The Pharma Innovation Journal 2022; 11(8): 1148-1151

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 1148-1151
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www.thepharmajournal.com
Received: 08-06-2022
Accepted: 21-07-2022

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Management studies on *Sclerotinia sclerotiorum* (Lib.) de Bary, causing sclerotinia rot of cauliflower through fungicides and oil cakes

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Abstract
In case of six fungicides tested under pot condition by seedling-cum-foliar application, carbendazim (54.45%) was most effective in reducing the disease incidence, next to it by carbendazim + mancozeb (companion) (49.12%) as compared to control. Out of the five oil cakes which were tested in pot condition by soil application technique neem cake (38.99%) followed by castor cake (36.53%) showed maximum per cent disease control.

Keywords: Incidence, maximum, fungicides, tested, neem cake

Introduction
Cauliflower (*Brassica oleracea* var. *botrytis* L.) belonging to family Brassicaceae is one of the important cole crops and has obtained a popular place in vegetable crops because of its delightful taste, flavour and nutritive value (Mitra *et al*. 1990) [3]. It is cultivated for tender succulent thick profused and underdeveloped flower stalks (curd). The head is eaten while the stalk and surrounding thick, green leaves are used in vegetable broth or for feeding animals. Cauliflower is rich source of vitamins, especially A and C. It contains about 70 mg of vitamin A and about 75 mg of vitamin C per 100 gm of sample and is deviant in stability of vitamin C after cooking (Singh, 1987) [6]. Cauliflower is reported to have 91.7% water and the food values per 100 g of edible portion are: energy 31 calories, protein 2.4 g, calcium 2.2 g and vitamin A 40 I.U. Cauliflower is rich in minerals like Potassium, Sodium, Iron, Copper, Phosphorous, Magnesium, carbohydrates and amino acids such as Arginine, Histidine, Lysine, Tryptophan, Tyrosine, Cystine, Methionine, Threonine, Leucine and Valine. Cauliflower crop suffers from various diseases caused by fungi and other microorganism. Important diseases are white rust caused by *Albugo candida*, powdery mildew caused by *Erysiphe polygoni*, damping off caused by *Pythium debaryanum*, downy mildew caused by *Pernospora parasitica*, sclerotinia rot caused by *Sclerotinia sclerotiorum*, black rot caused by *Xanthomonas campestris pv. campestris*, bacterial soft rot or curd rot caused by *Erwinia caratovora pv. caratovora*, cauliflower mosaic caused by cauliflower mosaic virus etc. these sclerotinia rot of cauliflower caused by *Sclerotinia sclerotiorum* (Lib.) de Bary is one of the major soil borne fungal diseases of cauliflower causing losses both in field, especially in the seed crop and in storage. Management of sclerotinia rot cauliflower mainly depends on fungicides (Triphati and Triphati, 2010) [9].

Material and Methods
Efficacy of fungicides against *Sclerotinia sclerotiorum* (*in vivo*)
The experiment was carried out in earthen pots (30 cm dia.) with cultivar Early Kunwari. The pathogen multiplied on sorghum grains at 20±1 °C for one week was used as the soil inoculum. Prior to transplanting, pots were surface sterilized with copper sulphate solution and filled with sterilized soil. The soil was sterilized at 1.045 kg/cm^2 for one hour for three consecutive days. Six fungicides (Table-1) were tested by applying as seedling dip (15 min.) and foliar application (25 DAT) in three replications. Seedlings were raised in pots filled with sterilized soil for all experiments and one month old seedlings were transplanted in all experiments.
The pots were inoculated with fungal inoculum multiplied on sorghum grains before transplanting and seedlings were also dipped in inoculum suspension of pathogen. For inoculation, the upper 5 cm layer of soil of each pot was thoroughly mixed with inoculum @20 g/pot. Five seedlings were transplanted per pot and kept in cage house.

At 25 days after transplanting (DAT), each fungicide of the respective concentration was used as single foliar spray. For comparison inoculated control was maintained without fungicide application. The disease incidence and per cent disease control were calculated 45 DAT and 60 DAT.

Table 1: Fungicides used against *Sclerotinia sclerotiorum* (*in vivo*)

S. No.	Common Name	Trade Name	Concentrations (%)
1.	Propineb 70 WP	Antracol	0.2
2.	Carbendazim 50 WP	Bavistin	0.1
3.	Carbendazim 12% + Mancozeb 63% 75 WP	Companion	0.2
4.	Azoxystrobin 75 WP	Amistar	0.2
5.	Captan 70% + Hexaconazole 5% WP	Steam	0.2
6.	Thio phanate-methyl	Topsin M	0.2

Efficacy of oilcakes against Sclerotinia rot of cauliflower (*in vivo*):

The experiment was carried out in pots (30 cm diameter) with cultivar early kunwari. The pathogen multiplied on sorghum grains at 20±1 °C for one week was used as the soil inoculum as well as for seedling dip. Five oil cakes (Table- 2) were used by applying as soil application @50 g/ pot in three replications.

These pots were inoculated with fungal inoculum multiplied on sorghum grains before transplanting and seedlings were also dipped in inoculum suspension of the pathogen. For inoculation the upper 5 cm layer of soil of each pot was thoroughly mixed with inoculum @20 g/ pot. Five seedlings were transplanted per pot. For comparison inoculated control was maintained without applications of oil cakes. The disease incidence and per cent disease control were calculated 45 DAT and 60 DAT.

Table 2: Oil cakes used against *sclerotinia* rot of cauliflower (*in vivo*)

S. No.	Common Name	Botanical Name	Dose (g/pot)
1	Castor	*Ricinus communis*	50
2	Cotton	*Gossypium harbesium*	50
3	Groundnut	*Arachis hypogea*	50
4	Mustard	*Brassica juncea*	50
5	Neem	*Azadirachta indica*	50
6	Control	-	-

Efficacy of fungicides against Sclerotinia rot of cauliflower through seedling- cum – foliar application (*In vivo*)

Among the six fungicides evaluated against the disease data (Table: 3 and Fig: 1) revealed that minimum disease incidence was observed with carbendazim (26.10 and 31.52% at 45 and 60 DAT, respectively) followed by carbendazim + mancozeb (30.25 and 35.21% at 45 and 60 DAT, respectively) as compared to control 54.62 and 69.21% at 45 and 60 DAT, respectively). Maximum reduction in disease incidence over control was observed with carbendazim (52.21and 54.45% at 45 and 60 DAT, respectively) followed by carbendazim + mancozeb (44.61 and 49.12% at 45 DAT and 60 DAT, respectively). Percent disease incidence of propineb (47.32 and 53.50% at 45 and 60 DAT, respectively) was found at par with azoxystrobin (43.61 and 48.26% at 45 and 60 DAT, respectively). Minimum reduction in disease was observed in propineb (13.36 and 22.69% at 45 and 60 DAT, respectively).

Six fungicides were used *in vivo* condition through seedling - cum foliar application in a pot experiment. All fungicides were able to reduce the disease incidence over control. Carbendazim was the best in reducing the disease incidence followed by companion and steam. These results are in similarity with the results of Singh *et al*. (1994) [8], Pathak and Godika (2002) [4], Singh *et al*. (2003) [7], Ghasoliya and Shivpuri (2008) [1], Sharma *et al*. (2011) [5]. They reported carbendazim as effective fungicide in disease control against *Sclerotinia sclerotiorum*.

Results and Discussion

Table 3: Efficacy of fungicides against Sclerotinia rot of cauliflower through seedling- cum – foliar application (*In vivo*)

Treatment	Dose (%)	45 DAT		60 DAT	
		Disease incidence* (%)	Per cent disease control	Disease incidence* (%)	Per cent disease control
Azoxystrobin	0.2	43.61 (41.33)	20.15	48.26 (44.00)	30.27
Carbendazim	0.1	26.10 (30.72)	52.21	31.52 (34.15)	54.45
Captan + hexaconazole	0.2	33.40 (35.30)	38.85	38.32 (38.25)	44.63
Carbendazim + mancozeb	0.2	30.25 (33.37)	44.61	35.21 (36.40)	49.12
Propineb	0.2	47.32 (43.46)	13.36	53.50 (47.01)	22.69
Thio-phanate methyl	0.2	39.50 (38.94)	27.68	44.42 (41.80)	35.96
Control	-	54.62 (47.65)		69.21 (56.30)	
S.Em±		1.52		1.76	
CD		4.67		5.42	

*Average of three replications

Figures given in the parenthesis are angular transformed values

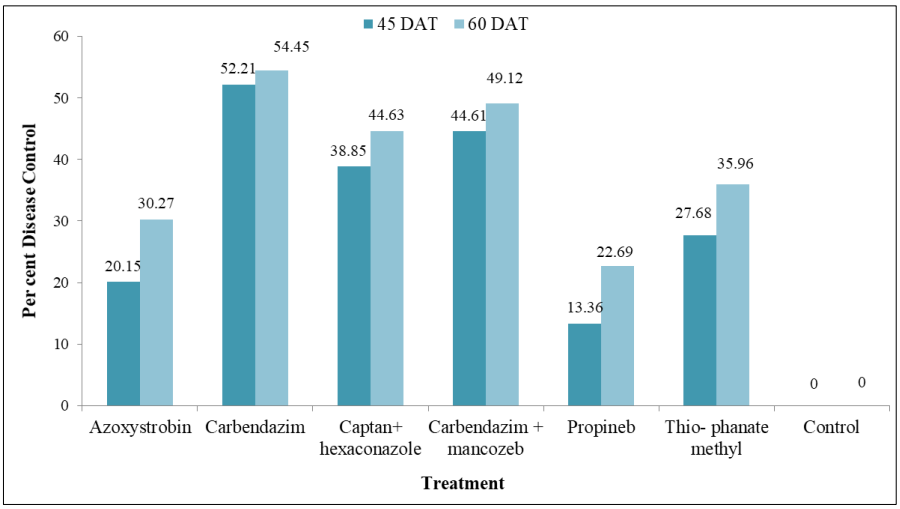

Fig 1: Efficacy of fungicides against Sclerotinia rot of cauliflower through seedling-cum-foliar application (*In vivo*)

Efficacy of oil cakes against Sclerotinia rot of cauliflower (*In vivo*)

Among the five oil cakes evaluated against the disease data (Table: 4 and Fig: 2) revealed that minimum disease incidence was observed with neem cake (36.52 and 43.28% at 45 and 60 DAT, respectively) followed by castor cake (40.05 and 45.03% at 45 and 60 DAT, respectively) as compared to control 57.08 and 70.95% at 45 DAT and 60 DAT, respectively. Maximum reduction in disease incidence over control was observed with neem cake (36.01 and 38.99% at 45 and 60 DAT, respectively) followed by castor cake (29.83 and 36.53% at 45 and 60 DAT, respectively). Percent disease incidence of groundnut cake (53.25 and 57.29% at 45 and 60 DAT, respectively) was found at par with mustard cake 49.03 and 53.15% at 45 DAT and 60 DAT, respectively. Minimum reduction in disease was observed in groundnut cake (6.70 and 19.25% at 45 DAT and 60 DAT, respectively).

Five Oil cakes namely castor cake, cotton cake, groundnut cake, mustard cake and neem cake were used *in vivo* conditions through soil application in pot experiment. Among all oil cakes, neem cake was found most effective to control the disease for reducing disease incidence, followed by castor cake. These results are in agreement with the results of Yadav *et al*. (2016) [10] and Kumawat and Godika (2017) [2]. Effectiveness of oil cakes in controlling this disease against *S. Sclerotiorum* was reported by them.

Table 4: Efficacy of oil cakes against Sclerotinia rot of cauliflower (*In vivo*)

Treatment	Dose (g/pot)	45 DAT		60 DAT	
		Disease incidence* (%)	Per cent disease control	Disease incidence* (%)	Per cent disease control
Neem	50	36.52 (37.18)	36.01	43.28 (41.14)	38.99
Cotton	50	45.66 (42.51)	20.00	49.99 (44.99)	29.54
Groundnut	50	53.25 (46.86)	6.70	57.29 (49.19)	19.25
Mustard	50	49.03 (44.44)	13.62	53.15 (46.81)	25.08
Castor	50	40.05 (39.26)	29.83	45.03 (42.15)	36.53
Control	-	57.08 (49.07)	-	70.95 (57.39)	-
S.Em ±	-	2.53		2.74	
CD	-	7.96		8.63	

*Average of three replications

Figures given in the parenthesis are angular transformed values

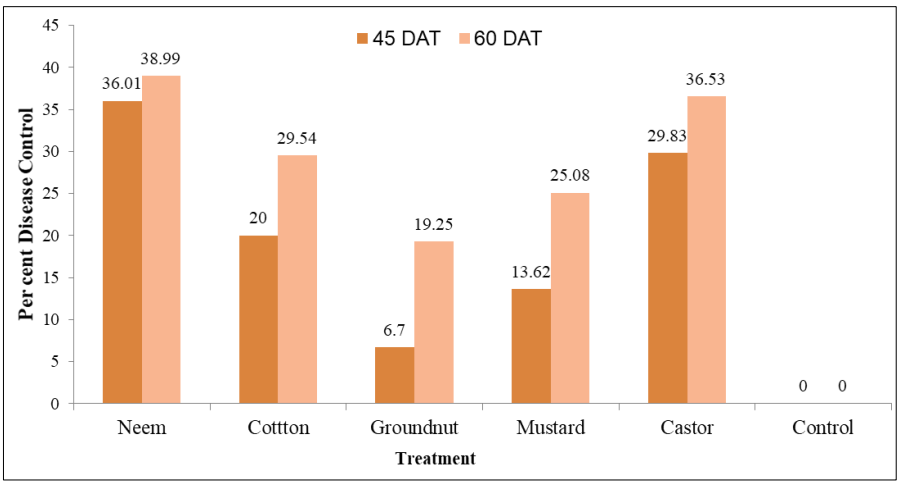

Fig 2: Efficacy of oil cakes against Sclerotinia rot of cauliflower (*In vivo*)

Conclusion

Fungicides and oil cakes were evaluated *in vivo* conditions against *Sclerotinia sclerotiorum*. Result showed that carbendazim and neem cake were found effective respectively.

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