Interreg NEXT Black Sea Basin

Co-funded by the European Union

AGRICOOP

BSB01005 AGRICOOP NATIONAL REPORT

Cooperation through Tech-Based Practices to Struggle Invasive Species and Climate Change for a Sustainable and Resilient Agriculture



LP1-TCE TÜRKİYE

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Publication Date: [August, 2026]

Varna Economic Development Agency

AGRICOOP – Interreg NEXT Black Sea Basin Programme (BSB01005)

Priority Agricultural Crops and Invasive Alien Species: AGRICOOP - National Report

Condensed Academic Report



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Türkiye – 2026

Abstract

Invasive alien species (IAS) and changing climatic conditions constitute pressures that should be considered jointly in terms of the sustainability of agricultural production in the Black Sea Region. The Türkiye-related studies conducted under Activity A1.1 of the AGRICOOP Project (Interreg NEXT Black Sea Basin, BSB01005) by LP1 – Trabzon Commodity Exchange (TCE) and PP4 – Ondokuz Mayıs University (OMU) are based on the integrated assessment of information obtained through a review of the literature and institutional sources, stakeholder consultations, surveys, and field visits. A total of 53 participants attended the stakeholder meeting in Trabzon, and the surveys of 36 participants were analysed. In addition, a standard interview form was administered to 12 producers during field visits in Trabzon. The stakeholder consultation and field studies conducted by OMU in Samsun, involving 24 participants, were used as supplementary data.

In the Trabzon stakeholder survey, the Brown Marmorated Stink Bug (*Halyomorpha halys*) was the most frequently reported invasive species, identified by 34 out of 36 participants (94.44%). The Citrus Longhorned Beetle (*Anoplophora chinensis*) and the False Cabbage Butterfly (*Orosanga japonica*) were each reported by 17 participants (47.22%). Among agricultural products, hazelnut was the most frequently identified, reported by 34 out of 36 participants (94.44%), followed by tea (26/36; 72.22%), maize (18/36; 50.00%), kiwifruit (14/36; 38.89%), and beans (10/36; 27.78%). Within the four equally weighted criteria-based assessment framework developed by BSU, hazelnut received the highest priority. Tea, maize, kiwifruit, and beans were also assessed as priority crops, taking into account regional importance, climate sensitivity, and exposure to IAS collectively.

Field and stakeholder findings particularly support the importance of the *H. halys*–hazelnut relationship. However, the available project data are not sufficient to establish a direct cause-and-effect relationship between climate change and pest populations. Therefore, the findings were interpreted within a framework that considers temperature, precipitation, seasonal variability, crop phenology, host plant availability, and pest activity collectively.

Keywords: invasive alien species; climate change; hazelnut; brown marmorated stink bug; Trabzon; Black Sea Region; multi-criteria assessment; stakeholder consultation

1. Introduction

The AGRICOOP project brings together partners from Türkiye, Bulgaria, and Georgia with the aim of developing technology-supported and collaborative approaches to address the impacts of invasive alien species (IAS) and climate change on agricultural production. Activity A1.1 establishes a common knowledge base for the identification of existing and potential IAS in the project regions, the assessment of their relationships with agricultural production, and the identification of priority agricultural crops that may be affected by IAS pressure and climate change.

In the Türkiye study, Trabzon constitutes the main field focus. The stakeholder consultation, field visits, and literature studies conducted by OMU in Samsun were considered as complementary evidence, particularly in supporting the findings regarding the relationship between hazelnut production and the brown marmorated stink bug. This report academically consolidates the comprehensive content of the Türkiye National Report and presents the regional context, methodology, stakeholder and field evidence, prioritisation of crops and IAS, brief catalogue profiles, discussion, and conclusions as an integrated whole.

As a scope limitation, the detailed biology and control methods of the priority IAS are summarised only to the extent necessary for interpreting the findings. The primary focus of Activity A1.1 is the identification of species and crops, assessment of the current situation, and establishment of an evidence base for subsequent project activities.

2. Regional Context: Climatic and Agroecological Conditions of Trabzon

Trabzon is characterised by humid and temperate conditions shaped by the combined influence of the Black Sea maritime climate and mountainous topography. The rapid increase in elevation from coastal areas towards inland zones creates pronounced differences in temperature, precipitation, vegetation, and agricultural production conditions over relatively short distances. According to the Turkish State Meteorological Service (MGM) climate classification for 1991–2020, Trabzon exhibits humid to semi-humid characteristics, with monthly average temperatures ranging approximately from 7.6 to 24.4 °C (MGM, 2026).

The province's mountainous and steep terrain results in fragmented agricultural areas, with production largely carried out by small- and medium-sized enterprises and family farms. According to DOKAP data, approximately 22.3% of Trabzon's total area consists of agricultural land, 26% of pastureland, and 43% of forest areas (DOKAP, 2026). While hazelnut and tea are economically prominent, maize, potato, kiwifruit, beans, and various fruits and vegetables contribute to the diversification of the regional production pattern.

The close intermixing of agricultural areas with forests, shrublands, settlements, and semi-natural vegetation may create a landscape that facilitates the movement of pests with broad host ranges among different plants and habitats. Climate change is not, in itself, the sole factor determining this system. While changes in temperature, precipitation, and humidity may affect pest development rates, overwintering success, and seasonal activity, conditions such as extreme

temperatures or irregular precipitation may constrain certain species. Therefore, the climate–IAS relationship has not been reduced to changes in mean temperature alone.

Agroecological factor	Implications for agricultural production	Potential implications for IAS/pests
Humid temperate coastal climate	Favourable conditions for perennial crops and crops with high moisture requirements	Favourable microclimatic conditions for the development and seasonal activity of certain pests
Elevation and microclimatic diversity	Rapid changes in cropping patterns over short distances	Potential local variation in pest activity and phenology
Fragmented small-scale farms	Hazelnut, tea, maize, kiwifruit, beans, and mixed cropping systems	Host continuity and heterogeneity in monitoring and control
Intermixing of natural and agricultural areas	Diverse agricultural landscape	Movement of polyphagous species across habitats

3. Materials and Methods

3.1 Document Review and Stakeholder Consultation

Scientific publications, official agricultural and plant health sources, climate data, agricultural statistics, and institutional reports were reviewed as part of Activity A1.1. Relevant sources were recorded using the common *Sources_List* format. The document review was complemented by information obtained through stakeholder consultations and field visits and was used to identify priority species and crops.

The Stakeholder Consultation Meeting held in Trabzon on 18 February 2026 and organised by TCE was attended by 53 participants, of whom 36 completed questionnaires were analysed. Participants represented public institutions/NGOs, cooperatives and producer associations, researchers/academics, agricultural engineers/advisors, farmers, and other groups. For multiple-response questions, both participant-based and response-based proportions were considered. The stakeholder consultation conducted by OMU in Samsun, involving 24 participants, constituted a second data source supporting the Türkiye findings.

3.2 Multi-Criteria Crop Prioritisation

Candidate crops were scored on a scale of 1–5 according to the common framework developed by BSU, using four equally weighted criteria: A – Agricultural Importance, B – Socioeconomic Importance, C – Climate Sensitivity, and D – IAS Exposure/Impact. The overall score was calculated using the formula (A+B+C+D)/4. Where possible, the scoring was based on literature, official statistics, and verifiable sources; in areas where quantitative data were limited, stakeholder and field information were used as supporting evidence.

3.3 Field Verification

Field visits were conducted in agricultural production areas in and around Trabzon and Samsun. In Trabzon, 19 agricultural production areas across different districts were visited, while 9 orchards were visited in Samsun by PP4-OMU. Observations regarding pest species, damage symptoms, producer experiences, and existing control practices were recorded.

In addition, standard interviews were conducted with 12 producers in Trabzon to assess pest occurrence periods, affected crops, impacts on production, and attitudes towards digital monitoring tools.

The fieldwork was conducted not to generate a statistical estimate of pest prevalence, but to verify and assess how the findings obtained from the document review and stakeholder consultations correspond to local production conditions.

3.4 Integrated Assessment of Evidence

Literature, official data, stakeholder perspectives, and field observations were not considered determinative on their own; rather, evidence that supported or constrained one another was interpreted collectively. In particular, for climate change–pest relationships, where the project data did not demonstrate direct causality, the findings were expressed within the framework of observed associations and risk.

4. Results

4.1 Findings from the Stakeholder Consultation

Half of the 36 survey participants in Trabzon were representatives of NGOs/public institutions. Representatives of cooperatives/producer associations accounted for 16.7%, researchers/academics for 13.9%, and agricultural engineers/advisors for 8.3%, while farmers and other participants each accounted for 5.6%.

Participant type	Number	Percent (%)
NGO / Public Institution	18	%50,0
Cooperative / Producer Association	6	%16,7
Researcher / Academic	5	%13,9
Agricultural Engineer / Consultant	3	%8,3
Farmer	2	%5,6
Other	2	%5,6
Total	36	%100

In the IAS-related question, *H. halys* was reported by 34 participants (94.44%), while *A. chinensis* and *O. japonica* were each reported by 17 participants (47.22%). In the crop-related question, hazelnut was identified by 34 participants (94.44%), followed by tea by 26 (72.22%), maize by 18 (50.00%), kiwifruit by 14 (38.89%), and beans by 10 (27.78%). These results were not interpreted as estimates of prevalence, but rather as signals of stakeholders' perceived regional importance and experience.

Indicator	1.	2.	3.	4.	5.
Most frequently reported IAS	H. halys 34 (%94,44)	A. chinensis 17 (%47,22)	O. japonica 17 (%47,22)	-	-
Most frequently reported crops	Hazelnut 34 (%94,44)	Tea 26 (%72,22)	Maize 18 (%50,00)	Kiwifruit 14 (%38,89)	Beans 10 (%27,78)

Hazelnut was particularly prominent among the IAS–crop associations. The relationship between the brown marmorated stink bug and hazelnut was reported by 32 participants, corresponding to 88.89% of the participants and 40.00% of all crop-related responses for *H. halys*. The relationship between *Anoplophora chinensis* and hazelnut was reported by 17 participants (47.22%; 40.48% of the responses), while the relationship between *O. japonica* and hazelnut was reported by 13 participants (36.11%; 30.95% of the responses).

In the climate perception questions, seasonal changes and drought were each identified as concerns by 22 participants (61.11%), followed by late frosts by 21 participants (58.33%), heat waves by 15 participants (41.67%), and extreme precipitation by 13 participants (36.11%). Regarding the view that climate change increases pest and disease problems, 28 participants responded "yes" and 7 responded "partly." Within this group, an increased number of generations per year, improved overwintering success, and spread into new areas were among the most frequently identified mechanisms.

4.1.1 Priority Agricultural Crop Assessment

The multi-criteria assessment identified hazelnut as the highest-priority crop. Tea, maize, kiwifruit, and beans were also included in the priority crop set due to their regional agricultural importance, climate sensitivity, and relationships with IAS/pests. In the source report, kiwifruit and beans were assigned an overall score of 3.75; hazelnut received the highest assessment due to its agricultural and socioeconomic importance and direct exposure to IAS.

Crop	Regional rationale	Main climate sensitivity	Main IAS/pest association
Hazelnut	High economic and social importance for Trabzon and Türkiye	Frost, drought, temperature and precipitation anomalies	H. halys; A. chinensis; O. japonica
Tea	Economically important crop concentrated in the Eastern Black Sea Region	Temperature, precipitation, humidity, and seasonal variability	O. japonica / *Ricania* records
Maize	Important in terms of local consumption and traditional production systems	High temperatures, water stress, and extreme precipitation	*H. halys*; potential risks from other invasive species
Kiwifruit	Valuable fruit crop providing alternative/complementary income	Late frost, temperature and water stress, and extreme events	H. halys; Metcalfa pruinosa; O. japonica
Beans	Important in small- and medium-scale production	High temperatures and water stress during the reproductive period	H. halys; O. japonica

4.1.2 Priority Invasive Alien Species

As a result of the joint assessment of the literature, stakeholder views, and field findings, three species emerged as priorities in the Türkiye study: *Halyomorpha halys*, *Anoplophora chinensis*, and *Orosanga japonica*.

Species	Status in Türkiye/Black Sea Region	Main crop association	Relevance to A1.1
Halyomorpha halys (Brown Marmorated Stink Bug)	Recorded in the Eastern Black Sea Region since 2017; a polyphagous invasive species showing westward spread	Hazelnut in particular, as well as kiwifruit, maize, beans, and numerous other crops	Strongest signal among stakeholders; yield, kernel quality, and quality losses in hazelnut production
Orosanga japonica (False Butterfly)	Established in the Eastern Black Sea Region and has a broad host range	Tea, kiwifruit, hazelnut, beans, grapevine, and other plants	Feeding on young shoots, honeydew/sooty mould; regional spread
Anoplophora chinensis (Citrus Longhorn Beetle)	Subject to quarantine measures; has shown localised distribution in Türkiye, with records associated with hazelnut in Trabzon	Hazelnut and numerous woody hosts	Detection and control difficulties due to larval development inside wood; phytosanitary risk

4.1.2.1 Brown Marmorated Stink Bug (*Halyomorpha halys*)

Halyomorpha halys (Stål, 1855) (Hemiptera: Pentatomidae) is an invasive and polyphagous species of East Asian origin with a broad host range. Its high mobility, ability to feed on a wide range of plants, adaptability to different environmental conditions, and ability of adults to overwinter in sheltered areas play important roles in its invasive success (Lee et al., 2013; Leskey & Nielsen, 2018). The first records in Türkiye were reported from the Eastern Black Sea Region in 2017, and its distribution was subsequently found to have expanded westward (Ak et al., 2019; Ak, Uluca, & Tunçer, 2023).

The development of the species is temperature-dependent. It has been reported that development from egg to adult can be completed at approximately 17–33 °C, with approximately 537.6 degree-days required for total development (Nielsen et al., 2008). In spring, overwintered adults become active and begin moving towards host plants, while populations may increase rapidly under favourable conditions during the summer period.

H. halys feeds with piercing-sucking mouthparts, particularly on fruits, seeds, and developing reproductive organs. In hazelnut, feeding damage may result in quality problems such as aborted or shrivelled kernels, kernel discolouration ("lemoning"), staining, mould formation, and decay. In a study conducted in Ordu, commercial kernel yield was determined to be 25.40% in heavily damaged hazelnuts, compared with 51.20% in the undamaged control group; the proportions of mouldy, decayed, and "lemoned" kernels also increased in heavily damaged samples (Kan, Akgün, & Turan, 2024).

Surveys conducted along the Black Sea coastal zone during 2019–2021 identified particularly high population densities in Artvin and Rize, and reported that the pest continued to spread from east to west. The same study indicated that, in addition to hazelnut, the species could reach densities capable of causing economic damage in kiwifruit, citrus, maize, and beans (Ak, Uluca, & Tunçer, 2023). Recent studies indicate that assessing the damage dynamics in hazelnut together with crop phenology is important for determining the timing of control measures (Uluca et al., 2026).

Monitoring and Control Assessment

Rather than relying on a single control method, an integrated pest management approach is recommended for the brown marmorated stink bug. Pheromone traps can be used to monitor population density and seasonal activity; studies conducted in Türkiye have shown that the capture performance of different trap and pheromone combinations can vary considerably (Uluca & Ak, 2023; Altanlar & Tunçer, 2023).

Although chemical control can provide rapid effects when pest populations reach the economic threshold, it is not a long-term solution on its own due to the species' broad host range and high mobility. The conservation of natural enemies, as well as residue and environmental impacts and application timing, should be taken into consideration. In biological control, the egg parasitoid *Trissolcus japonicus* has emerged as a prominent candidate, and production and release studies are being conducted in Türkiye. Supporting this approach with regular monitoring and scientific risk assessments is important (Abram et al., 2017; Leskey & Nielsen, 2018).

4.1.2.2 False Butterfly (*Orosanga japonica*)

Orosanga japonica (Melichar, 1898) (Hemiptera: Ricaniidae) is a polyphagous invasive species of East Asian origin with a broad host range. In early studies in Türkiye, the species was referred to as *Ricania simulans*; however, *Orosanga japonica* is the currently preferred nomenclature. The species was first recorded in Türkiye in 2009 and has been reported as an important agricultural and urban pest, particularly in the Eastern Black Sea Region during the 2010–2020 period (Ak, 2026).

The species produces one generation per year and overwinters in the egg stage. In the Eastern Black Sea Region, nymphs generally appear from mid-May onwards, while adults are observed during the summer, with adult density increasing during the second half of August. Both nymphs and adults feed on phloem sap from young shoots and leaves. The honeydew excreted during feeding can support the development of sooty mould, which may adversely affect photosynthetic capacity and plant development.

Tea, kiwifruit, hazelnut, beans, grapevine, fig, cherry laurel, and numerous wild plants have been reported as host plants (Ak, Güçlü, Eken, & Sekban, 2015). In Türkiye, studies have been conducted on entomopathogenic fungi and other biological control agents, including investigations into the potential of *Beauveria bassiana*, *Metarhizium* spp., and *Conidiobolus coronatus* (Ak et al., 2014; Göktürk, 2020).

4.1.2.3 Citrus Longhorned Beetle (*Anoplophora chinensis*)

Anoplophora chinensis (Forster, 1771) (Coleoptera: Cerambycidae) is an invasive quarantine pest of East Asian origin, capable of developing on a wide range of woody plants and included in the EPPO A2 List. Since larvae spend most of their life within plant tissues, detection and eradication are challenging. Important host plants include hazelnut, citrus, maple, plane, willow, poplar, apple, pear, and various *Prunus* species.

The species was first detected in Türkiye in Istanbul in 2014, followed by its detection in a nursery in the Maçka district of Trabzon in 2016 and in nearby hazelnut orchards in 2017. The infested area in Trabzon was reported to have reached approximately 409 hectares in 2021. The commercial movement of nursery material has been identified as an important risk factor for the long-distance spread of the species (Turan & Erdoğan, 2022; EPPO Global Database, 2026).

The primary source of economic damage is the galleries excavated by larvae in trunks, root collars, and roots. These galleries can impair vascular tissues and mechanical stability, potentially resulting in stunted growth, branch dieback, and general weakening of plants. Within the Maçka infestation, plants were uprooted for eradication purposes across hundreds of hectares of hazelnut-growing areas, and more than 172,000 hazelnut plants were reported to have been removed as of 2021 (Turan & Erdoğan, 2022).

The management of *A. chinensis* relies primarily on early detection, quarantine measures, the removal and safe destruction of infested plants together with their roots, regular inspection of surrounding host plants, and control of the movement of nursery material. Chemical control has limitations because the larvae are located inside the wood; entomopathogenic nematodes, fungi, and parasitoids are among the biological control options currently being investigated (Brabbs et al., 2015; Karaborklua et al., 2024).

4.2 Agricultural Crops Affected by Invasive Alien Species

In the stakeholder consultation survey, participants were asked to identify the agricultural crops they considered to be affected by the prominent invasive species. In this assessment, where multiple responses were permitted, hazelnut was the most frequently reported specific agricultural crop for all three invasive species.

For the brown marmorated stink bug (*Halyomorpha halys*), hazelnut was reported by 32 participants (88.89%), followed by maize (16.67%), beans (13.89%), tea (11.11%), and kiwifruit (5.56%). For *Anoplophora chinensis*, hazelnut ranked first at 47.22%, while beans and maize were reported at 11.11% and 8.33%, respectively. For *Orosanga japonica*, hazelnut was also the most frequently reported crop at 36.11%, while beans, maize, and tea were each reported at 8.33%.

Overall, the findings indicate that hazelnut was particularly strongly associated with *H. halys*, while the other crops were perceived as being associated with the three invasive species at varying rates. Reports were also received for fruits and vegetables as general crop categories for all three species. These findings reflect participants' observations and assessments and should not be interpreted directly as indicators of pest density or crop losses.

Priority crop	H. halys	A. chinensis	O. japonica
Hazelnut	88,89%	47,22%	36,11%
Maize	16,67%	8,33%	8,33%
Beans	13,89%	11,11%	8,33%
Tea	11,11%	2,78%	8,33%
Kiwifruit	5,56%	2,78%	2,78%

4.3 Field Verification Findings

Invasive species: In the field interviews and surveys conducted in Trabzon, the Brown Marmorated Stink Bug (*Halyomorpha halys*) was the most frequently reported invasive species, at 100%. It was followed by the Citrus Longhorned Beetle (25.0%), Bark Beetle (16.7%), Mole Cricket (8.3%), and False Butterfly (8.3%). Field observations also indicated that *Orosanga japonica* was particularly abundant in some production areas, especially in August.

Affected agricultural crops: Hazelnut was the crop reported as being most affected by invasive pests, identified by all 12 producers (100%). Hazelnut was followed by beans (58.3%), while maize, apple, pear, tomato, and eggplant were each reported at 16.7%. Potato, tea, pea, cherry laurel, lemon, and persimmon were each reported at 8.3%.

Impacts: All producers (100%) reported adverse effects on crop quality, while 83.3% reported yield losses and 75.0% reported crop losses. In hazelnut, particularly, reductions in kernel quality, staining, incomplete development, and the formation of shrivelled or undeveloped kernels were observed.

Occurrence period and climate relationship: Five of the 12 producers (41.67%) associated the occurrence or increased abundance of pests with increases in temperature. August (41.7%) was the most frequently reported month, followed by June and July (33.3% each). Producer observations and field findings indicate that the timing of pest occurrence should be assessed in conjunction with temperature patterns, seasonal variability, and local conditions.

Control practices: The most common control methods were chemical control (41.67%) and trap/pheromone applications (41.67%). Of the producers, 41.67% considered the existing control methods insufficient, while 25% considered them partially sufficient. Field interviews indicated the need for area-based and coordinated control in addition to individual control practices.

Digital monitoring: Nine producers (75%) expressed a positive attitude towards digital monitoring systems similar to MAPPEST, while three producers (25%) stated that they would consider using such a system. No producer expressed a negative opinion. This finding supports the potential use of digital tools for early detection, regular monitoring, and information sharing.

Samsun verification: Field studies conducted by OMU in Samsun supported the general assessment regarding the significance of Brown Marmorated Stink Bug pressure, particularly in hazelnut production areas. Thus, the main field findings obtained from Trabzon were assessed at the national level together with the supporting observations from Samsun.

Indicator	Key finding
Most frequently reported invasive species	Brown Marmorated Stink Bug – 100%
Most affected crop	Hazelnut – 100%
Adverse impact on crop quality	100%
Producers reporting yield loss	83.3%
Producers reporting crop loss	75.0%
Producers associating pest occurrence with increased temperature	41.7%
Most frequently reported period	August – 41.7%
Most common control methods	Chemical control + traps/pheromones – 41.7% each
Positive attitude towards digital monitoring systems	75.0%

4.4 Consolidated Crop–IAS Catalogue Profiles

TR-CROP-01 – Fındık (Corylus avellana L.)

Due to Türkiye's leading position in global hazelnut production and Trabzon's status as one of the important hazelnut-producing provinces, hazelnut represents the strongest priority in terms of economic and socioeconomic importance. In 2024, approximately 717,000 tonnes of hazelnuts were produced in Türkiye across approximately 749,000 hectares, generating USD 2.6 billion in revenue from approximately 323,000 tonnes of exports (TÜİK, 2026; FAO, 2026; Trabzon Commodity Exchange, 2025). Frost, drought, and temperature/precipitation anomalies are important in terms of crop phenology and yield. *H. halys* represents the most prominent IAS pressure; in hazelnut, it may cause quality problems such as aborted or shrivelled kernels, "lemoning", mould formation, decay, and reductions in commercial kernel yield (Kan et al., 2024).

TR-CROP-02 – Tea (Camellia sinensis)

The tea crop is concentrated within a limited geographical area in the Eastern Black Sea Region and is of high importance in terms of regional income. In Türkiye, approximately 1.3 million tonnes of tea were produced on around 810,000 decares of land in 2025, and Trabzon is reported to be one of the major tea-producing provinces after Rize (TÜİK, 2026). Tea yield is associated with temperature, precipitation, and humidity conditions (İrdem, 2022). Records of *O. japonica*/*Ricania* make monitoring regional pest pressure in tea-growing areas particularly important.

TR-CROP-03 – Maize (Zea mays L.)

In Türkiye, maize is an important crop for food, feed, and industrial raw materials, while in the Eastern Black Sea Region it is valued within small-scale and traditional production systems. High temperatures, water scarcity, excessive precipitation, and erosion risks may affect production conditions. *H. halys* is among the recorded host-associated pests of maize; therefore, monitoring climatic stress and biotic pressure together is important.

TR-CROP-04 – Kiwifruit (Actinidia deliciosa)

Doğu Karadeniz'in nemli-ılıman koşullarında yetiştirilen ekonomik değeri yüksek alternatif bir meyvedir. İlkbahar geç donları, aşırı sıcaklık, kuraklık ve su dengesizliği kritik streslerdir (Rajan et al., 2024; Shen et al., 2023). H. halys ile birlikte Metcalfa pruinosa ve O. japonica açısından ilgili zararlılar arasında değerlendirilmiştir.

TR-CROP-05 – Beans (Phaseolus vulgaris L.)

In the Eastern Black Sea Region, beans are cultivated for both fresh and dry consumption, predominantly by small- and medium-scale farms. High temperatures and water stress, particularly during the flowering, pollination, pod formation, and grain-filling stages, may lead to yield losses (Nadeem et al., 2022). The presence of *H. halys* in the region and its status as a recorded host of beans support direct exposure to IAS.

5. Discussion

The most prominent convergence in the Türkiye A1.1 findings is the identification of hazelnut as the priority crop and *H. halys* as the priority invasive species. This finding is consistently supported by the stakeholder survey, field observations, and scientific literature. Surveys conducted along the Black Sea coastal zone during 2019–2021 showed that *H. halys* reached high population densities, particularly in the eastern provinces, and continued to expand westward (Ak et al., 2023). In hazelnut, the damage has been reported to affect not only crop quantity but also kernel yield and commercial quality (Kan et al., 2024).

A second important finding of the study is that the relationship between climate and pest pressure should not be interpreted as unidirectional. Stakeholders and producers associated conditions such as increasing temperatures, seasonal shifts, drought, and late frosts with the timing of pest occurrence and production problems. The scientific literature also indicates that insect development and overwintering success are temperature-sensitive; however, conditions such as extreme temperatures, water stress, and irregular precipitation may have different effects on both plants and pests. Therefore, simultaneous assessment of weather conditions, crop phenology, and pest activity provides a more robust framework for monitoring.

Third, the fragmented and heterogeneous agricultural landscape of Trabzon complicates the management of polyphagous pests. The close proximity of hazelnut, tea, kiwifruit, maize, beans, and other host plants to natural and semi-natural vegetation may facilitate the movement of species with broad host ranges, particularly *H. halys* and *O. japonica*, among crops. Therefore, it is important that the outputs of A1.1 provide a basis for an approach that monitors crop–pest–climate interactions at the regional scale.

The limitations of the study should also be taken into consideration. Stakeholder and producer surveys provide complementary information on producer experiences and the current pest situation in the field, serving as sources of stakeholder perspectives and field-based signals. As field visits were limited to specific periods and locations, the findings should be treated as field-based evidence guiding prioritisation and monitoring activities rather than as definitive estimates

of pest prevalence in the region. Accordingly, rather than drawing causal and generalisable conclusions regarding pest prevalence or the effects of climate change, the findings will be used as evidence to guide prioritisation and subsequent monitoring activities.

6. Conclusions and Recommendations

The literature reviews, stakeholder consultations, surveys, and field visits conducted under A1.1 have demonstrated that invasive alien species constitute a pressure that should be taken into consideration in agricultural production in the Black Sea Region. In the Türkiye study, *Halyomorpha halys*, *Anoplophora chinensis*, and *Orosanga japonica* were identified as the prominent IAS, while hazelnut, tea, maize, kiwifruit, and beans were identified as priority agricultural crops.

The hazelnut–*H. halys* relationship represents the finding for which the different sources of evidence show the strongest convergence. The potential variation in pest impacts depending on their coincidence with sensitive developmental stages of hazelnut highlights the importance of considering crop phenology in monitoring and assessment. Climatic conditions should also be evaluated together with pest activity and crop development, while direct claims of climate–pest causality that are not supported by the available project data should be avoided.

In subsequent project activities, it is recommended that the priority species and crops identified in A1.1 be used as the basis for field monitoring; in particular, the brown marmorated stink bug–hazelnut relationship should be monitored in conjunction with seasonal activity and crop phenology. Producer and stakeholder observations should continue to be used as complementary sources of evidence. Furthermore, the species, crop, and field findings identified under A1.1 should provide inputs for the A1.2 activities and the CPDS and MAPPEST components.

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