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Contribution of Aqueous Extracts of *Aloe vera* to Improving Tomato Productivity in the Central-Western Region of Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

Abstract

Tomato production in Côte d'Ivoire faces a range of constraints, notably soil degradation, which significantly undermines the cropping system and leads to a decline in productivity. This study is underpinned by a commitment to sustainability and aims to compare the effects of aqueous extracts of *Aloe vera* on the growth and yield of tomatoes in the Daloa region, with a view to proposing an alternative that is environmentally friendly and beneficial to consumer health. To explore sustainable alternatives, aqueous extracts of *Aloe vera*, applied at different doses, and NPK mineral fertiliser (15 15 15) were evaluated on a plot of 150 tomato plants. The trial was conducted using a randomised complete block design, comprising ten treatments and three replicates. The treatments included different concentrations of gel (25 %, 50 %, 75 % and 100 %) and doses of leaf pulp (15 g, 30 g, 60 g and 100 g), an application of mineral fertiliser, as well as a control without fertilisation. The experiment was conducted at the experimental farm of Jean Lorougnon Guédé University in Daloa. The results showed that aqueous extracts of *Aloe vera* have positive effects on the vegetative growth of tomatoes, with values higher than those of the control. In particular, treatment with pure

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gel (100 %) resulted in an average plant height of 86.01 cm compared with 60 cm for the control, a stem diameter of 4.88 cm compared with 3.26 cm, and an average of 30 leaves compared with 17 for the control. Furthermore, yield was significantly improved, reaching approximately 35 t/ha compared with 7 t/ha for the control. Consequently, the use of *Aloe vera* extracts as a natural fertiliser offers a promising alternative for improving tomato productivity, whilst contributing to more sustainable agriculture.

Keywords: *Aloe vera; tomato; Solanum lycopersicum; aqueous extract; biofertiliser; biostimulant; NPK fertiliser; vegetative growth; fruit yield; sustainable agriculture.*

1. Introduction

The Ivorian economy relies primarily on its agricultural resources, which form a key pillar of national development. Indeed, the production of tropical fruits such as mangoes, papayas and tomatoes contributes not only to food security but also to exports and, consequently, to economic growth (Kossonou *et al.*, 2019). However, the government has prioritised industrial crops at the expense of food crops, which undermines the population's food security (Fondio *et al.*, 2013). Among these crops, the tomato (*Solanum lycopersicum* L.) occupies a special place. On the one hand, it is one of the most widely grown vegetable crops in the world, cultivated in over 170 countries (Mupepe *et al.*, 2026; Food and Agriculture Organization of the United Nations [FAO], 2013). Furthermore, it is significant in two respects: economically, as it generates income; and nutritionally, as it is rich in minerals, vitamins and fibre, thereby contributing to a balanced diet and the prevention of certain diseases (Ali *et al.*, 2019). However, despite this potential, Côte d'Ivoire remains a minor producer compared with major agricultural powers such as China or the United States. Nevertheless, the development of tomato cultivation in tropical regions faces numerous obstacles. Firstly, pests and diseases (Tonessia *et al.*, 2018) significantly reduce yields. Secondly, rudimentary farming practices, combined with population pressure and soil degradation, exacerbate the vulnerability of this crop (Kouamé *et al.*, 2021). As a result, farmers often rely on pesticides and chemical fertilisers (Tonessia *et al.*, 2018). Although such inputs can improve crop performance, pesticide misuse or overuse can adversely affect the environment and human health (Tudi *et al.*, 2021). The search for sustainable alternatives is therefore essential (du Jardin, 2015; Kossonou *et al.*, 2019; Mupepe *et al.*, 2026). In particular, plant-based biopesticides and biostimulants appear to be promising options. *Aloe vera*, a succulent plant containing polysaccharides, minerals, enzymes and other bioactive constituents, has attracted interest as a natural input (Hamman, 2008; Chowdhury *et al.*, 2021). Recent evidence indicates that plant-derived biostimulants can improve tomato yield and quality, although responses vary with product composition and production conditions (Mauro *et al.*, 2024; Vultaggio *et al.*, 2024). Studies focusing specifically on tomato have also reported beneficial responses to *Aloe vera*-containing inputs during seedling establishment and crop production (René *et al.*, 2024; Wise & Selby-Pham, 2025). Similarly, alternative biofertiliser strategies have been associated with improved tomato growth and nutrient acquisition, supporting continued evaluation of non-synthetic inputs (Patel *et al.*, 2025). Accordingly, a specific need remains to compare different doses and forms of aqueous *Aloe vera* extracts with a conventional NPK fertiliser under the field conditions of Daloa, using both vegetative and yield responses. Consequently, this study is underpinned by a commitment to sustainability and aims to compare the effects of aqueous extracts of *Aloe vera* on the growth and yield of tomatoes in the Daloa region, with a view to proposing an alternative that is environmentally friendly and beneficial to consumer health.

2. Materials and Methods

2.1 Study Site

The study site is located in the town of Daloa, specifically at Jean Lorougnon Guédé University. Daloa, the administrative centre of the Haut-Sassandra region, is situated in central-western Côte d'Ivoire, between 6° and 7° north latitude and 7° and 8° west longitude (Adjiri *et al.,* 2018). In terms of soil science, the substrate belongs to the ancient Precambrian bedrock, consisting of granites and migmatites. The soils, which are approximately 20 m deep and heavily leached, result from abundant rainfall and the rapid weathering of the rocks. In this region, the soils are predominantly ferralitic (Zro *et al.,* 2018). They are characterised by great depth and a high organic matter content.

2.2 Plant Material and Fertiliser

The plant material used consisted of tomato plants of the F1 Cobra 26 variety. This variety was chosen because of its moderate tolerance to pests and diseases and its productivity. The fertilisers comprised both organic and mineral fertilisers.

- The organic fertiliser consisted mainly of an aqueous extract of three-year-old *Aloe vera* leaves. *Aloe vera* leaves were used because of their high content of nutrients and plant hormones. Furthermore, they have good potential for the production of biopesticides and organic inputs, thus offering an environmentally friendly alternative to chemical products.
- The mineral fertiliser was the NPK 15-15-15 compound fertiliser commonly used in vegetable growing (Centre National de Recherche Agronomique [CNRA], 2021).

2.3 Methods

2.3.1 Experimental Design

The experimental design used was a randomised complete block design, with 10 treatments and three replicates. This design allowed all treatments with the same number of replicates to be compared. It consisted of three blocks, each subdivided into twelve

(12) subplots, including two (2) border plots (Fig. 1). The remaining ten (10) plots each corresponded to a different treatment. Each subplot contained ten plants spaced 0.5 metres apart. The subplots were spaced 1 metre apart, and the blocks were 2 metres apart. Excluding the border plots, a total of 300 active plants were monitored. Furthermore, each basic plot was ten metres long. The total area of the plot was 900 m² (45 m x 20 m), equivalent to 20.000 plants per hectare, with a spacing of 0.5 m x 1 m between plants. The different treatments were:

- Te: control group with no chemical treatment or aqueous extract of *Aloe vera*;
- A100: 100 per cent pure *Aloe vera* gel;
- A75: 75 per cent aqueous extract of the gel;
- A50: 50 per cent aqueous extract of the gel;
- A25: 25 per cent aqueous extract of the gel;
- F100: 100 g of crushed *Aloe vera* leaves;
- F60: 60 g of crushed *Aloe vera* leaves;
- F30: 30 g of crushed *Aloe vera* leaves;
- F15: 15 g of crushed *Aloe vera* leaves;
- NPK: 30 g of NPK 15-15-15 mineral fertiliser. The volume of aqueous extract used was 40 mL per tomato plant.

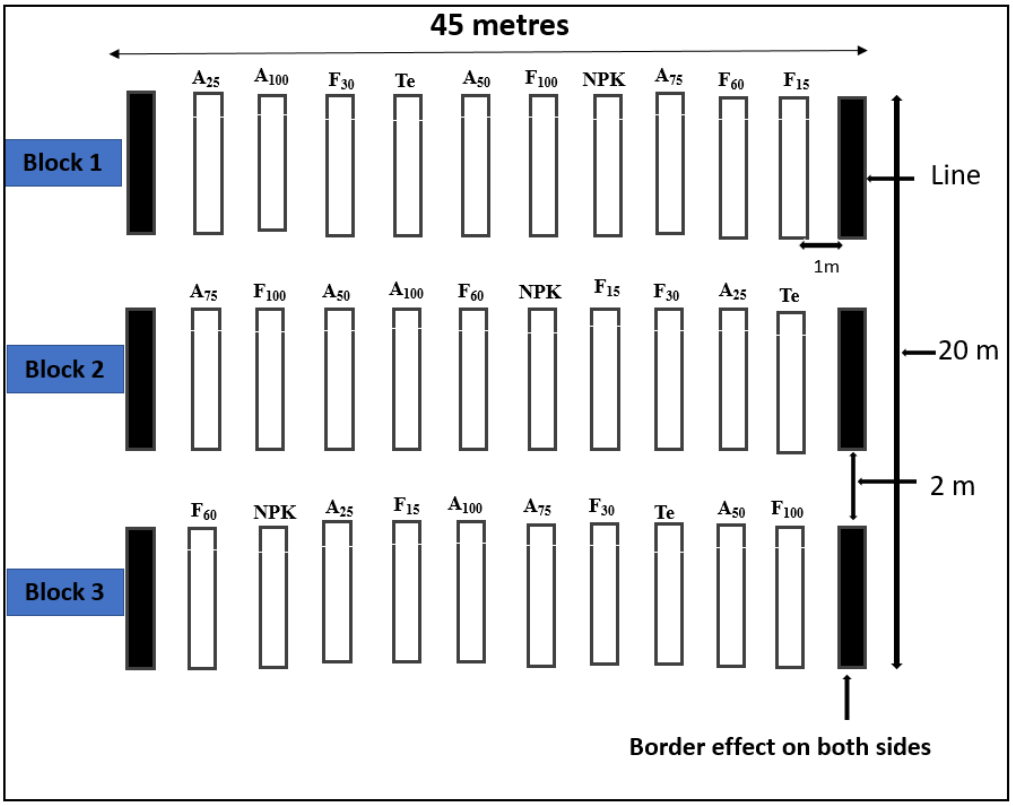

Fig. 1. Experimental set-up

Te: control treatment; A100: treatment with pure Aloe vera gel; A75: treatment with 75 per cent Aloe vera gel; A50: treatment with 50 per cent Aloe vera gel; A25: treatment with 25 per cent Aloe vera gel; F100: treatment with 100 g of Aloe vera leaf extract; F60: treatment with 60 g of leaf extract, F30: treatment with 30 g of leaf extract, F15: treatment with 15 g of leaf extract

2.3.2 Setting up and Conducting the Trial

2.3.2.1 Setting up the Seedbed

The seedbed was set up in 1200 cm² pots filled with topsoil taken from the site and then enriched with *Aloe vera*. Ten grams of Cobra 26 tomato seeds were sown in the seedbed near the plot. The seedbed was then covered with a protective net and straw to shield it from excessive sunlight, diseases and pests. The young plants, watered daily with a 15-litre watering can, remained there for 21 days before being transplanted into the field.

2.3.2.2 Setting up the Field Trial

During the experiment, several cultivation operations were carried out, including clearing the plot, preparing the beds and staking out the plot, which involved marking out the dimensions of the beds and the plot. Before transplanting, the nursery was thoroughly watered; the seedlings were then removed from their pots and transplanted in the afternoon. After transplanting, the plants were watered daily, once in the morning and once in the evening, using a watering can. A few days after transplanting, any dead plants were replaced.

2.3.3 Preparation of Aqueous Extracts of *Aloe vera*

- ***Aloe vera* gel:** After the leaves had been transported to the APA UJLoG laboratory, 15 kg of leaves were thoroughly washed with water and detergent to remove impurities, then stripped of their lateral spines. The leaves were then laid flat on a chopping board, and the thin layer on the underside was removed using a knife. The exposed gel was gently scraped out with a spatula, placed in a jar, and then blended to produce a homogeneous liquid. This liquid was used to prepare the various gel concentrations (25 per cent, 50 per cent, 75 per cent and 100 per cent).
- **Whole-leaf pulp:** The whole leaves were cut into small pieces and then blended using a food processor. The resulting pulp was used to prepare the various treatments applied to the tomato plants, at doses of 15 g, 30 g, 60 g and 100 g per plant.

2.3.4 Application of Treatments

The treatments consisted of applying either gel or pulverised whole *Aloe vera* leaves. These treatments were applied to the tomato plants either from the base upwards or at the collar, once every two weeks in the late afternoon. The gel was applied at a rate of 40 mL per plant, whilst the pulverised leaves and NPK fertiliser (15-15-15) were used at the recommended dose of 30 g/m² (300 kg/ha) for tomatoes (Kouamé *et al.,* 2021).

2.4 Collection of Data

During the growing season, fifteen plants per treatment were labelled, excluding those at the edges. Measurements were taken on five plants per treatment, amounting to fifty per sub-plot and a total of 150 plants. Observations focused on morphological and yield parameters in order to assess the effects of the treatments**.**

2.4.1 Morphological Parameters

For these parameters, 150 plants were measured on the 15th, 30th, 45th and 60th days after transplanting (DAT). The plants were selected at random and labelled prior to the data collection stage. Height was measured from the collar to the terminal bud using a tape measure. Collar diameter was measured using a vernier caliper. As for the number of leaves produced, the method involved counting the leaves on each plant to monitor the growth of the tomato plants.

2.4.2 Production Parameters

Production was determined by taking into account the mass of the harvested fruit and the yield. Harvesting took place when the tomatoes were red (ranging in colour from orange-yellow to red). The average fruit mass was calculated at each harvest for each treatment using an electronic balance, according to the following formula: Mm = Mtf / N, where Mm is the average fruit mass; Mtf is the total fruit mass of the fifteen plants (g); N is the number of fruits on the fifteen plants; and Rdt is the yield. The yield was determined at the end of the harvest. The calculation was carried out on a per-treatment basis before being extrapolated to a per-hectare basis using the formula below:

$$\mathrm{Rdt\ (t/ha)} = \frac{\mathrm{Rdt(kg/feet)X20000}}{1000}$$

With 20.000: number of plants per hectare and 1/100 as the conversion factor per hectare

2.5 Statistical Analysis and Data Processing

The data collected were entered into an Excel 2013 spreadsheet and subjected to a one-way analysis of variance (ANOVA) to compare treatment means for tomato plant growth. The Student–Newman–Keuls test was used to compare means when the analysis of variance revealed significant differences between treatments at a significance level of 5 per cent. Differences were considered significant when the probability value was less than 5 per cent (P ≤ 5 per cent). The statistical tests were carried out using Statistica 7.1 software.

3. Results

3.1 Variation in Average Plant Height According to Treatment and Time

Table 1 shows that tomato plant height varied significantly depending on the treatments. From 15 days onwards, the 100 per cent *Aloe vera* gel treatment resulted in the greatest average height (24.58 cm), whilst the control treatment showed the lowest (19.60 cm). The other treatments, including different doses of gel, leaf extracts and NPK, produced intermediate values ranging from 20.88 to 23.83 cm. On the 30th day after transplanting, pure *Aloe vera* gel (A100) produced the greatest average plant height (45.60 cm), followed by treatments A75, A50 and F100, whilst the control (TE) showed the lowest (34.13 cm). At 45 days, the NPK (74.73 cm) and F100 (71.58 cm) treatments led the way, followed by the other gel and leaf extract treatments, with the control retaining the lowest value (51.51 cm). On the 60th day, the NPK (87.20 cm) and A100 (86.01 cm) treatments recorded the highest growth, whilst the control retained the lowest value (60.00 cm). Overall, the treatments applied had a positive effect on tomato plant height.

Table 1. Average plant height values by treatment and time

Average plant heights				
	Measurement times			
Treatments	**15 days**	**30 days**	**45 days**	**60 days**
TE	19,60 ± 3,4^{bc}	34,13 ± 8,87^{c}	51,51 ± 10,96^{bc}	60,00 ± 12,72^{c}
A100	24,58 ± 4,06^{a}	45,60 ± 9,87^{a}	66,24 ± 10,97^{ab}	86,01 ± 11,03^{ab}
A75	23,27 ± 3,24^{b}	43,09 ± 8,35^{ab}	62,19 ± 8,58^{b}	75,06 ± 8,64^{b}
A50	22,55 ± 3,02^{ab}	43,65 ± 7,62^{ab}	64,22 ± 8,96^{ab}	72,51 ± 10,42^{bc}
A25	23,83 ± 3,32^{b}	40,32 ± 7,53^{bc}	65,82 ± 9,14^{ab}	74,56 ± 9,89^{b}
F100	20,88 ± 3,64^{ab}	43,04 ± 10,93^{ab}	71,58 ± 13,19^{a}	79,44 ± 9,96^{b}
F60	22,27 ± 4,01^{ab}	40,15 ± 7,58^{bc}	66,19 ± 11,79^{ab}	73,05 ± 11,60^{bc}
F30	22,49 ± 3,6^{ab}	38,99 ± 6,42^{bc}	62,74 ± 10,53^{b}	71,98 ± 10,00^{bc}
F15	21,99 ± 4,22^{ab}	42,14 ± 8,14^{b}	64,45 ± 10,73^{ab}	76,07 ± 10,68^{b}
NPK	22,47 ± 3,92^{ab}	43,98 ± 11,91^{a}	74,73 ± 11,93^{a}	87,20 ± 10,30^{a}
Probability	0,01	0,05	0,03	0,00

Means followed by different letters in the columns are significantly different at the 5 per cent significance level.
TE: control treatment, A100: treatment with pure Aloe vera gel, A75: treatment with 75% Aloe vera gel, A50: treatment with 50% Aloe vera gel, A25: treatment with 25% Aloe vera gel, F100: treatment with 100 g of Aloe vera leaf extract, F60: treatment with 60 g of leaf extracts, F30: treatment with 30 g of leaf extracts, F15: treatment with 15 g of leaf extracts and NPK: treatment with 30 g of mineral fertiliser

3.2 Variation in the Average Collar Diameter of Tomato Plants According to Treatment

The results presented in Table 2 indicate that, on the 15th day after transplanting, no significant difference was observed between the average diameters of the plants across the different treatments, as the probability obtained was greater than 0.05. However, a significant difference emerged from the 30th day onwards and persisted until the 60th day. On the 30th day after transplanting, treatments A100 and NPK recorded the highest collar diameters, at 3.10 ± 0.33 cm and 2.91 ± 0.47 cm respectively. These were followed by treatments F100 (2.89 ± 0.56 cm), A75 (2.81 ± 0.68 cm), F15 (2.84 ± 0.43 cm), A50 (2.72 ± 0.46 cm), A25 (2.71 ± 0.47 cm), F60 (2.66 ± 0.61 cm) and F30 (2.58 ± 0.39 cm). The lowest mean diameter was recorded for the TE control (2.37 ± 0.44 cm). On day 45, the trend observed was similar to that on day 30. The treatments A100, NPK, F100 and F15 recorded the largest diameters, with values of 3.61 ± 0.60 cm, 3.70 ± 0.53 cm, 3.69 ± 0.54 cm and 3.69 ± 0.59 cm respectively. These were followed by treatments A75 (3.41 ± 0.53 cm), A25 (3.40 ± 0.43 cm), A50 (3.28 ± 0.52 cm), F60 (3.20 ± 0.48 cm) and F30 (3.21 ± 0.48 cm). The control (TE) once again recorded the smallest diameter (2.98 ± 0.55 cm). On the 60th day after transplanting, the same trend was confirmed. The A100, NPK, F100 and F15 treatments had the highest mean diameters, at 4.88 ± 0.58 cm, 4.09 ± 0.52 cm, 3.98 ± 0.48 cm and 3.98 ± 0.61 cm respectively. The A75 treatment followed with 3.76 ± 0.48 cm, then the A25 (3.71 ± 0.61 cm), F30 (3.69 ± 0.62 cm), A50 (3.67 ± 0.48 cm) and F60 (3.55 ± 0.58 cm) treatments. The control group remained in last place with an average diameter of 3.26 ± 0.51 cm.

Table 2. Average collar diameter values of the seedlings by treatment and time

Average plant diameter				
	Measurement times			
Treatments	**15 days**	**30 days**	**45 days**	**60 days**
TE	1,87 ± 0,29^{a}	2,37 ± 0,44^{c}	2,98 ± 0,55^{c}	3,26 ± 0,51^{bc}
A100	2,26 ± 0,31^{a}	3,10 ± 0,33^{a}	3,61 ± 0,60^{a}	4,88 ± 0,58^{a}
A75	2,16 ± 0,20^{a}	2,81 ± 0,68^{b}	3,41 ± 0,53^{b}	3,76 ± 0,48^{ab}
A50	2,11 ± 0,26^{a}	2,72 ± 0,46^{b}	3,28 ± 0,52^{bc}	3,67 ± 0,48^{ab}
A25	2,17 ± 0,42^{a}	2,71 ± 0,47^{b}	3,40 ± 0,43^{b}	3,71 ± 0,61^{ab}
F100	2,21 ± 0,44^{a}	2,89 ± 0,56^{b}	3,69 ± 0,54^{a}	3,98 ± 0,48^{a}
F60	2,16 ± 0,34^{a}	2,66 ± 0,61^{bc}	3,20 ± 0,48^{bc}	3,55 ± 0,58^{b}
F30	2,12 ± 0,46^{a}	2,58 ± 0,39^{bc}	3,21 ± 0,48^{bc}	3,69 ± 0,62^{ab}
F15	2,23 ± 0,39^{a}	2,84 ± 0,43^{b}	3,69 ± 0,59^{a}	3,98 ± 0,61^{a}
NPK	2,14 ± 0,26^{a}	2,91 ± 0,47^{a}	3,70 ± 0,53^{a}	4,09 ± 0,52^{a}
Probability	0,14	0,01	0,00	0,01

Means followed by different letters in the columns are significantly different at the 5 per cent significance level.
TE: control treatment, A100: treatment with pure Aloe vera gel, A75: treatment with 75% Aloe vera gel, A50: treatment with 50% Aloe vera gel, A25: treatment with 25% Aloe vera gel, F100: treatment with 100 g of Aloe vera leaf extract, F60: treatment with 60 g of leaf extracts, F30: treatment with 30 g of leaf extracts, F15: treatment with 15 g of leaf extracts and NPK: treatment with 30 g of mineral fertiliser

3.3 Variation in the Average Number of Leaves According to Treatment and Time

The results set out in Table 3 showed that, 15 days after transplanting, no significant difference was observed between the average number of leaves produced by the plants across the different treatments, with the p-value being greater than 0.05. Leaf production was therefore similar between treated and control plants. However, from the 30th day up to the 60th day, statistical analysis revealed a significant difference in the number of leaves produced, varying according to the treatments applied. On the 30th day, the highest numbers of leaves, compared with the control, were recorded for treatments A100 (11.73 ± 2.36 leaves), A75 (11.11 ± 2.29 leaves), A50 (11.17 ± 2.61 leaves), F60 (11.19 ± 2.96 leaves), F30 (10.96 ± 2.13 leaves), F15 (10.92 ± 2.17 leaves) and NPK (11.35 ± 3.54 leaves). The intermediate treatments A25 (10.38 ± 2.67 leaves) and F100 (10.19 ± 2.57 leaves) showed slightly lower values. The lowest number of leaves was obtained with the control TE (8.87 ± 2.07 leaves). On the 45th day, the plants fertilised with NPK produced the highest number of leaves (20.93 ± 7.51), followed by those treated with pure *Aloe vera* A100 gel (17.56 ± 5.58 leaves), the F15 leaf extract (17.59 ± 4.10 leaves), F60 (17.35 ± 5.62 leaves), F30 (17.31 ± 4.45 leaves), A50 (16.96 ± 5.85 leaves), A75 (16.95 ± 8.79 leaves), F100 (16.49 ± 4.06 leaves) and A25 (16.48 ± 5.18 leaves). The control group (TE) recorded the lowest number of leaves (12.82 ± 4.16). On the 60th day after transplanting, the treatments A100 (30.35 ± 9.26 leaves), NPK (29.79 ± 7.33 leaves), A25 (26.78 ± 8.72 leaves) and F15 (26.12 ± 8.55 leaves) produced the highest numbers of leaves. These were followed by treatments F100 (24.72 ± 7.98 leaves), A75 (24.42 ± 8.46 leaves), F30 (23.57 ± 6.30 leaves) and A50 (22.96 ± 7.55 leaves). Plants treated with F60 ranked third with 20.57 ± 8.62 leaves. The control (TE) once again recorded the lowest average number of leaves (17.06 ± 6.21).

Table 3. Average values for the number of leaves produced, by treatment and time

Number of tomato leaves				
		Measurement times		
Treatments	**15 days**	**30 days**	**45 days**	**60 days**
TE	$5{,}96 \pm 0{,}76^{a}$	$8{,}87 \pm 2{,}07^{bc}$	$12{,}82 \pm 4{,}16^{c}$	$17{,}06 \pm 6{,}21^{c}$
A100	$6{,}67 \pm 0{,}99^{a}$	$11{,}73 \pm 2{,}36^{a}$	$17{,}56 \pm 5{,}58^{b}$	$30{,}35 \pm 9{,}26^{a}$
A75	$6{,}57 \pm 0{,}78^{a}$	$11{,}11 \pm 2{,}29^{a}$	$16{,}95 \pm 8{,}79^{b}$	$24{,}42 \pm 8{,}46^{ab}$
A50	$6{,}42 \pm 0{,}62^{a}$	$11{,}17 \pm 2{,}61^{a}$	$16{,}96 \pm 5{,}85^{b}$	$22{,}96 \pm 7{,}55^{ab}$
A25	$6{,}32 \pm 0{,}76^{a}$	$10{,}38 \pm 2{,}67^{b}$	$16{,}48 \pm 5{,}18^{b}$	$26{,}78 \pm 8{,}72^{a}$
F100	$6{,}31 \pm 0{,}97^{a}$	$10{,}19 \pm 2{,}57^{b}$	$16{,}49 \pm 4{,}06^{b}$	$24{,}72 \pm 7{,}98^{ab}$
F60	$6{,}59 \pm 0{,}85^{a}$	$11{,}19 \pm 2{,}96^{a}$	$17{,}35 \pm 5{,}62^{b}$	$20{,}57 \pm 8{,}62^{bc}$
F30	$6{,}35 \pm 0{,}91^{a}$	$10{,}96 \pm 2{,}13^{a}$	$17{,}31 \pm 4{,}45^{b}$	$23{,}57 \pm 6{,}30^{ab}$
F15	$6{,}09 \pm 0{,}60^{a}$	$10{,}92 \pm 2{,}17^{a}$	$17{,}59 \pm 4{,}10^{b}$	$26{,}12 \pm 8{,}55^{a}$
NPK	$6{,}13 \pm 0{,}85^{a}$	$11{,}35 \pm 3{,}54^{a}$	$20{,}93 \pm 7{,}51^{a}$	$29{,}79 \pm 7{,}33^{a}$
Probability	0,16	0,03	0,00	0,02

Means followed by different letters in the columns are significantly different at the 5 per cent significance level.
TE: control treatment, A100: treatment with pure Aloe vera gel, A75: treatment with 75% Aloe vera gel, A50: treatment with 50% Aloe vera gel, A25: treatment with 25% Aloe vera gel, F100: treatment with 100 g of Aloe vera leaf extract, F60: treatment with 60 g of leaf extracts, F30: treatment with 30 g of leaf extracts, F15: treatment with 15 g of leaf extracts and NPK: treatment with 30 g of NPK

3.4 Effect of Treatments on Tomato Fruit Weight and Yield

Table 4 shows the mean values for tomato fruit weight and yield according to treatment. The results showed that these parameters were significantly influenced by the treatments applied. Plants treated with 100% *Aloe vera* gel recorded the highest average weight (1733.74 ± 1340.10 g) as well as the highest yield (34.87 ± 26.80 t ha^{-1}). This treatment was followed by plants fertilised with NPK, which had an average mass of 1685.81 ± 761.78 g and a yield of 33.22 ± 15.24 t ha^{-1}. In contrast, the control (TE: no fertilisation or treatment) yielded the lowest values, with an average weight of 414.04 ± 392.58 g and a yield of 7.29 ± 7.15 t ha^{-1}.

Table 4. Tomato yield characteristics

Treatments	**Average mass (in g)**	**Average yield (t.ha^{-1})**
TE	$414{,}04 \pm 392{,}58^{b}$	$7{,}29 \pm 7{,}15^{c}$
A100	$1733{,}74 \pm 1340{,}10^{a}$	$34{,}87 \pm 26{,}80^{a}$
A75	$975{,}00 \pm 704{,}71^{ab}$	$19{,}50 \pm 14{,}09^{bc}$
A50	$1116{,}36 \pm 576{,}75^{ab}$	$22{,}33 \pm 11{,}54^{abc}$
A25	$1390{,}00 \pm 879{,}21^{ab}$	$27{,}80 \pm 17{,}58^{ab}$
F100	$1481{,}82 \pm 949{,}54^{ab}$	$29{,}64 \pm 18{,}99^{ab}$
F60	$986{,}36 \pm 523{,}97^{ab}$	$19{,}73 \pm 10{,}48^{bc}$
F30	$1254{,}01 \pm 822{,}34^{ab}$	$23{,}26 \pm 15{,}79^{ab}$
F15	$1563{,}64 \pm 1120{,}51^{ab}$	$31{,}27 \pm 22{,}41^{ab}$
NPK	$1685{,}81 \pm 761{,}78^{a}$	$33{,}22 \pm 15{,}24^{ab}$
Probability	0,01	0,01

Means followed by different letters in the columns are significantly different at the 5 per cent significance level.
TE: control treatment, A100: treatment with pure Aloe vera gel, A75: treatment with 75% Aloe vera gel, A50: treatment with 50% Aloe vera gel, A25: treatment with 25% Aloe vera gel, F100: treatment with 100 g of Aloe vera leaf extract, F60: treatment with 60 g of leaf extracts, F30: treatment with 30 g of leaf extracts, F15: treatment with 15 g of leaf extracts and NPK: treatment with 30 g of mineral fertiliser

4. Discussion

Natural substances are now emerging as promising alternatives to chemical fertilisers. Against this backdrop, this study assessed the effect of a biofertiliser based on an aqueous extract of *Aloe vera* on the agromorphological parameters of tomatoes. The results revealed a highly significant variation in growth parameters, notably plant height, stem base diameter and number of leaves. Thus, the treatments applied had a positive effect on the tomato plants. More specifically, plants treated with pure *Aloe vera* gel (A100), 100 g of leaf pulp (F100) and NPK (30 g) performed best, in contrast to the control group and the other treatments. This difference may be associated with biostimulant effects on nutrient-use efficiency and plant physiological processes (du Jardin, 2015). Furthermore, the growth observed could be attributed to increased photosynthetic activity in the treated plants, enhanced by the presence of minerals such as calcium (Ca), nitrogen (N), phosphorus (P), potassium (K) and magnesium (Mg). These elements are essential components of plant mineral nutrition and support core physiological functions, including photosynthesis and metabolism (White & Brown, 2010). Furthermore, *Aloe vera* gel contains minerals, amino acids, enzymes and other bioactive constituents (Hamman, 2008; Surjushe *et al.*, 2008). Auxins and gibberellins have also been reported among the constituents of *Aloe vera* (Surjushe *et al.*, 2008). These phytohormones are involved in plant growth and developmental regulation. Finally, plant biostimulants can enhance nutrient-use efficiency and nutrient acquisition, providing a plausible basis for improved vegetative performance (du Jardin, 2015).

With regard to yield, performance characteristics were significantly improved with pure *Aloe vera* gel, even outperforming the NPK treatment under the conditions of this experiment. This result may be associated with improved plant nutrition and biostimulant activity. In tomato, supplementation with an *Aloe vera*-containing biostimulant complex has been associated with increased flower and fruit number (Wise & Selby-Pham, 2025), while plant-derived biostimulants have also increased tomato yield and mineral accumulation in other production systems (Mauro *et al.*, 2024). *Aloe vera* gel contains polysaccharides and a range of other constituents, including minerals, vitamins and enzymes (Hamman, 2008; Surjushe *et al.*, 2008). In addition, fertilisation studies in *Aloe vera* have demonstrated that nutrient supply significantly influences mineral uptake and biochemical composition (Chowdhury *et al.*, 2021). Lastly, the control plants (unfertilised) performed the worst, highlighting the importance of nutrient supply. Nitrogen, phosphorus, potassium, calcium and magnesium are among the essential mineral nutrients required for normal plant growth and physiological function (White & Brown, 2010).

5. Conclusion

Under the field conditions of Daloa, aqueous *Aloe vera* extracts improved the measured vegetative and yield responses of tomato relative to the untreated control. Among the plant-based treatments, pure *Aloe vera* gel (A100) showed the strongest overall performance, with a mean plant height of 86.01 cm, collar diameter of 4.88 cm, 30.35 leaves, and yield of 34.87 t ha^{-1} at the reported assessment points. The corresponding control values were 60.00 cm, 3.26 cm, 17.06 leaves, and 7.29 t ha^{-1}. The A100 yield was also comparable to the NPK treatment, which produced 33.22 t ha^{-1}. These results indicate that undiluted *Aloe vera* gel has potential as a plant-derived input for tomato production under the conditions tested. Its use may contribute to reducing reliance on conventional mineral fertilisation where comparable responses can be achieved. However, the findings should be interpreted within the specific experimental conditions, and further evaluation across production environments would be useful before broader agronomic recommendations are made.

6. Limitation

The study was conducted at a single experimental site in Daloa and evaluated one tomato variety under the reported field conditions. Accordingly, the results primarily describe treatment responses within this experimental context. The assessment focused on the stated morphological and yield parameters over the study period. Replication of the experiment across additional locations, seasons, and tomato varieties would help determine the consistency and wider applicability of the observed responses to *Aloe vera* extracts.

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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