Original Research Article

Effect of organic and mineral fertilizers on the growth and production parameters of maize (*Zea mays* L.) at Djalingo in the north region of Cameroon

ABSTRACT

In Cameroon, maize (*Zea mays* L.) remains the staple food crop the most consumed in the northern part of that country. Therefore, investigation of the effects of organic and inorganic fertilizers applied singly or in combination on growth and production parameters of TZEE-W maize variety was carried out from June to September 2015 in the locality of Djalingo in the North region of Cameroon. Field experiments were designed in Randomised Complete Block Design (RCBD) in three replicates treatments single or combinations of organic manures (Cow dung, Poultry manure and Cotton crab) with the inorganic fertilizer (NPK 150 kg/ha). Plant maize receiving the mixture of mineral and organic fertilizers significantly improved their growth and production traits. The highest maize grain yield up to 6.33 tons/ha was registered in the maize plot treated with the mixture of 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK while a moderate maize grain yield of 3.87 and 3.76 tons/ha were obtained in the combination treatments of 1/2 Cotton crab+ 1/2 NPK treatment and 1/2 Cow dung + 1/2 NPK, respectively. Thus, fertilization strategies that mix inorganic fertilizer with organic manures should be developed and adopted by farmers to increase and improve maize yield, especially in the northern part of Cameroon where famine and poverty are recurrent.

Keywords: Maize, inorganic, manures, fertilizers, combination, growth, yield

1. INTRODUCTION

In Sub-Saharan Africa, cereals such as maize, wheat, rice and millet constitute the main staple food for diverse households. In that continent, approximately 98 million hectares of cultivated areas are allocated to cereal crops for a production about 162 million tons annually [1]. Among these cereals, the maize (*Zea mays* L.) remains the most cultivated in Africa and covers an area up to 34 million hectares for an estimated production of 70 million tons [1]. According to [2], an estimated 300 million people of sub-Saharan Africa exclusively depend on maize grains as sources of food security and economic income. However, maize production in sub-Saharan Africa is facing diverse biotic and abiotic factors that significantly decrease the yield production of that cereal. The major factors that limit its production include cultivars being grown weed infestation, soil fertility, imbalanced nutrition, disturbed soil properties, etc. [3].

So, the use of the mineral fertilizer for their immediate beneficial action on the productivity of the maize crop brings an immediate solution to this problem of deficit in mineral elements indispensable to soil fertility. For fast-growing maize plant, it needs sufficiently N, P and K essential elements supply and chemical fertilizers are mainly solicited by the farmers [4]. Nevertheless, their high cost and their unavailability make them almost inaccessible to small farmers [5]. Moreover, it's exclusive use increase soil acidity, a degradation of the physical status and a reduction of the organic elements of the soil [6]. In such a context, scientific research recommends adaption of strategies based on the use of biological manures or bio-fertilizing [5][7]. According to [8], organic fertilizers, such as chicken manure, farmyard manure, sheep manure, etc., may substitute chemical fertilizers in the maize crops when farmer's financial situation is limited. Since P nutrient can be increased with the use of organic manure, the use of sustainable, inexpensive and renewable resources able to maintain soil fertility that are readily available on the farm is needed [9]. The use of biological fertilizers rich in biogenic elements are important for a better production quality and yield. Organic fertilizers improve soil fertility by maintaining it healthy without any residual effects and are much cheaper [10]. Several previous studies reported that a high maize grain yield was obtained when inorganic fertilizer is combined with organic manures. Study reported by [11] revealed that the application of the mixture of inorganic fertilizers with compost significantly improve maize growth parameters leading to high grain yield. Similarly, study conducted by [12] revealed that instead of using organic or inorganic fertilizer separately, the integration of organic and inorganic fertilizers seemed to be the best treatment for the high maize quality and yield production. Other research revealed also that combining organic and inorganic sources of nutrients led to the high maize yield compared to the singly application [13].

In that context, the present study aimed to improve maize production by using less inorganic fertilizer and increasing utilization of organic manures (Cow dung, Cotton crab and chicken droppings) in the soudano-Sahelian agro-ecological zone in the north region of Cameroon.

2. MATERIAL AND METHODS

2.1 Study site

The present investigation was conducted in 2019 the locality of Djalingo (located between latitude 9°18.5'N and longitude 13°23.51'E) situated around the IRAD of the Garoua located in the Division of Benoue in the North region of Cameroon. The agro-ecological zone belongs to

the Soudano-Sahelian climate type characterized by a short rainy season (from May to September) and long dry season (from October to April). An alternated hot blowing and harmattan coming from the North-East characterized the dry season of the zone. That agro-ecological zone is characterized by massif mountains, plains and periplains as well as high plateaus and basins. Benoue River and its tributaries constitute the hydrographic system and ferruginous soils are the most found in the area. Plants *Imperata cylindrica* and *Pennisetum purpureum* constitute the principal herbaceous stratum and vegetation is dominated by a shrubby savannah. In that study site, average annual rainfall was 226 mm with an average temperature of 29.56°C and relative humidity of 764.02%.

2.2 Maize variety

The maize seed used in this present study was the TZEE-W variety supplied by the Institute of Agriculture for development (IRAD) of Garoua in north region of Cameroon. It is a white grain maize variety with a production yield of 5 tons/ha, tolerant to streak, having short vegetative cycle (less than 3 months) and highly appreciated as fresh corn by the consumers.

2.3 Fertilizers

The organic fertilizers used in this present assessment included poultry manure, cow dung, decayed cotton crab in which, each organic manure was applied at 7 tons/ha. The inorganic fertilizer used in this study was NPK 14-24-14 (150 kg/h) and was applied singly or mixed with organic manures in proportion of 50% for binary combination and 25% for tetra combination.

2.4 Experimental design and crop treatments

The experiments were conducted in 1003 m^2 area previously cleared, plough and moved in about 30 cm depth to completely discard weed roots. As maize plant is very sensitive to weeds, non-selective weed-killer Kalash (Glyphosate acid 680g/kg) was applied before seedling and 7 days post seedling, the selective weed-killer known under the commercial name as Atrazine was sprayed to eliminate recalcitrant weeds that persist in the farm.

Then, 27 experimental units were constituted according to Randomised Complete Block Design (RCBD) comprising 9 treatments in 3 replicates. In the 27 experimental units of the area, 9 treatments were set. These treatments included: T1= negative control, T2= mineral fertilizer NPK 14-23-14 (150 kg/ha), T3= 146 g of cow dung/seed hole, T4= 146 g of cotton crab/seed hole, T5= 146 g of poultry manure/seed hole, T6= 1/2 cow dung + 1/2 NPK, T7= 1/2 cotton crab

+ 1/2 NPK, T8= 1/2 poultry manure + 1/2 NPK and T9= 1/4 cow dung + 1/4 cotton crab + 1/4 poultry manure + 1/4 NPK. Each experimental unit covered 25 m^2 (5 m length × 5 m wide) with 1m space between 2 experimental units and 1.5 m between plots. Maize seeds were sowed in 3-6 cm depth seed holes distant of 25 cm in each row and distance of 80 cm between two rows in the same plot was maintained. Seven days (7) after seedling, surplus maize plants in each seed hole were discarded to remain only one plant/hole and inorganic fertilizer or organic manures were applied singly or in combination to the maize plants. Weeding of the whole experimental area was conducted manually starting from 21 days after seedling followed by earthing up.

2.5 Agronomic parameters assessed

Seven (7) days after, the germination rate (%) was determined by counting number of plants germinated in each seed hole. The germination rate was calculated according to the following formula:

$$\text{Germination rate (\%)} = \frac{\text{number of seeds germinated}}{\text{Number of seeds sowed}} \times 100$$

During the vegetative phase, growth parameters including plant height, number of leaves and noose stem girth were evaluated each week starting from 2 weeks after seedling. Days to anthesis, days to silking and ear height from the ground were also recorded during the assessment period. Production parameters such as length of ear (cm), number of grains/row of ear, number of ear/treatment, weight of 1000 grains (kg) and grain yield (ton/ha) were determined.

2.6 Statistical analyses

Data of growth and production parameters of TZEE-W maize variety were subjected to the analysis of variance (ANOVA) using SPSS (Statistical Package for the Social Sciences) version 16.0 software. Using the same software, Tukey test at P=0.05 was conducted for means comparison.

3. RESULTS

3.1 Influence of organic and inorganic fertilizers on the growth parameters of maize

Table 1 presents the effect of organic and inorganic fertilizers applied singly or in combination on the number of days starting seedling to anthesis, to silking and anthesis-silking interval as

well as ear height from the ground of maize assessed. The number of days from seedling to anthesis significantly ($F_{(8, 18)}$=9.80; P<0.001) varied from 49 days in T2, T8 and T9 to 59 days in the negative control. The number of days to silking were also significantly ($F_{(8, 18)}$=19.76; P<0.001) short in the treatments T1 (52 days), T6 (51 days), T8 (51 days) and T9 (51 days) compared to the negative control. Although a high anthesis to silking interval was noticed in the negative control (5 days) but, no significant ($F_{(8, 18)}$=1.68; P>0.05) difference was noticed between the all treatments assessed. The position of ear from the ground significantly ($F_{(8, 18)}$=4.34; P<0.01) varied with treatments and were high in the treatments T6 (75.06 cm), T7 (74.10 cm), T8 (76.93 cm) and T9 (70.63 cm) compared to the negative control (48.46 cm).

Table 1. Influence of organic and inorganic fertilizers on days to anthesis, days to silking, anthesis-silking interval and ear height from the ground of maize cultivated in the locality of Djalingo in the North region of Cameroon.

Treatments	Days to anthesis	Days to silking	Anthesis to silking interval (Days)	Ear height (cm) from ground
T1	56.00±0.57a	62.00±1.15a	5.33±1.20a	48.46±1.25b
T2	49.00±1.73c	52.00±0.57bc	3.67±1.76a	69.40±1.04ab
T3	52.00±0.57bc	56.00±1.15b	4.00±1.73a	65.86±2.21ab
T4	51.00±0.57bc	54.00±0.57bc	3.00±1.15a	60.86±2.44ab
T5	53.00±0.00ab	54.00±1.15bc	1.67±0.67a	62.70±7.35ab
T6	50.00±0.57bc	51.00±0.57c	1.67±0.67a	75.06±1.48a
T7	52.00±0.57bc	53.00±0.57bc	1.00±0.00a	74.10±7.47a
T8	49.00±0.57c	51.00±0.00c	2.00±0.57a	76.93±6.05a
T9	49.00±0.00c	51.00±0.57c	2.00±0.57a	70.63±1.34a
$F_{(8, 18)}$	9.80***	19.76***	1.68ns	4.34**

T1= Negative control, T2= NPK (150 kg/ha), T3= Cow dung, T4= Cotton crab, T5= Poultry manure, T6= 1/2 Cow dung + 1/2 NPK, T7= 1/2 Cotton crab + 1/2 NPK, T8= 1/2 Poultry manure + 1/2 NPK and T9= 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK. Mean±Standard error of the mean in each column followed by the same letter did not differ significantly according to Tukey test (P=0.05). ^{ns}P>0.05, **P<0.01 and ***P<0.001. Each datum represents the mean of 3 replicates values.

Fig 1 presents the influence of inorganic and organic fertilizers used singly or in combination on the noose stem girth of the maize plant. Globally, noose stem girth of the maize plants significantly varied with the fertilizer treatments applied and the time period after seedling. The noose stem girth of the varied significantly ($F_{(8, 18)}$=2.78; P=0.034<0.05) from 1.40 cm (negative control) to 2.20 cm (Poultry manure + NPK), 14 days after seedling. Three weeks (21 days) after seedling. The noose stem girth of the varied but not significantly ($F_{(8, 18)}$=1.20; P=0.35>0.05) from 2.20 cm (1/2 Cotton crab + 1/2 NPK) to 3.03 cm (NPK 150 kg/ha), 14 days after seedling. Fourteen (14) days after seedling, a high noose stem girth were recorded in the plant maize

treated with NPK 150 kg/ha (2.00 cm), cow dung + NPK (2.10 cm), Poultry manure (2.20 cm) and 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK (2.00 cm). These stem diameter increased also to 3.03 cm for NPK 150 kg/ha treatment, 2.90 cm for dung + NPK treatment and 2.33 cm 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK after treatment, 21 days post-seedling.

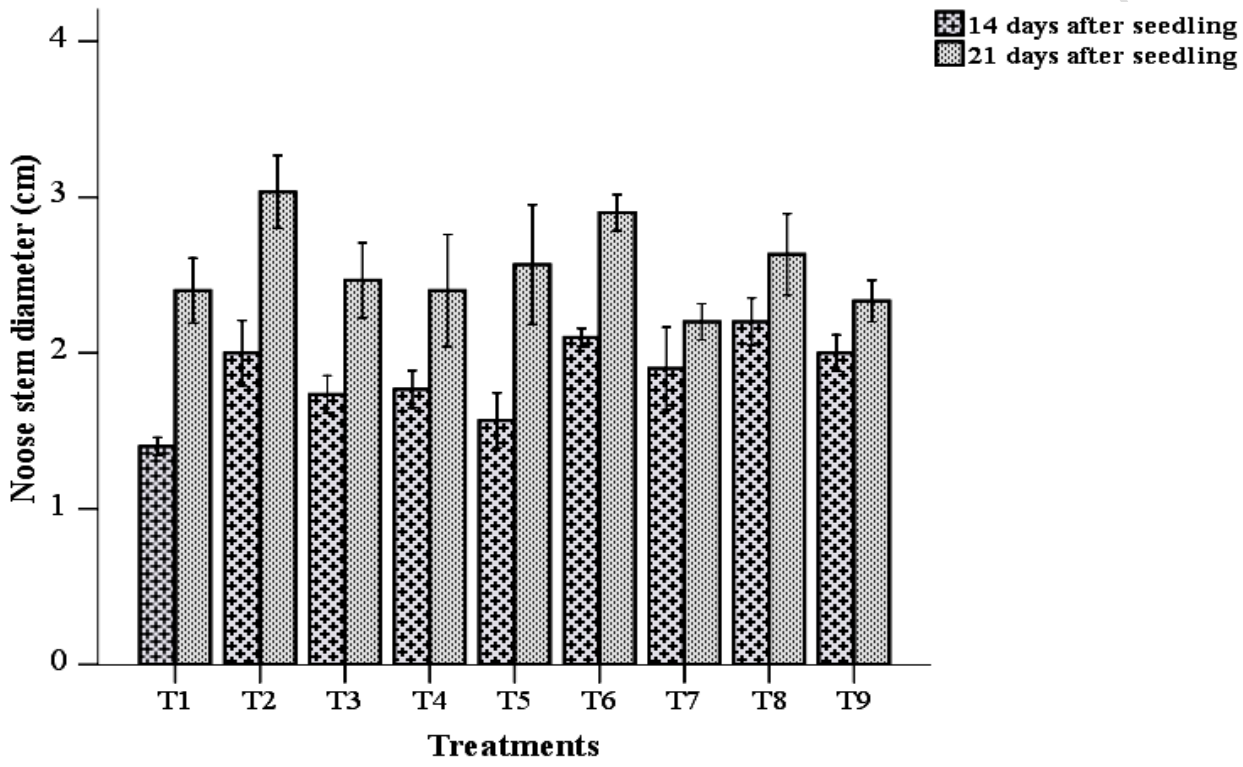

Fig 1. Effect of inorganic and organic fertilizers used singly or in combination on the noose stem diameter of the maize plant. T1= Negative control, T2= NPK 150 kg/ha, T3= Cow dung, T4= Cotton crab, T5= Poultry manure, T6= 1/2 Cow dung + 1/2 NPK, T7= 1/2 Cotton crab + 1/2 NPK, T8= 1/2 Poultry manure + 1/2 NPK and T9= 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK.

The results of the weekly variation of the number of leaves and height of maize plants treated with mineral fertilizer and organic manures are presented in the table 2. Globally, the number of maize plant leaves did not varied significantly ($P>0.05$) with different fertilizer treatment applied, but significantly ($P<0.001$) increased with the increasing time periods (Weeks). After 2 weeks post seedling, the number of maize leaves in all treatments applied did not differ significantly and ranged from 4 to 5 leaves depending of the treatments. After 5 weeks post-seedling, the number of leaves ranging from 10 to 11 leaves depending of each treatment was recorded. Regarding time period, more plant leaves were registered in treatments T1 (Negative

control), T3 (Cow dung), T4 (Cotton crab), T7 (1/2 Cotton crab + 1/2 NPK) and T8 (1/2 Poultry manure + 1/2 NPK) in which up to 5 leaves were counted in each maize plant after 2 weeks post-seedling. After 5 weeks post seedling, an average of up to 11 leaves per plant was recorded in treatment T1, T2 (NPK 150 kg/ha), T3 (Cow dung), T4 (Cotton crab), T5 (Poultry manure) and T6 (1/2 Cow dung + 1/2 NPK).

Similarly, the maize plant heights did not varied significantly ($P>0.05$) after application of the diverse fertilizer applied. In general, the maize height significantly ($P<0.001$) increased with the increasing time period for all treatment set up and the high maize height was registered in the treatments T1 (Negative control) and T2 (NPK 150 kg/ha) while T2 (NPK 150 kg/ha) and T6 (1/2 Cow dung + 1/2 NPK) treatment recorded a significant height after 5 weeks post-seedling. The maize height ranged but not significantly ($F_{(8, 18)}=0.65$; $P=0.72>0.05$) from 12.60 cm (T3= Cow dung) to 14.83 cm (T1= Negative control), 2 weeks after seedling while it ranged from 64.13 cm (T7= 1/2 Cotton crab + 1/2 NPK) to 86.03 cm (T2= NPK 150 kg/ha) after 5 weeks post-seedling.

Table 2. Weekly variation of the number of leaves and height of maize plants treated with organic and inorganic.

Parameters	Treatments	Number of weeks after seedling				$F_{(3, 8)}$
		2	3	4	5	
Number of plant leaves	T1	5.07±0.03aD	7.06±0.40aC	9.36±0.18aB	11.26±0.03aA	144.31***
	T2	4.96±0.14aD	7.10±0.17aC	9.53±0.31aB	11.80±0.35aA	127.31***
	T3	5.00±0.11aD	6.50±0.20aC	8.93±0.18aB	11.16±0.43aA	105.70***
	T4	5.10±0.10aD	6.93±0.06aC	9.06±0.37aB	11.16±0.61aA	51.73***
	T5	4.83±0.14aC	6.96±0.38aB	9.30±0.70aA	11.10±0.95aA	18.86***
	T6	4.76±0.13aD	7.23±0.26aC	9.90±0.40aB	11.93±0.56aA	68.10***
	T7	5.03±0.08aD	6.73±0.17aC	8.93±0.46aB	10.60±0.15aA	85.30***
	T8	5.23±0.14aD	6.96±0.40aC	9.26±0.40aB	10.96±0.49aA	42.79***
	T9	4.96±0.12aD	6.60±0.20aC	9.00±0.20aB	10.56±0.32aA	122.38***
	$F_{(8, 18)}$	1.35ns	0.75ns	0.65ns	0.84ns	
Plant height (cm)	T1	14.83±0.48aD	29.00±1.68aC	51.33±1.14aB	78.70±3.24aA	208.92***
	T2	14.30±0.75aD	29.56±0.44aC	56.03±1.61aB	86.03±4.53aA	165.91***
	T3	12.60±0.87aC	24.00±2.55aC	45.16±5.34aB	69.23±8.02aA	24.82***
	T4	13.20±0.25aC	26.70±1.64aC	47.73±6.48aB	71.83±8.72aA	21.68***
	T5	13.07±1.09aC	25.66±3.66aBC	47.73±7.82aB	73.50±12.73aA	11.83**
	T6	13.00±0.85aD	29.23±1.85aC	55.16±1.77aB	84.56±6.70aA	75.01***
	T7	13.53±0.99aD	25.26±1.08aC	44.90±2.38aB	64.13±5.40aA	53.52***
	T8	13.50±0.86aC	29.26±3.43aC	51.43±6.12aB	78.40±8.59aA	25.65***

T9	13.46±1.09aD	27.60±2.88aC	47.73±2.73aB	69.43±4.58aA	62.48***
$F_{(8, 18)}$	0.65ns	0.75ns	0.77ns	0.96ns	

T1= Negative control, T2= NPK (150 kg/ha), T3= Cow dung, T4= Cotton crab, T5= Poultry manure, T6= 1/2 Cow dung + 1/2 NPK, T7= 1/2 Cotton crab + 1/2 NPK, T8= 1/2 Poultry manure + 1/2 NPK and T9= 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK. Mean±Standard error of the mean in each column followed by the same letter did not differ significantly according to Tukey test (P=0.05). ^{ns}P>0.05, **p<0.01 and ***P<0.001. Each datum represents the mean of 3 replicates values.

3.2 Influence of organic and inorganic fertilizers on the production parameters of maize

The influence of organic and inorganic fertilizers on the production parameters of maize cultivated in the locality of Djalingo in the North region of Cameroon is presented in table 2. The length of the maize ear was significantly ($F_{(8, 18)}$=9.49; P<0.001) short in the negative control (10.80 cm) compared to the other treatments and high ear length ranging from 14-15 cm were registered in organic manures used singly or in combination with the inorganic fertilizer (NPK 14-23-14, 150 kg/ha). The number of grains per row of ear significantly ($F_{(8, 18)}$=8.93; P<0.001) varied from one treatment to another and the highest number of maize grain per row of ear up to 30 grains was registered in the treatment (T9) in which all the fertilizers evaluated are mixed together, while only 20.76 grains/row was recorded in the ear of the negative control. The number of ear per treatment significantly ($F_{(8, 18)}$=4.40; P<0.05) varied with treatments and the high number of ears was registered in treatments T2 (51.66 ears) and T3 (53 ears) compared to the negative control T1 (37 ears). The weight of 1000 grains was significantly ($F_{(8, 18)}$=11.75; P<0.001) high in the treatment T9 (0.34 kg) compared to the other treatments (T2=0.26 kg, T3=0.21 kg, T4= 0.20 kg, T5= 0.22kg, T6=0.20 kg, T7=0.21 kg and T8=0.20 kg) and the lowest weight was recorded in the negative control (0.17 kg).

Table 3. Influence of organic and inorganic fertilizers on the production parameters of maize in the locality of Djalingo in the north region of Cameroon.

Treatments	Length of ear (cm)	Number of grains/row of ear	Number of ear/treatment	Weight of 1000 grains (kg)
T1	10.80±0.32b	20.76±0.90b	37.00±7.02b	0.17±0.01c
T2	13.66±0.68a	28.30±0.65a	51.66±6.35ab	0.26±0.02b
T3	15.06±0.14a	29.30±0.35a	53.00±3.21a	0.21±0.01bc
T4	15.00±0.11a	29.43±0.56a	52.33±5.45a	0.20±0.01bc
T5	14.33±0.64a	27.50±1.20a	27.33±4.33ab	0.22±0.02bc
T6	14.93±0.26a	29.20±0.45a	38.00±7.93ab	0.20±0.00bc
T7	15.73±0.47a	29.86±1.63a	45.66±9.87aa	0.21±0.01bc

T8	14.93±0.85a	28.76±1.42a	38.66±4.84ab	0.20±0.01bc
T9	15.20±0.10a	30.06±0.52a	46.66±12.38ab	0.34±0.02a
$F_{(8, 18)}$	9.49***	8.93***	4.40*	11.75***

T1= Negative control, T2= NPK (150 kg/ha), T3= Cow dung, T4= Cotton crab, T5= Poultry manure, T6= 1/2 Cow dung + 1/2 NPK, T7= 1/2 Cotton crab + 1/2 NPK, T8= 1/2 Poultry manure + 1/2 NPK and T9= 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK. Mean±Standard error of the mean in each column followed by the same letter did not differ significantly according to Tukey test (P=0.05). ^{ns}P>0.05 and ***P<0.001. Each datum represents the mean of 3 replicates values.

Figure 2 presents de yield of TZEE-W maize genotype treated with organic and inorganic fertilizers used singly or in combination in the locality of Djalingo in the North region of Cameroon. Globally, the yield in grain of the maize genotype assessed significantly ($F_{(8, 18)}$= 18.08, P<0.001) varied with the fertilizer treatments applied. The highest maize yield was obtained in the treatment combination of 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK in which 6.33 ton/ha was recorded. The binary combination organic-inorganic fertilizers treatments showed a moderate maize grain yield of 3.87 tons/ha for 1/2 Cotton crab+ 1/2 NPK treatment, 3.76 tons/ha for 1/2 Cow dung + 1/2 NPK treatment and 3.07 tons/ha for 1/2 Poultry manure + 1/2 NPK treatment. The plots maize plants treated singly with organic or inorganic fertilizers produced low yields of 2.93, 2.71, 2.54 and 2.53 tons/ha for cotton crab, cow dung, NPK 150 kg/ha and poultry manure applications, respectively. The lowest grain yield of 1.53 ton/ha was recorded in the plot set as negative control (plot without fertilizer application).

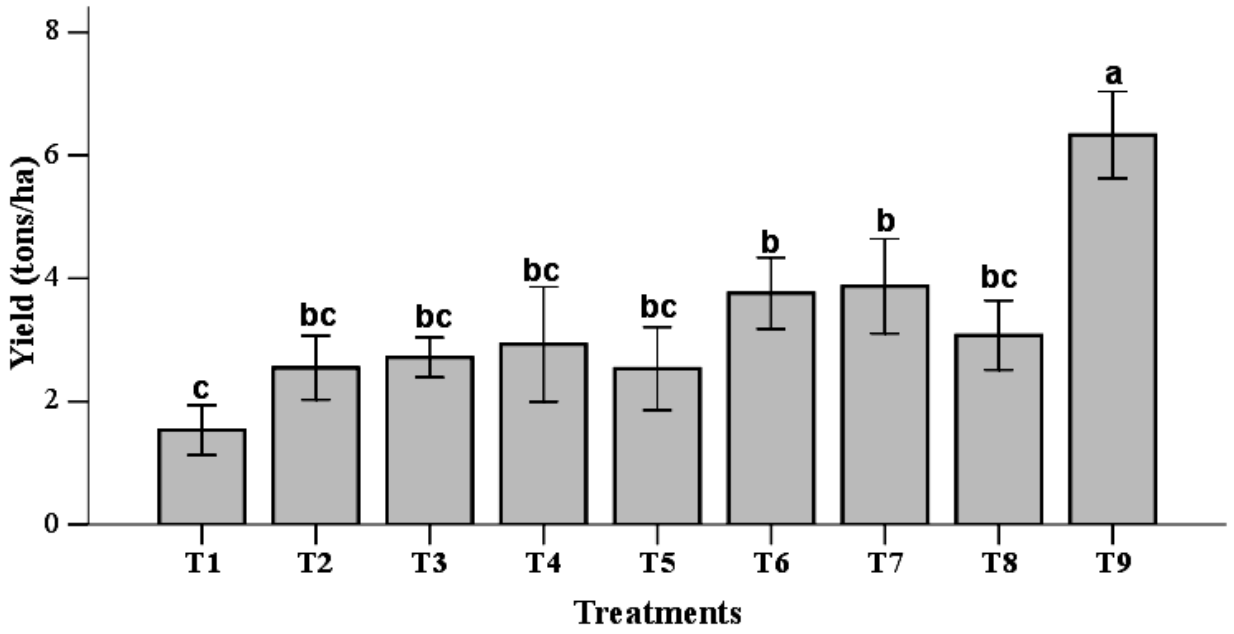

Fig 2. Grain yield (tons/ha) of TZEE-W maize genotype obtained by treating maize plants with organic and inorganic fertilizers applied singly or in combination. T1= Negative control, T2= NPK (150 kg/ha), T3= Cow dung, T4= Cotton crab, T5= Poultry manure, T6= 1/2 Cow dung + 1/2 NPK, T7= 1/2 Cotton crab + 1/2 NPK, T8= 1/2 Poultry manure + 1/2 NPK and T9= 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK. Mean±Standard error of the mean in each column followed by the same letter did not differ significantly according to Tukey test (P=0.05). ^{ns}P>0.05 and ***P<0.001. Each datum represents the mean of 3 replicates values.

4. DISCUSSION

The inorganic and organic fertilizers used singly or in combination significantly improved growth and production parameters of the maize variety assessed. Globally, the mixture of mineral and organic fertilizers was the best compared to singly application of each fertilizer. Globally, growth parameters including height, number of leaves and noose stem girth of the maize crop were significantly influenced by the inorganic fertilizer application compared to the other treatments. High corn plant height observed in the plots receiving inorganic fertilizers could be attributed to the ready available nitrogen compared to N from organic manures, which firstly should be decomposed and mineralized before releasing nitrogen assimilable by plants [14][15]. The slow release of nutriments from the organic manure treatments might explain the delay in growth of maize plants within weeks observed in this present study.

The application mineral and organic fertilizers in combination in this present study significantly improved the growth parameters of the plant maize assessed. Similarly, [16] found that the

application mixture of 50% NPK+50% chicken manure significantly increased the height of corn up to 195.25 cm compared to the singly used of each fertilizer (50% NPK= 186.25 cm and 50% chicken manure= 153 cm). Indeed, organic manure incorporated in the soil reduces the evaporation and enabling adequate water for plant root growth. Organic manure renders soil soft and facilitates the rapid expansion of plant roots to get properly water required for plant growth [17]. According to [18], plant nutrient sources from the organic and inorganic fertilizers combination stabilize the synergism and synchronization between nutrient release and plant recovery for better maize crop growth and yield. Organic manure improved soil moisture contents and it porosity and has capacity to hold water by reducing soil compaction and bulk density [19]. Among the binary combination of inorganic chemical with organic manures, the combination of cow dung 7 tons/ha or cotton crab 7 tons/ha with NPK 150 kg/ha in this present investigation significantly increased growth parameters and moderately augmented maize grain yield. Similarly, study conducted by [20] in Uganda showed that the application of inorganic combined with different cattle manures (cattle manure stored under shade, cattle manure stored in the open, cattle manure slurry digested and vermi-compost) significantly increased ($p < 0.05$) maize growth parameters and yields when compared with the singly application and the control. Conversely to the findings of the present study, [21] reported that plants treated with poultry manure assimilated efficiently nitrogen compared to those receiving cattle slurry, pig manure, sheep manure or ammonium sulphate as fertilizer. Study conducted by [22] showed also that the treatment of plant maize with NPK 120 kg N/ha combined with poultry manure produced a high number of grain line up to 12.62 lines, high number of grain per ear (360 grains) and the weight of 1000 grains (299.9 g). This difference could be explained by the difference organic manures composition in fertilizing elements and the rate process of their decomposition since advanced decomposed organic manures easily release ammonium ions which are a source of mineral nitrogen readily utilized by plants [23][24].

The combination of the inorganic fertilizer with the three organic manures mixed together led to the highest maize grain yield compared to single or binary mixture treatments. Similarly, the treatment of maize crop with the mixture of N (120 kg/ha), compost (10 ton/ha) and S (15 kg/ha) led to high grain yield (7.9 ton/ha), plant height (252 cm), number of grain per ear (486 grains), ear weight (0.14 g) and weight of 1000 grains (492 g) [11]. From Egypt, the mixture of compost (10 tons/fed) and sheep manure added to ureaform (50 kg/fed) significantly conducted to the

highest grain yield and quality of maize [12]. Maize crop treated with inorganic fertilizer NPK at 150-85-50 kg/ha combined with 8 ton/ha Sheep manure, 8.5 ton/ha farmyard manure and 7 ton/ha poultry manure yielded high 1000 grains weight up to 220.8, 215.0 and 234.4 g, respectively compared to their applications singly and control [3]. Multiple combination of inorganic fertilizer with organic manures may release sufficiently N, P and K essential elements and consequently may improve soil fertility for a better blooming of maize plant with good long ears well filled in grains.

5. CONCLUSION

The different fertilizer treatments used in this present study significantly improved the growth and production of the maize variety assessed. Anthesis to silking interval (Days) of maize treated with the combination of mineral and organic fertilizers were short (at most 2 days) compared to singly application of these fertilizers. Production parameters including length of ear (cm), number of grains per row of ear and number of ear per treatment of the maize were significantly improved when treated with the combination of NPK 150 kg/ha with cow dung, chicken manure and cotton crab fertilizers. The highest maize yield was obtained in the treatment combination of 1/4 Cow dung + 1/4 Cotton crab +1/4 Poultry manure +1/4 NPK in which 6.33 ton/ha was recorded. The binary combination organic-inorganic fertilizers treatments showed a moderate maize grain yield of 3.87 tons/ha for 1/2 Cotton crab+ 1/2 NPK, 3.76 tons/ha for 1/2 Cow dung + 1/2 NPK and 3.07 tons/ha for 1/2 Poultry manure + 1/2 NPK. Applications of inorganic fertilizer combined with organic manures like cow dung, cotton crab and poultry manure should be used at optimum rates by farmers with low income to increase and improve their maize yield production in the north region of Cameroon where famine and poverty are recurrent.

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