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Influence of essential oils and neem products on management of *Turcicum* leaf blight caused by *Helminthosporium turcicum* (Pass.) in maize

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Abstract
Field trials were conducted to test verify the effectiveness of various essential oils and neem products for the management of *Turcicum* leaf blight in different seasons during 2015-16. The experiments were laid out in a randomized block design replicated thrice. The treatments comprised of six essential oils, three neem products along with a control. The *turcicum* pathogen multiplied in the laboratory conditions were inoculated in the fields. Observations on disease incidence and grain yield were recorded. The results revealed that palamrosa oil (0.05%) recorded the lowest TLB incidence of 18.94% followed by eucalyptus oil (0.1%) 21.05%, lemon grass oil (0.05%) 22.09% and geranium oil (0.05%). The lesion length and width was also reduced by the above oils compared to control. With regard to grain yield, palmarosa oil (0.05%) recorded the highest yield of 6466 kg/ha followed by eucalyptus oil (0.1%) (6356 kg/ha), lemongrass oil (0.05%) (6285 kg/ha) and geranium oil (0.05%) (6098 kg/ha).

Keywords Influence of essential oils neem products *Helminthosporium turcicum*

1. Introduction
Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in the world as well in India. It is a versatile crop and can be grown in diverse environmental conditions and has multiple uses. It has got immense potential and is therefore called as "**miracle crop**" and also "**queen of cereals"**. Maize, being a C_4 plant is an efficient converter of carbon and absorbed nutrients into food.

The demand for maize is increasing day by day in India with the increase in demand for poultry and cattle feed. Therefore, there is a need to increase the production of maize in the country; otherwise India may even have to start importing it in the ensuing years.

With the introduction of high yielding indigenous and exotic hybrids and use of fertilizers, there has been a phenomenal increase in area and production. However, at the same time the crop is prone to several foliar diseases. Among the foliar diseases affecting maize, the *turcicum* leaf blight, also called as northern leaf blight caused by *Exserohilum turcicum* (Pass.) leonard and suggs. (Syn. *Helmithosporium turcicum* Pass.) is of worldwide importance (Carlos 1997) [2]. *Turcicum* leaf blight of maize is considered to be the most devastating disease as its occurrence and incidence assumes greater significance resulting in reduction of grain yield by 28 to 91 percent (Harlapur *et al*., 2007) [3]. Most of the commercial varieties and other breeders' materials are vulnerable and susceptible to the northern leaf blight (Muriithi, 1992) [6].

Even though various plant protection measures are available, about one third of the crops produced are destroyed by pests and diseases. The discovery of synthetic chemicals has contributed, greatly to the increase in food production by controlling pests and diseases. But, the use of pesticides and fungicides has been causing serious environmental problems and human health problems, thus encouraging the search for alternative products that could substitute these chemical components (Sarmento Brum *et al*., 2014) [5].

Use of plant products in disease management is a contemporary eco-friendly approach and gaining popularity considering that of its benefits over chemical compounds. These plant extracts are easily biodegradable, without any residue, non-phytotoxic and are easily absorbed by the plants and cost effective. The presence of naturally occurring substances in plants with antifungal properties had been stated and tested toward wide range of fungi infecting many commercially important crops. However, studies on control of *turcicum* leaf blight of maize with the aid of plant extracts are meager.

Essential oils have been presented in research as having great potential for phytopathogen control, thus reducing the incidence of pathogenic microorganisms that cause prejudice both in the agriculture and food industries (Bakkali *et al*., 2008) [1]. The presence of naturally occurring substances in plants with antifungal properties have been reported and tested against wide range of fungi infecting many commercially important crops. Jayalaxmi and Seetharaman (1998) [4] reported that palmarosa oil was effective in reducing the fruit rot and die back of chilli followed by *Ocimum sanctum* leaf. With all these ideas in view, this experiment was planned and conducted to find out the influence of essential oils for ecofriendly management of *turcicum* leaf blight of maize.

Material and methods

Pathogenicity studies

The diseased specimen of maize *Turcicum* leaf blight disease was collected from the fields of Maize Research Station, Vagarai and the pathogen was isolated in the laboratory and purified in PDA slants. The same was multiplied in sorghum grain inoculums in the conical flask and inoculated in the maize plants raised in the pots. The whorl drop method of inoculation of *turcicum* pathogen was followed. The inoculated plants were observed for the symptom development. The infected leaf samples were collected and the *turcicum* pathogen was reisolated and purified and used for further studies.

Lab studies

Essential oils and chemicals were used for assessing their efficacy *in vitro* by poisoned food technique in the laboratory. The recommended dose of concentration of essential oils and neem products was mixed in the PDA medium in petriplates and PD broth in conical flask. The pathogen was inoculated in 9 mm disc and incubated for one week. A control was maintained without essential oils and neem products. Once the control plate showed the full growth of the fungus, the radial growth and mycelial dry weight were calculated.

Field trials

Field trials were laid out during *Kharif* 2015, *Rabi* 2015, *Kharif* 2016 and *Rabi* 2016 with regular package of practices. The experiments were laid out in a randomized block design replicated thrice. The treatments comprised of six essential oils, three neem products along with a control. The hybrid CoHM 6 was used as the test hybrid. *Helminthosporium turcicum* culture was artificially inoculated in the plants in the fields. The periodical sub culturing of fungus in the laboratory was made for further inoculation on plants. Essential oils were applied 10 days after artificial inoculation of pathogen and also repeated once after 20 days. The observations *viz.*, plant height, lesion length and lesion width and the disease incidence observation were made and recorded. The leaf blight severity was recorded at silk drying stage following 1-5 rating scale.

Results

Lab studies

Among the essential oils and neem products tested, all the chemicals were effective in inhibiting the pathogenic mycelial radial growth and mycelial dry weight when compared to control (Table 1).

In the case of essential oils and neem products tested, plamarosa oil (0.05%) and lemon grass oil (0.05%) were effective in reducing the pathogenic mycelial growth recording 1.03 cm and 1.60 cm respectively, followed by geranium oil (0.05%) (2.17 cm) and eucalyptus oil (0.1%) (2.33 cm) and neem oil (3.0%) (4.33 cm), whereas others were ineffective in controlling the pathogen. The above treatments also effectively reduced the mycelial dry weight of the pathogen when compared to control (Table 2).

Field experiments

In *kharif* 2015, among the essential oils and neem products tested in the field, palamrosa oil (0.05%) recorded taller plants of 175.3 cm followed by eucalyptus oil (0.1%) (174.3 cm). With regard to the disease incidence, palamrosa oil (0.05%) recorded less TLB incidence of 18.80% followed by eucalyptus oil (0.1%) (20.51%), lemon grass oil (0.05%) (21.36%) and geranium oil (0.5%) (23.93%). The lesion length and width were also reduced by the above oils compared to control. With regard to the grain yield, palamrosa oil (0.05%) recorded the highest yield of 6893 kg/ha followed by eucalyptus oil (0.1%) (6778 kg/ha) lemon grass oil (0.05%) (6712 kg/ha) and geranium oil (0.05%) (6534 kg/ha) (Table 2).

The same trend of results was evident in *Rabi* 2015, *Kharif* 2016 and *Rabi* 2016 also.

The pooled mean data of all the experiments revealed that palamrosa oil (0.05%) recorded the lowest TLB incidence of 18.94% followed by eucalyptus oil (0.1%) (21.05%), lemon grass oil (0.05%) (22.09%), geranium oil (0.05%) (24.47%), neem oil 3% (24.85%), NCE 5% (25.70%) and NSKE 5% (26.11%). The lesion length and width were also significantly reduced by the above oils compared to control. With regard to cob yield, palmarosa oil (0.05%) recorded the highest of 6466 kg/ha followed by eucalyptus oil (0.1%) (6356 kg/ha), lemongrass oil (0.05%) (6285 kg/ha), geranium oil (0.05%) (6098 kg/ha). The least yield was recorded with control which recorded 4879 kg/ha.

The results revealed that all the essential oils and neem products recorded lesser incidence of TLB and higher grain yield than control. The least TLB incidence and the highest yield were recorded with palmarosa oil (0.5%).

Table 1: Efficacy of essential oils against mycelial growth of *Helminthosporium turcicum in vitro*

Treatment	Mycelial radial growth (cm)	Percent inhibition over control	Mycelial dry weight (mg)	Percent inhibition over control
T1- Palamrosa oil (0.05%)	1.03	88.55	56.66	81.82
T2- Eucalyptus oil (0.1%)	2.33	75.22	89.66	71.23
T3- Lemon grass oil (0.05%)	1.60	82.22	93.66	69.95
T4- Geranium oil (0.05%)	2.17	75.88	104.00	66.63
T5- Mahua oil (0.1%)	7.93	11.88	307.33	01.38
T6- Neem oil (3.0%)	4.33	51.88	207.66	33.37
T7- Pungam oil (3.0%)	7.23	19.66	281.00	09.84

T8- Neem Seed Kernel Extract- NSKE (5%)	5.57	38.11	229.66	26.31
T9- Neem Cake Extract - NCE (5%)	6.00	33.33	223.66	28.23
T10- Control	8.96	-	311.66	-
CD (P = 0.05)	0.74	-	28.81	-

Table 2: Efficacy of essential oils on *turciucm* leaf blight, growth parameters and yield of maize (*Kharif*, 2015)

Treatment	Plant height (cm)	Disease incidence (%)	Disease Severity (Grade)	Lesion length (cm)	Lesion width (cm)	Yield kg/ha
T1- Palamrosa oil (0.05%)	175.3	18.80	1	2.59	1.19	6893
T2- Eucalyptus oil (0.1%)	174.3	20.51	2	2.98	1.53	6778
T3- Lemon grass oil (0.05%)	171.3	21.36	3	2.79	1.98	6712
T4- Geranium oil (0.05%)	172.6	23.93	3	3.34	2.03	6534
T5- Mahua oil (0.1%)	155.6	42.73	5	7.65	3.32	5178
T6- Neem oil (3.0%)	171.3	25.64	3	3.21	1.38	6431
T7- Pungam oil (3.0%)	153.6	41.02	4	12.34	3.68	5123
T8- NSKE (5%)	169.3	25.64	3	3.95	1.35	6412
T9- NCE (5%)	168.9	24.76	3	3.33	1.78	6314
T10- Control	149.9	52.99	5	15.34	3.78	5162
CD (P = 0.05)	12.9	6.23	-	0.63	0.14	310

Table 3: Efficacy of essential oils on *turciucm* leaf blight, growth parameters and of maize (*Rabi*, 2015)

Treatments	Plant height (cm)	Disease incidence (%)	Disease Severity (Grade)	Lesion length (cm)	Lesion width (cm)	Yield kg/ha
T1- Palamrosa oil (0.05%)	184.6	21.87	1	3.48	1.58	5361
T2- Eucalyptus oil (0.1%)	183.6	23.34	2	3.86	1.96	5246
T3- Lemon grass oil (0.05%)	181.6	24.66	3	3.68	2.37	5180
T4- Geranium oil (0.05%)	183.3	26.53	3	4.34	2.49	5002
T5- Mahua oil (0.1%)	165.3	46.93	5	8.54	3.48	3646
T6- Neem oil (3.0%)	180.6	28.65	3	4.12	1.85	4899
T7- Pungam oil (3.0%)	163.3	45.62	4	13.22	4.14	3599
T8- NSKE (5%)	179.6	28.73	3	4.75	1.84	4880
T9- NCE (5%)	178.9	28.66	3	4.25	2.15	4782
T10- Control	161.6	59.35	5	18.56	5.89	4080
CD (P = 0.05)	17.5	2.95	-	0.98	0.57	228

Table 4: Efficacy of essential oils on *turciucm* leaf blight, growth parameters and yield of maize (*Kharif*, 2016)

Treatments	Plant height (cm)	Disease incidence (%)	Disease Severity (Grade)	Lesion length (cm)	Lesion width (cm)	Yield kg/ha
T1- Palamrosa oil (0.05%)	173.3	16.32	1	2.03	1.02	6760
T2- Eucalyptus oil (0.1%)	172.3	18.13	2	2.29	1.43	6662
T3- Lemon grass oil (0.05%)	168.3	19.21	3	2.62	1.93	6569
T4- Geranium oil (0.05%)	169.3	20.33	3	3.18	1.98	6363
T5- Mahua oil (0.1%)	152.3	32.63	5	6.92	2.92	5091
T6- Neem oil (3.0%)	170.3	20.12	3	2.99	1.71	6152
T7- Pungam oil (3.0%)	155.3	34.36	5	9.32	2.96	5102
T8- NSKE (5%)	168.3	22.31	3	2.93	1.46	6197
T9- NCE (5%)	167.3	21.62	3	2.99	1.62	6149
T10- Control	151.6	38.43	5	14.28	4.94	5133
CD (P = 0.05)	1.25	1.48		0.69	0.14	94.83

Table 5: Efficacy of essential oils on turciucm leaf blight, growth parameters and yield of maize in (*Rabi*, 2016)

Treatments	Plant height (cm)	Disease incidence (%)	Disease Severity (Grade)	Lesion length (cm)	Lesion width (cm)	Yield (kg/ha)
T1- Palamrosa oil (0.05%)	189.9	18.75	1	3.41	1.55	6853
T2- Eucalyptus oil (0.1%)	187.6	22.20	2	3.43	1.44	6741
T3- Lemon grass oil (0.05%)	181.6	26.37	3	3.82	2.27	6682
T4- Geranium oil (0.05%)	185.1	27.08	3	4.54	2.78	6496
T5- Mahua oil (0.1%)	163.9	38.18	5	8.41	3.74	5137
T6- Neem oil (3.0%)	183.3	25.0	3	4.52	1.83	6386
T7- Pungam oil (3.0%)	165.7	38.87	5	14.53	4.75	5132
T8- NSKE (5%)	181.3	27.77	3	4.65	1.89	6376
T9- NCE (5%)	181.0	27.77	3	4.43	2.27	6267
T10- Control	167.0	45.83	5	18.99	6.19	5143
CD (P = 0.05)	12.9	1.53	-	0.63	0.14	287

Table 6: Efficacy of essential oils on *turciucm* leaf blight of maize (Pooled mean)

Treatment	Disease incidence %	Lesion length (cm)	Lesion width (cm)	Yield kg/ha
T1- Palamrosa oil (0.05%)	18.94	2.88	1.34	6466
T2- Eucalyptus oil (0.1%)	21.05	3.14	1.59	6356
T3- Lemon grass oil (0.05%)	22.90	3.23	2.14	6285
T4- Geranium oil (0.05%)	24.47	3.85	2.32	6098
T5- Mahua oil (0.1%)	40.12	7.88	3.37	4763
T6- Neem oil (3.0%)	24.85	3.71	1.69	5967
T7- Pungam oil (3.0%)	39.97	12.35	3.88	4739
T8- NSKE (5%)	26.11	4.07	1.64	5966
T9- NCE (5%)	25.70	3.75	1.96	5878
T10- Control	49.15	16.79	5.20	4879
CD (P=0.05%)	1.91	0.81	0.20	310

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