Effect of the micro-organism-basedbiofertiliser Tokyo 8 on the growth and development of maize (Zeamays l.) in farmers' fields in southern Côte d'Ivoire

Summary:

The exclusive use of mineralfertilisers for production contributes to the destruction of certain microflora and microfauna in the soil, as well as reducing the organicmatter content, which in turnreducessoilfertility. With the aim of finding an alternative to crop fertilisation on the farm, a micro-organism-basedbiofertiliser (Tokyo 8) wasintroduced and tested on maizecrops. Three types of Tokyo 8 doses weretested: T2: Tokyo 8 diluted 50 times, T3: Tokyo 8 diluted 75 times and T4: Tokyo 8 diluted 100 times. In addition, twocontrolsweretested, namely T0: control without fertiliser and T1: control with NPK 12-22-22 fertiliser. The trials were set up in a Fisher block design withthreereplicates. The results show that, like NPK, biofertiliserimprovesmaizegrowthparameters and yield components. It provides the mineralelementsrequired for maizegrowth and development. However, to beusedeffectively, Tokyo 8 biofertiliserneeds to bedilutedsensibly. A dilution of 75% seems to be the ideal for optimum use in maizecrops.

Keywords:biofertilizer (Tokyo 8), micro-organisms, maize (Zeamays), Ivory Coast

1. INTRODUCTION

Maize, alsoknown by itsscientificnameZeamays L., is a tropical plant belonging to the Poaceaefamily, with the world'slargest area of cultivation [1].Maizeplays an important role in maintainingfoodsecurity. Maize grain iseaten in a variety of ways:cooked, grilled or in soup. It isalsoused to makebiodegradable plastics, biofuels and evenalcohol[2].

Maizeis the world'smostwidelygrowncrop, with production estimated at 1,120 million tonnes for the 2019-2020 season [3].Amongcereals, itranksthird and first respectivelyahead of wheat and rice in terms of cultivated area and production. Maize and oilseed grains are the most important source of food for humans. In manydeveloping countries, itaccounts for the bulk of people'sdiets[4].

In Côte d'Ivoire, maizeis the second mostwidelygrowncerealafterrice[5].Annual national maize production isestimated at around 600,000 tonnes, 60% of whichcomesfrom the savannahregion, with a yield of 1.9 tonnes per hectare from a total planted area of 350,000 ha [6].In our country, maizeis essential for foodsecurity[7],and isalsoused in animal feed for poultry, pigs and cattle, and as a rawmaterial in certain industries (brewing, soap production and oil production)[8].

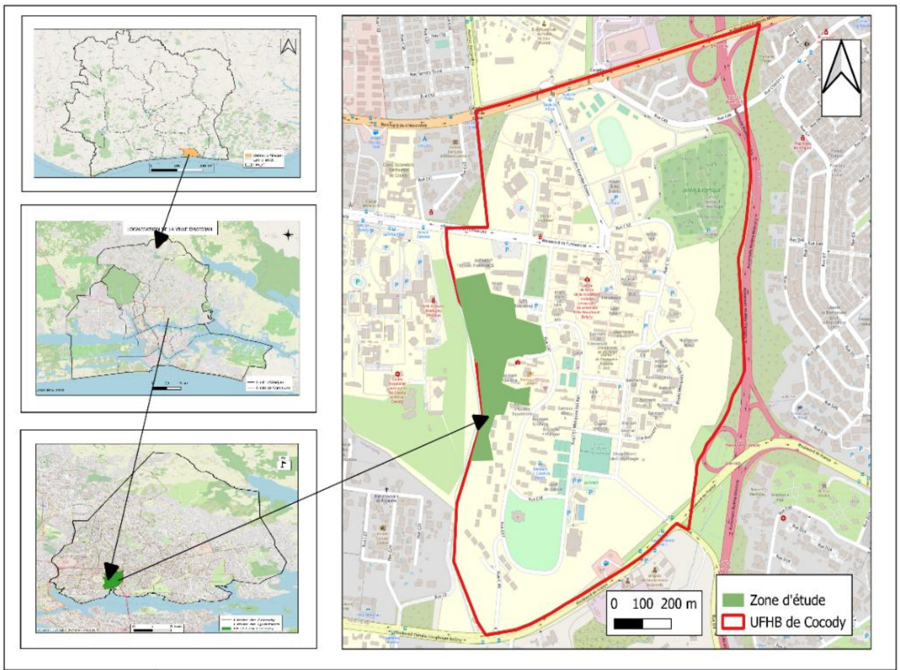
However, maizeyields in Côte d'Ivoire remainlow and local production coversonly 30% of consumptionneeds[9].This lowyieldis due to a combination of factors[10],including, alongwithdisease and pests, a decline in soilfertility[11]. This ismainly due to intensive cultivation and soilerosion. To overcomethis major constraint to maize cultivation, farmers use mineral and organicfertilisers[12, 13, 14 and 15], but above all chemicalfertilisers, which are known for theirability to improvecropyields. Unfortunately, chemicalfertilisers are expensive and harmful to the environment and humanwell-being[16].Given the decline in soilfertility, the rise in the price of chemicalfertilisers on the market and theirharmfuleffects on the environment and humanhealth, itis vital to look for alternatives thatwill enable sustainable agriculture. It isagainstthisbackdropthat the effect of a biofertiliser (Tokyo 8) has been assessedwith a view to sustainablesoilrestoration.

The aim of thisstudyis to contribute to sustainablemaize production on the farm. More specifically, the aimis to assess the effect of the biofertiliser (Tokyo 8) on maizegrowth and yield.

2. STUDY AREA

The field trial wascarried out at the Université Félix HOUPHOUËT-BOIGNY (UFHB) in Cocody (Abidjan) on the experimental plot of the Unité Pédagogique et de Recherche de Physiologie et Pathologie Végétales (UPR PPV). The plot islocated in Abidjan, a city in the south of Côte d'Ivoire withgeographicalcoordinatesbetween latitudes 4°10 and 5°30 North and longitudes 3°50 and 4°10 West.

The relief varies between 0 and 300 m from the Gulf ofGuinea, between latitudes 4°17N and 7°N and longitudes 2°40W and 8°40W. It is made up of Precambrianbedrockwith a sedimentary cover of UpperCretaceous-Quaternaryage in the south-eastern part of the geologicallevel. The soilsfoundthere are mainlyferrallitic and ferruginous, withsomebrowneutrophic tropical soils. By virtue of itsgeographical location, the Université Félix HOUPHOUËT-BOIGNY site belongs to a humid tropical climate zone characterised by a highlycontrastingrainfall and temperatureregime(Fig.1).



Source: Google Map/Terrain

Fig.1.Map of the study area

3. MATERIALS AND METHODS

3.1 Material

3.1.1 Plant material

The experimentfocused on the LG501 hybridmaizevariety. It has a development cycle of 90 days and a yield of 7 t/ha. It originatesfrom Limagrain, a group of semi-processingcooperatives.

3.1.2 Fertilisersused

The fertilisersused are shown in Fig.2. The synthetic fertiliser NKP (12-22-22) usuallyapplied in the field for marketgardening, vegetables and maizewasused as a reference control.

Biofertilisant Tokyo 8 is a formulation of micro-organisms, enzymes and trace elements and nutrients. It wastested at 3 doses obtained by dilution to 50, 75 and 100%. It isalreadybeingused in Ghana and Liberia, and iscurrentlybeingtested in Côte d'Ivoire and Guinea.

Fig.2.Fertilisersused

3.1.3 Technicalequipment

The technicalequipmentused in thisstudyconsistedmainly of tools and instruments required for growing, maintaining and observing plants in the field and in the laboratory. Items such as machetes, a decameter, ropes, stakes and a backpacksprayerwereused to set up and care for the plants. Observations and measurementswere made using a variety of tools, including a tapemeasure, a calliper, a 30 kg weighingscale of a specific brand, transparent polyethylene plastic bags, permanent markers and a digital camera.

3.2. METHODS

3.2.1 Experimental design

The experimental design was a Fisher randomisedcomplete block design. The factor studiedwas the dose of biofertiliserwiththree (3) treatments and three (3) replications. The experimental plot was 14 m long and 11 m wide, i.e. an area of 154 m2. The distance between the blocks was 2 m, and thatbetween the individual plots 1 m (Fig.3). Eachindividual plot had an area of 6 m2.

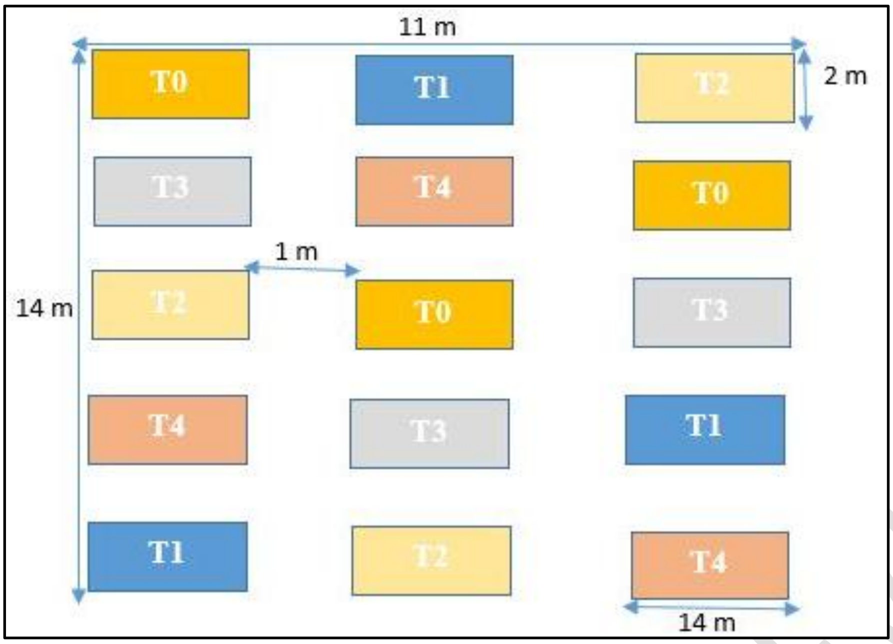


Fig.3.Experimentalset-up

T0 : *control without fertiliser ;* ***T1 :*** *control with NPK 12-22-22 fertiliser ;* ***T2 :*** *Tokyo 8 diluted 50 times ;* ***T3 :*** *Tokyo 8 diluted 75 times ;* ***T4 :*** *Tokyo 8 diluted 100 times*

3.2.2 Setting up and running the trial

The previouscrop in the experimental plot wasfallow. As a result, the plot waspreparedbefore the trial was set up. This involved clearing the land and ploughing to a depth of 15-20cm. The experimentallayoutwasthen laid out. Each micro-plot consisted of 4 rows, eachbearing 52 bunches. Sowingwascarried out after a usefulwatering of 45 l of water per micro plot. Sowingwascarried out manually, withtwoseeds per plot. Fertiliser wasapplied 15 and 35 daysaftersowing. Weedingwascarried out beforeeach application. A total of three doses of Tokyo 8 biofertiliserweretested in comparisonwith NPK (12- 22- 22) at a dose of 150 kg/ha and an untreated control. The biofertiliser doses wereobtained by diluting the recommended dose of 1 ml/m2. The dilution factorswere 50, 75 and 100%. Thus, 6 ml of biofertiliserwereplaced in a beaker and then water wasaddeduntil a volume of 900, 1350 and 1800 ml wasreached for the 50, 75 and 100% dilutions respectively. This quantity of spray mixture wasthen put into a sprayer and applied to the microplotsconcerned. The biofertiliserwasapplied by sprinkling at the foot of the plants, while the NPK fertiliser wasapplied by spreading at the foot of the maize plants. The biofertiliserwasapplied to the plants by foliarspraying. Phytosanitarytreatmentsbased on cypercal (50ml/7.5l of water) werecarried out to reduceattacks by the armyworm.

3.2.3 Data collection

Observations focused on measurements of agro-morphologicalparameters and yield components of maize plants. The quantitative variables weremeasured on twenty (20) marked plants selected at randomfromeachmicroplot. Observations were made everyweekfrom 30 DAS untilfloweringbegan.

3.2.4 Agro-morphologicalparameters

Measurementsweretaken on 5 plants per rowselected at random on eachelementary plot and in each block, i.e. a total of 20 plants per microplot. Somecharacteristicswereselectedfromamong the maizedescriptors. Plant heightwasmeasuredwith a tapefrom the crown to the stem apex 50 cm above the ground. This wasdoneeveryweekuntilflowering. The number of leaveswasdetermined by countingthemeveryweek. Stem diameterwasalsomeasuredusing a caliper at the neck of the plants.

These data wereused to calculate the vigour index (IV) according to the equation in[17] :

$$\mathbf{IV = Log\ [(H*C^2)\ /4\pi],}$$

Where**π**is the constant **3.14**; **IV :**Vigour index; **H:** Plant height; **C:** Plant circumference.

3.2.5 Yield components

3.2.5.1 Flowering

As soon as the first male flowers (panicle) and femaleflowers (ear) appeared, i.e. 52 daysaftersowing, the number of flowersthatappearedwascounted on all the plants. Theywereassessed by counting the flowerseverytwodays, which made it possible to calculate the number of days at 50% male flowering and femaleflowering.

3.2.5.2 Freshyield

At harvest, the freshyieldwasassessed. To do this, the two central lines of eachmicroplot, bearing a total of 15 plants, wereharvested. The number of ears and the mass of eachearweredetermined. The number of ears per m2 wascalculated by dividing the number of ears by the area harvested. Similarly, the averageear mass wascalculated by dividing the total ear mass by the number of ears. The yieldinduced by eachtreatmentwascalculated by dividing the total mass of ears by the area harvested.

3.2.5.3 Data analysis and processing

All the data collectedwasenteredusing Excel. An analysis of variance (ANOVA) wasperformedusingStatistica software version 7.1. The Newman Keul test wasused for the comparison of means to establish the significance of differencesbetweentreatments at the 5% threshold.

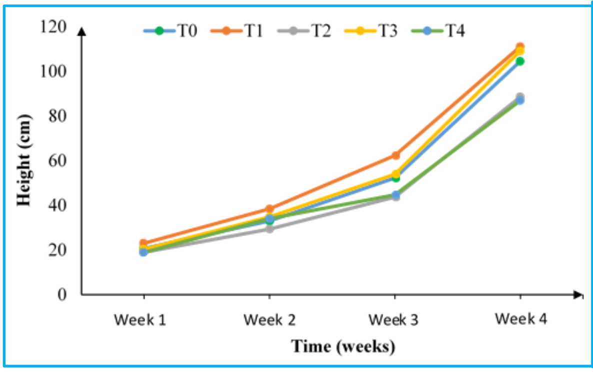
4. RESULTS

4.1 Effect of biostimulant doses on maize agro-morphologicalparameters

4.1.1 Changes in plant height as a function of treatment

Changes in average plant height as a function of treatment and time are shown in Fig.4, which shows thataverage plant heightincreasedsharply over time, regardless of treatment. The averageheightrangedfrom 18.97 to 23.13 cm at week 1, and by week 4 hadrisen to values rangingfrom 86.99 to 111.17 cm. However, the average plant height in treatments T1 and T3 washigherthroughout the evaluationperiod.

The averageheight of the maize plants obtained at the end of the observations variedsignificantlyfrom one treatment to another. Treatment T1 (NPK fertiliser) produced the highestheights, with an averageheight of 58.77 cm. On the other hand, treatments T2 and T4 (Tokyo 8 diluted 50 and 100%) showedlowheightswithmeanheights of 45.23 and 46.19 cm respectively. Treatments T0 (no fertiliser) and T3 (biofertiliserdiluted 75%) gave intermediateheightswithmeanheights of 52.66 and 54.64 cm respectively (Fig.5).



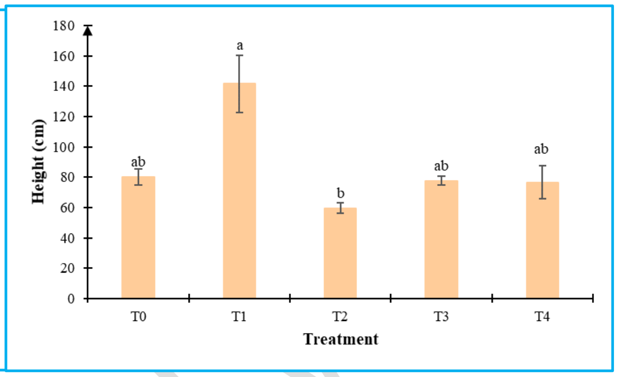


Fig.4.Height versus time curveFig.5. Plant height as a function of treatment

T0: *control without fertiliser*, ***T1:*** *control with NPK 12-22-22 fertiliser*, ***T2:*** *Tokyo 8 diluted to 50%*, ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ;*Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.

4.1.2 Changes in plant diameter as a function of treatments

At the end of the observations, a significantdifferencewasrecordedbetween the stem diametersobtained on the treatments. Treatment T1 (NPK fertiliser) produced the largestdiameterwith an average of 17.66 mm. The smallestdiameterswereobserved in treatments T2, withaverages of 14.23 (Fig.6). Treatments T0, T3 and T4 producedstatisticallyidenticalintermediatediameters.

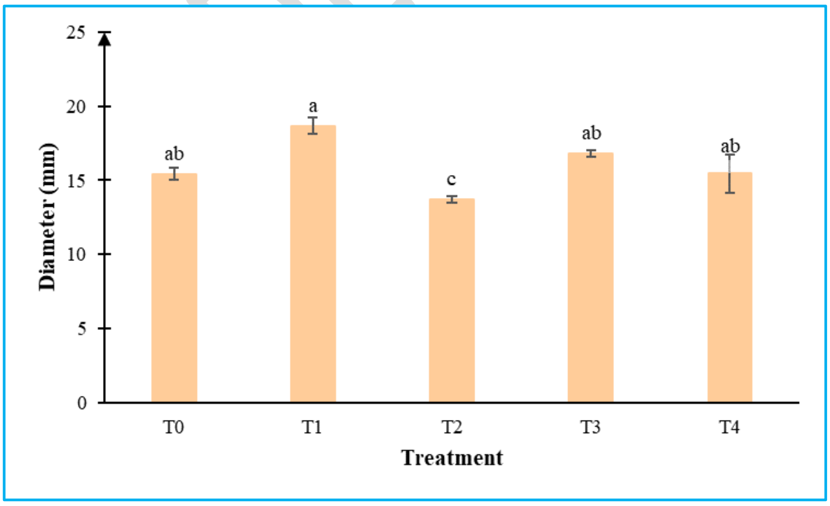


Fig.6.Effect of treatments on plant diameter

T0: control without fertiliser, T1: control with NPK 12-22-22 fertiliser, T2: Tokyo 8 diluted to 50%, T3: Tokyo 8 diluted to 75%. T4: Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.

4.1.3 Changes in plant leafemission as a function of treatment

Fig.7 shows the evolution of plant leafemission as a function of treatment and time. This figure shows thatleafemissionincreasedslightlywith time, whatever the treatment. The greatestnumber of leaveswasrecorded in treatments T0, T1 and T3 over the entire observation period. T2 and T4 induced the lowestnumber of leaves in weeks 1 and 3. At the end of the observations, data analysisshowed no significantdifference (p > 0.05) betweentreatments. The number of leavesemittedwas 11.25, 11.01, 10.98, 10.38 and 10.31 respectively for treatments T0, T1, T2, T3 and T4 (Fig. 8).

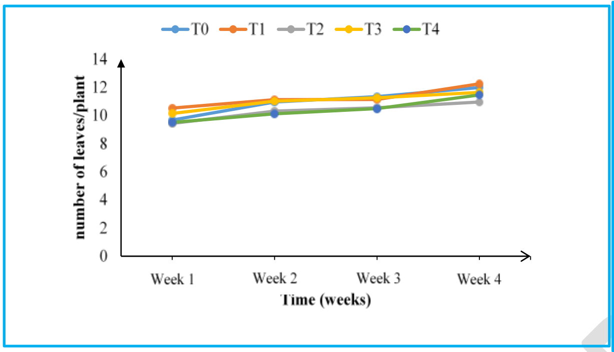


Fig.7. Evolution of the number of leaves as a function of time

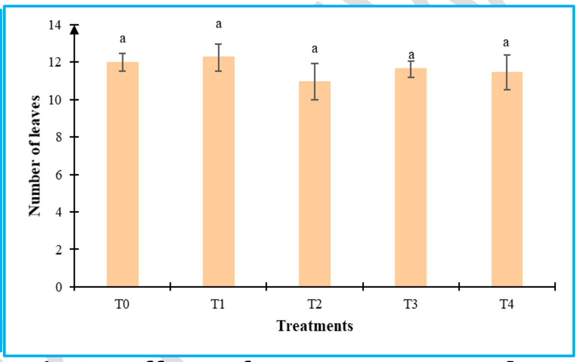


Fig.8. Effect of treatments on the number of leaves emitted

T0: control without fertiliser, T1: control with NPK 12-22-22 fertiliser, T2: Tokyo 8 diluted to 50%, T3: Tokyo 8 diluted to 75%. T4: Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.

4.1.4 Vigour index as a function of treatment

Analysis of variance of the data revealedsignificantdifferencesbetweentreatments in terms of vigour index. The mostvigorous plants wereobserved in treatment T1, with an average index of 3.05. On the other hand, the least vigorous plants wereobserved in treatments T2 and T4, withaverages of 2.72 and 2.77 respectively. Treatments T3 and T0 recordedintermediatevigour indices of 2.91 and 2.90 respectively (Fig.9).

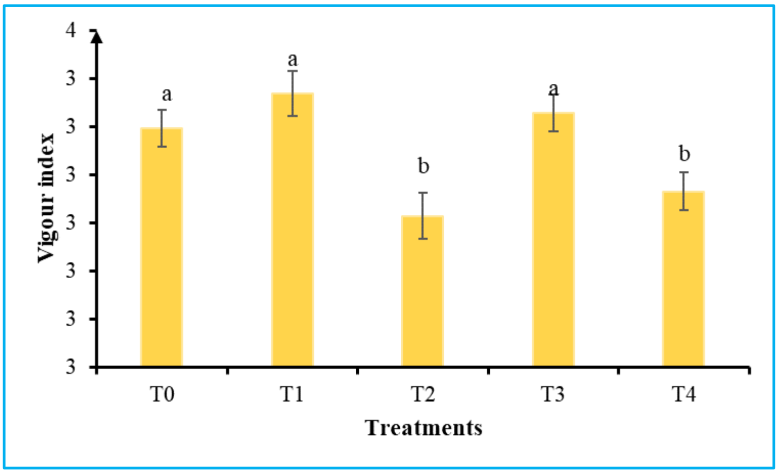


Fig.9.Effect of treatments on vigour index

4.2 Effect of treatment on yield components

4.2.1 Evolution of flowering of plants according to treatments

The first male and femaleflowerswereobserved on days 52 and 56 respectivelyaftersowing. The rate of male floweringincreasedslightlyuntilday 54 and thensharplyuntil the end of the observations. Treatment T1 induced the highest rates of male floweringthroughout the observation period. It wasfollowed by T3 and then T0. Treatments T2 and T4 induced the lowestflowering rates. At the end of the observations, the male flowering rate was 78, 62, 57, 43 and 41% for treatments T1, T3, T0, T4 and T2 respectively. However, analysis of variance showed no significantdifference ($p > 0.05$) betweentreatments (Fig.10 and 11).

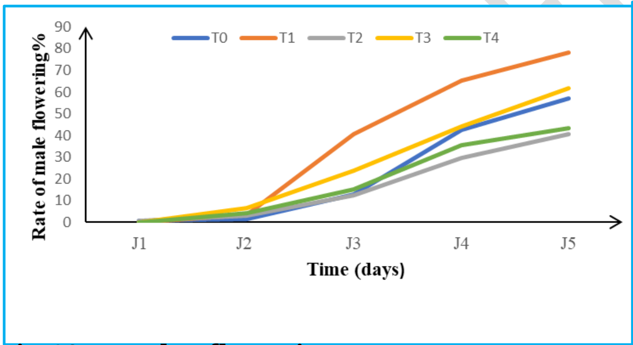


Fig.10. Male flowering rate as a function of time

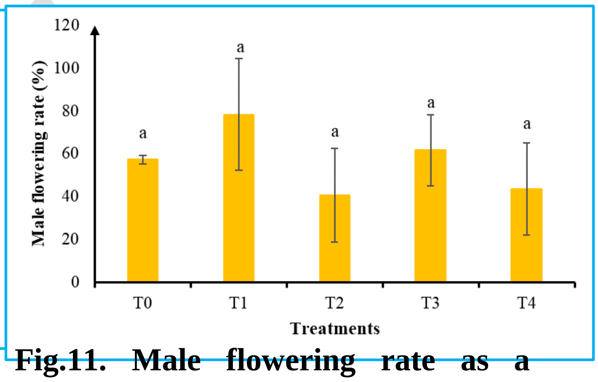


Fig.11. Male flowering rate as a function of treatment

T0: *control without fertiliser,* ***T1:*** *control with NPK 12-22-22 fertiliser,* ***T2:*** *Tokyo 8 diluted to 50%,* ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ;* ***J1,2,3 ;4,5 :*** *Day 1,2,3 ;4,5 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.*

In the case of femaleflowers, the rate of floweringincreasedsharply over time. Treatment T1 recorded the highestflowering rate over the entire observation period. It wasfollowed by treatment T3 and then the control T0. The femaleflowering rates observed in treatments T4 and T2 werebelowthose of the control.

At the end of the observations, the femaleflowering rate was 23, 21, 17.14 and 9% respectively on treatments T1, T3, T0, T4 and T2. However, analysis of variance showed no significantdifference ($p > 0.05$) betweentreatments (Fig.12 and 13).

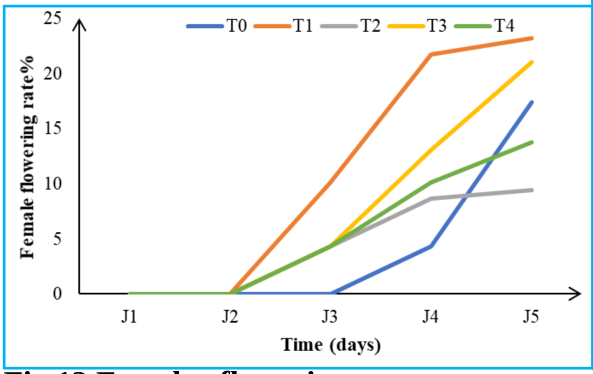


Fig.12.Female flowering rate as a function of time

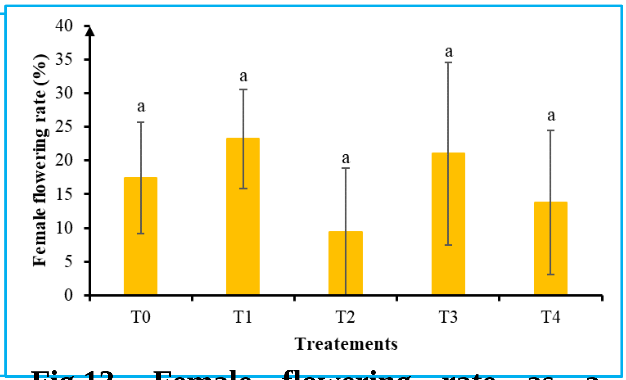


Fig.13. Female flowering rate as a function of treatment

T0: *control without fertiliser,* ***T1:*** *control with NPK 12-22-22 fertiliser,* ***T2:*** *Tokyo 8 diluted to 50%,* ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ;* ***J1,2,3 ;4,5 :*** *Day 1,2,3 ;4,5* ***;*** *Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.*

4.2.2 Number of freshears as a function of treatment

The number of ears per plant variedsignificantlyfrom one treatment to another. Treatmentwith T1 induced the highestnumber of earswith an average of 24.67. The lowestnumber of earswasrecorded in the untreated control with an average of 16.3. Treatments T3 and T4 inducedearnumbersvery close to those of T1. Treatment T2 produced an earnumbervery close to that of T0 (Fig.14).

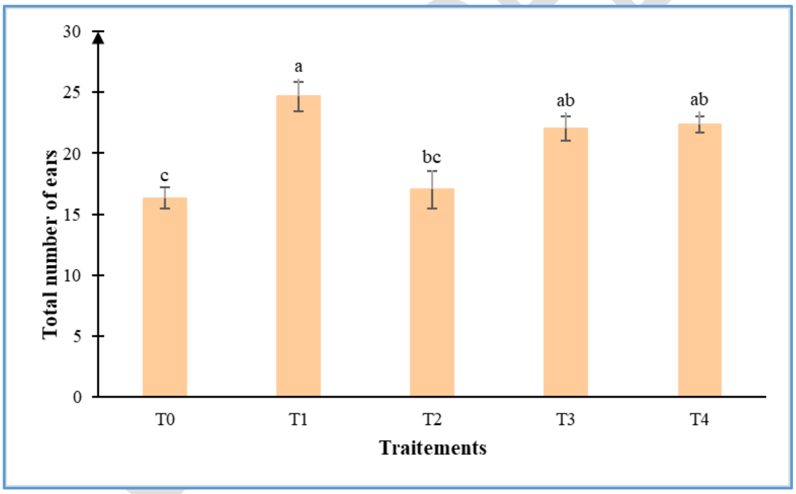


Fig.14.Number of spikes as a function of treatment

T0: *control without fertiliser,* ***T1:*** *control with NPK 12-22-22 fertiliser,* ***T2:*** *Tokyo 8 diluted to 50%,* ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.*

4.2.3 Averagefreshearweight by treatment

The average mass of the earwas 0.24, 0.25, 0.21, 0.20 and 0.20 kg respectively for treatments T1, T2, T3, T4 and T0. However, analysis of the data revealed no significantdifferences. (Fig.15)

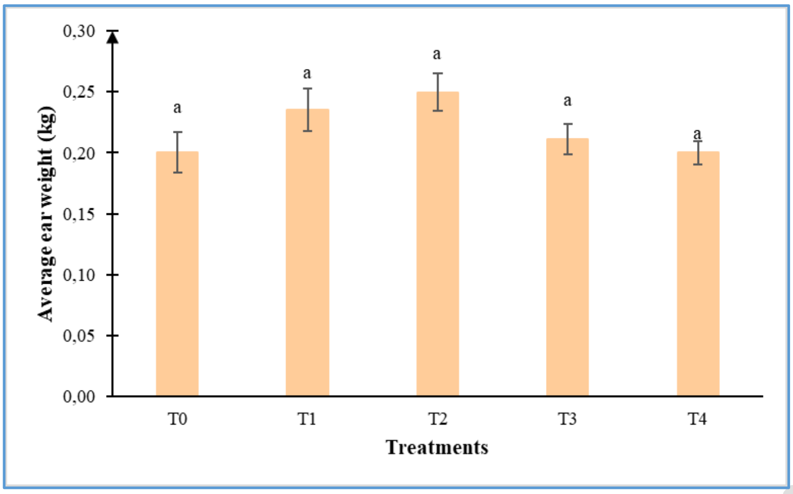


Fig.15.Averageearweight as a function of treatment

T0: *control without fertiliser,* ***T1:*** *control with NPK 12-22-22 fertiliser,* ***T2:*** *Tokyo 8 diluted to 50%,* ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.*

4.2.4 Yield in kg/ha as a function of freshtreatment

The yieldsobtainedfrom the differenttreatments are shown in Figure 16. Analysis of variance revealed a significantdifference ($p < 0.05$) betweentreatments. Treatmentwith T1 produced the highestyield, with an average of 18888.89 kg/ha. By contrast, the lowestyieldwasrecorded for treatment T2 with 7933.33 kg/ha. Treatments T3, T4 and T0 recordedintermediateyieldswith 14888.89, 14833.33 and 14000 kg/ha respectively. (Fig.16)

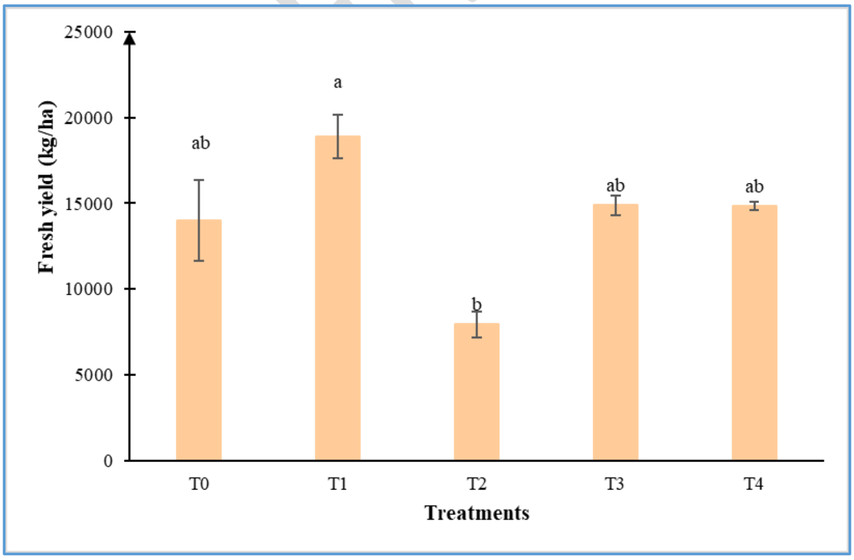


Fig.16.Freshyield as a function of treatment

__T0:__ control without fertiliser, __T1:__ control with NPK 12-22-22 fertiliser, __T2:__ Tokyo 8 diluted to 50%, __T3__: Tokyo 8 diluted to 75%. __T4:__ Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.

4.2.5 Dry yield in kg/ha as a function of treatment

The mass in kg/ha of dry maize kernels withoutearswasa function of treatment (Fig.17). Analysis of variance revealed a significantdifference ($p < 0.05$) betweentreatments. Treatments T1 and T3 gave the highestyields, with an average of 2.98 and 2.63 kg/ha respectively. By contrast, the lowestyieldwasrecorded in treatment T2 with 1.8 kg/ha. Treatments T0 and T4 recorded 2.04 and 2.17 kg/ha respectively.

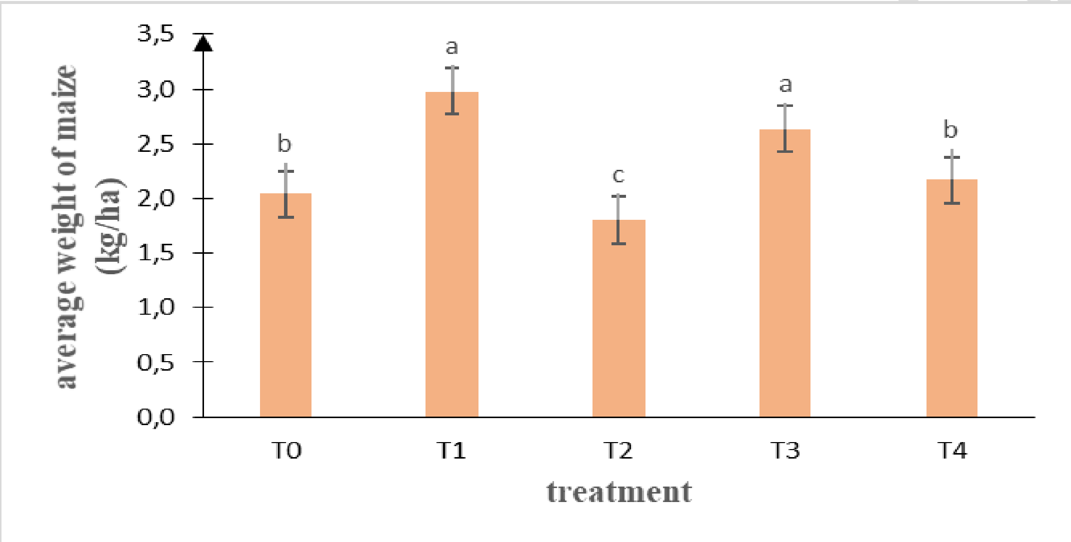


Fig.17. Dry yield as a function of treatment

__T0:__ control without fertiliser, __T1:__ control with NPK 12-22-22 fertiliser, __T2:__ Tokyo 8 diluted to 50%, __T3__: Tokyo 8 diluted to 75%. __T4:__ Tokyo 8 diluted to 100 ; Error bars with the sameletters are statisticallyidenticalaccording to the N-Keuls test with a threshold of α=0.05.

4.2.6 Correlationbetweengrowthparameters and yield components

Principal component analysis (PCA) wascarried out on the data collected on the growthparameters and yield components of maizeafter application of the different doses of Tokyo 8 biofertiliser. Theseweremeanheight, diameter, number of leaves, vigour index, male and femaleflowering rate, number of ears, meanearweight and freshyield. The resultsshowedthat axes 1 and 2, which express 91.1% of the inertia, weresufficient to characterise the variables studied. All the variables werestronglypositivelycorrelatedwith axis 1, whichaccounted for more thanhalf (60.93%) of the information, with the exception of yield and number of ears. The latter werestronglypositively and stronglynegativelycorrelatedrespectivelywith axis 2, whichaccounts for 30.74%. Height, diameter, vigour index and the percentage of female and male flowerswerestronglycorrelatedwitheachother. The dispersion of the treatmentsrevealed four homogeneous groups. Treatments T1 and T3 produced the best maizegrowth and yield.

Treatment T2 recorded the lowest values and treatments T0 and T4 recordedintermediate values. (Fig.18 and 19)

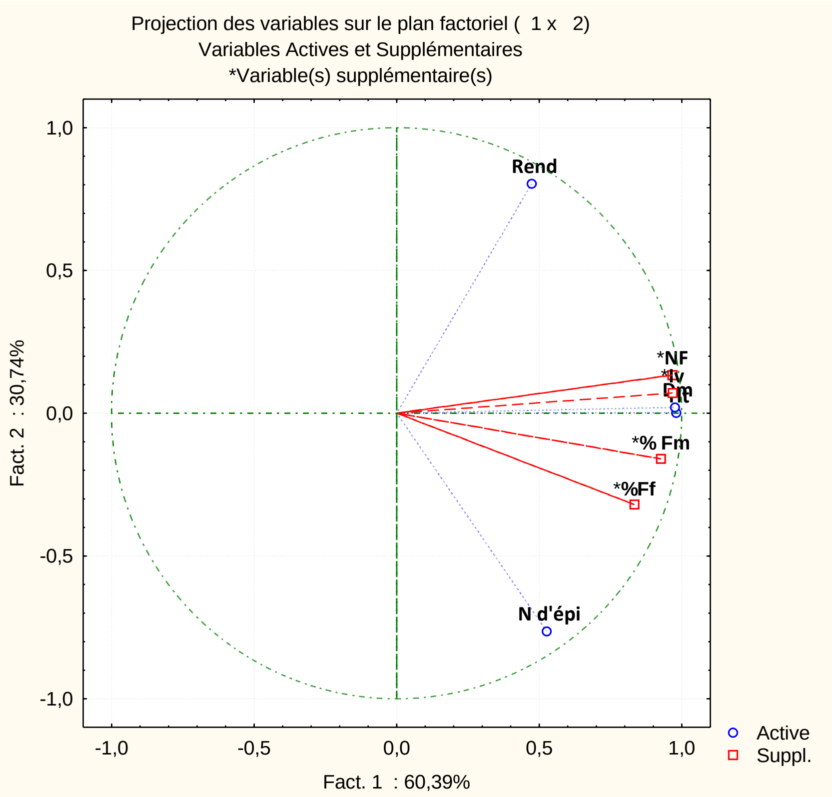


Fig.18. Correlationcircleaccording to PCA of treatments

Ha:*height; Dm: diameter;* ***iv:****vigour index,* ***Ff:****femaleflowers;* ***Fm:*** *male flowers ;* ***Rend:****yield;* ***N'épi:****number of ears*

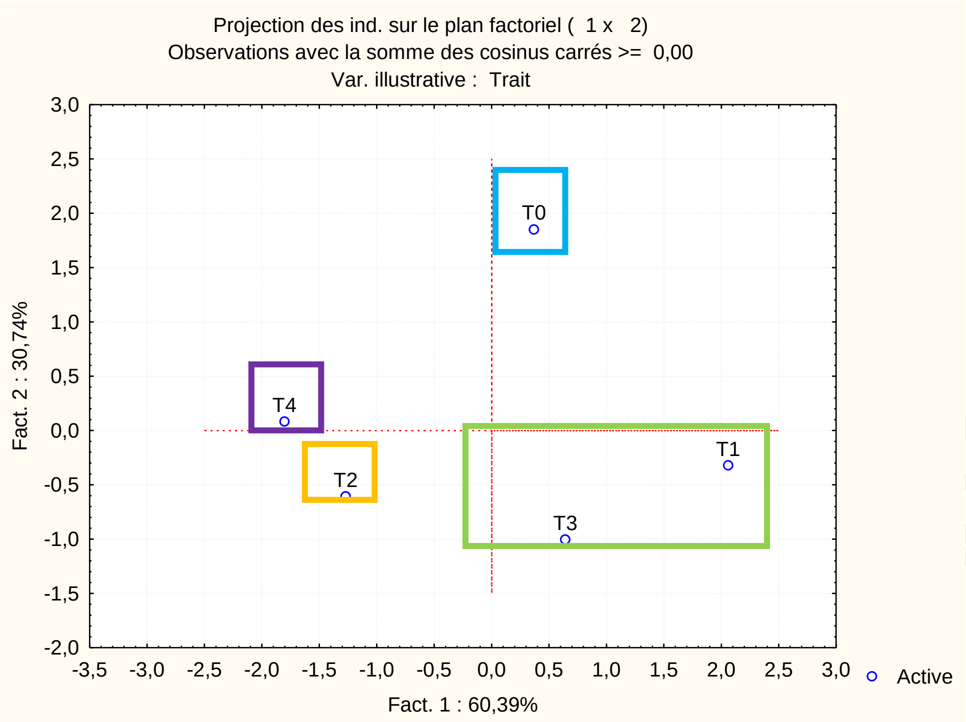


Fig.19. Dispersion of treatments

T0: *control without fertiliser,* ***T1:*** *control with NPK 12-22-22 fertiliser,* ***T2:*** *Tokyo 8 diluted to 50%,* ***T3****: Tokyo 8 diluted to 75%.* ***T4:*** *Tokyo 8 diluted to 100 ;*

5. DISCUSSION

Chemical fertiliser produced the best growth and yield in maize. This isbecause the chemical fertiliser provided the plants with the mineralelementsrequired for optimum growth and development. It isrich in nitrogen, phosphorus and potassium, the levels of which correspond to the needs of the maizecrop. This supply of mineralelementsthat can bedirectlyassimilated by the plant in sufficientquantitiesisresponsible for the rapidgrowth and good developmentobserved. Our results are in line withthose of [18],whoshowedthat plant nutrition and nitrogen fertilisation are essential factors in determining the yield and quality of agricultural production in tropical environments. According to the work of [19]and [20], the nitrogen (N), phosphorus (P) and potassium (K) contained in chemicalfertilisers are involvedthroughout the plant development cycle. As a result, their absence can lead to unsatisfactorydevelopment and yields[18].

The effects of the variousfertilisers on growthparameterswereremarkable. The Tokyo 8 biofertiliserimproved the growth of the maize plants comparedwith the untreated control. This resultcouldbeexplained by the composition of thisbiofertiliser. It iscomposed of mineralelementssuch as nitrogen, whichwould have played an active role in the vegetativegrowth of the maize. Our results are in agreement withthose of[20]whoshowedthatnitrogenis a determining factor in plant growth and the determination of plant yield. Also, [21]showedthatbiofertilisers have the necessarymineralelements for the growth and development of fieldcropssuch as maize.

Tokyo 8 biofertiliserisalsorich in enzymes and microorganisms. Thesewould have stimulatedmechanisms to improve the bioavailability of nutrients in the soil;qualitativelymodifysoilmicrobialcommunities (new equilibrium) and increasesoilmicrobialactivityfavourable to good plant development. Our resultscorroboratethose of[22], whoshowedthatbiofertilisersalsoimprovesoil structure by simulatingmicrobialactivities and nitrogenuptake by plants by modifyingtheirmorphological and physiologicalcharacteristics.

As with the growthparameters, the Tokyo 8 biofertiliserapplied to the cropled to an improvement in the components of maizedevelopment and yield. This resultcouldbejustified on the one hand by the good growthinduced by the biofertiliser. Our observation is in line withthat of[23], whohighlighted the improvement in maizeyield by four types of organic fertiliser through the good growthinduced by them. Thus, good plant growthis a prerequisite for good cropyields. Tokyo 8 biofertiliseralsocontainsmicro-organisms. According to the work of [24], micro-organisms release gibberellininto the environment, whichisinvolved in bud initiation, stem growth, flowering, the breaking of seeddormancy and fruit growth. All theseresultsprovethat Tokyo 8 biofertiliseris an organic fertiliser thatisveryrich in the mineralelements essential for healthy plant development.

The biofertiliserdiluted to 75% gave yieldssimilar to those of the chemical NPK fertiliser (12 22 22). The 50% dilution slowed down maize plant growth and significantlyreducedyields. As for the 100% dilution, itinducedgrowth and yieldvery close to that of the control. Theseresults show that Tokyo 8 biofertiliserneeds to bedilutedcarefully if itis to be effective. A dilution of 75% seems to be the mostsuitable for improving the effectiveness of Tokyo 8 biofertiliser in maizecrops. This resultissimilar to thoseobtained by [25]in tomatocropsusingseaweed-basedbiofertilisers. Theseauthorsshowedthatthesebiofertiliserswere effective from the 50% dilution, whereas the 25% dilution was ineffective.

The factthat the Tokyo 8 biofertiliserdiluted to 75% inducedgrowth and yield close to that of the NPK chemical fertiliser shows thatits composition issufficient to ensure optimal nutrition of maize plants. Our results are in agreement withthose of[26]who show thatfoliarspraying of a seaweedextract (SE) biofertiliserimproved the yield of baby lettuceunderlownitrogen conditions. However, unlikechemicalfertilisers, which have a negative impact on the environment, plants and humanhealth, biofertilisers have the advantage of improving physico-chemicalproperties and boostingbeneficialsoilmicro-organisms. According to the work of [27], biofertilisersimprovemicrobialactivity or the physico-chemicalproperties of the soil, enablingorganic compounds to bedegraded more effectively.

6. CONCLUSION

This studywascarried out with the aim of contributing to sustainablemaize production on the farm. To this end, the biofertiliser Tokyo 8 wastested in comparisonwith the chemical fertiliser NPK 12 22 22 and a control. The resultsshowedthat, like NPK, the biofertiliserimprovesmaizegrowthparameters and yield components. It provides the mineralelementsrequired for maizegrowth and development. It alsostimulatesimprovedbioavailability of nutrients in the soil, as well as the microbiologicalactivity in the soilthatunderpins the plant'sdevelopment. However, for Tokyo 8 biofertiliser to beusedeffectively, it must bedilutedcarefully. A dilution of 75% wouldappear to beideal for optimum use in maizecrops. Tokyo 8 biofertiliserdiluted to 75% inducesvegetativegrowth and maizeyieldsvery close to those of chemical NPK fertiliser. It couldbeused to enrich the soil.

In view of thisstudy, itwouldbeadvisable to :

- Test the Tokyo 8 biofertiliser on othercropsgrown by farmers.
- Evaluate the effect of the biofertiliser in combination with NPK
- Test the biofertiliser in otherlocalities.

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