

BIOEFFICACY STUDIES OF NEW FUNGICIDE MOLECULES (RIDOMIL GOLD 68%WP) AGAINST LEAF SPOT AND FRUIT SPOT/ROT OF POMEGRANATE

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ABSTRACT

Leaf spot and fruit spot/rot complex in pomegranate caused by *Alternaria alternata* (Fr.) Keissler have emerged as a new threat in Tamil Nadu. The present investigation was undertaken at farmer's field in Madurai during the year 2013-2014 (I and II season), to assess the field evaluation with new fungicide molecules for the management of leaf spot of pomegranate. Field evaluation for two seasons revealed that among the different treatments, spraying of Ridomil Gold 68% WP @ 3.0 ml/lit (T_3) recorded the lowest leaf spot (8.23 and 10.45%) and fruit rot (7.23 and 8.00%) incidence at 15 days after second spray followed by Ridomil Gold 68% WP @ 2.5 ml/lit (8.5 and 11.20 % ; 7.58 and 8.25 %). Application of Ridomil Gold 68 %WP @ 3.0 ml/lit gave higher fruit yield (6.45 and 5.76 t/ha) while the yield of pomegranate was less in untreated control (4.25 and 3.67 t/ha). The results also showed that Ridomil Gold 68% WP @ 3.0 ml/lit and 6.0 ml/lit did not show any phytotoxicity symptoms. These fungicide molecules even at higher doses do not manifest any phytotoxicity symptoms and also exhibiting an appreciable increase in fruit yield of pomegranate.

INTRODUCTION

Pomegranate (*Punica granatum* L.), an ancient and commercially important fruit of both tropical and subtropical countries, belongs to the smallest botanical family puniceae. It is known as the 'fruit of paradise' native of Iran, but spread to the Mediterranean countries at an early date. Pomegranate is a crop of high impact and is a vital cash crop of India gaining greater economic importance. In India, it is grown in an area of 113 ha with a production of 745 milloin tons (Anonymous, 2012-2013). Among the different states growing pomegranate, Maharashtra is the largest producer occupying 2/3rd of total area in the country followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan (Sannakki and Rajpurohit, 2015). In India, it is regarded as a "vital cash crop". The fruit is symbolic for its cool, refreshing juice and valued for its medicinal properties. However, the crop is under threat due to number of serious diseases such as bacterial blight (*Xanthomonas axonopodis* pv. *punicae*), wilt due to *Ceratocystis fimbriata*, anthracnose (*Colletotrichum gloeosporioides*) and leaf spot and severe fruit rotting due to *Alternaria alternata*, *Cercospora* sp., *Pseudocercospora* sp., *Drechslera* sp. and *Sphaceloma* sp. etc., take a heavy toll on the crop (Khosla and Bhardwaj, 2013).

Among these, *Alternaria alternata* (Fr.) Keissler has caused severe infections in pomegranate growing areas of Tamil Nadu, India. The pathogen *A. alternata* responsible for fruit rot was first reported in India by Madhukar and Reddy (1976) and subsequently from USA, Mexico (Farr *et al.*, 2007). Leaf spot

and fruit rot has been noticed in northern Karnataka including Bijapur, Bagalkot and Koppal districts with disease incidence ranging from 15-80% in almost all the pomegranate growing areas. This results in drastic reduction in the yield as well as ultimate marketability by way of severe spotting on the fruit. In view of importance of the crop and effect of fungal diseases on yield, there is need for the development of effective control methods.

Primary methods of controlling leaf spot include preventing long periods of wetness on the leaf surface, cultural scouting, sanitation and development of the host plant resistance with the application of fungicides (Jambhulkar *et al.*, 2012; Kumar and Srivastava, 2013). Though resistant cultivars would be most effective economic choice presently no such resistant varieties are available in India. The disease is still primarily managed by use of foliar fungicides. However frequent use of fungicides over a period of time led to the development of resistance in *Alternaria* resulting in emergence of fungicidal resistant strains.

Regarding the management of leaf spot of pomegranate many workers had done lot of works based on the chemical control. Earlier workers reported that application of fungicides is the most effective method of *Alternaria* spot and found that Chlorothalonil, Ziram, Prochloraz, Captan, Copper oxy chloride and Hexaconazole (Rawal, 2006; Jamadar and Patil, 2007; Supe *et al.*, 2013). Navale *et al.* (1998) found that Copper oxy chloride, Ziram, Mancozeb and Captan as the best fungicides for controlling leaf spot and fruit spots of

pomegranatae in mrigbahar caused by *A. alternata*, *Cercospora sp.*, *Colletotrichum gloeosporioides*. Archana and Jamadar (2014) reported that fungicides were the most efficient in managing the natural infection of the leaf spot and resulted in producing the highest fruit yield compared with antioxidants as well as the alteration between them.

Most of the new generation fungicides are highly specific and single site in mode of action. Thus a novel fungicide with novel mode of action needs to be identified and evaluated under field conditions. One of the new generation fungicidal groups is the Phenylamide group of fungicides. They are broad spectrum systemic fungicides active against wide range of diseases in many crops. The paper deals with the efficacies of different doses of fungicide formulations as foliar application against leaf and fruit spot on pomegranate. Its effect on the fruit yield and its phytotoxic actions were also evaluated.

MATERIALS AND METHODS

Two field trials were conducted in the pomegranate variety Paper Shell at Kattunkudi village of Madurai district to test the efficacy of different fungicides against leaf spot and fruit rot disease of pomegranate during 2013 and 2014. The trials were laid out in a Randomized Block Design (RBD) with ten year old pomegranate plants with three replications. First spray was given at the initiation of disease and subsequent sprays were given at 10-12 days interval for 2 times. The severity of leaf spot was recorded 20 days after each spray. First observation on disease incidence was recorded before the beginning of first spray and subsequent observations after first spray and before second and third spray. The observations on the disease incidence were recorded separately for leaves and fruits. The observations were recorded by selecting 10 samples from each replication random for all the two categories. The systemic fungicide namely Ridomil Gold 68% WP were tested at different concentration (0.10%, 0.14%, 0.17%, 0.20% and 0.41%) and these were compared with two chemicals namely Ridomil 72% WP and Mancozeb 75% WP. Subsequently untreated check was also maintained (Kumari *et al.*, 2015).

The details of treatments are: T₁- Untreated Check; T₂- Three sprays of Ridomil Gold 68% WP (Metalaxyl-4% + Mancozeb-64% @1.5 ml/litre of water); T₃- Three sprays of Ridomil Gold 68% WP (Metalaxyl-4% + Mancozeb-64% @2.0 ml/litre of water); T₄- Three sprays of Ridomil Gold 68% WP (Metalaxyl-4% + Mancozeb-64% @2.5 ml/litre of water); T₅- Three sprays

of Ridomil Gold 68% WP (Metalaxyl-4% + Mancozeb-64% @3.0 ml/litre of water); T₆- Three sprays of Ridomil Gold 72% WP (Metalaxyl-8% + Mancozeb-64% @3.0 ml/litre of water) and T₇- Three sprays of Mancozeb 75% WP @2.7 ml/litre of water.

The required quantities of chemical of WP formulations weighed with micro-balance or pipetted out and suitably dissolved in a requisite quantity of water to get desired concentrations. Spraying was done with manually operated high volume (knapsack) sprayer. The observation on the disease incidence in each treatment after final spray were recorded using 0-9 scale and per cent disease index(PDI) was worked out using wheeler's (1969) formula.

$$PDI = \frac{\text{Sum of all ratings}}{\text{Total number leaves observed}} \times \frac{100}{\text{Maximum grade in scale}}$$

Phyto-toxicity

The fungicide (Ridomil Gold 68% WP) was sprayed at the concentration of 3.0 and 6.0 ml/lit and compared with untreated check. The phytotoxicity symptoms (leaf tip/surface injury, wilting, vein clearing, necrosis, epinasty and hyponasty) were recorded (Archana, 2009) at 0, 1, 3, 5, 7 and 10 days after each spray as per CIB guidelines using a rating scale of 0-10. Pomegranate fruit yield was recorded at each harvest and expressed as total fruit yield in t/ha.

RESULTS AND DISCUSSION

Effect of Ridomil Gold 68% WP on pomegranate disease incidence

All the treatments significantly reduced the per cent leaf spot and fruit rot incidence as compared to control (Table 1). During the first season trial, the lowest leaf spot incidence was observed in foliar spray with Ridomil Gold 68 %WP @ 3.0 ml/lit (T₅) with 69.51 per cent reduction, which was at par with the dose of Ridomil Gold 68% WP @ 2.5 ml/lit (T₄) (68.51%). The disease incidence on fruits also expressed the similar results with the maximum control of fruit rot by the treatment of Ridomil Gold 68 %WP @ 3.0 ml/lit (T₅) compared to control.

In the second season trial also, similar results were obtained with different treatments (Table 2). Ridomil Gold 68% WP @ 3.0 ml/lit (T₅) provided maximum control of the disease on leaves and fruits which was at par with the dose of Ridomil

Table 1: Efficacy of Ridomil Gold 68% WP on leaf spot and fruit rot disease complex in Pomegranate: Season-I (OCT 2013-JAN 2014)

Trt. No.	Treatments (g/lit of water)	Leaf Spot complex (PDI)*			% disease reduction over check	Fruit rot complex (PDI)*	Fruit yield (t/ha)
		PTO	15 days after I spray	15 days after II spray			
T ₁	Untreated check	3.56	12.60 ^d (20.79)	27.00 ^d (31.31)	-	22.56 ^c (28.36)	4.25 ^c
T ₂	Ridomil Gold 68 WP @ 1.5	3.45	9.13 ^c (17.58)	15.20 ^c (22.95)	43.70	11.00 ^b (19.37)	5.30 ^b
T ₃	Ridomil Gold 68 WP @ 2.0	3.60	7.46 ^b (15.85)	10.23 ^b (18.65)	62.11	8.25 ^a (16.69)	6.32 ^a
T ₄	Ridomil Gold 68 WP @ 2.5	3.50	6.50 ^a (14.77)	8.50 ^a (16.95)	68.51	7.58 ^a (15.98)	6.40 ^a
T ₅	Ridomil Gold 68 WP @ 3.0	3.60	6.20 ^a (14.42)	8.23 ^a (16.67)	69.51	7.23 ^a (15.60)	6.45 ^a
T ₆	Ridomil 72 WP @ 3.0	3.53	7.40 ^b (15.79)	10.10 ^b (18.53)	62.59	8.30 ^a (16.74)	6.20 ^a
T ₇	Mancozeb 75 WP @ 2.7	3.50	9.20 ^c (17.66)	15.10 ^c (22.87)	44.07	10.88 ^b (19.26)	5.43 ^b

*Mean of three replications. PTO- Pre treatment Observation. PDI - Per cent Disease Index. Values in the parentheses are arc sine transformed values. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Table 2: Efficacy of Ridomil Gold 68% WP on leaf spot and fruit rot disease complex in pomegranate: Season-II (Jan-April, 2014)

Trt. No.	Treatments (g/lit of water)	Leaf spot complex (PDI)*		% disease reduction over check	Fruit rot complex (PDI)*	Fruit yield (t/ha)	
		PTO	15 days after I spray				
T ₁	Untreated check	5.97	14.30 ^d (22.22)	36.00 ^d (36.87)	-	27.40 ^d (31.56)	3.67 ^c
T ₂	Ridomil Gold 68 WP @ 1.5	5.90	12.40 ^c (20.62)	17.23 ^c (24.53)	52.13	12.56 ^c (20.76)	5.00 ^b
T ₃	Ridomil Gold 68 WP @ 2.0	5.93	8.50 ^b (16.95)	13.35 ^b (21.43)	62.91	9.65 ^b (18.10)	5.56 ^a
T ₄	Ridomil Gold 68 WP @ 2.5	6.00	7.70 ^{ab} (16.11)	11.20 ^a (19.55)	68.88	8.25 ^{ab} (16.69)	5.68 ^a
T ₅	Ridomil Gold 68 WP @ 3.0	6.10	7.00 ^a (15.34)	10.45 ^a (18.86)	70.97	8.00 ^a (16.43)	5.76 ^a
T ₆	Ridomil 72 WP @ 3.0	5.90	8.30 ^b (16.74)	13.60 ^b (21.64)	62.22	9.56 ^b (18.01)	5.60 ^a
T ₇	Mancozeb 75 WP @ 2.7	6.13	12.20 ^c (20.44)	16.25 ^c (23.77)	54.86	11.40 ^c (19.73)	5.12 ^b

*Mean of three replications. PTO- Pre treatment Observation. PDI- Per cent Disease Index. Values in the parentheses are arc sine transformed values. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT

Gold 68 %WP @ 2.5 ml/lit (T₄). The control recorded the least disease incidence.

The results from first and second season trails clearly revealed that Ridomil Gold 68% WP @ 3.0 ml/lit (T₅) recorded the lowest incidence of leaf spot which is at par with Ridomil Gold 68% WP @ 2.5 ml/lit (T₄). This is in agreement with the findings of Kumari *et al.* (2015) reported that Propiconazole (0.05%) and Carbendazim (0.05%) were highly effective providing 89.9 and 90.7 per cent and 89.5 and 90.3 per cent disease control on leaves and fruits, respectively. Spraying with Propiconazole @0.1% recorded significantly the least disease incidence (PDI-4.37%) followed by Thiophanate methyl and Hexaconazole recording 11.70 and 14.47 per cent disease index, respectively. Carbendazim showed the least efficacy with 52.43 and 23.33 per cent disease index at both the concentrations *viz.*, 0.05 and 0.1 per cent, respectively (Archana and Jamadar, 2014). Jamadar and Patil (2007) recorded that foliar application with Difenconazole (Score 25EC) and Prochloraz 45EC @1.0 ml/l each resulted in the management of pomegranate leaf spot and fruit spot achieving more than 74.0 to 86.7 per cent reduction of the disease, respectively over unsprayed control. Spraying with Zineb / Ziram (0.2%) or Chlorothanil (0.2%) at fortnightly intervals effectively, controlled leaf spot and fruit rot disease in pomegranate (Rawal, 2006). Navale *et al.* (1998) found that Copper oxy chloride, Ziram, Mancozeb and Captan as the best fungicides for controlling leaf spot and fruit spots of pomegranatae in mrigbahar caused by *Alternaria alternata*, *Cercospora sp.*, *Colletotrichum gloeosporioides*. The above results lend support to the present findings.

Effect of Ridomil Gold 68% WP on pomegranate fruit yield

Among the various treatments conducted in the field trial-I and II, Ridomil Gold 68% WP @ 3.0 ml/lit of water found significantly superior in giving highest fruit yield (6.45 t/ha; 5.76 t/ha) which was at par with Ridomil Gold 68% WP @ 2.5 ml/lit. The next best treatment was Ridomil Gold 68% WP @ 2.5 ml/lit (6.32 t/ha and 5.56 t/ha). The control recorded the lowest fruit yield of 4.25 t/ha and 3.67 t/ha (Table 1 and Table 2).

The results are in agreement with findings of Ginoya and Gohel (2015) reported that two foliar applications with Tebuconazole and Trifloxystrobin @0.05 per cent at an interval of 15 days was the most effective in reducing the fruit rot intensity and increasing the fruit yield of chilli over control. Archana and

Jamadar (2014) reported that spraying with Propiconazole recorded significantly the highest fruit yield (36.15t\ha) followed by Thiophanate methyl (31.70), Azoxystrobin (31.31t\ha), Hexaconazole (29.65t\ha), Difenconazole (23.80t\ha) was recorded in untreated control.

Jamadar and Patil (2007) reported that significantly highest fruit yield and more TSS was obtained by spraying of Score 25EC @1 ml/l (9831 kg/ha; 16.2) followed by Score 0.5 ml/l. In similar investigations Suryachandraselvan *et al.* (1993) and Shamarao *et al.* (1998) reported the efficacy of Paushamycin 500 ppm + copper oxy chloride (0.2%) and Kitazin 48%EC @0.15% effectively checked the pomegranate anthracnose. Thus the results of earlier workers are also in line with the results obtained in the present investigations.

Phyto-toxicity

All the newer fungicides tested did not cause any phytotoxicity symptoms in terms of necrosis/wilting/hyponasty/epinasty/vein clearing or any other injury either on the foliage or fruits on 0, 1, 3, 5, 7 and 10 days after fungicide.

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