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Effect of fungicides, bioagents and botanicals against seed borne microflora of soybean *in-vitro*

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Abstract

The experiment entitled “Effect of fungicides, bioagents and botanicals against seed borne microflora of soybean *in-vitro*” was conducted at Department of Plant Pathology and Agriculture Microbiology. The experiment was laid out in CRD design with four replication and three treatment. The treatment Carbendazim + mancozeb (0.2%) found most effective as compared to vitavax, recorded 0 percent incidence of internally and externally seed borne pathogens. Among the bioagents *Trichoderma harzianum* recorded 2, 3, 2, 2 and 1 percent incidence of *Fusarium oxysporum*, *Fusarium moniliforme*, *Macrophomina phaseolina*, *Alternaria alternata*, *Colletotrichum truncatum* as against in the control treatment. Among the botanicals Garlic bulb extract showed 1, 3, 3, 2 and 2 percent incidence against these pathogens. Among the bioagents *Trichoderma harzianum* (0.6%) showed 3, 4, 3, 4, 3, 2, 1, 2 and 2 percent incidence of externally seed borne pathogens *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candida*, *Curvularia lunata*, *Cladosporium* sp., *penicillium* sp., *Phoma medicaginis*, *Botrytis cinerea*, *Mucor* sp. as against the control treatment. Among the botanicals, Garlic bulb extract recorded 3, 2, 3, 0, 0, 2, 1, 2 and 1 percent incidence of these pathogens as against the control treatment.

Keywords: Soybean, vitavax, carbendazim + mancozeb, *Trichoderma harzianum*, garlic, pathogens

Introduction

Soybean is an important commercial crop known as the “GOLDEN BEAN”. Seed damage is an important quality factor for grading, marketing and end use of Soybean. Seed damage can also be caused by weather, fungi, insects, artificial drying, and by mechanical handling during harvest, transportation, storage and handling (Kinnikar *et al.*, 2015)^[9]. Seed-borne pathogens causes enormous losses to crops in the world as well as in India. The presence of pathogenic propagules in a seed lot is pivotal because infected seed fail to germinate which causes infection to seedlings and growing plants (Fakir, 1983)^[5].

Pathogens can be found in seeds before or after germination (Garuba *et al.*, 2014). Seed-borne pathogens are agents that are found internally or externally in seeds and have the potential to cause diseases in plants (Gupta *et al.*, 2017; Pedraza *et al.*, 2018)^[7, 19]. Several pathogenic fungi like *Rhizopus*, *Alternaria*, *Curvularia*, *Diaporthe*, *Mucor*, *Corynespora*, *Cercospora*, *Colletotrichum*, *Phoma*, *Pythium*, *Fusarium*, *Aspergillus*, and *Cladosporium* have been isolated from soybean seeds (Saylendra and Fatmawaty 2010; Kinnikar *et al.*, 2015^[9]; Escamilla *et al.*, 2019)^[21, 9, 4].

More than 30 fungi are associated as a seed-borne on soybean for example *Phomopsis spp.*, which causes pod and stem blight disease and reduces seed viability. While purple seed stain is caused by *Cercospora kikuchii* which affects on seed quality. However, most of the fungi that are associated with soybean seeds are unknown (McGee and Nyvall, 1994)^[24].

Methodology

Effect of fungicides, bioagents and botanicals as seed treatment on seed microflora, seed germination and seedling vigour index

The fungicides, bioagents and botanicals used for seed treatment were Carbendazim + mancozeb (0.2%), Carboxin (0.2%), *Trichoderma harzianum* (0.6%), *Pseudomonas fluorescense* (0.6%), Ginger rhizome extract (10%) and Garlic bulb extract (10%). The experiment was laid out in completely randomized design with four replications.

Seed treatment to naturally infected seed

The seed treatment of each fungicides, bioagents and botanicals to the naturally infected seeds of soybean variety JS-335 was given in plastic vessels.

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Seed treatment to artificially inoculated seed

The seed were inoculated by dipping the seeds in concentrated suspension of spores/active hyphae of important seed microflora of soybean for 12 hrs and then seeds were dried under shade for 12 hrs. The inoculated seeds were treated with fungicides and the inoculated but untreated seeds were served as control.

Effect of fungicides, bioagents and botanicals on seed microflora

The effect on seed microflora due to fungicides, bioagents and botanicals treated and untreated naturally infected as well as artificially inoculated seeds were studied by standard blotter test described earlier. Ten seeds were plated in each plate. The plates were incubated at 20 ± 2 °C in incubation room with an alternate cycle of 12 hrs dark and 12 hrs near fluorescent light for 7 days. The observations on microflora were recorded on 8th day. The percent incidence of microflora was worked out in each of the treatment.

Effect of fungicides, bioagents and botanicals on seed germination and seedling vigour index

The effect of fungicides, bioagents and botanicals treated and untreated naturally infected as well as artificially inoculated seed were kept for germination by adopting 'Between Paper Method' described earlier. The germination and root + shoot length was recorded and seedling vigour index was computed in each treatment.

Result and Discussion

Efficacy of Fungicides, Bioagents and Botanicals against Internally Seed Borne Fungi

The results in respect of efficacy of fungicides, bioagents and botanicals against seed borne microflora of naturally infected seeds of var. JS-335 are presented in Table 1.

The treatment carbendazim + mancozeb (0.2%) recorded no disease incidence of *Fusarium oxysporum*, *Fusarium moniliforme*, *Macrophomina phaseolina*, *Alternaria alternata*, *Colletotrichum truncatum* as against 77, 81, 76, 57 and 82 percent in the control treatment. The disease incidence of these pathogens were controlled due to this treatment was 100 percent, respectively over control. Among the bioagents *Trichoderma harzianum* (0.6%) recorded 2, 3, 2, 2 and 1 percent incidence of *Fusarium oxysporum*, *Fusarium moniliforme*, *Macrophomina phaseolina*, *Alternaria alternata*, *Colletotrichum truncatum* respectively as against 77, 81, 76, 57 and 82 percent in the control treatment. The disease of incidence of these pathogens was controlled due to this treatment was 97.41, 96.30, 97.37, 96.50 and 98.79 percent, respectively over control. Among the botanicals Garlic bulb extract (10%) showed 1, 2, 4, 2 and 1 percent incidence of these pathogens as against 77, 81, 76, 57 and 82 percent respectively in the control treatment. The disease of incidence of these pathogens were controlled due to this treatment was 98.71, 97.57, 94.74, 96.49 and 98.79 percent, respectively over control.

Efficacy of Fungicides, Bioagents and Botanicals against Externally Seed Borne Fungi

The results on the efficacy of fungicides, bioagents and

botanicals against externally seed borne microflora of soybean seeds of var. JS-335 are presented in Table 2. The fungicidal, bioagents and botanicals treatments were found statistically significant over control.

The treatment fungicides, carbendazim + mancozeb (0.2%) showed no incidence of *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candida*, *Curvularia lunata*, *Cladosporium* sp., *penicillium* sp., *Phoma medicaginis*, *Botrytis cinerea*, *Mucor* sp. respectively as against 96, 94, 97, 72, 78, 83, 80, 78 and 73 percent in the control treatment. These pathogens were controlled due to this treatment was 100 percent over control. Among the bioagents, *Trichoderma harzianum* (0.6%) showed 3, 4, 3, 4, 3, 2, 1, 2 and 2 percent incidence of *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candida*, *Curvularia lunata*, *Cladosporium* sp., *penicillium* sp., *Phoma medicaginis*, *Botrytis cinerea*, *Mucor* sp. respectively as against 96, 94, 97, 72, 78, 83, 80, 78 and 73 percent in the control treatment. These pathogens were controlled due to this treatment was 96.88, 95.75, 96.91, 94.45, 96.16, 97.60, 98.75, 97.44 and 97.26 percent over control. Among the botanicals treatment, Garlic bulb extract (10%) recorded 3, 2, 3, 0, 0, 2, 1, 2 and 1 percent incidence of *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candida*, *Curvularia lunata*, *Cladosporium* sp., *penicillium* sp., *Phoma medicaginis*, *Botrytis cinerea*, *Mucor* sp. as against 96, 94, 97, 72, 78, 83, 80, 78 and 73 percent in the control treatment. These pathogens were controlled due to this treatment was 96.87, 97.88, 96.91, 100, 100, 97.60, 98.75, 97.44 and 98.64 percent over control.

Efficacy of fungicides, bioagents and botanicals on seed germination and seedlings vigour index with internal seed borne pathogen

The efficacy of fungicides, bioagents and botanicals against internally seed borne fungal microflora (artificially inoculated) were observed and results on seed germination and seedling vigour index of soybean var. JS- 335 are presented in Table 3. The treated treatments viz., fungicides, bioagents and botanicals were found statistically significant over control in respect of seed germination and seedling vigour index.

Effect on seed germination

The seed treatment with carbendazim + mancozeb (0.2%) recorded 86, 82, 88, 77 and 89 percent seed germination of soybean seeds internally infected with *Fusarium oxysporum*, *Fusarium moniliforme*, *Macrophomina phaseolina*, *Alternaria alternata*, *Colletotrichum truncatum*, respectively as against 65, 67, 71, 64 and 68 percent in respective control treatment. The increase in seed germination due to use of fungicidal treatment was 32.30, 22.38, 23.94, 20.31 and 30.88 percent, respectively over control. Among the bioagents treatment, *Trichoderma harzianum* (0.6%) seed treatment showed maximum seed germination of soybean seeds internally infected with *Macrophomina phaseolina* i.e. 86 percent and minimum seed germination infected with *Alternaria alternata* i.e. 77 percent against 71 and 64 percent over control treatment. The increase in seed germination due to *Trichoderma harzianum* (0.6%) treatment was 21.12 and 20.31 percent, respectively over control.

Table 1: Efficacy of fungicides, bioagents and botanicals against internally seed borne fungi of soybean

Sr. No.	Treatments	Conc.	Incidence of seed borne microflora on seed after treatment									
			<i>Fusarium oxysporum</i>	Reduction over control	<i>Fusarium moniliforme</i>	Reduction over control	<i>Macrophomina phaseolina</i>	Reduction over control	<i>Alternaria alternata</i>	Reduction over control	<i>Colletotrichum truncatum</i>	Reduction over control
1.	Vitavax	0.2%	3	96.11	4	95.07	3	96.06	6	89.47	2	97.56
2.	Carbendazim + mancozeb	0.2%	0	100	0	100	0	100	0	100	0	100
3.	<i>Trichoderma harzianum</i>	0.6%	2	97.41	3	96.30	2	97.37	2	96.50	1	98.79
4.	<i>Pseudomonas fluorescens</i>	0.6%	2	97.41	4	95.07	4	94.74	5	91.22	3	96.34
5.	Ginger rhizome extract	10%	1	98.71	2	97.57	4	94.74	2	96.49	1	98.79
6.	Garlic bulb extract	10%	1	98.71	3	96.30	3	96.06	2	96.49	2	97.57
7.	Control		77	-	81	-	76	-	57	-	82	-
	S.E.±		0.53	-	0.34	-	0.57	-	0.46	-	0.40	-
	CD at 5%		1.57	-	1.01	-	1.69	-	1.36	-	1.20	-
	CD at 1%		2.14	-	1.38	-	2.31	-	1.85	-	1.63	-

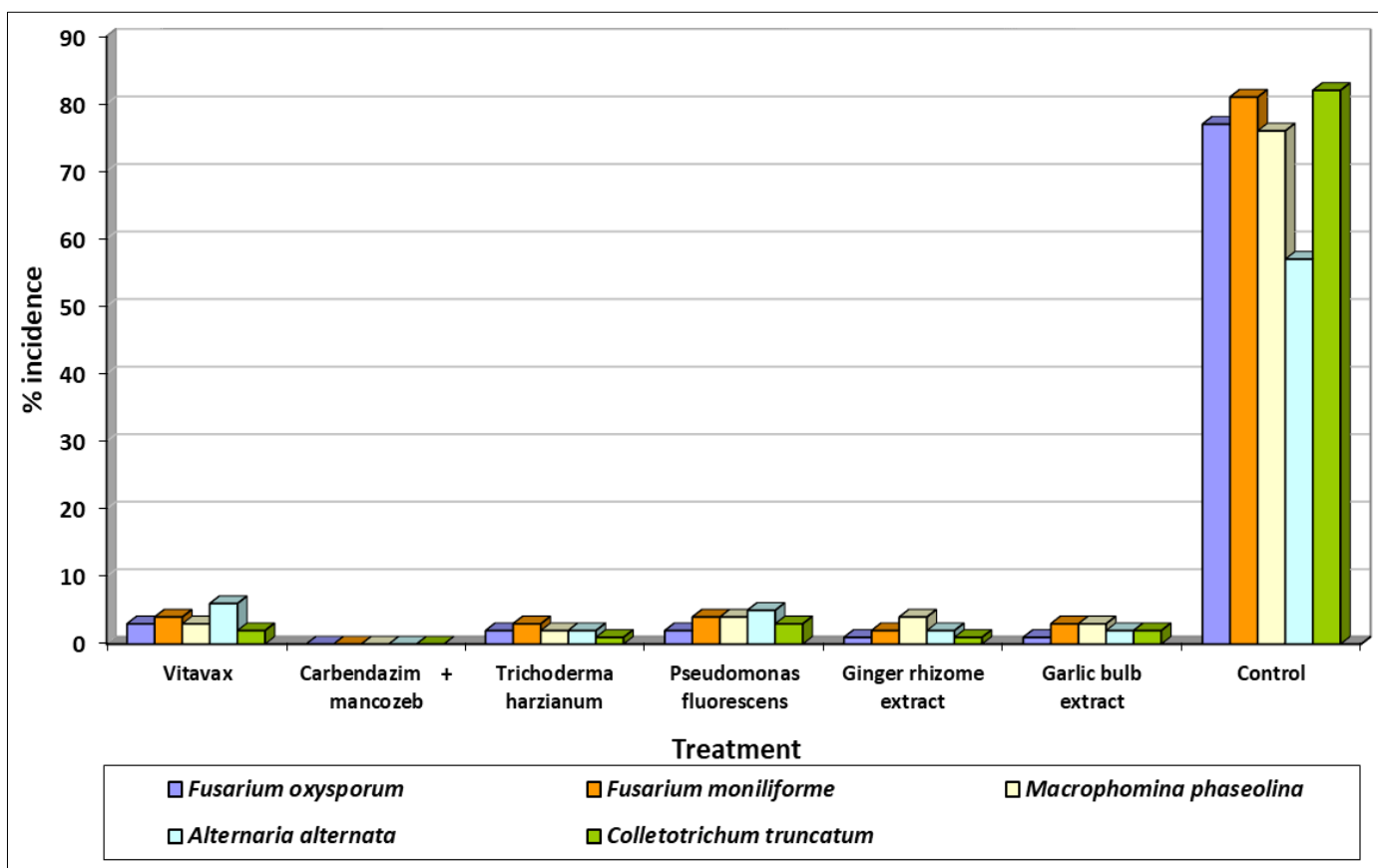
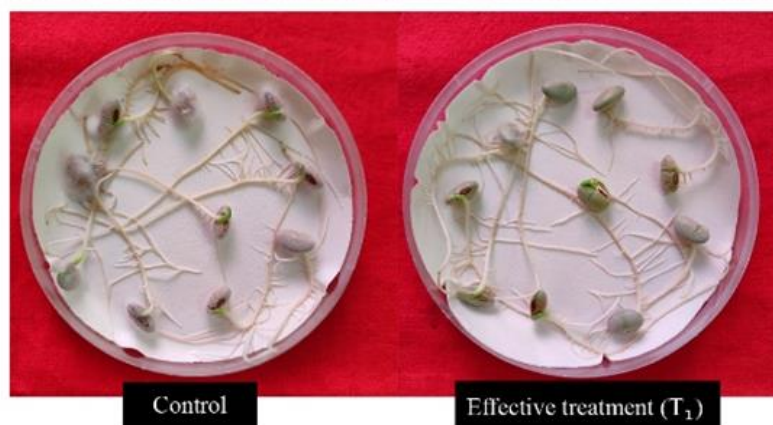


Fig 1: Efficacy of fungicides, bioagents and botanicals against internally seed borne fungi of soybean



Effect of seed treatment with carbendazim + mancozeb @ 0.2% on incidence of inoculated seeds with *fusarium oxysporum*



Effect of seed treatment with *Trichoderma harzianum* @ 0.6% on incidence of inoculated seeds with *fusarium oxysporum*



Effect of seed treatment with Garlic (10%) on incidence of inoculated seeds with *fusarium oxysporum*



Effect of seed treatment with Garlic (10%) on incidence of inoculated seeds with *Macrophomina phaseolina*

Plate 1: Efficacy of fungicides, bioagents and botanicals against internally seed borne pathogens

Table 2: Efficacy of fungicides, botanicals and bioagents against externally seed borne fungi of soybean

Sr. No.	Treatments	Conc.	Incidence of seed borne microflora on seed after treatment									
			<i>Aspergillus flavus</i>	Reduction over control	<i>Aspergillus niger</i>	Reduction over control	<i>Aspergillus candida</i>	Reduction over control	<i>Curvularia lunata</i>	Reduction over control	<i>Cladosporium sp.</i>	Reduction over control
1.	Vitavax	0.2%	3	96.87	5	94.68	4	95.88	7	90.28	9	88.47
2.	Carbendazim + mancozeb	0.2%	0	100	0	100	0	100	0	100	0	100
3.	<i>Trichoderma harzianum</i>	0.6%	3	96.88	4	95.75	3	96.91	4	94.45	3	96.16
4.	<i>Pseudomonas fluorescens</i>	0.6%	4	95.84	7	92.56	5	94.85	7	90.28	5	93.59
5.	Ginger rhizome extract	10%	4	95.84	3	96.81	2	97.94	2	97.23	3	96.16
6.	Garlic bulb extract	10%	3	96.87	2	97.88	3	96.91	0	100	0	100
7.	Control	-	96	-	94	-	97	-	72	-	78	-
	S.E.±	-	0.40	-	0.34	-	0.46	-	0.51	-	0.37	-
	CD at 5%	-	1.20	-	1.01	-	1.36	-	1.50	-	1.11	-
	CD at 1%	-	1.63	-	1.38	-	1.85	-	2.04	-	1.51	-

Sr. No.	Treatments	Conc.	Incidence of seed borne microflora on seed after treatment							
			<i>Penicillium sp.</i>	Reduction over control	<i>Phoma medicaginis</i>	Reduction over control	<i>Botrytis cinerea</i>	Reduction over control	<i>Mucor sp.</i>	Reduction over control
1.	Vitavax	0.2%	4	95.19	5	93.75	4	94.88	3	95.90
2.	Carbendazim + mancozeb	0.2%	0	100	0	100	0	100	0	100
3.	<i>Trichoderma harzianum</i>	0.6%	2	97.60	1	98.75	2	97.44	2	97.26
4.	<i>Pseudomonas fluorescens</i>	0.6%	3	96.39	3	96.25	2	97.44	3	95.90
5.	Ginger rhizome extract	10%	2	97.60	2	97.5	3	96.16	1	98.64
6.	Garlic bulb extract	10%	2	97.60	1	98.75	2	97.44	1	98.64
7.	Control	-	83	-	80	-	78	-	73	-
	S.E.±	-	0.59	-	0.55	-	0.46	-	0.30	-
	CD at 5%	-	1.75	-	1.63	-	1.36	-	0.90	-
	CD at 1%	-	2.39	-	2.22	-	1.85	-	1.23	-

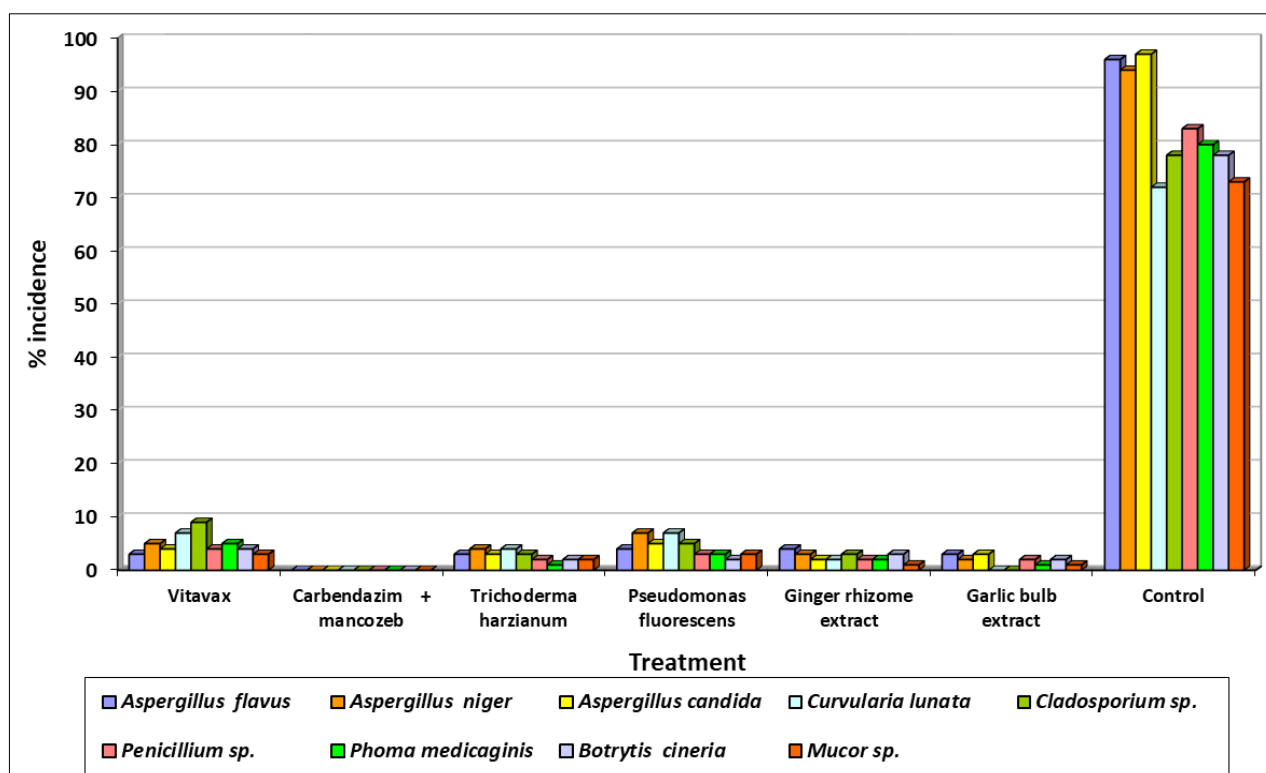


Fig 2: Efficacy of fungicides, bioagents and botanicals against externally seed borne fungi of soybean

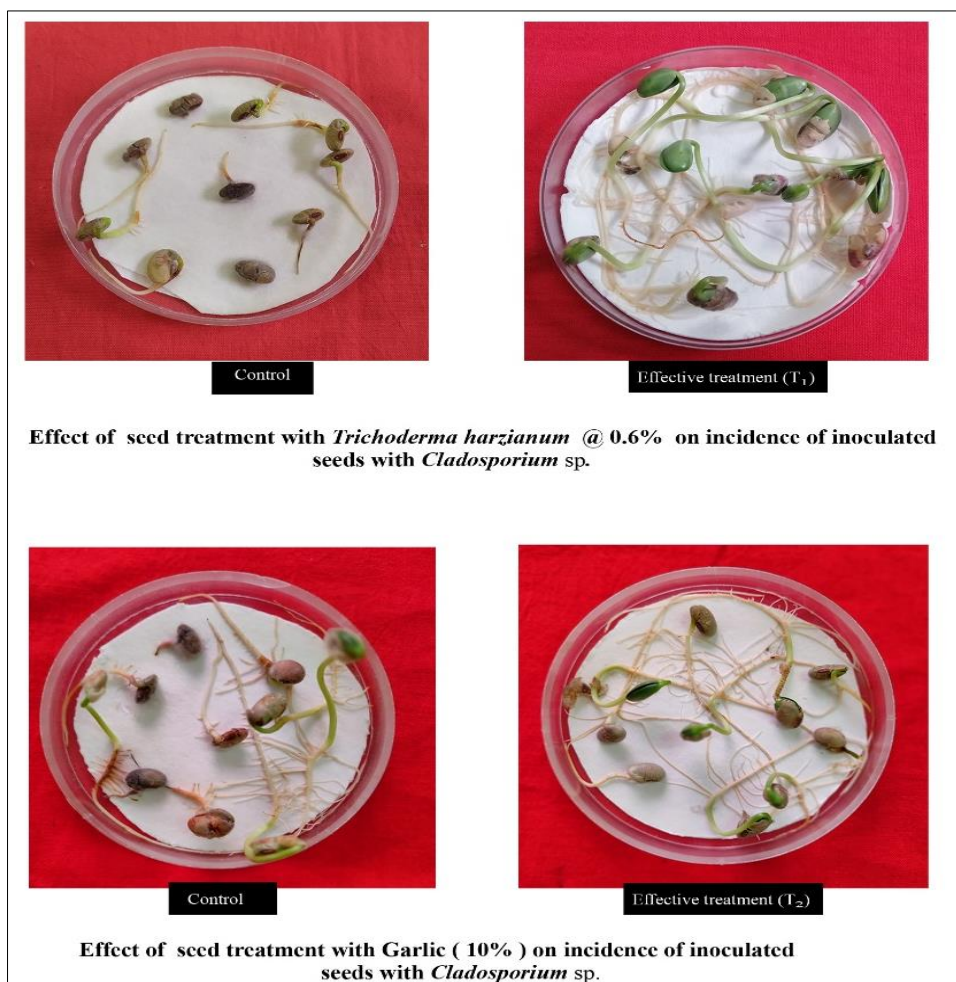
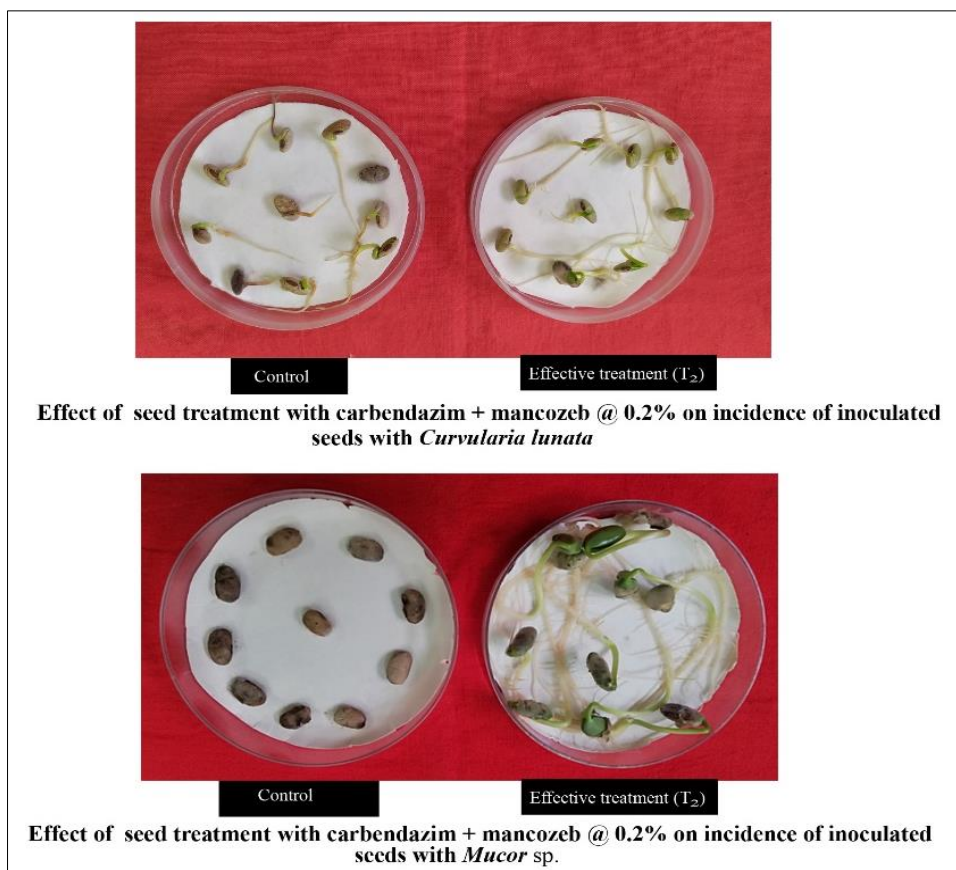


Plate 2: Efficacy of fungicides, bioagents and botanicals against externally seed borne pathogens

Among the botanicals treatment, Garlic bulb extract (10%) seed treatment showed maximum seed germination of soybean seeds internally infected with *Colletotrichum truncatum* i.e. 86 percent and minimum seed germination infected with *Alternaria alternata* i.e. 75 percent against 68 and 64 percent over control treatment. The increase in seed germination due to Garlic bulb extract (10%) treatment was 26.47 and 17.18 percent, respectively over control.

Effect on seedling vigour index

The treatment carbendazim + mancozeb (0.2%) showed 2347.8, 2182.2, 2631.2, 1572.0 and 2430.33 seedling vigour index with *Fusarium oxysporum*, *Fusarium moniliforme*, *Macrophomina phaseolina* *Alternaria alternata* and *Colletotrichum truncatum* as against 614.8, 711.8, 987.3, 731.0 and 946.2, respectively in the control treatment. The increase in seedling vigour index due to this fungicidal treatment was 281.88, 206.57, 166.50, 115.04 and 156.85 percent, respectively over control. Among the bioagents treatment, *Trichoderma harzianum* (0.6%) seed treatment recorded maximum seedling vigour index in soybean seeds internally infected with *Colletotrichum truncatum* i.e. 2445.3 percent as against 946.2 over control treatment and minimum seedling vigour index infected with *Alternaria alternata* i.e. 1542.12 percent as against 731.0 percent over control treatment. The increase in seedling vigour index due to this bioagent treatment was 158.43 and 110.96 percent, respectively over control. Among the botanicals treatment, Garlic bulb extract (10%) seed treatment showed maximum seedling vigour index in soybean seeds internally infected with *Colletotrichum truncatum* i.e. 2386.00 percent as against 946.2 percent over control treatment and minimum seedling vigour index infected with *Alternaria alternata* i.e. 1429.0 percent as against 731.0 percent over control treatment. The increase in seedling vigour index due to Garlic bulb extract (10%) treatment was 152.16 and 95.48 percent, respectively over control.

Efficacy of Fungicides on Seed Germination and Seedlings Vigour Index with External Seed Borne Pathogen

The efficacy of fungicides, bioagents and botanicals against externally seed borne fungal microflora (artificially inoculated) were studied and results on seed germination and seedling vigour index of soybean var. JS- 335 are presented in Table 4. The treatments were found statistically significant over control in respect of seed germination and seedling vigour index.

Effect on seed germination

The treatment carbendazim + mancozeb (0.2%) showed 88, 81, 80, 78, 76, 83, 82, 86 and 77 percent seed germination of soybean seeds externally infected with *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus candida*, *Curvularia lunata*, *Cladosporium* sp., *penicillium* sp., *Phoma medicaginis*, *Botrytis cinerea* and *Mucor* sp., respectively as against 68, 66, 62, 63, 65, 66, 69, 68 and 64 percent in respective control treatment. The increase in seed germination due to this fungicidal treatment was 29.41, 22.72, 29.03, 23.80, 16.92, 25.75, 18.84, 26.47 and 20.31 percent, respectively over control. Among the bioagents treatments, *Trichoderma harzianum* (0.6%) seed treatment showed maximum seed germination of soybean seeds externally infected with *Aspergillus flavus* i.e. 86 percent and minimum seed germination infected with *Cladosporium* sp. i.e. 74 percent against 68 and 65 percent over control treatment. The increase in seed germination due to *Trichoderma harzianum* treatment was 26.47 and 13.84 percent, respectively over control. Among the botanicals treatment, Garlic bulb extract (10%) seed treatment showed maximum seed germination of soybean seeds externally infected with *Aspergillus flavus* i.e. 84 percent and minimum seed germination infected with *Cladosporium* sp. i.e. 72 percent against 68 and 65 percent over control treatment. The increase in seed germination due to Garlic bulb extract treatment was 23.52 and 10.76 percent, respectively over control.

Table 3: Efficacy of fungicides, bioagents and botanicals on seed germination and seedlings vigour index of seed with internal seed borne pathogen

Sr. No.	Treatments	<i>Fusarium oxysporum</i>				<i>Fusarium moniliforme</i>				<i>Macrophomina phaseolina</i>			
		Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. over control	Seedling vigour index	% inc. Over control
1.	Vitavax	82	26.15	2263.2	268.17	79	17.91	1627.84	128.69	81	14.08	2118.58	114.58
2.	Carbendazim + mancozeb	86	32.30	2347.8	281.88	82	22.38	2182.2	206.57	88	23.94	2631.2	166.50
3.	<i>Trichoderma harzianum</i>	85	30.76	2346.47	281.66	80	19.40	2103.58	195.52	86	21.12	2396.58	142.74
4.	<i>Pseudomonas fluorescens</i>	83	27.69	2253.2	266.49	77	14.92	1545	117.05	80	12.67	2122.60	114.99
5.	Ginger rhizome extract	81	24.61	2191.04	256.38	75	11.94	1432	101.18	77	8.45	1532	55.17
6.	Garlic bulb extract	83	27.69	2243.32	264.88	78	16.41	1586	122.81	85	19.71	2342	137.21
7.	Control	65	-	614.8	-	67	-	711.8	-	71	-	987.3	-
	S.E.±	0.67		0.18		0.57		1.05		0.53		0.66	
	CD at 5%	1.97		0.55		1.69		3.09		1.57		1.95	
	CD at 1%	2.69		0.75		2.31		4.20		2.14		2.65	

Sr. No.	Treatments	<i>Alternaria alternata</i>				<i>Colletotrichum truncatum</i>			
		Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control
1	Vitavax	73	14.06	1288.0	76.19	77	13.23	1520.0	102.63
2	Carbendazim + mancozeb	77	20.31	1572.0	115.04	89	30.88	2430.33	156.85
3	<i>Trichoderma harzianum</i>	77	20.31	1542.12	110.96	87	27.94	2445.3	158.43
4	<i>Pseudomonas fluorescens</i>	74	15.62	1388.00	89.87	78	14.70	1595.00	68.56
5	Ginger rhizome extract	73	14.06	1352.00	84.95	78	18.70	1592.42	68.29
6	Garlic bulb extract	75	17.18	1429.00	95.48	86	26.47	2386	152.16
7	Control	64	-	731.0	-	68	-	946.2	-
	SE±	0.61		0.86		0.40		0.46	
	CD at 5%	1.81		2.53		1.20		1.35	
	CD at 1%	2.47		3.44		1.63		1.85	

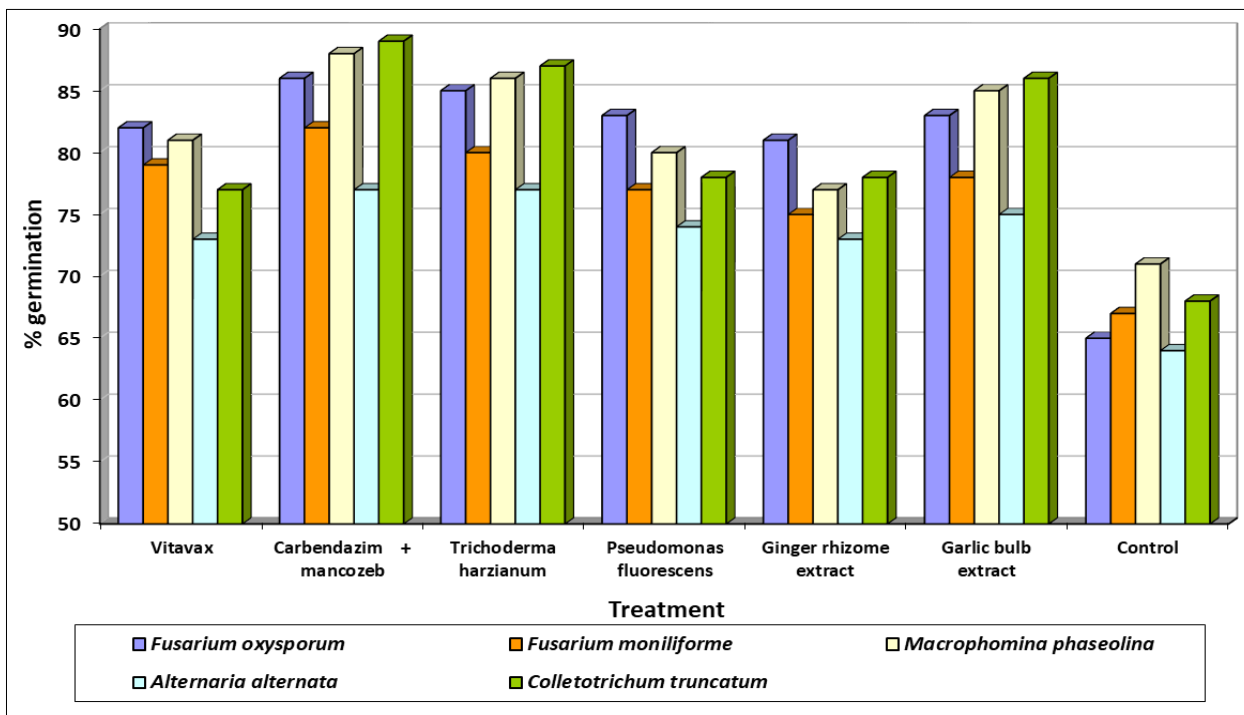


Fig 3: Efficacy of fungicides, bioagents and botanicals on seed germination of seeds with internal seed borne pathogen

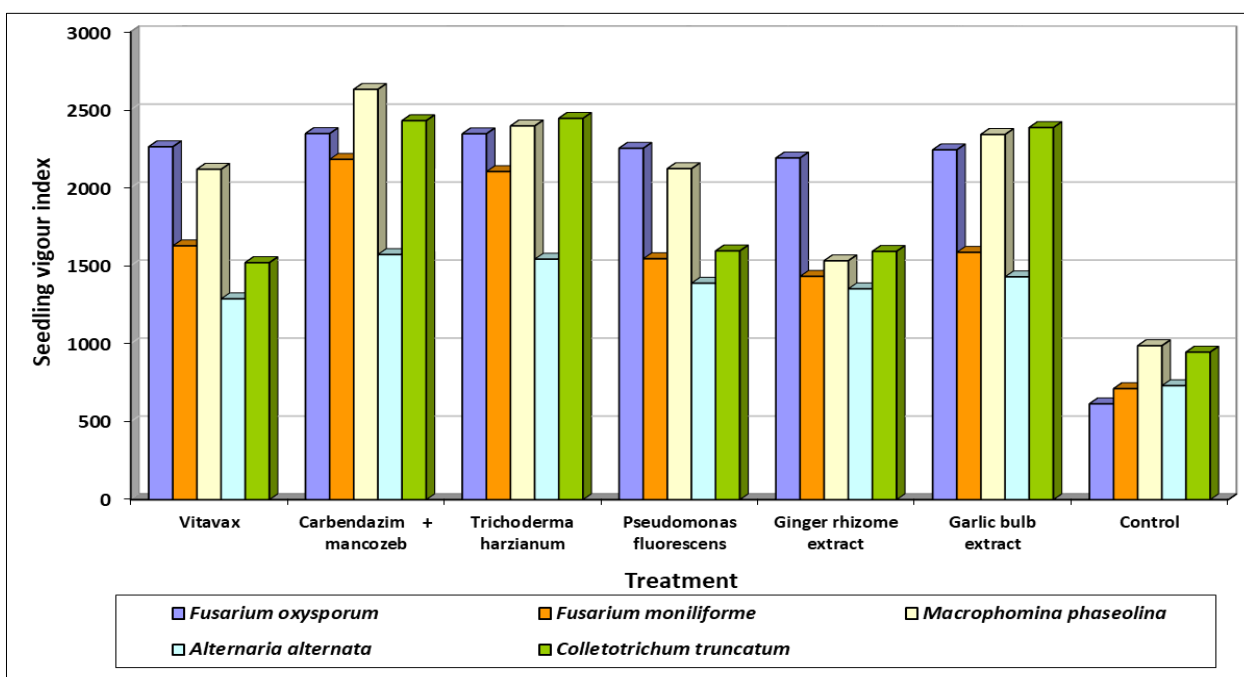


Fig 4: Efficacy of fungicides, bioagents and botanicals on seedling vigour index of seeds with internal seed borne pathogen

Effect on seedling vigour index

The treatment carbendazim + mancozeb (0.2%) showed 2352.56, 1932.40, 1896.32, 1782.45, 1690.0, 2142.03, 1999.30, 2286.0 and 1716.43 seedling vigour index with these pathogens as against 884.21, 711.11, 684.37, 666.66, 617.14, 794.44, 733.33, 857.89 and 644.11, respectively in the control treatment. The increase in seedling vigour index due to this fungicidal treatment was 166.06, 171.74, 177.08, 167.37, 173.34, 169.62, 172.63, 166.46 and 166.48 percent, respectively over control. Among the bioagents treatment, *Trichoderma harzianum* (0.6%) seed treatment recorded maximum seedling vigour index in soybean seeds externally infected with *Aspergillus flavus* i.e. 2282.55 percent as

against 884.21 percent over control treatment and minimum seedling vigour index infected with *Cladosporium* sp. i.e. 1693.24 percent as against 617.14 percent over control treatment. The increase in seedling vigour index due to this bioagent treatment was 158.14 and 174.85 percent, respectively over control. Among the botanicals treatment, Garlic bulb extract (10%) seed treatment showed the maximum seedling vigour index in soybean seeds externally infected with *Aspergillus flavus* i.e. 2206.48 percent as against 884.21 percent over control treatment and minimum seedling vigour index infected with *Cladosporium* sp. i.e. 1473.0 percent as against 617.14 percent over control treatment.

Table 4: Efficacy of fungicides on seed germination and seedlings vigour index of seed with external seed borne pathogen

Sr. No.	Treatments	<i>Aspergillus flavus</i>				<i>Aspergillus niger</i>				<i>Aspergillus candida</i>			
		Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. over control	Seedling vigour index	% inc. Over control
1.	Vitavax	84	23.52	2196.32	148.39	78	18.18	1791.60	151.94	79	27.41	1720.00	151.32
2.	Carbendazim + mancozeb	88	29.41	2352.56	166.06	81	22.72	1932.40	171.74	80	29.03	1896.32	177.08
3.	<i>Trichoderma harzianum</i>	86	26.47	2282.55	158.14	79	19.69	1877.21	163.98	78	25.80	1824.35	116.57
4.	<i>Pseudomonas fluorescens</i>	82	20.58	1991.46	125.22	76	15.15	1780.26	150.34	75	20.96	173.33	153.85
5.	Ginger rhizome extract	80	17.64	1890.40	113.79	75	13.63	1652.00	132.31	73	17.74	1552.00	126.77
6.	Garlic bulb extract	84	23.52	2206.48	149.54	78	18.18	1796.42	152.62	77	24.19	1704.55	149.06
7.	Control	68	-	884.21	-	66	-	711.11	-	62	-	684.37	-
	S.E.±	0.53	-	0.45	-	0.97	-	0.32	-	0.65	-	0.38	-
	CD at 5%	1.57	-	1.33	-	2.87	-	0.95	-	1.92	-	1.12	-
	CD at 1%	2.14	-	1.82	-	3.90	-	1.30	-	2.62	-	1.52	-

Sr. No.	Treatments	<i>Curvularia lunata</i>				<i>Cladosporium</i> sp.				<i>Penicillium</i> sp.			
		Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. over control	Seedling vigour index	% inc. Over control
1.	Vitavax	72	14.28	1496.66	124.50	71	9.23	1404.30	127.54	79	19.69	1822.53	129.41
2.	Carbendazim + mancozeb	78	23.80	1782.45	167.37	76	16.92	1690.00	173.84	83	25.75	2142.03	169.62
3.	<i>Trichoderma harzianum</i>	76	20.63	1793.42	169.01	74	13.84	1693.24	174.85	82	24.24	1967.07	147.60
4.	<i>Pseudomonas fluorescens</i>	70	11.11	1588.57	138.28	70	7.69	1587.14	157.18	77	16.66	1809.09	127.71
5.	Ginger rhizome extract	70	11.11	1388.00	108.20	70	7.69	1382.00	123.93	75	13.63	1643.00	106.81
6.	Garlic bulb extract	74	74.46	1632.00	144.80	72	10.76	1473.00	138.68	79	19.69	1834.63	130.93
7.	Control	63	-	666.66	-	65	-	617.14	-	66	-	794.44	-
	S.E.±	0.57	-	0.37	-	0.61	-	0.34	-	0.65	-	0.53	-
	CD at 5%	1.69	-	1.11	-	1.81	-	1.01	-	1.92	-	1.57	-
	CD at 1%	2.31	-	1.51	-	2.47	-	1.38	-	2.62	-	2.14	-

Sr. No.	Treatments	<i>Phoma medicaginis</i>				<i>Botrytis cinerea</i>				<i>Mucor</i> sp.			
		Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. Over control	Seedling vigour index	% inc. Over control	Seed germination (%)	% inc. over control	Seedling vigour index	% inc. Over control
1.	Vitavax	76	10.14	1693.33	130.90	81	19.11	1943.30	126.52	72	12.50	1509.33	134.32
2.	Carbendazim + mancozeb	82	18.84	1999.30	172.63	86	26.47	2286.00	166.46	77	20.31	1716.43	166.48
3.	<i>Trichoderma harzianum</i>	80	15.94	1903.75	159.60	82	20.58	1979.26	130.71	75	17.18	1736.00	169.51
4.	<i>Pseudomonas fluorescens</i>	74	7.24	1706.75	132.73	79	16.17	1889.87	120.29	70	9.37	1590.00	146.85
5.	Ginger rhizome extract	72	4.34	1483.00	102.22	77	13.23	1738.83	102.68	70	9.37	1373.90	113.30
6.	Garlic bulb extract	78	13.04	1793.00	144.50	81	19.11	1922.53	124.09	74	15.62	1601.02	148.56
7.	Control	69	-	733.33	-	68	-	857.89	-	64	-	644.11	-
	S.E.±	0.57	-	0.41	-	0.74	-	0.55	-	0.98	-	0.35	-
	CD at 5%	1.69	-	1.22	-	2.17	-	1.63	-	2.90	-	1.04	-
	CD at 1%	2.31	-	1.67	-	2.96	-	2.23	-	3.95	-	1.42	-

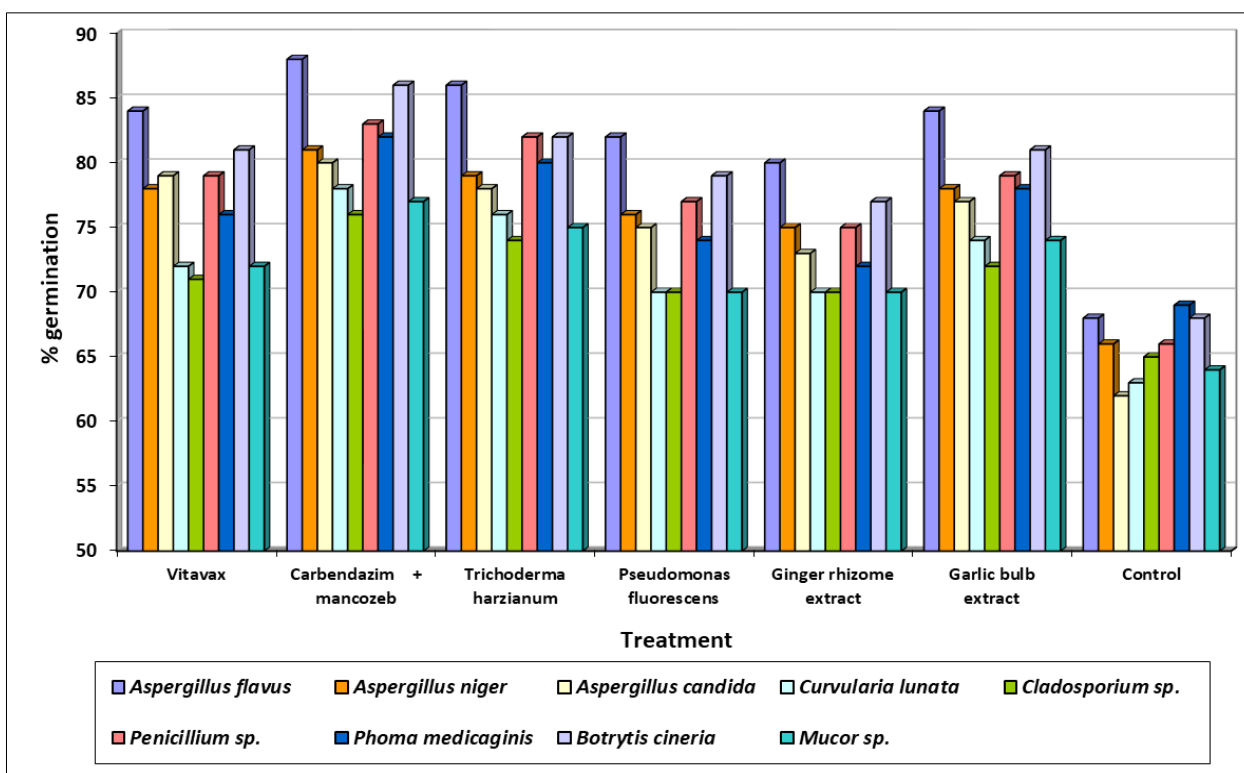


Fig 5: Efficacy of fungicides, bioagents and botanicals on seed germination of seeds with external seed borne pathogen

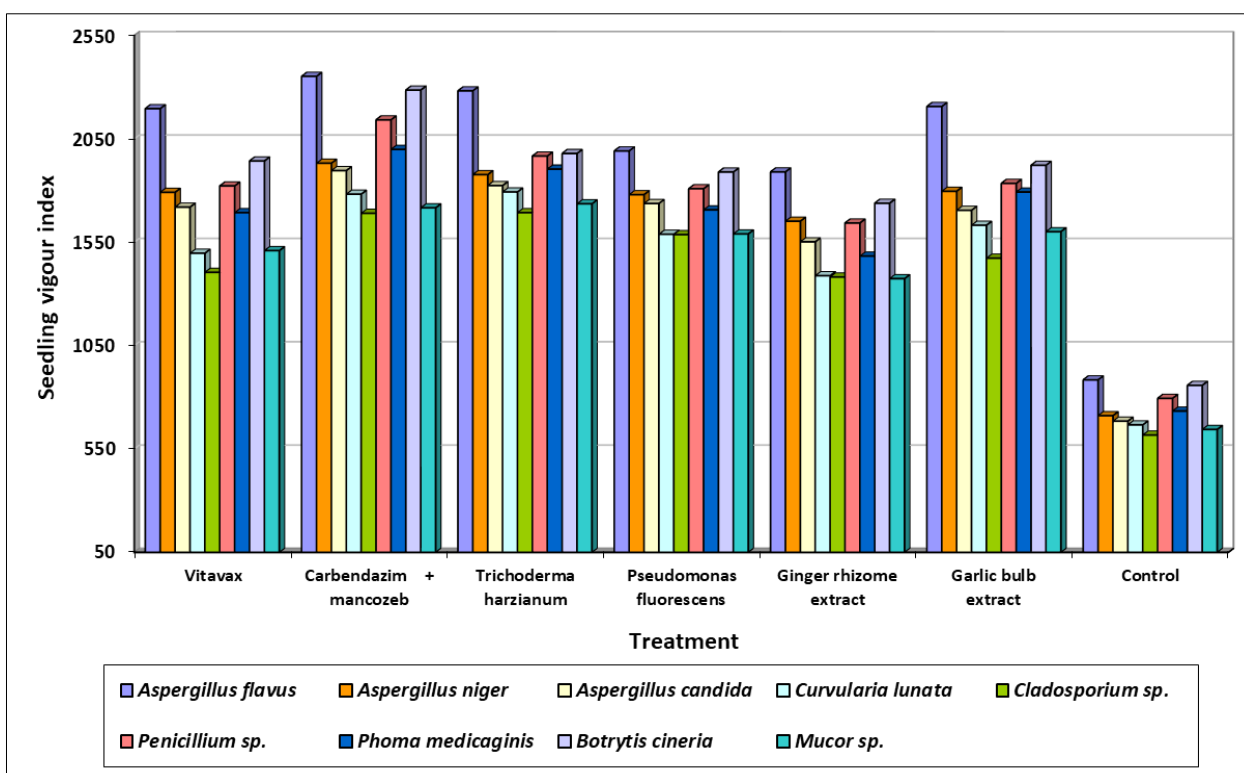


Fig 6: Efficacy of fungicides, bioagents and botanicals on seedling vigour index of seeds with external seed borne pathogen

References

1. Alemu K. Seed Borne Fungal Pathogen Associated with Soybean (*Glycine max* L.) and their Management in Jimma, Southwestern Ethiopia. *J Biol. Agril. and Healthcare*. 2014;4(25):15-18.
2. Bradley CA. Effect of fungicide seed treatments on stand establishment, seedling disease and yield of soybean in North Dakota. *Plant Dis*. 2008;92(1):120-125.
3. Dhawan SS, Magar SJ, Navale MD, Markad HN. Bioefficacy of Bioagents against Pathogenic Mycoflora of Soybean Seeds. *Bull. Env. Pharmacol. Life Sci*. 2019;8(7):27-31.
4. Escamilla D, Rosso ML, Zhang B. Identification of fungi associated with soybeans and effective seed disinfection treatments. *Food Sci. Nutr*. 2019;7(10):3194-3205.
5. Fakir GA. Teaching, research and training activities on

- seed pathology in Bangladesh. *Seed Sci. Technol.* 1983;11:1345-1352.
6. Garuba T, Abdulrahman AA, Olan GS, Abdulkareem KA, Amadi JE. Effects of fungal filtrates on seed germination and leaf anatomy of maize seedlings (*Zea mays* L., Poaceae). *J Appl. Sci. Environ. Manage.* 2014;18(4):662-667.
 7. Gupta S, Dubey A, Singh T. *Fusarium semitectum* as a dominant seed-borne pathogen in *Albizia lebbek* (Linn.) Benth., its effect on location and transmission studies. *Res. J.* 2017;11:13-18.
 8. Kakad SA, Parate RL, Bramhankar SB, Pawar RD, Wasnik DG, Dinkwar GT, *et al.* Evaluation of fungicides and botanicals against major seed borne fungi of groundnut. *International J Chem. Studies.* 2019;7(1):1949-1952.
 9. Kinnikar A, Desai P, Jahagirdar S. Identification and Detection of Seed Borne Diseases of Soybean Using Image Processing: A Survey. *International J Emerging Technol. in Comp. Scie. and Electronics.* 2015;14(2):363-368.
 10. Kuri SB, Islam RM, Mondal U. Antifungal potentiality of some botanical extract against important seedborne fungal pathogen associated with brinjal seeds, *Solanum melongena* L. *J Agril., Technol.* 2011;7:1139-1153.
 11. Lakshmeesha TR, Sateesh MK, Vedashree S, Sofi MS. Antifungal activity of some medicinal plants on Soybean seed-borne *Macrophomina phaseolina*. *J Applied Pharmaceutical Sci.* 2013;3(02):084-087.
 12. Lengai GMW, Muthomi JW, Mbega ER. Effect of plant extracts on important fungal pathogens and germination of tomato seed. *Int. J Biosci.* 2021;18(4):77-92.
 13. Mangla CA, Gupta AK, Aggarwal A. Fungitoxic effect of biocontrol agent and botanicals on seed mycoflora and seed germination of oilseed crops. *Annals of Plant Protect. Sci.* 2010;18(2):434-437.
 14. Mangwende E, Chirwa PW, Aveling TAS. Evaluation of seed treatments against *Colletotrichum kahawae* subsp. *cigarro* on *Eucalyptus* spp. *Crop Protection.* 2020;132:15-18.
 15. Masangwa JIG, Kritzinger Q, Aveling TAS. Germination and seedling emergence responses of common bean and cowpea to plant extract seed treatments. *The J Agril. Sci.* 2017;155(1):18-31.
 16. Mancini V, Romanazzi G. Seed treatments to control seedborne fungal pathogens of vegetable crops. *Pest Manag. Sci.* 2014;70:860-868.
 17. Mukewar PM, Sheo Raj, Meshram MK. Evaluation of fungicides for the elimination of seed borne infection of *Alternaria macrospora* in *Gossypium arborium*. *Indian J Plant Prot.* 1995;23(2):180-184.
 18. Onyeke CC, Ugwuoke KI. Effects of Botanical Extracts on the Mycelial Growth of Seed Borne Fungi of The African Yam Bean, *Sphenostylis stenocarpa* (Hochst ex a. Rich) Harms. *Nig J Biotech.* 2011;22:1-7.
 19. Pedraza LA, Bautista J, Uribe-Vélez D. Seed-born *Burkholderia glumae* infects rice seedling and maintains bacterial population during vegetative and reproductive growth stage. *Plant Pathol J.* 2018;34(5):393-402.
 20. Rao TV. Studies on seed borne fungi of soybean and its management. 2nd International Conference on Agricultural & Horticultural Sciences; c2014. p. 03-05.
 21. Saylendra A, Fatmawaty A. Identification of microbes carried by soybean seed varieties of Galunggung, Wilis, dan Anjasmoro. *J Agroekoteknologi.* 2010;2(1):27-30.
 22. Swati D, Potdukhe SR, Damayanti G. Efficacy of Bioagents, Botanicals and Fungicides against seed borne mycoflora of Onion (*Allium cepa* L.). *J Soils and Crops.* 2011;1:51-59.
 23. Thakur KD, Mounisha V, Bramhankar SB, Pillai T, Andge RB. Efficacy of Fungicides, Bio-agents and Plant extract against seed borne mycoflora of paddy in eastern vidarbha zone. *International J Res. in Biosci., Agril. and Technol.* 2015;2(7):319-322.
 24. McGee DC, Nyvall RF. Prediction of PSD by measuring soybean pod infection. *Plant Dis.* 1986;70:329-333.