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EVALUATION OF THE INFLUENCE OF NITROGEN SOURCES ON THE GROWTH CHARACTERISTICS AND CULTURAL-MORPHOLOGICAL CHARACTERS OF *Triangularia setosa* AND *Sordaria fimicola* IN CULTURE

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The study of coprophilous ascomycetes is highly relevant due to their biotechnological potential, including metabolite production, biodegradation, and roles in nutrient cycling.

Aim. The introduction of *Triangularia setosa* and *Sordaria fimicola* into culture, as well as the evaluation of the effects of nitrogen sources on their growth characteristics and cultural-morphological traits.

Methods. The moist chamber method was used to detect and obtain fruiting bodies of ascomycetes. Mycelial cultures were isolated from the obtained ascocarps. Colonies were cultivated on solid agar media to assess the impact of nitrogen sources on radial growth rate and morphological characteristics. Cultural and morphological features of the mycelial colonies were described according to the classification by J.A. Stalpers.

Results. For the first time, it was found that morphogenesis and growth of *T. setosa* and *S. fimicola* significantly depend on the type of nitrogen source, which is manifested in the growth rate, expressed morphological, and strain-specific variability.

Conclusions. The revealed sensitivity to the nitrogen regime indicates these species' potential as models for studying adaptive mechanisms of metabolic regulation in coprophilous ascomycetes.

Key words: coprophilous ascomycetes, *Triangularia setosa*, *Sordaria fimicola*, nitrogen sources, cultural characteristics, morphological traits.

The unique biological and biosynthetic properties of dikaryotic fungi (Ascomycota and Basidiomycota) underpin their extensive application in modern biotechnology, pharmacology, and biomedicine. Research on their chemical composition aims to develop valuable food products, therapeutic and prophylactic agents, and isolated natural biologically active substances [1]. While the significance of dikaryotic fungi in modern biotechnology and medicine is undeniable, research in Ukraine on their morpho-physiological characteristics predominantly focuses on Basidiomycetes [2–4]. In contrast, Ascomycetes, particularly Sordariomycetes, remain underexplored despite their ability to synthesize a wide range of biologically active compounds [5]. Among Sordariomycetes, coprophilous species are especially noteworthy. Their specialized substrate and competition

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for limited coprophilous resources drive their high synthetic activity and the production of a diverse array of substances [6–8].

Coprophilous fungi are convenient objects for studying the organization of natural fungal communities [9] and are used as models in molecular and genetic studies (*Triangularia anserina* (Rabenh.) X. Wei Wang & Houbraken, *Sordaria fimicola* (Roberge ex Desm.) Ces. & De Not., *S. macrospora* Auersw.) [10–13]. Some species (*Chaetomium globosum* Kunze [14], *Coniochaeta ligniaria* (Grev.) Cooke [15], *Saccobolus saccoboloides* (Seaver) Brumm.) [16–17] produce cellulolytic enzymes, while others (*Coniochaeta ellipsoidea* Udagawa, *Hypocopra rostrata* Griffiths, *Neurospora intermedia* F.L. Tai, *N. pannonica* J.C. Krug & R.S. Khan, *Sordaria alcina* N. Lundq., *Sporormiella australis* (Speg.) S.I. Ahmed & Cain, etc.) exhibit antibiotic and antimycotic activity [18–24].

In many countries, highly productive strains of various species of coprophilous pyrenomycetes, particularly those belonging to the order Sordariales, have been studied extensively [5, 16, 17, 25]. Recently, scientific interest in coprophilous species from such leading genera of this order as *Sordaria* Ces. & De Not. and *Podospora* s.l. (sensu lato) like promising producers of biologically active compounds with various properties [26–36]. It should be noted that in many biotechnological studies, the genus *Podospora* is given in a broad sense (s.l.) and includes not only phylogenetically confirmed species but also related taxa that were excluded from this genus in recent taxonomic studies, for example, *Rhypophila* Y. Marín, A.N. Mill. & Guarro and *Triangularia* Boedijn [37, 38]. Species belonging to these genera are often cited under synonymous names [27, 31, 33, 34, 39].

Species of the genus *Podospora* s.l. are known to produce secondary metabolites with antimicrobial, cytotoxic, and antioxidant properties. Notably, several new anthracene derivatives and other aromatic compounds have been identified in *Triangularia anserina* (syn. *Podospora anserina* (Rabenh.) Niessl), exhibiting significant antibiotic activity against Gram-positive bacteria, including *Staphylococcus aureus* Rosenbach and *Bacillus subtilis* (Ehrenberg) Cohn [40]. Polyketide derivatives were also found in cultures of this species, exhibiting cytotoxic activity against cancer cell lines [5]. Some isolated metabolites of *T. anserina* demonstrated the ability to inhibit enzymes involved in inflammatory processes, highlighting their potential as anti-inflammatory agents [41]. In addition, oxylipins (octane oxyacids) were identified in this species. These molecules, synthesized under the action of cyclooxygenases and lipoxygenases, perform a protective function in *T. anserina*. They are released as volatile organic compounds that repel nematodes, aiding the species to survive in competitive environments [42]. Three furanones were obtained from cultures of another species, *Podospora appendiculata* (Auersw.) Niessl, which showed antibiotic and antimycotic activity. Two new tetracyclic sesquiterpene lactones were isolated from cultures of *Rhypophila decipiens* (G. Winter) Y. Marín, A.N. Mill. & Guarro (syn. *Podospora decipiens* Niessl), which exhibited antimycotic activity [27]. Cultures of *Rhypophila pleiospora* (G. Winter) Y. Marín, A.N. Mill. & Guarro (syn. *Podospora pleiospora* (G. Winter) Niessl) in liquid medium synthesized sordarins, diterpene glycosides that showed minimal inhibitory concentrations against yeast [27, 33].

Fungi of the genus *Sordaria* are recognized for their ability to biosynthesize various secondary metabolites with antimicrobial and immunosuppressive properties. Numerous novel and unique secondary metabolites have been identified in these species. For instance, cyclosordariolone, isolated from *S. macrospora*, demonstrated antimicrobial activity against *Bacillus subtilis*, *Pseudomonas agarici* Young, and *Micrococcus luteus* (Schroeter) Cohn [5]. Moreover, sordariol dimers synthesized by *S. macrospora* exhibited radical-scavenging activity against ABTS radicals [43] and demonstrated antioxidant properties [35]. Additionally, dioxopiperazine-type constituents isolated from *S. goundaensis* were characterized by significant immunosuppressive activity [29].

The present study aimed to introduce *Triangularia setosa* and *Sordaria fimicola* into culture and to evaluate the impact of various nitrogen sources on their growth characteristics and their cultural and morphological traits.

Material and Methods

The study utilized pure cultures of two coprophilous ascomycetes: *Triangularia setosa* (4 strains) and *Sordaria fimicola* (3 strains).

The fungal cultures were isolated from the feces of animals from diverse geographical origins. These were collected from natural

Table 1

List of studied strains of *Sordaria fimicola* and *Triangularia setosa* and their origin

Strain	Geographical origin of the strain
Sordaria fimicola	
Sfim 01	Sumy Region, Sumy District, vicinity of the village Nyzy, on goat feces, 28 March 2015, 50°45′33.9″N, 34°45’22.6″E.
Sfim 03	Sumy Region, Shostka District, vicinity of the Znob-Novhorodske settlement, Desna-Stara Huta National Nature Park, on hare feces, 16 July 2015, 52°20′31.4″N, 33°49′51.3″E.
Sfim 05	Sumy Region, Okhtyrka District, vicinity of the village Khukhra village, Hetmanskyi National Nature Park, on cow feces, 20 September 2015, 50°12′22.8″N, 34°47′06.0″E.
Triangularia setosa	
Pset 01	Sumy Region, Sumy District, vicinity of the Nyzy village, on cow feces, 28 March 2015, 50°45′33.9″N 34°45′22.6″ E.
Pset 02	Sumy Region, Sumy District, vicinity of the Nyzy village, on roe deer feces, 28 March 2015, 50°45′25.2″ N 34°45′18.5″E.
Pset 03	Sumy Region, Shostka District, vicinity of the Znob-Novhorodske settlement, Desna-Stara Huta National Nature Park, on hare feces, 16 July 2015, 52°20′31.4″N, 33°49′51.3″E.
Pset 04	Sumy Region, Okhtyrka District, vicinity of the Yamne village, Hetmanskyi National Nature Park, on horse feces, 27 June 2015, 50°25′23.2″N, 35°23′41.0″E.

habitats at various locations within the Sumy region (Table 1).

The Petri dish moist chamber method, as described by W. S. Keyworth [44], was employed to facilitate the formation of fruiting bodies in coprophilous ascomycetes. This method is effective because it replicates stable and favorable conditions, particularly maintaining consistent substrate humidity necessary for the development and maturation of ascomata.

Mycelial cultures were isolated from ascomata following established protocols [45]. Healthy, mature fruiting bodies were aseptically transferred over a flame (spirit lamp) to Petri dishes containing PGA (Potato Glucose Agar). The PGA medium had the following composition (g/L, pH 7.6): filtered potato broth — 1000; glucose — 20; cellulose — 5; agar — 40. Petri dishes were incubated in a thermostat at 26 ± 1 °C until visible mycelial growth appeared. After 2–3 successive passages, cultures were subcultured into test tubes with PGA and stored at 4 °C in a refrigerator. Cultures were maintained by subculturing on PGA every three months.

To study the effect of nitrogen sources on growth and morphology, an agarized glucose-aspartic acid (GAA) nutrient medium with the following composition (g/L, pH 7.5) was used: L-asparagine — 0.4; glucose — 10.0; KH_2PO_4 — 1.0; $MgSO_4 \cdot 7H_2O$ — 0.5; agar — 40.0; distilled water — up to 1000 ml. To investigate nitrogen nutrition, the medium was modified by replacing asparagine with alternative nitrogen sources: peptone, urea, and ammonium sulfate. The quantity of each compound was calculated to ensure an equivalent elemental nitrogen content of 0.085 g/L, matching that provided by 0.4 g/L of asparagine. The corresponding concentrations were as follows: peptone — 0.6 g/L (pH 7.8); urea — 0.18 g/L (pH 7.16); ammonium sulfate — 0.4 g/L (pH 6.58).

To determine the growth rate, discs of vegetative mycelium with a diameter of 10 mm were aseptically cut using a sterile steel tube at a distance of 8–10 mm from the edge of an actively growing colony. The discs were placed in the center of Petri dishes containing the respective growth media. Cultures were incubated at 26 ± 1 °C. To calculate the average radial growth rate (VR, mm/day), the colony mycelium radius was plotted against cultivation time on media of different compositions. During the phase where the radius increased linearly with time, the average growth rate (mm/day) was calculated using the formula:

$$V_R = \frac{R_1 - R_v}{t_1 - t_0},$$

where R_1 is the colony radius at the end of the growth period, mm; R_0 is the colony radius at the start of the linear growth phase, mm; $t_1 - t_0$ is the duration of the linear growth

phase, days. The colony radius was measured in two mutually perpendicular directions at regular time intervals until the Petri dish was completely overgrown. Experiments were conducted in five replicates.

Statistical analyses were performed using Excel statistical functions in Microsoft Office XP, version 11.5 (SPSS, Inc., 2002). Data are presented as mean ± standard error of the mean (SEM). Differences with $p \leq 0.05$ were considered statistically significant.

All Latin names of fungi and their author citations mentioned in the article are provided in accordance with the taxonomy database "Index Fungorum" (http://www.indexfungorum.org/, accessed on 15.06.2025).

Results and Discussions

Despite the specific ecological habitat of coprophilous ascomycetes, the isolates obtained were relatively easy to isolate and establish in culture. From 10 samples, three strains of *Sordaria fimicola* (Sfim 01, 03, 05) and four strains of *Triangularia setosa* (Pset 01–04) were successfully isolated. The PDA medium proved favorable for both culturing and growth of the studied micromycetes, consistent with previous reports in the literature [47–49].

In research on coprophilous ascomycetes, one of the primary and most critical stages is the identification of highly productive strains. This process involves not only their successful isolation but also the establishment of reproducible growth characteristics and stable culture maintenance. Particular emphasis is placed on detailed studies of physiological and morphological parameters, such as growth kinetics and colony morphology, which can vary depending on the composition of the culture medium. Among the key factors influencing the cultivation of higher fungi, the nitrogen source in the culture medium plays a pivotal role. Nitrogen-containing compounds are fundamental constituents of proteins, which serve as essential structural and functional components of the cell. For fungi incapable of fixing atmospheric nitrogen, nitrogen is assimilated exclusively in the form of inorganic salts (e.g., ammonium, nitrate) or organic compounds (e.g., amino acids, peptides, urea). Coprophilous fungi colonizing nitrogen-rich substrates, such as animal dung, exhibit specific adaptations to different available nitrogen forms. Therefore, the selection of nitrogen sources and evaluation of their effects on growth, morphogenesis, and sporulation are crucial for understanding the nuances of their nitrogen metabolism, mechanisms of ecological adaptation, and for optimizing conditions for laboratory and industrial cultivation.

The experimental results revealed the nitrogen requirements of the studied *Sordaria fimicola* strains (Fig. 1). Overall, all strains of *S. fimicola* utilized ammonium sulfate relatively well, exhibiting growth rates exceeding 10 mm/day. The maximum growth rate for strains Sfim01 and Sfim03 was achieved in the presence of urea in the nutrient medium, whereas strain Sfim05 showed the highest growth with ammonium sulfate. Notably, strain Sfim03 demonstrated the ability to assimilate a wide range of nitrogen sources, showing active growth on media containing all tested compounds.

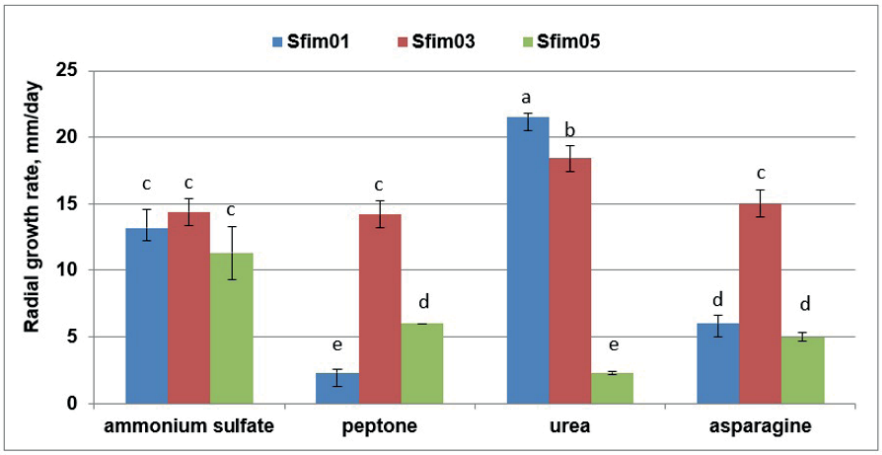

Fig. 1. **Growth rate of *Sordaria fimicola* strains in relation to different nitrogen sources**

Different lowercase letters above bars indicate significant differences in growth rates ($P \leq 0.05$) between strains within each nitrogen source. Strains sharing the same letter are not significantly different, while strains with different letters show statistically significant differences.

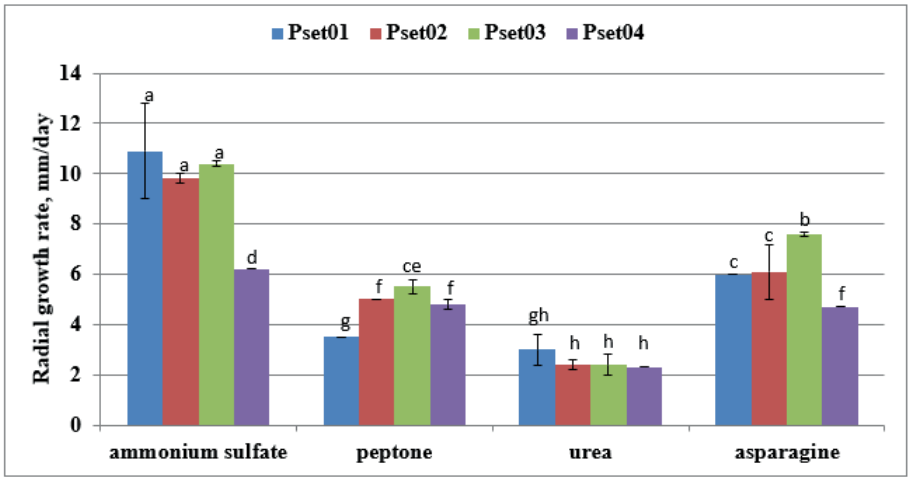

Fig. 2. **Growth rate of *Triangularia setosa* strains in relation to different nitrogen sources**

Different lowercase letters above bars indicate significant differences in growth rates ($P \leq 0.05$) between strains within each nitrogen source. Strains sharing the same letter are not significantly different, while strains with different letters show statistically significant differences.

Table 2

Effect of peptone concentration on the growth rate of *Sordaria fimicola* and *Triangularia setosa* strains

Strain	Peptone concentration	
	0.6 g/L	3.0 g/L
Sordaria fimicola		
Sfim01	2.3±0.3*	12.7±0.3*
Sfim03	14.2±0.1	11.9±0.6
Sfim05	6.0±1.0*	3.5±0.0*
Triangularia setosa		
Pset01	3.5±0.1*	1.3±0.1*
Pset02	5.0±0.0*	1.4±0.3*
Pset03	5.5±0.3*	1.6±0.1*
Pset04	4.8±0.2*	1.3±0.4*

Notes: The symbol * indicate statistically significant difference at the 0.05 level ($P \leq 0.05$).

Furthermore, for efficient biomass accumulation of this strain, ammonium sulfate presents an economically viable alternative to more costly nitrogen sources such as peptone and urea.

Strains of *T. setosa*, in contrast to those of *S. fimicola*, exhibited similar physiological requirements (Fig. 2). They assimilated inorganic nitrogen sources more effectively than organic ones. The highest radial growth rates for all studied *T. setosa* strains were observed when ammonium sulfate was used as the nitrogen source. Conversely, the poorest growth across all strains occurred in the presence of urea as the sole nitrogen source. Among the studied sources of organic nitrogen, it was found that for some strains, peptone and asparagine are functionally equivalent; that is, they can replace for each other as a nitrogen source (in particularly for Pset02 and Pset04 strains).

The observed differences in the growth of *S. fimicola* strains on urea and *T. setosa* strains on ammonium sulfate can be attributed to several factors. It is likely that the Sfim01 and Sfim03 strains possess a highly efficient urease enzyme for urea hydrolysis, whereas the Pset01 and Pset03 strains are better adapted for direct ammonia assimilation. Additionally, variations in the regulatory mechanisms governing the

expression of genes responsible for nitrogen metabolism [50] are likely to exist among the strains. The coprophilous fungal strains examined are functionally heterotrophic, attributable to their metabolic flexibility in exploiting diverse nitrogen sources. They assimilate both organic compounds and inorganic forms, particularly ammonium (NH_4^+), thereby accessing a broad spectrum of nitrogen substrates. These fungi colonize animal excrement, deploying a suite of enzymes to degrade complex organic matter (cellulose, lignin, undigested residues, nitrogenous compounds) and acquire essential carbon and nitrogen. Differences in growth rates among strains arise not from an inability to utilize specific nitrogen forms, but from variation in the efficiency and temporal dynamics of adaptive enzyme system activation. Given that peptone is one of the most common and versatile sources of organic nitrogen in culture media, a series of experiments was conducted to investigate the effect of its concentration in the culture medium on the growth of strains from both species (Table 2). Peptone contains a complex mixture of amino acids and short peptides, making it a valuable substrate for assessing the metabolic flexibility of organisms. Including peptone in the study provides insights into the strains' ability to assimilate complex organic compounds, which is essential for understanding their adaptation to various natural substrates.

The analysis of the effect of peptone on the growth of three strains (*S. fimicola*: Sfim01, Sfim03, Sfim05) revealed pronounced variability in their responses to changes in peptone concentration. Notably, for strain Sfim01, a significant increase in growth, approximately 5.5-fold, was recorded when the peptone concentration was increased from 0.6 to 3.0 g/L. In contrast, strains Sfim03 and Sfim05 exhibited slight decreases in growth under similar conditions, by approximately 1.2-fold and 1.7-fold, respectively. These findings highlight the individual physiological plasticity of *S. fimicola* strains in adapting to different concentrations of organic nitrogen sources, likely due to unique regulatory mechanisms of nitrogen metabolism. In contrast, all studied *T. setosa* strains (Pset01, Pset02, Pset03, and Pset04) displayed a marked decrease in growth intensity as peptone concentrations increased from 0.6 to 3.0 g/L. Specifically, the growth of strain Pset01 decreased by 2.7-fold, Pset02 by 3.6-fold, Pset03 by 3.4-fold, and Pset04 by 3.7-fold. These results indicate that *T. setosa* strains are considerably more sensitive to elevated peptone concentrations than *S. fimicola*, especially to strain Sfim01. The observed growth inhibition in *T. setosa* strains underscores their specific physiological responses to high concentrations of organic nitrogen, which may involve the limitation or suppression of adaptive enzyme systems under such conditions.

In addition to quantitative growth parameters, changes in colony morphology represent an essential aspect of strain adaptation to different nitrogen sources. An analysis of the morphological and cultural features of mycelial colonies in the studied *T. setosa* and *S. fimicola* strains, cultivated on nutrient media with different nitrogen sources, identified several morphological characteristics of the mycelial colonies based on J. A. Stalpers' classification [46]. The following morphotypes were distinguished:

1) Woolly: The colony surface is characterized by relatively long, interwoven hyphae or groups of hyphae from the aerial mycelium, somewhat tangled together and resembling woolen fabric. This morphotype was observed in strains of both species: *S. fimicola* (Fig. 3, *A*) and *T. setosa* (Fig. 3, *D*);

2) Cottony: The colony surface is marked by a rather tall aerial mycelium, with individual hyphae spreading and intertwining in multiple directions. Over time, small, cotton-like nodules may form on the mycelial surface. This morphotype was observed exclusively in *T. setosa* (Fig. 3, *E*);

3) Felty: The colony surface consists of a dense aerial mycelium that initially appears cottony or woolly but becomes matted or compressed over time. It is composed of short, tangled hyphae without tall aerial hyphae, and emergent hyphae are absent. This morphotype was observed in strains of both species: *S. fimicola* (Fig. 3, *B, C*) and *T. setosa* (Fig. 3, *F*).

In addition, the characterization of the cultural and morphological traits of the strains included an assessment of colony density, surface relief, margin morphology, reverse color, and the presence or absence of exudate. These characteristics hold diagnostic significance as they reflect the physiological and biochemical properties of microorganisms, facilitating more precise strain identification and comparative analysis. The experimental results demonstrated a clear dependence of morphotypes, colony density, surface relief, and margin morphology of the studied strains from both species on the composition of the growth medium (Fig. 4).

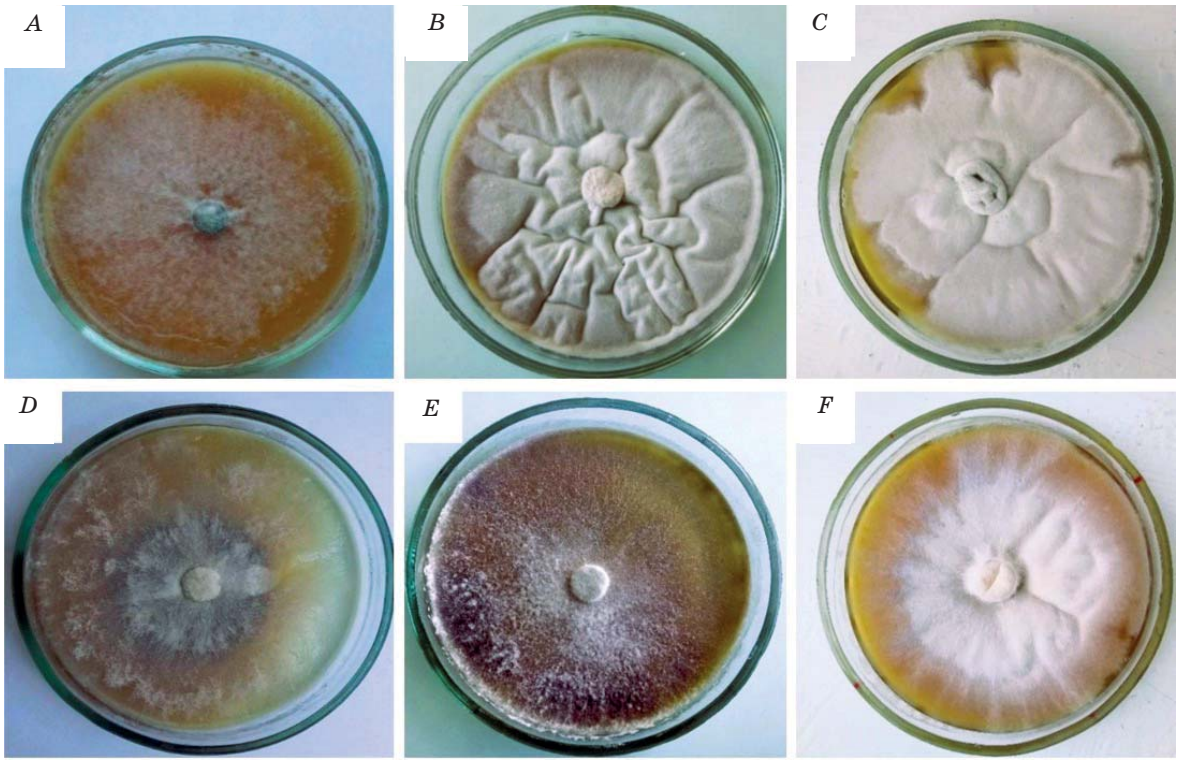

Fig. 3. **Morphological forms of mycelial colonies.**
Sordaria fimicola: A — woolly on peptone medium; *B* — felty on urea medium; *C* — felty on ammonium sulfate medium;
Triangularia setosa: *D* — woolly on peptone medium; *E* — cottony on urea medium; *F* — felty on ammonium sulfate medium.

For both species, colony morphotypes varied depending on the nitrogen source, with *T. setosa* exhibiting greater morphological plasticity. Colonies of *S. fimicola* strains predominantly displayed woolly or felty morphologies across all media (Fig. 4, *A*). In contrast, the studied *T. setosa* strains demonstrated greater variability: in addition to woolly and felty morphotypes, cottony colonies were observed when urea was used, indicating a specific response of this species to that nitrogen source (Fig. 4, *B*). Notably, the felty morphotype predominated in both species (Fig. 4, *A, B*).

A common feature of both species is the variation in colony density depending on the nitrogen source, with moderate-density colonies predominating overall. Denser colonies were observed in the presence of ammonium sulfate, suggesting efficient assimilation of this inorganic nitrogen source (Fig. 4, *C, D*). Notably, asparagine facilitated a broader range of colony densities in *T. setosa*, ranging from dense to sparse. This finding underscores the high metabolic plasticity of this species and its variable response to the availability of an organic nitrogen source.

The surface relief of the colonies also varied depending on the type of nitrogen source used. Smooth colony surfaces predominated across both species (Fig. 4, *E, F*). However, wrinkled or grooved colony morphotypes were also frequently observed, which may reflect increased metabolic activity of the mycelium in response to readily absorbed nitrogen sources. Readily available nitrogen compounds are rapidly integrated into the primary metabolism of hyphal cells, particularly via the glutamine synthetase pathway, which stimulates intensive biomass accumulation [51, 52]. This intensified growth often results in an uneven distribution of hyphae and the layering of cellular structures, morphologically expressed as wrinkled or grooved colony surfaces. Furthermore, significant compaction of the mycelial mass may induce localized changes in the colony's microenvironment, such as reduced access to oxygen or nutrients in deeper layers. These conditions could trigger compensatory morphogenetic responses, including structural reorganization of the colony surface, to maintain functional activity [53].

The colony margin morphology of the studied cultures also depended on the nitro-

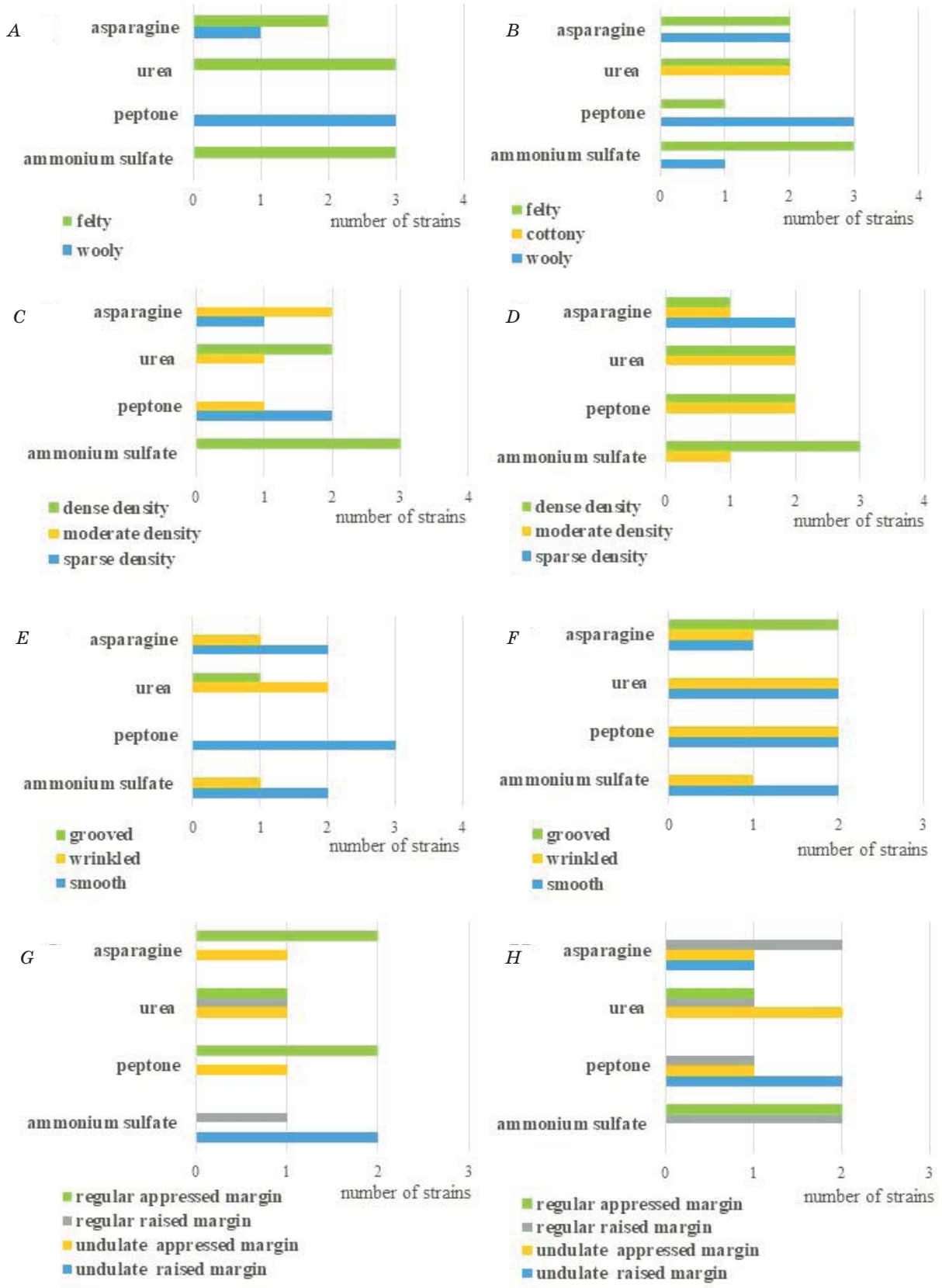

Fig. 4. **Effect of different nitrogen sources on the cultural and morphological characteristics of colonies of *Sordaria fimicola* (*A, C, E, G*) and *Triangularia setosa* (*B, D, F, H*):** *A, B* — colony morphotype; *C, D* — colony density; *E, F* — surface relief of colonies; *G, H* — colony margin morphology.

gen source used. For *S. fimicola* strains, an appressed margin predominated (Fig. 4, *G*). This may indicate coordinated hyphal branching at the colony periphery, with limited extension of free hyphae beyond the growth front. Such a margin type is often characteristic of fungi with lower hyphal plasticity or a tendency toward internal consolidation of the mycelium [51, 52]. Conversely, most strains of *T. setosa* predominantly exhibited a raised margin (Fig. 4, *H*), reflecting active vertical hyphal growth and a preference for apical growth over lateral branching. This morphology creates a gently raised or undulating margin and may be associated with species-specific features of peripheral hyphal differentiation or reduced coordination among hyphae at the peripheral zone of the colony [53].

The study revealed the presence of exudate on the surface of mycelial colonies, an important feature for assessing their cultural and morphological traits. In *S. fimicola* strains, exudate was observed exclusively on ammonium sulfate medium between days 12 and 15. In contrast, for *T. setosa* strains, exudate was more widespread, appearing across the entire colony surface: on ammonium sulfate medium between days 7 and 20, and on urea medium between days 16 and 18. On asparagine medium, exudate formation was rare, occurring only in strain Pset04, where it was localized at the colony center. No exudate formation was observed in any *T. setosa* strains on peptone medium.

The study identified characteristic colony reverse color, which complements the overall cultural and morphological traits of the studied species. Changes in the reverse of colonies were observed in both species across all media. In *S. fimicola*, the colony reverse predominantly turned black, with changes occurring between days 3 and 5, and on ammonium sulfate medium — between days 10 and 12. In *T. setosa*, the reverse colony color shifted to dark brown or black-brown, primarily between days 3 and 7, while on urea medium, the change was observed later, between days 13 and 14.

Overall, these findings align with previous research indicating that nitrogen sources in nutrient media influence both the growth and morphological traits of various fungal species [54–56].

Conclusions

This study demonstrated, for the first time under artificial culture conditions, that the morphogenesis and growth rate of *Triangularia setosa* and *Sordaria fimicola* colonies are significantly influenced by the source of nitrogen source in the culture medium. Both species exhibited notable morphological plasticity in response to varying nitrogen sources, with clear strain-specific responses to organic and inorganic forms. The results indicate a high sensitivity to nitrogen composition, manifested in variations in growth rates and colony morphology. These findings highlight intraspecific variability likely rooted in genetic differences, reflecting adaptive mechanisms regulating physiological and biochemical processes within the Sordariaceae family.

Nitrogen sources affected morphological traits such as colony morphotypes, density, surface texture, edge structure, and pigmentation. These characteristics can serve as diagnostic features for strain identification and indicators of ecological plasticity. Compared to *S. fimicola*, *T. setosa* exhibited greater morphological variability, suggesting distinct adaptive strategies to nitrogen nutrition.

The data obtained expand current knowledge of the trophic sensitivity of coprophilous ascomycetes and provide a foundation for in-depth studies of nitrogen metabolism, morphogenesis regulation, and secondary metabolism in fungi. The observed sensitivity to nitrogen availability underscores the potential of these species as model organisms for investigating adaptive mechanisms of metabolic regulation in coprophilous ascomycetes. Exploring the molecular genetic basis of these strain-specific responses, alongside their prospective applications in biotechnology and applied soil mycology, holds considerable promise.

Author contributions

L.Y.I., S.M. and K.T.A. conceptualized, designed the study, analyzed the data, and drafted the manuscript. The experimental part was performed by L.Y.I. All authors participated in the editing of the manuscript and approved the final version for submission.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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ОЦІНКА ВПЛИВУ ДЖЕРЕЛ АЗОТУ НА РОСТОВІ ХАРАКТЕРИСТИКИ ТА КУЛЬТУРАЛЬНО-МОРФОЛОГІЧНІ ОЗНАКИ *Triangularia setosa* ТА *Sordaria fimicola* У КУЛЬТУРІ

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Вивчення копрофільних аскоміцетів є надзвичайно актуальним завдяки їхньому біотехнологічному потенціалу, включаючи продукування біологічно активних метаболітів, біодеградацію та роль у кругообігу поживних речовин.

Мета. Інтродукція *Triangularia setosa* та *Sordaria fimicola* в культуру, а також оцінка впливу джерел азоту на їхні ростові характеристики та культурально-морфологічні ознаки.

Методи. Для виявлення та одержання плодових тіл аскоміцетів було використаний метод вологих камер, міцеліальну культуру виділяли з одержаних аском грибів. Культивування колоній для оцінки впливу джерел азоту на швидкість радіального росту та морфологічні ознаки проводилося на твердих агаризованих середовищах. Культуральні та морфологічні характеристики міцеліальних колоній описані за класифікацією Дж. А. Сталперса.

Результати. Уперше встановлено, що морфогенез і ріст *T. setosa* та *S. fimicola* суттєво залежать від джерела азоту, що проявляється у швидкості росту, вираженій морфологічній та штамоспецифічній варіабельності.

Висновки. Виявлена чутливість до азотного режиму свідчить про потенціал цих видів як моделей для дослідження адаптивних механізмів метаболічної регуляції у копрофільних аскоміцетів.

Ключові слова: копрофільні аскоміцети, *Triangularia setosa*, *Sordaria fimicola*, джерела азоту, культуральні характеристики, морфологічні особливості.