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Integrated Management against Seed-Borne Diseases of Farmers Stored Chickpea

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Keywords: *integrated, chickpea, disease, fungicides, botanical, bio-fertilizer, healthy seeds.*

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Integrated Management against Seed-Borne Diseases of Farmers Stored Chickpea

M. J. Islam [α], A. M. Akanda [σ], M. K. A. Bhuiyan [ρ], A. H. M. M. Haque [Ѡ] & M. F. Hossain [¥]

Abstract- Performance of different treatments was evaluated to find out effective control measures against some fearsome diseases of farmers stored Chickpea seeds. A set of seven treatments were used in the study: two fungicides (Provax 200WP and bavistin 70WP), two botanical extracts (Neem leaf and Garlic clove), bio-fertilizer, breeder seeds and healthy seeds. All treated seeds including breeder seeds and healthy seeds performed better compared to control. Fungicides successfully inhibited fungal growth in laboratory and field conditions. In blotter method, seeds treated with Provax 200WP and Bavistin 70WP showed the highest results against *Fusarium oxysporum, Sclerotium rolfsii* and *Botrytis cinerea* compared to control and all other treatments. In controlling the radial growth of fungi at 100, 200 and 400ppm, Provax 200WP performed the best against *Sclerotium rolfsii,* Bavistin 70WP against *Fusarium oxysporum* and both of the treatments performed best against *Botrytis cinerea* and % inhibition increased with increasing concentrations. Also, the highest plant population and the lowest incidence per pot or plot exhibited with fungicides application, and in some cases, a combination of healthy seeds and Bavistin 70WP showed insignificant results. Combination of botanicals, bio-agents and healthy seeds with fungicides may be considered as part of the integrated approach. Therefore, application of fungicides could be suggested as the best treatment to control storage and field diseases of farmers stored chickpea seeds.

Keywords: integrated, chickpea, disease, fungicides, botanical, bio-fertilizer, healthy seeds.

I. Introduction

Chickpea (*Cicer arietinum* L.), is an annual pulse crop and mostly appreciable for its high edible protein content (20.8%) (Saxena and Singh, 1987). Pulses crops are inherently low yield potential, susceptibility to poor seed quality, diseases and insect pests and sensitivity to microclimate changes, contribute to their yield instability (Fakir and Rahman, 1989). A pure viable seed of a high yielding variety is of little or no use, if that seed is infected or contaminated by pathogens (Rahman *et al*., 1982). Most of the farmers are bound to use their stored seeds because only 1.15% seeds are produced by BADC. In most of the cases farmers stored seeds are badly infested with stored grain pests and molds resulting very poor germination (Mia *et al*., 2000, Khokon *et al*., 2005). More than 60 pathogenic fungi including 20 major ones can infect seeds and transmit different diseases in the field causing considerable yield loss (Bakr and Rashid, 2007). Seed-borne diseases are the major limitations for chickpea cultivation. Out of 17 diseases of chickpea recorded so far in Bangladesh, Botrytis Gray Mold is as one of the most damaging diseases of chickpea (Bakr, 1994). The fungus has been reported to cause up to 80% yield losses. The wilt disease (*Fusarium oxysporum)* and Collar rot (*Sclerotium rolfsii)* are other destructive diseases (Nene *et al*., 1996). The pathogens are soil, seed and air borne and can also survive in the residual stubbles for more than three years (Nene *et al*., 1987). The pathogens may remain alive in the seed after harvest and in storage in dormant condition.

Proper seed health technology such as seed cleaning, integrated seed disease management approach and field seed health standard is needed for the improvement of quality farmer stored chickpea seeds. According to the experts, 20% crop yield can be increased by using quality seed (Faruque, 2006). Still, research on improvement of farmer's stored chickpea is scanty. Maintaining the quality of farmer's seeds is essential as to ensure increased chickpea production. Therefore, this present study was undertaken to evaluate the efficacy of integrated measures to find out appropriate sole or combine control strategies for farmers stored chickpea diseases.

II. Materials And Methods

a) *Collection of Seed Samples*

The variety BARI Chola-5 of Chickpea (*Cicer arietinum* L.) was used in the study as a test crop. The farmer's seed was collected from 16 farmers of Godagari, Rajshahi district through focal group discussion (FGD). Each farmer used their own stored seeds for sowing of BARI Chola-5 and had at least 0.135 ha of his chickpea cultivable field. The seed samples (1 kg/sample) were collected for the present studies following the International Rules for Seed Testing (ISTA, 2001) at 15 days before sowing. The seed samples were preserved at cool room temperature in the laboratory of plant pathology department of Bangabandhu Sheikh Mujibur Rahman Agricultural University for subsequent use in the study. The studies

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were carried out in the Plant Pathology laboratory, Bangladesh Agricultural Research Institute (BARI), Gazipur.

b) Isolation and Identification of Fungi

The samples of infected plant parts were collected from characteristic field symptoms of foot and root rot (*Sclerotium rolfsii*), Fusarium wilt (*Fusarium oxysporum*) and Botrytis Gray Mold (*Botrytis cinerea*). The plant samples were cut into small pieces for surface sterilization (1% HCl) and parts were placed in PDA media to allow growth of fungi as to prepare pure culture. The fungi were identified based on morphological characteristic of fungi as described by Mathur and Kongsdal (2003).

c) Mortality of Seedling (Pot Experiment)

To determine the effect of seed treatments on seedling mortality an experiment was set in the pot (12 X 9.5 inch). The experiment was laid out in Complete Randomized Design (CRD). Pots were filled with mixture of sand and soil. Then the pots were inoculated by *Sclerotium rolfsii*. 25 seeds were sown in each pot and four pots were used as one replication for each sample.

d) Preparation of Mixture of PDA Media with Treatments

Two chemical viz., Provax 200 WP and Bavistin 70 WP at 100, 200 and 400 ppm and two plant extract viz., Neem and Garlic at 5, 10 and 20% concentration were used to determine the effect of fungicides on radial growth of fungus. PDA was prepared by mixing infusion of 200g peeled potato, 20g dextrose and 17g agar in 1000 ml distilled water. The medium was cooked properly and poured into conical flasks at 100 ml per flask. Before solidification, requisite quantity of individual fungicides (Provax 200 and Bavistin 70 WP) was added to the medium to have concentrations of 100, 200, 400 ppm and botanical extracts (Garlic and Neem) was added to the medium to have concentrations of 5, 10 and 20%. After thorough mixing the medium was autoclaved at 121° C under 1.1 kg/cm^2 pressures for 20 minutes. Approximately 15ml of melted PDA mixed was poured into each 90 mm petri dishes.

e) Determination of Radial Growth Inhibition

The effect of fungicides on radial growth of *Botrytis, Fusarium and Sclerotium* were determined on the prepared PDA medium. The 5mm discs of 3 days old PDA cultures of fungi were used to inoculate the media. The discs were cut with a flame sterilized cork borer (5mm diameter). The inoculums were placed at the center of the test plates using a flame-sterilized needle at one disc per plate inside a clean bench. Three plates were used for each dose of every fungicide. Three replicated PDA plates received no fungicides were also inoculated as the control. The inoculated plates were incubated at 27^0 C and data on radial growth was taken after 60hrs of inoculation. The diameter of the colonies on PDA with and without fungicides were measured from the bottom side of the petri dishes. Inhibition of radial growth was computed based on colony diameter on control plate using the following formula shown below:

$$\% \text{ Inhibition} = \frac{X - Y}{X} X\ 100$$

X = radial growth of control plates, and Y = radial growth of fungicide-treated plates

f) Evaluating performance of different treatments against fungi in blotter paper and field conditions

The experiments were conducted in the Pulse Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Eight treatments with four replications were used in the experiment namely T1 = Provax-200 WP (0.25%) + Spraying Provax-200 WP (0.1%), T2 = Bavistin-70WP (0.25%) + Spraying Bavistin-70 WP @ (0.1%), T3 = Neem leaf extract (1:1) + Spraying neem leaf extract @ 1: 9 of water, T4 = Garlic clove extract (1:1) + Spraying garlic clove @ 1:9 of water, T_5 = Apparently healthy seeds + Spraying Bavistin-70 WP @ 1ml/l water, T_6 = Bio-fertilizer + Spraying Bavistin-70 WP @ 1ml/l water, T7 = Breeder seed + Spraying Bavistin-70 WP @ 1ml/l water and T_8 = Control (farmer's seed). Seeds were taken in a plastic container (9cm) and required amount of fungicides were added. The container was shaken well for uniform coating on to the seeds. After 24 hours the treated seeds were used for studying the efficacy of the fungicides. Two plant extract i.e., Neem leaf (*Azadirachta indica*) and Garlic (*Allium sativum*) @ 1:1 (water: extracts) concentrations were used for the experiment. Two different plant species were collected from the campus of BARI, Gazipur that was used in this study. The collected plant parts were chopped after cleaning under running tap water. The extracts were prepared by crushing the plant parts in a blender with distilled water at 1:1 (100g crushed plant materials in 100 ml water). However, extracts were used for field treatment as spraying purpose then it's ratio was 1: 9 (100g crushed plant materials in 900 ml water). The extracts were filtered through cheesecloth. The extracts thus obtained were kept in a refrigerator at 4±1° C until use. The seeds were dipped into 1:1 dilution of Garlic and Neem leaf extracts for 20-30 minutes. After proper covering of the seed coat with the extracts and seeds were used for studying the efficacy of the applied botanicals. Four hundred seeds were taken in a beaker (500 ml) and 4 drops of water were added for moistening the seed surface uniformly to allow maximum adherence of the Bio-fertilizer on the whole surface of seeds. Seeds were then treated with Bio-fertilizer @ 4% of seed weight until the whole surface of seeds was coated with the Bio-fertilizer. Seeds were taken randomly and tested following the blotter method to test the efficacy of fungicides and botanicals. The experiment was laid out in Completely Randomized Design (CRD) with four replications. Seed-borne infection of fungi was observed at the 8th day of incubation.

For field evaluation, treated seeds were sown in lines about 2.0 cm depth after air drying and immediately covered with soil. The line to line and plant to plant distances were 30 cm and 5 cm respectively. The seeds were sown in the field in the afternoon at the rate was 50 kg/ha. Fungicides and botanicals were sprayed in the same chemicals and botanicals which were described previously. Fungicides and botanicals were spayed 3 times at 10 days of intervals in the experimental plot to reduce the major seed-borne diseases of Chickpea. The sprays were started at flowering stage of Chickpea plants. The field experiment was conducted in a Randomized Complete Block Design (RCBD) having three replications for each treatment. Each unit plot size was 4m × 3m = 12m2. The collected data were analyzed by ANOVA. The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT). A statistical computer package MSTATC was used for analyzing the data.

III. Results

a) *Seed treatment in blotter method for controlling seed-borne fungi*

Provax 200 WP showed the highest efficacy to control *Aspergillus niger* over untreated seeds followed by Bavistin 70 WP and Bio-fertilizer. Untreated seeds showed the highest percentage of infection (81.00 %) and the lowest (14.75%) was recorded in Provax 200WP treated seeds. All the treated seed appeared to be fruitful to combat *Aspergillus flavus* in comparison with the untreated control seeds. The maximum infection (12.25%) was found in control, and the lowest (1.75%) was recorded in Bavistin 70WP treated chickpea seeds. In suppressing the growth of *Fusarium sp.,* all the treated seed appeared to be effective in comparison with the control treatment. The highest incidence (42.25%) was found in untreated seeds, and the minimum (14.55%) of *Fusarium* spp. was in Provax 200WP treated seeds and was followed by Bio-fertilizer and Bavistin 70 WP treated seeds. Maximum (10.25%) *Sclerotium rolfsii* was recorded in untreated seeds, and the minimum (0.50%) was in Provax 200WP treated seeds.

Alternaria spp. were found to be inhibited by all seed-treating agents. The highest prevalence (16.50%) of *Alternaria spp*. were in untreated control seeds, and the minimum (2.00%) was in Bio-fertilizer treated seeds and healthy seeds. All seed treating chemicals and plant extract inhibited *Penicillium notatum* compared to that of control. The maximum occurrence of seed-borne infection by *Penicillium notatum* (63.00%) was recorded in untreated seeds, while Provax 200WP (6.25%) and Bavistin 70WP (2.50%) treated seeds showed the lowest infection. The highest incidence (45.25%) of *Rhizopus stolonifer* was in untreated seeds, and the minimum (12.00%) was obtained in neem leaf extract followed by Provax 200WP (15.00%) treated seeds. *Botrytis cinerea* was found to be controlled by most of the treatment used. The highest seed infection (11.25%) by *Botrytis cinerea* was recorded in control, and the minimum incidence (0.75%) in Bavistin 70WP treated seeds followed by Provax 200WP (1.25%) treated seeds and utilizing healthy seeds (1.50%) (Table 1).

Table 1: Seed Treatments in Controlling Prevalence of Seed-Borne Fungi of Farmers' Stored Chickpea Seeds

Treatment	Aspergillus Niger	Aspergillus Flavus	Fusarium Spp.	Sclerotium Rolfsii	Alternaria Spp.	Penicillium Spp.	Rhizopus Spp.	Botrytis Cinerea
Provax 200 WP	14.75 f	6.25 bc	14.55 c	0.50 c	2.50 c	6.25 c	15.00 cd	1.25 e
Bavistin 70 WP	20.75 f	1.75 e	21.50 bc	1.00 c	4.50 c	2.50 c	23.75 bcd	0.75 e
Neem Leaf Extract	64.25 b	8.75 b	26.00 b	0.75 c	2.50 c	24.00 b	12.00 d	2.50 cd
Garlic Clove Extract	48.75 c	3.25 cde	24.00 b	3.35 bc	2.25 c	25.25 b	17.50 cd	3.25 c
Healthy Seeds	61.25 b	5.25 cd	24.00 b	2.5 c	2.00 c	29.75 b	25.75 bc	1.50 de
Bio-Fertilizer	30.25 e	2.25 de	15.25 c	0.75 c	2.00 c	31.50 b	31.50 b	3.25 c
Breeder Seed	36.50 d	2.25 de	23.00 bc	6.50 b	10.50 b	38.75 b	8.50 e	7.00 b
Control	81.00 a	12.25 a	42.25 a	10.25 a	16.50 a	63.00 a	45.25 a	11.25 a
LSD (0.05)	6.062	3.021	8.199	3.23	5.59	17.14	13	1.087
CV%	**6.86**	**9.33**	**12.46**	**7.51**	**8.9**	**12.59**	**13.18**	**14.71**

** Figures (s) in the column having the common letter(s) do not differ significantly at 5% levels.*

b) Radial growth inhibition of Sclerotium rolfsii

The result showed that Provax 200 WP at 200 and 400 ppm completely inhibited the radial growth of *Sclerotium rolfsii.* The % inhibition was significantly higher in all other treatment except garlic extract at 20% concentration. Garlic clove extract at 20% level also showed the effective result (96.26%) against the growth followed by Provax 200 WP at 100 ppm (94.44%). Bavistin 70 WP showed a negative outcome on Growth inhibition of *Sclerotium rolfsii* with the increase in concentration. The result showed that Bavistin 70 WP was less potent at high concentration rather than low level in reducing the radial growth of *Sclerotium rolfsii.* It inhibited the radial growth 27.04, 7.83 and 0.00% at 100, 200 and 400 ppm, respectively. In case of Neem extract at 5% level did not affect the radial growth inhibition of *Sclerotium rolfsii* and reduced only 5.56 and 32.22% at 10 and 20% level, respectively. Garlic clove extract inhibited the radial growth of *Sclerotium rolfsii* up to 6.72, 28.89 and 96.26% at 5, 10 and 20% level, respectively (Table 2).

Table 2: Effect of Treatments on the Percentage of Radial Growth Inhibition of *Sclerotium Rolfsii* on Farmers' Stored Chickpea Seeds

Treatments	Concentration (Dose)	% Inhibition
Provax 200 WP (ppm)	100	94.44 b
	200	100 a
	400	100 a
Bavistin 70 WP (ppm)	100	27.04 c
	200	7.83 d
	400	0.00 e
Neem Extract (% w/v)	5	0.00 e
	10	5.56 d
	20	32.22 c
Garlic Clove Extract (% w/v)	5	6.72 d
	10	28.89 c
	20	96.26 b
Control (Growth)	90 mm (0.00% inhibition)	

** Figure (s) in the column having a common letter(s) do not differ significantly at 5% level.*

c) Radial growth inhibition of Fusarium oxysporum

The results of the effect of selected PDA amended fungicides on the radial growth of *Fusarium oxysporum* are presented in Table 3. The result of the experiment showed that Bavistin 70 WP at all concentration significantly inhibited the radial progress of *Fusarium oxysporum* compared to all other treatments. Garlic clove extract at 5% level exhibited the lowest inhibition (20.41%). Provax at 400 ppm showed a better effectiveness (73.71%) against the *Fusarium oxysporum* to inhibit its growth but lower than those of Bavistin. It also results in 58.55 and 68.63% inhibition of growth at 100 And 200 ppm concentrations. Neem extract displayed in 35.72, 39.86 and 41.32% inhibition of growth at 5, 10 and 20% level respectively. Its performance however is less than those of Bavistin and Provax. Garlic clove extract inhibited the radial growth of *Fusarium oxysporum* having 20.41, 39.81 and 64.15% at 5, 10 and 20% level respectively.

Table 3: Effect of Treatments on the Percentage of Radial Growth Inhibition of *Fusarium Oxysporum* on Farmers' Stored Chickpea Seeds

Treatments	Concentration (Dose)	% Inhibition
Provax 200 WP (ppm)	100	58.55 d
	200	68.63 c
	400	73.71 b
Bavistin 70 WP (ppm)	100	100 a
	200	100 a
	400	100 a
Neem Extract (% w/v)	5	35.72 f
	10	39.86 ef
	20	41.32 e
Garlic Clove Extract (% w/v)	5	20.41 g
	10	39.81 ef
	20	64.15 c
Control (Growth)	86.00 mm (0.00% inhibition)	

** Figure (s) in the column having the common letter(s) do not differ significantly at 5% level.*

d) Radial growth inhibition of Botrytis cinerea

In case of *Botrytis cinerea*, all treatment showed the significant effect over control. The result of the laboratory experiment showed that both Provax 200 WP and Bavistin 70 WP significantly inhibited the radial growth of *Botrytis cinerea* at all selected concentrations compared to plant extract. Garlic clove extract showed the lowest effectiveness in inhibiting the growth of *Botrytis cinerea*. Neem Extract inhibited the radial growth of *Botrytis cinerea* 29.63, 32.22 and 38.52% at 5, 10 and 20% concentration respectively. In case of Garlic clove extract, the inhibition percentages were 12.22, 17.04 and 31.48 at the concentration of 5, 10 and 20% respectively (Table 4).

Table 4: Effect of Treatments on the Percentage of Radial Growth Inhibition of *Botrytis Cinerea* on Farmers' Stored Chickpea Seeds.

Treatments	Concentration (Dose)	% Inhibition
Provax 200 WP (ppm)	100	100 a
	200	100 a
	400	100 a
Bavistin 70 WP (ppm)	100	100 a
	200	100 a
	400	100 a
Neem Extract (% w/v)	5	29.63 c
	10	32.22 c
	20	38.52 b
Garlic Clove Extract (% w/v)	5	12.22 e
	10	17.04 d
	20	31.48 c
Control (Growth)	90 mm (0.00% inhibition)	

** Figure (s) in the column having a common letter(s) do not differ significantly at 5% level*

e) Effect on plant population per plot

The plant population of chickpea under different seed treatments was recorded at 10, 20 and 60 days after sowing and the results are presented in Table 5. At 10 DAS the maximum plant population (336.8) per plot was observed in Provax 200WP treated seeds and Breeder seeds (333.5) while the minimum plant population (272.5) was found in the untreated plot. Garlic extract and healthy seeds + Bavistin 70WP showed a statistically dissimilar population per plot. Bavistin 70WP alone, Neem leaf extract and Bio-fertilizer + Bavistin 70WP showed statistically similar result. The highest plant population per plot at 20 DAS (320.0) and 60 DAS (306.0) was reported in Provax 200 WP treated plot while the lowest plant population at 20 DAS (224.0) and 60 DAS (183.0) was recorded in control.

Table 5: Effect of Treatment on Plant Population Grew from Farmers Stored Chickpea Seeds in the Field

Treatment	Plant Population / Plot		
	10 DAS	20 DAS	60 DAS
Provax-200 WP	336.8 a	320.0 a	306.0 a
Bavistin 70 WP	325.2 b	299.3 c	275.3 bc
Neem Leaf Extract	321.2 b	291.7 d	265.3 cd
Garlic Clove Extract	300.5 d	265.7 f	232.7 e
Healthy Seeds + Bavistin 70 WP	311.2 c	278.7 e	248.3 de
Bio-Fertilizer + Bavistin 70 WP	325.2 b	296.7 c	255.7 cd
Breeder Seed + Bavistin 70 WP	333.5 a	311.3 b	293.3 ab
Control	272.5 e	224.0 g	183.0 f
LSD (0.05)	7.153	4.99	19
CV (%)	**1.41**	**1.07**	**4.52**

** Figures (s) in the column having a common letter(s) do not differ significantly at 5% levels*

f) Foot and root rot control in both pot and field conditions

In Pot % infection was determined after 7, 14 and 21 DAS. At all DAS treatments showed significantly lower % incidence in the pot compared to that of control. After 7 DAS no infection was found in Provax 200 WP. At 14 DAS and 21 DAS, the Provax 200 WP treatment showed the lowest infection of 1.75% and 3.0%, respectively followed by Bavistin 70 WP and Healthy seeds which were statistically identical to those of Provax 200WP treated plot.

In the field, data were gathered at ten days' interval at 10DAS to 30 DAS. At 10 DAS the percent infection per m^2 was different for different treatments (Table 6). In case of control, the highest infection (27.88%) was recorded and the lowest infection (9.25%) per m^2 was found in the plots treated with Provax 200WP alone followed by Breeder seeds + Bavistin 70WP (12.14%), only Bavistin 70WP (12.88%), healthy seed + Bavistin 70WP (14.08%), Garlic extract (16.15%), Neem leaf extract (18.75%), Bio-fertilizer + Bavistin 70WP (19.43%) (Table 6).

Table 6: Performance of Different Treatments against Foot and Root of Chickpea in the Field

Treatment	% Infection in Pot			% Infection/m^2 in Field		
	7 DAS	14 DAS	21 DAS	10 DAS	20 DAS	30 DAS
Provax 200 WP	0.00 c	1.75 f	3.0 e	9.25 e	7.67 f	9.55 e
Bavistin 70 WP	1.5 b	2.5 ef	3.0 e	12.88 de	9.85 ef	11.27 de
Neem Leaf Extract	2.0 b	4.0 cde	7.0 cd	18.75 bc	11.52 de	14.63 bc
Garlic Clove Extract	1.0 bc	4.25 bcd	9.0 bc	16.15 bcd	12.80 cde	12.86 bcd
Healthy Seeds + Bavistin 70 WP	2.0 b	3.0 def	5.0 de	14.08 cde	15.49 bc	11.91 cde
Bio-Fertilizer + Bavistin 70 WP	1.0 bc	5.75 b	11.0 b	19.43 b	18.81 b	15.69 b
Breeder seed + Bavistin 70 WP	2.0 b	5.0 bc	8.0 bcd	12.14 de	14.09 cd	11.88 cde
Control	3.5 a	7.75 a	15.0 a	27.88 a	28.45 a	19.21 a
LSD (0.05)	1.16	1.52	3.76	4.802	3.424	3.22
CV%	**11.23**	**6.83**	**8.57**	**16.8**	**13.18**	**14.34**

** Figures (s) in the column having the common letter(s) do not differ significantly at 5% levels.*

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g) Performance of different treatments against Fusarium wilt

The incidence of Fusarium wilt at three dates after sowing following treatments with divergent chemicals, botanicals using healthy seeds and breeder seeds has shown in Table 7. At 45 DAS, the mean number of Fusarium-infected plant per plot (11.33 plants) was the highest in untreated control plot and the lowest in Bavistin 70 WP (4.33 plants) treated plot followed by Provax 200 WP (4.67 plant), apparently healthy seeds (5.33 plants) and breeder seeds (5.33 plants). At 60 DAS, again the highest number (12.67) of *Fusarium* infection occurred in control plot and the lowest in Bavistin 70 WP (5.00) followed by Provax 200 WP (5.67 plants), using healthy seeds (6.67 plants) and breeder seeds (7.00 plants). At 75 DAS, Bavistin 70 WP exhibited the lowest (3.33 plants) infected plant per plot followed by Provax 200 WP (4.00 plants), apparently healthy seeds (5.00 plants) and breeder seeds (5.33 plants). The highest *Fusarium* infection was noted in control plot (12.67 plants).

Table 7: Effect of Different Treatments on Fusarium Wilt in Field Condition

Treatment	Plant Population / Plot		
	45 DAS	60 DAS	75 DAS
Provax-200 WP	4.67 d	5.67 d	4.00 ef
Bavistin 70 WP	4.33 d	5.00 d	3.33 f
Neem Leaf Extract	6.01 bcd	8.00 bc	6.67 bcd
Garlic Clove Extract	7.33 b	8.33 bc	7.00 bc
Healthy Seeds + Bavistin 70 WP	5.33 cd	6.67 cd	5.00 def
Bio-Fertilizer + Bavistin 70 WP	6.67 bc	9.00 b	7.67 b
Breeder Seed + Bavistin 70 WP	5.33 cd	7.00 bcd	5.33 cde
Control	11.33 a	12.67 a	12.67 a
LSD (0.05)	1.682	1.934	1.703
CV (%)	**15.07**	**14.18**	**15.06**

* Figures (s) in the column having a common letter(s) do not differ significantly at 5% levels.

h) Grey mold control in field condition

All the treatment showed the significantly dissimilar outcomes over untreated plot. At 65 DAS significantly the highest number (14 plants) was observed in untreated control plot and the lowest in Bavistin 70 WP (2.67 plants) treated plot followed by Provax 200 WP (3.00 plants) but they were statistically similar. Utilization of apparently healthy seeds and breeder seeds had *Botrytis* gray mold infection of 5.33 plants/plot and 6.67 plants/plot at 65 DAS. At 80 DAS, significantly the highest number (16.33 plants) of infected plant found in control plot and the lowest in Provax 200 WP (5.33 plants) followed by Bavistin 70 WP (5.67 plants). At 95 DAS, the lowest number (3.33 plants) of infected plant found in Provax 200 WP followed by Bavistin 70 WP (4.67 plants) which are statistically alike. Healthy seed + Bavstin 70WP treated plot exhibited 5.00 plants/plot infections by BGM which was statistically similar to Bavistin 70WP (4.67). Garlic extract and neem extract resulted in 8.67 and 7.33 BGM infected plants per plot, respectively at 95 DAS which were statistically similar (Table 8).

Table 8: Performance of Different Treatments against Botrytis Gray Mold of Chickpea

Treatment	Plant Population / Plot		
	65 DAS	80 DAS	95 DAS
Provax-200 WP	3.00 f	5.33 e	3.33 f
Bavistin 70 WP	2.67 f	5.67 e	4.67 ef
Neem Leaf Extract	7.67 cd	9.00 cd	7.33 cd
Garlic Clove Extract	9.00 c	10.33 c	8.67 c
Healthy Seeds + Bavistin 70 WP	5.33 e	7.67 d	5.00 e
Bio-Fertilizer + Bavistin 70 WP	11.67 b	12.33 b	10.33 b
Breeder Seed + Bavistin 70 WP	6.67 de	7.67 d	6.67 d
Control	14.00 a	16.33 a	15.33 a
LSD (0.05)	1.351	1.62	1.57
CV (%)	**10.29**	**12.63**	**14.24**

** Figures (s) in the column having the common letter(s) do not differ significantly at 5% levels*

IV. Discussion

The experiments were conducted following seed treatment in blotter method, pot and field spray with fungicides, botanicals, bio-fertilizer and healthy seeds. Results of the study reveals that all treated seeds including healthy seeds showed significant performance against associated fungi compared to control. However, fungicides significantly inhibited growth of fungi in culture media, *Sclerotium rolfsii* in pot and field incidence of all pathogens. In blotter method, Provax 200WP had shown significant performance compared to other treatments. Untreated seeds showed the maximum occurrence of seed-borne fungi. Among the tested fungicides, Provax 200 WP appeared to be the best in inhibiting the radial growth of the pathogen *Sclerotium rolfsii* at 200 and 400 ppm concentration.

Garlic clove Extract at 20% was effective. Except Bavistin 70 WP at 400 ppm and Neem Extract at 5% level all other treatments showed effective result against the *Sclerotium rolfsii*. Bavistin 70 WP exhibited results and may need a special consideration before set the applying concentration against *Sclerotium rolfsii.* Bavistin 70 WP appeared to be the best in inhibiting the radial growth of the pathogen *Fusarium oxysporum* at all selected concentration. Provax 200 WP also showed the significant result but better at 400 ppm. In case of both Neem and Garlic clove extract, at 20% level showed the more effectiveness compared to 5 and 10% concentration. It seems that Provax 200 WP and Bavistin 70 WP were the best radial growth inhibiting fungicides at all concentration compared to Neem Extract and Garlic clove Extract in inhibiting the radial growth of *Botrytis cinerea* at all its concentration. It reveals that Vitavax-200 played appreciable role in controlling *Sclerotium rolfsii*, *Fusarium oxysporum*, *Botrytis cinerea* etc. Also, Bavistin 70WP successfully protected *Fusariumm oxysporum* in culture and field condition, and considerably reduced other fungal prevalence. In controlling field incidence of Foot and root rot at 20 DAS and 30 DAS Provax 200 WP showed significantly the highest performance but statistically similar to those of Bavistin 70WP respectively. The results showed that in all parameters Provax 200 WP performed the best compared to other treatments. Healthy seed + Bavistin 70WP showed moderate efficiency but significantly better than untreated control.

Many authors have reported that fungicides efficiently reduce infection and vitavax-200 was the most effective in controlling the seed-borne fungi (Tewari *et al*., 2003; Salam, 2004; Haque *et al*., 2009; Masum *et al*., 2008; Behrani *et al*., 2015; Saranya *et al*., 2017). Between the two botanical extracts, garlic clove extracts performed better than neem extracts. In case combinations of Bavistin 70WP with healthy seeds, bio-fertilizer and breeder seeds; the Bavistin 70WP and healthy seeds exhibited better performance. A good number of researchers showed that the plant extracts were a potential agent for the control of seed-borne pathogens and also improved germination of various seed (Hawlader, 2003; Sinha *et al*. 2004; Riazuddin *et al*., 2009). There are reports that garlic and neem extracts appreciably inhibited radial growth and spore germination of *Fusarium* spp. (Ahmed and Islam, 2000; Mondall *et al*., 2009; Perelló *et al*., 2013; Awad, 2014). Bio-fertilizers significantly control seed-borne diseases and able to enhance plant growth (Hossain *et al*., 1999; Khan *et al*., 1998; Rahman *et al*., 2006; Kibria and Hossain, 2004; Khalequzzaman, 2015). It reveals that fungal prevalence depicted an opposite relation with time and concentration as incidence increased with prolongation, but decreased with increasing concentration of different treatments. These finding agreed well with Khan *et al*., 2017 who has reported reduced incidence with increasing storage period after fungicidal treatment as toxicity of the chemicals declined.

V. Conclusions

It is clear that fungicides acted as a safeguard to control the prevalence of foot and root rot, Fusarium wilt, gray mold etc. diseases of farmers' stored chickpea. Provax 200WP and Bavistin 70WP may be considered as the best seed treating agent for health and quality maintenance during storage and in field conditions. Also, the use of Healthy seeds with Bavistin 70WP spray may be considered as an efficient practice. Combination of botanicals, bio-agents and healthy seeds with fungicides may be suggested as part of integrated control, but had less impact on fungal growth inhibition.

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