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Efficacy of Fungicides and Bio-control Agents against *Aspergillus flavus*

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ABSTRACT: Of the various biotic stresses in groundnut, *Aspergillus* spp infect both in the field and storage causing most of the post harvest losses. Pre harvest infection by *A. flavus* is the major cause of aflatoxin contamination in peanut. Efficacy of various fungicides and bio-control agents was evaluated against *A. flavus* infecting groundnut. Seeds of 13 groundnut varieties were artificially inoculated with *A. flavus* (10^6 conidia ml^{-1}). Inoculated seed was treated with fungicides *viz*. mancozeb @ 3g/kg, carbendazim @ 2 g/kg, tebuconazole @ 1 g/kg, carboxin+thiram @ 2 g/kg; bio-control agents *Trichoderma viride* @ 10 g/kg and *Pseudomonas fluorescens* @ 10 g/kg and then incubated in rolled paper towels. Observations on various seed quality parameters including germination (%), seedling length (cm), seedling dry weight (g) and seedling vigour indices revealed that among the test fungicides and bio-control agents, tebuconazole recorded the highest germination and maximum per cent disease control where as carbendazim recorded highest seedling length, seedling vigour index I, seedling dry weight and seedling vigour index II.

Keywords: *Aspergillus flavus*, fungicides, Groundnut, *Pseudomonas fluorescens*, *Trichoderma viride*, seed treatment.

INTRODUCTION

Groundnut is cultivated in India as a rainfed crop and post-harvest losses in groundnut range from 10 to 25% of the production in Asia (Azeemoddin, 1993). Fungi such as *Aspergillus niger*, *A. flavus*, *Alternaria dianthicola*, *Curvularia lunata*, *Fusarium oxysporum*, *Macrophomina phaseolina*, *Rhizopus stolonifer* cause rotting, seed necrosis, loss in germination and toxification of oil seeds. *Aspergillus* is a common mold in tropical and sub tropical countries and causes aflatoxin contamination in groundnut and cereals (Chavan and Kakde, 2008). Seed germination decreased from 90% to 35 and 30% in groundnut, due to *A. niger* and *A. flavus*, respectively (Kakde and Chavan, 2010). *A. flavus* is the most important storage fungus that causes seed rot and leads to aflatoxin contamination in groundnut seeds. Seed treatment is cost effective against seed borne diseases resulting in healthy and vigorous plant stand and reduces subsequent bulk consumption of chemicals in the field as foliar sprays. Significant reduction of *A. flavus* populations and kernel infection was obtained in both greenhouse and field experiments (Waliyar *et al*., 2008). Therefore, efficacy of different fungicides and biocontrol agents on seedling quality characters was investigated.

MATERIALS AND METHODS

The present investigation was carried out in the laboratory of Plant Pathology, Regional Agricultural Research Station, Lam and Department of Seed Science and Technology, Advanced Post Graduate Centre, Guntur, Andhra Pradesh during 2018-2019. Seeds of 13 groundnut cultivars *viz*., Abhaya, Amaravati, Chitravati, Dharani, Haritandhra, ICGV 00 350, Kadiri 6, Kadiri 9, Narayani TAG 24, TCGS 1073, TCGS 1616 and TCGS 1694 were surface sterilized, soaked in conidial suspension of *A. flavus* (10^6 conidia $ml^{-1)}$ for 20 min and dried at room temperature overnight. Seeds soaked in sterile distilled water served as control. The inoculated seed was treated with various fungicides and biocontrol agents *viz*., mancozeb @ 3g kg^{-1}, carbendazim @ 2 g kg^{-1}, tebuconazole @ 1 g kg^{-1}, carboxin+thiram @ 2 g kg^{-1}; bio-control agents *Trichoderma viride* @ 10 g kg^{-1} and *Pseudomonas fluorescens* @ 10 g kg^{-1}. The treated and control (uninoculated) seeds were kept for germination using rolled paper towel method in four replications of hundred seeds and the following observations were recorded.

Germination (%): On 10^{th} day (final count), all the normal seedlings were counted. The germination percentage from each sample in each replication was computed as per the formula:

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

Seedling Length (cm): Ten normal seedlings were taken from each sample at random on the 10th day and length was measured from the tip of the primary leaf to the tip of the primary root with a scale.

Seedling Dry Weight (g): Ten normal seedlings collected as above were dried in a hot air oven at 75±1°C for 48 hours and mean seedling dry weight was recorded.

Seedling Vigour Index: Seedling vigour index I was computed using the formula of Abdul- Baki and Anderson (1973).

Seedling vigour index I = Germination (%) × Mean seedling length (cm)

Seedling vigour index II was computed as per the formula of Reddy and Khan (2001):

Seedling vigour index II = Germination (%) × Seedling dry weight (g)

The data recorded were analyzed statistically by adopting Completely Randomized Design (CRD) as described by Panse and Sukhatma (1985).

RESULTS AND DISCUSSION

Significant increase in germination (%), seedling length, seedling vigour indices, seedling dry weight and reduced infection (%) due to seed treatment over the inoculated control was observed irrespective of the genotype.

The germination in uninoculated control (91.31%) decreased to 70.65% due to inoculation with *A. flavus* (Table 1, Fig. 1). Tebuconazole @ 1 g kg^{-1} seed recorded the highest germination (91.00%) followed by carbendazim @ 2 g/kg seed (90.35%), carboxin+thiram @ 2 g kg^{-1} seed (89.63%) and mancozeb @ 3 g kg^{-1} seed (88.92%). The average seedling length in *A. flavus* inoculated treatment was 16.04 cm as against 20.81 cm in uninoculated control (Table 2, Fig. 2). Carbendazim @ 2 g kg^{-1} seed recorded the highest seedling length (18.93 cm) followed by carboxin+thiram @ 2 g kg^{-1} seed (18.55 cm) and mancozeb @ 3 g/kg seed (18.00 cm). *T. viride* @ 10 g/kg seed (17.07 cm) and *P. fluorescens* @ 10 g kg^{-1} seed (16.89 cm) were superior to inoculated control (16.04 cm). Tebuconazole @ 1 g kg^{-1} seed recorded the lowest seedling length of 14.25 cm i.e., less than inoculated control (16.05).

The seedling vigour index I of 1907 in uninoculated control was reduced to 1145 due to inoculation with *A. flavus* (Table 3, Fig. 3). Carbendazim @ 2 g kg^{-1} seed recorded the highest seedling vigour index (1716) followed by carboxin+thiram @ 2 g kg^{-1} seed (1669) and mancozeb @ 3 g/kg seed (1607). Seed treatment with tebuconazole @ 1 g kg^{-1} seed recorded the lowest (1300). The seedling dry weight of 0.24 g in uninoculated control was reduced to 0.19 g due to *A. flavus* (Table 4, Fig. 2). Carbendazim @ 2 g kg^{-1} seed recorded the highest seedling dry weight (0.23 g) followed by carboxin+thiram @ 2 g kg^{-1} seed (0.22 g) and mancozeb @ 3 g kg^{-1} seed (0.22 g) whereas tebuconazole @ 1 g kg^{-1} seed recorded the lowest (0.19 g). The seedling vigour index II of uninoculated control was 21.55 whereas *A. flavus* inoculated seed recorded 13.45 (Table 5, Fig. 3). Carbendazim @ 2 g kg^{-1} seed recorded the highest seedling vigour index II (20.60) followed by carboxin+thiram @ 2 g kg^{-1} seed (19.83) and mancozeb @ 3 g kg^{-1} seed (19.22) and tebuconazole @ 1 g kg^{-1} seed recorded the lowest (16.98).

Adithya *et al.* (2017) obtained higher germination of *A. flavus* inoculated seed with *Trichoderma* spp and *P. fluorescens* followed by carbendazim and mancozeb. Increase in seedling length vigour index I and dry weight of inoculated seeds of groundnut due to seed treatment with carbendazim, mancozeb and carboxin+thiram was observed earlier (Adithya *et al.*, 2017) and Ahmad and Zaidi (2018). The growth retarding effect of triazoles is attributed to the inhibition of gibberillic acid biosynthesis that helps in shoot elongation.

The per cent infection of 8.69 in uninoculated control increased to 41.23 due to inoculation with *A. flavus* (Table 6, Fig. 4). Tebuconazole @ 1 g kg^{-1} seed recorded the lowest infection (3.88%) followed by carbendazim @ 2 g/kg seed (6.54%), carboxin+thiram @ 2 g kg^{-1} seed (6.96%) and mancozeb @ 3 g kg^{-1} seed (7.46%). Reduction in per cent infection with carbendazim, tebuconazole, carboxin+thiram was observed by Islam *et al.* (2015) and Kumari *et al.* (2016). Seed treatment with propiconazole and carbendazim (Rohtas *et al.*, 2016) and carbendazim (Dolas *et al.*, 2018) also recorded decrease in per cent disease incidence.

Table 1: Effect of seed treatment on germination (%) in groundnut genotypes inoculated with *Aspergillus flavus*.

Genotypes	Germination (%)								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	89.25 (71.09)	89.75 (71.32)	90.25 (71.79)	89.25 (70.86)	70.75 (57.08)	70.50 (56.92)	70.00 (56.46)	90.25 (71.80)	82.50 (65.92)^{cd}
Amaravati	89.00 (70.61)	89.50 (71.07)	90.50 (72.02)	89.25 (70.84)	72.00 (58.03)	71.75 (57.87)	65.75 (53.56)	90.50 (72.05)	82.28 (65.76)^{bcd}
Chitravati	88.75 (70.39)	89.50 (71.07)	90.75 (72.27)	89.00 (70.61)	71.25 (57.24)	71.00 (57.08)	69.50 (55.69)	90.50 (72.02)	82.53 (65.80)^{bcd}
Dharani	86.75 (68.63)	87.75 (69.50)	88.25 (69.94)	87.50 (69.27)	65.25 (53.86)	64.50 (53.41)	63.75 (52.37)	88.25 (69.93)	79.00 (63.36)^{a}
Haritandhra	88.25 (69.95)	89.75 (71.32)	90.00 (71.55)	89.00 (70.62)	70.00 (56.77)	69.75 (56.46)	69.25 (55.84)	90.50 (72.02)	82.06 (65.56)^{bc}
ICGV 00 350	88.25 (69.94)	90.25 (71.78)	90.50 (72.02)	89.50 (71.07)	70.75 (57.24)	70.50 (57.08)	69.00 (55.84)	91.25 (72.80)	82.50 (65.97)^{cd}
Kadiri 6	87.00 (68.84)	90.00 (71.55)	90.75 (72.28)	88.75 (70.39)	72.75 (58.51)	73.25 (58.84)	71.25 (57.25)	90.50 (72.05)	83.03 (66.21)^{d}
Kadiri 9	89.00 (70.61)	90.75 (72.27)	91.50 (73.05)	89.75 (71.31)	76.25 (60.82)	74.25 (59.49)	72.00 (57.87)	91.00 (72.53)	84.31 (67.24)^{ef}
Narayani	90.00	92.50	93.00	91.25	73.00	72.00	71.00	92.75	84.44

	(71.55)	(74.08)	(74.65)	(72.78)	(58.67)	(58.03)	(57.24)	(74.36)	(67.67)^{f}
TAG 24	95.25 (77.43)	96.50 (79.21)	98.00 (81.97)	96.00 (78.48)	86.50 (68.43)	85.00 (67.20)	84.25 (66.61)	98.00 (83.15)	92.44 (75.31)^{g}
TCGS 1073	90.00 (71.55)	90.75 (72.28)	91.00 (72.53)	90.25 (71.79)	73.00 (58.68)	72.25 (58.19)	71.25 (57.40)	91.75 (73.30)	83.78 (66.96)^{d}
TCGS 1616	87.00 (68.91)	87.75 (69.50)	88.50 (70.17)	88.00 (69.71)	71.25 (57.56)	71.50 (57.40)	71.00 (56.92)	90.75 (72.30)	81.97 (65.31)^{e}
TCGS 1694	87.50 (69.30)	89.75 (71.31)	90.00 (71.55)	87.75 (69.55)	71.25 (57.55)	70.75 (57.24)	70.50 (56.77)	91.00 (72.56)	82.31 (65.73)^{bcd}
Mean	88.92 (70.68)^{D}	90.35 (72.02)^{F}	91.00 (72.75)^{G}	89.63 (71.33)^{E}	72.62 (58.49)^{C}	72.08 (58.09)^{B}	70.65 (56.91)^{A}	91.31 (73.14)^{G}	83.32 (66.68)

*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

	Genotype	Treatment	G × T
SEm	0.18	0.14	0.52
CD (5%)	0.46	0.39	1.22
CV (%)	1.561		

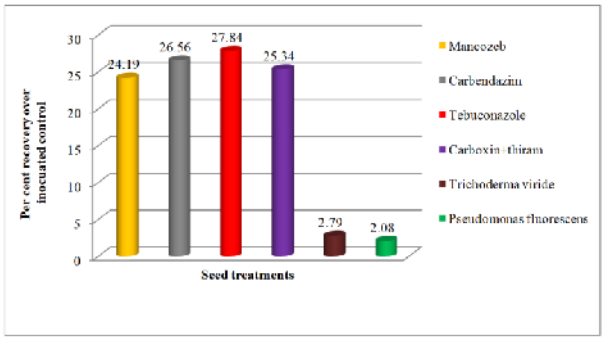

Fig. 1. Per cent recovery of germination in different seed treatments over inoculated control of *Aspergillus flavus.*

Table 2: Effect of seed treatment on seedling length (cm) in groundnut genotypes inoculated with *Aspergillus flavus.*

Genotypes	Seedling length (cm)								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	14.95	16.82	14.71	16.71	15.66	15.13	14.78	19.43	16.02^{e}
Amaravati	15.37	16.02	13.11	15.66	14.61	14.57	14.46	18.84	15.33^{c}
Chitravati	16.20	17.49	12.65	17.25	15.62	15.59	14.64	17.41	15.85^{d}
Dharani	15.72	15.86	13.70	15.84	13.79	13.79	13.56	16.69	14.87^{a}
Haritandhra	17.39	17.77	13.88	18.74	16.00	15.94	14.85	19.16	16.71^{f}
ICGV 00 350	15.37	15.76	12.65	15.75	13.84	13.68	13.43	18.14	14.83^{a}
Kadiri 6	17.13	19.17	12.93	17.53	16.24	15.74	15.01	20.80	16.82^{g}
Kadiri 9	18.68	20.36	11.85	18.94	17.52	17.46	17.26	20.90	17.87^{h}
Narayani	18.75	19.00	15.30	18.96	18.41	18.35	17.95	20.56	18.41^{i}
TAG 24	27.60	27.80	18.66	27.79	27.32	27.33	24.76	31.18	26.55^{k}
TCGS 1073	24.55	25.86	18.95	24.53	21.50	21.47	20.42	28.27	23.19^{j}
TCGS 1616	14.70	15.38	12.89	15.34	15.41	14.67	12.35	19.61	15.04^{b}
TCGS 1694	17.65	18.75	13.97	18.14	16.08	15.86	15.04	19.55	16.88^{g}
Mean	**18.00**^{E}	**18.93**^{G}	**14.25**^{A}	**18.55**^{F}	**17.07**^{b}	**16.89**^{C}	**16.04**^{B}	**20.81**^{H}	17.57

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

	Genotype	Treatment	G × T
SEm	0.04	0.03	0.10
CD (5%)	0.09	0.08	0.24
CV (%)	1.165		

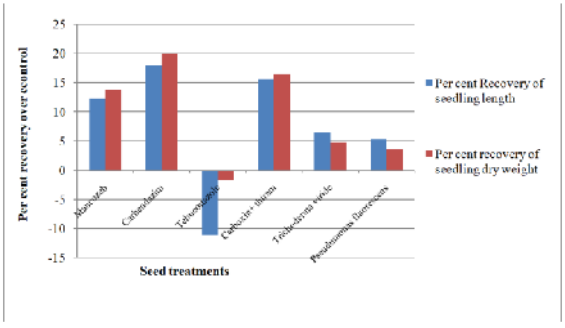

Fig. 2. Per cent recovery of seedling length and dry weight in different seed treatments over inoculated control of *Aspergillus flavus.*

Table 3: Effect of seed treatment on seedling vigour index I of groundnut genotypes inoculated with *Aspergillus flavus.*

Genotypes	Seedling Vigour Index I								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	1334	1510	1327	1491	1108	1067	1035	1753	1328^{e}
Amaravati	1368	1434	1187	1398	1051	1045	950	1705	1267^{c}
Chitravati	1438	1566	1148	1535	1113	1107	1017	1575	1312^{d}
Dharani	1364	1391	1209	1386	900	889	864	1472	1184^{a}
Haritandhra	1534	1595	1249	1667	1120	1111	1028	1734	1380^{f}
ICGV 00 350	1356	1423	1144	1410	979	964	927	1655	1232^{b}
Kadiri 6	1490	1725	1173	1556	1182	1153	1069	1883	1404^{g}
Kadiri 9	1662	1848	1084	1700	1336	1296	1243	1902	1509^{h}
Narayani	1688	1757	1422	1730	1344	1321	1274	1907	1555^{i}
TAG 24	2629	2682	1829	2668	2363	2323	2086	3055	2454^{k}
TCGS 1073	2209	2347	1725	2214	1570	1551	1455	2593	1958^{j}
TCGS 1616	1278	1350	1141	1350	1098	1049	876	1780	1240^{b}
TCGS 1694	1544	1683	1257	1592	1146	1122	1060	1779	1398^{g}
Mean	1607^{E}	1716^{G}	1300^{D}	1669^{F}	1254^{C}	1231^{B}	1145^{A}	1907^{H}	1479

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

	Genotype	Treatment	G × T
SEm	4.27	3.35	12.07
CD (5%)	10.75	8.97	28.38
CV (%)	1.632		

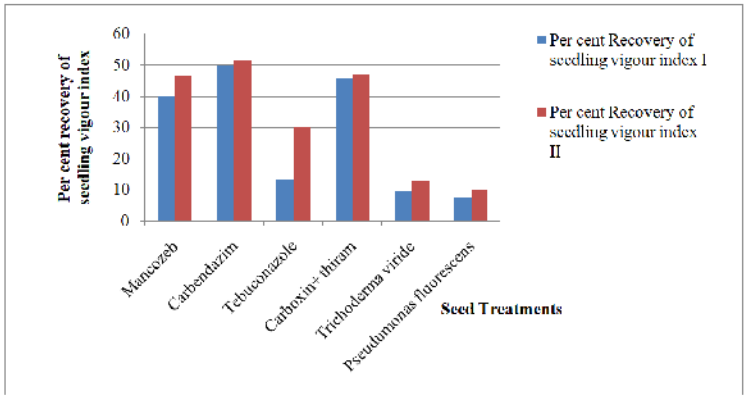

Fig. 3. Per cent recovery of seedling vigour index I and II in different seed treatments over inoculated control of *Aspergillus flavus.*

Table 4: Effect of seed treatment on seedling dry weight of different groundnut genotypes inoculated with *Aspergillus flavus.*

Genotypes	Seedling dry weight (g)								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	0.19	0.20	0.19	0.19	0.19	0.19	0.17	0.22	0.19^{c}
Amaravati	0.21	0.22	0.18	0.21	0.20	0.20	0.18	0.25	0.21^{e}
Chitravati	0.20	0.20	0.17	0.19	0.17	0.17	0.17	0.21	0.19^{b}
Dharani	0.18	0.19	0.15	0.18	0.17	0.17	0.16	0.19	0.17^{a}
Haritandhra	0.20	0.21	0.18	0.20	0.19	0.19	0.18	0.21	0.20^{d}
ICGV 00 350	0.19	0.20	0.17	0.19	0.18	0.17	0.17	0.20	0.19^{b}
Kadiri 6	0.21	0.24	0.19	0.23	0.20	0.19	0.19	0.24	0.21^{f}
Kadiri 9	0.23	0.25	0.19	0.25	0.20	0.20	0.20	0.25	0.22^{h}
Narayani	0.25	0.26	0.22	0.26	0.22	0.22	0.22	0.26	0.24^{j}
TAG 24	0.25	0.26	0.19	0.26	0.23	0.22	0.22	0.26	0.24^{i}
TCGS 1073	0.27	0.30	0.25	0.28	0.26	0.26	0.25	0.30	0.27^{k}
TCGS 1616	0.19	0.20	0.17	0.19	0.17	0.17	0.17	0.21	0.19^{b}
TCGS 1694	0.24	0.24	0.18	0.24	0.20	0.19	0.18	0.25	0.21^{g}
Mean	**0.22**^{E}	**0.23**^{G}	**0.19**^{A}	**0.22**^{F}	**0.20**^{D}	**0.20**^{C}	**0.19**^{B}	**0.24**^{H}	0.21

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

	Genotype	Treatment	GxT
SEm	0.000574	0.00045	0.00162
CD (5%)	0.001447	0.00121	0.00382
CV (%)	1.56		

Table 5: Effect of seed treatment on seedling vigour index II of groundnut genotypes inoculated with *Aspergillus flavus.*

Genotypes	Seeding Vigour Index II								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	17.29	17.61	16.83	16.71	13.28	13.04	11.69	19.95	15.80^{c}
Amaravati	18.45	19.33	16.11	19.17	14.67	14.55	11.54	22.69	17.06^{e}
Chitravati	17.37	17.95	15.11	17.18	12.43	12.34	11.69	18.80	15.36^{b}
Dharani	15.33	16.32	13.66	15.71	10.95	10.69	10.49	16.33	13.68^{a}
Haritandhra	17.41	18.69	16.58	17.71	13.32	13.22	12.78	19.32	16.13^{d}
ICGV 00 350	16.90	18.39	15.57	17.18	12.38	12.28	12.00	18.59	15.41^{b}
Kadiri 6	18.51	21.40	16.95	20.57	14.33	14.08	13.73	21.70	17.66^{f}
Kadiri 9	20.81	22.32	17.20	22.24	15.40	14.94	14.44	22.79	18.77^{g}
Narayani	22.72	23.89	20.79	23.50	16.39	16.11	15.83	24.35	20.45^{h}
TAG 24	23.50	25.40	18.42	24.70	19.87	19.10	18.54	25.95	21.94^{i}
TCGS 1073	24.19	27.20	22.30	25.02	18.69	18.53	17.46	27.91	22.66^{j}
TCGS 1616	16.71	17.57	15.18	17.07	12.43	12.26	11.80	19.20	15.28^{b}
TCGS 1694	20.63	21.67	16.07	21.01	14.23	13.58	12.90	22.57	17.83^{f}
Mean	19.22^{E}	20.60^{G}	16.98^{D}	19.83^{F}	14.49^{C}	14.21^{B}	13.45^{A}	21.55^{H}	17.54

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

	Genotype	Treatment	G × T
SEm	0.07	0.05	0.19
CD (5%)	0.17	0.14	0.45
CV (%)	2.16		

Table 6: Effect of seed treatment on per cent infection of different groundnut genotypes inoculated with *Aspergillus flavus.*

Genotypes	Per cent infection								
	Mancozeb	Carbendazim	Tebuconazole	Carboxin+ thiram	*Trichoderma viride*	*Pseudumonas fluorescens*	Inoculated control	Uninoculated control	Mean
Abhaya	8.00 (16.37)	6.50 (14.71)	5.00 (12.830	7.00 (15.26)	34.50 (35.95)	35.50 (36.55)	38.25 (38.19)	7.25 (15.28)	17.75 (23.14)^{b}
Amaravati	6.75 (14.89)	6.25 (14.37)	3.25 (10.36)	6.50 (14.66)	34.75 (36.10)	36.50 (37.15)	40.75 (39.65)	8.50 (16.94)	17.91 (23.01)^{b}
Chitravati	7.00 (15.24)	6.50 (14.660	3.50 (10.68)	7.00 (15.19)	37.50 (37.74)	38.75 (38.47)	41.00 (39.80)	7.75 (15.92)	18.63 (23.46)^{bc}
Dharani	8.75 (17.18)	7.75 (16.15)	4.50 (12.22)	7.25 (15.05)	37.50 (37.74)	38.50 (38.33)	42.00 (40.38)	8.50 (16.78)	19.34 (24.23)^{c}
Haritandhra	7.75 (15.87)	7.50 (15.70)	5.25 (13.14)	8.25 (16.62)	36.25 (37.00)	35.75 (36.70)	41.25 (39.94)	10.00 (18.36)	19.00 (24.17)^{c}
ICGV 00 350	10.00 (18.39)	8.25 (16.67)	4.75 (12.44)	9.00 (17.44)	49.00 (44.41)	53.00 (46.70)	55.75 (48.28)	8.50 (16.94)	24.78 (27.66)^{e}
Kadiri 6	6.75 (15.00)	5.75 (13.84)	2.50 (8.84)	5.75 (13.76)	36.50 (37.15)	39.00 (38.63)	40.00 (39.22)	9.25 (17.68)	18.19 (23.01)^{b}
Kadiri 9	8.00 (16.41)	6.50 (14.62)	4.75 (12.44)	7.00 (15.19)	34.00 (36.65)	34.25 (35.80)	39.00 (38.63)	9.00 (17.12)	17.81 (23.23)^{bc}
Narayani	3.50 (10.64)	5.00 (12.71)	2.75 (9.23)	4.25 (11.83)	32.50 (34.73)	34.50 (35.95)	37.50 (37.74)	8.50 (16.92)	16.06 (21.22)^{a}
TAG 24	6.25 (14.23)	4.00 (11.24)	3.25 (10.04)	6.00 (14.05)	32.00 (34.43)	32.75 (34.89)	33.25 (35.19)	9.75 (18.15)	15.91 (21.53)^{a}
TCGS 1073	7.75 (16.06)	6.75 (15.03)	3.00 (9.83)	7.00 (15.27)	29.00 (32.51)	30.00 (33.17)	36.00 (36.85)	9.25 (17.64)	16.09 (22.05)^{a}
TCGS 1616	8.00 (16.41)	7.25 (15.59)	4.00 (11.49)	7.50 (15.86)	47.50 (43.55)	48.50 (44.12)	51.25 (45.70)	8.50 (16.94)	22.81 (26.21)^{d}
TCGS 1694	8.50 (16.94)	7.00 (15.27)	4.00 (11.49)	8.00 (16.39)	34.50 (35.95)	35.00 (36.25)	40.00 (39.22)	8.25 (16.56)	18.16 (23.51)^{bc}
Mean	7.46 (15.67)^{C}	6.54 (14.66)^{B}	3.88 (11.16)^{A}	6.96 (15.12)^{BC}	36.58 (37.15)^{E}	37.85 (37.90)^{F}	41.23 (39.91)^{G}	8.69 (17.02)^{D}	18.65 (23.57)

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

	Genotype	Treatment	G × T
SEm	0.064	0.051	0.182
CD (5%)	0.162	0.135	0.428
CV (%)	1.54		

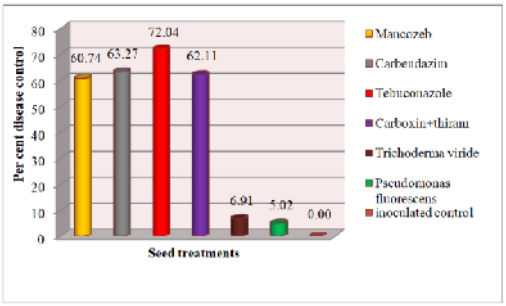

Fig. 4. Per cent disease control in different seed treatments over inoculated control of *Aspergillus flavus.*

CONCLUSION

Seed treatment with tebuconazole or carbendazim efficiently controls the seed borne infection of *A. flavus* in groundnut. Tebuconazole recorded the highest germination and maximum per cent disease control where as carbendazim recorded the highest seedling length, seedling vigour index I, seedling dry weight and seedling vigour index II. Hence protection with tebuconazole @ 1g/kg seed or carbendazim @ 2g/kg seed is recommended.

FUTURE SCOPE

New alternative chemicals *i.e.*, CIB & RC recommended new chemical fungicides and their combinations may be tested against pathogens of groundnut for preventing pre- and post harvest losses and quality seed production.

Conflicts of Interest. None.

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