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INTRODUCTION

We had the great honor of 9th International Conference on Applied Engineering and Natural Sciences ICAENS 2026. It was truly a great pleasure for us togreet a lot of participants from many different countries to attend ICAENS 2026! We firmly believe thatthe conference will become an important international event in the field of cross-industry discussion about innovations in Academic Studies.

Three cooperating organizations supported the two-day conference. There were 161 papers accepted for presentation at ICAENS 2026, contributed from different countries.We had plenary speeches and several well-known scientists and experts, to give invited talks at differentsessions.

The purpose of ICAENS 2026 was to provide a forum for the participants to report and review innovative ideas, with up-to-date progress and developments, and discuss novel approaches to the application in the field of their own research areas and discuss challenges of doing science.

We sincerely hope that the exchange of ideas on doing research, science and improving education will help the participants, and international cooperation sharing the common interest will be enhanced.

On behalf the Organization Committee of ICAENS 2026, we would like to heartily thank our cooperating organizations for all they have done for the conference. We would also like to thank the authors for their contribution to the proceedings; the participants and friends of ICAENS 2026, for their interest and efforts in helping us to make the conference possible; and the Editorial boards for their effective work and valuable advice, especially the ICAENS 2026 secretariat and the ICAENS 2026 staff, for their tireless efforts and outstanding services in preparing the conference and publishing the Proceedings.

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Cultural Characteristics and Temperature-Dependent Growth of *Rhizoctonia* Anastomosis Groups Isolated from Strawberry*

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Abstract **–**This study evaluated the cultural characteristics and temperature-dependent growth of *Rhizoctonia* anastomosis groups (AGs) isolated from strawberry plants. Significant differences were observed among AGs in colony morphology, pigmentation, and sclerotia formation on PDA. *Rhizoctonia solani* groups (AG-2-1 and AG-3) showed darker colonies and higher sclerotia production, while binucleate *Rhizoctonia* groups (AG-A, AG-G, AG-H and AG-K) generally formed lighter colonies. Temperature significantly affected mycelial growth, with most groups showing optimum growth at 25°C, although some exhibited tolerance to higher temperatures. These findings indicate that morphological and physiological traits provide valuable criteria for distinguishing *Rhizoctonia* AGs and understanding their ecological adaptability.

Keywords - Rhizoctonia, *anastomosis groups, colony morphology, temperature, mycelial growth, strawberry*

**: This paper includes a section from the doctoral thesis titled "Anastomosis groups, pathogenicity and biological control of Rhizoctonia species isolated from strawberry plants in Erzurum province"*

INTRODUCTION

Rhizoctonia spp. are soil-borne fungal pathogens with a wide host range and are responsible for significant yield losses in many agricultural crops, including strawberry. These fungi are commonly associated with root and crown rot diseases and can survive in soil or plant residues as saprophytes in the absence of a host [1]. In strawberry, *Rhizoctonia* spp. are among the primary causal agents of the black root rot complex, which leads to root decay, plant weakening, and eventual yield reduction [2,3].

The genus *Rhizoctonia* exhibits considerable diversity and is classified into different anastomosis groups (AGs) based on hyphal fusion reactions. These groups differ in their host range, virulence, cultural characteristics, and physiological properties [4]. In addition, hyphal interaction types (C0–C3) have been used to distinguish between compatible and incompatible isolates, providing a reliable basis for grouping [5].

Cultural and morphological characteristics, such as colony color, mycelial growth pattern, and sclerotia formation, are commonly used in the identification and differentiation of *Rhizoctonia* isolates. However, these traits may vary not only among different AGs but also among isolates within the same group, reflecting a high level of phenotypic variability.

Environmental factors, particularly temperature, play a crucial role in fungal growth, survival, and distribution. Variations in temperature tolerance among anastomosis groups may influence their ecological adaptation and pathogenic potential. Previous studies have shown that *Rhizoctonia* isolates exhibit different growth rates and thermal optima, which can affect their ability to colonize host plants and persist in the soil environment [6].

Given the importance of both morphological and physiological traits in understanding *Rhizoctonia* diversity, this study aimed to evaluate the cultural characteristics and temperature-dependent growth of *Rhizoctonia* anastomosis groups isolated from strawberry plants.

I. MATERIALS AND METHODS

Fungal Isolates

Rhizoctonia isolates obtained from strawberry plants were used in this study. The isolates were previously classified into different anastomosis groups (*Rhizoctonia solani* AG-2-1 and AG-3; binucleate *Rhizoctonia* AG-A, AG-G, AG-H and AG-K) based on hyphal anastomosis reactions [7].

Cultural and Morphological Characterization

The isolates were cultured on Potato Dextrose Agar (PDA) at 25°C for 10 days. Colony characteristics including color, mycelial density, and sclerotia formation were recorded. Observations were made at regular intervals to evaluate differences among anastomosis groups.

Effect of Temperature on Mycelial Growth

To evaluate the effect of temperature on mycelial growth, isolates representing each anastomosis group were tested under different temperature conditions. For anastomosis groups with more than 10 isolates, 10 representative isolates (AG-3, AG-A and AG-G) were selected, whereas for groups with fewer isolates, all available isolates (2 isolates of AG-2-1, 4 isolates of AG-H, and 7 isolates of AG-K) were included in the experiment. Mycelial growth was assessed at 5, 10, 15, 20, 25, 30, and 35°C by measuring daily colony diameters. For this purpose, 5-mm-diameter mycelial discs were taken from the actively growing margins of 5-day-old colonies cultured on PDA at 25°C in darkness and placed at the center of 9-cm Petri dishes containing 15 ml PDA. Each isolate and temperature combination was replicated using three Petri dishes. Colony diameters were measured after 72 hours of incubation in darkness by taking the average of two perpendicular measurements. The daily growth rate was calculated by dividing the mean colony diameter by the number of incubation days [8].

II. RESULTS

Cultural and Morphological Characteristics

Distinct differences were observed among *Rhizoctonia* anastomosis groups in terms of colony morphology on PDA. *Rhizoctonia solani* isolates generally produced darker brown colonies and more abundant sclerotia compared to binucleate groups. Among these, AG-3 isolates exhibited dense, dark brown colonies with intensive sclerotial formation, whereas AG-2-1 isolates showed relatively lighter pigmentation and fewer sclerotia (Figure 1).

In contrast, binucleate groups (AG-A, AG-H, and AG-K) formed colonies that were typically white or hyaline with limited or light-colored sclerotia. AG-G differed from other binucleate groups by exhibiting variable pigmentation ranging from light to dark brown (Figure 1). Additionally, noticeable variability in colony morphology was observed among isolates within the same anastomosis group, indicating phenotypic diversity.



Figure 1. Morphological appearance of AG-A, AG-G, AG-H, AG-K, AG-2-1, AG-3 isolates

Effect of Temperature on Mycelial Growth

Temperature significantly affected mycelial growth of *Rhizoctonia* isolates. At 5°C, AG-2-1, AG-3 and AG-H isolates showed measurable growth, whereas AG-A, AG-G, and AG-K (except for one isolate) isolates did not grow.

As temperature increased, colony growth rates increased in all groups, with most anastomosis groups reaching optimum growth at 25°C. However, AG-G isolates continued to increase their growth up to 30°C.

At 35°C, only AG-A, AG-G and AG-K isolates maintained growth, while AG-2-1, AG-3 and AG-H isolates failed to grow. Among all groups, AG-2-1 isolates exhibited the highest growth rate, whereas AG-H isolates showed the slowest development (Figure 2).

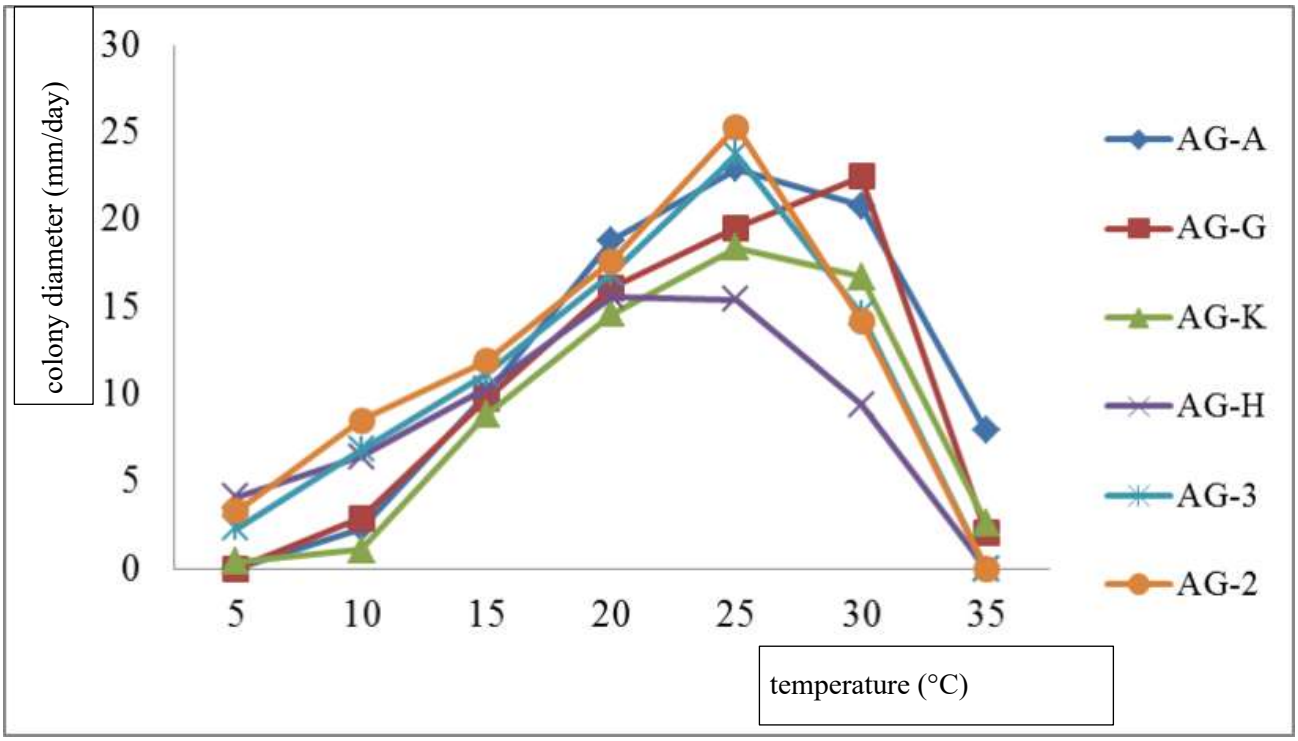


Figure 2. Daily colony diameters of anastomosis groups at temperatures between 5-35ºC.

III. DISCUSSION

The present study demonstrated that *Rhizoctonia* anastomosis groups differ markedly in their cultural characteristics and temperature-dependent growth patterns. The darker colony pigmentation and higher sclerotial production observed in *R. solani* groups are consistent with previous reports indicating that multinucleate *Rhizoctonia* isolates generally exhibit more aggressive growth and higher survival structures compared to binucleate groups [4,9]. The lighter colony coloration and reduced sclerotia formation in binucleate groups observed in this study also align with earlier findings suggesting that these groups often display lower virulence and different ecological strategies compared to *R. solani* [1]. However, the variability observed within the same anastomosis groups highlights the limitations of relying solely on morphological traits for identification, as also emphasized by [6].

Temperature response analysis revealed significant differences among AGs, indicating ecological adaptation to different environmental conditions. The ability of AG-2-1, AG-3 and AG-H isolates to grow at low temperature (5°C) suggests that these groups may be better adapted to cooler climates. This finding

is particularly relevant for regions with low soil temperatures, where such isolates may have a competitive advantage.

On the other hand, the ability of AG-A, AG-G and AG-K isolates to grow at higher temperatures (35°C) indicates a broader thermal tolerance. Similar variability in temperature optima and growth limits has been reported in previous studies, where *Rhizoctonia* isolates exhibited group-specific thermal preferences affecting their distribution and pathogenicity [4].

The faster growth rate of AG-2-1 isolates observed in this study may be associated with their competitive ability and potential pathogenicity. Faster-growing isolates are generally more capable of colonizing host tissues and competing with other soil microorganisms. Conversely, the slower growth observed in AG-H isolates may indicate a more specialized ecological niche or reduced aggressiveness.

Overall, the findings of this study emphasize that both cultural characteristics and temperature responses are important determinants of *Rhizoctonia* diversity. The integration of morphological and physiological data provides a more comprehensive understanding of anastomosis groups and their ecological behavior. Such information is essential for predicting disease development and designing effective management strategies under varying environmental conditions.

IV. CONCLUSION

The present study demonstrated that *Rhizoctonia* anastomosis groups differ significantly in both cultural characteristics and temperature-dependent growth patterns. *Rhizoctonia solani* groups were characterized by darker colony pigmentation and higher sclerotia production, whereas binucleate groups generally exhibited lighter colony morphology. Temperature was identified as a key factor influencing mycelial growth, with most groups showing optimum development at 25°C, while certain groups displayed tolerance to higher temperatures. The ability of some anastomosis groups to grow under a wider temperature range suggests a higher level of ecological adaptability. Moreover, the observed variability among and within anastomosis groups highlights the importance of integrating morphological and physiological parameters for accurate characterization of *Rhizoctonia* isolates. Overall, these findings contribute to a better understanding of the biological diversity of *Rhizoctonia* populations and may provide useful insights for disease management strategies, particularly under varying environmental conditions.

REFERENCES

[1] Carling, D.E., Rothrock, C.S., MacNish, G.C., Sweetingham, M.W., Brainard, K.A. & Winters, S.W. (1994). Characterization of anastomosis group 11 (AG-11) of *Rhizoctonia solani.* Phytopathology, 84, 1387-1393.

[2] Maas, J. L. (1998). Compendium of Strawberry Diseases. Beltsville, MD: APS Press. 138 pp. Second edition

[3] Hancock, J. F. (1999). Strawberries. CABI Publishing, University Press, 273 p, Cambridge.

[4] Sneh, B., Jabaji-Hare, S., Neate, S. & Dijst, G. (1996). Rhizoctonia Species: Taxonomy, Moleculer Biology, Ecology, Pathology and Disease Control. Kluwer Academic Publishers, 577 p. London.

[5] Carling, D.E., Kuninaga, S., & Leiner, R. H. (1988). Relatedness within and among intraspecific groups of *Rhizoctonia solani*: A comparison of grouping by anastomosis and by DNA hybridization. Phytoparasitica, 16, 209-210.

[6] Demirci, E. (1991). Erzurum Yöresinde Patateslerden İzole Edilen *Rhizoctonia solani* Kühn (*Thanatephorus cucumeris* (Frank) Donk)'nin Yayılışı, Bio-Ekolojisi ile Anastomosis Grupları ve Bunların Patojenisitelerinin Belirlenmesi Üzerinde Çalışmalar. Doktora Tezi, Atatürk Üniversitesi Fen Bilimleri Enstitüsü Bitki Koruma Anabilim Dalı, Erzurum.

[7] Demirer Durak, E. & Demirci, E. (2018). Anastomosis groups and pathogenicity of *Rhizoctonia* species from strawberry plants in Erzurum province, Turkey. Fresenius Environmental Bulletin, 27, 4206-4211.

[8] Hollins, T.W., Jellis, G.J. & Scott, P.R. (1983). Infection of potato and wheat by isolates of *Rhizoctonia solani* and *R. cerealis*. Plant Pathology, 32, 303-310.

[9] Ogoshi, A. (1975). Grouping of *Rhizoctonia solani* Kühn and their perfect stages. Review Plant Protection Research, 8, 93-103.