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Effect of *Aspergillus* spp. on Seed Quality Characters of Groundnut

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ABSTRACT

Background: *Aspergillus niger* and *A. flavus* cause rotting, damping-off, loss in germination and toxification of oil seeds. *Aspergillus* is a common mold in tropical and Sub-tropical countries and causes aflatoxin contamination. *A. flavus* and *A. niger* were responsible for storage rot of groundnut. In addition to storage rot, aflatoxin contamination also leads to adverse effects on consumer health. Therefore, present study was conducted to estimate the impact of both *A. niger* and *A. flavus* on seed quality parameters of groundnut.
Methods: Effect of major seed borne fungi *A. niger* and *A. flavus* on seed quality characters of thirteen different genotypes of groundnut was observed in the present study. All the seedling quality characters were measured as per ISTA guidelines.
Result: On an average *A. niger* caused 25.14, 25.18, 43.99, 26.20 and 44.75 per cent reduction in seed germination, seedling length, seedling vigour index I, seedling dry weight and seedling vigour index II, respectively, over the control whereas *A. flavus* caused average per cent reduction of 22.38, 24.23, 41.18, 23.92 and 40.95 in seed germination, seedling length, seedling vigour index I, seedling dry weight and seedling vigour index II, respectively, over the control.

Key words: *A. niger*, *Aspergillus flavus*, Germination, Groundnut, Seed quality characters.

INTRODUCTION

Groundnut is an important crop and is considered as the king of oil seeds. It is cultivated globally in 26.4 million hectares with a total production of 37.1 million tonnes. India ranks first in area with coverage of about 70 lakh hectares in acreage and second in production with an output of about 85 lakh tones (IOPEPC Survey of Groundnut Crop, *Kharif*-2017).

Of the various biotic stresses, seed borne and soil borne diseases account for most of the reduced pod yields. Fungal diseases such as collar rot caused by *A. niger* and storage rot caused by *A. flavus* result in major losses. Hence the present studies were carried out to study the influence of major seed borne fungi *A. niger* and *A. flavus* on the seed quality characters of thirteen different genotypes of groundnut.

MATERIALS AND METHODS

The present investigation was carried out in the laboratory of Plant Pathology, Regional Agricultural Research Station, Lam and the Department of Seed Science and Technology, Advanced Post Graduate Centre, Lam, Guntur, Andhra Pradesh during 2018-2019. Apparently healthy seed of groundnut cultivars were surface sterilized and soaked in conidial suspension of *A. niger* and *A. flavus* containing 10^6 conidia ml^{-1} for 20 min and dried at room temperature overnight. The seeds of control treatments were similarly treated except that they were soaked in sterile distilled water.

The inoculated seed and control (uninoculated) seeds were kept for germination using rolled paper towel method in four replications of hundred seeds each and the following observations were recorded.

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Germination (%)

On 10th day (final count), all the normal seedlings were counted. The germination percentage from each sample in each replication was computed as per the formula mentioned here under:

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} \times 100$$

Seedling length (cm)

Ten normal seedlings were taken from each sample at random on the 10th day and the seedling length was measured from the tip of the primary leaf to the tip of the primary root with the help of a scale and was expressed in centimeters.

Seedling dry weight (g)

Ten normal seedlings were taken from each sample at random on the 10th day and the seedling dry weight was measured after drying them in a hot air oven at 75±1°C for 48 hours and mean seedling dry weight was expressed in grams.

Seedling vigour index I

Seedling vigour index I was computed using the following formula given by Abdul Baki and Anderson (1973).

Seedling vigour index I =

Germination (%) × Mean seedling length (cm)

Seedling vigour index II

Seedling vigour index II was computed using the following formula suggested by Reddy and Khan (2001) as given below:

Seedling vigour index II =

Germination (%) × Mean seedling dry weight (g)

RESULTS AND DISCUSSION

Germination

Significant variation was observed in germination between the uninoculated and inoculated samples irrespective of the genotype. The germination ranged between 64 (Dharani) and 84.5 (TAG 24) in seeds inoculated with *A. flavus* and 62 (Dharani) to 83.75 (TAG 24) in seeds inoculated with *A. niger*as against 88 (Dharani) and 97.75 (TAG24) in control. The average germination of 91.42 per cent in control decreased to 70.90 and 69.09 due to inoculation with *A. flavus* and *A. niger,* respectively (Table 1).

Maximum per cent reduction in germination of 30.14 was recorded in Amaravati followed by Dharani (29.55) due to *A. niger*. Similar trend was noticed in seeds inoculated with *A. flavus.* Minimum reduction in germination was recorded in TAG 24 in both *A. niger* and *A. flavus* inoculated seeds (Fig 1).

The reduction in germination is due to release of mycotoxins like aflatoxin by the fungus which interfere with enzymatic activity and damages the developing embryo. Decrease in germination due to inoculation with *Aspergillus* spp. was observed in wheat by Harman and Pfleger (1974) and Sauer (1988). The germination of 90% in maize decreased to 72, 85 and 80% due to *A. flavus* in local variety, Vijay and VL-16, respectively (Paul, 1991). Kakde and Chavan (2010) also observed decrease in germination in soybean due to inoculation with *A. flavus*. Deepavali and Nilima (2014) observed that maize seeds soaked in the culture filtrate of *A. niger*, showed germination decreased from 80% to 20% in African tall and 100% to 40% in Amber.

Seedling length (cm)

Seedling length varied significantly between the uninoculated and inoculated samples irrespective of genotype. The seedling length ranged between 12.52 cm (TCGS 1616) and 24.78 cm (TAG 24) in seeds inoculated with *A. flavus* and 12.26 cm (TCGS 1616) and 24.63 cm (TCGS 1616) in seeds inoculated with *A. Niger* as against 16.82 cm (Dharani) and 31.52 cm (TAG 24) in control. Highest seedling lengths of 24.63 cm and 24.78 cm were recorded in TAG 24 inoculated with *A. niger* and *A. flavus,* respectively followed by TCGS 1073 with 21.41 cm and 20.58 cm respectively while the uninoculated TAG 24 and TCGS 1073 showed 31.52 cm and 28.33 am, respectively. Lowest seedling lengths of 12.26 cm and 12.52 cm were expressed in TCGS 1616 due to inoculation with *A. niger* and *A. flavus*, respectively (Table 1).

The average seedling length decreased from 20.93 cm in control to 16.06 cm and 16.17 cm due to inoculation with *A. niger* and *A. flavus* respectively. The maximum per cent reduction in seedling length due to *A. niger* was recorded in TCGS 1616 (37.42%) followed by Kadiri 6n (28.46%). Similar results were recorded in seeds inoculated with *A. flavus*. The lowest per cent reduction of 13.45 and 12.92 due to inoculation with *A. niger* and *A. flavus* respectively was recorded in Narayani (Fig 2).

The reduction in seedling length might be due to the utilization of energy rich compounds by the fungi which are otherwise translocated to the seedling for their growth. Increase in the concentration of aflatoxins also decreased seed shoot growth in pulses (Janardhan *et al*., 2011). Deepavali and Nilima (2014) observed shoot length in African tall seed treated with the culture filtrate of *A. niger* decreased from 38.3 cm to 36 cm, whereas Amber seed showed no decrease in shoot length. Paul (1991) observed the effect of *A. flavus* on seed quality of three varieties of maize. Seedling length decreased significantly from 37 cm to 22.9 cm in local variety and 28 cm to 20 cm in VL-16 while it is not significant in Vijay.

Seedling vigour index I

Significant decrease in both germination and seedling length of different groundnut genotypes after inoculation with *Aspergillus* spp. resulted in the decrease of seedling vigour index I. The seedling vigour index I ranged between 877 (Dharani) and 2094 (TAG 24) in seeds inoculated with *A. flavus* and 841 (Dharani) and 2063 (TAG 24) in seeds inoculated with *A. niger* as against 1480 (Dharani) and 3081 (TAG 24) in control (Table 1).

The average seedling vigour index I of 1920 decreased to 1158 and 1123 due to inoculation with *A. flavus* and *A. niger* respectively. The maximum per cent reduction in seedling vigour index I due to *A. niger* was recorded in TCGS 1616 followed by Amaravati. Similar results were recorded in seeds inoculated with *A. flavus*. The minimum per cent reduction in seedling vigour index I of 33.04 and 32.04 due to *A. niger* and *A. flavus* respectively was recorded in TAG 24 (Fig 3).

Aspergillus niger and *Fusarium* spp. are associated with damage of plumule and hypocotyl of germinating seedling which consequently lead to the reduction of germination and

Table 1: Effect of seed inoculation with *Aspergillus* spp. on seed quality of different genotypes of groundnut.

Genotype	Germination (%)				Seedling length (cm)				SVI I			
	Aspergillus niger	*Aspergillus flavus*	Control	Mean	*Aspergillus niger*	*Aspergillus flavus*	Control	Mean	*Aspergillus niger*	*Aspergillus flavus*	Control	Mean
Abhaya	67.75 (55.38)	70.25 (56.93)	90.50 (72.04)	76.17 (61.45)^{c}	14.73	14.92	19.69	16.45^{e}	998	1048	1782	1276^{d}
Amaravati	63.75 (52.96)	66.00 (54.31)	91.25 (72.82)	73.67 (60.03)^{b}	14.31	14.72	18.96	15.99^{d}	912	971	1730	1204^{c}
Chitravati	66.75 (54.77)	69.75 (56.61)	91.00 (72.53)	75.83 (61.30)^{c}	14.52	14.74	17.63	15.63^{c}	969	1028	1604	1200^{c}
Dharani	62.00 (51.92)	64.00 (53.11)	88.00 (69.71)	71.33 (58.25)^{a}	13.57	13.70	16.82	14.69^{a}	841	877	1480	1066^{a}
Haritandhra	67.00 (55.22)	68.00 (56.46)	67.50 (72.28)	75.92 (61.32)^{c}	14.77	14.91	19.32	16.33^{e}	997	1036	1753	1262^{d}
ICGV 00 350	67.50 (55.22)	69.25 (56.30)	(91.25 (72.79)	76.00 (61.44)^{c}	13.46	13.69	18.21	15.12^{b}	909	948	1661	1173^{b}
Kadiri 6	69.50 (56.47)	71.50 (57.72)	90.50 (72.05)	77.17 (62.08)^{cd}	14.90	15.03	20.83	16.92g	1036	1075	1885	1332^{f}
Kadiri 9	70.25 (56.93)	72.25 (58.19)	90.75 (72.28)	77.75 (62.47)^{d}	17.31	17.40	20.95	18.55^{h}	1216	1257	1901	1458^{g}
Narayani	69.50 (56.46)	71.25 (57.55)	92.75 (74.36)	77.83 (62.79)^{d}	17.90	18.01	20.68	18.86^{i}	1244	1283	1918	1482^{h}
TAG 24	83.75 (66.26)	84.50 (66.80)	97.75 (81.72)	88.67 (71.58)^{e}	24.63	24.78	31.52	26.98^{k}	2063	2094	3081	2413^{j}
TCGS 1073	70.75 (57.24)	71.50 (57.71)	91.75 (73.29)	78.00 (62.75)^{d}	21.41	20.58	28.33	23.44^{j}	1515	1471	2599	1862^{i}
TCGS 1616	69.75 (56.612)	71.25 (57.55)	91.00 (72.58)	77.33 (62.25)^{cd}	12.26	12.52	19.58	14.79^{a}	855	892	1782	1176^{b}
TCGS 1694	69.50 (56.46)	70.75 (57.24)	91.25 (72.79)	77.17 (62.17)^{cd}	15.06	15.18	19.56	16.60^{f}	1046	1074	1785	1302^{e}
Mean	69.09 (56.29)^{A}	70.90 (57.42)^{B}	91.42 (73.17)^{C}		16.063^{A}	16.17^{B}	20.93^{C}		1123A	1158B	1920C	
	G	T	G×T		G	T	G×T		G	T	G×T	
SEm	0.29	0.14	0.51		0.05	0.03	0.09		7.19	3.45	12.46	
CD (p=0.05)	0.74	0.58	1.24		0.13	0.10	0.22		18.13	14.27	30.14	
CV (%)		1.639				1.021				13.295		

*Values in the parenthesis indicate angular transformed values.

*Values followed by same alphabet in the same column do not differ significantly at 5% level of significance.

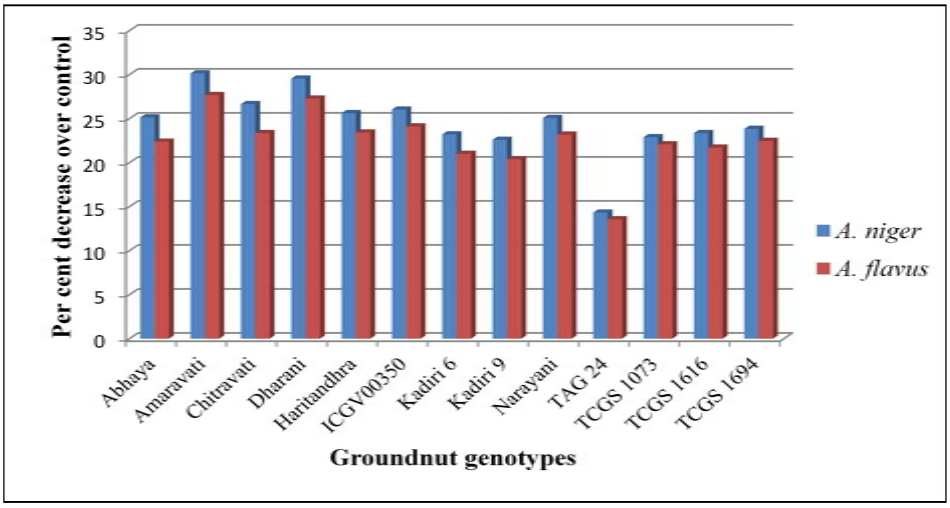

Fig 1: Per cent decrease in germination over control due to *Aspergillus* spp.

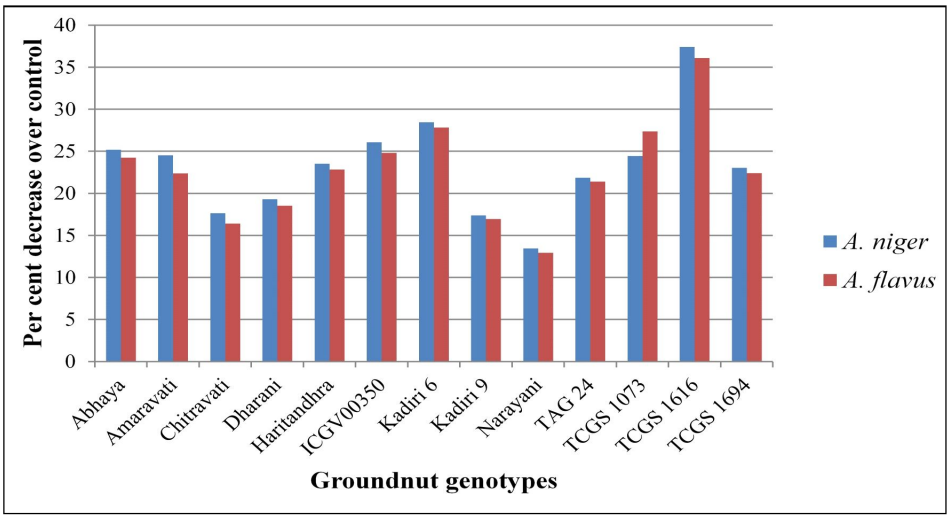

Fig 2: Per cent decrease in seedling length over control due to *Aspergillus* spp.

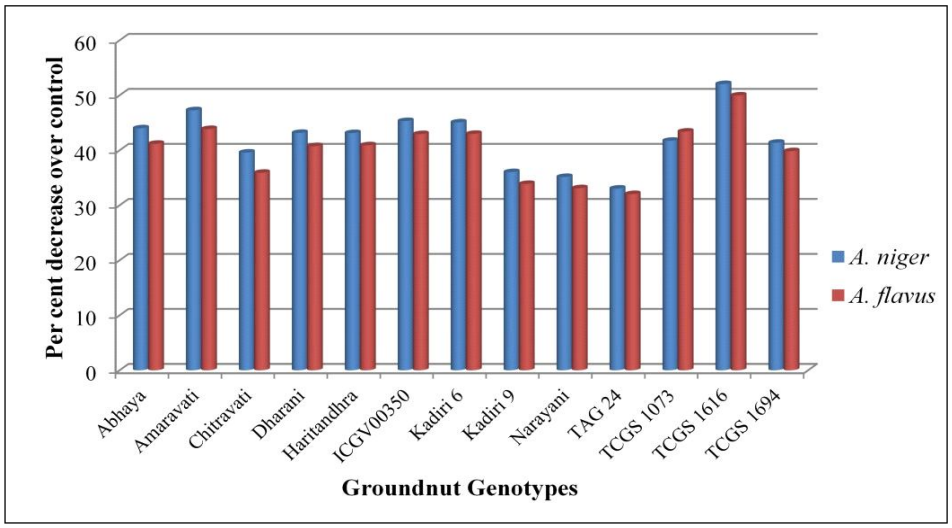

Fig 3: Per cent decrease in seedling vigour index I over control due to *Aspergillus* spp.

seedling length which consequently leads to reduction in seedling vigour index I (Akonda *et al.* 2016). Begum *et al.* (2013) reported decrease in seedling vigour index I of groundnut seed inoculated with *A. Flavus*. Rohtas *et al.* (2016) studied the effect of collar rot fungus, *A. niger* in four groundnut genotypes *viz.,* MH-4, MH-21, M-522 and HNG-10. MH-1 showed maximum per cent reduction in germination (20%), plumule length (25.18%), radical length (23.9%), fresh weight (34.02%) and dry weight (37.93%) whereas HNG-10 showed minimum per cent reduction for all the above seed quality characters.

Seedling dry weight (g)

Significant reduction in seedling dry weight was observed in seed samples inoculated with both *A. niger* and *A. flavus*. The seedling dry weight ranged between 0.165 g (Dharani) and 0.245 g (TCGS 1073) in seed inoculated with *A. flavus* and between 0.139 (ICGV 00 350) and 0.246 g (TCGS 1073) in seed inoculated with *A. niger* as against 0.184 g and 0.306 g in control (Table 2).

The average seedling dry weight decreased from 0.238 g in control to 0.184 g and 0.193 g in seeds inoculated with *A. niger* and *A. flavus,* respectively. The maximum per cent

Table 2: Effect of seed inoculation with *Aspergillus* spp. on seed quality of different genotypes of groundnut.

Genotype	Seedling dry weight (g)				SVI II			
	Aspergillus niger	*Aspergillus flavus*	Control	Mean	*Aspergillus niger*	*Aspergillus flavus*	Control	Mean
Abhaya	0.162	0.167	0.219	0.183^{b}	10.98	11.73	19.87	14.19^{c}
Amaravati	0.155	0.176	0.243	0.191^{c}	9.89	11.58	22.16	14.54^{d}
Chitravati	0.169	0.168	0.209	0.182^{b}	11.29	11.74	19.02	14.02^{c}
Dharani	0.166	0.165	0.184	0.172^{a}	10.29	10.53	16.15	12.32^{a}
Haritandhra	0.175	0.185	0.221	0.194^{c}	11.78	12.82	20.01	14.87^{e}
ICGV 00 350	0.139	0.174	0.206	0.173^{a}	9.39	12.05	18.77	13.40^{b}
Kadiri 6	0.192	0.193	0.241	0.209^{e}	13.36	13.78	21.77	16.30^{g}
Kadiri 9	0.198	0.201	0.253	0.217^{f}	13.89	14.49	22.94	17.11^{h}
Narayani	0.225	0.223	0.264	0.237^{g}	15.64	15.89	24.49	18.67^{i}
TAG 24	0.222	0.220	0.266	0.236^{g}	18.57	18.59	26.02	21.06^{j}
TCGS 1073	0.246	0.245	0.306	0.266^{h}	17.41	17.52	28.05	20.99^{j}
TCGS 1616	0.164	0.212	0.234	0.203^{d}	11.44	15.07	21.31	15.94^{f}
TCGS 1694	0.182	0.183	0.247	0.204^{d}	1.65	12.95	22.52	16.04^{fg}
Mean	0.184^{A}	0.193^{B}	0.238^{C}		12.81^{A}	13.75^{B}	21.78^{C}	
	G	T	G×T		G	T	G×T	
SEm	0.00093	0.000445	0.002		0.106	0.0507	0.183	
CD (p=0.05)	0.00234	0.001839	0.004		0.266	0.2096	0.443	
CV (%)		1.566				2.272		

*Values in the parenthesis indicate angular transformed values.
*Values followed by same alphabet in the same column do not differ significantly at 5% level of significance.

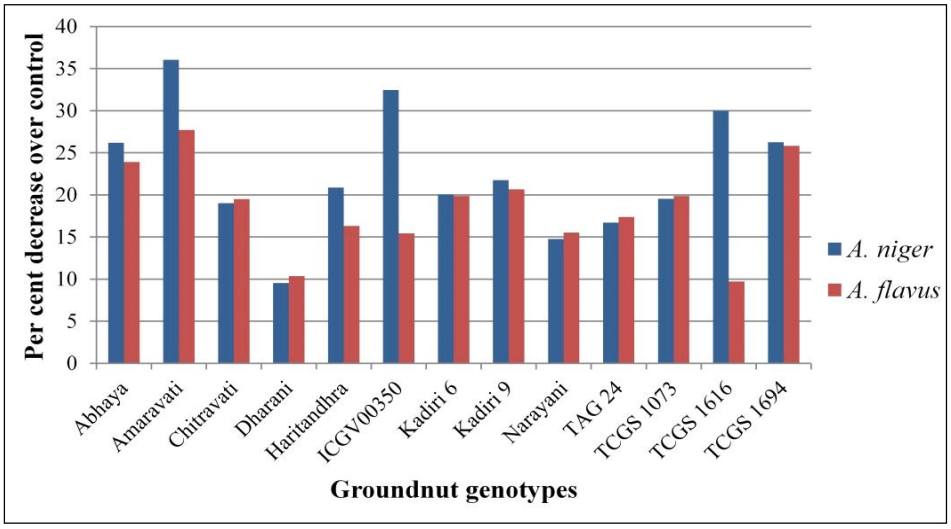

Fig 4: Per cent decrease in seedling dry weight over control due to *Aspergillus* spp.

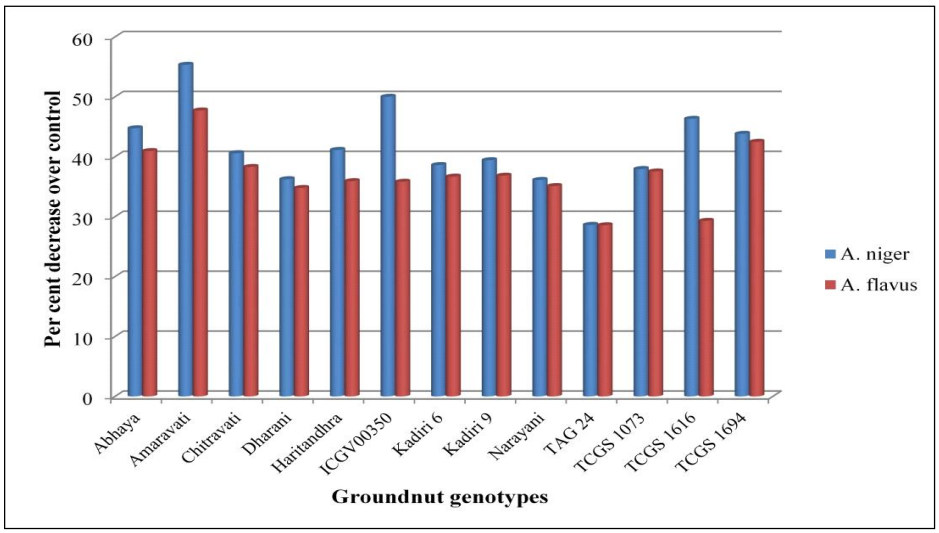

Fig 5: Per cent decrease in seedling vigour index II over control due to *Aspergillus* spp.

reduction in seedling dry weight due to *A. niger* was recorded in Amaravati (36.05%) followed by ICGV 00 350 (32.44%).The maximum per cent reduction in seedling dry weight due to *A. flavus* was recorded in Amaravati (27.70%) followed by TCGS 1616 (25.84%). The minimum per cent reduction in seedling dry weight due to *A. niger* was recorded in Dharani (9.54%) while due to *A. flavus* was recorded in TCGS 1616 (9.71) (Fig 4).

The reduction in seedling dry weight might be due to the utilization of energy rich compounds by the fungi which are otherwise translocated to the seedling for dry matter accumulation.

Seedling vigour index II

Significant reduction in seedling vigour index II was found in seeds inoculated with both *A. niger* and *A. flavus*. The seedling vigour index II was in the range of 10.53 (Dharani) and 18.59 (TAG 24) in seeds inoculated with *A. flavus* and between 9.39 (ICGV 00 350) and 18.57 (TAG 24) in seeds inoculated with *A. niger* as against 16.15 (Dharani) and 28.05 (TCGS 1073) in control (Table 2).

The average seedling vigour index decreased from 21.78 in control to 13.75 and 12.81 in *A. flavus* and *A. niger* inoculated seed, respectively. The maximum per cent reduction in seedling vigour index II due to *A. niger* was recorded in Amaravati (55.34%) followed by ICGV 00 350 (50.01%). The maximum per cent reduction in seedling vigour index II due to *A. flavus* was recorded in Amaravati (47.72) followed by TCGS 1694 (42.49). The minimum per cent decrease in seedling vigour index II was recorded in TAG 24 in both *A. niger* (28.62) and *A. flavus* (28.57) inoculated seed (Fig 5).

Reduction in seedling dry weight was observed earlier in maize due to *A. flavus* (Paul, 1991) and in soybean due to *A. niger* (Haikal, 2008). Decrease in seedling dry weight of groundnut was reported due to *A. niger* (Rohtas *et al.,* 2016).

Seed treatment with carbendazim, tebuconazole, carboxin+thiram reduced infection by collar rot pathogen, *A. niger* was observed by Kumari *et al.* (2016). Hence seed dressing with appropriate fungicides is suggested to protect groundnut from seed borne *Aspergillus* spp.

CONCLUSION

A. niger and *A. flavus* caused maximum per cent reduction in germination, seedling length and seedling vigour index I in groundnut varieties *viz*., Amaravati, TCGS 1616 and TCGS 1616. Amaravati also recorded maximum per cent reduction in seedling dry weight and seedling vigour index II due to inoculation of seed with *A. niger* and *A. flavus*. Protection with seed dressing fungicides like tebuconazole or carbendazim is important for raising healthy crop.

Conflict of interest

All authors declare that they have no conflict of interest

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