth and yield of maize. Also [6] conducted a field experiment in Western Kenya to compare the effects of organic and inorganic fertilizers on maize yield. These researches focused on the effects of different organic fertilizers and their rates of application while a wide gap on the application methods of the fertilizers exists. This study therefore sought to investigate the effects of different methods of organic fertilizer applications to enhance agronomic performance of maize.

II. Methods and Materials

The site for this study was located in Ogun State College of Health Technology, Ilese-Ijebu, Ijebu North East Local Government Area of Ogun State, Nigeria (6.8012452°N 3.9509314°E). The College is occupying an area of about 100 hectares of land. It is bordered in the North by old Ijebu-Ode/Benin road and in the South by the Lagos/Benin express way; in the East by Ijebu-Mushin and in the West by REGUN and Oke-Owa Sawmill of Ijebu North East and Odogbolu Local Government Area respectively. The soil used for the experiment had no history of previous cultivation and as such, therewas no recordof fertilizer usage.The experimental plot was dividedinto seven blocks each containing 8 stands of maize plant. Each bed sizewas 2m × 1m. Seedlings were transplanted at 2 weeks after planting.Maize (*Zea mays***L**) with commercial name 'Oba Super 2' was produced by Premier Seed Nigeria Limited, Chikaji Industrial Estate, Zariawith yield capacity of 5 to 7 tons per hectare and germination rate of 90%. Organic fertilizer was sourced from a company at Alesinloye market, Ibadan, Nigeria.

The treatment comprised trial on seven different methods of fertilizer application: A-Land application, B- Broad casting, C- Organic tea preparation, D- No fertilizer (Control), E - Point application, F- Ring application and G-planting into water soaked fertilizer. In land application (A), the fertilizer was firstly applied to the land and tilled into the soil two weeks before planting to fertilize the soil. The broad casting (B) was carried out by sprinkling the fertilizer on the seedlings. Organic tea (C) was prepared by soaking the fertilizer in water in ratio 1:1 for 24 hours, leached and applied as liquid fertilizer. Point (E) and ring (F) applications were carried out by placing the fertilizer at 5 cm away from the plant at one side or in making circle around the plant, as the case may be. The G method comprised making the compost into paste, putting a handful amount in a hole (5cm depth) at a distance of 5cm away from the maize plant and covering with a little soil.Fertilizer was applied two weeks after planting with the exception to A in which the fertilizer was applied before planting of maize. In all application, same quantity of the fertilizer was applies (3 tons ha^{-1}).

Variation of agronomic parameters: number of leaves, plant height, stems girth and length of leave was determined from two weeks after the fertilizer application (one month after planting) and continued for four weeks. Number of leaves was obtained by counting; plant height, length of leave and stem girth was measured using metric rule. In addition, effects of application methods on seed germination were also investigated by applying the fertilizer before planting and counting the day of first appearance of foliage. Data were analyzed using descriptive statistics, ANOVA and means were separated by Duncan Multiple Range Test[8]at 5% level of significance.

Figure 1. Experimental plots showing maize plant

III. Results and Discussion

Results of agronomic performances in the growth of maize applied with organic fertilizer through various means of application are shown in Tables 1 to 4 and Figure 2. At two weeks after the fertilizer application, there was no much variation in the number of maize leaves observed in various plots with exception to the plot with B (broad casting method). The number of leaves in B plot was lower (1.4±1.5**)** than any of the other methods**,** including that of D plot**(**3.0±0.0)which is the control without any fertilizer application**.** The same trend was noted in other agronomic parameters in which the lowest values were obtained in B plot: plant height (0.8±0.9 cm), length of leave (4.6±5.6 cm) and stem girth (0.6±0.6cm). As such, there was no significant difference between plant height in both B (0.8±0.9cm) and D (1.4±0.5 cm) plots. The reason for the lowest values in the B plot may probably be due foliar burning that was caused by contact of the organic fertilizer with shoot of the maize plantlets. During the broadcast, there was possibility of grains of solid fertilizer hanged on the foliage of the maize seedling that could haveresulted inphyto-toxicity of the plant and retarded its growth. Plot C showed maize with longest leaf after the first two weeks of application (13.6±1.6 cm). These may be related to availability of nutrient in organic tea in the form that can be readily available to plant. The same reason might be accountable for the observation in the C plot for the subsequent weeks.

Table 1. Effect of different modes of fertilizer application on the agronomic parameters of maize at two weeks after application (Mean ± SD, n=8)

Agronomic Parameter	Mode of Application							F value	P value
	A	B	C	D	E	F	G		
Number of Leaves	3.0±0.5**b**	1.4±1.5**a**	3.5±0.54**b**	3.0±0.0**b**	3.0±0.0b	3.0±0.0**b**	3.1±0.4**b**	8.7	*0.0
Plant Height (cm)	1.9±0.7**b**	0.8±0.9**a**	2.9±0.1**c**	1.4±0.5**a b**	1.6±0.4**b**	1.7±0.7**b**	1.7±0.9**b**	5.7	*0.0
Length of Leave (cm)	8.9±5.3**b**	4.6±5.6**a**	13.6±1.6**c**	10.5±2.0 **bc**	10.2±3.0**b c**	11.5±1.6**b c**	10.0±3.9**b c**	4.7	*0.0
Stem Girth (cm)	1.5±0.3**b**	0.6±0.6**a**	1.4±0.2**b**	1.2±0.2**b**	1.3±0.2**b**	1.2±0.1**b**	1.3±.3**b**	7.5	*0.0

Different letters (a, b and c) indicate significant differences along the rows
(*Significant at p = 0.05)

Table 2. Effect of different modes of fertilizer application on the agronomic parameters of maize at three weeks after application (Mean ± SD, n=8)

Agronomic Parameter	Mode of Application							F value	P value
	A	B	C	D	E	F	G		
Number of Leaves	5.6±0.5**a**	4.9±1.0**a**	6.6±0.5**b**	5.0±0.0**a**	5.1±1.0**a**	5.0±0.5**a**	5.0±0.8**a**	6.5	***0.0
Plant Height (cm)	5.2±0.9**b**	4.0±1.4**a**	7.50±1.3**c**	3.3±1.0**a**	4.3±0.8**ab**	3.7±0.7**a**	4.2±0.9**ab**	15.0	***0.0
Length of Leave (cm)	24.2±3.6 **bc**	18.2±6.3 **a**	28.9±6.3**c**	16.8±6.9 **a**	19.6±3.4**a b**	19.2±3.3**a b**	21.6±4.1**a b**	5.4	***0.0
Stem Girth (cm)	2.1±0.4**b**	1.86±.34 **ab**	2.6±0.3**c**	1.6±0.2**a**	1.9±0.3**ab**	1.7±0.2**a**	1.7±0.2**a**	11.7	***0.0

Different letters (a, b and c) indicate significant differences along the rows
***Significant at p = 0.05**

Table3. Effect of different modes of fertilizer application on the agronomic parameters of maize at four weeks after application (Mean ± SD, n=8)

Agronomic Parameter	Mode of Application							F value	P value
	A	B	C	D	E	F	G		
Number of Leaves	7.9±1.1**b**	7.9±1.5**b**	9.3±0.9**c**	6.5±0.9**a**	7.5±1.2**ab**	6.9±1.4**ab**	7.1±0.4**ab**	5.4	***0.0
Plant Height (cm)	9.9±2.9**d**	9.3±2.6**c d**	14.4±2.3**e**	5.3±1.9**a**	7.7±1.6**bc**	5.8±1.1**ab**	7.3±0.9**ab c**	18.8	***0.0
Length of Leave (cm)	33.9±7.3 **c**	34.5±7.1 **c**	45.9±5.0**d**	24.7±7.1 **a**	31.0±5.5**b c**	27.0±4.6**a b**	32.1±2.6**b c**	11.0	***0.0
Stem Girth (cm)	3.4±0.8**b**	3.5±0.8**b**	4.7±0.9**c**	2.3±0.4**a**	2.9±0.6**ab**	2.4±0.6**a**	2.7±0.2**a**	13.2	***0.0

Different letters (a, b, c, d and e) indicate significant differences along the rows
***Significant at p = 0.05**

Table 4. Effect of different modes of fertilizer application on the agronomic parameters of maize at five weeks after application (Mean ± SD, n=8)

Agronomic Parameter	Mode of Application							F value	P value
	A	B	C	D	E	F	G		
Number of Leaves	10.1±1.4 **b**	10.0±2.0 **b**	9.9±0.8**b**	8.1±1.3**a**	7.8±2.1**a**	7.9±1.5**a**	7.8±0.7**a**	4.8	*0.0
Plant Height (cm)	18.1±4.7 **b**	17.2±5.1 **b**	23.7±4.3**c**	10.3±3.5 **a**	13.3±3.4**a**	10.3±2.3**a**	11.8±1.2**a**	14.1	*0.0
Length of Leave (cm)	51.8±9.8 **d**	50.8±8.2 **cd**	57.7±3.6**d**	39.0±8.0 **ab**	38.6±4.6**a b**	36.6±7.2**a**	44.2±3.0**b c**	11.2	*0.0
Stem Girth (cm)	4.1±0.8**b c**	4.5±0.8**c d**	4.9±0.8**d**	3.0±0.5**a**	3.5±0.7**ab**	3.4±0.5**a**	3.3±0.4**a**	8.4	*0.0

Different letters (a, b, c and d) indicate significant differences along the rows
***Significant at p = 0.05**
KEY: A- Land application, B- Broad casting, C- Organic tea preparation, D- No fertilizer (Control), E- Point application, F- Ring application and G-planting into water soaked fertilizer.

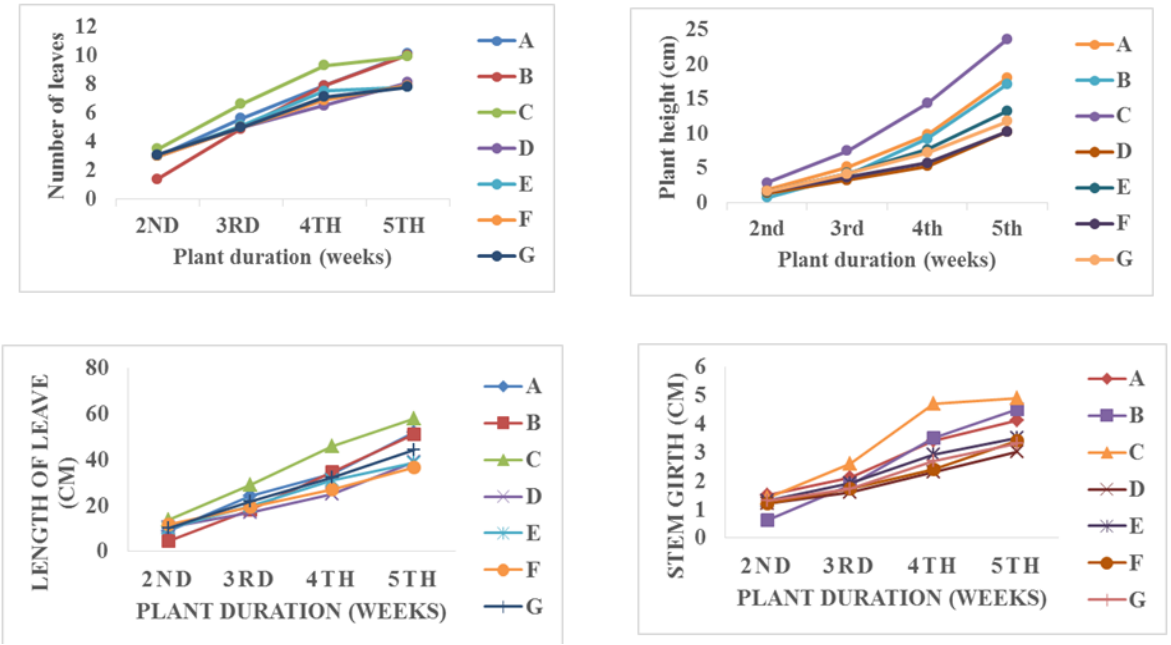

Figure 2: Trend of number of leaves, plant height, length of leave and stem girth development in maize by weeks
KEY: A- Land application, B- Broad casting, C- Organic tea preparation, D- No fertilizer (Control), E- Point application, F- Ring application and G-planting into water soaked fertilizer.

At third week after the application, the plot with the C method of application was the only one that showed a marked difference significantly in all the growth parameters: number of leaves (6.6±0.5), plant height (4.0±1.4 cm), length of leave (18.2±6.3 cm) and stem girth (1.86±.34 cm). This is closely followed by plot A which also showed a significant difference in length of leave (24.2±3.6 cm).At the fourth week after application, all the parameters picked up in plot B indicating the availability of the nutrients to the plant. Plot D without fertilizer had the lowest values for all the parameters comparing to any other plot. Plot C continued to have significantly highest values of all parameters especially in plant height (14.4±2.3 cm) and length of leave (45.9±5.0cm) while plot A was the next in terms plant height (45.9±5.0cm). Towards the end of five weeks after the fertilizer application, plots A and B displayed similar characteristics in terms of number of leaves, length of leave and plant height while there was more increase in stem girth B (4.5±0.8 cm) than plot A (4.1±0.8 cm) though the difference is not significant. Plot C showed the best performances in all the agronomic parameters.

The days of germination when various modes of fertilizer application were carried out concurrently with planting of the maize seeds are shown in Figure 3. This actually is a reflection of relationship between each mode of application and phytotoxic effect of fertilizer on maize. The germination days in majority of the plot were approximately 4 days while the germination was delayed in plots with B (8 days) and G (almost 6 days) mode of application. The reason for prolonged germination day in plot with B mode of application is not yet understood. However, too much water in the water soaked fertilizer might be responsible for the delay in G.

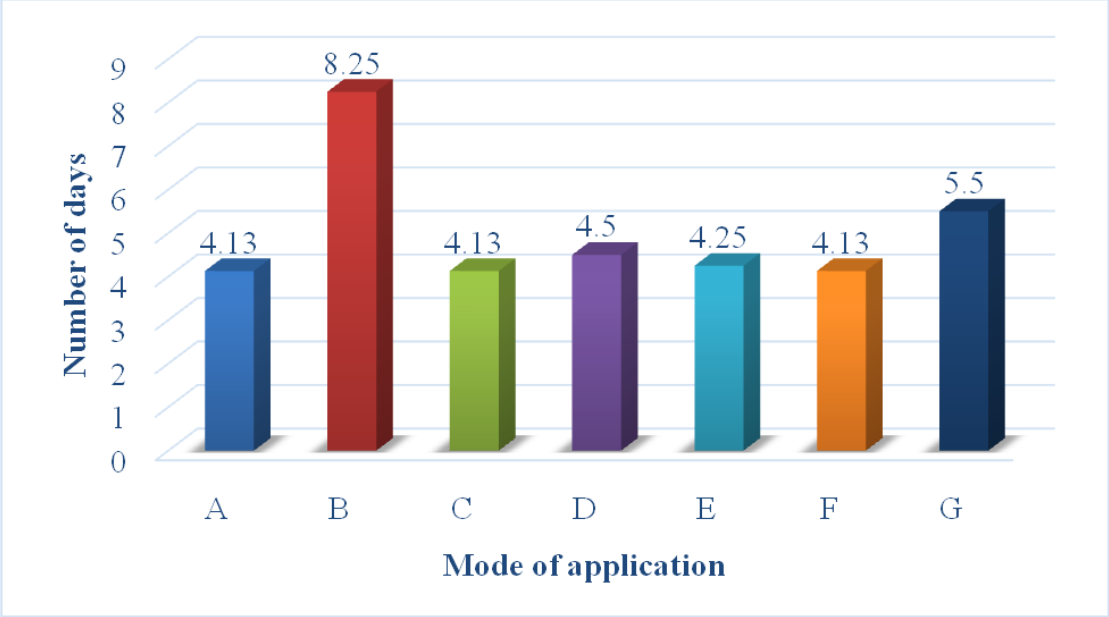

Figure 3. Days of germination of maize seeds planted with different methods of organic fertilizer application KEY: A- Land application, B- Broad casting, C- Organic tea preparation, D- No fertilizer (Control), E- Point application, F- Ring application and G-planting into water soaked fertilizer.

IV. Conclusion

It is evident from the findings of this study that application of fertilizer by all tested methods improved maize growth better than the not to apply fertilizer at all.Application of fertilizer through tea and foliar spray is the best for maize growth. There is no difference in maize growth by applying organic fertilizer either through land application or broad casting.Germination of maize seeds is not favoured by broad casting organic fertilizer before planting the seeds or by planting the seeds in the fertilizer soaked with water. To get expected results from the use of organic fertilizer on maize plantation, the fertilizer has to be applied with appropriate methods.

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T. B Hammed. "Comparative Studies on Different Methods of Applying Organic Fertilizer to Maize (Zea mays L) for Effective Plant Growth." IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) 13.6 (2019): 56-61.