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Responses of Maize and Tomato Crops to Fertilization with Three Agroforestry Litter Species (*Annona senegalensis*, *Terminalia macroptera* and *Parkia biglobosa*)

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Authors' contributions

This work was carried out in collaboration among all authors. Author TJM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AN plotted graghs and managed the statistical analyses of the data. Author AI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to assess the effect of *Annona senegalensis*, *Parkia biglobosa* and *Terminalia macroptera* litters amended to soil in order to improve growth and yield of tomato and maize plants. Trials were conducted at the University of Ngaoundere in a complete randomised block design for each of the two crops. Treatments consisted for each crop of a control (T) and three litters-based fertilizers of *A. senegalensis* (AS), *P. biglobosa* (PB) and *T. macroptera* (TM). The analysis of variance (ANOVA) was used to compare means between treatments. The results obtained indicate that the chemical characteristics of litters varied from one plant species to another. The pH of the three litters AS, PB and TM (6.06; 6.02; 6.07) was acid, while nitrogen

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content ranged from 2.43% (PB) to 1.40% (TM). A significant difference was observed between treatments for plant height of tomato (p = 0.0016) and maize (p = 0.039). The litters of *A. senegalensis* (80.33 g) and *P. biglobosa* (70.60 g) stimulated a significant production of more maize biomass compared to that of the control (37.26 g). The tomato biomass produced under soil amended with litter of *A. senegalensis* (27.33 g) and *T. macroptera* (31.27 g) was significantly more abundant (p = 0.035) than that of control (17.31 g). For tomato plants, the highest yield was observed for the treatment litter of *A. senegalensis* (7.35 t/ha), while the lowest yield accounted for the control (3.48 t/ha). The yield variation between treatments was in the following order: AS> PB>TM>T. As for maize, the yield varied from 4.15 t/ha (litter of *T. macroptera*) to 1.66 t/ha (control), and was classified between different treatments as: TM> PB > AS> T. Among the three tested litters, *Annona senegalensis* litter was the best for tomato, whereas *Terminalia macroptera* litter was better for maize production.

Keywords: Litters; Annona senegalensis; Parkia biglobosa; Terminalia macroptera; maize; tomato; yield.

1. INTRODUCTION

Agriculture in the sub-Saharan Africa is facing many problems including the aggressiveness of climate, the scarcity of precipitation, alteration of both chemical and physical properties of soil [1, 2]. Therefore, there is a loss of nutrients and organic matter reserves in the soil [3]. As a matter of facts, soils are depleted of their quality and become infertile [4]. This soil infertility could lead to lower yields, particularly for cereals, which makes it insufficient to cover the global food demand of an ever-increasing population [5]. The low productivity mainly due to the decline in soil fertility and the difficulties encountered by farmers in solving this problem is one of the causes of the reduced agricultural potentials in sub-Saharan Africa [6]. Consequently, there is increased food insecurity, especially in Cameroon where about one out of five households suffers from it [7].

Farmers usually tackle the reduced soil fertility through the use of mineral fertilizers, although often inaccessible to them, because of their high cost [8,9]. In addition to their inaccessibility and inadequacy to provide a good long-term yield, chemical inputs are also sources of pollution both on the environment and on human health [10]. Hence, there is an urgent need to develop and promote appropriate, alternative technologies that will promote soil fertility [11,12]. The alternative is to use locally available natural resources such as woody or herbaceous plant litters, compost, green manure, improved fallows based on legumes or herbs to improve the physico-chemical and biological properties of soils [13]. Organic amendments have been revealed to have beneficial effects on the physico-chemical and biological properties of the soil, and could lead to increased productivity in agricultural systems, and to protection of the environment [14]. However, the successful use of these resources depends on the quality of the organic matter used and the quantity of nutrients contained in this matter [15]. Recent studies focused on organic farming to solve the problem of the physico-chemical and biological quality of the soil, are concerned with organic fertilization, biochar, beneficial microorganisms, fallows and compost [16,17,18,19].

However, in recent years attention has been paid to litter boxes, which are also reputed as fertilizers and are readily available. These litters, during the course of their decomposition processes, control the nutrient and carbon cycle in several ecosystems [20]. The constant decomposition of litter is a factor that largely determines the fertility of soil [21], and its regulation plays an important role in the functioning of agro-ecosystems, especially in poor soils [22]. Promising studies have been carried out in several African countries on the agronomic efficiency of litter boxes [12,15,23, 24]. However, in Cameroon, research on agroforestry species with potentials to improve soil fertility in the savannah of Adamawa is yet to be achieved, apart from research on litters of *V. paradoxa*, *M. intense* and of *P. americana* applied on tomato plants [25]. The aim of this research was therefore; to assess the effects of organic improvement based on litters of *Parkia biglobosa*, *Terminalia macroptera* and *Annona senegalensis* on the growth and production of tomato and maize in the field.

2. MATERIALS AND METHODS

2.1 Description of the Study Site

This study took place at Bini-Dang (Ngaoundere III) in the Adamawa province, within the

University campus, precisely behind the dean office. The site is located at 7°42'247'' North latitude, at 13°53'997'' East longitude and at 1096 m elevation. Ngaoundere III is located in Adamawa, within department of Vina. The climate is of Sudano-Guinean type characterized by two alternate of seasons: a rainy season, which for 7 months (from April to October), and a dry season comprising 5 months (from November to March). The local population is made up of the Foulbes, Mbororo, Gbaya, Mboum, Dourou, Haoussa and Laka, and some non-natives inhabitants from the far north (Toupouri, Moundang and Moufou). The most economic activity of this population is agriculture.

2.2 Plant Material

Plant material consisted of (a) tomato seeds of the RIO GRANDE variety from SENAGRI (15 kg/m^2), and (b) maize grains of the SHABA variety from IRAD (5-8t/ha) in Wakwa-Ngaoundere. The organic biomass was litters of (c) *Annona senegalensis*, (d) *Parkia biglobosa*and (e) *Terminalia macroptera* (Fig. 1). These plant species were chosen based on the surveys carried out within the study site. In addition they were cited as indicators of soil fertility and were appreciated by the local population for their socio-economic importance.

2.3 Soil and Litter Sampling

Ten composite soil samples of ferralitic type were collected from the entire plot at 0-15 cm depth. Litter samples were also collected under three plants of each of the tested species, and transformed into fine particles. Soil and litter samples were analyzed to determine the following characteristics: pH, organic carbon, total nitrogen, lignin and available phosphorus. Carbon, nitrogen and phosphorus analyses were carried out respectively by the previously described methods [26,27,28]. These analyses were carried out in the laboratory of the Geological and Mining Research Institute (IRGM), Nkolbisson, Yaounde, according to the methods described [29,30]. The pH was determined using a pH-meter in the physico-chemical laboratory of the National Higher School of Agro-food Sciences (ENSAI) of the University of Ngaoundere.

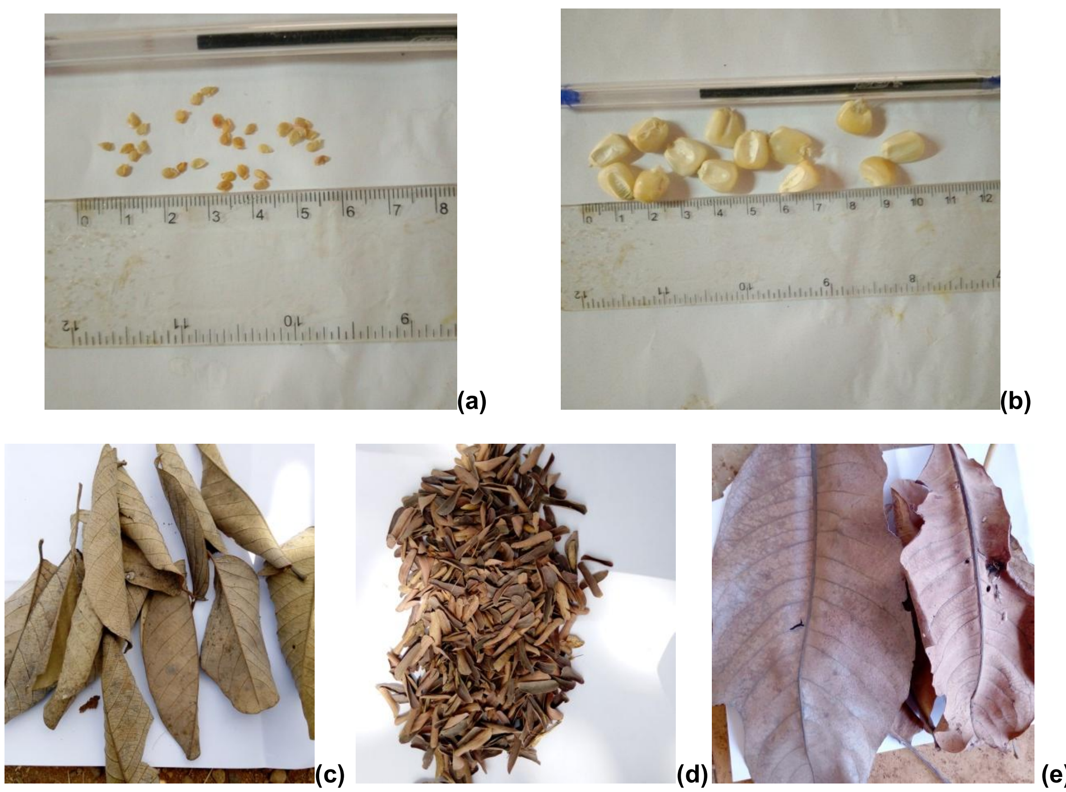

Fig. 1. Seeds (Tomato (a); maize (b)) and leaves of different tested plants within litters used (*Annona senegalensis* (c); *Parkia biglobosa* (d);*Terminalia macroptera* (e)

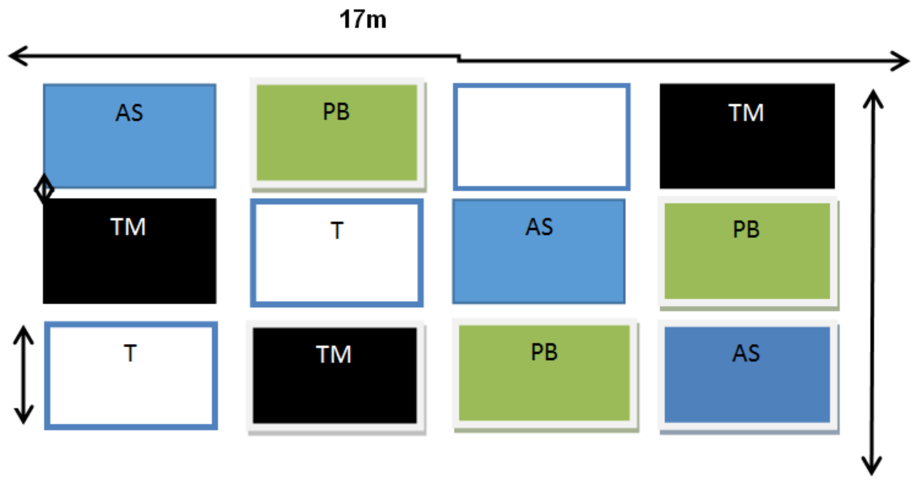

Fig. 2. Experimental layout set out separately for each of the Tomato and maize fields

2.4 Experimental Design and Treatments

The trial was conducted during the rainy season. The preparation of the experimental field was performed manually with hoes, before the field was divided into experimental plots, with one part allocated to tomato, and the other for maize, the two fields being separated each other 2 m apart. Each field consisted of 12 experimental unit plots (2 m x 4 m = 8 m^2), separated by 25 cm apart. The organic matter of different litters was buried at 15 cm soil depth according to the dose defined, which is 8t/ha [31]. This dose corresponds to 6.67 kg of litter for our experimental unit. The sowing was carried out two weeks after burial of the litters. Maize was sown at 3-6 cm depth, at the rate of two seeds per sowing hole, with 80 cm x 20 cm within and between plant, for a density of 30 plants per plot. As for tomato, plants from a three weeks nursery were transplanted two weeks after litters were buried in the various plots. The experimental design for either maize of tomato plants was a complete randomized block comprising each the same four treatments, each of which was replicated three times. Treatments consisted of litter of three plant species, namely *Annona senegalensis* (AS), *Parkia biglobosa* (PB), *Terminalia macroptera* (TM), with the soil not amended with litter considered as the control (T). Fig. 2 represents the experimental layout of each of the tomato or maize field.

2.5 Assessed Parameters

The growth variables were observed two months after sowing for the two crops, while yield parameters were evaluated at harvest. For each parameter, the measurements were carried out on ten plants chosen randomly from an experimental plot, for a total of 30 plants per treatment [32]. The parameters taken into account for the cultivation of maize are: the crown diameter, the plant height, the number of rows per cob, the biomass, the weight of 100 grams, the cob weight with or without husks. For tomato, plant diameter, plants height and biomass, number, length, diameter and weight of fruits were assessed. The plant diameter was measured using a Manutan A367504 calipers. Plant height, cob length, cob diameter, fruit, length and diameter were determined using a measuring tape; the number of fruits and the number of rows per ear were counted manually. The biomass, 100 grains weight, ears weight with or without husks, as well as fruit weight were measured using an electronic balance type ISO-9001, LC 2015 at 0.001 g sensitivity.

Maize and tomato yields were determined by extrapolation based on the number of grains or fruits per elementary plot and the weight of grains and fruits. The method consisted of counting the total number of cobs per plot, then ten cobs were randomly chosen on which the number of seeds were determined. The 100 grains weight was estimated, and then the total number of seeds per plot, the total weight of seeds per plot was used to express the yield in tons per hectare. The yield of the tomato was determined by counting the total number of fruits produced in each plot, and the weight of 10 fruits per plot. The general formula used is as follow [33]:

Yield (Kg/ha) = Weight seeds (g)/Number cobs harvested+ 10^4 (m^2)/ DS.10^6 (m^2) x 1 kg/1000 g

Where,

DS is the plant density in m^2. The yield express in tons per hectare was then derived from this formula.

2.6 Statistical Analysis

The collected data were subjected to the analysis of variance (ANOVA) at the 5% probability threshold using the STATGRAPHIC.5 software. The means were compared between treatments using the Duncan multiple range test.

3. RESULTS AND DISCUSSION

3.1 Chemical Quality of Litter and Soil

Table 1 summarizes the content of some chemical elements in the litter and the studied soil. The ANOVA indicates the experimental soil was significantly (p = 0.003) more acid (pH = 5.03) than that AS (pH = 6.06), PB (pH = 6.02); and TM (pH = 6.07) litters. This soil contains significantly less carbon, nitrogen and phosphorus (7.24%; 0.12%; 0.04%) than AS (47.77%; 2.41%; 0.16%), PB (49.18%; 2.43%; 0.32%) and TM (22.58%; 1.40%; 0.17%) litters. The C/N ratio of the control soil was significantly very high (p = 0.002) compared to that AS, PB and TM litters (19.79; 20.22; 17.30). This high C/N ratio indicates the poverty of the soil in mineral elements and organic matter. These soil nitrogen and phosphorus values seem to be lower compared to the reference values found reported by other authors in the Guinea savannah soils of Cameroon [25].

The carbon content of PB litter (49.18%) and AS litter (47.77%) was consistently (p < 0.0001) more elevated than that of TM litter (22.58%). Similarly, the phosphorus content was significantly higher in the PB litter (0.32%) than in the AS (0.16%); and TM (0.17%) litters. On the other hands, the litter of *T. macroptera* contains less nitrogen (1.40%) than the litter of *A. senegalensis* (2.41%) and *P. biglobosa* (2.43%). The carbon content results are weak in *T. macroptera* compared to that of the other species. This is in line with results obtained in T. macroptera (18.12%) compared to other species [34]. The obtained phosphorus content values were higher than those reported [35], Nsowa (2014), indicating that phosphorus content varying from 0.04% in *S. guineense* var. macrocarpum to 0.05% in *A. senegalensis*. The nitrogen values obtained in the AS, PB and TM litters seem closer to the reference values as revealed by other authors in the litters of the Guinean savannah species in Cameroon [25,36]. A variation in nitrogen content from 1.79% in the litters of *Desmodium intortum* to 3.53% and *Tithonia diversifolia* was found within the humid forest zone of Cameroon [15].

Lignin content values varied between treatments, with 5.22% in AS litter, significantly (p < 0.0001) lower than that of PB (8.77%) and TM litter (12.82%). These values are higher than those obtained in the litters of *V. paradoxa* (1.05%) and *L. lanceolata* (5.37%) [22].

The pH and C/N ratio did not differ significantly between the AS, PB and TM litters. The C/N ratio was reported to roughly translate the carbohydrate/protein ratio, and seems to be an important indicator of litter quality [37]. Litter with a C/N values closed to 20 and 25 are considered to be good fertilizers [38]. The C / N ratio of the three studied litters studied varied from 17.30 to 20.22, respectively in *T. macroptera* and *P. biglobosa.* Thus, the aforementioned range

Table 1. Differences in the chemical characteristics litter and the control soil

	Ph	C(%)	N (%)	P(%)	C/N	Lignin (%)
AS	6.06(0.15)b	47.77(1.32)c	2.41(0.10)c	0.16(0.05)b	19.79(0.41)a	5.22(0.91)a
PB	6.02(0.03)b	49.18(0.54)c	2.43(0.03)c	0.32(0.02)c	20.22(0.18)a	8.77(0.40)b
TM	6.07(0.07)b	22.58(3.01)b	1.40(0.52)b	0.17(0.09)b	17.30(4.89)a	12.82(0.54)c
Ctrl soil	5.03(0.50)a	7.24(1.46)a	0.12(0.02)a	0.046(0.007)a	59.23(19.26)b	
P-value	0.003	<0.0001	<0.0001	0.002	0.002	<0.0001

pH = Hydrogen potential, C=carbon, Ctrl= control, N=nitrogen, P = phosphorus, C/N = carbon/nitrogen ratio, AS= Annona senagalensis, PB= Parkia biglobosa TM= Terminalia macroptera. For each chemical element, values of a column affected by the same letter are not significantly different at the indicated level of probability

The litters of *A. senegalensis*, *P. biglobosa* and *T. macroptera* were all acid, lining with the acidity values previously reported in litters of *V. paradoxa*, *M. intense* and *P. americana* [25]. In general, the chemical properties of litter mainly depend on the type of plant species. The ability of an agroforestry species to improve the productivity of a soil depends on its yield biomass, as well as the chemical quality of this biomass [39].

3.2 Effect of Litter Quality on Growth Height of Tomatoes and Maize

Height of tomato and maize plants measured two months after sowing (Fig. 3), as influenced by the treatments. The analysis of variance indicates a significant difference (p = 0.0016) between the treatments for the parameter height of tomato. The average height of the tomato plants recorded in plants amended with the litter of *A. senegalensis* (46.93 cm) was greater than that of the control (27.5 cm), but not significantly difference was observed between the height of other plants amended with PB and TM litters. In the savannah of Adamawa, litters of *V. paradoxa* and *M. intense* were reported to significantly increase the size of tomato plants compared to that of the control [25,36].

Growing maize on litter of *P. biglobosa* (168.95 cm) and *A. senegalensis* (160.93 cm) had a significant effect on the height of the maize plants compared to that of the control plants (118.63 cm), unlike on the litter of *T. macroptera* (149.52 cm), although it was greater than that of the control. This could be explained by the reduced nitrogen content found in PB litter, as recently observed after application of *Tithonia diversifolia*, *Sena floribunda* and *Entada abyssinica* litters to maize [12]. The general tendency of improvement of growth parameter by various litters have been reported by several authors on different plant species [13,25,32], and have been attributed to their richness in mineral nutrients, particularly nitrogen [24], or lignin [13].

3.3 Impact of Litter Quality on the Diameter of Tested Plants

Maize diameter did not differ significantly between the litters treatments and control (Fig. 4), but all the litter used (AS, PB and TM) have increased the maize diameter.

The diameter of the tomato plants amended with litter of *A. senegalensis* and *P. biglobosa* showed values greater than that of the control, but not significantly different (Fig. 4).

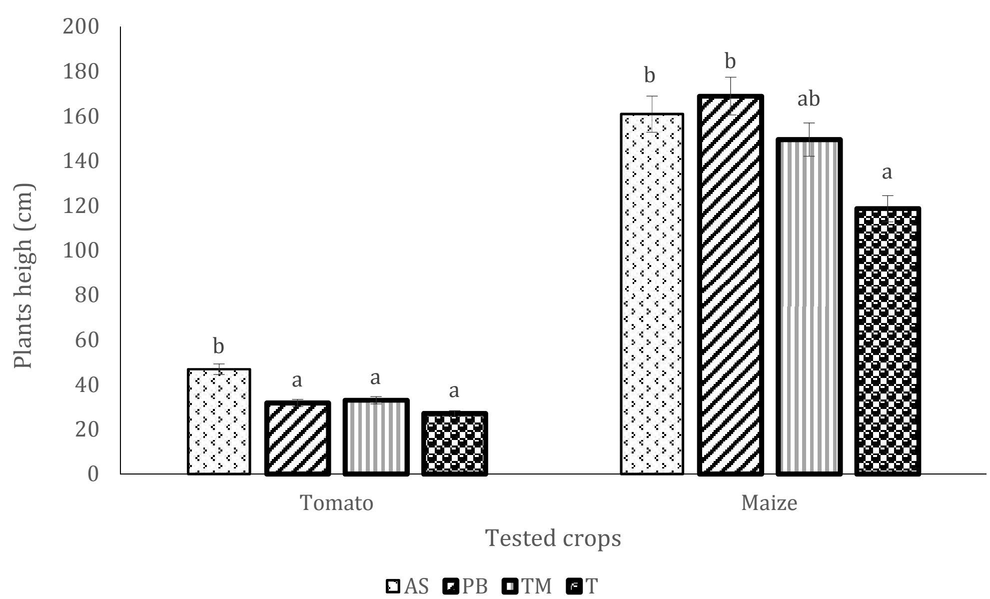

Fig. 3. Difference in growth height of maize and tomato plants amended or not with various litters

AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each of the tested plant species, bars affected by the same letter are not significantly different at the indicated level of probability

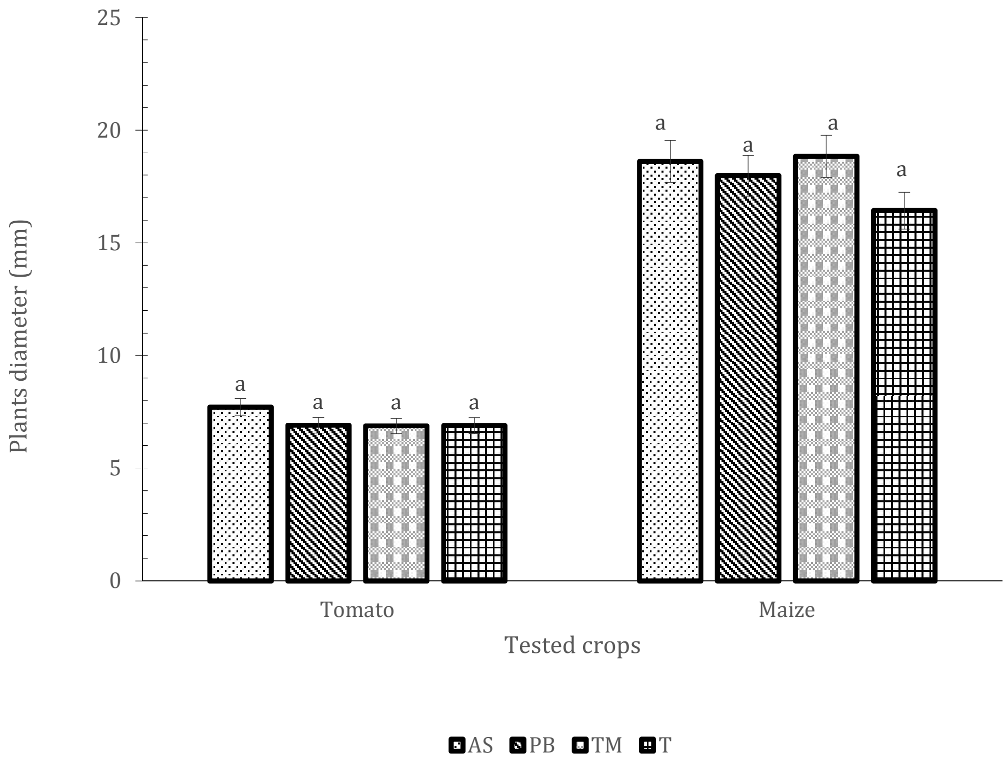

Fig. 4. Variation of the diameter of maize and tomato plants amended or not with various litters
AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each of the tested plant species, bars affected by the same letter are not significantly different at the indicated level of probability

However, the diameter of plants applied with *T. macroptera* litter was less than that of the control. This could be explained by the fact that the nutrient reserves (especially mineral nitrogen) that were provided by the litter of this species during this growth period might be insufficient to stimulate the diameter of the tomato. Furthermore, litter of *E. tremula* and *A. gayanus* was reported to have a depressive effect on the diameter of maize [13]. Similarly, litter extracts of *A. indica* at different doses was reported to significantly inhibited the height, the number of plants, and the biomass of several plants [40]. The effect of litter therefore depends on how it is used (powder or extract, decomposed litter, etc.) [24].

3.4 Influence of Litter Quality on Total Biomass of Maize and Tomato Plants

The total biomass (Fig. 5) obtained on the tomato plants differs significantly between the treatments. The biomass of the tomato plants from AS and TM litter treatments (27.33 g; 31.37 g) was significantly ($p = 0.035$) more abundant than that measured of the control plants (17.13 g). In contrast, *P. biglobosa* litter did not influence the biomass of tomato plants when compared to the biomass of control plants. As for the biomass of maize (Fig. 6), *T. macroptera* litter did not influence that of the control, but the biomasses under litters of *A. senegalensis* (80.33 g) and *P. biglobosa* (70.60 g) significantly differed from that of the control (37.26 g). In a related work, it was revealed an increased biomass of millet under the influence of *C. pinnata* litter. The stimulating effect of *A. indica* and *F. albida* litters, and the inhibitory effect of *A. holosericea*, *A. gayanus*, *C. equisetifolia* and *E. tremula* were highlighted [13].

3.5 Effect of the Litter Quality on the Production Parameters of Tomato

Table 2 illustrates the effect of different litters on the number of fruits, the length of the fruits, the diameter of the fruits and the fresh weight of the fruits of tomato measured at harvest. It appears from this table that despite the absence of a significant difference between treatments (p = 0.164), the number of fruits developed on plants amended with litters of *A. senagalensis*, *P. biglobosa* and *T. Macroptera* was always higher than that of the control treatment. Similarly, applying tomato plants with *A. senagalensis, P. biglobosa* and *T. Macroptera* litters increased the length, diameter and weight of fruits, but not enough to be significant. A recent study has shown the positive effect of organic fertilizers (compost) on the length and weight of tomato fruits [18], as well as an improvement in the weight of tomato fruits under biochar supply has been reported [41].

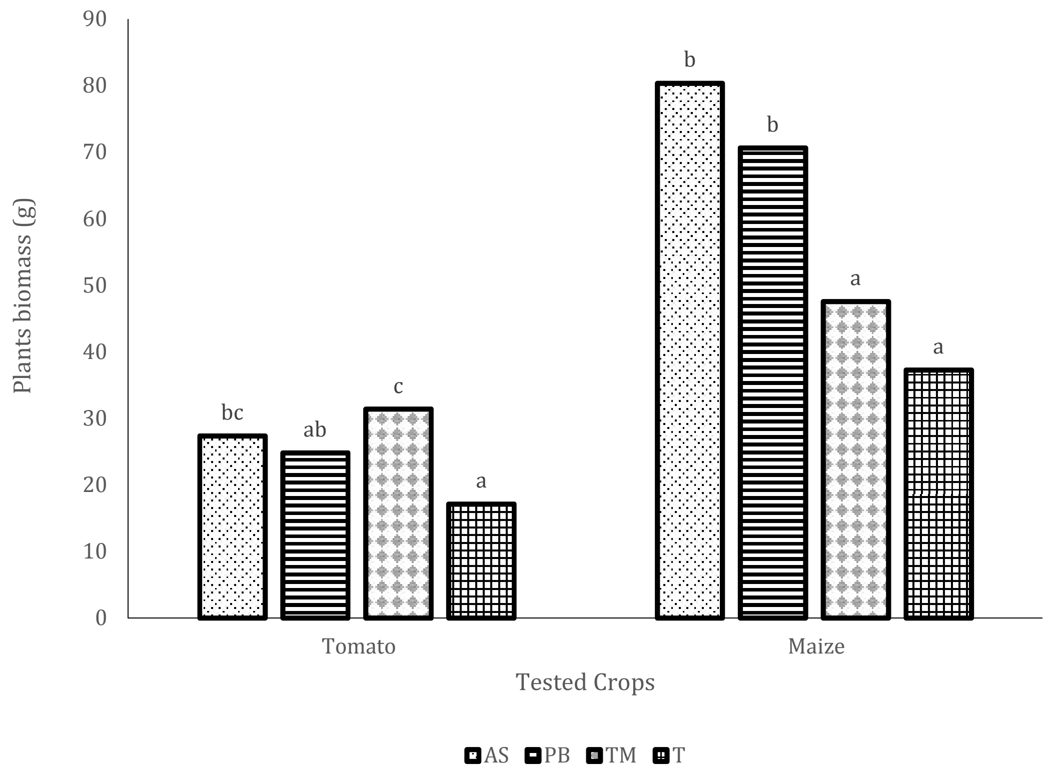

Fig. 5. Differences in the biomass of maize and tomato plants amended or not with various litters

AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each of the tested plant species, bars affected by the same letter are not significantly different at the indicated level of probability

Table 2. Variation of production parameters in tomato between treatments

Treatments	Number fruits	Length fruits	Diameter fruits	Weight fruits
AS	11.66(6.66)ab	4.8(0.2)ab	8.16(0.29)a	38.57(13.36)a
PB	8.66(0.57)ab	3.87(1.06)ab	9.65(0.31)ab	33.88(15.26)a
TM	7.33(1.15)ab	3.4(0.51)a	8.77(0.42)ab	27.65(13.94)a
Ctrl	4.33(2.51)a	3.57(0.55)ab	8.93(1.05)ab	25.31(13.74)a
P-value	0.164	0.118	0.09	0.663

AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each production parameter, values of a column affected by the same letter are not significantly different at the indicated level of probability

3.6 Effect of the Litter Quality on the Production Parameters of Maize

When maize was amended with *T. macroptera* litter (Table 3), the cob length was significantly greater (26.80 cm) than that of the control (22.46 cm). The mean weight value of maize cobs without husks recorded for all the litter treatments AS (139.46 g) PB (132.62 g) and TM (130.17 g) were significantly higher (p = 0.035) than that of the control treatment (112.14). The weight of cobs without husks varied significantly (< 0.0001) between treatments from 138.8 g, 171.41 g to 181.80 g, respectively for PB, AS to TM litters as compared to cob weight (122.30 g) of the control treatment. The weight of 100 grains represents a very relevant parameter for the quality of grains. The 100 grains weights of litter treatments AS (48.14 g), PB (53.9 g) and TM (57.49 g) were higher than that of the control treatment (42.32 g). The weight of 100 grains obtained was greater than values between the range 28.66-22.22 g as recently reported [31]. Another work on maize on fallow soils with *M. pruriens* has yielded 30 g/100 grains [42]. Indeed, an elevated grain yield does not always indicate a good yield in terms of quality. In fact, the more organic material the plant accumulates in its grains, the higher the grain weight [18].

These results are linked to the intrinsic properties of the tested varieties, and on the other hand to the properties of the soil [12]. Plant species used in agroforestry may be involved in increasing the productivity on site, through the ecological and physico-chemical changes they induce in the soil through their litter. This could also be due to the provision of mineral nitrogen to the soil necessary to stimulate the growth and production of plants by litter through the conversion of organic N into the form NO_3 and NH_4 + two weeks after their application as demonstrated on the litter of *T. diversifolia* [43].

3.7 Effect of Various Litters Son Tomato and Maize Yields

The variance analysis on the tomato yield indicates a significant difference (p = 0.035) between the different treatments (Fig. 6). The yield increment by different treatments was classified in the following order: AS> PB> TM> Ctrl, supporting other reported result on tomato yield after application of *V. paradoxa*, *M. intense* and *P. americana* litters [25], or compost-based treatments [18].

An increase in the yield of tomato under biochar application was previously reported [41]. Maize plants applied with litters of *A. senagalensis*, *P. biglobosa and T. macroptera* at dose 8t/ha was revealed to give significantly higher yields (3.46/ha; 4.51 t/ha; 3.51 t/ha) than (1.66 t/ha)in treatment control [32,44]. These observations are in line with those reported that increased maize production after application of *E. abyssinica* litter and *T. diversifolia* litter [31]. The application of *T. diversifolia*, *E. abyssinica* and *S. floribunda* litter in the field as an amendment was revealed to increase the maize yield by 40 to 80% [12]. Whereas the contribution of *A. indica* litter to the improvement of sorghum yield was also reported [23,45], the soil fertility level was instead claimed to be increased after application of plant biomass [46,47]. The fact that grain yields of maize and tomato fruits obtained after amendment with litters of *A. senagalensis*, *P. biglobosa* and *T. macroptera* were higher than those of the control could be explained by the availability of mineral nitrogen in litter as previously demonstrated [13].

Table 3. Variation of production parameters in maize between treatments

Treatments	Cob length	Cob diameter	Number rows/cob	Weight cobs with husks	Weight cobs without husks	Weight 100 grains
AS	25.3(2.8)ab	14.88(2.3)a	15.0(1.4)ab	171.41(8.36)c	139.4(4.1)b	48.1(0.8)b
TM	26.86(3.3)b	15.33(1.1)a	15,14(0.6)ab	181.8(4.88)d	130.1(7.3)b	57.5(0.4)d
PB	24.4(2.8)ab	14.2(2.5)a	14.2(1.6)ab	138.9(1.31)b	132.62(0.77)b	53.9(1.64)c
Ctrl	22.4(2.1)a	14.6(1.5)a	13.7(0.7)a	122.3(4.01)a	112.1(5.36)a	42.3(0.1)a
P-value	0.05	0.780	0.114	< 0.0001	0.035	< 0.0001

AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each production parameter, values of a column affected by the same letter are not significantly different at the indicated level of probability

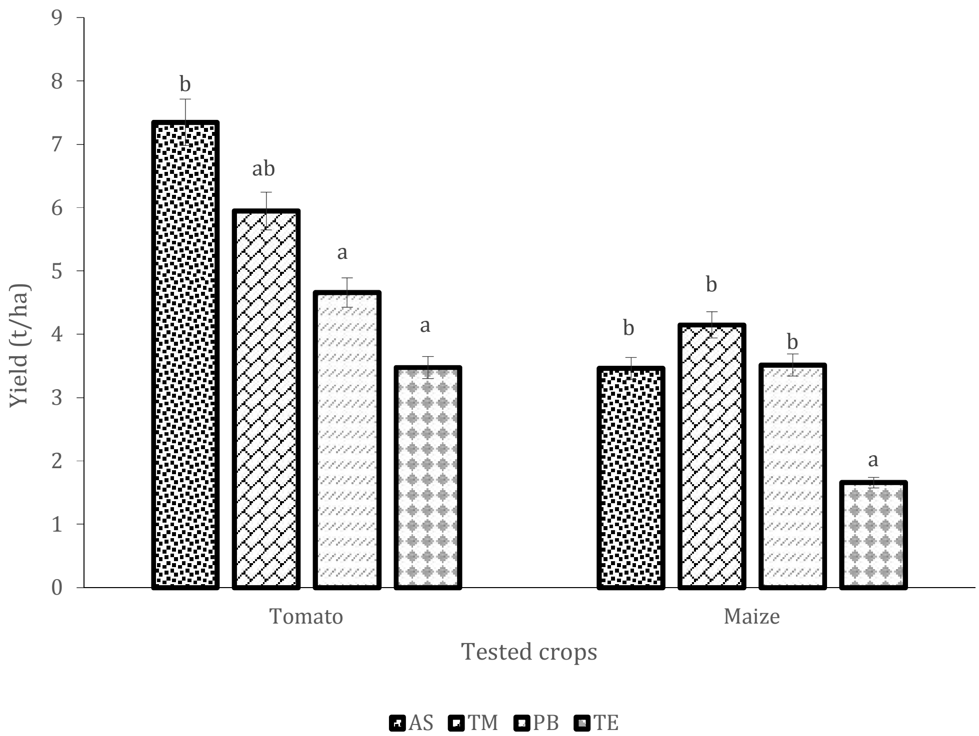

Fig. 6. Variation of tomato and maize yield between treatments

AS= Annona senagalensis, PB= Parkia biglobosa, TM= Terminalia macroptera; Ctrl= Control. For each of the tested plant species, bars affected by the same letter are not significantly different at the indicated level of probability

The acid pH of litter could also have favored the production of these two crops. A slightly acidic pH in certain organic materials were reported to optimize the mineralization conditions, and thus improves the crop yields [48,49].

4. CONCLUSION

In this study we assessed the effect of *Annona senegalensis*, *Parkia biglobosa* and *Terminalia macroptera* litters amended to soil in order to improve growth and yield of tomato and maize plants. Obtained results have shown that litter can be used to improve the growth and production of tomato and maize crops, although responses differ from one litter plant species to another, and from one tested plant to another. When applied on tomato, the litter of *A. senegalensis* better acted on the yield, than that of *P. biglobosa* and *T. macroptera*, whereas for maize *T. macroptera* litter was the best to be used to boost growth, followed by *P. biglobosa* and *A. senegalensis* litters. Among the three tested litters, *Annona senegalensis* litter was the best for tomato, whereas *Terminalia macroptera* litter was better for maize production. These results could contribute to the integration of these local species in agroforestry systems, where the exploitation of their litter in various forms by farmers will increase their production and maintain the soil fertility level while preserving the environment.

THE DATA AVAILABILITY STATEMENT

Data used to support the findings of this study are available from the corresponding author upon request (raw data, tables, figures or any other supplementary document). There is no restriction to any reader on data access.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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