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Original Article

# Evaluation of fungicides and nutritional amendments against powdery mildew of pumpkin

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## Abstract

*Sphaerotheca fuliginea* is the most commonly recorded fungus that cause powdery mildew of cucurbits. The outbreak of this disease occurred in Pakistan in Neelam valley. Current study was conducted to minimize significant economic losses by using different combinations of fungicides and nutritional amendments. Fungicides Bravo (Chlorothalonil) and Score (Difenoconazol) and nutrient solutions of Agsil (Potassium silicate) and Peak (mono potassium phosphate) were applied alone and in combination to manage the disease. Bravo and Score were applied @ 1.5ml/L and 2.5ml/, respectively while 0.1% solutions of both Agsila and Peak was used. Nutritional amendments were used before the onset of disease and fungicides were applied after the appearance of disease. All the treatments were randomized in three replications. The findings described the combination of fungicides was most efficient in decreasing disease incidence as it reduced the powdery mildew incidence upto 60%. In individual fungicidal applications, Bravo treated plants showed less disease incidence (36%) than Score (40%). However to avoid from the environmental hazards nutritional amendments is the safest option which gave 50% reduction in disease incidence. Agsil was more effective than Peak in individual applications and it showed 47% disease incidence that was 49% in case of Peak.

**Keywords**: Powdery mildew, Pumpkin, Management, Evaluation

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## Introduction

Pumpkin is a valuable crop of tropical and temperate zones worldwide (Jun et al., 2006). The fruit contains fat, proteins, carbohydrates and vitamin A (Tellez et al., 2002). Production of pumpkin is affected by genotype selection, sowing date, soil type, insect infestation, diseases and disorders (Schaefer and Renner, 2011). Different bacterial, viral and fungal diseases also disrupt the pumpkin physiology and growth (Vucurovic et al., 2012). Among these, *Sphaerotheca fuliginea* fungus causes the most

devastating disease powdery mildew (McGrath and Thomas, 1996). It causes significant reduction in pumpkin quality and quantity (Kiss, 2003).
*Sphaerotheca fuliginea* cannot be cultured on artificial medium (Kristkova et al., 2009). Firstly mature leaves and stem are infected by the fungus resulting in defoliation, reduced photosynthesis and ultimately low yield (Mossler and Nesheim, 2003). Leaves infected with powdery mildew generally died and wilted as a result plants senesce prematurely (Zitter et al., 1996). Pathogen growth reduces the photosynthetic area of the leaves (Cohen et al., 2007) and cause up to 70% yield losses (EI-Naggar et al., 2012). Plant infection results in reduced sugar contents that decrease quality of fruits and its market value (Dik and Albajes, 2002).
Race-specific genes through genetic resistance can be used to control Powdery mildew (Kuzuya et al., 2006). Due to the fast genetic changes inside the pathogen population, genetic resistance is not long-lasting (Hosoya et al., 2000). Resistant cultivars and fungicides provide best control of powdery mildew disease in cucurbits (McGrath and Thomas, 1996). Quinoxyfen, triflumizole, and penthiopyrad are highly efficient in controlling powdery mildew disease in susceptible varieties (Zhang et al., 2011). Experiment carried out in greenhouse and field conditions to evaluate the efficacy of systemic fungicides (Rubigan 12% Master 10%, Topas 10% Vectra 10%) in order to control muskmelon powdery mildew disease that reduced disease severity (Ashour et al., 2009). Fungicide Bayleton significantly reduces the powdery mildew disease incidence as compared to other fungicides (Matheron and Porchas, 2000). Mixing of curative and preventive fungicides is the best tactic to get rid of fungicidal resistance (Briggs et al., 2007). Repeated use of chemicals build up resistance in pathogens against fungicides (Gullino et al., 2000). Despite the fungicide usage is an effective strategy to control plant diseases (Matheron and Porchas 2013) but continuous use may deteriorate the environment. Foliar spray of potassium salts decrease powdery mildew incidence (Kettlewell et al., 2000). Nutrient supplements play an important role for controlling the fungal disease in plants (McGrath, 2001). Silicon decreases the various diseases in monocotyledons and dicotyledons incited by the pathogens such as biotrophic, necrotrophic and hemibiotrophic (Datnoff et al., 2007). Nutrient solutions enhance the tolerance of pumpkin against powdery mildew disease (Savvas et al., 2009). Foliar spray of nutrients enhance the growth and development of plants that leads to improved disease resistance and increased yield. Potassium silicate (KSi) impose suppressive effect on fungal growth and increase plant immunity by forming a physical barrier on leaf surface (Liang et al., 2005). KSi enhance the concentration of free amino acids and defense related enzymes in the plants (Souza et al., 2014). Monopotassium phosphate ($KH_2PO_4$) cause malformed conidial and mycelia growth of fungus (Arslan, 2015). $KH_2PO_4$ suppresses disease by affecting pathogen multiplication, metabolism of the plant and stomatal functions (Perrenoud, 1990). It induces systemic acquired resistance by disturbing cell membrane of the target pathogen (Gottstein and Kuc, 1989).
Funigicides and nutrients could be helpful in decreasing disease incidence and enhanced yield. Therefore, different nutrients and fungicides were applied to control the powdery mildew of pumpkin.

## Material and Methods

Experiment was carried out in research field, Department of Plant Pathology, University of Agriculture, Faisalabad (Pakistan) N 31°26′1.18968 E 73°3′56.01204. Area used for this experiment was (54 × 29 square foot). Genotype (Mahadeev) seeds were collected from AARI (Ayub Agricultural Research Institute, Faisalabad). The study was focused on disease management so that susceptible variety was selected to get the maximum disease pressure. The experiment was conducted by following randomized complete block design (RCBD) with three replications. The seeds were sown on the bed with a distance of 2 feet.

### Inoculation of powdery mildew

Inoculum was taken from Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad. Conidia was slowly added in two drops of distilled water and counted using a haemocytometer to give a conidial suspension of $3\times l0^4$ $ml^{-1}$ for inoculation, the upper surface of plant was sprayed evenly with a hand sprayer. Leaves of the plant were inoculated with inoculums of *Sphaerotheca fuliginea* at the 3-4 leaf stage. In evening, water was also sprayed daily to ensure favorable environmental conditions for disease development.

**Disease assessment**
The following formula was used to calculate incidence of powdery mildew infection

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected plants}}{\text{Total plants}} \times 100$$

(Mir, 2011)

**Management of powdery mildew of pumpkin through nutritional supplements and chemicals**
Two chemicals Bravo (chlorothalonil), Score (Difenocnazole), and their combination with a standard dose were evaluated in a field condition. Two nutritional supplements Agsil (potassium silicate), Peak (mono Phosphate - potassium) and their combination were evaluated against powdery mildew disease.

**Table-1: Treatments used against powdery mildew disease of pumpkin**

| Sr.No | Fungicide | Active Ingredient | Recommended |
|---|---|---|---|
| T1 | Score | Difenconazole | 250ml/100L |
| T2 | Bravo | Chlorothalonil | 150ml/100L |
| T3 | Bravo +Score | Chlorothalonil+ Difenconazole | 2.5+1.5mL/L |
| T4 | Agsil | Potassium Silicate | 0.1% |
| T5 | Peak | Monopotasium Phosphate | 0.1% |
| T6 | Agsil+ Peak | Potassium Silicate + Monopotasium Phosphate | 0.2% |
| T7 | Control | Distilled water | |

**Statistical analysis**
Analysis of variance (ANOVA) was carried out to interpret the data of disease incidence. Software like Statistix 8.1 was used to perform statistical tests. Means were compared using (LSD) test (Steel, 1997).

## Results

All the treatments (fungicides, nutrients and their combinations) contributed towards reducing the powdery mildew disease incidence on pumpkin as compared to control (Table.2). The combination of both fungicides gave the most effective control of fungus (58%) and disease incidence was significantly decreased (34%) as compared to untreated plants (80%). Efficacy of individual fungicide remained good and Score was better than Bravo which gave 55% control of the disease.
Proper plant nutrition strengthens its vigor and stimulates the defense mechanisms. The combination of two nutrient solutions Agsil (Potassium silicate) and Peak (monopotassium phosphate) remained significant in controlling the disease after the individual and combined use of fungicides. When mineral nutrients were used separately, Agsil (41.25%) proved better than Peak (38.75%). Combined use of nutrients gave 46% reduction in disease incidence. Overall evaluation showed that fungicides most significantly reduced disease incidence in comparison to nutrients.

**Table-2: Effect of fungicides and nutrients on powdery mildew disease incidence**

| Serial # | Treatment | Disease incidence (%) | Decrease over control (%) |
|---|---|---|---|
| T1 | Peak | 49 b | 38.75% |
| T2 | Agsil+Peak | 43 d | 46.25% |
| T3 | Bravo | 40 e | 50.00% |
| T4 | Agsil | 47 c | 41.25% |
| T5 | Score | 36 f | 55.01% |
| T6 | Bravo+Score | 34 g | 57.51% |
| T7 | Control | 80 a | |
| | LSD | 1.2 | |

Different letters show significantly different values in coloumn at (P =0.05).

Powdery mildew disease incidence significantly reduced after every spray (Table.3). The significant difference was observed in disease incidence in all treatments after first and third spray. The results revealed that disease incidence was most significantly reduced in plants treated with Agsil as compared to others.

**Table-3: Efficacy of treatments after each spray**

| Treatments | Disease Incidence (%) | | |
|---|---|---|---|
| | $Spray_1$ | $Spray_2$ | $Spray_3$ |
| Agsil | 57 d | 43 g | 28 j |
| Peak | 56 d | 52 e | 38 h |
| Agsil + Peak | 57 d | 48 f | 34 i |
| Score | 47 f | 33 i | 28 j |
| Bravo | 51 e | 43 g | 34 i |
| Score + Bravo | 43 g | 38 h | 23 k |
| Control | 75 c | 80 b | 85 a |
| | LSD | 2.1556 | |

## Discussion

*Sphaerotheca fuliginea* was isolated from powdery mildew affected plants of cucurbitaceae family (McGrath, 2001). In present study, fungicides gave best control of the powdery mildew. Chlorothalonil and difenoconazole effectively reduced the powdery mildew disease incidence. Chaudhury et al. (2000) recorded 46% control of the disease by using score (difenconazole) that halts fungal growth by interfering with sterol biosynthesis. Minimum disease incidence was recorded in plants treated with fungicide (Score). Score is an effective preventive and curative fungicide due to its quick absorption and high translaminar activity (Jacobsen et al., 2004). These results are in line with Kiran and Ahmad (2005) who recorded maximum powdery mildew disease reduction by the use of Score. Sharma (2006) tested 6 fungicides against powdery mildew and found that difenoconazole is the most effective.

The effect of Bravo (chlorothalonil) was also significant in reducing the pumpkin mildew disease. These results are in line with the results of (Matheron and Porchas, 2013) who evaluated fungicides for the management of powdery mildew of pumpkin. Bravo has multisite mode of action against lower fungi causing powdery mildew (Naidu et al., 2012).

Regular use of chemicals is not cost effective and environmental friendly option. In present study, efficacy of mono-potassium phosphate, potassium silicate and their combination against powdery mildew disease was assessed. Combined effect of both nutrients was better than their individual application. Potassium silicate proved more effective than monopotassium phosphate. Dallagnol et al. (2011) findings supported present results on powdery mildew control through potassium silicate. *S. fuliginea* spore germination was minimum after the application of mono-potassium phosphate and potassium silicate (Menzies et al., 1992). Savvas et al. (2009) observed minimum mildew growth in silicon treated plants. Kettlewell et al. (2000) described significant reduction in fungal colonies as a result of silicon spray. Nofal and Haggag (2006) recorded reduced powdery mildew disease severity in pumpkin fields where potassium silicate was applied before the inoculation of pathogen. The impact of biotic stresses could be minimized by using silicon (Epstein, 2009). According to Ma and Yamaji (2008) silicon acts as physical barrier and host defense modulator against pathogens. Silicon reduced the hyphal elongation and inhibited the fungal mycelium growth under in-vitro conditions (Bekker et al., 2006). Potassium silicate solution reduced the germination of powdery mildew conidia by 40–60% (Kanto et al., 2004).

Local and systemic induced resistance can be activated in plants by using different nutrients containing phosphate (Reuveni et al., 1998). Mosa (2002) determined the efficacy of $KH_2PO_4$ in reducing powdery mildew disease incidence. Reuveni et al. (2006) indicated that foliar application of potassium phosphate inhibits the fungal growth and found it as an eco-friendly management tactic. Weekly spray of $KH_2PO_4$ gave significant reduction in powdery mildew disease in roses (Pasini et al., 1997). Orober et al. (2002) stated that phosphate induced resistance by the mechanism of localized cell death and generating reactive oxygen species.

## Conclusion

Spray of nutrient solutions before the onset of disease, result in significant reduction of disease incidence. Nutrient application can compensate the deficiencies in plant growth by accelerating the plant physiology. Fungicides alone and in combination were more effective in controlling the powdery mildew disease. Similarly, combined application of nutrients proved better than individual applications in reducing disease incidence.

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## Contribution of Authors

Yousaf M: Conducted experiment
Anjum R: Supervised research and approved manuscript
Ahmed N: Statistical analysis and data interpretation
Zeshan MA: Data collection and manuscript write up
Ali S: Literature review and manuscript write up
Ghani MU: Helped in experimental layout and spray formulations