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Bioefficacy studies of new fungicide molecules (Proquinazid 20 EC) against powdery mildew of apple

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Abstract
Powdery mildew disease is one of the most important diseases in apple caused by *Podosphaera leucotricha* (Ell. and Ev.). The present investigations were undertaken at Ambri Apple Research Center Shopian, SKUAST-Kashmir during 2015 and 2016 to assess the field evaluation of new fungicide molecule; Proquinazid 20EC, for the management of Powdery mildew disease in Ambri Apple. Field evaluation for two seasons revealed that three sprays of Proquinazid 20EC @ 0.025 completely controlled the disease and recorded 0.0 per cent disease incidence and disease intensity. The fungicide was also effective at 0.02% concentration and recorded 4.2 and 1.0 per cent disease incidence and intensity, respectively, which was lesser than the standard fungicide, Sulphr 80% WP @ 0.2% concentration. The highest yield (29.70t/ha.) was also observed in Proquinazid 20EC @0.025% followed by the same chemical at 0.02% concentration. The results also showed that Proquinazid 20EC even at higher doses (0.04 and 0.08%) did not manifest any Phytotoxicity symptoms and also exhibited an appreciable increase in fruit yield of Ambri apple.

Keywords: Apple, proqunazid 20ec, powdery mildew

Introduction
Powdery mildew (PM) is one of the most important diseases of apple throughout the world. The disease is caused by *Podosphaera leucotricha* (Ell. and Ev.) and is present in all apple growing countries. In some countries as many as 18 fungicidal sprays are required to control the disease (Yoder 2000) [10]. The pathogen may cause death of vegetative shoots or flower buds, and russetting of fruit (Jones and Aldwinckle 1990) [3]. The grower's primary concern with mildew is the russet symptoms that markedly reduce fruit quality (Spotts *et al*. 1986) [6]. Infected young trees of susceptible cultivars may be seriously damaged or become poorly shaped because of retarded vegetative growth or loss of terminal buds. Sulphur fungicides are most common fungicides used to manage Powdery mildew disease, however, Sulphur is known to causes fruit russetting in many of the apple varieties. The repeated use of Demethylation-inhibiting fungicide for control of apple disease including powdery mildew has resulted in emergence of resistance (Gao *et. al.* 2009) [1]. Therefore, there is need of evaluating new chemicals for the management of the disease. In the present studies the bio-efficacy of a new chemical; Proquinazid 20 EC, was tested against the powdery mildew disease in Ambri Apple under field conditions.

Methods and Materials
The present studies were conducted at Ambri Apple Research Center Shopian of SKUAST-K during 2015 and 2016. The bio-efficacy of the chemical, Proquinazid 20 EC, was tested at three concentrations of the product *viz.*, 0.015, 0.020 and 0.025% using Ambri cultivar of apple. The experiment was laid out in Randomized block design with three trees as three replications. The efficacy of the chemical was tested and compared with two chemicals, Dino cap 48EC and Sulphur 80% WP at recommended doses. Three sprays were applied just before the initiation of the disease and repeated at 15 days interval.
To record Powdery mildew incidence, four scaffold branches from four sides of tree canopy were marked. Five terminals randomly selected from each marked branch were assessed for per cent disease incidence and intensity. The per cent disease incidence was calculated by the formula (Mirza 1999)

$$\text{Disease incidence (\%)} = \frac{\text{Number of mildewed terminals}}{\text{Total number of terminals observed}} \times 100$$

Table 1: To assess the percent disease intensity (PDI), the mildewed terminals were categorized as under

Category	Numerical value	Criteria
I	0	Disease free
II	1	1 to 25% of annual extension growth mildewed
III	2	26 to 50% of annual extension growth mildewed
IV	3	51 to 75% of annual extension growth mildewed and bud necrosis
V	4	Above 75% of annual extension growth mildewed and bud necrosis

$$\text{Whereas mildewed annual extension growth \%} = \frac{\text{Mildewed length}}{\text{Total Annual extension growth}} \times 100$$

Percent disease intensity was calculated by the formula (Mirza 1999)

$$PDI = \frac{\Sigma (n \times v)}{N \times S} \times 100$$

Whereas,
Σ = summation
n = number of terminals in each category
v = numerical value of each category
N = Total number of terminals examined
S = the maximum numerical value
Per cent disease control of the disease was calculated. The apple fruit yield was converted into tons per hectare basis.

Phytotoxicity: The fungicide (Proquinazid 20 EC) was sprayed at the concentration 0.04 and 0.08% (product dose) and compared with untreated check. The phytotoxic effects such as leaf necrosis, leaf tip injury; wilting, vein clearing, epinasty and hyponasty were recorded at 0, 1st, 3rd, 5th, 7th and 10th days after application (DAA) of fungicide at fruit development stage 1st as per CIB guidelines. The level of Phytotoxicity was estimated by visual assessment by using 0-10 scale.

Results and Discussions

The pooled data of year 2015 and 2016 revealed that all the fungicides significantly reduced powdery mildew per cent disease incidence and intensity of apple as compared to control (Table 1). The lowest disease incidence (0.0%) was recorded by Proquinazid 20EC at 0.025% concentration with 100% disease reduction, which was at par with Proquinazid 20EC @ 0.02%. Dinocap 48% EC reduced 88.62% disease incidence over untreated check and recorded 9.2% disease incidence which was significantly lower than per cent disease incidence recorded in treatment Proquinazid 20EC @ 0.15% (16.7%) and Sulphur 80%WP (18.4%). The pooled data (Table 1) further revealed that Proquinazid 20EC @ 0.025% was significantly superior to other treatments and recorded 100 per cent disease reduction over control. The next best treatment was Proquinazid 20 EC at 0.02% which exhibited 1.0% disease intensity with 98.15% disease reduction over control. Dinocap 48% EC was superior over Proquinazid 20EC @ 0.15% concentration and recorded 2.3 and 4.2% disease intensity, respectively. Sulphur 80%WP recorded maximum disease intensity of 4.6% among the fungicidal treatments, however, the disease intensity was at par with 4.2% observed in Proquinazid 20 EC@ 0.015% concentration. The results are in agreement with the findings of Rather *et al*. (2015) [17] who reported efficacy of Triademifon 25WP, 0.05%, Myclobutanil 10WP @ 0.03, Dinocap 48%EC @0.05% and Sulphur 80% WP@ 0.2% in controlling powdery mildew disease of Ambri apple in Kashmir valley. The effectiveness of Difenoconazole, Dinocap, Sulphur and Bitertanol were reported by various workers (Gupta & Sharma 2009) [2].

The data (Table 1) further revealed that treatment with Proquinazid 20EC @ 0.025 exhibitedhighestyield with 29.7t/ha. The yield of 29.60t/ha, 28.95t/ha and 28.85t/ha was observed by the treatments with Proquinazid 20EC @ 20%, Dinocap 48% EC @ 0.03% and Proquinazid 20 EC @ 0.015%, respectively. All the treatments recorded significantly better yield over control, however, the difference within the treatments was statistically non-significant. The results are in agreement with findings of Muthukumar and Udhayakumar (2015) [5] reported that application of Ridomil Gold 68%WP @ 3.0 ml/lit gave higher fruit yield than untreated controlin pomegranate. In fruit crops like apple, fungicidal treatments may largely influence quality of the fruits and can be ineffective in increasing fruit bud initiation or fruit set in apples (Rich 1957, Ross and Longley 1963) [8, 9]. However, by keeping the photosynthetic area of leaves free from diseased spots, fungicides can increase the yields of the fruit crops also, apart from improving the quality of the fruit.

Table 1: Bio-efficacy of fungicide bearing Code- 308 (Proquinazid 20 EC) against Powdery mildew disease of Apple during 2015 & 2016 in Kashmir J&K (District Shopian)

S. No.	Fungicide	Conc.	Incidence (%)*	PDC	Intensity (%) *	PDC	Yield * Tons/ ha.
1	Proquinazid 20 EC	0.015	16.7 (4.20)	79.35	4.2 (2.28)	92.25	28.85
2	Proquinazid 20 EC	0.020	4.2 (2.28)	94.80	1.0 (1.41)	98.15	29.60
3	Proquinazid 20 EC	0.025	0.0 (1.0)	100.0	0.0 (1.0)	100.0	29.70
4	Dinocap 48% EC	0.030	9.2 (3.19)	88.62	2.3 (1.81)	95.75	28.95
5	Sulphur 80% WP	0.200	18.4 (4.40)	77.25	4.6 (2.36)	91.51	28.65
6	Check		80.9 (9.05)		54.2 (7.43)		25.6
CD (p=0.05)			1.31		0.37		2.6
SE(m)			0.43		0.12		0.9

*Pooled data of 2015 and 2016- Values in parenthesis are square root transformation.

Phytotoxicity

It was also observed that there was no phytotoxic or other harmful effect at 0, 1st, 3rd, 5th, 7th and 10th day of application of test chemical, Proquinazid 20EC at 0.04 and 0.08% concentration. Thus it can be concluded that test chemical, Proquinazid 20 EC when sprayed up to 0.08% concentration (80ml/100 litre of water) do not cause any type of phytotoxic symptoms in terms of necrosis/wilting/hyponasty/epinasty/ vein clearing or any other injury either on the foliage or fruits on the test cultivar of Apple.

The fungicide (Proquinazid 20 EC) at 0.020 and 0.025% concentration proved most effective and superior fungicide to

all other treatments in controlling Powdery mildew disease of Apple caused by *Podosphaera leucotricha* and was completely safe to tree and fruits without causing any type of phytotoxic effect/ injury to the test cultivar.

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