Biological Forum – An International Journal **14(2a): 178-183(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Survey on the Status of Post Flowering Stalk Rots in Telangana State

M. Bhavani[1*], B. Mallaiah[2], D. Bhadru[3], M. Prameela[4] and S. Vanisri[5]

[1]P.G. Scholar, Department of Plant Pathology, College of Agriculture, PJTSAU, Hyderabad (Telangana), India.
[2]Senior Scientist, Department of Plant Pathology,
Maize Research Centre, Agriculture Research Institute, Rajendranagar, Hyderabad (Telangana), India.
[3]Senior Scientist, Department of Plant Breeding and Genetics,
Maize Research Centre, Agriculture Research Institute, Rajendranagar, Hyderabad (Telangana), India.
[4]Senior Scientist, Department of Plant Pathology Mushroom Cultivation Scheme,
College of Agriculture, PJTSAU, Rajendranagar, Hyderabad (Telangana), India.
[5]Professor, Department of Molecular biology and Biotechnology,
Institute of Biotechnology, PJTSAU, Rajendranagar, Hyderabad (Telangana), India.

(Corresponding author: M. Bhavani)*
(Received 17 April 2022, Accepted 21 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Post-flowering stalk rots (PFSR) are complex and one of the economically important diseases of maize. The PFSR incidence has been increasing in most of the maize growing areas of Telangana. A roving survey was conducted during *Kharif* -2021 for maize plants with typical symptoms of PFSR in major maize growing areas of Telangana state. Samples were collected from 30 villages in 9 districts. Disease incidence varied from 1.66 % to 48.52% in different villages. The maximum disease incidence was reported in Porandla (Thimmapur) village of Karimnagar district and minimum disease incidence was recorded in Appajipally (Balanagar) village of Mahabubnagar district. Pathogen associated in all the samples were isolated and morphologically identified as *Fusarium verticillioides* in 17 samples *and Macrophomina phaseolina* in 13 samples. The disease incidence was high in red soils compared to black soils. Hence, this kind of surveys help in timely identification of associated pathogen and take up necessary IDM measures to overcome the disease incidence.

Keywords: Post flowering stalk rot, Fusarium stalk rot, Charcoal rot, survey, samples.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important and third largest grown cereal crop in India after paddy and wheat.

Currently, nearly 1162.7 million MT of maize is being produced together by over 170 countries from an area of 201.8 million ha with average productivity of 5.75t/ha (FAOSTAT, 2020) accounting for ~9% of total food grain production. In India, it was cultivated in an area of 9.891 Mha during 2020-2021 with a production of 31.65 MT and productivity of 31.99 q/ha. In Telangana state, the crop is grown in almost all districts in an area of 259 thousand hectares with a production of 1756.57 thousand tonnes and productivity of 6782Kg's/ha (INDIASTAT, 2020-2021). In India nearly 61 diseases are infecting maize. Among them stalk rots are one of the economically important diseases of maize all over the world (Payak and Sharma 1985). Post-flowering stalk rots (PFSR) are complex disease, which are widely distributed in almost all the maize growing regions across the world. A number of fungi are involved in decaying pith causing pre-mature wilting of the plants (Shekar *et al*, 2006). In India three bacteria and eight fungi were reported to cause stalk rots (Raju and Lal 1976). Stalk rot disease caused by fungal pathogens are the most destructive disease of maize (Munkvold, 2003). Among all Fusarium stalk rot (*F. verticillioides*), Charcoal rot (*M. phaseolina*), Late wilt (*Cephalosporium maydis*) are more destructive in nature (Khokhar *et al*., 2014). However, predominantly *M. phaseolina* and *F. verticillioides* incidence were high in Telangana. Generally stalk rot occurs in areas where drought conditions prevails at or after flowering. The disease is favoured by high soil temperature (30^{o}C to 42^{o}C) with low soil moistures. In a field survey conducted in 2019-2020 in Telangana the disease incidence ranged from 27% to 76.8% with a yield loss of 30% (Mamatha *et al*., 2020).

MATERIALS AND METHODS

Survey. The survey for stalk rot of maize was conducted during *Kharif*-2021, in 30 villages of 9 districts. Survey was typically conducted when crop was at physiological maturity stage and stalk rot symptoms were likely to appear (Kelly *et al*., 2017). In each village, five fields were selected with 10 km distance apart. Data regarding GPS, soil type, crop stage, previous crop sown, source of irrigation, crop variety, agronomic practices followed by farmer were recorded.

Sampling procedure. The disease incidence was recorded by enumerating the number of wilted plants out of total number of plants in a 4m × 4m area of the field at all the four corners and in the centre (Ramesha, V and Krishnan, 2017).

Disease incidence percentage was calculated by using the formula

$$Disease\ incidence\ (\%) = \frac{Number\ of\ infected\ plants}{Total\ number\ of\ plants} \times 100$$

Diseased stalk sections were packed in paper bags, labelled and brought to the laboratory for isolation and identification of associated fungal pathogens. Diseased samples were examined under light microscope and infected stems with typical stalk rot symptoms were processed further.

Isolation . The plants with typical symptoms were first washed with tap water followed by sterile distilled water. Three 5 mm diseased stalk bits were taken at 5, 10 and 15 cm from the first internode above the brace roots (Scauflaire *et al*., 2011). Diseased portions were cut into small bits of 3-5 mm size, surface sterilized by dipping them in sodium hypochlorite (1%) solution for one minute and then 3-4 bits were transferred aseptically to petri plates containing Potato dextrose agar (PDA) medium that was amended with streptomycin sulphate to inhibit bacterial growth and were incubated at 25 ± 2ºC in BOD incubator. The pathogens isolated from the infected tissue were further purified by single spore isolation method as described by (Ho and Ko 1997) and identified based on cultural and morphological characters.

RESULTS AND DISCUSSION

In Telangana, disease prevalence was observed in almost all the surveyed villages ranging from 1.66 % to 48.52% in different districts. The highest disease incidence (48.52%) was recorded in Porandla village of Karimnagar district followed by Rajendranagar village in Rangareddy district with 42.42% disease incidence while the lowest recorded in Appajipally village of Mahabubnagar district (Table 1). The disease incidence was high in red soils (1.66% -48.52%) than in black soils (14-42.4%)under rainfed conditions than in irrigated conditions. Variation in incidence and severity of stalk rot disease at different locations might be attributed to variation in various soil and environmental factors, time of irrigation, rainfall, cropping patterns, variety grown, management practices followed in the locations (Doohan *et al*., 2003; Scauflaire *et al*., 2011). It was found that samples from Vikarabad (Dharur), Nizamabad (Morthad), Karimanagar (Kondapaka), Warangal (Kurchapalle), Mahababubadh (Nadivada, Bayyaram), recovered *F. verticillioides* and samples from Mahabubnagar (Jadcherla), Karimnagar (Choppadhandi) reported only *M. phaseolina* isolate while samples from Khammam (Kothagudem, Konijerla), Karimnagar (Ramakrishnapuram, Porandla, Medipally), Siddipet (Pragnapur), Rangareddy (Rajendranagar), Warangal (Chagal, Dharmasagar, Velair), Mahabubnagar (Peddharevalle) reported both *F. verticillioides* and *M. phaseolina* indicating their complex nature in soil. Maize plants showing characteristic Fusarium stalk rot symptoms includes rotting that extend from infected roots to the stalk and causes premature drying, ear dropping, stalk breakage. Thus reducing maize yields significantly (Hooda *et al*., 2018). The disease causes internal tissue decay, vascular tissue discolouration, blocking translocation of nutrients and water and resulting in lodging and death of the plant and Charcoal stalk rot symptoms which ranged from seedling blight, rotting of stalk, roots and kernels. It produces brown, water soaked lesions on the plant roots which later gives black discolouration (Thahir *et al*., 2019). As the plants fungus spread into the lower internodes of the stalk, causing, shredding (Fig. 1), premature ripening and breaking at the crown. Interior stalks gave a charred appearance because of numerous black sclerotia in vascular strands (Fig 1) (Kaur *et al.*, 2008). Sclerotia is found just under the stalk surface and also on the roots. The fungus infects the kernel by turning them black (Shekhar *et al.*, 2006). Gum deposition was observed in the cortical tissues of roots were randomly sampled from each location.

These results are in agreement with the (Mamatha *et al*., 2020) reported that maximum disease incidence was noticed in Karimnagar district because of favourable conditions prevailing during flowering compared to other districts in Telangana. Also (Munkvold, 2003) reported that cultural practices and geographical location including tillage, planting date, crop rotation and fertilizer application also affect the disease incidence of all *Fusarium* spp causing stalk rot of maize. Also (Khokhar *et al.*, 2014) reported that late sown crop and hot and humid weather favours the disease development more because of heavy inoculum built up in the soil and moisture stress during flowering period. Identification of these isolates were made based on morphological and cultural characters. The fungal colony of *F. verticillioides* isolates on PDA were initially white, cottony (Plate 1)which after 7 days of incubation at 28±2ºC developed pigmentation like pink, light purple, dark violet (Ayesha *et al*., 2020). The mycelia growth was observed 24-48 hours after inoculation on PDA medium in *M. phaseolina* isolates. Within 6-7 days, the colonies became carbonaceous, fluffy, brown to black in colour (Plate 2) covering the complete plate and numerous sclerotia developed throughout the colony with time. Based on morphological and cultural characters of both the pathogens they were identified as *F. verticillioides* and *M. phaseolina*. The morphology of the pathogen was in accordance with the description given for maize stalk rot pathogens by Iqbal *et al*. (2018); Abhay *et al*. (2020).

Table 1: Survey on the status of PFSR of maize in different maize growing areas of Telangana state during *kharif*-2021.

S. No.	District	Mandal	Village	Latitude	Longitude	Soil type	Rainfed/ irrigated	Crop stage (DAS)	*Wilt incidence (%)	Pathogen isolated
1.	Mahabubnagar		Peddharevalle	16°90'7N	78°24'1E	Red soil	Rainfed	80-85	17.3(24.6)**	*F. verticillioides + M. phaseolina*
2.	Mahabubnagar	Balanagar	Modhampalle	16°91'2N	78°23'2E	Red soil	Rainfed	80-85	9.43(26.8)	-
3.	Mahabubnagar	Balanagar	Appajipally	16°92'1N	78°21'2E	Red soil	Rainfed	80-85	1.66(24.6)	-
4.	Mahabubnagar	Rajapur	Agraharam	16°89'7N	78°20'2E	Red soil	Irrigated	85-90	5.45(26.8)	-
5.	Mahabubnagar	Rajapur	Potlapalli	16°87'6N	78°20'5E	Red soil	Rainfed	85-90	8.39(23.8)	-
6.	Mahabubnagar	Rajapur	Kallepalli	16°88'2N	78°20'7E	Red soil	Rainfed	85-90	5.38(26.7)	-
7.	Mahabubnagar	Jadcherla	Nagasala	16°73'5N	78°15'4 E	Red soil	Rainfed	85-90	16.4(30.1)	*M. phaseolina*
8.	Mahabubabadh	Mahabubabadh	Redyala	17°38'0N	80°08'1E	Black soil	Rainfed	85-90	14.7(33.8)	-
9.	Mahabubabadh	Mahabubabadh	Nadivada	17°36'2N	80°06'5E	Red soil	Rainfed	90-95	21.3(30.4)	*F. verticillioides*
10.	Mahabubabadh	Bayyaram	Bayyaram	17°58'8N	80°11'1E	Black soil	Rainfed	85-90	15.3(30.0)	*F. verticillioides*
11.	Mahabubabadh	Dornakal	Kannegundla	17°44'5N	80°15'6E	Red soil	Irrigated	90-95	18.4(29.8)	-
12.	Khammam	Khammam urban	Kothagudem	17°21'2N	80°16'1E	Black soil	Irrigated	90-95	31.4(30.4)	*F. verticillioides + M. phaseolina*
13.	Khammam	Konijerla	Thanikella	17°13'2N	80°91'1E	Black soil	Rainfed	85-90	32.7(26.8)	*F. verticillioides + M. phaseolina*
14.	Khammam	Chinthakani	Chinthakani	17°31'3N	80°12'5E	Black soil	Irrigated	85-90	30.4(30.4)	-
15.	Khammam	Chinthakani	Raghavapuram	17°8'4N	80°11'5E	Black soil	Irrigated	90-95	27.5(31.7)	-
16.	Siddipet	Pragnapur	Pragnapur	18°10'19N	78°85'2E	Red soil	Rainfed	90-95	34.4(30.1)	*F. verticillioides + M. phaseolina*
17.	Karimnagar	Medipalli	Gundlapalli	18°17'4N	79°63'3E	Red soil	Rainfed	85-90	39.4(36.5)	*F. verticillioides + M. phaseolina*
18.	Karimnagar	Thimmapur	Makthapally	18°31'6N	79°19'4E	Red soil	Rainfed	90-95	40.5(33.4)	-
19.	Karimnagar	Thimmapur	Porandla	18°35'44N	79°21'1E	Red soil	Rainfed	85-90	48.5(37.3)	*F. verticillioides + M. phaseolina*
20.	Karimnagar	Choppadhandi	Rukmapur	18°53'40N	79°15'06E	Red soil	rainfed	90-95	32.5(31.6)	*M. phaseolina*
21.	Karimnagar	Veenavanka	Kondapaka	18°37'22N	79°42'8E	Red soil	Rainfed	85-90	36.7(33.6)	*F. verticillioides*
22.	Karimnagar	Veenavanka	Ramakrishna puram	18°36'68N	79°44'E	Red soil	Irrigated	85-90	34.6(36.0)	*F. verticillioides + M. phaseolina*
23.	Warangal	Velair	Velair	18°00'59N	79^{0}32'E	Red soil	Rainfed	90-95	37.6(33.6)	*F. verticillioides + M. phaseolina*
24.	Warangal	Dharmasagar	Dharmasagar	17°98'8N	79°36'99E	Red soil	Irrigated	90-95	35.5(36.8)	*F. verticillioides + M. phaseolina*
25.	Warangal	Station ghanpur	Chagal	$17^{o^{0}}$82'22N	79°34'E	Red soil	Rainfed	85-90	38.5(33.7)	*F. verticillioides + M. phaseolina*
26.	Warangal	Raghunathpalle	Kuruchapalle	18°00'48N	79°58'8E	Red soil	Rainfed	85-90	34.5(33.4)	*F. verticillioides*
27.	Rangareddy	Rajendra nagar	Rajendra nagar	17°33'13N	78°41'21E	Black soil	Irrigated	85-90	42.4(37.6)	*F. verticillioides + M. phaseolina*
28.	Vikarabad	Dharur	Dharur	17°33'64N	77°90'48E	Red soil	Rainfed	90-95	41.6(36.6)	*F. verticillioides*
29.	Vikarabad	Dharur	Dornal	17°27'52N	77°75'88E	Red soil	rainfed	80-85	32.6(39.5)	-
30.	Nizamabad	Morthad	Morthad	18°81'2N	78°46'31	Red soil	Rainfed	80-85	34.3(35.8)	*F. verticillioides*

*Percent disease incidence **arc sine transformed values

(a) Field infected with PFSR

(b) PFSR Infected plant in field

(c) Vascular discolouration and internal shredding of maize stem due to *F. verticillioides*

(d) Black sclerotial bodies of *M. phaseolina* on maize stem.

Fig. 1. Symptoms of Post Flowering Stalk Rot of maize.

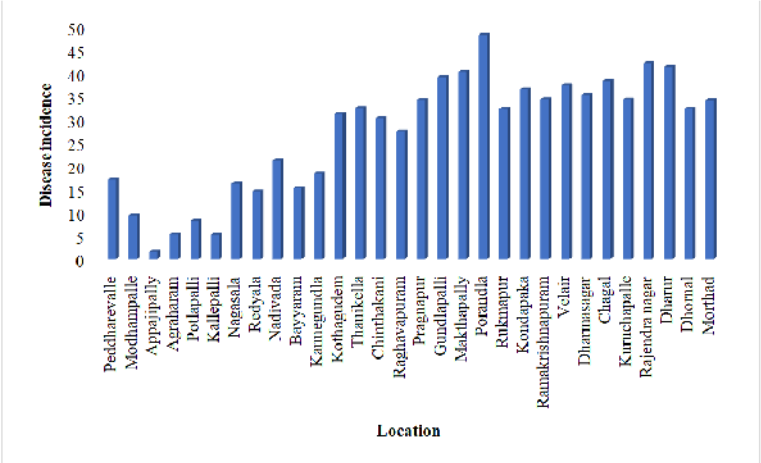
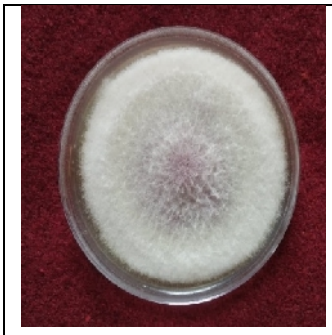
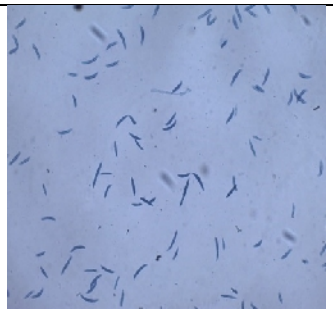


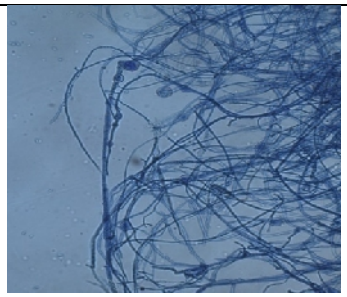
Fig. 2. Survey on the incidence of Post Flowering Stalk Rot of maize in different maize growing areas of Telangana**.**



(a) Pure culture of *F. verticillioides*



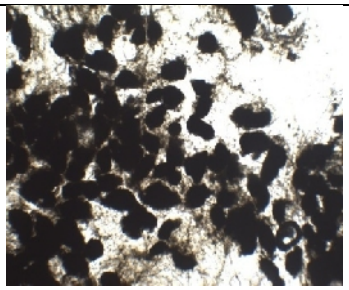
(b) Macroconidia (10X)



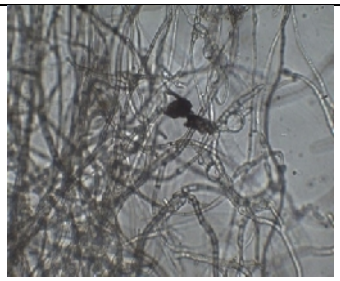
(c) Chlamydospores and Microconidia

Plate 1. Morphological characters of *F. verticillioides*

(a) Pure culture of *M. phaseolina*



(b) Sclerotial bodies (10X)



(c) Septate mycelium

Plate 2. Morphological characters of *M. phaseolina.*

CONCLUSION

The present study concludes that generally stalk rot of maize is present in almost all the surveyed maize fields with variable intensities. Karimnagar, Warangal, Khammam are among the predominant areas with respect to severity of stalk rot of maize. *F. verticillioides* and *M. phaseolina* are responsible for stalk rot of maize in Telangana. Therefore, similar kind of studies should regularly be carried out in different maize growing areas to assess the status of PFSR and making suitable management strategies for future.

Acknowledgement. Authors are thankful to the Maize research centre, ARI, Rajendra nagar, Hyderabad for constant encouragement and support. Authors are also thankful to the Head of the department, Plant Pathology and other officials of PJTSAU for funding and providing necessary support during the study.

Conflict of Interest. None.

REFERENCES

Abhay, K., Rishi, R., Abhishek, R. and Ramakrishnan, M. (2020). Morphological and molecular characterization of *M. phaseolina* isolated from three legume crops and evaluation of mungbean genotypes for resistance to dry root rot. *Crop Protection*.

Ayesha Tabassum, Sanath Kumar, V. B. and Kiran, K. N. (2020). Variability of *F. verticillioides* isolates causing maize Post Flowering Stalk Rot with respect to growth parameters on culture media. *International Journal of Current Microbiology and Applied Sciences*, *9*(8): 747-752.

Doohan, F. M., Brennan. J. and Cooke, B. M. (2003). Influence of climatic factors on *Fusarium* spp pathogenic to cereals. *European Journal of Plant Pathology*, *109*: 755-768.

FAOSTAT. 2020. Agricultural Production Year Book. (http://faostat.fao.org.)

Ho, W. C. and Ko, W. H. (1997). A simple method for obtaining single spore isolation of fungi.*Botanical Bulletin of Academia Sionica*, *38*: 41-44.

Hooda, K. S., Bagaria, P. K., Khokhar, M., Kaur, H. and Rakshit, S. (2018). Mass screening techniques for resistance to maize diseases. ICAR-Indian Institute of Maize Research, PAU Campus, Ludhiana- 141004. pp. 68-70.

INDIASTAT.2020-2021. http://www.indiastat.com/agriculture/2/s tats.aspx.

Iqbal, M., Usman Ghazanfar, M. and Imran Hamid, M. (2018). Cultural and morphological variability of *M. phaseolina* (Tassi) Goid causing Charcoal rot of sunflower in Sargodha Pakistan. *International Journal of Biosciences*, *13*(5): 371-377.

Kaur, H., Sharma, S. and Saxena, A. K. (2008). Biochemical indicators for resistance to Charcoal and Fusarium stalk-rot in maize hybrids. *Agricultural Research Journal*, *45*(3 & 4): 117-200.

Kelly, L., Tan, Y., Ryley, M. and Aitken, E. (2017). *Fusarium* spp associated with stalk rot and head blight of grain sorghum in queensland and new south wales, Australia. *Plant Pathology*, *66*: 1413-1423.

Khokhar, M. K., Sharma, S. S. and Gupta, R. (2014). Integrated management of Post Flowering Stalk Rot of Maize caused by *F. verticillioides*. *Indian Phytopathology*, *67*(3): 228-233.

Khokhar, M.K., Hooda, K.S., Sharma, S.S. and Singh, V. (2014). Post Flowering Stalk Rot Complex of Maize - Present Status and Future Prospects. *Maydica*, 59:226-242.

Mamatha, C.h., Mallaiah, B., Vidyasagar. B. and Bhadru, D. (2020). Survey on the incidence of Post Flowering Stalk Rots of maize in Telangana State during *Kharif* - 2019. *International Journal of Current Microbiology and Applied Sciences*, *9*(11): 2745-2754

Munkvold, G. P. (2003). Cultural and genetic approaches to managing mycotoxins in maize. *Annual review of phytopathology*, *41*(1): 99-116.

Payak, M. M. and Sharma, R. C. (1985). Maize diseases and approaches to their management in India, *Tropical Pest Management*, *31*(4): 302-310.

Raju, C.A. and Lal, S. (1976). Relationship of *Cephalosporium acremonium* and *Fusarium moniliforme* with stalk rot of maize. *Indian Phytopathology*, *3*: 227- 231

Ramesha, V. and Krishna, N. L. (2017). Survey and identification of Post Flowering Stalk Rot of maize caused by *Fusarium moniliforme*.*Journal of Pharmacognosy and Phytochemistry*, *6*(5): 1923-1925.

Scauflaire, J.,Mahieu, O., Louvieaux, J., Foucart, G., Renard, F. and Munaut, F. (2011). Biodiversity of *Fusarium* spp in ears and stalks of maize plants in Belgium. *European Journal of Plant Pathology*, *131*: 59.

Shekhar, M., Kumar, S., Sharma, R.C. and Singh, R. (2010). Sources of resistance against Post Flowering Stalk Rot of maize. *Archives of Phytopathology and Plant Protection*, *43*(3): 259-263.

Shekhar, M., Sharma, R. C., Lokendra, S., Ram, D. (2006). Morphological and pathogenic variability of *Macrophomina phaseolina* (Tassi) Goid incitant of Charcoal rot of maize in India. *Indian Phytopathology*, *59* (3): 294-298

Thahir, A., Javaid., Khan, N.S. and Riaz, M. (2019). Distribution of stalk rot of maize in Punjab, Pakisthan. *International Journal of Biology and Biotechnology*, *16*(3): 703-708.

How to cite this article: M. Bhavani, B. Mallaiah, D. Bhadru, M. Prameela and S. Vanisri (2022). Survey on the Status of Post Flowering Stalk Rots in Telangana State. *Biological Forum – An International Journal*, *14*(2a): 178-183.