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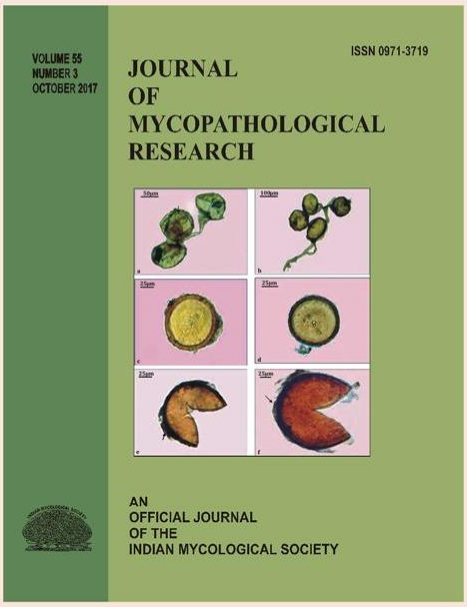

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Mould incidence and aflatoxin contamination in freshly harvested Maize kernels from Karnataka

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In this study, mould incidence and mycotoxin contamination were determined in freshly harvested maize samples collected from different districts of Karnataka. The mould incidence was noticed in all the samples collected from different locations. The mould incidence in samples collected during *kharif* 2013 ranged from 2.78 to 15.28 per cent for *Aspergillus flavus* and 4.17 to 19.44 per cent for *Fusarium* spp. The samples from Bagalkot district showed maximum incidence of both the *Aspergillus flavus* (11.73%) and *Fusarium* spp. (12.89 %). The minimum mould incidence was recorded in samples of Dharwad (5.09 %) and Belagavi district (8.62 %) for the *Aspergillus flavus* and *Fusarium* spp. respectively. Incidence of *A. flavus* and *Fusarium* spp. during *rabi* 2013-14 ranged from 2.78 to 11.11 and 4.17 to 16.67 per cent, respectively. The aflatoxin content in samples was quantified through indirect competitive ELISA technique. Aflatoxin content was highest (104 µg/kg) in the samples collected from Bagalkot district and it was least in the samples collected from Belagavi district (13.20 µg/kg)

Key words: Aflatoxin, *Aspergillus flavus*, *Fusarium* spp., maize, survey

INTRODUCTION

Maize (*Zea mays* L., 2n=20) is an important cereal crop belonging to the grass family Poaceae. It is native to Central America. It has two close relatives among the American *Maydeae, viz*. genus *Tripsacum* (gama grass) and *Teosinte* (Euchalaena). It is grown from 58°N to 40°S, from sea level to altitude of higher than 3000 m and in areas with 250 mm to more than 5000 mm of rainfall per year (Downsell *et al*. 1996). Maize acreage and production is increasing due to introduction of hybrids and the potential of heterosis has just begun to be exploited in developing countries. Globally maize occupies an area of 182.06 million ha, with the production of 987 million tonnes and productivity of 5423 kg ha^{-1}. In India, maize occupies an area of 8.55 million ha with a production of 22.33 million tonnes and with average productivity of 2600 kg ha^{-1}. The states that contribute to large production are Andhra Pradesh (20.9%), Karnataka (16.5%), Rajasthan (9.9%), Maharashtra (9.1%) and Bihar (8.9%). States with highest production potential and productivity is Andhra Pradesh followed by Karnataka (Anon, 2013) In Karnataka, the crop occupies an area of 1.36 million ha and production of 4.09 million tonnes with productivity of 3018 kg ha^{-1} (Anon., 2013).

Major constraints in maize production are pests and diseases. Important diseases are *viz*. leaf blights, downy mildews, stalk rots, rusts and ear rots. In storage condition, mycotoxin contamination is the major problem which affects the quality and some times the quantity of the produce throughout the year there by affecting exporting prospects of maize. Mycotoxin contamination of agricultural commodities has gained global significance as a result of their deleterious effects on human as well as animal health and its importance to international trade (Potty, 2006).In order to assess the incidence of mycotoxin producing organisms in Bagalkot, Belagavi, Dharwad and Haveri districts the present study is undertaken.

MATERIALS AND METHODS

A roving survey was conducted in four districts of

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Karnataka *viz.*, Bagalkot, Belgaum, Dharwad and Haveri districts during *kharif* 2013 and *rabi* 2013-14 and the observations were collected on variety grown, type of soil, stage of sampling, irrigated or rain fed, moisture percentage in grain and other details. Mould incidence in the samples was assessed by using the following formula:

$$\text{Per cent incidence of } \textit{Aspergillus flavus} = \frac{\text{No. of seeds colonized with } \textit{Aspergillus flavus}}{\text{Total No. of seeds incubated}} \times 100$$

$$\text{Per cent incidence of } \textit{Fusarium} \text{ spp.} = \frac{\text{No. of seeds colonized with } \textit{Fusarium} \text{ spp.}}{\text{Total No. of seeds incubated}} \times 100$$

Mean incidence of both the organisms was calculated and tabulated. Samples collected from different districts of Karnataka were sent to ICRISAT, Hyderabad for aflatoxin estimation by using indirect competitive ELISA technique.

RESULTS AND DISCUSSION

The results indicated that *A. flavus* and *Fusarium* spp. incidence was noticed in all the surveyed talukas of four districts. The *A. flavus* incidence ranged from 2.78 to 15.28 per cent. Among the villages surveyed, maximum incidence of *A. flavus* was recorded in Gaddanakeri cross village of Bagalkot district (15.28 %) and minimum incidence was recorded in Bammigatti village of Dharwad district (2.78 %) (Table1).

The *Fusarium* spp. incidence ranged from 4.17 – 19.44 per cent. Among the villages surveyed maximum incidence of *Fusarium* spp. was recorded in Yamanur village of Dharwad district (19.44 %) and minimum incidence was recorded in Durdundi village of Belagavi district (4.17 %) (Table 1).

Among the talukas, the maximum *Fusarium* spp. incidence was noticed in Mudhol taluka (16.67 %) and the minimum incidence was recorded in Gokak taluka (7.84 %). Among the districts surveyed, the mean maximum incidence was noticed in Bagalkot district (12.89 %) and the mean minimum incidence was noticed in Belagavi district (8.62 %) (Table 3).

Among the talukas, the maximum *A. flavus* incidence was noticed in Bagalkot (13.19 %) and the minimum incidence was recorded in Kalghatagi taluka (3.47 %). Among the districts surveyed, the mean maximum incidence was noticed in Bagalkot district (11.73 %) and the mean minimum incidence was noticed in Dharwad district (5.09 %) (Table 2). As evidenced from the results, four northern districts of Karnataka grow maize crop throughout the year, *i.e.*, *kharif*/*rabi*/summer indicating presence of the crop in the field at various stages in relay manner. The crop grown mainly under irrigated ecosystem in Bagalkot and Belagavi districts, cultivated mainly in black soil and two genotypes *viz.*, 900 M Gold and Arjun occupied large number of fields under study.

A. flavus and *Fusarium* spp. occurred in all surveyed villages during both *kharif* 2013 and *rabi* 2013-14. This may be due to the presence of the organisms in the fields as the crop is grown throughout the year.

Marikunte *et al.* (2010) reported that *Aspergillus* spp. and *Fusarium* spp. occured quite frequently on different genotypes, though the proportion of their occurrence on different genotypes varied. Sreenivasa *et al.* (2011) collected the 86 samples from different parts of Karnataka and reported that *Fusarium* and *Aspergillus* were predominant in all the samples. Venkataramana *et al.* (2014) collected 150 samples of freshly harvested maize from different agroclimaitc regions of India and reported that *Fusarium, Aspergillus* and *Penicillium* were predominant among all the fungal genera.

Through indirect competitive ELISA technique, the aflatoxin was assessed from the samples collected from different districts (Table 4). Results indicated that aflatoxin content in the samples collected from Bagalkot district was highest (104 mg/kg) and the least aflatoxin content was observed in the samples collected from Belagavi district (13.20 mg/kg). Bagalkot district had quite higher afltoxin than other districts. However, in all the district the aflatoxin content higher than permissible limit (10 mg/kg). This suggests that agroclimatic situations of Bagalkot district might have supported higher contamination with *A. flavus* or the cultivars grown in Bagalkot district may be more proned to the infection. However, it is quite alarming situation that maize produced in Bagalkot district is contaminated with higher quantity of aflatoxin. Study carried out by Venkataramana *et al.* (2014) reported that samples from Karnataka showed the higher Aflatoxin content of 58-270 mg/kg. Janardhan *et*

Table 1: Incidence of *Aspergillus flavus* and *Fusarium* spp. in maize seeds collected during *kharif* 2013

District	Taluk	Village	Soil type	Rainfed / Irrigated	Genotype	Stage of sampling	Moisture in grain samples (%)	*A. flavus* incidence (%)	*Fusarium spp* incidence (%)
Bagalkot	Bagalkot	Agasinakoppa	Black	Irrigated	900 M Gold	Harvesting	18.52	11.11	8.33
		Gaddankeri cross	Black	Irrigated	DKC9117	Threshing	19.20	15.28	9.72
							Mean	13.19	9.03
	Jamkhandi	Algur	Black	Irrigated	900 M Gold	Harvesting	17.92	6.94	9.72
		Chikkapadasalgi	Black	Irrigated	KH 5991	Threshing	16.46	9.72	12.50
		Madarkhandi	Black	Irrigated	900 M Gold	Harvesting	18.60	13.89	16.67
							Mean	10.19	12.96
	Mudhol	Lokapur	Black	Irrigated	900 M Gold	Harvesting	18.23	11.11	18.06
		Nagaral	Black	Irrigated	Arjun	Threshing	18.40	12.50	15.28
							Mean	11.81	16.67
Belagavi	Bailhongal	Anigol	Black	Irrigated	Arjun	Harvesting	13.20	9.72	6.94
		Budurkatti	Red	Rainfed	Arjun	Harvesting	14.50	8.33	9.72
		Kittur	Black	Irrigated	900 M Gold	Harvesting	16.92	11.11	6.94
							Mean	9.38	7.87
	Gokak	Arabhavi	Black	Irrigated	Arjun	Threshing	13.10	9.72	13.80
		Duradundi	Red	Irrigated	900 M Gold	Threshing	15.40	12.50	4.17
		Kallolli	Black	Irrigated	Arjun	Harvesting	13.10	6.94	5.56
								9.72	7.84
	Raibag	Hidakal	Black	Irrigated	Arjun	Harvesting	11.40	4.17	5.56
		Yabaratti	Black	Irrigated	KH 5991	Threshing	15.46	6.94	11.11
							Mean	5.56	8.33
	Saundatti	Inamhongal	Black	Irrigated	900 M Gold	Threshing	13.20	8.33	5.56
		Murgod	Black	Irrigated	900 M Gold	Harvesting	12.92	4.17	9.72
							Mean	6.25	7.64
Dharwad	Dharwad	Dharwad	Black	Irrigated	Arjun	Threshing	13.00	5.56	8.33
		Garag	Red	Irrigated	DKC9117	Threshing	15.40	4.17	18.06
		UAS, Dharwad	Black	Irrigated	DMIL-103	Harvesting	18.10	6.94	9.72
		Yamanur	Black	Irrigated	900 M Gold	Harvesting	17.60	8.33	19.44
							Mean	6.25	13.89
	Kalghatgi	Bammigatti	Red	Rainfed	900 M Gold	Harvesting	11.40	2.78	5.56
		Nelliharavi	Red	Irrigated	KH 5991	Harvesting	15.40	4.17	11.11
							Mean	3.47	8.33

(Contd. Part Table 1)	Navalgund	Morab	Black	Irrigated	Arjun	Threshing	12.20	4.17	6.94
		Nalawadi	Black	Irrigated	Arjun	Threshing	15.80	6.94	9.72
							Mean	5.56	8.33
Haveri	Hanagal	Akki alur	Black	Irrigated	900 M Gold	Harvesting	11.30	4.17	5.56
		Havanagi	Black	Irrigated	DKC9117	Harvesting	17.40	5.56	15.28
		Masankatti	Black	Irrigated	900 M Gold	Threshing	16.40	8.33	12.50
							Mean	6.02	11.11

Table 2: Incidence *of Aspergillus flavus* and *Fusarium* spp. in maize seeds collected during *rabi* 2013-14

District	Taluk	Village	Soil type	Rainfed / Irrigated	Cultivars	Stage of sampling	Moisture in grain samples (%)	*A. flavus* incidence (%)	*Fusarium* spp. incidence (%)
Bagalkot	Bagalkot	Agasinakoppa	Red	Irrigated	900 M Gold	Harvesting	11.30	4.17	5.16
		Gaddankeri cross	Red	Irrigated	DKC9117	Harvesting	15.60	9.72	6.94
		Sunag	Red	Irrigated	900 M Gold	Threshing	12.30	5.56	5.56
							Mean	6.48	5.88
	Jamkhandi	Algur	Black	Irrigated	900 M Gold	Harvesting	16.72	8.33	5.56
		Chikkapadasa\gi	Black	Irrigated	KH 5991	Harvesting	16.46	5.56	12.50
		Madarkhandi	Black	Irrigated	900 M Gold	Harvesting	13.60	11.11	9.72
							Mean	8.33	9.26
	Mudhol	Lokapur	Black	Irrigated	900 M Gold	Threshing	17.00	11.11	13.89
		Nagaral	Black	Irrigated	Arjun	Harvesting	13.40	9.72	12.50
							Mean	10.42	13.19
Belagavi	Bailhongal	Belawadi	Red	Irrigated	Arjun	Harvesting	14.20	9.72	6.94
		Kittur	Black	Irrigated	900 M Gold	Harvesting	14.92	6.94	9.72
		Pattihal KB	Red	Irrigated	900 M Gold	Threshing	11.90	4.17	6.94
							Mean	6.94	7.86
	Gokak	Arabhavi	Black	Irrigated	Arjun	Harvesting	13.10	4.17	9.72
		Duradundi	Red	Irrigated	DKC9117	Threshing	11.10	2.78	5.56
		Kalloli	Black	Irrigated	900 M Gold	Threshing	12.40	5.56	4.17
							Mean	4.17	6.48
	Raibag	Hidakal	Black	Irrigated	Arjun	Harvesting	16.40	9.72	5.56
		Koligudda	Black	Irrigated	KH 5991	Harvesting	15.46	6.94	9.72
							Mean	8.33	5.56
	Saundatti	Inamhongal	Black	Irrigated	900 M Gold	Threshing	13.20	4.17	9.72
		Murgod	Black	Irrigated	900 M Gold	Harvesting	15.90	9.72	11.11
							Mean	6.94	10.41
Dharwad	Dharwad	Dharwad	Black	Irrigated	Arjun	Harvesting	12.00	2.78	4.17

(Contd. Part Table 2)

		Garag	Red	Irrigated	DKC9117	Harvesting	16.40	5.56	16.67
		UAS, Dharwad	Black	Irrigated	NEI-9	Harvesting	13.50	4.17	8.33
		Yamanur	Black	Irrigated	900 M Gold	Harvesting	15.60	9.72	12.50
							Mean	5.55	10.42
	Kalghatgi	Kalghatgi	Red	Irrigated	900 M Gold	Harvesting	16.40	6.94	8.33
		Nelliharavi	Red	Irrigated	KH 5991	Threshing	14.80	4.17	11.11
							Mean	5.56	9.72
	Navalgund	Moraba	Black	Irrigated	Arjun	Harvesting	16.40	4.17	8.33
		Nalawadi	Black	Irrigated	Arjun	Threshing	14.20	5.56	9.72
							Mean	4.86	9.03
Haveri	Hanagal	Akki alur	Black	Irrigated	900 M Gold	Threshing	14.40	4.17	5.56
		Havanagi	Black	Irrigated	DKC9117	Harvesting	16.80	5.56	11.11
		Masankatti	Black	Irrigated	900 M Gold	Harvesting	16.20	8.33	9.72
							Mean	6.02	8.80

Table 3: Mean incidence of *Aspergillus flavus* and *Fusarium* spp. during *kharif* and *rabi*

District	Taluk	*A. flavus* incidence (%)		*Fusarium* spp. Incidence (%)	
		Kharif 2013	*Rabi* 2013-14	*Kharif* 2013	*Rabi* 2013-14
Bagalkot	Bagalkot	13.19	6.48	9.03	5.88
	Jamakhandi	10.19	8.33	12.96	9.26
	Mudhol	11.81	10.42	16.67	13.19
	Mean	11.73	8.41	12.89	9.44
Belagavi	Bailhongal	9.38	6.94	7.87	7.86
	Gokak	9.72	4.17	7.84	6.48
	Raibag	5.56	8.33	8.33	5.56
	Saundatti	6.25	6.94	10.42	10.41
	Mean	7.72	6.59	8.62	7.57
Dharwad	Dharwad	6.25	3.82	13.89	10.42
	Kalaghatagi	3.47	5.56	8.33	9.72
	Navalgund	5.56	4.86	8.33	9.03
	Mean	5.09	4.75	10.18	9.72
Haveri	Hanagal	6.02	4.17	11.11	8.80
	Mean	6.02	4.17	11.11	8.80

Table 4: Aflatoxin content in Maize samples of different districts collected during *kharif* 2013

District	Aflatoxin (µg/kg)
Bagalkot	104.00
Belagavi	13.20
Dharwad	25.50
Haveri	19.90

al. (1999) analysed the samples from different agroclimatic conditions of Karnataka and indicated that the aflatoxin content in bulk samples was 18 mg/kg. Owing to the high incidences of toxigenic moulds and mycotoxins in the study area, there is a need for the creation of mycotoxin awareness among maize farmers of Karnataka to control the chronic adverse health effects on humans and livestock due to mycotoxins.

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