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IMPROVEMENT OF CHIVES (*ALLIUM SCHOENOPRASUM* L.) PRODUCTIVITY THROUGH THE USE OF ENRICHED COMPOST IN KADIOGO PROVINCE, BURKINA FASO

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ABSTRACT

This study aimed to evaluate the influence of compost enriched with the antagonistic and biostimulant fungus *Trichoderma harzianum* (CETh) on the agromorphological performance and financial profitability of chives (*Allium schoenoprasum* L.) under the pedoclimatic conditions of Burkina Faso. An experimental design was established to compare different CETh application rates with a conventional mineral fertilizer and an absolute control without input. The different treatments applied are as follows: T0 = control, T1 (150 kg/ha NPK 14-23-14 + 50 kg/ha urea), T2 (5 t/ha CETh), T3 (10 t/ha CETh), T4 (12.5 t/ha CETh), T5 (15 t/ha CETh), and T6 (20 t/ha CETh). Growth parameters, tissue moisture content, and yield components were measured. A financial analysis based on the Value-Cost Ratio (VCR) and the Acceptability

Index (AI) complemented the agronomic evaluation. The results reveal that CETh application significantly stimulated vegetative growth compared to mineral fertilization alone. While doses of 15 t/ha and 20 t/ha induced the best morphological performance and maximum water retention (92.38%), the techno-economic optimum was achieved with the 10 t/ha dose (T3). This treatment recorded a leaf yield of 36.63 t/ha, a net profit of USD 46 861,09, a VCR of 6.57, and an AI of 1.53. The incorporation of *Trichoderma harzianum* into compost enhances nutrient bioavailability and the efficiency of organic fertilization. For sustainable and profitable chive production in Burkina Faso, the application of 10 t/ha of CETh is recommended, offering an optimal balance between input investment and productivity gains.

Keywords : *Allium schoenoprasum L., Trichoderma harzianum, enriched compost, financial profitability, biostimulation, Burkina Faso.*

RÉSUMÉ

Amélioration de la productivité de la ciboulette *(Allium schoenoprasum L.)* par l'utilisation de compost enrichi dans la Province du Kadiogo, au Burkina Faso

Cette étude visait à évaluer l'influence d'un compost enrichi en *Trichoderma harzianum* (ceth) - un champignon aux propriétés antagonistes et biostimulantes - sur les performances agromorphologiques et la rentabilité financière de la ciboulette (Allium schoenoprasum L.) Dans les conditions pédoclimatiques du burkina faso. Un dispositif expérimental a été mis en place pour comparer différents taux d'apport de ceth avec un engrais minéral conventionnel et un témoin absolu sans apport. Les traitements appliqués étaient les suivants : T0 = témoin, T1 (150 kg/ha de NPK 14-23-14 + 50 kg/ha d'urée), T2 (5 t/ha de ceth), T3 (10 t/ha de CETh), T4 (12,5 t/ha de CETh), T5 (15 t/ha de CETh) et T6 (20 t/ha de CETh). Les paramètres de croissance, la teneur en eau des tissus et les composantes du rendement ont été mesurés. Une analyse financière fondée sur le rapport valeur/coût (RVC) et l'indice d'acceptabilité (IA) a complété l'évaluation agronomique. Les résultats révèlent que l'apport de CETh a stimulé de manière significative la croissance végétative par rapport à la fertilisation minérale seule. Si les doses de 15 t/ha et 20 t/ha ont induit les meilleures performances morphologiques et la rétention d'eau maximale (92,38 %), l'optimum technico-économique a été atteint avec la dose de 10 t/ha (t3). Ce traitement a permis d'obtenir un rendement en feuilles de 36,63 t/ha, un bénéfice net de 46 861,09 USD, un RVC de 6,57 et un IA de 1,53. L'incorporation de *Trichoderma harzianum* au compost améliore la biodisponibilité des nutriments ainsi que l'efficacité de la fertilisation organique. Pour une production de ciboulette durable et rentable au Burkina Faso, l'apport de 10 t/ha de CETh est recommandé, car il offre un équilibre optimal entre l'investissement en intrants et les gains de productivité.

Mots-clés : *Allium schoenoprasum L., Trichoderma harzianum, compost enrichi, rentabilité financière, biostimulation, Burkina Faso.*

I - INTRODUCTION

Vegetable farming plays a significant role in the local economy of Burkina Faso, particularly in peri-urban areas such as Kadiogo Province. Among vegetable crops, chives (*Allium schoenoprasum* L.) are highly valued for their culinary uses and nutritional value. However, their productivity remains limited by low soil fertility, land degradation, and poor agricultural practices. In addition, the impacts of climate change further hinder the ability to meet the food needs of a rapidly growing population [1]. The use of organic amendments, particularly compost, represents a sustainable alternative for improving soil fertility and increasing crop yields [2, 3]. Several studies have also demonstrated that enriched compost supplemented with additional nutrients or biological activators can stimulate plant growth, enhance nutrient availability, and strengthen the resilience of agricultural systems [4 - 6]. In the context of Kadiogo, where demographic pressure and rising demand for vegetable products intensify fertilization needs, assessing the effectiveness of enriched compost with *Trichoderma harzianum* on chive productivity is highly relevant. This study aims to evaluate the effect of enriched compost on chive growth and yield, thereby contributing to locally adapted agronomic strategies for vegetable producers. The primary objective of the study is to analyze the effect of enriched compost on chive productivity in Kadiogo Province and to contribute to the advancement of sustainable fertilization practices in vegetable production systems in Burkina Faso.

II - METHODOLOGY

II-1. Study site description

The study was conducted at an experimental site located in the rural commune of Saaba (Gampéla), in the central region of Burkina Faso. The site is situated at 12°25′8″ N and 1°22′9″ W, on a leached tropical ferruginous soil. The climate is classified as tropical north-Sudanian, characterized by two contrasting seasons: a rainy season extending from June to October, and a dry season from November to May. The mean annual rainfall in Gampéla ranges between 700 and 800 mm, while temperatures generally vary from 28 °C to 40 °C depending on the time of year.

II-2. Experimental materials

II-2-1. Plant material

The chive variety (*Allium schoenoprasum* L.), produced by a seed production association in Burkina Faso, was used as the plant material because of its adaptation to local ecological conditions, high yield potential, and agro-food relevance. This variety has a growth cycle ranging from 60 to 70 days and produces fresh biomass between 15 and 30 t/ha per year. It is well adapted to the agro-climatic zones of Burkina Faso**.**

II-2-2. Enriched compost

The chemical properties of the enriched compost were described by [4]. Compost application was carried out two weeks before transplanting.

II-3. Methods

II-3-1. Experimental design and setting

The experiment was conducted using a completely randomized Fisher block design with seven (07) treatments and three (03) replications. The recommended mineral fertilization (Fmv) consisted of NPK (Nitrogen Phosphorus Potassium) and urea. An application of 150 kg/ha of NPK (14–23–14) was carried out on the 14th day after transplanting (DAT), while urea was applied at a rate of 50 kg/ha, split into two applications of 25 kg/ha each on the 28th and 42nd DAT. The treatments applied were as follows: control (T0), mineral fertilization (T1), and enriched compost at rates of 5, 10, 12.5, 15, and 20 t/ha (T2–T6). Seven treatments replicated four times yielded 21 experimental units (1 m² each). Transplanting was done at 20 × 20 cm spacing, one plant per hole, giving a density of 250,000 plants/ha. Weed control was achieved through regular hand weeding's. Pest and disease management involved applications of Pacha EC (10 g/L) and AZOX Pro (1 L/ha) at recommended rates.

II-3-2. Plant nursery

The nursery was established on a plot of 8.75 m² (2.5 m × 3.5 m). After shallow tillage to a depth of 15 cm, soil disinfection by solarization was carried out on June 21, 2025. Following the incorporation of basal manure, sowing was performed on June 25, 2025, with a row spacing of 20 cm. A straw mulch was applied to optimize seedling emergence, which occurred 14 days after sowing. To limit weed competition, three hand weeding's were conducted on July 9, 16, and 21, 2025. Finally, a twice-daily irrigation regime was maintained for 27 days to prevent water stress.

II-3-3. Observed and derived parameters

II-3-3-1. Survival rate

The survival rate was determined as the percentage of transplanted seedlings that successfully established in the field. The parameter was calculated according to ***Equation 1***.

$$\text{Survival rate (\%)} = \frac{\text{Number of suriving plants}}{\text{Total number of plants initially tranplanted}} \times 100 \qquad (1)$$

II-3-3-2. Monitoring of leaf number per plant

Leaf number per plant was recorded weekly from the second to the ninth week after transplanting, for a total of seven observations.

II-3-3-3. Plant height and collar diameter

Plant height (cm) was measured from the collar to the tip of the longest leaf using a measuring tape, while collar diameter (mm) was measured on the same plants as height using a digital caliper, from the 21st day after transplanting (DAT) until the semi-heading stage (65th DAT). These measurements were used to assess the vegetative vigor of the plants in response to the different compost treatments.

- ***Moisture rate***

The determination of moisture content aimed to evaluate the water content of plant tissues at harvest. This parameter is crucial for assessing biomass quality and predicting its storage potential. Moisture content was calculated according to the following ***Equation 2*** :

$$\text{moisture content (\%)} = \frac{W_{fresh} - W_{dry}}{W_{fresh}} \quad (2)$$

where, W_{fresh} = fresh weight of the sample; W_{dry} = dry weight of the sample after oven-drying.

II-3-3-4. Leaf yield

Leaf yield was determined by block at the level of each experimental unit using ***Formula 3*** :

$$\text{leaf yield (t.ha}^{-1}\text{)} \ \frac{\text{Fresh weight of harvested leaves per plot (kg)}}{\text{plot area (m}^2\text{)}} \times 100 \quad (3)$$

A conversion factor of 100 was applied to express yields obtained per square meter in tons per hectare.

II-3-3-5. yield gain

Yield gain is defined as the ratio between the difference in yield of the treatment and the yield of the control, divided by the yield of the control. It is expressed as a percentage and calculated according to ***Formula 4*** :

$$\text{Yield gain (\%)} = \frac{\text{Yield treatment - Yield control}}{\text{Yield control}} \times 100 \quad (4)$$

II-3-4. Financial profitability analysis of the treatments

The Value-Cost Ratio (VCR) and the Acceptability Index (AI) were calculated to determine which doses (treatments) would be easily adoptable for onion (chives) fertilization under the conditions of the central region of Burkina Faso. The cost of one ton of compost enriched with *Trichoderma harzianum* from the BIOPROTECT-B company was USD 127.25, with an additional transport cost of USD 12.5 per ton of enriched compost. Labor cost was USD 242 per hectare, while the average price of onion seed was USD 6.7. The average market price of one kilogram of leaves was USD 0.42 in Burkina Faso. In addition, the cost of NPK (14-23-14) fertilizer was USD 41.66 per 50/kg bag, and that of urea was USD 30.83 per 50/kg bag. Net benefit was obtained by applying a 20% reduction to the gross benefit to account for post-harvest losses.

II-3-4-1. Acceptability Index (AI)

The Acceptability Index (AI) was calculated to identify the best treatment that could be easily adopted by farmers [7]. This index compares the profitability of new treatments with that of the reference treatment well known to farmers. It is therefore defined as the ratio of the benefits of the two treatments, according to ***Formula 5*** :

$$\text{Acceptability Index} = \frac{\text{Net benefit of the tested treatment (USD.ha}^{-1}\text{)}}{\text{Net benefit of the reference treatment (USD.ha}^{-1}\text{)}} \quad (5)$$

This technology can only be easily adopted if the Acceptability Index (AI) is greater than or equal to 2 [8]. Adoption occurs with reluctance if this ratio is between 1.5 and 2, and below 1.5 the treatment is rejected [6].

II-3-4-2. Value-Cost Ratio (VCR)

The Value-Cost Ratio (VCR) is defined as the ratio between the net monetary gain and the cost of the fertilizer. It allows comparison of the profitability of new treatments with that of the reference treatment well known to farmers. The reference formula [9, 10] was used and is given as follows :

$$\text{Value - cost ratio} = \frac{\text{net benefit treatment - net benefit control}}{\text{cost of fertilizer applied}} \quad (6)$$

The Value-Cost Ratio (VCR) must be greater than 2 in order to enable producers to cover the direct expenses related to the use of fertilizers [11, 12]. If the VCR value is equal to 2, the technology is not profitable but no loss is incurred. Yield gain allows the expenses made for fertilizer purchase to be covered. The technology is not profitable and, on the contrary, a financial loss is recorded when the VCR value is less than 2.

II-3-5. Statistical data analysis

All collected data were analyzed using RStudio software (version 2026.01.1+403) coupled with R version 4.5.0. An analysis of variance (ANOVA) was performed for all treatments. The Newman–Keuls test was applied to separate the means when treatment effects were significant at the 5% level.

III - RESULTS

III-1. Effect of applied treatments on plant height dynamics

The results concerning the evolution of chive plant height are presented in ***Figure 1***. Statistical analysis performed at the 5% significance level did not reveal any significant differences among treatments. Between the 22nd and 29th days, plant heights varied slightly across treatments, resulting in overlapping growth curves that made their distinction difficult at this stage. However, from the 36th to the 57th day after transplanting, growth patterns became clearly differentiated among treatments. A more pronounced increase was observed under treatment T5 (15 $t.ha^{-1}$ of compost enriched with *Trichoderma harzianum*), which recorded the highest values, reaching 42.29 cm on day 36 and 55.66 cm on day 57. In contrast, treatment T1 (NPK + Urea) exhibited the lowest performance, with an average plant height of 34.82 cm on day 36 and 45.94 cm on day 57. These results underscore the more favorable influence of compost enriched with *Trichoderma harzianum* on chive growth, clearly outperforming the contribution of conventional mineral fertilizers.

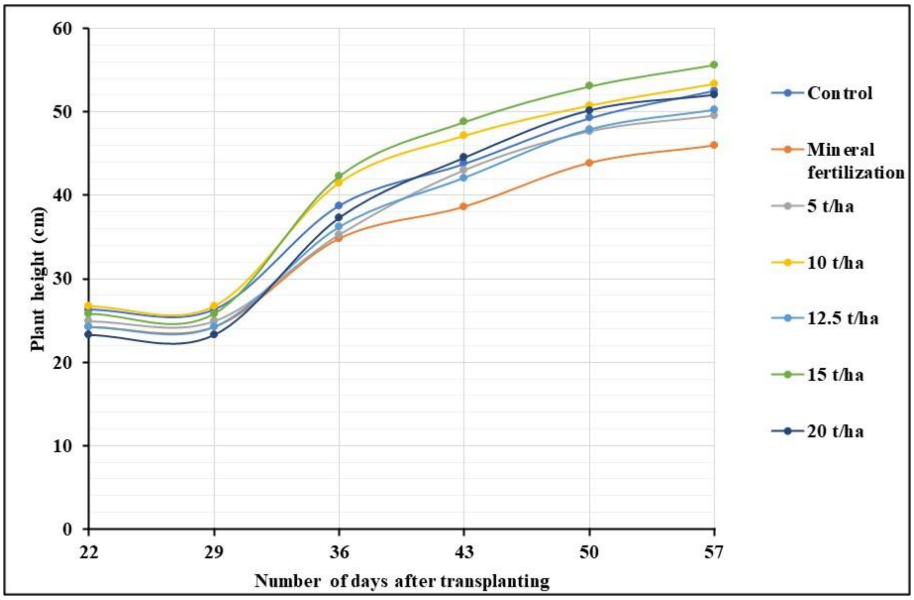

Figure 1 : *Growth curves of plant height under the effect of treatments*

III-2. Evolution of collar diameter under the effect of applied treatments

The evolution of collar diameter in chive plants, as influenced by the treatments, is presented in Figure 2. Although statistical analysis at the 5% significance level did not reveal any significant differences, a notable increase in diameter was observed as early as the 29th day after transplanting. This phase of active growth followed a period of slower development between the 22nd and 29th days. Treatment T5 (15 t.ha^{-1} of compost enriched with Trichoderma harzianum) stood out by producing the largest diameters, increasing from 7 mm on day 29 to 29.79 mm on day 57. Conversely, treatment T1 (Fmv) exhibited the lowest values, with 5.08 mm and 20.08 mm recorded on the same dates.

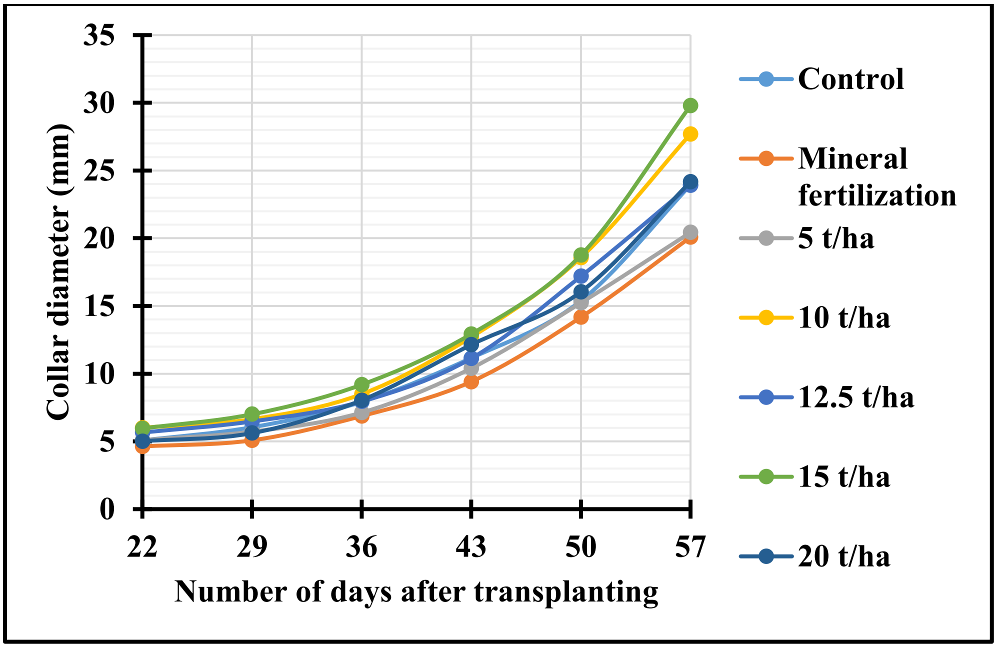

Figure 2 : *Growth curves of collar diameter under the effect of treatments*

III-3. Effect of applied treatments on onion leaf number, transplant survival rate, and relative leaf growth rate of plants

The results (Figure 3) indicate that all treatments (T0 to T6) resulted in a very high survival rate, ranging from 98% to 100%. No significant mortality was observed regardless of the treatment applied. Treatments T4, T5, and T6 (100%) exhibited the highest survival rates, with low variability among replicates, reflecting a strong adaptation of the seedlings to transplanting conditions. Treatment T3 (10 t/ha) showed slightly greater dispersion, suggesting a more heterogeneous response among seedlings. Finally, the control (T0 = 100%) also displayed a fully satisfactory survival rate. Leaf growth measured 57 days after transplanting (DAT) varied according to the treatments applied ***(Figure 3)***. The number of leaves is an indicator of vegetative vigor. Treatments T1 (29.37% ± 3.64) and T3 (31.18% ± 3.53) recorded the highest mean values, indicating better vegetative recovery of the plants following transplantation. Treatment T2 (5 t/ha CETh) was characterized by high variability and relatively low values (21.39% ± 8.26), which may reflect inconsistent effectiveness of the amendment. Treatments T0 (26.46% ± 1.22), T4 (24.86% ± 5.61), T5 (29.08% ± 3.16), and T6 (24.45% ± 4.19) showed intermediate but generally stable growth.

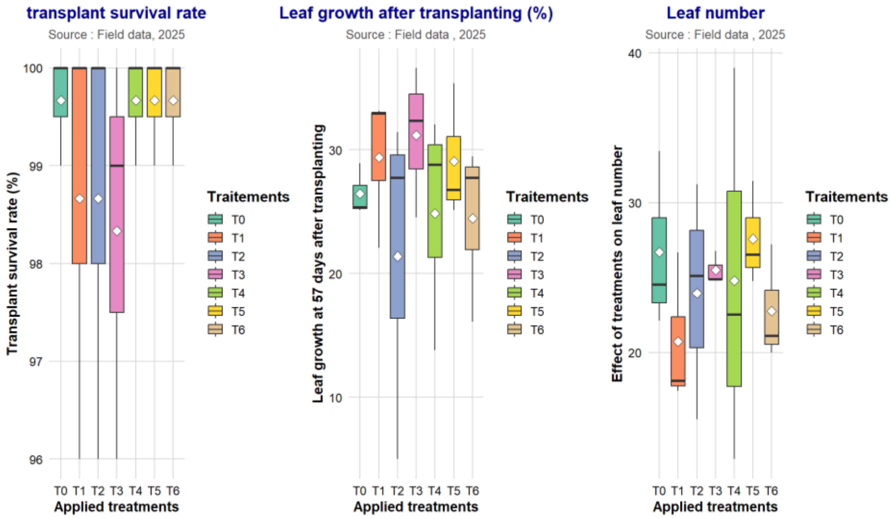

Figure 3 : *Effect of applied treatments on onion leaf number, transplant survival rate, and relative leaf growth rate of plants*

Leaf count is a reliable proxy for assessing vegetative vigor. The number of leaves ***(Figure 3)*** varied significantly among treatments. Treatment T5 (15 t/ha) recorded the highest leaf count (29), indicating enhanced vegetative vigor. Conversely, treatment T1 (Fmv) exhibited the lowest mean leaf number (20.70), despite satisfactory leaf growth, suggesting a tendency toward leaf elongation rather than leaf multiplication.

III-4. Effect of different treatments on the moisture content of chive plants (*Allium schoenoprasum* L.)

The results ***(Figure 4)*** highlight the influence of the applied treatments on the moisture content of chive plants (Allium schoenoprasum L.), with values ranging between 87.3% and 92.4%. The application of 20 t/ha of compost enriched with Trichoderma harzianum (T6) resulted in the highest moisture content, whereas the 10 t/ha dose (T3) recorded the lowest. Although these differences were not statistically significant, the findings suggest that higher organic inputs may contribute to improved water retention in plants.

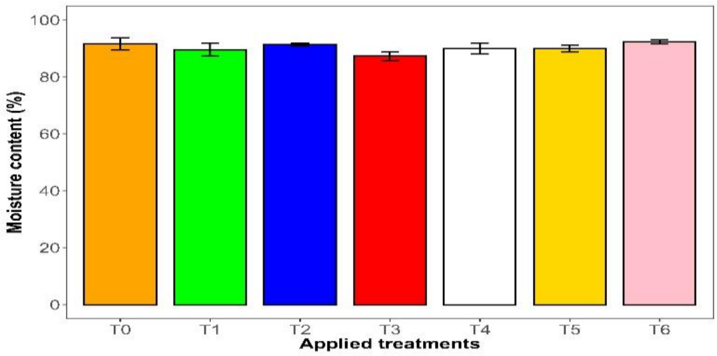

Figure 4 : *Effect of organic treatments on the moisture content of chive plants (Allium schoenoprasum L.)*

III-5. Influence of applied treatments on leaf yield and yield gain in chives (*Allium schoenoprasum* L.)

The results illustrating the influence of organic fertilization on onion leaf yield are presented in Figure 5. Although statistical analysis at the 5% threshold did not reveal significant differences among treatments, certain trends were observed. The highest leaf yield was obtained with treatment T3 (10 t/ha of compost enriched with *Trichoderma harzianum*), reaching 36.63 t/ha. This performance highlights the effectiveness of this biological amendment in enhancing chive productivity, which logically translated into the maximum yield gain (66.6%) for this treatment. In contrast, the conventional mineral fertilization (T1: NPK + urea) recorded the lowest productivity (23.3 t/ha), with a minimal yield gain of 10.04 %.

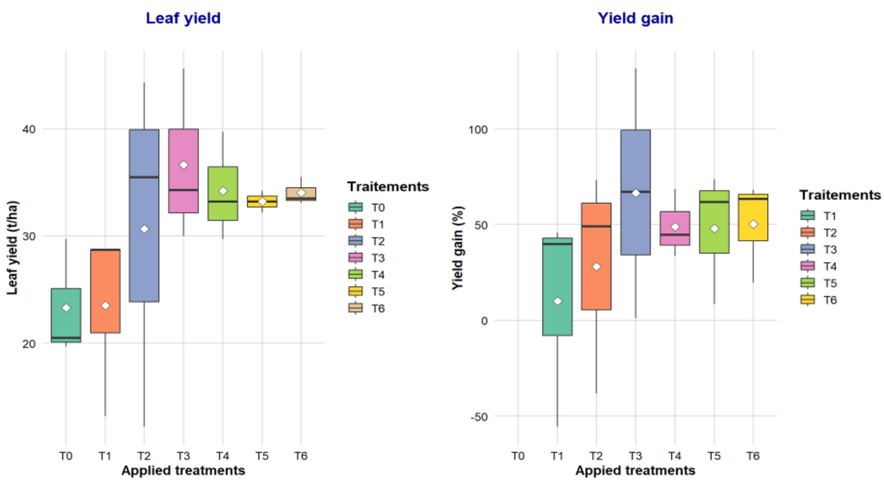

Figure 5 : *Leaf yield and yield gain of chive plants under different treatments*

III-6. Effect of compost enriched with *Trichoderma harzianum* on financial profitability

The financial profitability results are presented in Table 1, highlighting several indicators such as total variable costs, leaf yield, net benefit, Acceptability Index (AI), and Value-Cost Ratio (VCR). The results show that variable costs increased progressively from the control treatment (USD/ha 579,63) to treatment T6 (USD/ha 3 646,72). Analysis of Table 1 indicates that treatment T3 (10 t/ha) generated the highest net benefit (USD/ha 46 861,09), whereas the control (T0) recorded the lowest net benefit (USD.ha^{-1} 30 602,97). When comparing the value-cost ratios, treatment T3 (VCR = 6.57; AI = 1.53) was clearly superior to the other treatments. These findings suggest that treatment T3 (10 t/ha), with its relatively low production cost, could represent a viable alternative to mineral fertilizers, which are often inaccessible to producers. However, from an environmental perspective, the promotion of this technology should take into account the potential acidifying effect of this compost.

Table 1 : *Evaluation of the effectiveness of increasing doses of Trichoderma harzianum enriched compost on the financial profitability of chive cultivation*

Applied Treatments	TVC (USD)	Leaf Yield (t/ha)	Gross Profit (USD)	Net Profit (USD)	AI	VCR
Control	579,63	23,3	3 753,71	30 602,97	-	-
Fmv (NPK + urée)	916,10	23,3	38 300,57	30 640,46	1,00	0,04
5 t.ha^{-1} of CETh	1 672,32	30,67	49 444,35	39 555,48	1,29	5,35
10 t.ha^{-1} of CETh	2 473,64	36,63	5 909,70	46 861,09	1,53	6,57
12,5 t.ha^{-1} of CETh	2 714,25	34,2	54 285,75	43 428,60	1,42	4,73
15 t.ha^{-1} of CETh	2 997,17	33,2	52 336,17	41 868,93	1,37	3,76
20 t.ha^{-1} of CETh	3 646,72	34,03	53 069,95	42 455,96	1,39	3,25

TVC: Total Variable Costs; AI: Acceptability index; VCR: Value cost ratio; Fmv: Recommended mineral fertilization; CETh: Compost enriched with Trichoderma harzianum.

IV - DISCUSSION

Our findings reveal pronounced variability in vegetative growth depending on the applied treatments, as evidenced by differences in plant height, collar diameter, and leaf number. Seedlings receiving *Trichoderma harzianum* enriched compost (CETh) demonstrated superior vigor relative to those fertilized with conventional mineral inputs (NPK + urea). This superiority underscores the biostimulant function of CETh, which not only optimizes nutrient bioavailability but also invigorates microbial activity, thereby reinforcing soil biological fertility and enhancing the overall resilience of the plant canopy [13]. These observations are consistent with Sawadogo [4], who reported synergistic effects in sorghum–cowpea systems under enriched organic fertilization. Similar trends were also observed in the work of Traoré [13], who reported that compost enriched with *Trichoderma harzianum* improved the growth of lettuce plants. The analysis of moisture content demonstrated a clear advantage of treatment T6 (20 t/ha CETh), which attained 92.38%, outperforming both mineral fertilization (91.62%) and the control (89.6%). This improvement suggests that substantial incorporation of CETh enhances the water holding capacity of chive tissues, thereby increasing fresh biomass.

Such findings align with [14], who reported that *Trichoderma* strains contribute to improved water retention and vegetative growth. The analysis of leaf growth dynamics indicates a resurgence of vegetative activity and photosynthetic metabolism. The enhanced performance observed under treatment T3 (10 t/ha) seems to stem from greater bioavailability of essential nutrients. Conversely, the pronounced variability noted under T2 (5 t/ha) could reflect heightened sensitivity to environmental fluctuations or be attributable to physiological stress endured by seedlings during the pre-transplanting stage [15]. The observed increase in leaf number is indicative of intensified vegetative activity and photosynthetic metabolism, which may ultimately result in greater biomass accumulation and improved yield potential. However, the variability recorded under treatment T4 (12.5 t/ha) suggests a positive yet uneven response, possibly arising from complex interactions between the applied treatment and other environmental or physiological factors [14, 16]. The assessment of treatment effects on leaf yield demonstrates the superiority of compost enriched with *Trichoderma harzianum*. At the application rate of 10 t/ha (T3), this treatment achieved the highest yield of 36.63 t/ha, corresponding to a 66.6% increase compared to the other treatments. In contrast, the absolute control (T0) exhibited the lowest productivity, thereby confirming the necessity of fertilization to optimize chive cultivation [17, 18]. These findings corroborate the results of Woo [19, 20], who reported that fertilizer application significantly enhances harvestable biomass. Soil amendment thus emerges as an essential driver of agronomic performance [21, 22]. Financial evaluation of profitability reveals that treatment T3 (10 t/ha of CETh) performed best, achieving a Value-Cost Ratio (VCR = 6.57) and an Acceptability Index (AI = 1.53). Such performance supports its recommendation to producers. However, consistent with prior research, an AI ranging from 1.5 to 2 denotes a profitable technology, though adoption should be approached with caution [7, 8, 23]. Higher doses (T4, T5, and T6) produced lower yields and reduced net returns relative to T3, primarily due to elevated production costs. These results underscore that the optimal application rate of 10 t/ha maximizes profitability, whereas excessive inputs increase costs without delivering proportional productivity benefits.

V - CONCLUSION

The study conducted on the productivity of chives (*Allium schoenoprasum* L.) demonstrates that the use of compost enriched with *Trichoderma harzianum* (CETh) represents a major agronomic lever. The results highlight a significant improvement in vegetative growth and plant water content, particularly at application rates of 15 and 20 t/ha. However, the techno-economic analysis reveals that treatment T3 (10 t/ha) provides the highest profitability, with a leaf yield of 36.63 t/ha, a net profit of USD 46 861,09, a Value-Cost Ratio (VCR) of 6.57, and an Acceptability Index (AI) of 1.53. This moderate dosage thus appears to be the techno-economic optimum, maximizing productivity while ensuring the financial viability of the crop. These findings confirm the effectiveness of CETh as a sustainable alternative or complement to conventional mineral fertilization. By stimulating microbial activity and enhancing nutrient bioavailability, this biostimulant not only strengthens productivity but also improves the water resilience of horticultural systems.

REFERENCES

[1] - K. A. KOUAMÉ, A. E. L. ÉBA, D. SERGE KOUAKOU, B. F. DÉABO et K. DONGO, *Revue Ivoirienne des Sciences et Technologie*, 45 (1) (2025) 88 - 105. DOI: https://www.revist.net

[2] - J. SAWADOGO, P. J. D. A. COULIBALY, F. J. BAMBARA, A. C. SAVADOGO, E. COMPAORE et J. B. LEGMA, *Afrique SCIENCE*, 17 (6) (2020) 44 - 57. DOI: http://www.afriquescience.net

[3] - J. SAWADOGO, R. F. W.-P. KABORE, A. OUIYA, C. A. SAVADOGO, M. BOUGOUMA et J. B. LEGMA, *Afrique SCIENCE*, 25 (4) (2024) 15 - 24. DOI: http://www.afriquescience.net

[4] - J. SAWADOGO, S. B. SANON, H. F. M. KABORÉ, N. OUADRAOGO, A. COULIBALY et H. DIALLO, *Revue Ivoirienne des Sciences et Technologie*, 46 (1) (2025) 34 - 49. DOI: http://www.revist.ci

[5] - J. SAWADOGO, P. J. D. A. COULIBALY, M. BEOGO, C. A. SAVADOGO et J. B. LEGMA, *International Journal of Innovation and Applied Studies*, 35 (2) (2022a) 249 - 259. DOI: http://www.ijias.issr-journals.org/

[6] - J. SAWADOGO, H. F. M. KABORE, M. TRAORE, S. B. SANON, S. FOUSSENI et A. COULIBALY, *Afrique SCIENCE*, 27 (1) (2025) 66 - 78. DOI: http://www.afriquescience.net

[7] - J. SAWADOGO, P. J. D. A. COULIBALY, B. TRAORE, M. S. D. BASSOLE, C. A. SAVADOGO et J. B. LEGMA, *Journal of Applied Biosciences*, 167 (1) (2021) 17375 - 17390. DOI: https://doi.org/10.35759/JABs.167.8

[8] - F. KAHO, M. YEMEFACK, P. FEUJIO-TEGUEFOUET et J. TCHANTCHAOUANG, *Tropicultura*, 29 (1) (2011) 39 - 45

[9] - M. A. KITABALA, U. J. TSHALA, M. A. KALENDA, I. M. TSHIJIKA et K. M. MUFIND, *Journal of Applied Biosciences*, 102 (1) (2016) 9669 - 9679. DOI: http://dx.doi.org/10.4314/jab.v102i1.1

[10] - R. V. DIOGO et T. BIGNON, *Annales de l'Université de Parakou-Série Sciences Naturelles et Agronomie*, 9 (1) (2019) 133 - 140

[11] - U. S. YANNICK, B. L. LOUIS, N. K. LUCIENS, M. MUBEMBA. *Journal of Applied Biosciences*, 54 (2012) 3935 - 3943

[12] - K. KONAN, A. SÉVERIN, Y. WONGBÉ, D. SÉKOU, K. K. EUGÈNE, K. N. ALPHONSE, K. BOAKÉ et S. DIABATÉ. *European Scientific Journal*, 10 (18) (2014). DOI: Site université Felix Houphouet Boigny

[13] - O. TRAORÉ, A. R. OUÉDRAOGO, D. M. GUEBRÉ, I. WONNI et I. SOMDA, *Sciences Naturelles et Appliquées*, 42 (2 (1)) (2023) 167 - 178

[14] - B. MOURIA, A. OUAZZANI-TOUHAMI et A. DOUIRA. *Phytoprotection*, 88 (3) (2007) 103 - 110. DOI: https://doi.org/10.7202/018955ar
[15] - A. R. OUÉDRAOGO, F. C. KAMBIRÉ, R. A. ISOLA, R. H. NÉBIÉ et I. SOMDA, *Sciences Naturelles et Appliquées*, 39 (2 (2)) (2020) 12 - 12
[16] - M. BTISSAM, O. T. AMINA et D. ALLAL, *Journal of Applied Biosciences*, 70 (1) (2013) 5531 - 5543. DOI: https://dx.doi.org/10.4314/jab.v70i1.98751
[17] - Y.-C. CHANG, Y.-C. CHANG, R. BAKER, O. KLEIFELD et I. CHET, *Plant Disease*, 70 (2) (1986) 145 - 148. DOI: 10.1094/-70 - 145
[18] - R. MCGOVERN, L. DATNOFF et L. TRIPP, Effect of mixed infection and irrigation method on colonization of tomato roots by Trichoderma harzianum and Glomus intraradix. in Proceedings of the Florida State Horticultural Society, 105 (1992) 361 - 363
[19] - L. W. SHERIDAN, R. MICHELINA, V. FRANCESCO, N. MARCO, M. ROBERTA, L. NADIA, P. ALBERTO, L. STEFANIA, M. GELSOMINA et M. MATTEO, *The Open Mycology Journal*, 8 (1) (2014) 71 - 126
[20] - M. FRIDLENDER, J. INBAR, I. CHET. *Soil biology and Biochemistry*, 25 (9) (1993) 1211 - 1221. DOI: https://doi.org/10.1016/0038-0717(93)90217-Y
[21] - L. ZIDANE, Étude des groupements messicoles dominés par l'avoine stérile (Avena sterilis L. spp. macrocarpa Mo.) dans quelques régions du Maroc occidental et de la compétitivité de cette adventice vis-à-vis du blé dur, Thèse de doctorat: Université Ibn Tofail, Faculté des Sciences, Kénitra (Maroc), 178 p.
[22] - Z. J. SHAIKH, Cloning and characterization of endoglucanase genes from *Trichoderma* spp, Department of biotechnology, University of Agricultural Sciences, 131 p.
[23] - J. SAWADOGO, W. N. A. E. SIMPORE, S. B. SANON, U. S. ZABSONRE, F. SOMA et E. M. W.-D. NANA, *Afrique SCIENCE*, 26 (6) (2025b) 65 - 76. DOI: http://www.afriquescience.net