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Survey on *Phytophthora* Species in Aliabad and Gharetapeh Villages from Varamin City of Iran by GIS Software

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Abstract

During the sampling of sub-crop areas in Aliabad and Gharetapehh of Varamin, 181 soil samples collected from the location set by GPS. After baiting and cultured samples on specific medium of the genus *Phytophthora*, species identified by valid keys and recorded the pollution of the genus *Phytophthora* in all samples conducted by GIS software. The results confirmed the existence of two species *Phytophthora drechsleri* and *Phytophthora capsici*. After searching about infection rate of each samples to the phytophthora by kriging algorithm with GIS software and correlation comparison of kriging map for amount of disease ,the percentage of sand in the soil and ups and downs on earth results showed that the slope of the land, pond areas, and that places with less electrical conductivity were contaminated.

Keyword: GIS, *Phytophthora*, Varamin, Iran

1. Introduction

Varamin city has long been by produce of numerous agricultural products, especially vegetables considered as the hub of agricultural products in Tehran province. Some of the agriculture products of this city have a global reputation such as cucumbers, tomatoes, eggplants, and melons. This city has provincial and national top scores in various fields of agriculture, so that in crop year 2015 more than 1200 hectares of Varamin lands were under cultivation of cantaloupe (reference). Despite the economic importance of the products of this province and reports of *Phytophthora* rot, identifying *Phytophthora* species and major host's distribution areas, seems necessary.

Fungi are important plant pathogens that cause more significant yield losses than bacteria or viruses. In crop plants, fungi cause more economic damage than any other group of microorganisms, with annual losses estimated at more than 200 billion US$ (Lorestani et al., 2013). Damage caused by damping off depending on plant species, fungi species, temperature and precipitation of soil moisture and can be very variable (Ghaderi et al., 2011). Genus *Phytophthora* has more than 60 species that are the major cause of various disease in many crops, Symptoms such as damping-off, shoot blight, fruit, stem, crown and root rot, can be seen in most cases and leads to death of the host. Cantaloupe damping-off disease first studied in 1944 and in 1965; genus *Phytophthora* was isolated from infected root of cantaloupe plant in Varamin by Ershad (Ershad et al., 1992).

Phytophthora species as a leading cause various diseases have been identified in a large number of plants that by their attacks on the plant created signs, such as damping-off, shoot blight, fruit, stem, crown and root rot and in most cases leads to death of the host. The role of the environment in this interaction is important because diseases need specific conditions to develop. Temperature and moisture are two of the most important environmental conditions that influence plant diseases. In addition, balanced and adequate soil fertility for any crop reduces plant stress, improves physiological resistance, and decreases the risk of disease .Global Positioning Systems (GPS) and Geographic Information Systems (GIS) technologies can utilized to geospatially reference information from disease forecasting models, disease surveys and then be used to accurately define prescription management zones (Lorestani et al., 2013).

Seem (1993) reported that GIS could be an effective system for prognosis of pests and diseases of agricultural areas, although prevention heavy economic damage has been registered and provide for the future. GIS is the important software for predicting plant diseases reported in the region and adds that this software can help to identify the level of risk for the cultivation of a product.

Lorestani et al. (2013) studied on fungal disease in wheat fields of Qarasoo in Golestan province- Iran by using GIS software then stated autumn rain and amount of Zn and N of soils as they involved the most severe on the fungal diseases of wheat. To develop effective disease management strategies, there is a need to understand the relationship between species and the environment in which they exist so as to be able to decide which areas are the most important to protect. Consequently, mapping areas with high fungal pathogen diversity is a priority for crop managers. The effective management of diseases can thus only be achieved when this valuable spatial information exists (Lorestani et al., 2013).

Other researchers are also using this software for examined the dependencies weed growth, soil and climatic condition (Wilson et al., 1993), create the interaction between nature, hosts, pests and diseases (Coulson, 1992), the relationship between migration and distribution of whiteflies in sweet potato land (Byrne et al., 1996), the distribution of *Aspergillus flavus* and division it based aflatoxin production (Orum et al., 1997), the relationship between ants and whiteflies (Everitt et al., 1996) and distribution of rice pests (Song et al., 1994).

The aim of this study was to significant areas with high rates of disease can be used by planting resistant plants to the fungi for increased efficiency. In addition, the effect of soil texture correction in reducing disease is investigated by finding the relation between the percentage of disease and amount of sand in the soil.

2. Methods and Materials

2.1 Sampling

Sampling of Aliabad and Gharetapeh in Varamin city had been done in geographical west longitude of 51725167 and geographical east latitude of 35304233 (Figure 1). 181 Samples were taken from moist soil, near healthy roots at least 5 cm below the soil surface in agricultural fields of Aliabad and Gharetapeh. Soil samples were placed in plastic bags to prevent drying out and put them in icebox then they had transferred the samples to the laboratory and reserved at 10-15 centigrade degree.

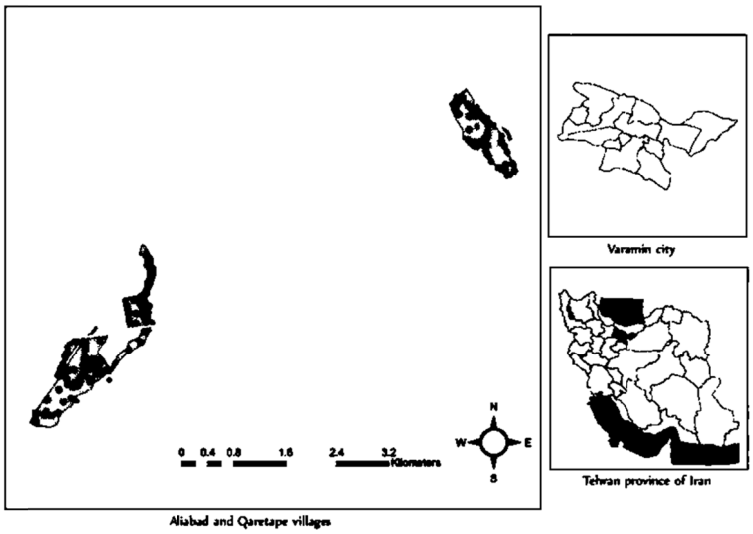

Figure 1. View map of sample locations in Iran and Tehran Province

2.2 Phytophthora spp. Isolation and Identification

Isolation of *Phytophthora* species directly from soil samples by using baiting techniques. Tow procedures of baiting techniques were used. The first method had been done a single leaf baiting citrus in method of Grimm and Alexander (1973) and second; apple baiting had been done in the Campbell (1949) method.

Bait in a different baiting that had shown fungi *Phytophthora* pollution were set on general culture fungi environment and all grown fungi on glass slides environment investigated. Isolation of target fungi was

transferred to specific culture medium and sub culture was prepared for purification of them.

2.3 The Percentage of Polluted Samples

All citrus leaves and amount of patient texture with all apple baiting of healthy texture were transferred for isolated *Phytophthora* species to selective medium. Then disease percentage in each samples were recorded according to number of baitings that showed fungi phytophthora spp. pollution (Tables 1-2). Since 20 baiting were for each soil samples, 5% pollution were considered for each one after the authenticity of pollution in each baiting to fungus *Phytophthora*.

After pure isolation of *Phytophthora* species identification the species based on taxonomic keys of Waterhouse (1963) and Stamps et al. (1990).

2.4 GIS

This software and fellowship of Aliabad and Gharetapeh that were prepared from Iranian New Farms from Etka Company of Varamin city were used for recording the results to study degree of distribution and percentage of disease in the areas.

In addition, we can compare and evaluate our own information with information related to amount of sand in the soil of mentioned area.

Raster map was prepared from amount of fungi *Phytophtora* spp. in soil of mentioned area then its Kriging algorithm was drawn by GIS 9.3. Kriging algorithm related to amount of sand in the soil texture of two areas was taken in Iranian New Farms of Etka company in Varamin city then dependence of two algorithms in each area were studied separately by GIS.

3. Results

3.1 Isolation and Identification

Separated isolations were detected based on available resources such as Stamps et al. (1990), Waterhouse (1970), and Ershad (1992) and existence of two species in names of *Phytophthora capsici* and *Phytophthora drechsleri* were confirmed in two areas.

Phytophthora capsici: The fast growth on agar environment, round colonies with smooth margins without specific structure and downy, hypha had an acute angle to right one, hypha width was 3.5 to 7.5 micrometers, inflammation of hypha and chlamydospor had not seen in any of cultures. Sporangiophores were disorderly and proliferation mode had not been found in them. Sporangia formed a lot on agar and liquid environments. Sporangia were long, non-dropping with large papillae .They can be seen in different shapes such as ellipse, upside-down pear, and oval shapes. Most of sporangia were thinner in base .Their sizes were in 94-32 × 17-44 and in average 32 × 51 and in average length to width ratio were1, 59. Oogons are spherical, colorless and nearly fills Oogonium. Their diameters in average were 28 micrometer and their walls had 1.5-micrometer thickness. *Phytophthora drechsleri*: Hypha was without transverse wall and its width was between 3-5-6 micrometers, often root inflammations were separate single and separately in hypha and their sizes were varied in 12-21 micrometer. Chlamydospore was not found in any samples, Proliferation mode was visible in all samples. Sporangia were terminal and without papillae and mostly they were seen in shape of upside-down pear or elongated pear. In some Isolations, wall of sporangia were seemed thicker like a thin crescent. Sporangia were formed in huge numbers after putting cannabis on special cultural environment in white glow then putting seeds in distilled water in mentioned conditions. Sporangiophores were a little thinner than hypha and they had same width. They were nondropping, in size of 23-48 × 26-97, in average 32 × 56 micrometer, length to width ratio of them in average were 1.69. Egg wall was plane, its diameter in average was 2.8 micrometer, and diameter of egg was 27 micrometer.

3.2 Study of Disease Percentage in Samples

Disease percentage in all detected samples by baiting techniques, purification and identification of invasive fungal in all sampled areas had been recorded by GPS after examining 181 collected samples from Aliabad and Gharetapeh in Varamin city (Tables 1-2).

Table 1. The results of the percent of infection rate in the samples relating to Aliabad area

Subject	X	Y	Disease percent	Subject	X	Y	Disease percent
1.	567819	3910477	50	2.	567764	3910967	80
3.	567820	3910477	50	4.	567767	3910967	80
5.	568049	3910580	60	6.	567857	3910440	70
7.	568060	3910572	60	8.	567925	3910772	60
9.	567694	3910501	20	10.	567414	3910706	40
11.	567415	3910572	40	12.	567484	3910978	100
13.	567419	3910572	70	14.	567737	3911078	100
15.	567463	3910878	30	16.	567736	3910633	20
17.	567485	3910878	30	18.	567442	3910822	50
19.	568731	3912358	30	20.	567497	3910381	50
21.	568688	3912390	20	22.	568643	3911744	100
23.	568775	3912225	50	24.	568751	3912023	65
25.	567854	3910429	40	26.	568753	3912033	65
27.	567437	3910535	30	28.	568709	3912415	20
29.	567586	3910614	30	30.	567887	3910725	60
31.	567589	3910611	30	32.	568801	3912106	60
33.	568725	3912278	40	34.	568766	3911616	80
35.	568711	3911980	70	36.	568111	3910600	50
37.	568663	3911632	90	38.	567962	3910640	50
39.	567833	3910651	80	40.	568679	3911469	70
41.	567905	3910650	80	42.	567997	3910756	100
43.	568698	3911630	50	44.	568708	3912241	50
45.	567836	3910423	60	46.	568115	3910621	50
47.	567482	3910609	30	48.	567656	3911068	60
49.	568612	3911642	40	50.	568723	3911798	60
51.	567760	3910823	80	52.	567928	3910600	70
53.	568716	3911571	40	54.	567945	3910544	70
55.	567884	3910774	80	56.	567649	3910364	50
57.	568737	3911626	100	58.	567650	3910364	50
59.	568625	3911701	50	60.	568690	3911429	40
61.	567352	3910571	100	62.	567576	3910346	60
63.	567758	3911039	30	64.	568818	3912195	40
65.	568028	3910763	80	66.	568708	3911350	50
67.	567795	3910613	50	68.	567671	3910412	50
69.	568699	3911390	80	70.	567749	3910577	90
71.	568740	3911592	60	72.	568686	3911546	60
73.	567377	3910636	60	74.	567687	3910472	60
75.	567378	3910636	60	76.	568639	3911641	50
77.	567592	3910382	70	78.	567755	3910776	60
79.	567592	3910383	70	80.	568796	3911355	40
81.	567608	3910415	100	82.	568768	3912342	35
83.	567591	3911064	60	84.	568719	3911899	60
85.	568754	3912311	35	86.	568661	3911535	55
87.	567933	3910681	40	88.	567770	3911047	70
89.	568725	3912278	40	90.	567250	3909903	100
91.	568750	3912219	50	92.	567140	3909905	100
93.	567482	3910474	30	94.	567007	3909812	100
95.	567955	3910651	70	96.	567021	3909944	100

97.	567956	3910651	45	98.	567161	3909974	100
99.	567736	3910704	70	100.	567188	3910146	40
101.	567736	3910698	45	102.	567356	3910305	40
103.	567586	3910614	45	104.	568226	3910721	65
105.	567589	3910611	45	106.	568432	3910928	65
107.	567346	3910519	35	108.	568611	3911059	50
109.	567334	3910521	35	110.	568681	3911218	50
111.	567860	3910659	70	112.	567988	3911070	70
113.	567762	3910926	70	114.	568542	3911341	40
115.	567828	3910466	70	116.	568440	3911377	55
117.	568665	3911752	40	118.	568437	3911496	55
119.	568612	3911683	40	120.	568551	3911494	40
121.	567547	3910170	80	122.	568414	3911593	40
123.	567426	3910116	80	124.	568513	3911700	70
125.	567347	3909949	100	126.	568383	3911701	55

Table 2. The results of the percent of infection rate in the samples relating to Gharetapeh area

Subject	X	Y	Disease percent	Subject	X	Y	Disease percent
1.	30	3914545	573962	2.	60	3913738	574249
3.	90	3913701	574298	4.	20	3914647	573805
5.	40	3914586	573841	6.	30	3913972	574018
7.	50	3914504	574006	8.	60	3914173	573902
9.	100	3913760	574190	10.	60	3914715	573728
11.	50	3914745	573527	12.	50	3913844	574428
13.	75	3913718	574462	14.	35	3914589	573762
15.	60	3914148	573735	16.	35	3914638	573913
17.	35	3914208	573705	18.	20	3914210	574003
19.	50	3914012	574347	20.	60	3914868	573621
21.	60	3914423	574044	22.	50	3914425	574134
23.	100	3914104	574308	24.	70	3914265	574258
25.	30	3914578	573896	26.	20	3914165	573813
27.	50	3914196	573700	28.	60	3914872	573524
29.	50	3914672	573493	30.	30	3914710	573753
31.	80	3914154	574242	32.	80	3914751	573697
33.	100	3913647	574378	34.	80	3914818	573524
35.	40	3913859	574086	36.	35	3914090	573815
37.	40	3913936	574047	38.	50	3914566	573728
39.	20	3914025	573994	40.	35	3914312	574041
41.	80	3914819	573565	42.	35	3914264	574037
43.	40	3914083	573875	44.	35	3914577	573780
45.	50	3914113	574038	46.	50	3914540	574030
47.	50	3913632	574326	48.	50	3914409	573857
49.	50	3914225	573987	50.	50	3914358	573722
51.	20	3914477	574043	52.	50	3914601	573569
53.	30	3914709	573869	54.	80	3913815	574313
55.	30	3914116	573777				

3.3 To Study Percentages on Maps Based on GPS by GIS Software

GIS Software set sampled points on studied maps so that it is possible to study degree of distribution and how to distribute disease in cultural land of Aliabad and Gharetapeh in Varamin city (Figure 2).

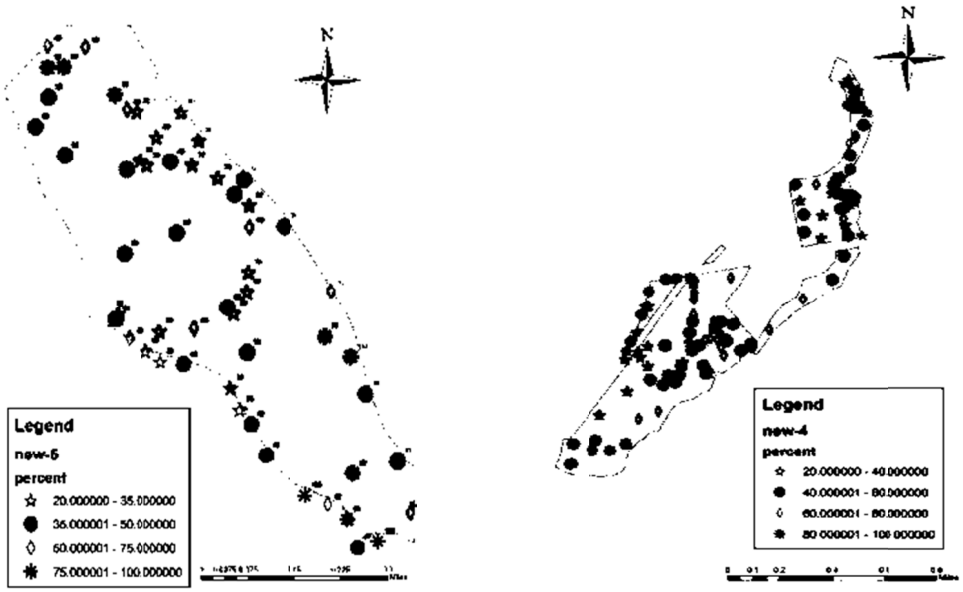

Figure 2. Percent of disease in the sample points of Aliabad and aretape areas

3.4 To Study in Kriging

This way was used to estimate the occurrence of disease in unsampled points and to determine degree of disease distribution (Figure 3).

Comparison of Kriging algorithm for amount of disease and sand in the soil in the area stated considerable negative correlation between these two factors (Table 3).

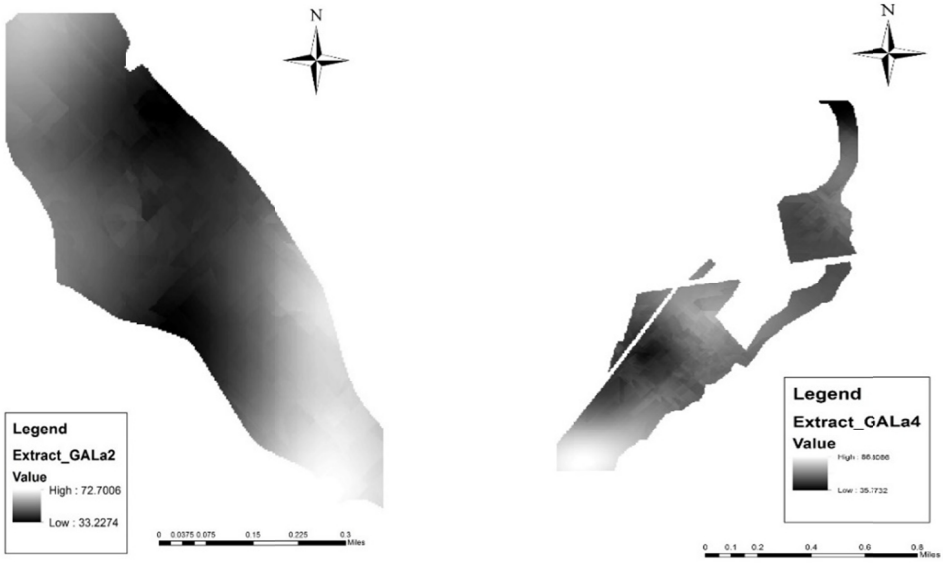

Figure 3. The distribution of the disease in the Aliabad and Gharetapeh by Kriging method

Table 3. The correlation between the percentage of disease and sand in the soil of Gharetapeh and Aliabad areas

Gharetapeh area				
Layer	MIN	MAX	MEAN	STD
Disease %	47.6044	52.3327	50.0049	0.7673
Sand %	35.7732	86.6066	59.3842	9.9549
COVARIANCE MATRIX				
Layer	1		2	
1	0.13910		-1.16397	
2	-1.16397		23.41073	
CORRELATION MATRIX				
Layer	1		2	
1	1.00000		-0.64503	
2	-0.64503		1.00000	
Aliabad area				
Layer	MIN	MAX	MEAN	STD
Disease %	44.4228	51.3211	47.9189	1.7015
Sand %	33.2274	72.7006	50.0725	10.0545
COVARIANCE MATRIX				
Layer	1		2	
1	1.29634		-5.81090	
2	-5.81090		45.26510	
CORRELATION MATRIX				
Layer	1		2	
1	1.00000		-0.75858	
2	-0.75858		1.00000	

4. Discussion

In 2009, Sarpele et al. (2009) survey showed *Phytophthora* species is one of the main disease factors in green houses in Varamin city that results of this survey confirmed Sarpele et al. (2009) survey and it stated detailed results about existence and percentage distribution of mentioned fungi in Aliabad and Gharetapeh in Varamin city.

The results show distribution extent of disease in these two areas are a lot, according to vegetables, one of the main agricultural products in these areas, such as cantaloupe and watermelon, they can provide the way to damage agricultural products due to that resistant cultivars and insensitive hosts are recommended in these areas.

Further studies and comparative amount of sand in soil texture and degree of disease show that amended soil texture can be effective to control disease. In addition, one of the main factors in increasing disease percentage is rugged cultural land because estimated percent disclosed pond places and pits had large amount of pathogen fungi. It seems leveling of agricultural land can be a great help to reduced pathogen damage in these areas.

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