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Assessment of Losses in Sweet Sorghum Genotype (SSV 74) due to Leaf Blight caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs

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ABSTRACT

Background: Leaf blight caused by *Exserohilum turcicum* (*E. turcicum*) is commonly or generally found on sorghum grown in the sub-tropics and tropical lowlands during summer. The pathogen is easily wind disseminated and apparently most consistent in their occurrence and severity across the diverse sorghum growing environments. The sweet sorghum variety SSV 74 was released by University of Agricultural Sciences, Dharwad for *kharif* season mainly for fodder purpose. This variety is also good for ethanol production and jaggery making. However, for the last several years this variety was showing its susceptibility to the leaf blight caused by *E. turcicum* and causes heavy losses both in fodder and its quality. Even though there are reports of the presence of leaf blight caused by *E. turcicum* on the grain sorghum, no precise information is available on the presence of the leaf blight on sweet sorghum in India as well as in the world and no information is available about the magnitude of losses caused by this disease. Hence, the experiment was conducted to assess the losses caused by the *E. turcicum.*

Methods: An experiment on loss assessment in sweet sorghum due to leaf blight caused by *E. turcicum* was carried out at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, during *kharif* 2017 using randomized complete block design (RCBD) with three replications and seven treatments. Six treatments were imposed with hexaconazole at 0.1% besides a treatment with unsprayed control.

Result: Lowest per cent disease index (PDI) (24.76%) as well as area under disease progressive curve (789.61) was observed in treatment involving six sprays of hexaconazole at 0.1% followed by five sprays, (PDI: 27.51%, AUDPC: 815.32) and four sprays T_4 (PDI: 32.57%, AUDPC: 908.80). Highest fodder yield (46.47 t/ha), brix value (12.47%), crude fibre content (28.22%), leaf ash content (23.08%) and crude protein content (5.29%) was observed in treatment with six sprays of hexaconazole at 0.1%. With respect to the per cent increase over control, 17.47-37.20 per cent increase in fodder yield, 7.4-21.17 per cent in brix value, 11.64-9.66 per cent in crude fibre content, 12.74-62.91 per cent in leaf ash content and 4.36-13.00 per cent in crude protein content was observed at one spray to six sprays with hexaconazole at 0.1 per cent, respectively.

Key words: AUDPC (Area under disease progressive curve), Leaf blight, PDI (Per cent disease index), Sweet sorghum.

INTRODUCTION

Sorghum bicolour (*S. bicolar*) commonly known as sorghum, which cultivated widely in tropical and subtropical regions of the world. Sorghum is important cereal crop which occupies the fifth position after the rice, wheat, maize and barley (Amarnath *et al.*, 2018). It is one of the essential staple food for the poorest and most food-insecure people in the world. Different types of sorghum are known to be cultivated in the world like grain and grass sorghum, sweet sorghum [*Sorghum bicolour* (L.) Moench] is the one which can be used for different purposes, like food (grain from its ear head), sugary juice and leaves make excellent fodder for animals. Sorghum is affected by number of foliar diseases *viz*., anthracnose, leaf blight, grey leaf spot, rust and downy mildew are widespread over all the humid regions of the world when high rainfall occurs. Leaf blight caused by *E. turcicum* is found to be more consistent in the sub-tropics and tropical lowlands during summer (Frederiksen, 1982) whereas, cooler temperate and tropical environments are not favorable for the occurrence of this pathogen. Since the pathogen is wind disseminated, occurrence of this disease is apparently most consistent and causes severe lose across the various sorghum growing environments. In India, the disease become first mentioned by Butler (1918) on the cultivated sorghum leaves and later it was reported by Mitra (1923) from Punjab. The symptoms of this disease may also vary keeping view with geographical region, host cultivar and pathogen. Yield losses attributed because of this ailment will usually vary with sorghum growing areas and with surroundings (Frederiksen 1982).

The variety SSV 74 (sweet sorghum variety 74) was released by University of Agricultural Sciences, Dharwad

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for *kharif* season mainly for fodder purpose and it's also good for ethanol production and jaggery making. However, the variety was susceptible to leaf blight caused by *E. turcicum* from several years, causing heavy loss in phrases of fodder and its quality. Even though there are limited reports on presence of leaf blight caused by *E. turcicum* on the grain sorghum, no accurate information is available on presence of the leaf blight on sweet sorghum and magnitude of loss it causes in India as well as the world. Keeping the above fact in view, loss assessment study was undertaken to find the amount of loss it causes in fodder as well as its quality.

MATERIALS AND METHODS

Field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2017 by following randomized complete block design (RCBD) with three replications and seven treatments having the gross plot size of 2.4 m×5 m and net plot size of 1.8 m×5 m and spacing followed was 30 cm×10 cm (Cv. SSV 74). Six treatments were imposed with hexaconazole (found effective under *in vitro* conditions) at 0.1% besides a treatment with unsprayed control and the treatments were implemented as T_1: One spray at the onset of the disease, T_2: Two sprays: at T_1 and one week after T_1, T_3: Three sprays: at T_1, T_2 and one week after T_2, T_4: Four sprays: at T_1, T_2, T_3 and one week after T_3, T_5: Five sprays: at T_1, T_2, T_3, T_4 and one week after T_4, T_6: at T_1, T_2, T_3, T_4, T_5 and one week after T_5, T_7: Unsprayed control.

The inoculum of *E. turcicum* was mass multiplied on sweet sorghum leaves. For this leaves were cut into small bits of 5 to 6 cm in conical flasks and autoclaved at 15 psi pressure and 120°C temperature. Sterilized flasks were inoculated with *E. turcicum* culture and incubated at 25°C ±1°C with 12 h darkness for 8-10 days. Mycelium and spores developed on these leaves were harvested by flooding the flask with sterilized distilled water and scraping the growth by a brush. Spore suspension thus obtained was adjusted to desired concentration (1×10^5 spores/ml) and sprayed twice uniformly on all treatment plots at alternative days in the evening hours when the crop was 21 days old to create high disease pressure. Observations on leaf blight severity in different treatments were taken at weekly intervals after the onset of disease by following 0-9 scale of Mayee and Datar (1986). Further, per cent disease index (PDI) was calculated using the formula (Wheeler 1969).

Per cent disease index =

$$\frac{\text{Sum of individual disease ratings}}{\text{No. of leaves observed} \times \text{Max. grade}} \times 100$$

Later, PDI values were used to calculate area under disease progressive curve (AUDPC) using the following formula given by Wilcoxson *et al.* (1975).

$$\text{AUDPC} = \sum_{i=1}^{k} [\frac{1}{2}(S_i + S_{i-1})\, d]$$

Where,
S_i = Disease severity at the end of time.
S_{i-1}= Number of successive evaluations of blight.
d = Interval between two evaluations.

Then fodder yield per plot was taken by harvesting each treatment separately 85 days after sowing. Later fodder quality parameters *viz.*, crude protein (Anonymous, 1990), crude fibre (Horwitz 2000) and leaf ash content (Thiex *et al.* 2012) and Brix values were recorded as per the procedure given below.

Crude protein content

Leaf sample from each treatment were collected one day before harvest in brown paper bag and the sample was shade dried and further oven dried overnight for the removal of moisture. Further oven dried leaf sample were ground using the mixer grinder and ground samples were maintained separately in the polybags.

Two grams of prepared sample was transferred carefully to the Kjeldhal flask, to this 10 g of potassium sulphate, 0.5 g of copper sulphate and 25 ml of concentrated sulphuric acid was added and were placed in an inclined position and heated until frothing ceased, heated and digested till the mixture was clear. After cooling the contents were transferred quantitatively to round bottom flask with water, the total quantity of water used was 200 ml. Then few pieces of fumic stones were placed prior to the addition of sodium hydroxide to make the solution alkaline so as to avoid mixing at once with acid solution.

The digested material was made up to a volume of 100 ml in a volumetric flask. Five ml of aliquot was taken in the receiver of distillation apparatus. Ten ml of 45 per cent solution of sodium hydroxide was added till the blue colour was formed.

Released ammonia was collected in 10 ml of two per cent boric acid solution. Faint reddish boric acid colour started changing to green colour since the released ammonia was absorbed by boric acid solution. Released ammonia was allowed to distil till the original volume of 10 ml of boric acid became 30 ml. Green coloured boric acid back titrated with N/100 sulphuric acid using microburette. Used volume of this standard solution was noted down.

After completion of distillation, sample in the receiver was taken by creating negative pressure of cooling. Total nitrogen per cent by weight was calculated as:

Total nitrogen (N) per cent by weight =

$$\frac{\text{Titre volume} \times 0.00014 \times \text{Volume made} \times 100}{\text{A liqout taken} \times \text{Weight of substance on dry matter basis}} \text{ g/100 g}$$

A= Volume of N/ 100 H_2SO_4
Total crude protein per cent = N × 6.25.

Crude fibre content

Leaf sample from each treatment were collected in the brown paper bag and shade dried and further oven dried overnight for the removal of moisture. Ground sample was defatted using the petroleum ether by placing 5 g of the sample and 80ml of petroleum ether in 100 ml beaker overnight. The defatted sample was oven dried until the constant weight is achieved. Later, estimation of crude protein was done by taking 3 g of defatted sample was taken in 500 ml beaker to which 200 ml of sulphuric acid (1.25%) was added and boiled for 30 min. keeping the volume constant by adding water at constant interval (a glass rod was placed or kept in the beaker for smooth boiling). After boiling it was filtered through muslin cloth and left out residue was washed with the boiling water until washings are no longer acidic. Then the residue was added to another beaker (500 ml) with 200 ml of NaOH and which was further boiled for 30 min. Again, it was filtered through muslin cloth, washed with hot distilled water till it was free from alkali followed by washing with some alcohol and ether. The residue left on the muslin cloth was transferred to a crucible, dried overnight at 80-100°C and weighed (We). Then oven dried sample was again dried in muffle furnace for 2-3 h at 600°C. cooled and weighed (Wa). Difference in the weights (We-Wa) represents the weight of the crude fibre.

Crude fibre (g/100 g) =

$$\frac{\text{we} - \text{wa}}{\text{Weight of the sample taken}} \times 100$$

Leaf ash content

Ash content was determined using the high temperature muffle furnace capable of maintaining the temperatures between 500-600°C. The dried leaf sample is weighed before and after ashing to determine the concentration of ash present. The ash content can be expressed on dry basis.

$$\text{Per cent ash (dry basis)} = \frac{\text{Mash}}{\text{Mdry}} \times 100$$

Where,

Mash = Mass of the ashed sample.

Mdry = Mass of the original dried sample.

Brix percentage

Five plants from each treatment were selected randomly a day before harvest and then brix percentage from those plants was recorded using the pocket refractometer (0-93%)

RESULTS AND DISCUSSION

Symptomatology and appearance of the disease

Symptoms are visible from the seedling stage to the crop maturity stage. Small, round to irregular reddish or dark brown spots develop on seedlings. On mature plants, long, elliptical, reddish purple or brown spots develop on both surface of the leaf (Fig 1a and 1b), later these spots enlarge and coalesce resulting in blighted appearance of the entire leaf (Fig 1c). Size of the spot varies from one to few centimetres in length and few millimetres in width. It primarily attacks leaf blade but under extended disease conducive environment it may also attack leaf sheath, node and stem. In humid weather, numerous greyish black spores are produced in the lesions in concentric zones. During the experiment first appearance of the disease was observed after the 30 days of sowing *i.e.* between 23rd July to 29th July (30th standard meteorological week) of 2017.

Disease severity and area under disease progressive curve (AUDPC)

Different disease severity levels were observed in different treatments. Treatment involving six sprays of hexaconazole recorded least leaf blight severity (24.76%) and AUDPC (789.61). This was followed by treatments involving five sprays and four sprays of hexaconazole at 0.1% which have recorded leaf blight severity and AUDPC of 27.15% and 815.32, 32.71% and 908.80, respectively. Highest leaf blight severity (67.41%) and AUDPC value (1818.55) was observed in unsprayed control (Table 1a).

Fodder yield and quality parameters

Difference in fodder yield and different quality like brix value, crude fibre content, leaf ash content and crude protein content as influenced by different number of fungicidal sprays was found significant. Highest fodder yield (46.47 t/ha), brix value (12.47%), crude fiber content (28.22%), leaf ash content (23.08%) and crude protein content (5.29%) was recorded in treatment involving six sprays of hexaconazole at 0.1% and significantly lowest fodder yield (29.18), brix value (9.83%) crude fiber content (22.67%), leaf ash content (8.56%) and crude protein content (8.56%) was recorded in unsprayed control. Fodder yield and most of the quality parameters in treatments involving one, two and three sprays of hexaconazole at 0.1% were found on par with each other (Table 1b).

Losses in fodder yield and quality parameters varied in different spray schedules. Highest increase in fodder yield (37.20%), brix value (21.17%), crude fiber content (19.66%), leaf ash content (62.91%) and crude protein content (13.00%) over unsprayed control was observed in six sprays with hexaconazole @ 0.1% and it was found lowest in a single spray of hexaconazole at 0.1%, where in increase in fodder yield, brix value, crude fiber content, leaf ash content and crude protein were 17.47%, 7.40%, 11.64%, 12.74% and 4.36%, respectively over unsprayed control (Table 1b).

Leaf blight disease progressed faster and reached highest in control plot (61.41%) than treated plots with hexaconazole (24.76-47.58%) (Table 1a). Overall, present results are in accordance with Lee *et al.* (1986) who observed that 47 and 38% reduction in fresh and dry matter yield of sudan grass (*Sorghum Sudanese* (Piper.) Stapf) due to leaf blight and further they also reported that, the concentration of infected leaves loose part of their nutritive value like crude protein and crude fibre. Similarly, Bunker and Mathur (2006) reported grain and fodder yield loss in sorghum due to leaf blight (*E. turcicum*) in Kerki local and CSH 14 variety under field condition. They reported that, in two years of testing, the per cent disease index in Kerki local was ranged from 43 to 74 and resulted in 20 to 36 per cent reduction in grain and 12 to 27 per cent in fodder yield.

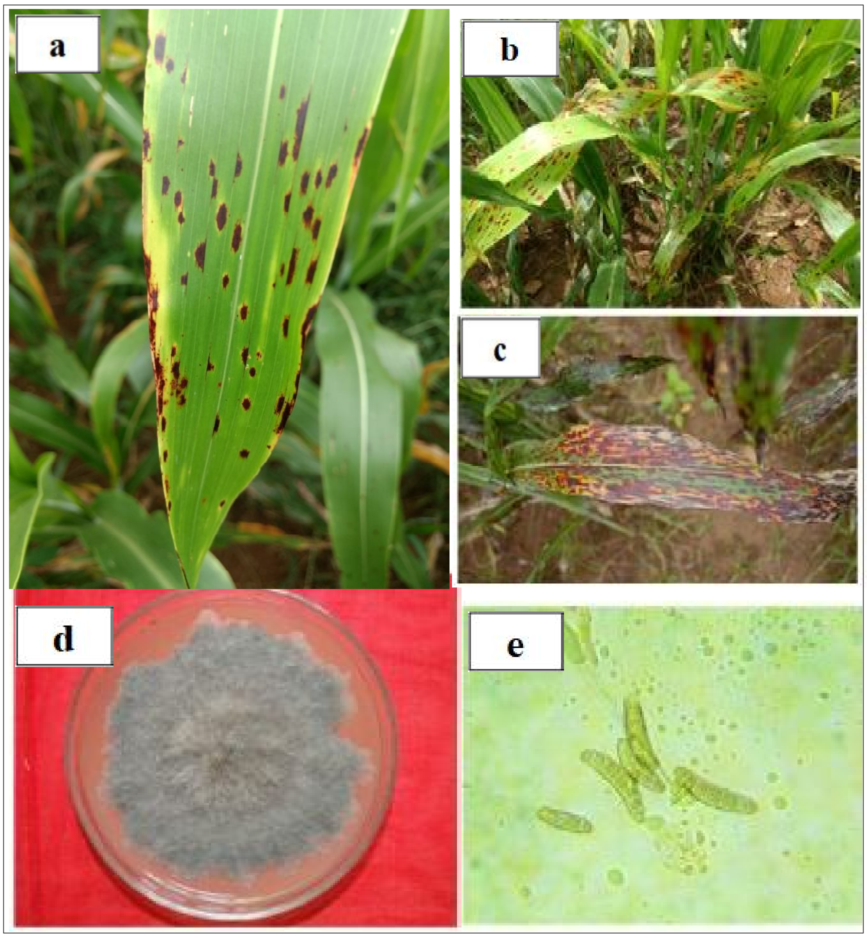

Fig 1: Symptoms of the disease and pathogen. a and b: Long, elliptical, reddish purple or brown spots on leaves, c: large coalesced spots on the leaf showing blighted appearance d. Pure culture of *E. turcicum*. e. Spores of the pathogen (40X).

Table 1a: Leaf blight severity at different intervals as influenced by hexaconazole (0.1%) spray.

Treatment no.	Treatment details	Per cent disease index (PDI)							AUDPC
		Before the first spray *i.e.* 30 DAS	37 DAS	44 DAS	51 DAS	58 DAS	65 DAS	72 DAS	
T_1	One spray of hexaconazole	5.24 (13.23)*	6.25 (14.47)	14.47 (22.28)	24.20 (29.40)	39.61 (39.00)	41.81 (40.28)	47.58 (43.61)	1221.93
T_2	Two sprays of hexaconazole	5.18 (13.16)	6.34 (14.42)	13.50 (21.50)	19.88 (26.09)	31.70 (34.26)	36.52 (37.18)	38.99 (38.64)	1040.22
T_3	Three sprays of hexaconazole	5.59 (13.67)	7.60 (15.98)	9.93 (18.37)	19.77 (26.40)	24.17 (29.43)	32.87 (34.98)	34.54 (35.97)	925.71
T_4	Four sprays of hexaconazole	5.48 (13.54)	9.48 (17.89)	11.51 (19.3)	19.84 (26.45)	25.20 (30.13)	29.47 (32.88)	32.57 (33.65)	908.80
T_5	Five sprays of hexaconazole	5.51 (13.57)	9.42 (17.86)	9.80 (18.21)	18.85 (25.71)	22.83 (28.45)	24.69 (29.79)	27.15 (31.38)	815.32
T_6	Six sprays of hexaconazole	5.54 (13.61)	9.68 (18.04)	9.70 (18.11)	18.51 (25.43)	22.02 (27.95)	23.64 (29.08)	24.76 (29.78)	789.61
T_7	No spray (Control)	5.53 (13.60)	18.79 (25.67)	23.87 (28.24)	36.42 (37.09)	52.59 (46.49)	59.17 (50.32)	67.41 (55.20)	1818.55
S.Em. ±		0.15	1.04	1.52	1.44	1.19	1.09	1.26	
C.D. @ 5%		NS	3.22	4.69	4.44	3.67	3.36	3.87	

*Angular transformed values, DAS: Days after sowing.

Table 1b: Losses in fodder yield and quality as influenced by leaf blight in sweet sorghum.

Treatments	Per cen disease index (PDI) At 72 DAS	Per cent reduction over the control	Fodder yield (t/ha)	Per cent increase in fodder yield over control	Brix value (%)	Per cent increase in brix value over control	Crude fiber content (%)	Per cent increase in crude fiber over control	Leaf ash content (%)	Per cent increase in leaf ash over control	Crude protein content (%)	Per cent increase in crude protein over control
T_1 -One spray of hexaconazole	47.58 (43.61)*	29.41	35.36	17.47	10.62	7.4	25.31	11.64	9.81	12.74	4.81	4.36
T_2-Twos prays of hexaconazole	38.99 (38.64)	42.15	35.54	17.89	11.69	15.91	26.80	15.41	9.85	13.09	4.89	5.93
T_3-Threesprays of hexaconazole	34.54 (35.97)	48.76	36.83	20.77	11.77	16.48	26.57	14.67	10.65	19.62	4.94	6.88
T_4- Four sprays of hexaconazole	32.57 (34.78)	51.68	40.96	28.76	12.17	19.22	25.90	12.00	13.19	35.10	5.04	8.73
T_5- Five sprays of hexaconazole	27.15 (31.38)	59.72	45.96	35.87	12.21	19.49	27.37	17.17	17.78	51.85	5.12	10.15
T_6- Six sprays of hexaconazole	24.76 (29.78)	64.17	46.47	37.20	12.47	21.17	28.22	19.66	23.08	62.91	5.29	13.00
T_7- No spray(Control)	67.41 (55.20)	-	29.18	-	9.83	-	22.67	-	8.56	-	8.56	-
S.Em. ±	1.11		1.72		0.83		1.82		0.38		0.08	
C.D. @ 5%	3.43		5.31		2.57		5.62		1.17		0.24	

* Angular transformed values, DAS: Days after sowing.

60.50 per cent loss in the grain yield and 41.35 per cent loss in the stover yield due to *E. turcicum* in foot hills of north western Himalayas on maize were reported by Rani *et al.* (2016). Kachapur and Hegde (1988), Pandurangegowda *et al.* (1993) and Wathaneeyawech *et al.* (2015) reported the Mancozeb sprays at 0.25% significantly reduced NLB and increased grain yield of maize while working with loss assessment. Nwanosike *et al.* (2015) reported grain losses of 23.9-40.4% in grain yield and 11.2-36.1% in 1000-grain weight in Morogoro, Tanzania. Perkins and Pedersen (1987) reported that reduction in 500-grain weights of maize affected yield losses due to loss of active leaf area caused by *E. tutcicum*.

CONCLUSION

Results from the experiment shows that crop losses varied significantly between the numbers of sprays with hexaconazole at 0.1%. The losses were directly proportional to disease severity. The higher per cent disease index observed in the variety in turn reflected on the magnitude of loss as it increased the fodder yield, brix value, crude fiber content, leaf ash content and crude protein by 17.47-37.20%, 7.4-21.17%, 11.64-19.66%, 12.74-62.91% and 4.36-13.00%, respectively over unsprayed control. Even though after the six sprays with hexaconazole at 0.1 per cent the disease was not able to manage completely. It may be concluded that losses due to blight disease can be effectively managed by combination of tolerant genotype along with the fungicide spray.

Conflict of interest: None.

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