Journal of Anatolian Environmental and Animal Sciences
(*Anadolu Çevre ve Hayvancılık Bilimleri Dergisi*)
https://doi.org/10.35229/jaes.1812330

JAES
Year: 11, 2026 (1-7)
AÇEH
Yıl: 11, 2026 (1-7)

ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

Fungal Diseases of Sugar Beet in Bayburt Province: Field Survey and Pathogen Characterization [*]

Oktay ÖZBAY [1] | **Elif TOZLU** [2] *

[1]*Sukkar Sugar Beet Factory, Bayburt, Türkiye*
[2]*Faculty of Agriculture, Department of Plant Protection, Atatürk University, 25240 Erzurum, Türkiye*

Received: *29.10.2025* ***Accepted:*** *09.12.2025*

How to cite: **Özbay, O., & Tozlu, E. (2026).** Fungal Diseases of Sugar Beet in Bayburt Province: Field Survey and Pathogen Characterization. *J. Anatolian Envion. Anim. Sci.*, ***11***(1), 1-7. https://doi.org/10.35229/jaes.1812330

Atıf yapmak için: **Özbay, O., & Tozlu, E. (2026).** Bayburt İlindeki Şeker Pancarı Ekim Alanlarında Fungal Hastalıkların Tespiti. *Anadolu Çev. Hay. Bil. Derg.*, ***11***(1), 1-7. https://doi.org/10.35229/jaes.1812330

***Corresponding author's:**
Elif TOZLU
Atatürk University, Faculty of Agriculture, Department of Plant Protection, 25240 Erzurum, Türkiye
✉: elifalpertozlu@atauni.edu.tr

Abstract: Sugar beet (*Beta vulgaris* L.) is one of the strategically important industrial crops in Turkey and is vulnerable to various biotic stress factors, particularly fungal pathogens that cause significant yield and quality losses. This study aimed to identify fungal pathogens and determine their prevalence in sugar beet cultivation areas located in the central district, Demirözü, and Aydıntepe regions of Bayburt Province. Survey studies were carried out in six agricultural fields, and plant samples showing disease symptoms were collected. Fungal isolates obtained from symptomatic plants were identified based on morphological and microscopic characteristics. The analyses revealed the presence of several fungal species across different locations: *Fusarium oxysporum* (BAA1-3) in Aşağıkırzı; *Fusarium redolens* (BDÇ1-1), *Fusarium solani* (BDÇ1-2), and *Apiospora arundini* (BDÇ1-3) in Çatalçeşme; *Fusarium equiseti* (BDŞ4-1), *Trichothecium roseum* (BDŞ1-4), and *Fusarium proliferatum* (BDŞ1-5) in Şirin; *Rhizoctonia solani* (BDG1-2) in Güneşli; and *Fusarium acuminatum* (BMÇ1-7) and *Botrytis cinerea* (BMÇ1-8) in Çayıryolu. These findings provide essential baseline data on the distribution and diversity of fungal pathogens affecting sugar beet cultivation in Bayburt Province and offer valuable insight for the development of effective, region-specific disease management strategies aimed at supporting sustainable production.

Keywords: Bayburt; *Fusarium* spp.; fungal pathogens; *Rhizoctonia solani*; sugar beet.

Bayburt İlindeki Şeker Pancarı Ekim Alanlarında Fungal Hastalıkların Tespiti

***Sorumlu yazar:**
Elif TOZLU
Atatürk Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, 25240 Erzurum, Türkiye
✉: elifalpertozlu@atauni.edu.tr

Öz: Şeker pancarı (*Beta vulgaris* L.), Türkiye'nin stratejik açıdan önemli endüstriyel bitkilerinden biridir ve özellikle verim ve kalite kayıplarına yol açan fungal patojenler dahil olmak üzere çeşitli biyotik stres etmenlerine karşı hassastır. Bu çalışma, Bayburt ilinin merkez ilçe, Demirözü ve Aydıntepe bölgelerindeki şeker pancarı yetiştiricilik alanlarında görülen fungal patojenlerin belirlenmesi ve yaygınlıklarının ortaya konulması amacıyla yürütülmüştür. Bu kapsamda altı tarım alanında sürvey çalışmaları gerçekleştirilmiş ve hastalık belirtisi gösteren bitki örnekleri toplanmıştır. Semptomlu bitkilerden elde edilen fungal izolatlar morfolojik ve mikroskobik özellikleri dikkate alınarak tanılanmıştır. Yapılan analizler sonucunda farklı lokalitelerde çeşitli fungal türlerin varlığı belirlenmiştir: Aşağıkırzı'da *Fusarium oxysporum* (BAA1-3); Çatalçeşme'de *Fusarium redolens* (BDÇ1-1), *Fusarium solani* (BDÇ1-2) ve *Apiospora arundini* (BDÇ1-3); Şirin'de *Fusarium equiseti* (BDŞ4-1), *Trichothecium roseum* (BDŞ1-4) ve *Fusarium proliferatum* (BDŞ1-5); Güneşli'de *Rhizoctonia solani* (BDG1-2); Çayıryolu'nda ise *Fusarium acuminatum* (BMÇ1-7) ve *Botrytis cinerea* (BMÇ1-8) tespit edilmiştir. Elde edilen bulgular, Bayburt ilinde şeker pancarı yetiştiriciliğini etkileyen fungal patojenlerin dağılımı ve çeşitliliğine ilişkin temel veriler sunmakta olup, bölgeye özgü etkili hastalık yönetimi stratejilerinin geliştirilmesine yönelik önemli bilgiler sağlamaktadır.

Anahtar kelimeler: Bayburt; *Fusarium* türleri; fungal patojenler; *Rhizoctonia solani*; şeker pancarı.

INTRODUCTION

Sugar beet (*Beta vulgaris* var. *saccharifera* L.) is a biennial plant widely cultivated as an important industrial crop, particularly in temperate climates (Gencer, 1988; Anonymous, 2024).

Sugar beet plays a strategic role in Turkey's agriculture-based industrial production, serving not only for sugar but also as a raw material for molasses, ethanol, yeast, animal feed, and organic fertilizers (Tosun, 2017).

Turkey ranks fifth worldwide and fourth in Europe in sugar production from beet, accounting for approximately 1.5% of total global sugar production (Ünsal, 2022). Despite

[*] *This study is part of the master's thesis of Oktay ÖZBAY and was presented as an oral presentation at the Sivas International Conference on Scientific and Innovation Research IV, held on 30-31 May 2025 in Sivas, Turkey. The abstract of the study was also published in the conference abstract book.*

its economic and industrial importance, sugar beet production is affected by both biotic and abiotic stress factors. Among these, fungal diseases such as root rot, leaf spot, and wilting significantly reduce yield and sugar content (Agrios, 2005; Booth, 1971).

Common fungal pathogens affecting sugar beet include *Cercospora beticola* (leaf spot), *Rhizoctonia solani* (crown rot), *Fusarium* spp. (root rot and wilting), *Pythium* spp., and *Aphanomyces cochlioides*, which are soil-borne agents (Misra et al., 2023; Harvesom et al., 2009). These pathogens are favored by soils with high water retention, rich organic matter, and poor drainage, which influence both crop growth and disease incidence (Wu et al., 1976).

Bayburt Province possesses areas suitable for sugar beet cultivation due to its continental climate and soil characteristics. In recent years, state-supported policies have increased sugar beet cultivation in the region (Karaca & Bayrak, 2017). However, there is a lack of sufficient phytopathological data on sugar beet fungal diseases in Bayburt, particularly regarding pathogen identification and prevalence.

This study aims to identify fungal pathogens affecting sugar beet in Bayburt Province using morphological, molecular characterization, and pathogenicity tests, and to determine their prevalence and distribution in cultivation areas. The results are intended to provide a scientific basis for developing effective, region-specific disease management strategies.

MATERIAL AND METHOD

Material:

Study area and survey design: Survey studies were conducted in the districts of Aydıntepe, Demirözü, and the Central District of Bayburt Province, specifically in the neighborhoods of Aşağıkırzı, Çatalçeşme, Şirin, Güneşli, and Çayıryolu.

Surveys were carried out during three separate periods throughout the 2024 sugar beet cultivation season. Long-term average temperature and precipitation data for the surveyed locations were collected (Figure 2).



Figure 1. Geographic map of Bayburt Province.

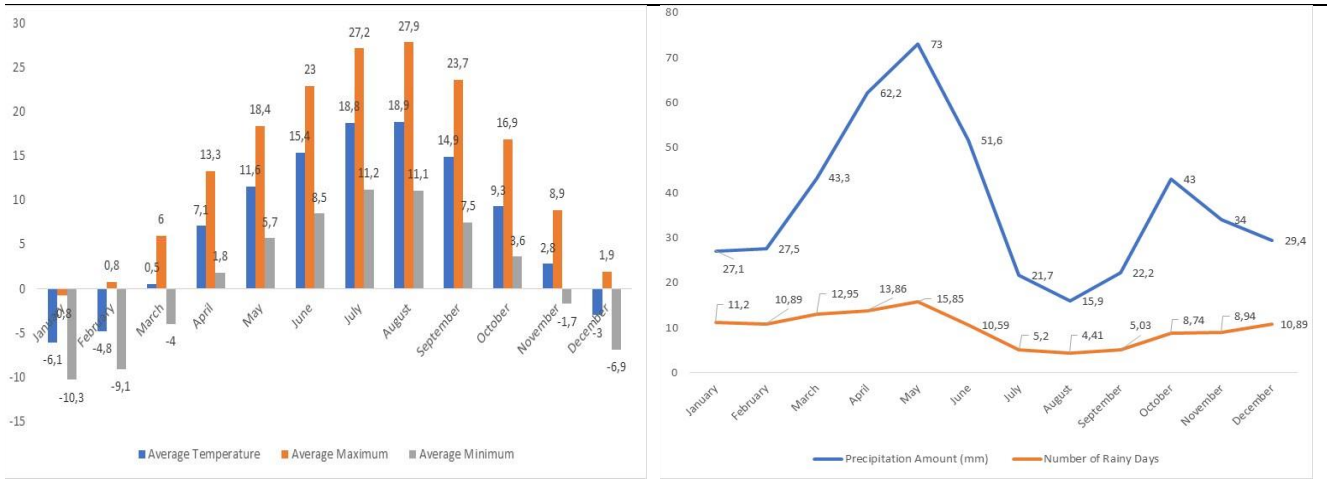

Figure 2. Meteorological data for Bayburt Province from 1959 to 2024 (monthly average temperatures (°C), monthly average precipitation (mm), and number of rainy days)

The field survey was conducted along diagonal transects. Depending on field size, 20-60 plants per plot were examined: 20 plants in 1-5 da plots, 40 in 6-10 da plots, and 60 plants in plots larger than 10 da. In total, 12 plots were surveyed, each considered one biological replicate (n = 12) and 51 symptom-free plants were included as controls. Plants showing wilting, loss of vitality, yellowing, leaf deformities, fungal lesions or necrosis, or discoloration or rot in the tuber tissue were classified as diseased.

Disease incidence (DI) was calculated using the following formula:

DI (%) = (Number of diseased plants / Total number of examined plants) × 100.

Mean DI and 95% confidence intervals were calculated for each plot.

Isolation of pathogenic fungi: Plant samples were washed, surface-sterilized in a 1% sodium hypochlorite (NaOCl) solution and diseased tissues were placed on Potato Dextrose Agar (PDA; 39 g/L, DIFCO) plates incubated at 20–25 °C. One isolate per diseased plant was obtained, yielding 160 fungal isolates. Mycelial disks (4 mm in diameter) from actively growing colonies were transferred to fresh PDA plates to obtain pure cultures. All isolates were stored at 4 °C for subsequent analyses. Pathogenicity tests were applied to all isolates, and only those determined to be pathogenic were advanced to the next stage. Pathogenic isolates were then grouped based on their morphological characteristics, and representative isolates from each group were subjected to molecular identification. Sequence analysis revealed that the pathogenic isolates belonged to 10 distinct fungal species.

Pathogenicity tests of fungi: Pathogenicity tests were performed to determine whether the isolated fungi could cause disease in sugar beet. For each isolate, 3 tubers were used, and the experiment repeated three times. Controls consisted of 3 tubers per repetition, wounded and treated with sterile PDA disks following the same procedure. Tubers were wounded, sprayed with water, inoculated with 4 mm mycelial disks, and wrapped with parafilm. Lesion development was monitored, and re-isolation from symptomatic tissues was performed to fulfill Koch's postulates.

Macroscopic and microscopic identification of pathogenic fungi: Pure cultures were examined based on colony morphology and microscopic features. Isolates with similar morphological traits were grouped, and representative isolates from each group were used for molecular identification.

Molecular identification of pathogenic fungi: Within each morphological group, the most virulent isolate was selected for ITS1–ITS4 sequencing. Isolates were cultured in 50 mL Potato Dextrose Broth (PDB; 24 g/L; DIFCO) at 25 °C and 100 rpm for 48 hours. After incubation, approximately 200 mg of fresh mycelial biomass was homogenized, and genomic DNA was extracted using a commercial fungal DNA extraction kit according to the manufacturer's protocol. DNA integrity and purity were assessed on a 0.8% (w/v) agarose gel prepared in 1× TAE buffer and electrophoresed at 75 V for 60 minutes.

PCR amplification of the ITS1–5.8S–ITS2 region was performed using the ITS1 (5′-TCC GTA GGT GAA CCT TGC GG-3′) and ITS4 (5′-TCCTCCGCTTATTGATATGC-3′) primers. The 50 µL PCR mixture contained: 2 µL ITS1 primer (10 µM), 2 µL ITS4 primer (10 µM), 5 µL 10× Taq buffer (with 15 mM $MgCl_2$), 2 µL dNTP mix (10 mM of each dNTP), 3 µL $MgCl_2$ supplement (25 mM), 0.5 µL Taq DNA polymerase (5 U/µL; final amount 2.5 U), 4.5 µL template DNA (20–50 ng/µL), and 31 µL nuclease-free water. The PCR cycling conditions consisted of initial denaturation at 95 °C for 2 min; 35 cycles of denaturation at 94 °C for 1 min, annealing at 55 °C for 2 min, and extension at 72 °C for 3 min; followed by a final extension at 72 °C for 10 min.

PCR amplicons were separated on a 1% (w/v) agarose gel prepared in 1× TAE buffer and electrophoresed at 80 V for 50 minutes. The products were purified using a commercial PCR purification kit and sequenced using the Sanger sequencing method on an ABI 3500 Genetic Analyzer (Applied Biosystems, USA) with both ITS1 and ITS4 primers. The obtained sequences were edited using BioEdit v7.2.5 and aligned with GenBank reference sequences using ClustalW. Molecular identification was based on ≥97% sequence identity, and sequences showing lower identity were not assigned to species level (Zhang et al., 2000).

Statistical analysis: Disease incidence was evaluated descriptively. No advanced statistical analyses were performed; mean DI values, standard deviations, and 95% confidence intervals were reported.

RESULTS

In 2024, sugar beet cultivation in Demirözü covered an area of 44,363.58 da. Surveys were conducted in the villages of Şirin, Güneşli, and Çatalçeşme; in the Central District (2,543.67 da), surveys were carried out in Çayıryolu; and in Aydıntepe, with 1,194.45 da of cultivated sugar beet, counts were performed in Aşağıkırzı (Figure 3).

Overall, the incidence ranged from 7.5% to 15%, the highest in Aşağıkırzı (Aydıntepe) and the lowest in Çayıryolu (Central District) (Table 1). Mean DI values and standard deviations were calculated for biological replicates.

After establishing the field-level distribution of the disease, molecular analyses were carried out to identify the pathogenic fungal species associated with the surveyed areas. The taxa identified through ITS-based sequencing, together with their corresponding GenBank accession numbers, are summarized in Table 2. The cultural characteristics of these isolates on PDA medium are also depicted in Figure 4. By integrating field observations with molecular and morphological diagnostics, this section provides a coherent and robust framework for accurately characterizing the pathogens involved.

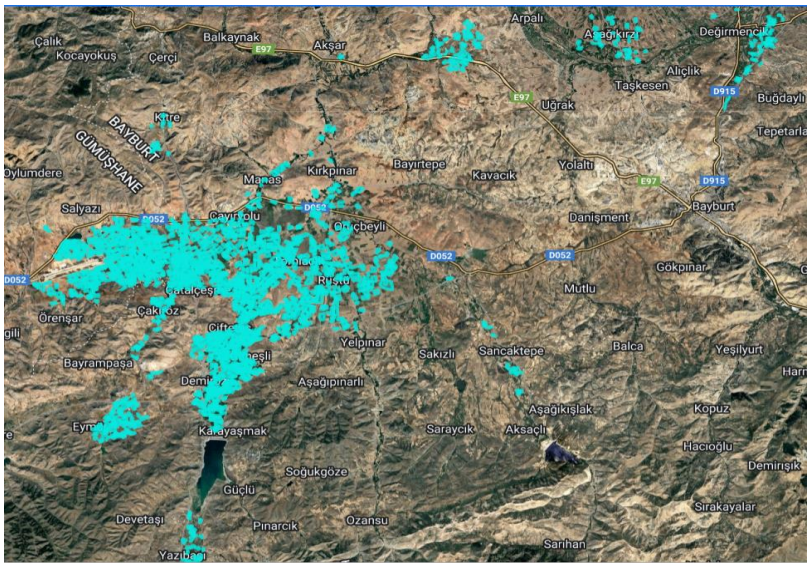

Figure 3. Locations surveyed for sugar beet cultivation.

Table 1. Disease incidence in surveyed sugar beet cultivation areas.

Lokality		Field Size (da)	Number of Plants Examined	Disease Incidence (%)
Aydıntepe	Aşağıkırzı	17	20/3	15.0
	Çatalçeşme	62	45/4	8.9
Demirözü	Şirin	48	20/2	10.0
	Güneşli	35	35/4	11.4
Merkez	Çayıryolu	70	40/3	7.5

Table 2. Molecular identification of pathogenic fungal isolates and GenBank accession numbers.

Location	Isolate	ITS Identification	ITS Sequence*	Pathogenicity
Aşağıkırzı	BAA1-3	*Fusarium oxysporum*	PX287137	+
Çatalçeşme	BDÇ1-1	*Fusarium redolens*	PX287170	+
Çatalçeşme	BDÇ1-2	*Fusarium solani*	PX287156	+
Çatalçeşme	BDÇ1-3	*Apiospora arundini*	PX286956	+
Şirin	BDŞ4-1	*Fusarium equiseti*	PX287202	+
Şirin	BDŞ1-4	*Trichothecium roseum*	PX287182	+
Şirin	BDŞ1-5	*Fusarium proliferatum*	PX287184	+
Güneşli	BDG1-2	*Rhizoctonia solani*	PX287187	+
Çayıryolu	BMÇ1-7	*Fusarium acuminatum*	PX287203	+
Çayıryolu	BMÇ1-8	*Botrytis cinerea*	PX287186	+

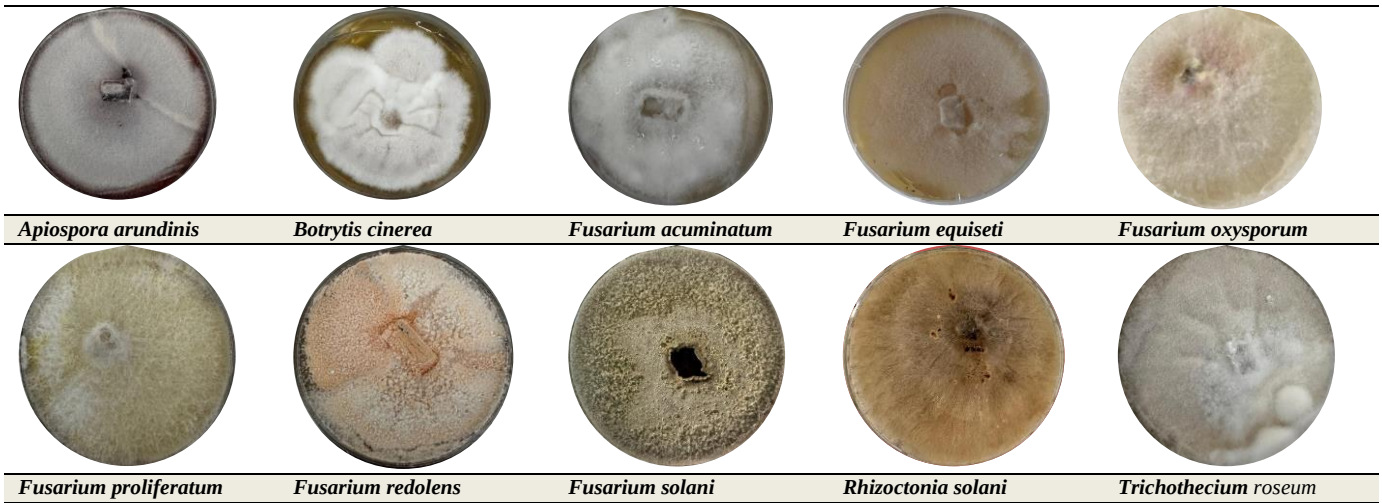

Figure 4. Growth of pathogenic fungal isolates on Potato Dextrose Agar (PDA)

DISCUSSION

Sugar beet diseases are among the most significant constraints to crop production. Of the 25 known diseases worldwide, approximately 15 are of economic importance. Among fungal diseases, seed and seedling diseases as well as foliar diseases are particularly significant (Abdulrazaq, 2024).

In this study, fungal pathogens in sugar beet cultivation areas in Bayburt Province were identified using morphological and molecular methods. The findings revealed that *Fusarium* species are dominant in the region, alongside the presence of other species such as *R. solani, B. cinerea, T. roseum*, and *A. arundinis*. Numerous studies have also reported that *Fusarium* and *Rhizoctonia* species are primarily responsible for yield-reducing diseases such as root rot and wilting in sugar beet (Windels, 2000; Christ, 2011).

Fusarium spp. (*F. oxysporum, F. solani*) observed in this study caused brownish rot in roots and vascular tissues, consistent with previous reports from Erzurum (Karyağdı, 2011) and Konya (Sarı & Boyraz, 2019), confirming their role as important root rot agents. Soil pH, moisture, temperature, and drainage are known to directly influence pathogen activity (Person & Olsson, 2007). The detection of *F. proliferatum, F. oxysporum, F. solani, F. equiseti, F. acuminatum* and *F. redolens* indicates a diverse *Fusarium* population, reflecting that Bayburt's cultivation areas provide highly suitable ecological conditions for these pathogens. In particular, *F. oxysporum* and *F. solani* are among the main causal agents of vascular wilt and root rot in sugar beet, frequently reported across different regions of Turkey (Özgönen & Kılıç, 2009; Karyağdı, 2011; Sarı & Boyraz, 2019).

F. proliferatum is considered significant not only because it causes root rot but also because it can produce mycotoxins such as fumonisins (Logrieco et al., 2002). Its presence in Bayburt sugar beet crops may pose risks to both agricultural production and food safety. Although *F. equiseti* and *F. acuminatum* are generally reported as secondary pathogens, they can trigger root infections under stress conditions (Leslie & Summerell, 2006). This suggests that Bayburt's climate, with cold winters and intermittent summer droughts, provides favorable conditions for opportunistic *Fusarium* species.

The disease incidence data indicate that *R. solani* reached 15% infection in Bayburt, whereas in a 2019 study conducted in Çumra, Konya, the rate was reported as 2.3% (Sarı & Boyraz, 2019). Such differences may be attributed to variations in climate, soil properties, irrigation practices, cultivation timing, and the susceptibility of sugar beet varieties in different regions. *R. solani*, which causes collar rot symptoms, was more frequently observed in irrigated, organic matter-rich areas. Similarly, in Europe, infections caused by *R. solani* have been reported to be more severe in wet areas (Buhre et al., 2009). This pathogen can lead to significant economic losses by causing collar rot and plant lodging. In Bayburt, limited irrigation facilities may result in uneven soil moisture, potentially facilitating pathogen development.

Some samples exhibited mixed infections, with *Fusarium* and *Rhizoctonia* species co-occurring in the same plant, complicating disease management and highlighting pathogen interactions. Similar combinations have been reported in Europe and the Balkans (Stojsin et al., 2006).

The isolation of *Botrytis cinerea* from sugar beet samples is a noteworthy detection. This fungus is commonly known as a grey mold pathogen of vegetables and fruits, but it has also been reported as a secondary pathogen in sugar beet roots (Williamson et al., 2007). It may pose a risk during post-harvest storage of roots in Bayburt.

T. roseum and *A. arundinis*, detected in this study, are rarely reported in sugar beet. T. roseum is generally considered a post-harvest rot pathogen (Domsch et al., 2007), suggesting that inadequate storage conditions in Bayburt could lead to significant losses. *A. arundinis*, on the other hand, is primarily known as the causal agent of several significant plant diseases (Yan & Zhang, 2024), and its isolation from sugar beet roots in this study suggests that the ecological role or behavior of the species may be influenced by the environmental conditions in Bayburt.

These results represent one of the first comprehensive studies documenting the diversity of fungal pathogens in sugar beet fields in Bayburt. The dominance of *Fusarium* species poses a serious threat to sustainable agricultural production, while the presence of rare species demonstrates that sugar beet interacts not only with classical pathogens but also with opportunistic microorganisms. This study is significant for Bayburt as it provides the first fungal disease survey and quantifies the local prevalence rates. The findings largely align with nationwide surveys in Turkey, though differences attributable to Bayburt's unique soil and climate conditions are evident (Tunalı et al., 2018; Sarı & Boyraz, 2019).

CONCLUSION

In conclusion, fungal diseases in sugar beet have substantial impacts on both yield and quality, highlighting the need for integrated disease management strategies. Preventive agronomic practices, along with biological and chemical control measures, should be employed concurrently. Educating local farmers, regular monitoring of pathogens in fields, and early detection of disease agents are critical for outbreak control. Moreover, climate change and agricultural practices (monoculture, irrigation

management, fertilization) influence pathogen prevalence. Future studies in Bayburt should consider these factors to obtain more comprehensive insights into the relationship between environmental variables and fungal diseases.

Declaration of generative AI and AI-assisted technologies in the writing process: During the preparation of this work, the authors used ChatGPT 4.0 / OpenAI to improve English. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Disclosure statement: No potential conflict of interest was reported by the authors.

Funding: No funding.

Authors' contributions: ET conceptualized and designed the study and supervised the entire research process. OO conducted the experiments as part of her master's thesis and collected the data. ET also performed the statistical analyses. Both authors contributed to interpreting the results, discussed the findings, and read and approved the final version of the manuscript.

REFERENCES

Abdulrazaq, S.M. (2024). *Control of sugar beet leaf spot disease (Cercospora beticola) using nanoparticles supplemented with oregano (Origanum onites) essential oil.* PhD thesis, Erciyes University, Graduate School of Natural and Applied Sciences, Türkiye, 98 pp.

Agrios, G.N. (2005). *Plant pathology*, 5th ed., Elsevier Academic Press., 948p.

Anonymous. (2024). *The plant list: A working list of all plant species, Beta vulgaris L.*

Booth, C. (1971). *The genus Fusarium*. Commonwealth Mycological Institute, Kew, Surrey, England.

Buhre, C., Kluth, C., Burcky, K., Marlander, B., & Varrelmann, M. (2009). Integrated control of root and crown rot in sugar beet: Combined effects of cultivar, crop rotation and soil tillage. *Plant Disease*, ***93***(2), 155-161. https://doi.org/10.1094/PDIS-93-2-0155

Christ, D. (2011). *Fusarium* in sugar beet – Species spectrum, pathogenicity, mycotoxin formation and cross-pathogenicity in wheat. Georg-August University of Göttingen, Faculty of Agricultural Sciences, Germany, 186 pp.

Domsch, K.H., Gams, W., & Anderson, T.H. (2007). *Compendium of soil fungi*. IHW Verlag.

Gencer, O. (1988). *General field crops (industrial crops)*. Çukurova University, Faculty of Agriculture, Textbook (42) (in Turkish).

Harveson, R.M., Hanson, L.E., & Hein, G.L. (2009). Beet disease management. In: *Compendium of beet diseases and pests*, 2nd ed., APS Press.

Karaca, M.E., & Bayrak, M. (2017). Research on suitable investment areas in Bayburt province. KUDAKA, 331 pp (in Turkish).

Karyağdı, O.F. (2011). *Fusarium species isolated from sugar beet (Beta vulgaris L.) plants and their pathogenicity in Erzurum-Pasinler district.* Ataturk University, Graduate School of Natural and Applied Sciences, 45 s (in Turkish).

Leslie, J.F., & Summerell, B.A. (2006). *The Fusarium laboratory manual*. Blackwell Publishing.

Logrieco, A., Mule, G., Moretti, A., & Bottalico, A. (2002). Toxigenic *Fusarium* species and mycotoxins associated with maize ear rot in Europe. *European Journal of Plant Pathology*, ***108***, 597-609. https://doi.org/10.1023/A:1020679029993

Misra, V., Mall, A.K., & Singh, D. (2023). *Rhizoctonia* root-rot diseases in sugar beet: Pathogen diversity, pathogenesis and cutting-edge advancements in management research. *The Microbe*, 100011. https://doi.org/10.1016/j.microb.2023.100011

Özgönen, H., & Kılıç, H.Ç. (2009). Determination of fungal diseases and their prevalence in sugar beet cultivation areas of Isparta province. *Süleyman Demirel University Journal of Faculty of Agriculture*, ***4***(1), 16-22.

Person, L., & Olsson, A. (2007). Soilborne pathogens on sugar beet in the south of Sweden – impact of crop rotation and soil characteristics. *70th IIRB Congress*, April, 13, 2007, Bjarred, Slottsvag, 81-82.

Sari, A., & Boyraz, N. (2019). A general evaluation of fungal diseases in sugar beet in Çumra, Konya. *Bahri Dağdaş Journal of Agricultural Research*, ***8***(2), 279-288 (in Turkish).

Stojsin, V.B., Maria, A.A., Jasnic, S.M., Bagi, F.F., & Marinkovic, B.J. (2006). Root rot of sugar beet in the Vojvodina Province. *Proceedings of Natural Sciences, Matica Srpska*, ***110***, 65-74.

Tosun, F. (2017). *Sugar beet product report*. Agricultural Economy and Policy Development Institute Publications, No. 291, 19 pp (in Turkish).

Tunalı, B., Kansu, B., Kutluk Yılmaz, N.D., Meyva, G., & Kaya, R. (2018). Prevalence, pathogenicity and resistance of some varieties to *Cercospora beticola* Sacc. in sugar beet in Turkey. *The Journal of Turkish Phytopathology*, ***47***(1), 21-30 (in Turkish).

Ünsal Y., (2022). *Sugar beet report.* Institute of Agricultural pp. Economics and Policy

Development. TEPGE Publication No. 354, 17 pp (in Turkish).

White, T.J., Brauns, T., Lee, S., & Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In M.A. Innis, D.H. Gelfand, J.J. Sninsky & T.J. White (Eds.), *PCR protocols: A guide to methods and applications* (pp. 315-322). Academic Press, San Diego.

Williamson, B., Tudzynski, B., Tudzynski, P., & van Kan, J.A.L. (2007). *Botrytis cinerea*: The cause of grey mould disease. *Molecular Plant Pathology*, ***8***(5), 561-580. https://doi.org/10.1111/j.1364-3703.2007.00417.x

Windels, C.E. (2000). Economic and social impacts of Fusarium head blight: Changing farms and rural communities in the northern Great Plains. *Phytopathology*, ***90***(1), 17-21. https://doi.org/10.1094/PHYTO.2000.90.1.17

Wu, M.T., Salunkhe, D.K., & Dull, G.G. (1976). Effects of environmental factors and agronomic and storage practices on quality of sugarbeet. *Critical Reviews in Food Science and Nutrition*, ***7***(3), 281-296. https://doi.org/10.1080/10408397609527209

Yan, X.N., & Zhang, C.L. (2024). Three new endophytic *Apiospora* species (Apiosporaceae, Amphisphaeriales) from China. *MycoKeys*, ***105***, 295-316. https://doi.org/10.3897/mycokeys.105.122583

Zhang, Y., Bell, A., Perlman, P.S., & Leibowitz, M.J. (2000). Pentamidine inhibits mitochondrial intron splicing and translation in *Saccharomyces cerevisiae*. *RNA*, ***6***(7), 937-951. https://doi.org/0.1017/s1355838200991726