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Influence of weather, dryspells and management practices on aflatoxin contamination in groundnut

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ABSTRACT: Contamination of groundnut with aflatoxins, is a serious problem that deteriorates quality. The adoption of improved production technologies is likely to help in improving the productivity and quality of groundnut by reducing aflatoxin contamination. Among 189 samples analysed, aflatoxin could not be assayed in 10.2 % samples and very high level of aflatoxin was observed in 9.7% of samples ranging from 35 to 8172.3 mg kg^{-1}. In TMV-2, the widely grown variety recorded > 30 mg kg^{-1} of aflatoxin contamination in 16.3% samples while samples of other varieties viz., JL-24, TAG-24, TG-26 and GG-2 had aflatoxin at very low level (< 5 mg kg^{-1}). Rainfed groundnut was more contaminated with aflatoxin ranging from 0-8172.3 mg kg^{-1} than winter crop under irrigated condition (0-535.3 mg kg^{-1}). Due to adoption of improved practices 90.2% of the samples had less than 15 mg kg^{-1}, while in control plots only 75.7% of the samples had less than 15 mg kg^{-1} aflatoxin. Improved management practices had reduced aflatoxin load in *kharif* than in *rabi*.

Key words: Weather, aflatoxin, groundnut

Contamination of groundnut with aflatoxins, the secondary toxic metabolites, produced by a fungus *Aspergillus flavus* is a serious problem deteriorating the quality of the produce and causing health hazards (Mehan *et al.,* 1991). Anantapur district is the largest groundnut growing district in the country and there is a high risk of aflatoxin contamination due to frequent dry spells during crop growth period. Cole *et al.* (1982) reported that dry spells during pod development stages significantly increased the aflatoxin contamination. Adoption of improved production technologies helps in improving the productivity of groundnut (Lakshmi Reddy *et al.,* 2000) and are likely to affect aflatoxin contamination. Hence, studies were conducted on aflatoxin production in on-farm trials under improved practices.

MATERIALS AND METHODS

Groundnut pod samples from farmers' fields of different villages were collected during *kharif* 1996, *rabi* 1996 and *kharif* 1997 to know the aflatoxin contamination in Anantapur district. Simultaneously on-farm trials were conducted with two treatments namely farmers' practice and improved production technology for groundnut in 112 farmers' fields of 21 villages during *rabi* 1997, *kharif* 1998, *rabi* 1998 and *kharif* 1999 to study the influence of improved production technology on aflatoxin contamintion. The various components included deep ploughing, sowing across the slope, improved varieties, seed treatment, intercropping with redgram, application of sand @ 40 t/ha, application of groundnut shells as mulch @ 5 t/ha, formation of conservation furrows at 3.6 m interval, soil test based fertilizer application, gypsum application @ 500 kg/ha during pegging stage, basal application of zinc sulphate @ 50 kg/ha once in two seasons or spraying 0.2% zinc sulphate at 35 and 45 days after sowing (DAS), integrated pest management, late leaf spot management, supplemental irrigation during drought, mechanical threshing and storing the produce on wooden dunnage after proper drying. The plot size was 0.4 ha. Groundnut pod samples were collected for aflatoxin analysis after one month of harvest of the crop. The samples of 500 g each were collected by random sampling method @ 30 primary samples for one tonne produce. By aggregating the primary samples, three samples of 200 g each were taken. Finally 200 g of representative sample was taken for aflatoxin analysis. Enzyme Linked Immunosorbent Assay (ELISA) method was adopted for the estimation of aflatoxin B_1 (Anjaiah *et al.*, 1987).

RESULTS AND DISCUSSION

Among the four rainy seasons, *kharif* 1998 and *kharif* 1996 were favourable seasons with 745 mm and 577 mm of rainfall during the crop growth period. *Kharif* 1997 was a bad year with very low amount of rainfall (297 mm) with two prolonged dryspells (Oct 3-24, Oct 31, Nov. 17) during pod development stage. Dry spells during 1997 were severe with 108 mm of potential evapotranspiration.

Among the 189 samples analysed for aflatoxin, 90.3 % of the samples were within the safe limits, as the permissable limit for aflatoxins in foods under Prevention of Food Adulteration Act is 30 mg kg^{-1} (Bhat *et al.*, 1990). The maximum permissible level of aflatoxin in groundnut for human consumption was first set at 30 mg kg^{-1} of kernels, but it was again revised to a level of 15 mg kg^{-1} (Mehan *et al.,* 1991). Aflatoxin levels were in traces (< 5 mg kg^{-1}) in 32.3% of the samples and in moderate levels (5-15 mg kg^{-1}) in 50.2% of the samples. But it was high (15-30 mg kg^{-1}) in 7.7% of the samples and very high in 9.7% of the samples (35-8172.3 mg kg^{-1}).

In general, the aflatoxin content was significantly low (ranging from 0 to 535.4 mg kg^{-1}) in *rabi* produce and high in *kharif* produce (ranging from 0 to 8172.3 mg kg^{-1}). Very high levels of <30 mg kg^{-1} aflatoxin was recorded in 13.3% of *kharif* samples whereas it was only 3.1% in *rabi* samples (Table 1).

The probable reasons for low aflatoxin in *rabi* might be due to (i) adequate soil moisture due to irrigation at regular intervals, (ii) no possibility of wetting pods during or after harvest of produce due to rain and (iii) dry weather during *rabi.* Habish *et al.* (1971) reported that the rainfed samples had a higher incidence of kernel contamination than those from irrigated areas. The *kharif* produce during the years 1997 and 1999 contained aflatoxin content ranging from 0 to 4000 mg kg^{-1} and 0 to 8172.3 mg kg^{-1} respectively with 21.1% and 12% of the samples respectively contained aflatoxin content more than 30 mg kg^{-1}. This may be due to prolonged dryspells during pod filling phase coupled with low rainfall content (297 and 331 mm respectively). The standard deviation from the general mean in aflatoxin was very high (1222.8 mg kg^{-1}) during *kharif* 1997 compared to *kharif* 1996 (12.8mg kg^{-1}). The deviation in aflatoxin content might be due to high intensity of drought and variation in intensity of drought between villages. Cole *et al.*, (1982) reported that dryspells during pod development stages significantly increased the aflatoxin

Table 1. Aflatoxin (B_1) content of groundnut kernel during different seasons

Season and year	No. of samples	Samples in each category (%)				Aflatoxin content (mg kg^{-1})		
		Traces (<5 mg kg^{-1})	Moderate (5-15mg kg^{-1})	High (15-30 mg kg^{-1})	Very high (>30 mg kg^{-1})	Mean	Range	Standard deviation
Kharif 1996	11	54.5	36.3	0.0	9.2	7.9	0.0-5.9	12.8
Rabi 1996	17	41.2	52.9	5.9	0.0	5.7	0.0-25.7	5.7
Kharif 1997	19	26.3	31.5	21.1	21.1	462.8	0.0-4000	1222.8
Rabi 1997	16	18.8	62.5	12.5	6.2	43.5	0.0-535.4	131.5
Kharif 1998	46	4.3	78.3	6.5	10.9	20.1	4.5-259.2	38.6
Rabi 1998	30	97.0	0.0	0.0	3.0	1.5	0.0-42.3	7.7
Kharif 1999	50	16.0	66.0	6.0	12.0	1480.5	0.1-8172.3	420.7
Seasonal variation in aflatoxin contamination								
Kharif						239.5	0.0-8172.3	
Rabi						13.3	0.0-535.4	

Table 2. Aflatoxin (B_1) levels in different varieties of groundnut

Varieties	No. of samples	Samples in each category (%)				Aflatoxin content (mg kg^{-1})		
		Traces (<5 mg kg^{-1})	Moderate (5-15mg kg^{-1})	High (15-30 mg kg^{-1})	Very high (> 30mg kg^{-1})	Mean	Range	Standard deviation
TTMV-2	92	36.0	41.0	7.7	16.3	143.5	0.0-4000	642.5
JL-24	10	40.0	60.0	0.0	0.0	5.0	0.0-12.1	4.1
Vemana	49	37.0	57.0	2.0	4.0	20.4	0.0-679.7	97.3
TAG-24	10	10.0	80.0	10.0	0.0	9.1	5.3-13.7	7.1
TG-26	6	16.7	50.0	33.3	0.0	11.2	6.6-17.7	5.6
GG-2	5	40.0	60.0	0.0	0.0	5.0	0.1-11.5	5.0

contamination.

TMV-2 is the widely grown variety in the district occupying 75% of the cultivated area. JL-24 is the another popular variety in the southern mandals of the district occupying 23% of the area. Aflatoxin content was more than 15 mg kg^{-1} in 24% of samples of TMV 2 (Table 2). The aflaxotin content in samples of TMV 2 variety ranged from 0 to 4000 mg kg^{-1} with a mean of 143.5 mg kg^{-1}. Varied environmental conditions in which TMV 2 variety grown may be one of the reasons for large variation in aflatoxin content with a highest standard deviation of 642.5 mg kg^{-1}. However, in Vemana variety aflatoxin content ranged from 0 to 679.7 mg kg^{-1}, with a mean of 20.4 mg kg^{-1}. Since the area under Vemana is comparatively less, the variation in aflatoxin contamination may be low. In other varieties viz., JL 24, TAG 24, TG 26 and GG 2 the aflatoxin content ranged from 0 to 17.7 mg kg^{-1} only.

Aflatoxin content was less than 15 mg kg^{-1} in 90.2% of the samples under plots with improved production technology. However, only 75.7% samples had aflatoxin content less than 15 mg kg^{-1} in control plots (Table 3). In control plots, 14.6% of the samples were having aflatoxin more than 30 mg kg^{-1} whereas only 4.4% of the samples in demonstration plots had aflatoxin more than 30 mg kg^{-1}. Aflatoxin content was ranging from 45 to 8172.3 mg kg^{-1} in control plots and 75.7 to 3652.7 mg kg^{-1} in demonstration plots. The standard deviation from general mean was less (388 mg kg^{-1}) due to adoption of improved practices when compared to control (1125.6 mg kg^{-1}). Low level of aflatoxin content in demonstration plots might be due to balanced fertilization, moisture conservation, application of gypsum and management of late leaf spot disease.

Table 3. Aflatoxin (B_1) content (mg kg^{-1}) of groundnut kernel as influenced by improved dryland practices

Treatments	Mean	Range	Standard Deviation	%samples having >15 mg kg^{-1}
Demonstration	54.4	0.0-3652.7	388.0	9.8
Control	265.2	0.0-8172.3	1125.6	24.3
Total	165.3	0.0-8172.3	863.4	17.1

The improved practices like cultivation across the slope and deep plohghing might have increased the available soil moisture, while application of potassium as per soil test based recommendation offered tolerance to invasion of *Aspergillus flavus.* Application of gypsum might have provided sufficient calcium to the plant and offered resistance to invasion of *Aspergillus flavus.* Adoption of all these components might had reduced aflatoxin contamination in demonstration plots. Davidson *et al.* (1983) reported that application of gypsum to soil in Georgia, USA, at the time of flowering reduced the aflatoxin contamination by 40%. Wilson *et al.* (1988) reported that gypsum application increased the yield, healthy kernels and reduced the kernel infection by *Aspergillus flavus.* Lakshmi Reddy (2000) reported that late leaf spot management in groundnut reduced the aflatoxin content.

Traces to moderate levels of aflatoxin (less than 15 mg kg^{-1}) was observed in 92.8% of the samples during *rabi* 1997 in demonstration plots, whereas 100% of samples were having high levels

Table 4. Aflatoxin content in groundnut kernels as influenced by improved dryland practices during different seasons

Aflatoxin content	Percentage of samples			
	Rabi		*Kharif*	
	1997	1998	1997	1998
Traces (< 5 µg/kg)				
Control	0.0	-	7.4	20.0
Demonstration	21.4	97.0	0.0	12.0
Moderate (5-15 µg/kg)				
Control	0.0	-	63.0	56.0
Demonstration	71.4	-	100.0	76.0
High (15-30 µg/kg)				
Control	50.0	-	11.1	8.0
Demonstration	7.2	-	0.0	4.0
Very high (>30 µg/kg)				
Control	50.0	-	18.5	16.0
Demonstration	0.0	3.0	0.0	8.0

(> 15 mg kg^{-1}) in control plots (Table 4). However, during 1998 *kharif*, 100% samples from demonstration plots had aflatoxin content at moderate level (less than 15 mg kg^{-1}) while 29.6% samples in control plots had high level of aflatoxin contamination (more than 15 mg kg^{-1}). During *kharif* 1999, only 12% of samples in demonstration plots were having more than 15 mg kg^{-1} of aflatoxin, whereas 24% of samples were having aflatoxin content more than 15 mg kg^{-1}. From the data it is clear that adoption of improved practices significantly reduced the aflatoxin content in the produce.

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