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EVALUATION AND STANDARDIZATION OF FUNGICIDES AGAINST PLANT DISEASES IN PUNJAB-PAKISTAN CROP PRODUCTION SYSTEM

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ABSTRACT

Present study was conducted at Plant Pathology Research Institute, AARI, Faisalabad, Punjab, Pakistan during 2001 to 2013, for evaluating and standardizing 168 fungicides against 28 different plants diseases on 15 various crops. The experiment was laid out in RCBD with two replications. Maximum percentage of fungicides were standardized against diseases of vegetables (69.64%) followed by fruit plants (16.07%) and field crops (14.29%). Maximum fungicides standardization percentage was recorded against potato diseases (30.36%) followed by muskmelon (18.45%), mango (12.50%), tomato (10.12%), rice (8.93%) and cucumber (6.55%). Maximum percentage of fungicides were standardized against potato late blight (26.19%), followed by muskmelon downy mildew (15.48%), mango powdery mildew (9.52%), tomato late blight (7.14%), cucumber downy mildew (5.36%) and rice blast (5.36%). All the fungicides standardized against the crop diseases, effectively controlled the maladies when used at their recommended doses. In general, all the fungicide treatments significantly reduced the disease incidence resulting in higher crops yield compared to untreated crops.

KEYWORDS: Field crops; fruit crops; diseases; fungi; chemical control; Punjab; Pakistan.

INTRODUCTION

Plant pathogenic fungal microbes are present everywhere in the environment throughout the world. More than 20,000 different fungal species require a host plant for continuation of their life cycle (8). Numerous spores are released by these fungal microbes for withdrawing food contents from an infected plant. In Pakistan fungicides are used vastly on vegetables, fruits and crops for protection against fungal invasion. Fungicides are essential to continue large scale production of fruits and crops. The importance of

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fungicides to crop production can be understood through historical perspective as well as recent experimental data, growers practices and performance of alternatives. Losses to crop plant by pathogens were common throughout the world as it is estimated that 34.5 percent of cereals, 32 percent of potato, 24.5 percent of sugar beet , 55 percent sugarcane, 27.7 percent of vegetables, 23.4 percent of fruits, 30.7 percent of oilseed crops of the potential world production are lost due to diseases, insects and weeds. Losses on account of diseases only are tremendous especially when diseases are in epidemic form, the losses are much higher. In 1968 U.S.S.R. suffered 15-83 percent loss in different gram fields due to blight disease whereas this disease caused 100 percent loss of the crop in Morocco in 1975 (1). Due to Irish famine of 1845-46 caused by late blight of potatoes, one million people died of hunger and almost the same number migrated to other continents (6). Bengal famine occurred in 1942 was mainly due to brown leaf spot disease of rice which caused yield loss from 50-90%. Similarly, there are many examples in history where plant diseases have played havoc.

Even in Pakistan, the situation is not different and every year these maladies cause a colossal loss to the field crops, fruits and vegetables which warrants concerted efforts to combat them. Gram blight epidemics of 1981-83 reduced the yields in Pakistan by 50 percent and the country had to bank upon the import of pulses to meet the national requirement**.** Similarly in 1991 bakanae disease of rice caused 50-90 percent plant mortality in basmati 385 in Punjab (4). Wheat rusts have caused 10 percent reduction in national yield during 1978 leaf rust epidemic. Yellow rust epidemic in KPK during 1995 caused 20 percent yield losses.The annual losses from rust have been estimated to Rs.30-40 million while in epidemic years they are very huge e.g; in 1977-78 epidemic of stripe and leaf rusts caused the total wheat production loss of 2.2 million tons worth US $ 330 million (3). In addition recurring losses are caused to the wheat crop every year by loose smut, karnal bunt, mildews etc. Red rot epidemic of sugarcane caused colossal loss to the sugar industry in the plains of Punjab during 1973. In 1986-88 collar rot severely affected the chillies crop and country had to import chilies. Shisham die back caused plant mortality along the road side from 5-25 percent during the year, 1998-99 which was increased to 43.17 percent during the year, 2000-2001 (2). Collar rot of mango caused 0.5 to 5.5 percent plant mortality during 1999-2002.

Recently numerous studies have concluded that no use of fungicides and lack of effective disease control lead to considerable low crop yield. Fungicides are usually used on the majority of field and fruit crops against

fungal attack as fungicides applications are essential for large scale production of fruits, vegetables and field crops.

As with the start of inventions in agriculture sector, development of the 1st fungicide was the result of good observations of using brining of grain with salt water followed by liming have taken place in the middle of the 17th century to control bunt and observed that seed wheat salvaged with the sea water was free of bunt. This had occurred before the discovery of Tillet for control of wheat bunt (*Tilletia tritici*, *T. laevis*). One more important finding was made in France in 1882 by Millardet, who observed that grape vines treated with a mixture of copper sulfate and lime prevented downy mildew growth on leaves. Millardet concluded that a mixture of copper sulfate and hydrated lime could effectively control downy mildew of grape. According to Schumann Gail L. (9) sulfur fungicide inhibited powdery mildew pathogen (*Uncinula necator*) in French wine which had reduced its production by 75 percent in the 1850s. The downy mildew fungus (*Plasmopara viticola*) lowered French wine grape production by 50 percent in years prior to the regular use of Bordeaux mixture. Same observations were recorded in use of bordeaux mixture at the University of Vermont (1890-1910) which resulted in an increase in average potato yield (64%) as a result of late blight control (13). Use of Bordeaux mixture as a fungicide in Pakistan was started in 1965 for control of plants diseases prevailing at that time. Then in same year, Copper oxychloride was standardized as Copper oxychloride 50 WP/Cobox 50 WP/Cupravit 50 WP/Copper A 50 WP for lowering the disease incidence of muskmelon downy mildew and potato late blight in the area. Mancozeb was the second most chemical which was standardized and used in 1969 as Dithane M-45 80 WP for control of powdery mildew in muskmelon. Third one chemical was propineb standardized as Antracol 80 WP in 1974 and recommended for control of fungal diseases of leaves and twigs in crop plants. Carboxin standardized as Vitavax and utilized as seed treatment in 1975 for loose smut control in wheat. Same Vitavax product was used for control of seed and soil borne diseases of barley and cotton. Thiophenate methyl first time standardized as Topsin M 70 WP in 1979 and used against diseases of wheat, mildews in melon, anthracnose and powdery mildew of mango. Similarly several various chemicals were standardized against various crop plants diseases from 1980 to 2000 in order to control the losses due to diseases in crop production system of the Punjab, Pakistan (3).

Many fungicides were standardized and utilized in developing and developed countries against field and horticultural crops diseases in order to increase their crops yields. The main objective of the study was to document the

status of various fungicides standardized at the Institute against various crops diseases in the Punjab, Pakistan.

MATERIALS AND METHODS

Present study was conducted at Plant Pathology Research Institute, AARI, Faisalabad, Punjab, Pakistan during 2001 to 2013, for evaluating and standardizing 168 fungicides against 28 different plants diseases in 15 various crops. The experiment was laid out in RCBD with two replications. First of all, the diseases were identified in the field before using the fungicides against crop plants diseases keeping in view the weather conditions (favourable for disease attack / spread) and lead to the fungicide standardization trial against the malady. A test was performed on a small portion of the plant / crop before proceeding and observed for 24 hours for any negative reaction. Fungicides spraying was carried out early in the morning or late in the evening keeping in view the effects of phyto-toxicity at higher temperature.

Three sprays of each fungicide against specific crop disease were carried out with 5 to 15 days intervals depending upon climatic condition of the area whereas in case of seed borne diseases, seeds of the crop were treated before plantation. All spray treatments were made with a high-volume applicator with hand machine. A pressure of 2,000 kPa was used and plants were sprayed till run-off. All other agronomic practices for the experimental units were kept uniform. Disease severity data were recorded on percentage disease incidence basis. A week after the last or 3rd spray of the test fungicide. Then disease incidence data were statistically analyzed as described by Steel *et al.* (20). After confirmation of the efficacy of each test fungicide against the receptive disease in the respective crop, data were sent to Technical Sub Committee and Punjab Standardization Committee for approval of the fungicide product with efficacy ranging from 80.00 to 100 percent against the disease. It was then recommended for its utilization against crops diseases. Data of fungicides standardized from 2001 to 2013 have been obtained from Directorate of Entomology, Plant Pathology (AARI), Faisalabad and from the Technical Sub Committee and Punjab Standardization Committee (3) and fungicides standardized percentage was calculated according to the formula given below:-

$$\text{Fungicides Standardization Percentage} = \frac{\text{No. of fungicides standardized against crops/vegetables/fruits/disease}}{\text{Total no. of fungicides standardized}} \times 100$$

RESULTS AND DISCUSSION

From 2001 to 2013, 168 fungicides were evaluated and standardized against 28 different plants diseases in the Punjab (3). All these fungicides/chemicals tested against crops diseases gave effective control. Maximum percentage (69.64%) of fungicides standardized against vegetables diseases whereas 16.07% fungicides standardized against diseases of fruit plants. In case of field crops, its percentage was remained to 14.29% as shown in Table 1.

Table 1. Fungicides standardized against diseases of field, vegetables and fruit crops during 2001 to 2013.

S. No.	Crops	Fungicides standardized (%)
1.	Diseases of vegetables	69.64
2.	Diseases of fruits	16.07
3.	Diseases of field crops	14.29

Maximum fungicides standardization percentage 30.36% was against potato diseases, 18.45% against muskmelon maladies, 12.50% against mango diseases, 10.12% against tomato diseases, 8.93% against rice and 6.55% against diseases of cucumber. The percentage of standardized fungicides against diseases of crops (apple, gram, tobacco, onion, chilies; mung bean, peas, wheat & citrus) ranged from 0.60% to 2.98% as shown in Table II.

Table 2. Cropwise comparison of fungicides standardized against diseases during 2001 to 2013.

Sr. No.	Crops	Fungicide standardized (%)
1.	Potato	30.36
2.	Muskmelon	18.45
3.	Mango	12.50
4.	Tomato	10.12
5.	Rice	8.93
6.	Cucumber	6.55
7.	Citrus	2.98
8.	Wheat	2.38
9.	Peas	1.79
10.	Mungbean	1.19
11.	Chilies	1.19
12.	Onion	1.19
13.	Tobacco	1.19
14.	Gram	0.60
15.	Apple	0.60

In case of crop plant diseases, maximum percentage 26.19% of fungicides standardized against potato late blight, 15.48% against muskmelon downy mildew, 9.52% against mango powdery mildew, 7.14% against tomato late blight, 5.36% against cucumber downy mildew whereas 5.36% fungicides standardized against rice blast. The percentage of standardized fungicides against apple powdery mildew, citrus withertip, citrus canker; mango postharvest anthracnose, gram blight, mungbean blight, mungbean leaf spot, wheat bunt; tobacco downy mildew, onion downy mildew, chilies collar rot, potato black scurf, cucumber powdery mildew, rice sheath blight; citrus gummosis, peas powdery mildew, wheat loose smut; mango anthracnose, rice brown leaf spot; tomato early blight, potato early blight, muskmelon powdery mildew was remained from 0.60% to 2.98%as shown in Table 3.

Table 3. Comparison of fungicides standardized against diseases during 2001 to 2013.

S. No.	Crops	Diseases	Fungicides standardized
1	Potato	Late blight	26.19
2	Muskmelon	Downy mildew	15.48
3	Mango	Powdery mildew	9.52
4	Tomato	Late blight	7.14
5	Cucumber	Downy mildew	5.36
6	Rice	Blast	5.36
7	Tomato	Early blight	2.98
8	Potato	Early blight	2.98
9	Muskmelon	Powdery mildew	2.98
10	Rice	Brown leaf spot	2.38
11	Mango	Anthracnose	2.38
12	Tobacco	Downy mildew	1.19
13	Onion	Downy mildew	1.19
14	Chilies	Collar rot	1.19
15	Potato	Black scurf	1.19
16	Cucumber	Powdery mildew	1.19
17	Rice	Sheath blight	1.19
18	Citrus	Gummosis	1.79
19	Peas	Powdery mildew	1.79
20	Wheat	Loose smut	1.79
21	Apple	Powdery mildew	0.60
22	Citrus	Withertip	0.60
23	Citrus	Canker	0.60
24	Gram	Blight	0.60
25	Mungbean	Blight	0.60
26	Mungbean	Leaf spot	0.60
27	Wheat	Bunt	0.60
28	Mango	Postharvest anthracnose	0.60

In total 168 various fungicide products are standardized and recommended against crops diseases from 2001 to 2013 whereas (5) recommended use of Bordeaux mixture as a fungicide for control of plants diseases prevailing in crops. According to study, three fungicides (Hombre 37.25% FS, Divident Star 036 FS, Raxil Ultra 12% FS) were standardized against wheat loose smut and one (Hombre 37.25% FS) against wheat bunt. Use of Raxil ultra 120 FS was found excellent in controlling wheat loose smut (7). Similarly nine fungicides (Ajyle 75% WP, Oracle 20% SC, Corel 25% EC, Spore Off 75% WP, Fork 6% WP, Armure30% EC, Dream-M 75%WP, Nativo 75% WG, Score 250 EC) against rice blast, four (Armure 30% EC, Kumulus DF 80% WG, Tilt 25% EC, Thiovit Jet 80% WG) against rice brown leaf spot, two (Contaf + 5.1% SC, Anvil 5% SC) against rice sheath blight are standardized and recommended. Three fungicides (Bavistin 50 DF, Shincar 50 SC, Sentinel 25% EC) against peas powdery mildew, one fungicide (Score 25% EC) against mungbean leaf spot & mungbean blight, one (Divident Star 036 FS) against gram wilt are standardized & recommended for disease control. Likewise twenty six fungicides (Primacy 25% SC, Co-Oxy 50% WP, Triger 25% EC, Chloronil 75%WP, Halonil 75% WP, Ridomil Gold 68% WG, Toss 50% WD, Feast-M 72% WP, Metacarb 25% WP, V-Nurse 70% WP, Melody Duo 66.8 WP, Crest 50% WP, Shelter 80% WP, Aleitte 80 WP, Dolomite 58% WP, Pre-Cure Combi 65% WP, Reconil-M 70%, Agrohit 50% WP, Kocide3000 52.4% WG, Curzate-M8 72% WP, Dew 25% EC, Alligate 70 WP, Nanco 80% WP, Big Time 80% WP, Folio Gold 440 SC, Index 76% WP) are standardized for control of muskmelon downy mildew and five fungicides (Contaf + 5.1% SC, Barb 25% EC, Plantomil Gold 72% WP, Pre-Cure Combi 65% WP, Topsin-M 70 WP) are recommended against muskmelon powdery mildew. Nine fungicides (Champion 77% WP, Folio Gold 440 SC, V-Nurse 70% WP, Ridomil Gold 68% WG, Feast-M 72% WP, Metacarb 25% WP, Proctor 25% EC, T-Zole 25% EC, Score 250 EC) are recommended against cucumber downy mildew and two (Score 250 EC, Rely 40% WP) against cucumber powdery mildew, whereas (5) described the use of Ridomil gold 68 WP, Score 25 EC, Cabriotop 60 WDG & Champion 77 WP for lowering the disease incidence of muskmelon downy mildew and (15) described the excellent control of the disease by the use of Ridomil gold 68 WP in case of cucumber downy mildew. Forty four various fungicides (Diesomil Platinum 72% WP, Melody Duo 66.8% WP, Primacy 25% SC, Co-Oxy 50% WP, Champion 77% WP, Kelsey 50% WP, Dew 25% EC, Big Time 80% WP, Cabrio Top 60% WDG, Triger 25% EC, Folio Gold 440 SC, Spectrum 30% EC , Valvet 80% WDG, Pick IT 80% WDG, Craze 80% WP, Flumax 60% EC, Index 76% WP, Pyrine 25% WP, Chloronil 75%WP, Halonil 75% WP, Ridomil Gold 68% WG, Kocide 3000 52.4%WG, Proctor Plus

50%EC, Toss 50% WDG, Excel 80% WP, Wisdom 80%WDG, Anadoul 80% WP, Metaman 72% WP, Tazolen 72% WP, Gift 70% WP, Tahaffuz 90% SP, Alligate 70 WP, Melody Duo 66.8 WP, Curzate-M8 72% WP, Cover 70% WP, Protest 70% WP, Aleitte 80 WP, Reconil-M 70% WP, Plantomil Gold 72% WP, Acrobat-MZ 90/600 G/kg WP, Agrohit 50% WP, Shelter 80% WP, Dolomite 58% WP, Pre-Cure Combi 65% WP) against potato late blight and five (Melody Duo 66.8% WP, Soleton 50% WP, Spectrum 30% EC, Kocide 3000 52.4%WDG, Folio Gold 440 SC) against potato early blight and two (Emesto 24% FS and Monceren 25% FS) are standardized and recommended against potato black scurf while (5) described the use of same fungicides for potato late blight control as described above for control of muskmelon downy mildew by (5). Similarly, (19) mentioned the use of sulfur as fungicide that suppresses the powdery mildew pathogens in vegetables and fruit plants. Twelve fungicides (Kocide 3000 52.4% WG, Champion 77% WP, Dew 25% EC, Triger 25% EC, Chloronil 75%WP, Halonil 75% WP, V-Nurse 70% WP, Feast-M 72% WP, Metacarb 25% WP, Melody Duo 66.8 WP, Curzate-M8 72% WP, Protest 70% WP) are standardized against tomato late blight and five (Diesomil Platinum 72% WP, Craze 80% WP, Big Time 80% WP, Index 76% WP, Definite 10% WDG) are recommended for tomato early blight control. Two fungicides (V-Nurse 70% WP, Feast-M 72% WP) against chilies collar rot and two (Folio Gold 440 SC, Ridomil Gold 68% WG) against onion downy mildew are recommended. Mango powdery mildew is controllable disease by the use of sixteen various fungicides (Soleton 50% WP, Vangard 25% EC, Cabrio Top 60% WDG, Nativo 75% WG, Triger 25% EC, Contaf + 5.1% SC, Barb 25% EC, Score 250 EC, Anpower 5% ME, Thiomil 70 WP, Pre-Cure Combi 65% WP, Crest 50% WP, Score 250 EC, Topsin-M 70 WP, Bavistin 50 DF, Shincar 50 SC) and against mango anthracnose 4 fungicides (Champion 77% WP, Cabrio Top 60% WDG, Nativo 75% WG, Kocide 3000 52.4%WDG) are registered whereas mango postharvest anthracnose is controlled through the use of only one recommended product Nativo 75% WG. Three fungicides (Folio Gold 440 SC, Ridomil Gold 68% WG, Aleitte 80 WP) are standardized against citrus gummosis and for citrus canker only one fungicide (Kocide 3000 52.4%WDG) is recommended. Similarly one fungicide (Score 250 EC) is recommended & found effective for control of citrus withertip. One fungicide product (Contaf Plus 051 SC) is standardized against apple powdery mildew. According to study of (3) propineb gave good control of fungal diseases of leaves and twigs in fruit plants. In a study of (6), Score 25 EC gave best results against mango anthracnose and in case of mango powdery mildew maximum control was achieved by the application of Topass 100 EC while (17) and (18) recommended the use of axosystrobin,

fluoxastrobin, pyraclostrobin and trifloxystrobin for its control. In case of tobacco downy mildew 2 fungicides (Folio Gold 440 SC, Ridomil Gold 68% WG) are standardized for control of the disease. (4) reported use of thiophenate methyl against wheat diseases, melon mildews, mango anthracnose and mango powdery mildew and till to date it is effective and recommended for diseases control in many crops. Similarly several various chemicals are standardized against various crop plants diseases from 1980 to 2000 in order to control the losses due to diseases in crop production system of the Punjab, Pakistan (3). Crop plants diseases, fungicides standardized from 2001 to 2013; their doses and year of registration in the Punjab, given in the table IV. In general, all the fungicide treatments significantly reduced the diseases incidence and produced higher yield of field and horticultural crops over the untreated crops.

Table 4. Fungicides standardized against crops diseases in the Punjab, Pakistan (2001-2013).

S. No.	Disease	Fungicides	Active ingredient	Dose	Year of registra-tion
1.	Wheat loose smut	Hombre 37.25%FS	Imidacloprid + Tebuconazole	2 ml/kg seed	2013
		Divident Star 036FS	Difenoconazole + cyproconazole	100 gm/100 kg seed	2006
		Raxil Ultra 12%FS	Tebuconazole	25ml/100 kgseed	
2.	Wheat bunt	Hombre 37.25%FS	Imidacloprid + Tebuconazole	2 ml /kg seed	2013
3.	Rice blast	Ajyle 75% WP	Tricyclazole	120 gm/acre	2012
		Oracle 20% SC	Fenoxanil	250 ml/acre	2011
		Corel 25% EC	Difenoconazole	125 ml/acre	2011
		Spore Off 75% WP	Tricyclazole	120 gm/acre	2011
		Fork 6% WP	Kasugamycin	250 gm/acre	2010
		Armure30% EC	Difenoconazole + propiconazole	120 gm/acre	2009
		Dream-M 75%WP	Tricyclazole	120 gm/acre	2009
		Nativo 75% WG	Tebuconazole+ Trifloxystrobin	65 gm/acre	2007
		Score 250 EC	Difenoconazole	125 ml/acre	2005
4	Rice brown leaf spot/leaf spot	Armure 30% EC	Difenoconazole + propiconazole	120 gm/acre	2010
		Kumulus DF80% WG	Sulphur	800 gm/acre	2011
		Tilt 25% EC	Propiconazol	80 ml/acre	2008
		Thiovit Jet 80% WG	Sulphur	1000 gm/acre	2008

5	Rice sheath blight	Contaf + 5.1% SC	Hexaconazole	400 ml/acre	2010
		Anvil 5% SC	Hexaconazole	400 ml/acre	2009
6.	Peas powdery mildew	Bavistin 50 DF	Carbendazim	100 gm/100 lit. water	2003
		Shincar 50 SC	Carbendazim	100 gm/100 lit. water	2003
		Sentinel 25% EC	Propiconazol	150 ml/acre	2011
7	Mung bean leaf spot	Score 25% EC	Difenoconazole	200 ml/acre	2011
8	Mung bean blight	Score 25% EC	Difenoconazole	200 ml/acre	2010
9	Gram wilt	Divident Star 036 FS	Difenoconazole + cyproconazole	1 gm/kg seed	2007
10	Musk melon downy mildew	Primacy 25% SC	Azoxystrobin	200 ml/acre	2011
		Co-Oxy 50% WP	Copper oxychloride	1000 gm/acre	2013
		Triger 25% EC	Tebuconazole	250 ml/acre	2011
		Chloronil 75%WP	Chlorothalonil	250 gm/acre	2010
		Halonil 75% WP	Chlorothalonil	200 gm/acre	2010
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	250 gm/acre	2010
		Toss 50% WD	Dimetomorph	250 gm/acre	2010
		Feast-M 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2010
		Metacarb 25% WP	Metalaxyl + Propamocarb	330 gm/acre	2010
		V-Nurse 70% WP	Fosetylaluminium + mancozeb	330 gm/acre	2010
		Melody Duo 66.8 WP	Iprovalicarb + Propineb	250 gm/acre	2008
		Crest 50% WP	Carbendazim	1 gm/lit. water	2006
		Shelter 80% WP	Mancozeb	800 gm	2006
		Aleitte 80 WP	Fosetylaluminium	250 gm/100 lit. water	2006
		Dolomite 58% WP	Metalaxyl + mancozeb	250 gm/acre	2006
		Pre-Cure Combi 65% WP	Thiophanate methyl 52.5% + diethofencarb 12.5 %	250 gm/acre	2006
		Reconil-M 70%	Chlorothalonil 6% + mancozeb 64%.	400 gm/acre	2006
		Agrohit 50% WP	Dimethomorph 6%+mancozeb44%	350 gm/acre	2005

		Kocide3000 52.4% WG	Copper Hydroxide	250 gm/acre	2009
		Curzate-M8 72% WP	Cymoxanil 8% +mancozeb 64%	600 gm/acre	2007
		Dew 25% EC	Difenoconazole	150 ml/acre	2012
		Alligate 70 WP	Fosetylaluminium + mancozeb	400 gm/acre	2007
		Nanco 80% WP	Mancozeb	800 gm/acre	2007
		Big Time 80% WP	Mancozeb	800 gm/acre	2012
		Folio Gold 440 SC	Mefenoxam 40gai + chlorothalonil 400gai/	1000 ml/acre	2012
		Index 76% WP	Propineb 70% + Cymoxanim 6%	400 gm/acre	2011
11	Musk melon powdery mildew	Contaf + 5.1% SC	Hexaconazole	200 ml/acre	2010
		Barb 25% EC	Difenoconazole	200 ml/acre	2007
		Plantomil Gold 72% WP	Cymoxanil 8% +mancozeb 64%	600 gm/acre	2006
		Pre-Cure Combi 65% WP	Thiophanate methyl 52.5% + diethofencarb 12.5.%	150 gm/acre	2006
		Topsin-M 70 WP	Thiophanate methyl	200 gm/100 lit. water.	2003
12	Cucumber downy mildew	Champion 77% WP	Copper Hydroxide	200 gm/acre	2012
		Folio Gold 440 SC	Chlorothalonil	1000 ml/100 lit.water	(2011
		V-Nurse 70% WP	Fosetylaluminium + mancozeb	330 gm/acre	2010
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	250 gm/acre	2010
		Feast-M 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2010
		Metacarb 25% WP	Metalaxyl + Propamocarb	330 gm/acre	2010
		Proctor 25% EC	Difenoconazole	200 ml/acre	2009
		T-Zole 25%	Tebuconazole	250 ml/acre	2009
		Score 250 EC	Difenoconazole	200 ml/100 lit. water	2006
13	Cucumber powdery mildew	Score 250 EC	Difenoconazole	200 ml/100 lit. water	2006
		Rely 40% WP	Myclobutanil	150 gm/100 lit.water	
14	Potato late blight	Diesomil Platinum 72% WP	Cymoxanil 8% +mancozeb 64%	250 gm/acre	2013

		Melody Duo 66.8% WP	Iprovalicarb + Propineb	500 gm/acre	2013
		Primacy 25% SC	Azoxystrobin	200 ml/acre	2012
		Co-Oxy 50% WP	Copper oxychloride	1000 gm/acre	2012
		Champion 77% WP	Copper Hydroxide	200 gm/acre	2012
		Kelsey 50% WP	Dimetomorph	250 gm/acre	2012
		Dew 25% EC	Difenoconazole	150 ml/acre	2012
		Big Time 80% WP	Mancozeb	800 gm/acre	2012
		Cabrio Top 60% WDG	Metiram 55% + Pyraclostrobin 5%	600 gm/acre	2012
		Triger 25% EC	Tebuconazole	250 ml/acre	2011
		Folio Gold 440 SC	Chlorothalonil	1000 ml/100 lit.water	2011
		Spectrum 30% EC	Difenoconazole + propiconazole	200 ml/acre	2011
		Valvet 80% WDG	Fosetylalu-minium	250 gm/acre	2011
		Pick IT 80% WDG	Fosetylalu-minium	250 gm/acre	2011
		Craze 80% WP	Mancozeb	800 gm/acre	2011
		Flumax 60% EC	Metalaxyl-m + Fluazinam	200 ml/100 lit.water	2011
		Index 76% WP	Propineb 70% + Cymoxanim 6%	400 gm/acre	2011
		Pyrine 25% WP	Pyrimethalin	350 gm/acre	2011
		Chloronil 75%WP	Chlorothalonil	250 gm/acre	2010
		Halonil 75% WP	Chlorothalonil	200 gm/acre	(2010
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	250 gm/acre	(2010
		Kocide 3000 52.4%WG	Copper Hydroxide	250 gm/acre	2010
		Proctor Plus 50%EC	Difenoconazole + propiconazole	75 ml/acre	2010
		Toss 50% WDG	Dimetomorph	250 gm/acre	2010
		Excel 80% WP	Fosetylalu-minium	250 gm/acre	2009
		Wisdom 80%WDG	Fosetylalu-minium	250 gm/acre	2009
		Anadoul 80% WP	Mancozeb	250 gm/acre	2009
		Metaman 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2009
		Tazolen 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2009
		Gift 70% WP	Propineb	800 gm/acre	2009
		Tahaffuz 90% SP	Fosetylalu-minium	180 gm/acre	2008
		Alligate 70 WP	Fosetylalu-minium + mancozeb	500 gm/acre	2007
		Melody Duo 66.8 WP	Iprovalicarb + Propineb	250 gm//acre	2007

		Curzate-M8 72% WP	Cymoxanil 8% +mancozeb 64%	600 gm/acre	2007
		Cover 70% WP	Propineb	800 gm/acre	2007
		Protest 70% WP	Propineb	800 gm/acre	2006
		Aleitte 80 WP	Fosetylalu-minium	250 gm/100 lit. water	2006
		Reconil-M 70% WP	Chlorothalonil 6% + mancozeb 64%.	400 gm/acre	2005
		Plantomil Gold 72% WP	Cymoxanil 8% +mancozeb 64%	250 gm/acre	2005
		Acrobat-MZ 90/600 G/kg WP	Dimethomorph + mancozeb	250 gm/acre	2005
		Agrohit 50% WP	Dimethomorph 6% + mancozeb 44%.	350 gm/acre	2005
		Shelter 80% WP	Mancozeb	600 gm/acre	2005
		Dolomite 58% WP	Metalaxyl+ mancozeb	250 gm/acre	2005
		Pre-Cure Combi 65% WP	Thiophanate methyl 52.5% + diethofencarb 12.5.%	250 gm/acre	2005
15	Potato early blight	Melody Duo 66.8% WP	Iprovalicarb + Propineb	300 gm/acre	2013
		Soleton 50% WP	Carbendazim 40% + Triadimefon 10%	240 gm/acre	2012
		Spectrum 30% EC	Difenoconazole + propiconazole	200 ml/acre	2011
		Kocide 3000 52.4%WDG	Copper Hydroxide	250 gm/acre	2011
		Folio Gold 440 SC	Chlorothalonil	1000 ml/100 lit.water	2011
16	Potato black scurf	Emesto 24% FS	Penflufen	100 ml/100 kg seed	2013
		Monceren 25% FS	Pencycuron	60 ml/100 kg seed	2009
17	Tomato late blight	Kocide 3000 52.4% WG	Copper Hydroxide	250 gm/acre	2013
		Champion 77% WP	Copper Hydroxide	200 gm/acre	2012
		Dew 25% EC	Difenoconazole	150 ml/acre	2012
		Triger 25% EC	Tebuconazole	250 ml/acre	2011
		Chloronil 75%WP	Chlorothalonil	250 gm/acre	2010
		Halonil 75% WP	Chlorothalonil	200 gm/acre	2010
		V-Nurse 70% WP	Fosetylaluminium + mancozeb	330 gm/acre	2010
		Feast-M 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2010

		Metacarb 25% WP	Metalaxyl + Propamocarb	330 gm/acre	2010
		Melody Duo 66.8 WP	Iprovalicarb + Propineb	250 gm/acre	2008
		Curzate-M8 72% WP	Cymoxanil 8% +mancozeb 64%	600 gm/acre	2007
		Protest 70% WP	Propineb	800 gm/acre	2007
18	Tomato early blight	Diesomil Platinum 72% WP	Cymoxanil 8% +mancozeb 64%	250 gm/acre	2013
		Craze 80% WP	Mancozeb	600 gm/acre	2012
		Big Time 80% WP	Mancozeb	800 gm/acre	2012
		Index 76% WP	Propineb 70% + Cymoxanim 6%	400 gm/acre	2011
		Definite 10% WDG	Difenoconazole	300 gm/acre	2009
19	Chillies collar rot	V-Nurse 70% WP	Fosetylalu-minium + mancozeb	330 gm/acre	2010
		Feast-M 72% WP	Metalaxyl+ mancozeb	250 gm/acre	2010
20	Onion downy mildew	Folio Gold 440 SC	Chlorothalonil	1000 ml/100 lit.water	2011
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	250 gm/acre	2010
21	Mango powdery mildew	Soleton 50% WP	Carbendazim 40% + Triadimefon 10%	240 gm/ 100 lit of water	2013
		Vangard 25% EC	Triadimenol	50ml/ 100 lit of water	2012
		Cabrio Top 60% WDG	Metiram 55% + Pyraclostrobin 5%	600 gm/ 100 lit of water	2012
		Nativo 75% WG	Tebuconazole + Trifloxystrobin	40 gm/100 lit Water	2012
		Triger 25% EC	Tebuconazole	40 ml/ 100 lit of water	2011
		Contaf + 5.1% SC	Hexaconazole	150 ml// 100 lit of water	2010
		Barb 25% EC	Difenoconazole	30 ml/ 100 lit. water	2007
		Score 250 EC	Difenoconazole	30 ml/100 lit. water	2006
		Anpower 5% ME	Hexaconazole	40ml/100lit.water	2006
		Thiomil 70 WP	Thiophanate-methyl	1 gm/lit. water	2006
		Pre-Cure Combi 65% WP	Thiophanate methyl 52.5% + diethofencarb 12.5.%	50gm/100 lit.water	2006

		Crest 50% WP	Carbendazim	1 gm/lit. water	2006
		Score 250 EC	Difenoconazole	30ml/ 100 lit.water	2004
		Topsin-M 70 WP	Thiophanate methyl	100 gm/100 lit. water	2003
		Bavistin 50 DF	Carbendazim	100 gm/100 lit. water.	2003
		Shincar 50 SC	Carbendazim	100 gm/100 lit. water	2003
22	Mango anthrac-nose	Champion 77% WP	Copper Hydroxide	200 gm/ 100 lit of water	2012
		Cabrio Top 60% WDG	Metiram 55% + Pyraclostrobin 5%	600 gm/ 100 lit of water	2012
		Nativo 75% WG	Tebuconazole + Trifloxystrobin	90gm/100 lit water	2012
		Kocide 3000 52.4%WDG	Copper Hydroxide	1 kg/ 100 lit of water	2011
23	Mango post harvest anthrax-cnose	Nativo 75% WG	Tebuconazole + Trifloxystrobin	30gm/ 100 lit. water	2012
24	Citrus gummosis	Folio Gold 440 SC	Mefenoxam 40gai + chlorothalonil 400gai/	1000 ml/ 100 lit of water	2012
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	1000 gm/100 lit of water	2012
		Aleitte 80 WP	Fosetylalu-minium	250 gm/100 lit. water	2006
25	Citrus canker	Kocide 3000 52.4%WDG	Copper Hydroxide	2.5gm/ lit. of water	2011
26	Citrus wither tip	Score 250 EC	Difenoconazole	30 ml/100 lit. water	2006
27	Apple powdery mildew	Contaf Plus 051 SC	Hexaconazole	50ml/100 lit. water	2011
28	Tobacco downy mildew	Folio Gold 440 SC	Chlorothalonil	1000 ml/100 lit.water	2011
		Ridomil Gold 68% WG	Mefenoxam + Mancozeb	250 gm/acre	2010

REFERENCES

1. Agrios, G. N. 1997. Plant Pathology. Edition. Academic Press, California, USA. Pp.635.

2. Aileen, R. 2006. Sampling and testing for plant pathogens. Bull. P. 1833-7244.
3. Anon. 2013. Fungicides, Pesticides standardized in the Punjab with their dose(s), crop(s) and target pest(s). Standardization Technical Sub Committee and duly approved by the Punjab Standardization Committee. p. 38-46.
4. Anon. 2010. Chemical Control of plant diseases/standardization of fungicides in: Fifty years achievements of Plant Protection/Plant Pathology, PPRI, p. 21-27.
5. Anon. 2012. Evaluation of fungicides for control of early blight and late blight of tomato, potato. Annual Raport 2011-12, Ayub Agricultural Research Institute, 2012-13. p. 61-62.
6. Anon. 2013. Evaluation of fungicides for control of blossom blight & powdery mildew of mango. Annual Detail Raport 2012-13, Plant Pathology Research Institute, AARI, Faisalabad. pp. 72-73.
7. Anon. 2013. Efficacy of different seed dressing fungicides on the incidence of loose smut of wheat. Annual Detail Raport 2012-13, Plant Pathology Research Institute, AARI, Faisalabad. Page 37.
8. Barnett, H. L. and B. H. Barry 1972. Illustrated genera of Imperfect fungi. Third edition. Burgess Publishing Company. p -200
9. Bisby, G. R. 1952. The name Oidium. Trans. Brit. Mycol. Soc. 35: 236-237.
10. Gill M.A; I. Ahmed; S.Ali; M.Aslam; A. Khan; M. Khan and R. M. Rafiq. 2001. *Phytophthora cinnamomi* - a cause of shisham decline in Punjab, Pakistan (Abstr.). Presented in 3rd National Conference of Plant Pathology 1-3 October, 2001 at NARC, Islamabad organized by Pakistan Phytopathological Society. Pp. 15.
11. Hafiz A. 1986. Plant Diseases Pub. PARC. Islamabad, pp.552.
12. Hussain A. and Saleem, A. 1991. A report on bakanae/foot rot of rice. The problem, disease situation and control submitted to the Secretary, Government of the Punjab, Agriculture Department, Lahore. p.15.
13. Jones L.R., N. J. Giddings and B. F. Lutman. 1912. Investigations of the Potato Fungus *Phytophthora infestans*, Vermont AgriculturalExperiment Station, Bulletin No. 168, August 1912.
14. Mehrotra R.S. 1986. Plant Pathology. Tata McGraw-Hill Publishing Company Limited New Delhi. McGraw Hill Book Co., New York, USA. Pp.771.

15. Nasir, M., B. Iqbal, M. Sajjad, M. Idrees and Ghulam Mohy-Ud-Din 2014. Effectiveness of fungicides against cucumber downy mildew under tunnel conditions. Pak. J. Phytopath. 27 (2) 175-179.
16. Ragsdale N. Nancy *et al*. 1991. Health and Environmental Factors Associated with Agricultural Use of Fungicides, USDA National Agricultural Pesticide Impact Assessment Program. 1991.
17. Reuveni, M., 2000. Efficacy of trifloxystrobin (Flint), a new strobilurin fungicide, in controlling powdery mildew on apple, mango and nectarine and rust on prune trees. Crop Prot. 19:335-341.
18. Reuveni, M., Harpaz, R.M., Reuveni, R., 1998. Integrated control of powdery mildew on field-grown mango trees by foliar sprays of mono-potassium phosphate, sterol inhibitor fungicides and the strobilurin kresoxym-methyl. Eur. J. Plant Pathol. 104:853-860.
19. Schumann Gail L., 1991. Plant Diseases: Their Biology and Social Impact, APS Press.
20. Steel, R. G. D., J. H. Torrie and D. A. Dickey. 1997. Principles and procedures of statistics: 3rd Ed. New York, USA.

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