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Community analysis of key pests associated with mentha crop at sitapur, U.P. India

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Abstract

An extensive survey was carried out during 2013 for the real situation in the crop to study the plant pathogenic fungus, bacteria and nematodes associated with Japanese Mint Mentha arvensis var piperascense growing fields. Soil and root samples were collected from 24 Mentha fields represents 15 different locations (villages) Akhtarpur, Tiwaripur, Shuklapur, Katia, Oripur, Ghuripur, Padariya and Dafara. Out of 120 soil samples, 16 soil samples were found infected with Fusarium oxysporum and 27 soil samples with Alternaria spp. 36 samples have the plant parasitic nematodes population. Results revealed that the maximum disease prevalence (DP) of Fusarium oxysporum was recorded at Shuklapur (27%), while the minimum disease prevalence was recorded at Ghuripur (3.4%). Alternaria spp. was more prevalent at Tiwaripur (42%) while root-knot nematode (Meloidogyne incognita) incidence was maximum at Katia (43%). The plant extracts were not so promising for inhibition of pathogenic fungi of Mentha crop.

Key words: Mentha Crop, Fungi, Soil

1. Introduction

An extensive survey was carried out during 2013 for the real situation in the crop to study the plant pathogenic fungus, bacteria and nematodes associated with Japanese Mint Mentha arvensis var piperascense growing fields. Soil and root samples were collected from 24 Mentha fields represents 15 different locations (villages) Akhtarpur, Tiwaripur, Shuklapur, Katia, Oripur, Ghuripur, Padariya and Dafara. Out of 120 soil samples, 16 soil samples were found infected with Fusarium oxysporum and 27 soil samples with Alternaria spp. 36 samples have the plant parasitic nematodes population. Results revealed that the maximum disease prevalence (DP) of Fusarium oxysporum was recorded at Shuklapur (27%), while the minimum disease prevalence was recorded at Ghuripur (3.4%). Alternaria spp. was more prevalent at Tiwaripur (42%) while root-knot nematode (Meloidogyne incognita) incidence was maximum at Katia (43%). The plant extracts were not so promising for inhibition of pathogenic fungi of Mentha crop.

Empirical knowledge of the properties of medicinal plants is the basis for their use as home remedies. In recent years, scientific interest in the potential clinical and pharmacological basis for the efficacy and safety of herbal medicines has increased trendmenously in view of the common occurrence of domestic self-medication with these agents (Rodriguez-Fragoso et al., 2007). Among the great diversity of plants in question, species of Mentha have been assessed by several authors (Nair, 2001; McKay and Blumberg, 2006; Gurib-Fakin, 2006; Hur et al., 2007) with respect to their use in the pharmacology (Oumzil et al., 2002; McKay and Blumberg, 2006), and cosmetology industries. The essential oil from Mentha spp. is used as an expectorant and against conditions such as discomfort of the gastrointestinal tract and upper bile ducts, irritation of the colon or irritable bowel syndrome, myalgia and neuralgia, as well as oral mucosal inflammation (McKay and Blumberg, 2006). A number of health care practioners believe that herbal medicines, such as the essential oil from

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Mentha spp. are relatively safe as they are “natural”, but recently the potential of these Mentha spp. has been questioned as it has severe consequences and may cause number of side effects (Gurib-Fakin, 2006 and Hur et al., 2007). Throughout history, a number of mint species have been used around the world for their various properties, both medicinal and culinary. Peppermint oil is one of the world's oldest herbal medicines. Peppermint oil is the most studied form of mint oil and menthol, one of the main constituents of peppermint, is a key ingredient in many commercial remedies, in addition to the huge commercial sales of mint-flavored sweet products. With the growing popularity of herbal remedies, among both the public and medical practitioners, it would seem that now is an opportune time to consider further what peppermint has to offer the world of medicine (Spirling and Daniels, 2001).

The cultivation of mentha in Uttar Pradesh is likely to see an upsurge this year after a lull in the past year. Uttar Pradesh records the highest production of mentha oil in the country. Reports suggest that metha sowing has already started with the recent rainy spell and would be over by the end of February. It is estimated that the overall sowing area may remain higher this year. The total area under mentha crop cultivation is expected at 2.10 lakh hectares (ha) this year from 1.75 lakh ha during the previous year. (Anonymous, 2013). The rotation of mint crop with other food crops is found to be a good way of controlling weeds. Continuous cropping of any of the mints is not advisable. The best rotation is Mint: Rice; Mint: Potatoes; and Mint: Vegetables: Peas, etc. depending upon cropping system followed in the region. A numbers of biotic and abiotic factors were found to reduce the Mentha production and may cause a huge loss to the farmers. A number of pests were recorded to be associated with Mentha cultivation in the Sitapur area (Anonymous, 2002).

Mentha crop is affected by many plant pathogenic microbes. The fusarium wilt and leaf blight on Mentha caused by fungus Fusarium oxysporum and Alternaria spp. respectively, are most catastrophic diseases of the world, causing heavy economic loss to the farmers (Mathur and Shekhawat, 1986). It is well known that use of fungicides is the shortest way to obtain efficient results of disease management. Fungicide treatments are generally the most effective control measure but are not economically feasible in all areas of the world and involve health risks in case of Mentha (Herriot et al., 1986). Utilization of resistant varieties against leaf blight and fusarium wilt is an environment friendly method but resistant varieties are either not available or not durable. Besides, the method is costly to develop, requires huge investment and technical knowledge. There is a great need to carry out field-level research, aiming to develop a holistic disease management model to manage early blight of Mentha. In these circumstances, investigation is aimed to develop eco-friendly management against early blight of Mentha using locally available botanicals. Use of botanicals in plant disease management assumes special significance by being an eco-friendly and cost-effective strategy, which can be used in integration with other strategies for a greater level of protection with sustained crop yields. The potential involvement of antimicrobial plant metabolites in plant defense system against microbial invaders is one of the longest studied plant responses to pathogens (Link et al., 1929). Many studies have shown that plant extracts effectively controlled various plant pathogens under laboratory conditions (Sankarasubramanian et al., 2008; Mishra et al., 2009; Yanar et al., 2011; Talibi et al., 2012). In form of spray, plant extracts are used in vivo to control airborne plant pathogenic microbes. They act by inactivating or killing the pathogen spores as they land on plant surface (Leksomboon et al., 2001; Govindappa et al., 2011). Idea behind the present study was to screen local flora to select most potent aqueous extracts for antipathogenic potential against Alternaria spp., which may be developed as effective fungicides in organic farming.

Plant parasitic nematodes are a serious problem facing mint growers in the India. Several nematode species, including the mint (needle) nematode (Longidorus elongates), the root-knot nematode (Meloidogyne incognata), and the root-lesion nematode (Pratylenchus penetrans), are capable of causing severe economic damage. Of these three species, Pratylenchus penetrans is probably the most important. Of these root-knot nematodes, Meloidoyne incognita are recognized as one of the major limiting factors in crop cultivation by either parasitizing alone or through disease complexes with other organisms (Sehgal & Gaur, 1999). Root-knot nematodes are serious and economically most important pest around the world (Trifonova et al. 2009). They cause losses up to 80% in heavily infested field (Kaskavalci, 2007). In susceptible plants, the nematode population build up to a maximum usually as crop reach maturity (Shurtleff & Averre, 2000) and in some cases the plants die even before reaching maturity (Singh & Khurma, 2007). Root-knot nematodes (Meloidogyne spp.) are global menace to crop production. Not only can this species reduce mint yields by up to 73%, but in the presence of other stress factors such as severe winters, damage can be even more severe. For example, root-lesion nematodes can interact with the soil pathogen, Verticillium dahliae, reducing peppermint yields by 40% more than by nematodes alone. The mint (needle) nematode, although not widespread, can cause devastating damage on sandy soils in the Willamette Valley of western Oregon.

Nematode feeding can cause weakened plants with short, weak root systems; damage will appear in patches throughout a field. The root- lesion nematode is the most serious of the many nematodes found in mint as they interact with Verticillium dahliae to cause more severe symptoms of wilt. Nematode populations fluctuate throughout the year but are usually highest in early summer and thus, a good time to sample for population density.

2. Materials and Methods

An extensive survey was carried out for the isolation of plant parasitic nematodes associated mentha fields. Total 120 soil and root samples (MSS-1 to MSS-120) from mentha growing fields were collected from 24 different locations (15 villages) of Sitapur districts, Uttar Pradesh for investigation of nematode infestations. Since nematodes are distributed in patches, a large number of subsamples (i.e. cores which are combined together to make a single sample for analysis) were taken from mentha growing field (mix. of 5 different places of one field). All the 120 samples were collected in polythene bags separately, sealed and brought to the laboratory. Each collected soil samples was thoroughly mixed to make homogenous before processing. Serial dilution agar plating (Apinis, 1963), Warcups soil plate and Waksman Direct inoculation methods were employed for the isolation of soil microbes; or viable plate count method was used for the isolation and enumeration of fungi, bacteria and actinomycetes which are the most prevalent microorganisms. This method is based upon the principle that when material containing microorganisms is cultured each viable microorganism will develop into a colony; hence, the number of colonies appearing on the plates represents the number of living organisms present in the sample. The number of colonies appearing on dilution plates are counted, averaged and multiplied by the dilution factor to find the number of cells/spores per gram (or ml) of the sample.

$$\text{No of cell/ml or gm} = \frac{\text{Colonies x Dilution factor}}{\text{Dry wt.of soil}}$$

Dilution factor = Reciprocal of the dilution

Sodium chloride (NaCl, 0.85%) was used as diluent, in place of sterile water, for the preparation of suspension of soil sample.

Soil samples were processed by Cobb's sieving and decanting method (Cobb 1913, 1918). Nematode species present in the suspension were identified and counted by taking known amount suspension in a counting disc under stereoscopic binocular microscope. Measurement of nematode was made according to De Man's method (1904). The nematode was identified using the references as given by Cobb, 1913. Root knot Index was calculated as suggested by Prot & Matias (1995). The calculation on following parameters related to nematode infestation was computed as suggested by Norton, 1978.

3. Results and Discussions

The survey was conducted in 15 different locations in Sitapur district of Uttar Pradesh to assess the incidence of Fusarium oxysporum and Alternaria spp. infestation on Mentha crop. A total of 120 samples were collected and analyzed; of which 16 soil samples (14.3%) were found infested with Fusarium oxysporum. Maximum disease prevalence (DP) of Fusarium oxysporum was recorded at Shuklapur (27%), while the minimum disease prevalence was recorded at Ghuripur (3.4%) (Table 1).

The observed data were analyzed and used for determination of various parameters related to the disease and pathogen (Fusarium oxysporum) such as Relative density (RD), Relative abundance (RA), Relative frequency (RF), Dominance value index (DIV), Disease prevalence (DP), Inoculum density (ID) and presented in table 1. Relative density (RD) and relative abundance (RA) of the pathogen were found to be maximum in Ghuripur (48.3%; 38%, respectively) while relative frequency was maximum at Oripur (56%). Dominance value index was maximum at Tiwaripur (48%) while the inoculum density was higher at village Dafra (27.4%) (Table 1).

Table 1. Incidence and distribution of Fusarium wilt (Fusarium oxysporum) in Sitapur district.

Location	No. of fields inspected	No. of fields infected	Total no. of samples examined	No. of samples with Fusarium oxysporum
Shuklapur	3	3	15	4
Tiwaripur	3	2	15	1
Akhtarpur	3	3	15	2
Ghuripur	3	2	15	1
Padariya	3	3	15	3
Dafara	3	1	15	1
Oripur	3	3	15	2
Katia	3	3	15	2
Total	**24**	**20**	**120**	**16**

Values	*1	*2	*3	*4	*5	*6	*7	*8
RD	26.1	39.1	18.7	48.3	21.4	16.8	24	17.6
RA	17.8	18.6	6.9	38	11.2	13.6	26.8	2.9
RF	17	46	38	16.9	16.2	17.2	56	37
DIV	17.8	48	36	28.7	17.8	16.8	29	27.4
DP	27	3.7	14.7	3.4	16.8	6.9	9.7	9.8
ID	18	16	18	27	19	27.4	18	16.8

RD= Relative density
RA= Relative abundance
RF= Relative frequency
DIV= Dominance value index
DP= Disease prevalence
ID= Inoculum density.
*1-8= Respective names of villages.

A total 27 soil samples out of 120 were found infested with Alternaria. Maximum disease prevalence (DP) of Alternaria spp. was recorded at Tiwaripur (42%), while the minimum disease prevalence was recorded at Katia (12.3%) (Table 2). The observed data were analyzed and used for determination of various parameters related to the disease and pathogen (Alternaria spp.) revealed that relative density (RD) of the pathogen was found to be maximum in Padariya (78%) and relative abundance (RA) was maximum at Katia (53%) while relative frequency was maximum at Ghuripur (66%). Dominance value index was maximum at Oripur (27%) while the inoculum density was higher at village Shuklapur (34) (Table 2).

Table 2. Incidence and distribution of leaf blight (caused by Alternaria spp.) in Sitapur district.

Location	No. of fields inspected	No. of fields infected	Total no. of samples examined	No. of samples with Alternaria spp.
Shuklapur	3	3	15	3
Tiwaripur	3	3	15	6
Akhtarpur	3	3	15	3
Ghuripur	3	3	15	3
Padariya	3	3	15	4
Dafara	3	3	15	3
Oripur	3	3	15	3
Katia	3	2	15	2
Total	**24**	**23**	**120**	**27**

Values	*1	*2	*3	*4	*5	*6	*7	*8
RD	18.6	19	21	67	78	72	58	54
RA	47	18	18.9	21.6	24.8	27.2	19.2	53
RF	42.6	18.3	26.6	66	64.3	29.8	28.8	12
DIV	17	18	12	13.4	24.6	22.8	27	16.9
DP	16.8	42	21.1	16.9	24.8	17.8	18.6	12.3
ID	34	29	31	32	30	33	28	32

RD= Relative density
RA= Relative abundance
RF= Relative frequency
DIV= Dominance value index
DP= Disease prevalence
ID= Inoculum density.
*1-8= Respective names of villages.

Out of 120 soil samples, soil samples were found infected with root-knot nematodes. Therefore, overall incidence of the disease was recorded 87 %. Different plan parasitic nematodes viz. Rotylenchus spp., Aphelenchoides spp., Longidorus spp., Pratylenchus spp., Xiphinema spp., Tylenchorhynchus spp., Hemicriconemoides spp. were identified and counted. Population of root-knot nematode was found maximum among all. Maximum disease prevalence (DP) of root-knot nematode (Meloidogyne incognita) was recorded at Katia (43%), while the minimum disease prevalence was recorded at Oripur (23%) (Table 3). Relative density, dominance value index and inoculum density of the pathogen were found to be maximum in Tiwaripur (64%; 34%; 54, respectively) while relative abundance was maximum at Dafra (42%). Relative frequency was maximum at Katia (39%) (Table 3).

Table 3. Distribution of root-knot nematode (Meloidogyne incognita) in the fields of mentha crop in Sitapur district.

Location	No. of fields inspected	No. of fields infected	Total no. of samples examined	No. of sample in with nematodes
Shuklapur	3	3	15	4
Tiwaripur	3	3	15	4
Akhtarpur	3	1	15	4
Ghuripur	3	2	15	4
Padariya	3	2	15	4
Dafara	3	2	15	4
Oripur	3	3	15	5
Katia	3	3	15	7
Total	**24**	**19**	**120**	**36**

Values	***1**	***2**	***3**	***4**	***5**	***6**	***7**	***8**
RD	12	64	17	16	12	13	14	11
RA	9	32	34	23	34	42	16	11
RF	28	27	29	28	28	27	29	39
DIV	14	34	12	16	29	28	30	16
DP	27	27	26	26	25	24	23	43
ID	10	54	36	34	38	11	26	16

RD= Relative density
RA= Relative abundance
RF= Relative frequency
DIV= Dominance value index
DP= Disease prevalence
ID= Inoculum density.
*1-8= Respective names of villages.

3.1 Activity of plant extracts against fungal pathogens

In the present study, it is observed that Ailanthus spp. plant extracts were not so active against the inhibition of germination of spores of Fusarium oxysporum (Table 4) and Alternaria spp. (Table 5) isolated from Mentha crop.
The results obtained were not so promising for inhibition of pathogenic fungi of Mentha crop. Although the earlier reports suggested positive action of a number of plants and their extracts for inhibition of various plant pathogenic fungi. In the present study only one extract was tested, this probably might not give any decisive result.

Table 4. Activity of plant extracts against Fusarium oxysporum.

Concentration of plant extract	**R-1**	**R-2**	**R-3**	**R-4**	**Average**	**% of inhibition**
0.25%	6.8	6.8	6.7	6.7	6.75	15.6
0.10%	7.2	7.1	7	7.1	7.1	11.25
0.05%	7.4	7.3	7.5	7.4	7.4	7.5
0.02%	7.6	7.6	7.5	7.7	7.55	6.25
0.01%	7.7	7.8	7.8	7.9	7.8	2.5
Blank	8	8	8	8	8	0
Control	8	8	8	8	8	0

Table 5. Activity of plant extracts against Alternaria spp.

Concentration of plant extract	R-1	R-2	R-3	R- 4	Average	% of inhibition
0.25%	6.5	6.3	6.4	6.2	6.35	20.63
0.10%	6.8	6.7	6.7	6.7	6.72	16
0.05%	7	6.9	6.9	7	6.95	13.12
0.02%	7.4	7.3	7.3	7.4	7.35	8.12
0.01%	7.7	7.6	7.7	7.7	7.67	4.12
Blank	8	6.8	8	C	7.6	5
Control	8	8	8	8	8	0

Where R- Replication

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