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Survey on Etiology and Distribution of Dieback / Decline of Hazelnuts (*Corylus avellana* L.) in Northern Iran

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A B S T R A C T

Hazelnut (*Corylus avellana* L.) is affected by dieback (DB) and decline (D) diseases causing significant losses to hazelnut production in the Eshkevarat (Guilan province, northern Iran) as the main region for hazelnut production in Iran. Although, causal agents of these disorders have remained uncertain for many years. During 2017-18, results of a survey on DB and D diseases in hazelnut -growing sites (HGS) from Roudsar (54 out of 199 villages) and Amlash (14 out of 124 villages) counties (Eastern Guilan) revealed that mean frequency distributions (%) of DB and D diseases based on the infected HGS in the Roudsar and Amlash counties were equal to 27.14 and 10.85%, respectively. DB and D diseases were widespread in the Eshkevarat region, where they occurred in 38.7 - 55.3% of the hazelnut orchards. Mean tree infection (%) ranged from 3.94 to 28.3% and 6.1 to 33.6% in Amlash and Roudsar counties, respectively. The fungi with different distribution frequencies included *Cytospora* sp. (33.60%), *Phomopsis* sp. (14.40%), *Verticillium dahliae* (11.20%), *Lasiodiplodia* sp. (16.80%), *Rosellinia necatrix* (10.40%), and *Pestalotiopsis* sp. (13.60%), which were isolated and identified based on their morphological and cultural characteristics and were tested for their pathogenicity. Fungal pathogens infected hazelnut trees individually, or in combinations, to cause hazelnut dieback. Most of these fungal pathogens initiate infections at wounds caused by insects, humans, machinery, lightning, wind, and hail.

Introduction

Hazelnut belongs to *betulaceae* family and *Corylus* genus (United States Department of Agriculture (USDA, 2011). European hazelnut (*Corylus avellana* L.) represents an economically important crop in several countries of Europe, Western Asia, Northern and Southern America, and Oceania (food and agriculture organization (FAO), 2017). Turkey (420,000 tons), Italy (120,572 tons), and the U.S. (34,473 tons) are the top three hazelnut producers, followed by Azerbaijan (33,941 tons), Georgia (29,500 tons), and China (26,071 tons) (https://www.atlasbig.com/en-us/countries-hazelnut-production). It has been reported that Iran's annual production of hazelnut is about 21,545 tons from 25,453 hectares throughout the country (financialtribune.com/articles/economy-domestic-economy/75837/hazelnut-production-at). Hazelnut is grown in Guilan, Mazandaran (Northern Iran), Qazvin (Northwestern Iran), Ardabil (Northeastern Iran) and Zanjan (Northwestern Iran) provinces (Salimi and Hoseinova, 2012). Eshkevarat region (including Roudsar, Amlash, and Syahkal counties, Gilan province) with high rainfall and relative humidity and 73% of Iran's total hazelnut production is the largest

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producer of the country producing about 15,300 tons and occupying an area of about 16,000 hectares.

Pests and diseases are the major restrictions in hazelnut production in the world. Since 2006, there has been an increase in the severity of dieback (DB) and decline (D) diseases in hazelnut trees in the Eshkevarat region. Disorders cause yellowing of leaves, root rot, wilting, and death of shoots and branches. In the advanced stages, symptoms are also characterized by drying of leaves, and discoloration of vascular tissues of the branches that begin to dry one after another in a sequence resulting in wilting and death of the trees (Fig. 1). Other symptoms emerge when inner-bark and wood die in lesions leading to a yield decline of up to 15% as reported in the literature. Severe infections on old trees result in death of the trees. When the hazelnut plant is at immature stage, shoot dieback can cause death of seedlings younger than 15 months.

Razzaz-Hashemi *et al*., (2000) reported the presence of *Phyllactinia guttata, Cytospora fukelii, Rosellinia necatrix, Armillaria mellea*, and *Polyporus* sp. from hazelnut trees in Qazvin province. Several other fungal species including *Alternaria alternata*, *Mamianiella coryli*, *Phyllactinia corylea*, *Diplodia theabrome*, and *Colletotrichum gloeosporioides* have also been identified as pathogens on leaves and stems and *Phomopsis* sp., *Fusarium semitectum*, *Fusarium anthophilum*, and *Verticillium* sp. have been isolated from crown and roots of hazelnut trees (MirHosseini-Moghaddam and Taherzadeh, 2007). Mirabolfathi *et al*., (2013) reported *Phomopsis* galls of hazelnut trees in Guilan province (Northern Iran). Arzanlou *et al*., (2018) reported a new species of powdery mildew on *C. avellana* from forest areas in the Ahar (East Azerbaijan province) and Khodaafarin (Ardabil province) regions of Iran. Battilani *et al*., (2018) isolated different fungi, such as *Alternaria*, *Colletotrichum,* Diaporthe, and *Pestalotiopsis* from the affected and symptomless hazelnut trees. The fungi of *Alternaria* spp. and *Piggotia coryli* have been isolated from symptomatic hazelnut trees showing blight and anthracnose diseases (Durga *et al*., 2016). Durga *et al*., (2017) recovered *Dothiorella sarmentorum* (*Botryosphaeriaceae*) from hazelnuts with dieback symptoms. Several fungal species have been isolated from dieback of the infected hazelnut trees in Iran; however, some of them were not able to produce disease according to different pathogenicity tests. Although, there are contradictory results regarding the ability of the species to cause dieback disease. Periodic occurrence of loss of hazelnut tree vigor, branch dieback and tree mortality caused by unknown or difficult reasons to determine among phenomena, which have frustrated growers and intrigued researchers for many years in Guilan province. Dead twigs and branches are common in hazelnut trees in Guilan province, but associated fungi, potential regional distribution, and incidence of DB or D diseases have not been fully investigated. Therefore, this survey was conducted to determine distribution, incidence, and fungal causes of hazelnut trees showing DB and D symptoms in the Guilan province.

Materials and Methods

Orchard surveys

This study was carried out in hazelnut-growing area of Eshkevarat (involving Roudsar and Amlash counties, Eastern Guilan province, Northern Iran) from September, 2017 to August, 2018 (Figs. 1-3). A total of 68 villages and 142 hazelnut orchards were inspected for dieback and decline disorders (Tables 1 and 3). Hazelnut orchards were arbitrarily chosen along the pre-determined routes. Incidence of disorders and symptoms including twig dieback, leaf wilting, dead bark, sunken lesions on tree twigs (or branches), internal wood necrosis, brown vascular discoloration or rotted roots was determined in 60 trees, arbitrarily chosen along the two diameters of the disordered orchards.

Isolation from the affected trees

Samples of twigs (or branches), shoots, and roots of the disordered trees were collected and possible fungi were isolated from the sampled tissues under laboratory conditions. In total, 175 samples (158 shoot/branch and 17 root samples) with a range of symptoms were collected from the disordered (infected) orchards, aged 15 years old or older. Samples were placed in bags, were transferred to laboratory and were kept at 4 °C. Samples were washed under running tap water and then, were surface sterilized using ethanol 70% (C_2H_5OH) solution and 0.6 % of sodium hypochlorite for 60 s, were rinsed thrice in sterile distilled water for 1 min and each of them was dried using sterile towel paper to remove water from their surface. Small pieces, 5-10 mm long, from the edge between healthy and the affected wood tissues were placed onto potato dextrose agar (PDA) (Difco, pH 6.5), and/or prostate specific antigen (PSA) and malt extract agar (MEA) plates amended with Tetracycline (1 mg/L) and were incubated at 25±1 °C for 3-5 days. The *Cytospora* isolates were collected directly from conidial masses exuding from freshly exposed pycnidia on declining branches. Pure cultures were obtained by transferring a single conidium or hyphal tip from margin of the fungal colonies (Lawrence *et al*., 2018).

Fig. 1. Symptoms of fungal canker, wilt and decline on hazelnut trees

Fig. 2. Canker, wood discoloration and associated twig dieback with *Lasiodiplodia* sp. (A), *Verticilium dahliae* (B), *Phomopsis* sp. (C) and *Cytospora* sp. (D) in hazelnut

Fig. 2. Continued.

Fig. 3. *Rosellinia necatrix* causes collar rot of hazelnut
(Cottony, white mycelia cover rotted collar)

Morphological characterization

The fungal isolates were identified with respect to their genus/or species based on phenotypic observations and micromorphological characteristics (Smith, 1965; Sivanesan and Holliday, 1972; Punithalingam, 1976; Sutton, 1980; Uecker, 1988; Petrini, 1993; Pegg and Brady, 2002; Santos *et al*., 2010; Abbasi *et al*., 2012; Maharachchikumbura *et al*., 2014).

Pathogenicity tests

Pathogenicity of *Cytospora* sp., *Phomopsis* sp., *Lasiodiplodia* sp., *Pestalotiopsis* sp., *V. dahliae*, and *R. necatrix* isolates was assessed. The first four fungal species were assessed on the detached shoots using a mycelium plug with 6 mm in diameter from 7-day-old cultures on PDA plates. The mycelium plug was placed with its upper surface facing downward on wounds made by a sterile blade (PDA plug without mycelium was used as control) under humid conditions. All control and inoculated twigs were maintained at 25 °C for 7-10 days. Then, fungal isolates were re-isolated from the symptomatic inoculated detached twigs. For the latter two, healthy 12-month-old propagated hazelnut seedlings (as rooted cuttings) were inoculated by dipping into a monoconidial *V. dahliae* suspension (4×10^6 per ml) for 30 min. (Colella *et al*., 2008). The inoculated seedlings were transplanted into sterile plastic pots containing sterile soil. Also, 9-month-old hazelnut rooted plantlets were potted in plastic pots containing 30 g of wheat seeds contaminated with *R. necatrix* mycelia from 14-day-old culture on MEA medium ,which was used per kg of sterile soil (Freeman *et al*., 1992).

Results

Importance and distribution

Symptoms of the affected hazelnut trees included twig dieback, leaf wilting, dead bark, sunken lesions on twigs, internal wood necrosis, brown vascular discoloration, or rotted roots. Frequency of the infected hazelnut orchards varied from 38.7 to 55.3% in the inspected orchards, with mean incidence of hazelnut trees with various symptoms of 6.8 - 33.6% (Roudsar county) and 3.94 - 28.3% (Amlash county), respectively (Tables 2 and 3). DB and D diseases were extensively distributed throughout the Eshkevarat region. The most affected hazelnut orchards were in the villages of Niloo (45.7%) and Koojid (28.3%), as shown by their higher values in disease assessment.

Fungal isolates

In this study, a total of 125 fungal isolates were obtained from symptomatic trees (112 from shoots and/or branches and 13 from roots) in 68 hazelnut orchards. These fungi were isolated in about 54% of the collected samples from aerial parts and roots. Seven genera were identified as follows: *Cytospora* sp. (33.60%) *Phomopsis* sp. (14.40%) *Verticillium dahliae* (11.20%), *Lasiodiplodia* sp. (16.80%), *Pestalotiopsis* sp. (13.60%) and *Rosellinia necatrix* (10.40%) (Figs. 4 and 5).

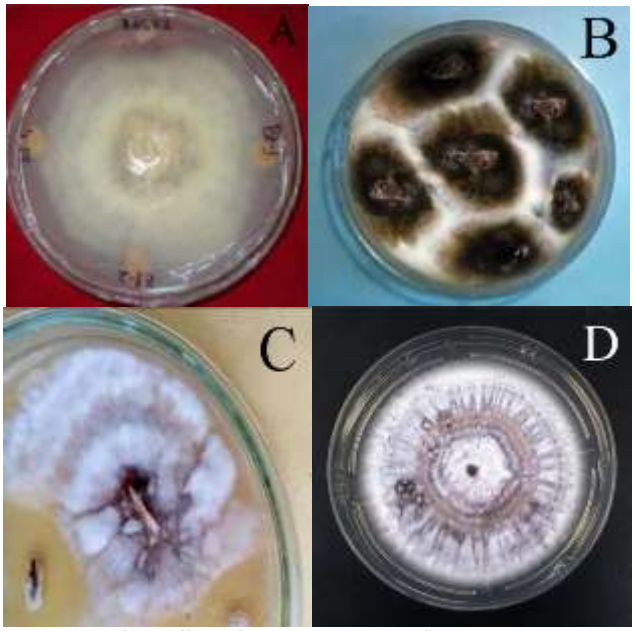

Fig. 4. The colonies on potato dextrose agar of the different fungal species isolated from hazelnut trees in Guilan province (northern Iran). A, *Cytospora* sp.;B, *Lasiodiplodia* sp.; C, *Pestalotiopsis* sp.; D, *Rosellinia necatrix*.

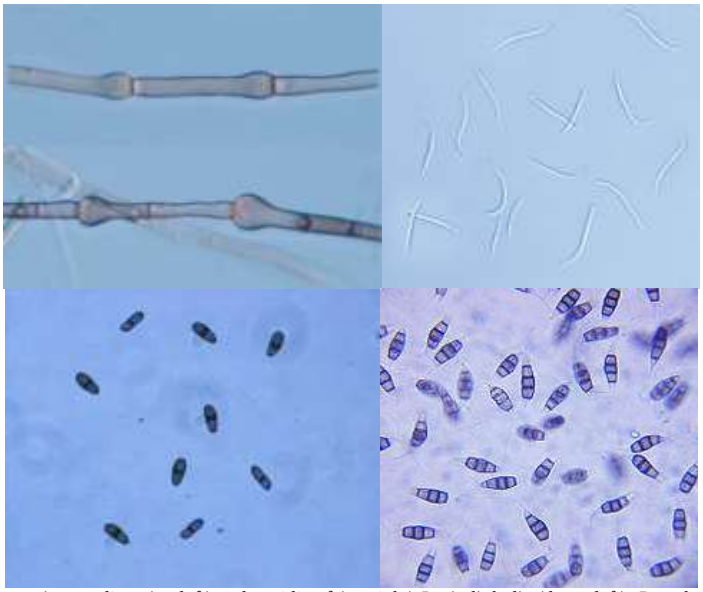

Fig. 5. *Rosellinia necatrix* mycelium (up-left) and conidia of (up-right) *Lasiodiplodia* (down-left), *Pestalotiopsis* (down-right)

The colonies of *Pestalotiopsis* sp. reaching 55 mm in diameter on PDA at 25±2 °C after 7 days. Acervuli formed on the cottony white aerial mycelium contained black and slimy conidial masses. The fungal conidiophores were hyaline and branched. Conidiogenous cells were annelidic, hyaline and smooth. The *Pestalotiopsis* sp. had five-septate and pigmented median cells of fusiform conidia with 3-4 apical appendages arising from the hyaline apical cell and a centric basal single long appendage (Sutton, 1980; Nag Rag, 1993). In *Lasiodiplodia* sp., the colony color on the MEA at 28°C and dark conditions was initially white with woolly aerial mycelia, becoming grey to black on the surface after two weeks and the reverse side of the it was grey to dark black. The diameter of fungal colony on MEA reached 77 mm after 48 h. For induction and formation of pycnidia and conidia, the Lasiodiplodia cultures were placed on 2% WA and incubated at 28 °C under 12h light/dark durations. The *Lasiodiplodia* sp. had pycnidial paraphyses and longitudinal striations on mature conidia. The *Phomopsis* sp. formed gray colony with thin mycelia that produced aerial hyphal over rings. Spherical and black pycnidia were scattered over the fungal colony after 12 days of incubation. The α-conidia were fusiform, hyaline, single-celled and aseptate. The β-conidia were filiform, hyaline, single-celled and aseptate. The *R. necatrix* isolate formed white mycelia with pear-shaped swellings near septa in hyphae. Conidiophores were erect, brown, branched and long (500 µm tall), 2.5-2.8 µm wide bearing 20-30 conidia in two rows on the conidiogenous cells of apical branches of the conidiophores. Conidia were hyaline (or subhyaline), one-celled, elliptical or ovate, 3.9-5×2-2.3 µm. After conidial detachment, scars were formed on the conidiogenous cells. Inoculations on detached shoots of *C. avellana* resulted in lesions with darkened or brown centers around the wounded sites that expanded as browning of the tissues (Fig. 6). No symptoms were observed on the controls. The pathogens were consistently re-isolated from the inoculated shoots of *C. avellana.*

Fig. 6. Detached shoots of hazelnut were inoculated by *Pestalotiopsis* sp. (left) and *Cytospora* sp. (right)

Discussion

DB and/or decline of hazelnut tree is referred to a gradual deterioration process characterized by loss of vigour, death of twigs and shoots, reduction in yield ,and ultimately death of trees as observed in Guilan province. Therefore, this multifaceted survey was conducted for the first time on DB and/or decline of hazelnut trees in hazelnut-growing areas of Eshkevarat region, Guilan province (Northern Iran). DB and D diseases were serious problems in some hazelnut orchards, affecting 45% or more of the inspected trees. Trees with abundant young shoots and older shoots showed a large amount of dead shoots and withered leaves. Incidence and severity of DB and D diseases are assumed to have steadily increased over the past few years. DB agents can destroy large areas of hazelnut orchards, eventually leading to loss of hazelnut production. But, causal agents of DB and D diseases have remained uncertain for many years due to different fungi, pests, and nutritional conditions associated with them. Under favorable conditions, infections are characterized by dying back of twigs from the top and downwards, followed by discoloration and death of leaves, and root rots, particularly in older hazelnut trees. There are different types of fungi responsible for a variety of DB and D diseases that can affect hazelnut trees. Common fungi causing dieback diseases belong to *Cytospora, Phomopsis, Verticillium, Lasiodiplodia,* Pestalotiopsis, and *Rosellinia* genera. Guerrero *et al*., (2014) detected phytopathogenic fungi of *Diaporthe* sp. and *Phomopsis* sp. from stem and twig cankers of hazelnut trees in Chile. Fungi of *Lasiodiplodia* spp. are cosmopolitan and occur on a variety of plant hosts causing dieback and canker diseases (Von Arx and Müller, 1954; Barr, 1987).

Lasiodiplodia theobromae (Pat.) Griffon & Maubl has been reported to cause numerous diseases including dieback, root rot, fruit rots, leaf spot, and witches' broom (Punithalingam, 1980). It also occurs as an endophyte (Rubini *et al*., 2005; Mohali *et al*., 2005). The *Phomopsis* spp. have also been isolated from hazelnut trees (Librandi *et al*., 2006). *Cytospora* canker is present in hazelnut-growing areas worldwide (Lamichhane *et al*., 2014). Causal agent is considered to be a secondary invader of the damaged tissue mainly attacking the stressed trees. Summer heat and low soil organic matter influence severity of hazelnut *Cytospora* canker (Salerno, 1961; Lamichhane *et al*., 2014).

Dieback of one or more branches within the hazelnut tree from *Cytospora* canker causes widespread deterioration in the entire orchard. The fungus attacks trees or the injured parts of the trees (winter injury or pruning wounds) or those that are in weak or stressed conditions (Luepschen *et al*., 1979). The pathogen is unable to invade healthy tissue of the tree and requires a wound as a mode of entry. Karaca and Erper (2001) and Göre *et al*., (2010) introduced *Pestalotiopsis guepinii* as a causal agent of twig blight on hazelnuts. Most of these fungi are soil-borne and/or air-borne wound pathogens that can affect all parts of the hazelnut trees at all ages. They invade to twigs and branches from their tips in hazelnut trees causing them to dry and the tree to wilt. The pathogenic fungus of *R. necatrix* has very wide host range and characteristic symptoms of this disease are rotting of roots, yellowing and falling of leaves, wilting and finally, death of the hazelnut tree. The Verticillium wilt (VW) of hazelnut trees is caused by the fungus of *Verticillium dahliae*, which is usually observed in

early summer as a progressive loss of leaves from the infected limbs, starting at the base of each branch (Sanei and Razavi, 2017). Occasionally, leaves may show a true wilt and when death of these leaves is very rapid, they may remain attached to the tree for several weeks. An entire tree may show VW symptoms, or infection may be confined to one side, or even one branch of the hazelnut tree. According to our results, no fungi were also isolated from 57 out of 158 shoot and/or branch samples (about 36.1%).

On the other hand, another leading cause of dieback could be abiotic agents. Thus, the observed dieback may have been caused by a combination of predisposing, inciting, and contributing factors in Guilan province. It is hypothesized that four factors including drought, insects, nutrition, and pathogens may have interacted with DB and D diseases in hazelnut trees in the studied area. Stress factors, such as spring frost, drought and winter pruning predispose hazelnut trees to DB disease. A change in the rainfall pattern and associated changes in the pest and disease incidence may be among the reasons for yield decline of hazelnut trees in Guilan province. Also it seems that, nutritional deficiency would be a reason for incidence of DB and D diseases and poor yield of hazelnut trees. Nutrients have an important role as a defense mechanism against pathogenic fungal infections (Walters and Bingham, 2007). It has been noted that when levels of potassium are decreased, trees become more susceptible to fungal and bacterial infections (Walters and Bingham, 2007). Areas showing signs of DB and D diseases have been subjected to extensive testing for fertility factors and soil chemistry. It appears that climatically-induced summer drought may be a primary factor for hazelnut dieback in Guilan province. Summer drought weakens hazelnut trees so that, they are predisposed to infection by opportunistic fungi including most of the canker fungi. Because, drought can cause bark cracking, it may also provide a wound for some fungi to penetrate the tree. Also, DB and D diseases were observed on hazelnut trees that had been already stressed or injured, which made them more susceptible to wood-boring insects. Insects like the Cerambycid borer, Scarab and Bark beetles constitute majority of hazelnut pests. Some tree pests are seen in some hazelnut-growing seasons and require immediate attention, while many others are found each year but cause little or no harm. Thus, insects and nutrition contribute to DB progression because additional stress would be added to the hazelnut trees. DB and D diseases have also been observed on Iranian native and improved hazelnut varieties associated with the variation in their susceptibility towards phyto-pathogenic fungi. Considering research results, it is necessary to take control measures for pathogens and insects of hazelnut as well as suitable cultural practices, in order to prevent the spread of pathogens on numerous other hosts and regions.

Conclusions

Our results revealed that DB and DC diseases were extensively distributed throughout the Eshkevarat region and it may have been caused by a combination of predisposing, inciting, and contributing biotic and abiotic factors. Poor orchard management is the main reason for hazelnut DB causing damage to tree, as a result of which there will be a possibility for fungal infection. DB and DC diseases are complex diseases, which cannot be attributed to any single factor. Although, there are many factors, which can cause this initial stress, root or soil-related diseases are the most common causes. Freezing temperatures can cause direct injury to hazelnut tree tissues, making them vulnerable to secondary abiotic or biotic stresses. This combination of DB most often occurs when the trees are weakened by an initial stress factor. Once the hazelnut tree is sufficiently weakened, secondary fungal invaders or boring insects commonly attack the tree resulting in its death.

Table 1. Geographic distribution of hazelnut growing area infected to dieback and decline diseases in Roudsar County (Eastern Guilan)

Geographical code	Area	Geographical code	Area
501135493-365047897	Tiola a	501298.426-3603572.33	Divroud
501207791-365036157	Tiola b	501428.086-365051177	Lima Govabar
501137-365326	Mazibon	501506.936-3650037.08	Limchal
5013501904-3645313596	Guilayeh	501506.159-364986661	Sang bonak
501447130--364759082	Tazeh-Abad	501482.802-3649806.92	Torbehpou
5014207805--3647299114	Detor-Sara	501500.408-3648601.06	Kiarmesh
5014294322--3647393142	Keykavoos	501476971-364917479	Roudbarak
5012511732--3641407988	Dashtak	50135801-365218473	Garmabdasht
5012267630--3647492115	Zaraki	501452272-365045601	Lebima
5013378308--3647364349	Shooyil	501427499-365302238	Sejiran
501151895--3648268180	Vakal-khani	501405721-365237787	Niloo
501422410--3648134548	Lardeh	501529393-364833092	Kakroud
5013270160--3643357288	Laseh-boo	50172011-36483911	Soleiman Cheer
5011555549--364687374	Baghsar	0437215-4074430	Parchkooh
5018244195--3648568748	Parachkooh	5014580-3649024	Naraki (1)
5017439417--3648219938	Cheshan	4073952-436605	Cheshan
5017198404--3648358477	Soleyman Cheer	432987-4086102	Chalmroud
5017121157--3648445061	Kala-Pahloo	5014465912--364965219	Naraki (2)
501081807--365429453	Sharmdasht	501507947--3648383216	Kiarmesh
509465514--36502244536	Baramkooh	5014320586--649280413	Roudbarak
5010452596--3649557419	Chamtookesh	5013358223-649470858	Mazoo-darreh
509477874--364908326	Reyab	5012562716--365019247	Leelaki
509335738--364960272	Nesam-Kooh	431805-4083172	Jirkol
5014530700--3653471309	Zorzoomeh	5013345864--365087256	Roomdasht
5010095-365121218	Arzeh-Gerden	500919770-365138433	Shevek
505385453-361259965	Meelash	50090921-3652027	Div-Darreh
5014587842--3643599979	Momen-zamin	501336303-365401575	Balalam

Table 2. The infection rates (%) of hazelnut orchards to dieback and decline diseases in Roudsar county (Eastern Guilan)

Tree infection (%)	Area	Tree infection (%)	Area	Tree infection (%)	Area
8.1	Parchkooh	6.4	Tiol A	11.4	Divroous
13.2	Naraki	7.6	Tiol B	8.3	Lima-Govabar
15.5	Cheshan	15.6	Mazibon	7.4	Limchal
8.9	Shevek	6.9	Parchkooh	7.2	Sang-Bonak
7.2	Bala-Lam	8.8	Kakroud	16.8	Soleyman-Cheer
6.7	Div-Darreh	7.4	Cheshan	12.1	Torbeh-Poo
8.3	Chalamroud	18.8	Sleyman-Cheer	13.7	Kiarmesh
10.84	Naraki	15.4	Kalay-Pahloo	14.5	Roudbarak
4.54	Kiarmesh	19.2	Sharmdasht	8.2	Garmabdasht
17.93	Roudbarak	9.3	Chamtookesh	6.6	Lebima
6.8	Arze-Gardan	10.4	Reyab	38.8	Sejiran

5.5	Meelash	9.35	Nesam kooh	45.7	Niliu
7.7	Maoodarreh	18.48	Jeerkol	21.69	Zorzoomeh
11.6	Guilayeh	21.4	Roomdasht	7.1	Leelaki
9.7	Keykavoos	8.3	Detoorsara	9.4	Tazeh-Abad
9.3	Showeel	6.7	Zaraki	10.9	Dashtak
7.9	Momen-Zamin	8.5	Lardeh	8.6	Vaka-Khani
9.6	Baram-Kooh	9.3	Bagh-Sar	7.2	Lesseh-Boo

Table 3. Geographic distribution of infected hazelnut growing to dieback and decline diseases and infection rates (%) of hazelnut orchards of Amlash county (Eastern Guilan)

Tree infection(%)	Geographical code	Area
28.3	500709.8-365331.4	Koojid
5.4	500802.5-365218.5	Estakhr-Sar
6.9	500838.2-365239.1	Dimajankesh
4.2	500910.1-365258.9	Roudbar-Dehsar
13.6	500645.5-365504.4	Somam
5.7	500901.1-365328.8	Garnay-Sar
7.28	39s0423041-4075976	Kalam-Roud
4.36	39s0420470-4079071	Booyeh
14.33	39s0417100-4080034	Malakoot
12.56	39s04177681-4076880	Moosa-Kelayeh
3.94	39s0420785-4075350	Siah-Estakhr
5.17	39s0432248-4075438	Gooraj
6.42	39s0415182-4077399	Chakroud
8.73	39s0414997-4080793	Leroud

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