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INFLUENCE OF *CHROMOLAENA ODORATA* L. ON SOIL MOISTURE, SOIL TEMPERATURE, AND MAIZE (*ZEA MAYS* L.) GROWTH IN WEST-CENTRAL CÔTE D'IVOIRE.

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ABSTRACT

Maize (*Zea mays* L.) production in Côte d'Ivoire is limited by declining soil quality and irregular water availability. The objective of this study was to analyze the effects of *Chromolaena odorata* L. biomass, applied alone or in combination with mineral NPK fertilizer, on soil temperature, soil moisture, and maize vegetative growth in the Centre-West region of Côte d'Ivoire. A randomized complete block design was used with four treatments: *C. odorata* biomass (CO), *C. odorata* + NPK (CO+NPK), NPK alone, and a Control, with four replicates. Soil temperature and moisture were monitored, while plant height and stem collar diameter were measured during maize development. *C. odorata*-based treatments significantly improved soil hydrothermal conditions and maize growth ($P < 0.001$). Mean soil moisture reached 36.93% under CO and 37.69% under CO+NPK, compared with 30.11% under Control and 30.05% under NPK. At 46 days after sowing, CO+NPK produced the greatest plant height (114.54 cm) and stem collar diameter (21.02 mm). These results suggest that combining *C. odorata* biomass with NPK may improve soil moisture conditions and maize growth.

Keywords: *Chromolaena Odorata*; Maize (*Zea Mays* L.); Soil Moisture; Soil Temperature; NPK Fertilizer; Maize Growth.

1 INTRODUCTION

Maize (*Zea mays* L.) is one of the major food crops in Côte d'Ivoire, where its production contributes substantially to food and feed supply, with an annual production of 1,600,000 tons in 2024 (1). However, maize productivity remains constrained by declining soil quality and increasing climatic variability, particularly irregular rainfall and periods of water deficit during critical stages of crop development. These constraints are especially important in the Centre-West

region of Côte d'Ivoire, where maintaining soil fertility and adequate water availability is essential for sustainable maize production (2,3). Conventional intensification based largely on mineral fertilizers can increase crop productivity, but its effectiveness may be limited when soil physical conditions restrict water availability and root development. This highlights the need for locally available soil management practices capable of simultaneously improving the soil environment and crop performance.

Organic biomass incorporation represents a promising approach to improving soil physical conditions while supplying nutrients through decomposition. Plant residues can modify soil moisture dynamics, reduce temperature fluctuations, increase organic matter inputs, and improve the soil environment for plant growth. In agroforestry and cereal–shrub systems, organic inputs from woody or herbaceous vegetation have been associated with improved soil water relations, nutrient cycling, and cereal development (4,5). Such effects are particularly relevant under conditions of rainfall variability, where the capacity of soil to retain and regulate water can strongly influence crop growth.

Chromolaena odorata is widely distributed in the tropical regions of Côte d'Ivoire and is generally considered a problematic invasive species because of its rapid growth and capacity to colonize agricultural and fallow lands (6,7). Nevertheless, its substantial biomass production also represents a potential source of organic material for soil management. Previous studies have shown that *C. odorata* biomass can contribute to soil organic matter accumulation, nutrient cycling, and improved soil conditions, with positive consequences for crop development (8–10). Recent studies conducted in central-western Côte d'Ivoire have reported positive effects of *C. odorata* on soil biodiversity and maize performance, as well as improved maize growth following the incorporation of its biomass alone or in combination with mineral fertilizer (11,12).

Despite these findings, the relationship between *C. odorata* biomass management, soil hydrothermal conditions, and maize vegetative growth remains insufficiently documented. In particular, limited information is available on how the presence or incorporation of *C. odorata* modifies soil temperature and moisture during maize development and how these changes are reflected in key growth parameters such as plant height and stem collar diameter. Understanding these relationships is important for determining whether *C. odorata* can contribute not only as a source of organic nutrients but also as a component of soil management adapted to variable climatic conditions.

Therefore, this study aimed to evaluate the effect of *C. odorata* association on soil physical conditions and maize growth in the Centre-West region of Côte d'Ivoire. Specifically, the study sought to (i) determine the effects of *C. odorata* on soil temperature and moisture dynamics and (ii) assess its effects on maize growth, particularly plant height and stem collar diameter. The study hypothesized that the presence or incorporation of *C. odorata* biomass would improve soil hydrothermal conditions and consequently promote maize vegetative growth.

2 MATERIALS AND METHODS

2.1 Site Description

The site is located in Sika N'guessankro (6.9176781 N, 6.3281935 W), in the centre-west (Haut-Sassandra) region of Côte d'Ivoire, near the Daloa district. The climate is bimodal, with a dry season from November to February and a rainy season from March to October, with a slowdown between mid-July and mid-August. The dry and wet seasons alternate, with average temperatures ranging from 24.78°C to 28.17°C (13).

Soil types are distributed along a smooth toposequence: ferrallitic soils (plinthic lixisols) are located on the upslope plateau; plinthic arenosols are located on the slope; and hydromorphic soils (fluvisols) are located in the lowlands (14). Findings on the physical properties reported a bulk density ranging from 1.57 to 1.43 g cm⁻³ and a texture ranging from loam to sandy loam (15).

2.2 Design and Management of Experimental Plots

The experimental design was a completely randomized block design with four replications. The plots were divided into four randomized blocks, each containing four subplots (4 m × 5 m), with a 2 m buffer between subplots and a 3 m buffer between blocks. The experiment used a randomized complete block design with two factors: the presence or absence of *C. odorata* and the fertilizer rate (0 or 1× the recommended NPK rate). Four blocks were established, each with four subplots, with two levels of shrub treatment (shrub-only or crop-and-shrub) and two levels of fertilizer treatment (0 or 1 rate of the recommended NPK). Each block consisted of four treatments: *Chromolaena odorata* only (CO); *C. odorata* plus fertilizer (CO+NPK); fertilizer only (NPK); and Control (crop only).

The experiment began on 15 March 2026 with manual clearing, plot staking, and delimitation of the blocks and experimental plots. In the plots assigned to the CO and CO+NPK treatments, *C. odorata* plants were cut manually at approximately 10 cm above the ground to allow subsequent regrowth and maintain coexistence between maize and *C.*

odorata. In the Control and NPK plots, weed was cut at ground level and removed from the plots. A 500-g subsample of *C. odorata* biomass was collected from each plot and dried in an oven at 60 °C for 72 h to determine its dry matter content. The dry matter proportion obtained from each subsample was then used to estimate the total dry biomass of *C. odorata* for the corresponding plot. The biomass was evenly spread over the soil surface and manually incorporated, with an average application of 10.06 kg plot⁻¹ (for CO and CO+NPK).

The maize variety used in this study was DK 7500, an improved hybrid commonly cultivated by local farmers. Developed by Bayer, DK 7500 is a yellow, semi-early to intermediate-maturity hybrid, with plants reaching approximately 246 cm in height and a high yield potential of 10–12 t ha⁻¹ under experimental station conditions(16).

Maize was sown on 1st April at a spacing of 80 cm × 40 cm, with two to three seeds per planting hole. Thinning was carried out 21 days after sowing, retaining the most vigorous plant in each planting hole. Mineral fertilizer was applied at a rate of 300 kg ha⁻¹ of NPK (14-18-18 + 6S + 1B203) 30 days after sowing in the CO+NPK and NPK treatments.

During crop maintenance, *C. odorata* in the CO and CO+NPK plots was repeatedly cut at approximately 10 cm above the ground, and the resulting biomass was left in situ to decompose and become incorporated into the soil. In contrast, vegetation in the Control and NPK plots was cut at ground level and the biomass was removed from the plots. This management approach maintained the intended contrast between treatments with and without *C. odorata* biomass inputs throughout the maize growing period.



Figure 1: *C. odorata*, (a) Before Cutting, (b) Cropping Season and (c) After Harvest; bar = 50 cm (12).

2.3 Soil water measurement

Soil water content was measured using a **PMS710 Soil Moisture Meter** (Tsingtao Toky Instrument, China), with a measurement range of 0–50% volumetric water content and a manufacturer-specified accuracy of ±2% under non-saturated soil conditions. Measurements were performed by inserting the probe into the pre-established access holes at depths of 10 cm below the soil surface. Soil moisture was recorded weekly at each treatment in central site of all experimental plots.

2.4 Soil temperature measurement

Temperature was measured using a Juanjuan TP300 pen-style digital thermometer (Henan Bingsheng Industrial Co., Ltd., China) with a resolution of 0.1 °C and a detection range of –50 to 300 °C. Measurements were performed by inserting the probe into pre-established access holes **to a depth of 10 cm** below the soil surface. Soil temperature was recorded weekly **for each treatment at the center of all** experimental plots

2.5 Crop Growth

Crop growth was monitored weekly on 12 maize plants along the two central rows of each subplot. The height of the plants was measured with a tape measure from the ground to the point where the last leaf was inserted, up until the flowering stage of the crop. In this study, the flowering stage of maize (*Zea mays* L.) was reached at 46 days after sowing (DAS).

At the same time, each plant stem diameter near the ground was measured using a digital caliper (Qianyuntong-COD Electronic Vernier Caliper, China).

2.6 Statistical Analysis

All collected data were analyzed to determine the effect of different fertilizer types on soil moisture, soil temperature and crop growth. Analysis of variance (ANOVA) was performed in Statistix v.8 to assess the significance of treatments on the measured parameters, using Tukey's HSD test ($p = 0.05$).

3 RESULTS

3.1 Soil temperature dynamics under organic and mineral fertilization

As illustrated in Table 1, the temporal variation in soil temperature, expressed in days after sowing (DAS), under the various treatments is evident. The temperature of the soil varied between 26.2 and 29.4°C over the course of the experiment. Overall, the Control and NPK treatments consistently recorded higher soil temperatures in comparison to the *Chromolaena odorata*-based treatments, CO and CO + NPK. The temperature of the soil exhibited an initial increase between 25 and 32 days after sowing (DAS), followed by a decrease at 46 DAS. Subsequent to this, an increase was observed until 60 days after sowing (DAS), after which a marked decline was recorded at 67 DAS. The maximum mean soil temperature was recorded at 60 days after sowing (28.79 °C), whereas the minimum occurred at 67 days after sowing (26.79 °C). Soil temperature varied significantly among treatments across all sampling dates. At 25 days after sowing (DAS), Control and NPK recorded significantly higher temperatures than CO and CO + NPK ($P \leq 0.001$), whereas CO and CO + NPK did not differ significantly ($P = 0.309$). A similar pattern was observed at 32 days after sowing (DAS), with the Control and NPK treatments significantly exceeding the CO and CO + NPK treatments ($P \leq 0.0004$). At 39 days after sowing (DAS), the variation was particularly evident: The control group was found to be 1.65°C warmer than CO ($P < 0.001$), while NPK was 1.40°C warmer than CO ($P < 0.001$). This trend persisted at 46 days after sowing (DAS), at which point the Control and NPK treatments were significantly warmer than the CO and CO + NPK treatments ($P \leq 0.0001$). At 53 days after sowing (DAS), Control and NPK again demonstrated significantly higher temperatures in comparison to both CO and CO + NPK ($P \leq 0.0009$). This pattern persisted at 60 and 67 days after sowing (DAS), with the Control and NPK treatments remaining significantly warmer than the *C. odorata*-based treatments ($P \leq 0.0002$). In contrast, no significant differences were detected between CO and CO + NPK or between Control and NPK at any observation date ($P > 0.05$).

Across the seven observation dates, mean soil temperatures were recorded at 27.43 °C under CO and 27.84 °C under CO + NPK, in comparison to 28.50 °C and 28.52 °C under Control and NPK, respectively. Consequently, the disparity between the CO and the control treatments was predominantly close to 1 °C, reaching 1.65 °C at 39 DAS.

The lower soil temperatures observed under the *C. odorata*-based treatments were accompanied by higher soil moisture contents, particularly at 46 days after sowing (DAS). At this time, soil moisture levels were recorded at 26.55% under CO, in comparison with 19.23% under Control. Additionally, soil temperature was measured at 26.68 °C under CO and 27.85 °C under Control. The concurrent increase in soil moisture and decrease in soil temperature suggests that *C. odorata* biomass may contribute to improved soil hydrothermal regulation. The results obtained demonstrate that *C. odorata*-based treatments resulted in cooler and potentially more moisture-conserving soil environments in comparison to the Control and NPK treatments throughout the experimental period.

Table 1: Changes in soil temperature (°C) across treatments and days after sowing (DAS)

Date after sowing (DAS)	Soil temperature (°C)			
	CO	CO + NPK	Control	NPK
25	27.33 ± 0.17 ^b	27.58 ± 0.25 ^b	28.33 ± 0.17 ^a	28.43 ± 0.17 ^a
32	28.23 ± 0.17 ^b	28.30 ± 0.18 ^b	29.23 ± 0.17 ^a	29.03 ± 0.17 ^a
39	27.28 ± 0.25 ^b	27.53 ± 0.17 ^b	28.93 ± 0.17 ^a	28.68 ± 0.22 ^a
46	26.68 ± 0.22 ^b	26.85 ± 0.21 ^b	27.85 ± 0.21 ^a	27.80 ± 0.14 ^a
53	28.08 ± 0.25 ^b	27.88 ± 0.25 ^b	28.98 ± 0.25 ^a	29.05 ± 0.21 ^a
60	28.23 ± 0.17 ^b	28.38 ± 0.25 ^b	29.23 ± 0.17 ^a	29.33 ± 0.17 ^a
67	26.23 ± 0.17 ^b	26.38 ± 0.25 ^b	27.23 ± 0.17 ^a	27.33 ± 0.17 ^a

Mean ± SD, $n = 4$. Within each date, means followed by different superscript letters differ significantly according to Tukey's HSD test at $P < 0.05$. CO: *Chromolaena odorata* only, CO+NPK: *Chromolaena odorata*+ NPK fertilizer; NPK: 300 kg/ha fertilizer rate and control.

3.2 Soil moisture dynamics under organic and mineral fertilization

Figure 2 shows the effects of organic (*Chromolaena odorata* biomass) and mineral (NPK) fertilization, applied alone or in combination, on soil moisture variations at different days after sowing. Soil moisture content was significantly affected by treatment, days after sowing (DAS) ($P < 0.001$). Despite differences among treatments, soil moisture followed a similar temporal pattern throughout the experimental period. It increased between 25 and 32 DAS, declined progressively until 46 DAS, increased again between 46 and 60 DAS, and subsequently decreased at 67 DAS.

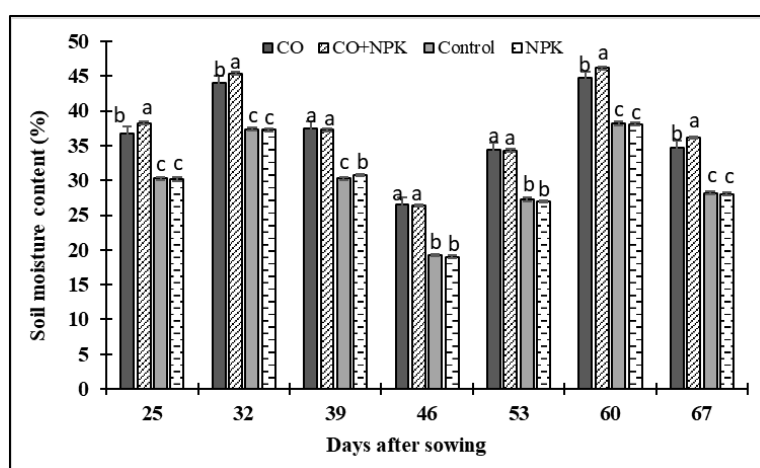
The highest soil moisture levels were consistently recorded under the *C. odorata*-based treatments, particularly CO + NPK. At 25 DAS, soil moisture reached $38.25 \pm 0.21\%$ under CO+NPK, significantly higher than Control and NPK ($30.28 \pm 0.25\%$ and $30.18 \pm 0.25\%$, respectively), while CO recorded an intermediate value of $36.78 \pm 0.22\%$. CO+NPK also differed significantly from CO ($P < 0.001$). At 32 DAS, moisture increased markedly to $45.35 \pm 0.21\%$ under CO + NPK and $43.98 \pm 0.25\%$ under CO, compared with $37.35 \pm 0.21\%$ and $37.28 \pm 0.25\%$ under Control and NPK, respectively. The *C. odorata*-based treatments were significantly higher than the control treatments ($P < 0.001$), whereas Control and NPK did not differ significantly ($P = 0.966$).

At 39 DAS, CO and CO + NPK showed similar moisture contents ($37.43 \pm 0.17\%$ and $37.25 \pm 0.21\%$, respectively), whereas Control and NPK remained significantly lower. CO differed significantly from both Control and NPK ($P < 0.001$), while CO+NPK also remained significantly higher than the control treatments ($P < 0.001$). NPK showed slightly higher moisture than Control, although this difference was relatively small.

The strongest reduction in soil moisture occurred at 46 DAS across all treatments, indicating a period of relatively low water availability. Nevertheless, the *C. odorata*-based treatments maintained significantly greater moisture levels than the controls. Soil moisture was $26.55 \pm 0.21\%$ under CO and $26.43 \pm 0.17\%$ under CO+NPK, compared with only $19.23 \pm 0.17\%$ under Control and $19.03 \pm 0.17\%$ under NPK ($P < 0.001$ for comparisons between the *C. odorata*-based treatments and the controls). CO and CO+NPK did not differ significantly ($P = 0.607$), nor did Control and NPK ($P = 0.984$). Thus, CO maintained approximately 38% more soil moisture than Control during this low-moisture period.

Following this decline, soil moisture increased at 53 DAS and reached its highest levels at 60 DAS. At 60 DAS, moisture reached $46.15 \pm 0.21\%$ under CO + NPK and $44.68 \pm 0.22\%$ under CO, compared with $38.18 \pm 0.25\%$ under Control. The *C. odorata*-based treatments were significantly higher than both controls ($P < 0.001$), while CO and CO+NPK did not differ significantly ($P = 0.699$). Similarly, Control and NPK showed no significant difference ($P = 0.883$). At 67 DAS, CO+NPK and CO continued to maintain significantly higher moisture contents than Control and NPK ($P < 0.001$), with differences of approximately 8 and 6.5 percentage points, respectively.

Overall, mean soil moisture across the observation period was 37.69% under CO+NPK and 36.93% under CO, compared with 30.11% under Control and 30.05% under NPK. Differences were particularly pronounced at 32 and 60 DAS, when soil moisture reached its highest levels, and remained highly significant during the marked decline observed at 46 DAS.



Means followed by the same letter in the same day do not differ statistically among themselves by the Tukey test ($p < 0.05$). CO: *Chromolaena odorata* only, CO+NPK: *Chromolaena odorata*+ NPK fertilizer; NPK: 300 kg/ha fertilizer rate and Control.

Figure 2: Changes in soil moisture content (%) across treatments and days after sowing.

3.3 Maize growth response to soil moisture and temperature

Figure 3 shows the effects of organic (*Chromolaena odorata* biomass) and mineral (NPK) fertilization, applied alone or in combination, on maize plant height at different days after sowing. Plant height increased progressively with days after sowing (DAS) under all treatments, but significant differences among treatments were observed at all observation dates ($P < 0.001$). At 25 DAS, plant height ranged from 10.04 ± 0.16 cm under the Control to 42.14 ± 0.16 cm under the combined CO + NPK treatment. This treatment effect became increasingly evident as maize development progressed. At 46 DAS, plants reached 114.54 ± 0.16 cm under CO + NPK, compared with 96.74 ± 0.16 cm under CO, 104.44 ± 0.16 cm under NPK, and 84.14 ± 0.16 cm under the Control. The incorporation of *C. odorata* biomass alone (CO), representing organic fertilization, significantly increased maize plant height compared with the Control at all observation dates ($P < 0.001$). At 46 DAS, plants under CO reached 96.74 ± 0.16 cm, compared with 84.14 ± 0.16 cm under the control, corresponding to a **14.97% increase** in plant height. Similar positive effects of CO were observed throughout the growing period, with increases, respectively of **144.42%, 43.43%, 28.51%, and 14.97%** relative to Control at 25, 32, 39, and 46 DAS.

Mineral fertilization with NPK also markedly improved maize growth compared with the control. At 46 DAS, NPK increased plant height to 104.44 ± 0.16 cm, representing a **24.13% increase** relative to Control. The corresponding increases were **183.07%, 56.06%, and 38.74%** at 25, 32, and 39 DAS, respectively. NPK therefore produced a stronger growth response than CO alone throughout the experiment. Comparison between the two fertilization modes showed that NPK resulted in plant heights **15.87%, 8.79%, 7.96%, and 7.96% higher than CO** at 25, 32, 39, and 46 DAS, respectively.

The combined application of *C. odorata* biomass and NPK (CO+NPK) produced the greatest plant height at every observation date. Compared with the control, CO+NPK increased plant height by **319.52%, 103.52%, 68.89%, and 36.15%** at 25, 32, 39, and 46 DAS, respectively. At 46 DAS, the combined treatment reached 114.54 ± 0.16 cm, corresponding to a **36.15% increase over Control**, while it was **9.68% higher than NPK alone** and **18.40% higher than CO alone**. Overall, mean plant height across the four observation dates was 58.96 cm under CO, 78.19 cm under CO + NPK, 64.88 cm under NPK, and 44.98 cm under the control. Relative to the control, CO increased mean plant height by **31.08%**, whereas NPK increased it by **44.24%** and CO + NPK by **73.83%**. Furthermore, the combined treatment produced plant heights **32.61% higher than CO alone** and **20.51% higher than NPK alone**.

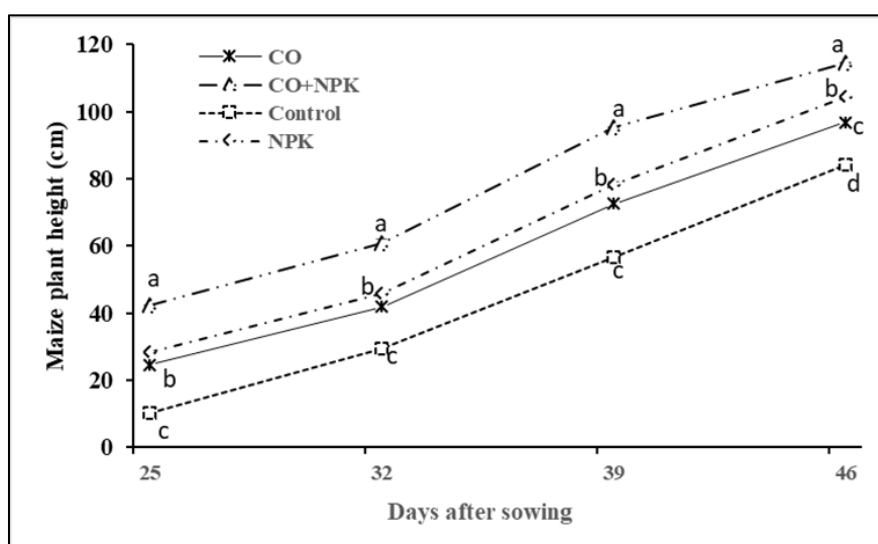


Figure 3: Comparative effects of *Chromolaena odorata* biomass and NPK fertilization on maize plant height

3.4 Maize stem collar diameter growth

Stem collar diameter was significantly affected by treatment at all observation dates ($P < 0.001$). The treatment effect was already evident at 25 DAS and remained highly significant throughout maize development.

Figure 4 shows a continuous increase in stem collar diameter from 25 to 46 DAS under all treatments, although the magnitude of this increase varied considerably among treatments. Throughout the observation period, CO + NPK maintained the highest values, followed by NPK, CO, and the Control.

At 25 DAS, stem collar diameter was 2.83 ± 0.40 mm under the Control, compared with 6.18 ± 0.15 mm under CO, 7.98 ± 0.13 mm under NPK, and 10.00 ± 0.14 mm under CO + NPK. The differences between treatments remained evident as

the crop developed. By 46 DAS, stem collar diameter had reached 13.14 ± 0.15 mm under the Control, 16.82 ± 0.19 mm under CO, 18.62 ± 0.18 mm under NPK, and 21.02 ± 0.18 mm under CO+NPK.

The growth trajectories also highlight the contrasting responses to the different fertilization regimes. Compared with the Control, CO increased stem collar diameter by 118.6% at 25 DAS, with the relative difference decreasing to 28.0% at 46 DAS. NPK produced increases of 182.2% and 41.7%, respectively, over the same period. The combined CO+NPK treatment showed the largest relative differences, reaching 253.7% at 25 DAS and 60.0% at 46 DAS compared with the Control.

The separation between the CO and NPK curves was also maintained throughout the growth period. NPK resulted in stem collar diameters 29.1%, 18.0%, 15.6%, and 10.7% higher than CO at 25, 32, 39, and 46 DAS, respectively. Meanwhile, CO + NPK remained above both individual fertilization treatments, exceeding CO by 61.8%, 56.6%, 35.6%, and 25.0%, and NPK by 25.3%, 32.8%, 17.3%, and 12.9%, respectively.

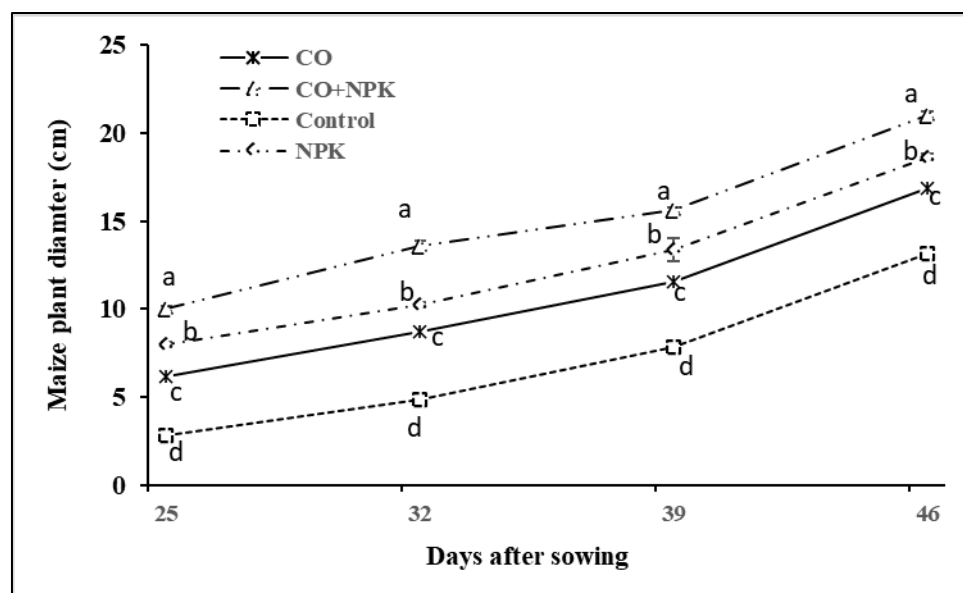


Figure 4: Dynamics of maize stem collar diameter under organic and mineral fertilization

4 DISCUSSION

The results obtained in this study reveal a consistent relationship between improved soil water availability and maize height growth, while also indicating the simultaneous contribution of nutrient-related mechanisms. Treatments incorporating *Chromolaena odorata* biomass maintained higher soil moisture, with mean values of **37.69% under CO + NPK and 36.93% under CO**, compared with **30.11% under the control and 30.05% under NPK**. This more favorable soil-water status was accompanied by greater maize growth, with plant height at 46 DAS reaching **114.54 ± 0.16 cm under CO+NPK, 104.44 ± 0.16 cm under NPK, 96.74 ± 0.16 cm under CO, and 84.14 ± 0.16 cm under the control** ($P < 0.001$). This concomitant response suggests that *C. odorata* biomass contributed to creating a more favorable soil environment for maize development, through mechanisms similar to those reported in cereal–shrub systems. Indeed, (4) showed that intercropping pearl millet with the native shrubs *Piliostigma reticulatum* and *Guiera senegalensis*, combined with the return of shrub biomass to the soil, improved crop water status and plant development. These findings support the hypothesis that shrub-derived biomass can influence cereal performance through **water regulation in addition to nutrient supply**. Similarly, (5) demonstrated that *P. reticulatum* associated with pearl millet increased soil carbon, nutrient availability, rainfall water-use efficiency and crop productivity, highlighting the role of shrubs in improving both soil fertility and water use. The higher soil moisture observed under treatments receiving *C. odorata* biomass is consistent with the findings of (17), who reported increased soil moisture and improved maize growth following *C. odorata* application in the Haut Sassandra region of Côte d'Ivoire. Similarly, (11) reported improved maize growth under *C. odorata* biomass and mineral fertilization treatments, while (12) confirmed the positive contribution of *C. odorata* to maize growth and yield under semi-deciduous forest conditions. These results are also consistent with cereal–shrub systems involving *P. reticulatum* and *G. senegalensis*, where shrub-associated organic inputs improve soil-water relations, nutrient cycling and cereal development (4,5). Woody perennial systems rely on long-term organic deposition to buffer microclimates. However, intensive annual intercropping systems have been shown to mimic these ecological benefits through precise resource optimization. (18) verified that the concurrent

regulation of organic input rates and field-capacity-based irrigation in a maize/mung bean system significantly improves the water use efficiency of maize.

Importantly, a similar functional role can be attributed to *C. odorata*. Despite its non-woody nature, its high growth dynamics and rapid biomass accumulation allow it to serve a comparable eco-physiological purpose by mitigating hydro-thermal stress and altering soil surface energy exchanges. Similar nutrient-recycling processes may occur following the incorporation of *C. odorata* biomass. However, the comparison between CO and NPK indicates that soil moisture alone cannot explain maize growth. Despite its lower soil moisture, NPK produced taller plants than CO, reaching 104.44 cm compared with 96.74 cm at 46 DAS, indicating an important contribution of the rapid availability of mineral nutrients. This observation agrees with (12), who reported strong maize growth under mineral fertilization and treatments involving *C. odorata*. The particularly high performance of CO+NPK, which simultaneously maintained the highest soil moisture and produced the tallest plants, therefore suggests a **complementary interaction between improved soil-water conditions and rapid nutrient availability**. Similar complementarity has been reported in long-term cereal-shrub systems, where the combination of shrub biomass and mineral fertilization improved crop productivity and soil fertility (19). Thus, the present findings suggest that *C. odorata* biomass may contribute to maize growth through several interconnected mechanisms, including **improved soil-water retention, organic matter inputs, and progressive nutrient release and enhanced soil biological activity**, while NPK provides readily available mineral nutrients during periods of high crop demand. This interpretation is consistent with the broader concept of shrubs as **resource islands**, in which organic inputs, nutrient cycling and water dynamics become spatially coupled around perennial vegetation and subsequently benefit associated cereals (20,21). Importantly, the use of *C. odorata* as incorporated biomass differs from living shrub-cereal intercropping because it provides soil-improving and nutrient-recycling functions without direct root competition for water, nutrients and light. Overall, the simultaneous increase in soil moisture and maize height under CO+NPK suggests that the superior growth response resulted from the convergence of **water conservation and nutrient availability**, providing a plausible mechanism for the enhanced performance of maize under integrated organic-mineral fertilization.

5 CONCLUSION

The objective of this study was to assess the effects of *Chromolaena odorata* biomass applied alone or in combination with mineral NPK fertilizer on soil conditions and maize (*Zea mays* L.) growth in the Centre-West region of Côte d'Ivoire. The results showed that the treatments involving *C. odorata* modified soil moisture and temperature dynamics, creating more favorable hydrothermal conditions for maize development. These conditions were associated with improved plant height and stem collar diameter, with CO + NPK consistently producing the highest growth performance, followed by NPK and CO, while the control recorded the lowest values. Overall, the results highlight the potential of integrating *C. odorata* biomass with mineral NPK to improve maize growth through the combined contribution of favorable soil hydrothermal conditions and nutrient availability. Further multi-season studies are needed to determine whether repeated application of *C. odorata* biomass could progressively enhance maize growth and allow CO alone to approach or exceed the performance of mineral fertilization.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

All authors must disclose any financial or non-financial conflicts of interest. If none exist, authors should state that there are no conflicts of interest.

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