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Incidence and severity of chrysanthemum flower blight in Andhra Pradesh, India

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Abstract
Chrysanthemum, a traditional flower crop of Andhra Pradesh, is being cultivated mainly for loose flower and as potted plants. Year-round cultivation under protected conditions enabled the crop to get establish as a commercial crop to meet the market requirements. Flower blight of chrysanthemum is one of the important and emerging diseases affecting its flower production across the world. Many organisms were reported to cause the disease but *Phoma ligulicola* was the most predominant pathogen causing the disease. In the present study, survey were conducted to assess the prevalence of flower blight disease in East Godavari, Chittoor and Visakhapatnam districts of Andhra Pradesh during *kharif* 2019-20 and 2020-21 where the crop was being cultivated both in open field and protected conditions. Four villages were surveyed from two mandals within each district and per cent disease incidence on flowers and per cent disease severity on leaves was calculated. Disease was observed in all the surveyed districts and varied in its intensity. Its incidence (48.40%) and severity (28.28%) was found to be the highest in East Godavari district when compared to Chittoor and Visakhapatnam districts. Flower blight disease incidence and severity varied differentially within the districts and the level of variation differed between districts. Of the six mandals surveyed Kadiyam mandal of East Godavari district was found with the highest mean disease incidence (61.12%) and severity (33.69%). It was noticed that disease incidence (88.42%) and severity (39.57%) was higher in protected conditions in general and in East Godavari district in particular when compared to open field conditions i.e., 44.12% disease incidence and 29.36% disease severity. Proper assessment of disease coupled with identification of the causal organisms helps in adopting better management practices.

Keywords: Chrysanthemum, flower blight, disease prevalence, symptomatology

Introduction
Chrysanthemum (*Chrysanthemum indicum* L.) is one of the important flower crops cultivatied around the world. It is commonly called as golden flower and belongs to Asteraceae family. Economically, the crop ranks first in some countries and ranks second next to rose in other countries. It is being cultivated as potted plant or field crop for its use as loose flower or cut flower. Major chrysanthemum growing states of India are Tamil Nadu, Karnataka, Andhra Pradesh, Telangana, Maharashtra, Rajasthan, Madhya Pradesh and Bihar. There is a huge demand for the production of chrysanthemum within and outside the country.

In Andhra Pradesh, it is one of the important traditional flower crops and its area under cultivation is increasing with the advanced crop production technologies. It is solely cultivated as loose flower crop in East Godavari, West Godavari, Chittoor, Kadapa and Ananthapuram districts. The crop is being cultivated in an area of 2,602 ha with a total production of 25,542 tonnes of flowers (www.indiastat.com, 2016-17) in our state. Chrysanthemum is well known for its varied shapes, sizes, colours, long lasting floret life, diversity of heights and growth habit of the plant. The plant is hardy in nature and easy to grow.

Diseases of fungal, bacterial and viral origin affect the crop. Among the fungal diseases, both foliar and soil borne pathogens affect chrysanthemum production of which flower blight is an important and emerging disease reducing the flower yield. Ray blight (*Phoma ligulicola*), ray speck (*Alternaria* sp.; *Stemphylium* sp.) and blossom blight (*Botrytis cinerea*) are the diseases reported on flower so far across the world. Approximately fifty percent losses were reported in chrysanthemum cuttings during 1975 in Connecticut because of the disease. Ray blight of pyrethrum by same pathogen recorded severe epidemics in Tasmanian fields of Australia (Pethybridge *et al.* 2008) [8]. The pathogen infects all the above ground plant parts, but initiates on flowers which gradually progresses down the peduncle.

As the flower head become infected and rot, the florets stick to one another. The disease spreads through infected planting material, soil, air and gets affected by temperature, rainfall and relative humidity. Though the incidence and damage of flower blight occurs in all chrysanthemum cultivated areas of Andhra Pradesh, there are lack of reports on symptomatology and prevalence of the disease in the state. With this scenario, the present study was conducted to assess the prevalence of flower blight incidence and severity over the geographical regions of Andhra Pradesh and to document the symptomatology of the disease caused by *Phoma* species.

Material and Methods

An intensive roving survey was conducted during 2019-20 and 2020-21 in chrysanthemum growing areas of East Godavari, Chittoor and Visakhapatnam districts in Andhra Pradesh. Disease incidence on flowers as well as disease severity on leaves was recorded as per the 0 to 5 scale developed by Tivoli *et al.* (1996) [10].

Table 1: Disease rating scale (0 - 5 scale) for accessing leaf spot severity

Severity rating	Symptom and lesion types
0	No lesion
1	A few scattered flecks
2	Numerous flecks
3	10–15% of leaf area necrotic and appearance of coalesced necrosis
4	50% of the leaf area dehydrated or covered by lesions
5	75–100% of the leaf area dehydrated or necrotic

Survey was conducted in four villages of the three districts and two fields per each village. Five plants each at five locations *i.e.*, at four corners and one at centre of the field were selected for recording the incidence of chrysanthemum flower blight. Per cent disease index of each field was calculated, mean for each mandal and district was worked out. Per cent incidence on flowers and per cent disease index on leaves were calculated using the following formulae:

$$\text{Per cent incidence} = \frac{\text{Number of flowers infected}}{\text{Total number of flowers observed}} \times 100$$

$$\text{Per cent disease index} = \frac{\text{Sum of individual disease ratings} \times 100}{\text{Total number of leaves observed x Maximum disease rating}}$$

Total number of leaves observed x Maximum disease rating

During survey, characteristic symptoms of the disease were studied. Infected plant parts from the areas of survey were collected for isolation of the pathogen and for further studies.

Results and Discussion

Symptomatology

Flowers are the important economic part of the plant and blight was most conspicuous on flowers and buds. Symptoms appear on all floral parts during various flowering stages. Initially they appeared on lower whorl of florets which later turned to straw or brown colour. Discolouration extend to other florets from base to centre, to sepals and down the peduncle up to 1-2 cm, occasionally even to four centimetres. Infected flowers failed to develop and withered. Pathogen produced various symptoms based on the stage of flower development. Infection at bud initiation stage resulted in browning, blackening and death of the entire flower bud. Infection during bud development and early bud opening stage led to poor development of florets on one side resulting in unequal opening of the flower. As the disease progressed, entire flower head turn necrotic and bend down producing characteristic shepherd crook's symptom. In some cases, entire flower heads gets infected and rotten florets adhere to each other. Infection extend down the peduncle resulting in blackening and girdling the flower stalk (Fig.1). On leaves wedge shaped brown lesions appear from leaf tip or lobes and extend down the leaf. Severe infection led to blightening of flowers and leaves. Similar symptoms in chrysanthemum (Stevens, 1907; Baker *et al*., 1961; Kim *et al*., 2001) [9, 1, 4] and pyrethrum (Pethybridge *et al*., 2003; Jones, 2010) [5, 3] were reported.

Occurrence of flower blight disease incidence and severity

Survey on flower blight disease of chrysanthemum was carried out in three districts of Andhra Pradesh during 2019-20 and 2020-21 both in open field cultivation and protected cultivation. The selected location wise data of Andhra Pradesh on disease incidence and severity of chrysanthemum flower blight have been presented in Table 2.

Incidence and severity of flower blight disease was assessed at a rate of two fields of a village, two villages in a mandal and two mandals in East Godavari, Chittoor and Visakhapatnam districts of Andhra Pradesh under open field and protected conditions. In the surveyed fields, per cent flower infection and per cent disease index on leaves was calculated. Diseased samples were collected from Ananthapuramu, YSR Kadapa and West Godavari districts for comparative studies.

Disease was observed in all the surveyed districts and varied in its intensity. Flower blight incidence (48.40%) and leaf spot severity (28.28%) was found to be the highest in East Godavari district when compared to Chittoor and Visakhapatnam districts. In East Godavari district incidence on flowers ranged between 27.82 and 88.42% while in Visakhapatnam district, disease incidence ranged between 11.65 and 29.94% and recorded the lowest mean incidence of 17.34% and flower blight incidence ranged between 8.22 to 25.77% in Chittoor district with mean per cent incidence of 17.82% (Table 2).

Leaf spot severity occurred in similar trend with the highest mean per cent disease index (PDI) in East Godavari district (28.78%) that ranged from 17.24 to 39.57%. In Chittoor district the lowest mean PDI of 13.71% was noticed which ranged from 7.92 to 17.83%. In Visakhapatnam district, leaf spot severity ranged from 10.51 to 22.15 with the mean PDI of 16.36.

Flower blight disease incidence and severity varied differentially within the districts and the level of variation differed between districts. Of the six mandals surveyed Kadiyam mandal of East Godavari district was found with the highest mean disease incidence (61.12%) and severity (33.69%). While the lowest mean disease incidence (14.58%) and severity (12.55%) was recorded in Madanapalle mandal of Chittoor district. It was noticed that disease incidence (88.42% in Vemagiri-1) and severity (39.57% in Vemagiri-2) was higher in protected conditions in general and in East Godavari district in particular when compared to open field conditions i.e., 44.12% disease incidence in Pottilanka and 29.36% disease severity in Kadiyapulanka.

Very high level of disease occurrence in vemagiri village of kadiyam mandal may possibly be due to continuous availability of inoculum year-round due to monoculturing of the crop under protected cultivation might have led to the highest per cent disease incidence and severity in all stages of the crop. Higher temperatures and relative humidity prevailing in protected conditions further aggravation disease incidence and severity. Variation in disease incidence and severity within the mandals was narrow in Visakhapatnam district while in Chittoor district wider variation in flower blight incidence and narrow variation in leaf spot severity was observed. It may be due to delayed harvesting of flowers in that particular fields (Table 2). Rainfall and temperature coupled with edaphic or site-specific factors were reported as risk factors in case of ray blight outbreaks on pyrethrum (Pethybridge and Hay, 2001; Pethybridge *et al*., 2009) [5, 6].

Table 2: Prevalence of flower blight disease in major chrysanthemum growing districts of Andhra Pradesh during kharif, 2019-20 and 2020-21

District	Mandal	Village	GPS Coordinates	Disease incidence on flowers (%)	Disease severity on leaves (PDI)	Variety	Phonological stage	Irrigation	Type of cultivation
East Godavari	Kadiyam	Vemagiri - 1	16.9225° N, 81.7941° E	88.42	39.30	New Man (white)	Flowering stage	Drip irrigation	Protected cultivation
		Vemagiri - 2	16.9136° N, 81.8183° E	84.12	39.57	New Man (white)	Bud initiation stage, Flowering stage	Drip irrigation	Protected cultivation
		kadiyapulanka	16.89305°N 81.8142°E	27.82	29.36	Wite, yellow, pink, maroon	Bud initiation stage, Flowering stage	Flood irrigation	Open field
		Pottilanka	16.8699° N, 81.8197° E	44.12	26.54	White, yellow	Flowering stage	Flood irrigation	Open field
	Mandal Mean			61.12	33.69				
	Peddapuram	Peddapuram	17.0757° N, 82.1360° E	34.14	17.24	White, yellow, pink, maroon	Flowering stage	Drip irrigation	Protected cultivation
				41.05	23.29	White, yellow	Flowering stage	Drip irrigation	Protected cultivation
		Kattamuru	17.1100° N, 82.1142° E	36.79	22.58	White, yellow, pink	Flowering stage	Drip irrigation	Protected cultivation
				30.74	32.36	White, yellow	Flowering stage	Drip irrigation	Protected cultivation
	Mandal Mean			35.68	23.87				
	District Mean			48.40	28.78				
Chittoor	B. Kottakota	Kottakota	13.6576° N, 78.2626° E	19.92	16.89	White, yellow	Bud initiation stage, Flowering stage	Drip irrigation	Open field
				25.77	13.20	White, yellow, pink, maroon	Bud initiation stage, Flowering stage	Drip irrigation	Open field
		Pulusumanipenta	13.6021° N, 78.3577° E	19.67	17.83	White yellow	Bud initiation stage, Flowering stage	Drip irrigation	Open field
				18.91	11.58	White, yellow	Bud initiation stage, Flowering stage	Drip irrigation	Open field
	Mandal Mean			21.07	14.88				
	Madanapalle	Madanapalle	13.5560° N, 78.5010° E	22.82	13.31	White, yellow	Flowering stage	Drip irrigation	Open field
				18.39	7.92	White, yellow	Flowering stage	Drip irrigation	Open field
		Molakaladinne	13.5313° N, 78.5519° E	8.88	12.71	White, yellow	Flowering stage	Drip irrigation	Open field
				8.22	16.25	White, yellow	Flowering stage	Drip irrigation	Open field
	Mandal Mean			14.58	12.55				
	District Mean			17.82	13.71				
Visakhapatnam	Anandapuram	Gidijala	17.8908° N, 83.2963° E	13.20	22.15	White (New Man)	Flowering stage	Drip irrigation	Protected cultivation
				29.94	20.96	White (New Man)	Flowering stage	Drip irrigation	Protected cultivation
		Anandapuram	17.9054° N,	19.77	11.36	White	Flowering stage	Drip	Protected

			83.3629° E			(New Man)		irrigation	cultivation
				15.55	14.27	White (New Man)	Flowering stage	Drip irrigation	Protected cultivation
	Mandal Mean			19.62	17.19				
	Chintapalle	Chintapalle	17.8713° N, 82.3533° E	20.03	21.82	White	Flowering stage	Flood irrigation	Open field
				13.14	16.28	White	Flowering stage	Flood irrigation	Open field
		Mothukupalle	17.3844° N, 78.2526° E	15.42	13.56	White, yellow	Flowering stage	Drip irrigation	Open field
				11.65	10.51	White	Flowering stage	Drip irrigation	Open field
	Mandal Mean			15.06	15.54				
	District Mean			17.34	16.36				

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