International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(3): 229-234

Received: 05-03-2021
Accepted: 15-04-2021

Pankaj Tiwari
Department of Plant Pathology, TDPG College, Jaunpur, Uttar Pradesh, India

Ramesh Singh
Department of Plant Pathology, TDPG College, Jaunpur, Uttar Pradesh, India

Corresponding Author:
Pankaj Tiwari
Department of Plant Pathology, TDPG College, Jaunpur, Uttar Pradesh, India

Effect of plant extracts against *Bipolaris sorokiniana* under *in vitro* and *in vivo* conditions

Pankaj Tiwari and Ramesh Singh

Abstract
Spot blotch caused by *Bipolaris sorokiniana* is a major disease of wheat in warm and humid regions of the world including South-east Asian countries such as India, Nepal and Bangladesh and the disease is very significant**,** especially in North Eastern Plains Zone (NEPZ) of India. Among botanicals eucalyptus leaf extract was highly effective in inhibiting the growth of *B. sorokiniana.* Garlic clove extract was second best plant extract in inhibiting the growth of *B. sorokiniana.* All the six plant extracts (garlic clove, eucalyptus leaf, neem leaf, onion bulb, ginger rhizome and black cumin) could significantly reduce PDI when compared with untreated check. Two sprays of garlic clove and eucalyptus leaf extracts @ five percent were equally effective in reducing disease to 50 percent and increasing grain yield.

Keywords: Plant extract, *Bipolaris sorokiniana*

Introduction
Wheat (*Triticum aestivum* L.) belongs to family Graminae, is one of the oldest and most important cereal crops. Since antiquity, wheat was cultivated in Mohanjo-Daro and Harappa nearly 5000 years back (Pal, 1966) [16]. In India, three species of wheat are cultivated, *Triticum aestivum*, *T. duram*, and *T. dicoccum* (Gupta, 2004) [8]. Bread wheat accounts for approximately 95 percent of the wheat grown, while 4 percent is duram wheat and 1 percent is dicoccum wheat (Gupta, 2004) [8]. Wheat is believed to have originated in South-west part of Asia. Some of the earliest remains of the crop have been found in Syria, Jordan and Turkey (Feldman, 2001) [7]. Wheat serves as a staple food for more than one billion people in the world and contributes about 20 percent of total food calories for human being. Nearly 55 percent of carbohydrate and 20 percent of food calories of human diet are obtained from wheat. Wheat grain contains all essential nutrients including carbohydrate (60 to 80 percent mainly as starch), proteins (8 to 15 percent) containing adequate amount of all essential amino acid except lysine, tryptophan and methionine, fats (1.5 to 2 percent), minerals (1.5 to 2 percent), vitamins and 2.2 percent crude fibre (Breiman and Graur, 1995) [4].
The wheat cultivation in the warmer and humid region of North-eastern plain zone has extended significantly after green revolution; however, many new diseases and pest problems have been encountered by this crop that created significant yield loss. Wheat crop is affected by many fungal diseases and likely to be exposed to various types of foliar diseases other than rust, powdery mildew, Karnal bunt and loose smut. Among these spot blotch emerged as number one problem in hot and humid wheat cultivating regions (Van Ginkel and Rajaram, 1998) [19].
Yield losses due to foliar blights are variable and in last two decades spot blotch has emerged as serious concern for wheat cultivation in the developing world. Spot blotch has been considered as a major constraint to wheat yields in South Asia due to reduction in 1000-grain weight and grain yield (Singh *et al.*, 2007) [18]. Annual yield loss of wheat due to this disease in South Asia is estimated to 15 to 20 percent (Duveiller and Sharma, 2009) [6]. In India, losses due to diseases may be 10 to 50 percent which can be devastating for farmers in the Eastern Gangetic Plains (EGPs) and depends on the level of resistance in a cultivar against leaf blight and weather conditions.
Spot blotch of wheat has emerged as serious concern for wheat cultivation in warmer and humid regions of world including South-east Asian countries such as India, Nepal and Bangladesh (Acharya *et al*., 2011; Chowdhary *et al*., 2013) [1, 5]. Iftikhar *et al.* (2009) [12] reported that *Bipolaris sorokiniana* caused serious foliar disease in South Asian countries. Bahadar *et al*. (2016) [3] concluded that spot blotch caused by *Bipolaris sorokiniana* is a major

disease of wheat in warm and humid regions of the world including South-east Asian countries such as India, Nepal and Bangladesh and the disease is very significant**,** especially in North Eastern Plains Zone (NEPZ) of India.

Akhter *et al.* (2006) [2] tested inhibition of conidial germination of *Bipolaris sorokiniana* using eight ethanolic plant extracts, ten aqueous plant extracts in combination with cow dung and five aqueous plant extracts in combination with cow urine. Hundred percent inhibition of conidial germination was with the application of ethanolic extracts of *Adhatoda vasica* (leaf) and *Zingiber officinale* (rhizome) at 2.5 percent concentration. After the treatment with *Vinca rosea*, *Piper betle* and *Azadirachta indica* extracts in combination with cow dung suspension showed 100 percent inhibition of conidial germination; where the lowest was noted in case of *Rauwolfia serpentine* (30 percent) extract at same concentration. At 2.5 percent concentration of *Calotropis procera* extracts in combination with cow urine, 91 percent inhibition of conidial germination was observed. In most cases, *Ocimum sanctum* extract exhibited less inhibitory effect against *B. sorokiniana*.

Islam *et al.* (2006) [13] applied eight plant extracts and Vitavax-200 against leaf spot (*Bipolaris sorokiniana*) of wheat and reported that onion, garlic, kalijira, ginger, biskatali and neem extract showed statistically similar grain yield as that of seed treatment with vitavax-200.

Malik *et al.* (2008) tested efficacy of foliar spray of 10 different botanicals and reported that the leaf extract of *Rauwolfia serpentine* at 10concentrations, significantly inhibited the spore germination up to 93.7 percent and increased grain yield by 28.9 percent over the check when applied as foliar sprays in the field.

Khalaf *et al.* (2011) [15] found that garlic extract treatment of wheat seeds significantly reduce the incidence of seed-borne fungi, increase seed germination, number of healthy seedlings and vigour index.

Hasan *et al.* (2012) [10] evaluated the effect of five botanical extracts namely garlic, onion, ginger, neem and black cumin at different concentrations (5, 10 and 15 percent) on the mycelial growth of *B. sorokiniana* and showed that the highest percent inhibition of mycelial growth was observed in the application of garlic extracts (67.50 percent) at 15 percent concentration.

Hasan (2013) [9] reported that among the ten plant extracts tested, garlic bulb, margosa leaf and ginger rhizome extract significantly reduced the seed-borne fungal infections as well as the population of individual target fungi *Bipolaris sorokiniana*, *Fusarium graminearum*, *Aspergillus flavus* and *Alternaria alternata*.

Perello *et al.* (2013) [17] reported that Allicin in garlic juice inhibited radial colony growth of *Drechslera tritici-repetis*, *Bipolaris sorokiniana* and *Septoria tritici* on agar plates and spore germination.

Katooli *et al.* (2014) [14] reported that eucalyptus essential oil at all concentration completely inhibited the mycelial growth of *Pythium ultimum* and *Rhizoctonia solani* only. In case of *B. sorokiniana* complete inhibition was only up to 5 days, after that there was mycelial growth.

Yadav *et al.* (2015) [20] evaluated extracts of eucalyptus leaf, garlic clove, neem leaf and neem cake and found that two applications of aqueous Eucalyptus leaf extract at tillering and boot leaf stage resulted in the higher wheat yield as compared to other botanical extracts.

Material and Methods

Effect of plant extract on radial growth of *Bipolaris sorokiniana*

Six plant extracts namely, Galic, Onion, Ginger, Eucalyptus, Neem and Black cumin were evaluated against *B. sorokiniana in vitro* by following the poison food technique. List of plant extracts used in the present study with their common name, scientific name and plant part used are given in Table 1.

Table 1: Common name, scientific name and plant part used of the plant extracts

Common name	Scientific name	Plant part used
Garlic	*Allium sativum*	Clove
Onion	*Allium cepa*	Bulb
Ginger	*Zingiberofficinale*	Rhizome
Eucalyptus	*Eucalyptus globulus*	Leaf
Neem	*Azadirachta indica*	Leaf
Black cumin	*Nigella sativa*	Seed

Cold water extract of the leaves of eucalyptus and neem, rhizome of ginger, bulb of onion, clove of garlic and seed of black cumin were evaluated against *B. sorokiniana in vitro* to evaluate their inhibitory effect on the growth of the fungus. For preparation of cold water extracts, fresh leaves, cloves, bulbs, rhizome and seeds as the case may be were washed with tap water followed by distilled water. It was then processed with distilled water in 1:1 ratio, i.e. 100 gram tissue in 100 ml distilled water. The plant parts were crushed in mortar and pestle and strained through double layer muslin cloth. This formed the standard extract solution (100%).

The plant extracts were incorporated into potato dextrose agar medium at three different concentrations, i.e. 2, 5 and 10 percent. For obtaining 2, 5 and 10 percent concentrations of plant extracts in the medium 2, 5 and 10 ml of plant extracts, respectively, were added in PDA to make volume 100 ml. Streptomycin 30 ppm and Penicillium 125 ppm were also added to the medium before pouring in the Petri-plates to prevent bacterial contamination. PDA not amended with extract served as check. The amended PDA @ 20 ml/plate was poured into 90 mm sterilized Petri-plates, aseptically. Four plates were poured for each treatment. All the Petri-plates were inoculated with 5 mm mycelia disc of 7 days old culture of *B. sorokiniana* and incubated at 28 ± 1°C for 7 days and observations were recorded on radial growth and sporulation. The data were converted in percent inhibition of growth over check by using the formula as described earliar.

Effects of spraying of plant extracts on spot blotch of wheat

Effects of spraying of six plant extracts namely, Garlic, Onion, Ginger, Eucalyptus, Neem and Black cumin on spot blotch of wheat under field conditions were evaluated during *Rabi* 2018-19 and 2019-20 at University Farm. The experiment was laid out (as per details given below):

Design	**:**	**Randomized block design (RBD)**
Treatments	:	Plant extracts
T_1	-	Two sprays of Garlic clove extracts @ 5% at 15 days intervals
T_2	-	Two sprays of Ginger rhizome extracts @ 5% at 15 days intervals
T_3	-	Two sprays of Neem leaf extracts @ 5% at 15 days intervals
T4	-	Two sprays of Onion bulb extracts @ 5% at 15 days intervals
T_5	-	Two sprays of Eucalyptus leaf extracts @ 5% at

		15 days intervals
T_6	-	Two sprays of Black cumin extracts @ 5% at 15 days intervals
T_7	-	Check (water Spray)
Replications	:	4
Variety	:	HD-2733
Plot size	:	5 m × 2 m
Seed rate	:	120 kg/ha
Row to row distance	:	20 cm
Fertilizer	:	120 kg N: 60 kg P_2O_5: 40 kg K_2O
Date of sowing	:	28thNovember 2018 and 25th November 2019

In neem and eucalyptus, leaves were taken whereas clove, bulb, rhizome and seed were taken in case of garlic, onion, zinger and black cumin, respectively. Standard plant extracts were prepared in cold water as per method described earlier. The extracts thus obtained were diluted to 5 percent by water and sprayed on wheat crop. Plots sprayed with water only served as check. Two consecutive sprays at an interval of 15 days were given. Observations on disease severity were recorded at dough stage following Saari-Prescot 0-9 scale as described earlier. The yield and 1000-grain weight were recorded after harvest of the crop. Data was analyzed statistically.

Experimental findings

Effect of plant extracts on radial growth of *Bipolaris sorokiniana*

Six plant extracts namely garlic clove, eucalyptus leaf, neem leaf, onion bulb ginger rhizome and black cumin at 2, 5 and 10 percent concentrations were evaluated against *B. sorokiniana* by poison food technique on potato dextrose agar medium. Data on the effect of three concentrations of six plant extracts on the radial growth of *B. sorokiniana* is presented in Table 2.

Table 2: Effect of plant extracts on radial growth of *Bipolaris sorokiniana*

Plant extract	Concentration (%)	Colony diameter (mm)*		Growth inhibition over check (%)*	
		5 days	7 days	5 days	7 days
Garlic clove	2	30.41	34.46	53.46	54.80
	5	26.20	27.88	59.72	66.20
	10	17.11	20.21	73.81	74.62
Eucalyptus leaf	2	24.28	29.92	61.02	63.11
	5	23.94	25.66	64.20	68.24
	10	16.21	17.11	75.30	78.82
Neem leaf	2	38.20	44.86	41.40	43.60
	5	28.60	31.02	56.20	61.57
	10	20.60	21.11	68.60	73.66
Onion bulb	2	58.68	65.20	9.80	18.82
	5	43.40	51.40	33.48	35.96
	10	35.27	41.20	46.28	49.11
Ginger rhizome	2	57.82	68.74	11.98	14.52
	5	47.11	55.40	27.96	30.98
	10	40.20	41.40	38.31	48.29
Black cumin	2	47.60	57.20	26.11	28.74
	5	43.72	44.20	33.22	44.40
	10	40.11	40.20	38.80	49.78
Check		65.74	80.52	-	-
CD 5%				5.90	3.12
SE(m)				2.08	1.11

*Average of 4 replications

Data presented in Table 2 clearly indicates that none of the plant extracts could completely inhibit the growth of *B. sorokiniana* even at 10 percent concentration. Eucalyptus leaf extract was highly effective in inhibiting the growth of *B. sorokiniana* as after seven days of incubation it produced 63.11, 68.24 and 78.82 percent growth inhibition of *B. sorokiniana* at 2, 5 and 10 percent concentration, respectively. Garlic clove extract was also very promising in inhibiting the growth of *B. sorokiniana* as it produced 54.80, 65.20 and 74.62 percent growth inhibition of *B. sorokiniana* at 2, 5 and 10 percent concentration, respectively. Growth inhibition produced by eucalyptus leaf extract after seven days of incubation was significantly more than those produced by garlic clove extracts. Next to garlic clove extracts, neem leaf extract had also good potential in inhibiting the growth of *B. sorokiniana* as it produced 43.60, 61.57 and 73.66 percent growth inhibition of *B. sorokiniana* at 2, 5 and 10 percent concentration, respectively. Growth inhibition produced by garlic clove extract and neem leaf extracts were statistically at par at all the three concentrations tested except two percent concentration at which garlic clove extracts was statistically superior than neem leaf extract in inhibiting growth of *B. sorokiniana* in culture. Onion bulb and black cumin seed extracts were effective to some extent only as they produced 18.82, 35.96 and 49.11 percent and 28.74, 44.40 and 49.78 percent growth inhibition of *B. sorokiniana* at 2, 5 and 10 percent concentration, respectively. Onion bulb extract was statistically superior than black cumin seed extract at 2 and 5 percent concentration in inhibiting the growth of fungus, however at 10 percent concentration both were equally effective. Ginger rhizome extract was least inhibitory to *B. sorokiniana* as it produced 14.52, 30.96 and 48.29 percent growth inhibition at 2, 5 and 10 percent concentration, respectively.

Data presented in Table 2 clearly indicates that eucalyptus leaf, garlic clove and neem leaf extract were very promising in controlling *B. sorokiniana* at all three concentrations. Onion bulb, black cumin seed and ginger rhizome extract were also effective in inhibiting *B. sorokiniana* at 5 and 10 percent concentrations but they were either less effective or practically non-effective in inhibiting the growth of *B. sorokiniana* at two percent concentration.

Effect of foliar spraying of plant extracts on spot blotch, yield and 1000-grain weight of wheat

The experiment was conducted in Randomized Block Design with four replications during 2018-19 and 2019-20 to find out the effect of foliar spraying of plant extracts on spot blotch, yield and 1000-grain weight of wheat. Six plant extracts namely, garlic clove, eucalyptus leaf, neem leaf, onion bulb, ginger rhizome and black cumin were tested in field condition. All six plant extracts were tested at five percent concentration in wheat field.

Effect on progress of spot blotch of wheat: Five observations on Percent Disease Index (PDI) and leaf blotch score (dd) were taken at fifteen and seven days intervals during *Rabi* 2018-19 and 2019-20, respectively. Data obtained on the effect of foliar spraying of plant extracts on disease progress of spot blotch of wheat is presented in Table 3.

Table 3: Effect of foliar spraying of plant extracts on disease progress of spot blotch of wheat

Plant product	Percent disease index (PDI)*				Leaf blotch score (0-9dd)*			
	2018-19		2019-20		2018-19		2019-20	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Garlic clove	10.76	38.84	10.30	33.16	12	37	11	35
Ginger rhizome	8.72	66.92	9.16	61.30	11	46	12	56
Neem leaf	10.86	51.42	12.72	49.16	12	46	12	46
Onion bulb	12.96	59.62	11.85	53.05	11	55	11	47
Eucalyptus leaf	9.50	42.40	8.84	37.60	12	44	12	36
Black cumin	12.71	73.02	7.21	67.40	12	56	11	58
Check	11.37	78.82	11.68	75.74	13	65	12	67
CD 5%	2.43	2.14	2.12	1.81				
SE(m)	0.81	0.72	0.71	0.62				

*Average of 4 replications

Data presented in Table 3 clearly indicates that in both the years, initially there was not much difference in PDI observed in different plant extract treatments. In *Rabi* 2018-19 and 2019-20, at initial stage PDI ranged from 8.72 to 12.96 and 7.21 to 12.72 percent, respectively; however, at final stage PDI ranged from 38.84 to 78.82 and 33.16 to 75.74 percent, respectively in different plant extract treatments. In both the years maximum PDI was recorded in untreated check which ranged from 11.37 to 78.82 and 11.68 to 75.74 percent in 2018-19 and 2019-20, respectively and minimum PDI was recorded in plots given sprays of garlic clove extract and PDI ranged from 10.76 to 38.84 and 10.30 to 33.16 percent in 2018-19 and 2019-20, respectively. In both the years, PDI was higher at final stage in all treatments including check in comparison to initial stage.

Similarly, in both the years at initial stage almost similar leaf blotch scores (dd) were observed in different treatments. In *Rabi* 2018-19 and 2019-20, at initial stage leaf blotch score (dd) ranged from 11 to 13 and 11 to 12, respectively. With the advancement of crop season it increased and at final stage, leaf blotch score (dd) ranged from 37 to 65 and 35 to 67 in 2018-19 and 2019-20, respectively. During both the years maximum leaf blotch score (dd) was recorded in untreated check which ranged from 13 to 65 and 12 to 67 in 2018-19 and 2019-20, respectively and minimum leaf blotch score (dd) was recorded in plots given sprays of garlic clove extract which ranged from 11 to 37 and 11 to 35 in 2018-19 and 2019-20, respectively. In both the year leaf blotch score (dd) were higher at final stage in all treatments including check as compared to initial stage.

Data presented in Table 3 clearly indicates that initially in the both years, almost similar PDI and leaf blotch score were observed in different plant extract treatments but with the advancement of season development of disease was different in different treatments and finally in both the years differences in PDI as well as leaf blotch score in different plant extract treatments were prominent or visible.

Effect on yield and 1000-grain weight of wheat

Data on the effect of two sprays of six plant extracts namely, garlic clove, eucalyptus leaf, neem leaf, onion bulb, ginger rhizome and black cumin on yield and 1000-grain weight along with Percent Disease Index (PDI) and percent disease control, during *Rabi* 2018-19 and 2019-20 is presented in Table 4.

Table 4: Effect of foliar spraying of plant extracts on percent disease index (PDI), yield, 1000-grain weight of wheat

Plant product	Dose (%)	PDI (%)*		Disease control over check (%)*		Yield (q/ha)*		1000-grain weight (g)*	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Garlic clove	5	38.82	33.16	50.60	56.15	41.50	44.74	42.80	45.62
Ginger rhizome	5	66.92	61.36	15.01	18.8	37.76	39.01	40.22	41.61
Neem leaf	5	51.42	49.11	34.60	35.04	39.40	41.01	39.50	43.08
Onion bulb	5	59.70	53.03	24.22	29.86	37.78	39.40	38.60	39.62
Eucalyptus leaf	5	42.40	37.60	46.11	50.20	40.11	43.20	41.60	43.12
Black cumin	5	73.01	67.40	7.30	10.92	35.74	36.78	38.90	40.10
Check		78.85	75.74	-	-	32.40	33.74	36.07	37.90
CD 5%		2.14	1.790	3.82	2.31	2.66	3.33	2.45	2.66
SE(m)		0.72	0.61	1.27	0.76	0.87	1.12	0.82	0.90

*Average of 4 replications

Data presented in Table 4 reveals that all plant extracts tested significantly reduced PDI when compared with untreated check during both the years. Plant extracts gave 7.30 to 50.60 percent disease control in the year 2018-19 and 10.92 to 56.15 percent disease control in the year 2018-19, respectively. Garlic clove extract @ 5 percent showed minimum PDI of

38.82 and 33.16 percent with maximum disease control of 50.60 and 56.15 percent over check during 2018-19 and 2019-20, respectively and was statistically superior to all other treatments except eucalyptus leaf extract which at five percent concentration gave 46.11 and 50.20 percent disease control over check during 2018-19 and 2019-20, respectively. Other plant extracts could produce less than 40 percent disease control over check. Minimum disease control of 7.30 and 10.92 percent was observed during 2018-19 and 2019-20, respectively in case of black cumin, indicating that black cumin was least effective in controlling spot blotch. Yield and 1000-grain weight observed in garlic clove and eucalyptus leaf extracts (two best plants extracts) were statistically at par during both the years. Yields were 41.40 and 40.11 q/ha in case of garlic clove and eucalyptus leaf extract in 2018-19 and 44.74 and 43.20 q/ha in 2018-19, respectively. Similarly 1000-grain weights were 42.80 and 41.60 g in 2018-19 and 45.62 and 43.12 g in 2018-19.Data clearly indicates that both garlic clove and eucalyptus leaf extracts are equally effective in reducing disease to 50 percent and increasing grain yield.

Discussion

In vitro screening of plant extracts against radial growth of *Bipolaris sorokiniana*

Present studies clearly indicate that eucalyptus leaf, garlic clove and neem leaf extract were very promising in controlling *B. sorokiniana* at all three concentrations (2, 5 and 10 percent). Onion bulb, black cumin seed and ginger rhizome extract were also effective in inhibiting *B. sorokiniana* at 5 and 10 percent concentrations but they were either less effective or practically non-effective in inhibiting the growth of *B. sorokiniana* at two percent concentration. Hasan *et al.* (2012) [10] who evaluated the effect of five botanical extracts namely garlic, onion, ginger, neem and black cumin at different concentrations (5, 10 and 15 percent) on the mycelial growth of *B. sorokiniana*, showed that the highest percent inhibition of mycelial growth was in the application of garlic extracts (67.50 percent) at 15 percent concentration. Perello *et al.* (2013) [17] reported that Allicin in garlic juice inhibit radial colony growth of *Drechslera tritici-repetis*, *Bipolaris sorokiniana* and *Septoria tritici* on agar plates and spore germination. Katooli *et al.* (2014) [14] reported that eucalyptus essential oil at all concentration completely inhibited the mycelial growth of *Pythiumultimum* and *Rhizoctonia solani* only. In case of *B. sorokiniana* complete inhibition was only up to 5 days, after that there was mycelial growth. Bahadar *et al.* (2016) [3] have reported that essential oil and ethanol extract of flowering buds were most effective and no inhibitory effect was noticed for the aqueous extract of leaves and bark in combating the pathogen. This is in contradiction to our present finding.

Effect of foliar spraying of plant extracts on spot blotch, yield and 1000-grain weight of wheat: Present findings clearly indicate that all the plant extracts tested by spraying twice @ 5 percent significantly reduced PDI when compared with untreated check during both the years. However, maximum disease control which could be achieved in either year was not more than 57 percent and it was recorded in plots sprayed with garlic clove extract. Yield and 1000-grain weight observed in garlic clove and eucalyptus leaf extracts (two best plant extracts) were statistically at par during both the years. This clearly indicates that both garlic clove and eucalyptus leaf extracts are equally effective in reducing disease to 50 percent and increasing grain yield.

Earlier Hassan *et al*. (2005) reported garlic extract completely controlled the intensity of *B. sorokiniana* and *Fusarium* spp. after the treatment of wheat seeds. Khalaf *et al.* (2011) [15] found that garlic extract treatment of wheat seeds significantly reduce the incidence of seed-borne fungi, increase seed germination, number of healthy seedlings and vigour index. Hasan (2013) [9] reported that among the ten plant extracts tested, garlic bulb, margosa leaf and ginger rhizome extract significantly reduced the seed-borne fungal infections as well as the population of individual target fungi *Bipolaris sorokiniana*, *Fusarium graminearum*, *Aspergillus flavus* and *Alternaria alternata*. Yadav *et al.* (2015) [20] evaluated extracts of eucalyptus leaf, garlic clove, neem leaf and neem cake and found that two applications of aqueous Eucalyptus leaf extract at tillering and boot leaf stage resulted in the higher wheat yield as compared to other botanical extracts.

Our findings are similar to earlier findings and based on present studies it can be said that garlic clove extract and eucalyptus leaf extract can be safely used in place of fungicides for the management of spot blotch of wheat to some extent.

Conclusion

Among plant extracts eucalyptus leaf extract was highly effective in inhibiting the growth of *B. sorokiniana* it produced 63.11, 68.24 and 78.82 percent inhibition at 2, 5 and 10 percent concentrations, respectively. Garlic clove extract was second best plant extract in inhibiting the growth of *B. sorokiniana*.

All the six plant extracts (garlic clove, eucalyptus leaf, neem leaf, onion bulb, ginger rhizome and black cumin) could significantly reduce PDI when compared with untreated check. Two sprays of garlic clove and eucalyptus leaf extracts @ five percent are equally effective in reducing disease to 50 percent and increasing grain yield.

References

1. Acharya K, Dutta AK, Pradhan P. *Bipolaris sorokiniana* (Sacc.) Shoem.: The most destructive wheat fungal pathogen in the warmer areas. Aust. J Crop Sci 2011;5:1064-1071.
2. Akhter N, Begum MF, Alam S, Md. Alam S. Inhibitory effect of different plant extracts, cow dung and cow urine on conidial germination of *Bipolaris sorokiniana*. J Bio. Sci 2006;14:87-92.
3. Bahadar K, Munir A, Asad S. Management of *Bipolaris Sorokiniana* the causal pathogen of Spot Blotch of Wheat by Eucalyptus Extracts. J Plant. Pathol. Microbiol 2016;7:326.
4. Breiman A, Graur D. Wheat Evaluation. Israel J Pl. Sci 1995;43:58-95.
5. Chowdhary AK, Singh G, Tyagi BS, Ojha A, Dhar T, Battacharya MP. Spot blotch disease of wheat-a new thrust area for sustainable productivity. J Wheat Res 2013;5:1-11.
6. Duveiller E, Sharma RC. Genetic improvement and crop management strategies to minimize yield losses in warm non-traditional wheat growing areas due to spot blotch pathogen *Cochliobolus sativus*. J Phytopathol 2009;157(9):521–534.
7. Feldman M. The origin of cultivated wheat. In: The wheat Book. A. Bonjean and W. Angus (eds.) (Paris: Lavoisier Tech. & Doc) 2001, 1-56.
8. Gupta RK. Quality of Indian wheat and infrastructure for analysis. In: Joshi, A.K., Chand, R., Arun, B., Singh, G.

(eds.) A compendium of the training program (26-30 December, 2003) on wheat improvement in eastern and warmer regions of India: Conventional and non-conventional approaches. NATP project, (ICAR), BHU, Varanasi, India 2004.
9. Hasan MM. Antifungal effect of plant extracts on seed-borne fungi of wheat. Bangladesh J Prog. Sci. Techn 2013;11(1):13-20.
10. Hasan MM, Ahmed F, Islam MR, Murad KFI. *In vitro* effect of botanical extracts and fungicides against *Bipolaris sorokiniana*, causal agent of leaf blotch of barley. J Agrofor. Environ 2012;6(1):83-87.
11. Hasan MM, Chowdhury SP, Shahidul A, Hossain B, Alam MS. Antifungal effects of plant extracts on seed-borne fungi of wheat seed regarding seed germination, seedling health and vigor index. Pak. J Biol. Sci 2005;8:1284–1289.
12. Iftikhar S, Shahzad A, Munir A, Ahmed I. Chracterization of *Bipolaris sorokiniana* isolated from different Agro-Ecological zones of wheat production in Pakistan. Pak. J Bot 2009;41(1):301-308.
13. Islam MA, Aminuzzaman FM, Islam MR, Zamal MS. Seed treatment with plant extract and Vitavax-200 in controlling leaf spot (*Bipolaris sorokiniana*) with increasing grain yield of wheat. Int. J Sustain. Agril. Tech 2006;2(8):15-20.
14. Katooli N, Maghsodlo R, Razavi SE. Evaluation of eucalyptus essential oil against some plant pathogenic fungi. Int. J Agroforestry Silviculture 2014;1(2):16-17.
15. Khalaf A, Emad IH, Khalid MA, Mahmoud A, Wesam AK, Jacob HJ *et al*. Identification and controlling *Pythium* sp. infecting tomato seedlings cultivated in Jordan Valley using garlic extract. Asian J Pl. Pathol 2011;5:84-92.
16. Pal BP. Wheat. Indian Council of Agricultural Research, New Delhi 1966, 370.
17. Perello A, Noll U, Slusarenko JA. *In vitro* efficacy of garlic extract to control fungal pathogens of wheat. J Med. Plants Res 2013;7(24):1809-1817.
18. Singh DP, Chowdhury AK, Kumar P. Management of losses due to seed-borne infection of *Bipolaris sorokiniana* and *Alternaria triticina* in wheat (*Triticum aestivum*) using seed treatment with Vitavax 200WS. Indian J Agric. Sci 2007;77:101-103.
19. Van Ginkel M, Rajaram S. Breeding for resistance to spot blotch in wheat: Global perspective. In: Duveiller, E., Dubin, H.J., Reeves, J. & McNab, A. (eds). Proc. Int. Workshop on Helminthosporium Diseases of Wheat: Spot Blotch and Tan Spot, CIMMYT, El Batan, Mexico 1998, 162-169.
20. Yadav B, Singh R, Kumar A. Management of spot blotch of wheat using fungicides, bio-agents and botanicals. Afr. J Agric. Res 2015;10(25):2494-2500.