REVIEW OF LITERATURE

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Various strategies are used to manage crop disease. These are cultural, physical biological and chemical. Among this chemical method gives very effective results. The leaf spot of Gerbera is caused by *Alternaria alternata* (Fries) Keissler. It is the serious disease of Gerbera in indoor or outdoor cultivations. But there are very few reports on the management of leaf spot of Gerbera caused by *Alternaria alternata*. Leaf spot of taro is also managed by carbendazim (Mane 2009). Similarly Apte (2008) reported that castor blight caused by *Alternaria ricini* is also managed by carbendazim. Farmers are using carbendazim irrationally to control diseases of crop plant. Therefore, there is development of carbendazim resistance in the pathogens. The primary site of action of carbendazim is nucleus of the pathogen. According to Davidse (1976) carbendazim stops mitotic activity of nucleus of the pathogen. Development of fungicide resistance in the pathogen results in the failure of plant disease control. There are several reports stating fungicide resistance against different fungicides (Table 1). In India no attention is paid towards this problem. There are some workers (Gangawane,1981;Annamalis and Lalithakumari, 1987, 1990; Kamble, 1991; Kamble1993,Chander and Thind, 1995; Bhale,2002; Wadikar, 2002; Hiwale,2003;Telmore,2004;Apte,2008;

More,2009 and Patil2009) who have reported fungicide resistance in plant pathogenic fungi. Fungicide resistance in a pathogen is detected by growing any propagule of the test pathogen on an agar plate containing various concentrations of fungicide (Dekker, 1982). Only those cells of pathogen which have undergone mutation will form colonies at higher concentration of the fungicide. Benomyl and thiabendazole resistance was reported in *Aspergillus nudulans,Cladosporium cacumerinum,Penicillium*

enpansum and *Ustilago muydis* by Van tuyl (1997). To study genetics of resistance ,UV treatment to *Aspergillus flavus* yielded 40 carbendazim & thiophanate resistance mutants (Gangawane & Reddy, 1985). Out of these 40 mutants 14 isolates were showing stability of fungicide resistance. Reddy (1986) reported that when *Aspergillus flavus,* (AF29) mycelium was irradiated with gamma rays at 800 rads produced benzimidazole resistant mutants. There was emergence of metalaxyl and carbendazim resistance in *Phytophthora drechselari* and *Puccinia arachides* (blight and ground nut rust) respectively.When treated with gamma rays EMS and Sodium azide. They have also reported mutation in *Puccinia arachidis* was highter due to spontaneous mutation (18/100) spores more than that of EMS (13/100 spores), UV and Gamma rays(1/100 spores). They found that Sodium azide has not induced mutation in these pathogens. According Kamble (1991) treatment of MNNG and SA to *Microphomina phaseolina* yielded 6 and 4 carbendazim resistant mutants.

Resistant factor of these mutants ranged from 9 to 15. Further he observed that mutants having high resistant factor also showed higher growth and all the mutants were persistence for fungicide resistance. However, he observed that these mutation showed lower infection percentage on potato tubers when compared with the wild sensitive isolates of *Macrophomina phseoline*. Similarly Hawale (2003) observed that treatment of UV and 5-bromouracil to *Sclerotium rolfsii* causing fruit rot of cucumber yielded 29 and 15 Carbendazim resistance mutants. Their resistant factor was ranging 6 to 9. But he observed that mutants having high resistant factor exhibited lower growth and all the mutants were stable for carbendazim resistance. Futher he noticed that resistant mutants showed low infection percentage on host as compared to wild sensitive *Fusarium*

semitechum mycelium causing leaf spot *Piper betle* gave 2, 3 and 4 beomyl resistant mutants (Telmore, 2004).

The development of fungicide resistant mutant in the laboratory to a particular fungicide is not correlated with failure of disease control by these fungicide. This only happens after a sizable population of the pathogen has emerged as resistant mutants to a particular fungicide. The development of fungicide resistance in a pathogen depends on many factors such as mode of action of fungicide, use of fungicide, survival ability of the pathogen in mixed population. But these laboratory studying are of great importance in the management of diseases.

Fungicide resistance in field:

There were negligible cases of fungicide resistance in the decad of 1970's after that many cases of fungicide resistance were reported when there was application of benomyl. Schroeder and Providenvi (1969) reported benomyl resistance in *Sphaerotheca fuliginea*. The incitant of powdery mildew of cucurbits in USA. Strains of *Erysiphe graminis* were resistant to benomyl (Vargas, 1973). Benomyl resistance in *Sclerotinia fruticola* was reported by Whan in 1976. Dekker (1977) noticed cases of acquired fungicide resistance in *Cercospora spp*; *Venturia inaequalis and* many other pathogenic fungi. There was wide spread resistance against benomyl in *Cercospora beticola* in Greece (Dovas et al; 1976). Pearson et al.(1980) found that strains of *Botrytis anerea* isolated from apples, beans and grapes were resistance to benomyl. Carbendazim and thiophonate resistance in strains of *Coccomyces hiemalis* the Cherry leaf spot pathogen was observed by Jones and Ehert in 1981. A simple method for detection of benzimidazole resistance in *Botrytis cinerea* was developed by Gullino and Garibaldi in

1986. This method helped to forcast within 24 hours of fungicide resistance situation in glasshouse. There are some workers who have reported fungicide resistance in different plant pathogenic fungi causing diseases to various crop plants (Pan and Sen.1980;Gangawane and Saler,1981;Choudhary and Putto, 1984; Kareppa;1990,Arora,et al;1992,Apte,2008;Patil,2009 and Mane,2009)

Management of Carbendazim resistance in plant pathogenic fungi :

Fungicide resistance in the fungus can be handled by applying alternate methods of application of fungicides (Dekker, 1981).Alternation in the genetic make up of pathogen leads to fungicide resistance because of the action of particular fungicide is on specific site of the pathogen. There are many more factors which are responsible for the development of fungicide resistance. These are actual contact of fungicide with the pathogen multiplication of pathogen, infection threshold, fitness and life cycle the pathogen. Besides these factors amount of frequency of fungicide treatment, effective of treatment and alternate or combined use of fungicide has been found to be useful (Shabi and Ogawa 1981). According to Shabi and Glipatrick (1981) observed that combination of benomyl with captan reduced the rate of infection of apple plant by *Venturia inaequalis* causing apple scab. *Cercospora species* cultured on medium containing carbendazim and naurimol alternately failed to grow after first being cultured on plates incorporated with naurimol (Horsten, 1979). Further Putto and Choudhary (1986) suggested that only those fungicides should be used against which fungicide resistance is not reported and which is having different mode of action. Chiba and Northon (1987) suggested .Use of new benzimidazole fungicide to avoid benomyl resistance.

Wild and Eckert (1982) suggested various measures to manage benzimidcozole resistance strain of *Penicillium* causing rot of citrus fruit. According to them sanitation of packing house with formaldehyde and quartonary ammonium reduced the build up of fungicide resistance in the pathogen. They found that hot solutions of boron and sodium carbonate reduced fruit infection. They found that mixture of benomyl and imazalil was very effective in controlling resistance strains. *Penicillium italicum* and *Pnicillium digitatum* strain resistant to benzimidazol fungicide were well controlled by mixtures of unrelated compounds such as etaconerde, topicanazol and flusilazole (Gullino and Garbalds,1986). Benzimidcozole resistant strains of *Botrytis cinerea* were very effectively controlled by using iprodione,vinclozolin and procymidose (Hartill,,1979).According to Bollen and Van Zayen (1975) there was good control of resistant population of *Cylindrocarpon species* causing disease to lily by treating these plants with mixture of benomyl and captafol. Use of chemicals other than fungicide in mixture with carbendazim gave good control of carbendazim resistant strain of *Aspergillus flavus* (Gangavane and Reddy, 1986). Benzimidcozola resistant strains of causing disease to grapes and other crops were well controlled by mixture of benzimidcozole fungicide with diethofenacarb (Elad et a.; 1992). Carbendazim in mixture with difoltan and Dithain M-45 gave cent percent control of *Macrophomina phaseolina* causing charcoal rot of potato (Gangawane and Kamble, 1993). According to Gangawane and Kamble, (2001) application of carbendazim with insecticides (paramar,endosulphan), antibiotics (mycostatin, aureofungin,griseofulvin, streptomycin), sweedicides(gromonone and atrazin) ,salts (berium chloride, sodium chloride andtin choride),fertilizers(super phosphate and muriate of potash) and micronutrients(Co, Bo,Zn

and Mb) controlled the pathogen *Macrophomina phaseolina* causing charcoal rot of potato resistant to carbendazim.

Similar results are also reported by many researchers in case of various agrochemicals in different fungal pathogens (Bhale, 2002; Wadikar, 2002; Bharade, 2002; Hiwale, 2003; Telmore, 2004; Apte, 2008; Mane, 2009; Patil, 2009; More, 2009 and Patil, 2009)

Table : Acquired Resistance of pathogens to Carbendazim in different countries

Sr.no	Carbendazim	Authors and countries
1	*Aspergillus flavus*	Gangawane and Saler (1981), Gangawane and Reddy (1985), India
2	*Aspergillus nidulans*	Davidse (1976), Georgopoulos (1982), Greece.
3	*Botrytis cinerea*	Geeson (1978), U.K.; Tripathi and Schloesser (1982), W. Germany, Delen and Yildiz (1981), Turkey; Leroux and Clerjeau (1985), France.
4	*Ceratocystis ulmi*	Gibbs and Brasier (1980), U.K.
5	*Cercosporidium personatum*	Katan and Shabi (1981), Israel.
6	*Cladosporium spp*	Delen and Yildiz (1981), Turkey
7	*Coccomyces hicmalis*	Jones and Ehret (1981), U.S.A.
8	*Colletotrichum coffeanum*	Okigga (1976), Kenya
9	*Fusarium oxysporum f. sp. dianthi*	Laeski (1977), Poland
10	*Fusarium oxysporum f. sp.curcumerinum*	Delen and Yieldiz (1981), Turkey.
11	*Macrophomina phaseolina*	Pan and Sen (1980), Kamble (1991), India.
12	*Cercosporella herpotrichoides*	Horsten and Fehrmann (1980), Netherlands.

13	*Puccinia arachidis*	Gangawane et al. (1988), India.
14	*Macrophomina phaseolina*	Gangawane and Kamble (1993), India
15	*Rhizoctonia solani*	Delen and Yieldiz (1981), Turkey.
16	*Sclerotinia sclerotiorum*	Delen and Yieldiz (1981), Turkey.
17	*Septoria leucanthemi*	Paulas et al. (1976), U.S.A.
18	*Septoria leucanthemi*	Horsten and Fehrmann. (1980), Netherlands.
19	*S. tritici*	Fisher and Griffin. (1984), U.K.
20	*Sporobolomyces roseus*	Nachmias and Barash (1976), Israel
21	*Venturia inaequalis*	Kiebacher and Haffmann. (1976), W. Germany; Chaudhary and Putto (1984), India. Shabi and Ben Yephet
22	*V. pirina*	Shabi and Ben Yephet (1976), Israel.
23	*Verticillium fungicula*	Bollen and Van Zaayen (1975), Netherlands.
24	*Alternaria ricini*	Apte(2008),India
25	*Alternaria tenuissima*	Mane(2009),India