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EFFICACY OF CHEMICAL FUNGICIDES FOR THE MANAGEMENT OF POWDERY MILDEW IN PUMPKIN

R. MOMOTAZ[1], M. M. ALAM[2], M. ARIFUNNAHAR[3]
M. M. ISLAM[4] AND M. S. ALI[5]

Abstract

The experiment was conducted to study the efficacy of nine new fungicides in managing powdery mildew disease of pumpkin under field conditions during *rabi* season using the variety 'BARI Mistikumra-2'. The fungicides were K-zeb M-45 WP (Mancozeb 80% WP), Cymozeb 72 WP (Mancozeb 64% + Cymoxanil 8%), Carbostin 50 WDG (Carbendazim 50% WP), Ridhuk 25 SC (Hexaconazole 3%), Lalon 75 WDG (T_5Trifloxostrobin 25% + Tebuconazole 50%), Kariwa 28 SC (Azoxystrobin 20% + Cyproconazole 80%), Limotar top 32.5 SC (Azoxystrobin 20% + Difenazole 12.5%), Switch 72 WP (Mancozeb 64% + Cymoxanil 8%) and Bioconazole plus 25 SC (hexaconazole 3% + Tricyclazole 22%). All fungicides enhanced vegetative growth and fruit yield of pumpkin in general. Among the fungicides, Carbostin 50 WDG (@ 2% performed better and reduced the present disease index by 3.17% resulted in a higher fruit yield (19.75 t/ha) of pumpkin. The investigation revealed that the application of Carbostin 50 WDG fungicide would be a potential aspirant for effective management of powdery mildew disease of pumpkins under field conditions.

Keywords: Powdery mildew, Pumpkin, Fungicide, Yield

Introduction

Pumpkin (*Cucurbita maxima*), a member of the Cucurbitaceae family, is a widely used vegetable in Bangladesh (Lisa *et al.*, 2022). It originated in Central America, domesticated in Mexico and is now widely distributed worldwide (Ahmad and Khan, 2019). It serves as a valuable source of functional components mainly carbohydrates, vitamins A, C, and E and various minerals which act as an antioxidant in human nutrition (Aziz *et al.*, 2023). Pumpkin seeds are a rich source of unsaturated fatty acids and oil (Lisa *et al.*, 2022). Approximately 1.40 lakh hectares in Bangladesh are used for growing this crop, with an average yield of 20-25 metric tons per hectare (Anon., 2021). Nowadays, pumpkin production has decreased dramatically due to the consequence of the occurrence of diseases.

Pumpkins are attacked by many diseases such as bacterial wilt, angular leaf spot, phytophthora blight, downy mildew, powdery mildew, etc. Among the diseases powdery mildew is common. This disease affects all cucurbits (Rhouma *et al.*, 2023). This disease is caused by two fungal species viz. *Podosphaera xanthii* and

[1&3]Plant Pathology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh; [2]Crop Division, Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh; [4&5]Department of Plant Pathology, Faculty of Agriculture, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh.

Erysiphe cichoracearum (Cohen *et al.,* 2004; Perez-Garcia *et al.,* 2009). In Bangladesh, the fungus *Erysiphe cichoracearum* (Perfect stage-*Oidium* spp.) causes most of the powdery mildew on cucurbits (Yasmin *et al.,* 2008). Powdery mildew appears on leaves, petioles and young stems as a white powdery mass composed of mycelium and numerous spores (Rhouma *et al.*, 2023; Glawe, 2008). Under favourable environmental conditions of this disease, the entire upper surface of the leaf may be covered with the powdery fungus and the whole field may appear to white within a few days (Cohen *et al*., 2004; Rhouma *et al.*, 2021) and the photosynthesis process is hampered. The resulting decrease in photosynthates may cause significant reductions in the quality and fruit yield and yield loss exceeds 30 to 34 % in the crop (Keinath and DuBose, 2004; Tisserat, 2006).

In the commercial sector, powdery mildew is commonly managed through the use of various synthetic fungicides and/or breeding methods that create cultivars with resistance. Many agricultural experts advised implementing a rotation of fungicides from different classes on a 7-10-day spray schedule once a disease has been detected (Horsfield, 2010). The reason why contact fungicides are effective in controlling powdery mildew is because the majority of plant infections occur on the surface of leaves, requiring thorough coverage for successful treatment. So, fungicide significantly reduces the powdery mildew disease incidence (Maryam *et al*., 2020). Repeated use of systemic chemicals builds up resistance in pathogens against fungicides (Gullino *et al.,* 2000). Mixing of curative and preventive fungicides is the best tactic to get rid of fungicidal resistance (Van den Bosch *et al.,* 2014). Despite the fungicide use is an effective strategy to control plant diseases (Matheron and Porchas, 2008) but continuous use may deteriorate the environment. Limited reports on the chemical control of pumpkin powdery mildew disease are available in Bangladesh. Hence, the present investigation was undertaken to evaluate some new chemical fungicides for the management of powdery mildew disease in pumpkin.

Materials and Methods

The experiment was conducted in the research field of the Plant Pathology Division, Bangladesh Agricultural Research Institute (BARl), Gazipur during the *rabi* season of 2017. The texture of the soil was loamy. The experiment was laid out in a Randomized Complete Block Design (RCBD) with ten treatments and each treatment was replicated three times. The following treatments were used in this experiment (Table 1).

The experimental land was well prepared by ploughing and laddering. Each plot size was 4×5 m^2 maintaining pits size 50×50×45 cm. The pumpkin variety BARI Mistikumra -2 was used in this experiment. The chemical fertilizers were used as nutrient sources for soil as recommended by BARI. Three seeds of pumpkin were sown in each pit and after germination one healthy seedling was allowed to grow in each plot. Weeding and irrigation was done when required. The insecticide Malathion 57 EC was applied three times at 10-day intervals to control pumpkin insects. The fungicides were sprayed three times at 9 days interval. The spray was stared with the first appearance of disease. Data were recorded on percentage of disease index, percentage of disease reduction over control, number of fruits per plot, yield per plot (kg). Per plot yield was converted into per hectare yield (ton). Ten leaves per plant in each treatment were considered for measurement of the percentage of disease index.

Table 1. The name of fungicides with their group name and concentration

Treatments & name of fungicides	Group name of fungicides with a.i.	Concentration (%) (g or ml/L)
T_1= K-zeb M-45 WP	Mancozeb 80% WP	2.00
T_2= Cymozeb 72 WP	Mancozeb 64% + Cymoxanil 8%	2.00
T_3= Carbostin 50 WDG	Carbendazim 50% WP	2.00
T_4= Ridhuk 25 SC	Hexaconazole 3% + Tricyclazole 22%	3.00
T_5= Lalon 75 WDG	T_5Trifloxostrobin 25% + Tebuconazole 50%	0.50
T_6= Kariwa 28 SC	Azoxystrobin 20% + Cyproconazole 80%	1.00
T_7= Limotar top 32.5 SC	Azoxystrobin 20% + Difenazole 12.5 %	1.00
T_8= Switch 72 WP	Mancozeb 64% + Cymoxanil 8%	1.00
T_9= Bioconazole plus 25 SC	Hexaconazole 3% + Tricyclazole 22%	1.00
T_{10}= Control	Spray water only	

Data on disease index for Powdery mildew was recorded 7 days after the last spray and converted into percent disease index by using the following formula (Malviya *et al.,* 2022).

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of numerical ratings}}{\text{Number of leaves observed} \times \text{Maximum rating scale}} \times 100$$

The data on diseases severity of Powdery mildew was rated following a 0-4 scale, where 0= healthy or no infection, 1= slight infection, fine coating of powdery growth on upper leaves, stem free from powdery mass, 2= moderately infected, nearly 50% plant is covered powdery mass, the stem also infected, 3= nearly 75% leaves infected, whole plants are covered with powdery mass, the stem also infected and 4= all leaves as well as stem and other parts coated with thick powdery mass, leaf colour changes to greyish and starts drying. The percentage of disease reduction of each treatment over control was calculated. Data on Percent disease index of powdery mildew (%) were transformed according to square root transformation formula before analysis.

Data were analyzed statistically using R software program. The significant differences in the treatment means were compared by Duncan’s Multiple Range Test (DMRT) at 1% level. The correlation between vegetative growth of crop and yield parameters with disease index (%) were also computed.

Results and Discussion

Disease index (%)

The effect of fungicides on the percent disease index of Powdery mildew of pumpkin was evaluated at 110 days after sowing (DAS). The PDI (percent disease index) ranged from 3.17% to 79.51%, which was found significantly different among the treatments (Table 2). The highest disease index (79.51%) was recorded in the control (only water spray) and the lowest disease index (3.17%) was recorded in the treatment T_3 (Carbostin 50 WDG @ 2%). So, the fungicide Carbostin 50 WDG showed highest potential to suppress the powdery mildew disease of pumpkin.

Disease reduction (%)

The disease reduced by the fungicide treatments ranged from 58.19% to 96.02% (Table 2). The lowest disease reduction was recorded from T_6 (Kariwa 28 SC) treatment and the highest disease reduction was obtained from T_3 over the control treatment.

Number of fruits per plot

Regarding the number of fruits per plot, the maximum number of pumpkin fruits per plot (28.60) was observed in T_3 and the minimum number of fruits per plot (15.08) was attained from the control (Table 3). Based on the findings, it could be figured out that Carbostin played an imperative role in controlling powdery mildew disease of pumpkin.

Table 2. Effect of fungicides on the severity (%) and percent reduction of powdery mildew disease of pumpkin under field condition

Treatments	Percent disease index of powdery mildew (%)	Disease reduction over control (%)
T_1= K-zeb M-45 WP	21.78 (4.67) d	72.61
T_2= Cymozeb 72 WP	15.49 (3.94) e	80.52
T_3= Carbostin 50 WDG	3.17 (1.78) i	96.02
T_4= Ridhuk 25 SC	24.95 (4.99) c	68.62
T_5= Lalon 75 WDG	17.23 (4.15) e	78.33
T_6= Kariwa 28 SC	12.43 (3.53) f	84.37
T_7= Limotar top 32.5 SC	33.25 (5.77) b	58.19
T_8= Switch 72 WP	6.04 (2.76) h	92.40
T_9= Bioconazole plus 25 SC	8.88 (2.98) g	88.84
T_{10}= Control	79.51 (8.92) a	-
Level of significance	**	
CV (%)	3.05	

Figures in the parenthesis are square root transformed values.

DAS = Days after Sowing, CV=Co-efficient of variations, Here, values in the column having a similar letter (s) are statistically identical (DMRT test at p<0.01). ** = 1% level of significance.

Table 3. Effect of different chemical fungicides on yield contributing characters of pumpkin combating powdery mildew under field conditions

Treatments	No. of fruits per plot	Yield per plot (kg)	Yield (t/ha)
T_1= K-zeb M-45 WP	22.33 d	32.43 c	16.29 bc
T_2= Cymozeb 72 WP	24.17 cd	33.52 bc	16.73 bc
T_3= Carbostin 50 WDG	28.60 a	39.53 a	19.75 a
T_4= Ridhuk 25 SC	22.23 d	31.82 c	15.76 c
T_5= Lalon 75 WDG	21.60 d	33.24 bc	16.65 bc
T_6= Kariwa 28 SC	23.34 cd	34.25 bc	17.16 b
T_7= Limotar top 32.5 SC	24.28 cd	28.53 d	14.27 c
T_8= Switch 72 WP	27.48 ab	35.64 b	17.74 b
T_9= Bioconazole plus 25 SC	25.26 c	34.53 bc	17.26 b
T_{10}= Control	15.08 e	18.56 e	9.26 d
Level of significance	**	**	**
CV (%)	2.33	5.67	6.23

CV=Co-efficient of variations, Here, values in the column having a similar letter (s) are statistically identical (DMRT test at $p<0.01$). ** = 1% level of significance.

Yield per plot (kg)

The fruit yield per plot varied significantly in different treatments (Table 3). The highest fruit yield per plot (39.53 kg) was found in T_3 and it was different significantly from the rest treatments. The findings of the study indicated that the pumpkin fruit yield per plot was varied among the treatments in the field conditions and Carbostin 50 WDG demonstrated the best performance in controlling powdery mildew disease and increasing crop yield.

Yield per hectare (tons)

Notably, significant variations were observed among the fungicide treatments in respect of pumpkin yield per hectare (Table 3). The highest yield per hectare (19.75 tons) was found in T_3 which was different significantly from the rest treatments. The lowest yield per hectare (9.26 tons) was recorded in the control.

The results of the investigation showed that there existed a substantial negative correlation between the severity of powdery mildew disease and vegetative growth as well as fruit yield of pumpkin (Figure 1). Significant negative correlations were found to be existed between the powdery mildew disease severity with number of fruits per plant ($y = -0.583x + 28.974$), yield per plot ($y = -0.8791x + 40.555$) and yield per hectare ($y = -0.4385x + 20.252$). The findings validated that the application of chemical fungicides would reduce the severity of powdery mildew disease and thereby, enhanced vegetative growth as well as the fruit yield of pumpkin.

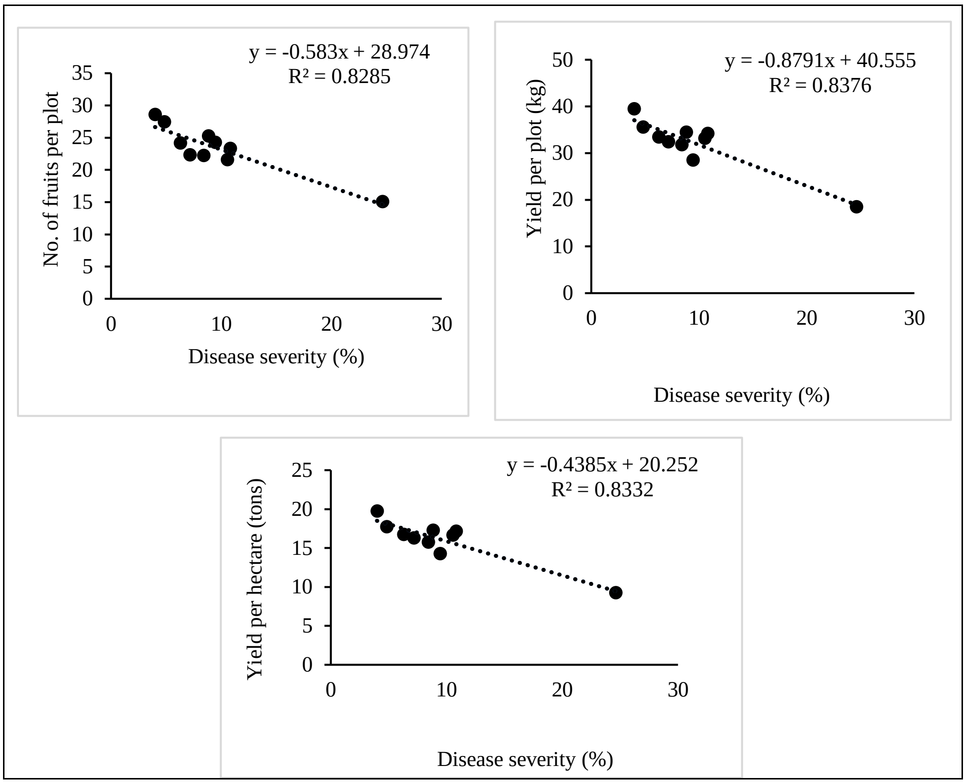

Fig. 1. Correlation between vegetative growth and yield parameters of pumpkin with powdery mildew disease severity (%) (a-c).

The impact of various fungicides was imperative on severity of powdery mildew disease, fruit yield, and yield components of pumpkin (Table 2 & 3). The outcomes demonstrated the significant effectiveness of all fungicides, viz. K-zeb M-45 WP, Cymozeb 72, Carbostin 50 WDG, Ridhuk 25 SC, Lalon 75 WDG, Kariwa 28 SC, Limotar top 32.5 SC, Switch 72 WP, and Bioconazole plus 25 SC against powdery mildew disease of pumpkin. Assessment of the percent disease index, percentage of disease reduction, number of fruits per plot, yield per plot (kg), and yield per hectare (tons) in various chemical fungicide treatments revealed compelling results. Due to fungicide treatments the severity of powdery mildew disease of pumpkin was ranged from 3.17 to 79.51%. The findings were aligned with McGrath *et al.* (2015), who reported that chemical fungicides showed a significant reduction in controlling powdery mildew disease of pumpkin. The percent of disease reduction over control ranged from 58.19% to 96.02%. The lowest diseases reduction was recorded from Kariwa 28 SC treatment and the highest disease reduction was obtained from Carbostin 50 WDG over the control treatment. These findings aligned with previous studies reported by Jones (1978). Matheron and Porchas (2008) found that fungicide treatments used in melon varieties reduced the percentage of diseases of powdery mildew compared to untreated control.

The effect on yield and yield contributing characters of pumpkin under set treatments were enhanced by the application of different fungicides. Moreover, similar findings were reported by Bhaskar *et al.* (2012) in groundnut, Meena *et al.* (2016) in green gram, Abhishek and Sobita (2017) in garden pea, Madhuri and Sagar (2020) in black gram, Jayasekhar and Ebenazar (2016), and Rhouma *et al.* (2023) in melon. The correlation study showed a substantial negative relation between vegetative growth and fruit yield of pumpkin with powdery mildew severity.

Conclusion

The findings of the experiment revealed that application of Carbostin 50 WDG @ 2% increased the fruit yield of pumpkin and lessened the severity of powdery mildew disease. Therefore, compared to other fungicides, Carbostin 50 WDG, a member of the Carbendazim group, was a better choice for reducing the powdery mildew disease of pumpkin under field conditions.

References

Abhishek, S. and S. Simon. 2017. Eco-friendly management of powdery mildew and rust of garden pea (*Pisum sativum* L.). *J. Pharm. Phyto.* **6** (5): 90-93.

Ahmad, G. and A. A. Khan. 2019. Pumpkin: horticultural importance and its roles in various forms; a review. *Int. J. Horti. Agri.* **4** (1): 1-6. http://dx.doi.org/10.15226/2572-3154/4/1/00124

Aziz, A., S., Noreen, W. Khalid, A. Ejaz, I. Faiz ul Rasool, A. Maham Munir, M. Farwa Javed, S. Ercisli, Z. Okcu, R. A. Marc, G. A. Nayik, S. Ramniwas and J. Uddin. 2023. Pumpkin and Pumpkin Byproducts: Phytochemical Constitutes, Food Application and Health Benefits. *ACS Omega.* **8** (26): 23346–23357. https:// doi.org /10.1021 /acsomega. 3c02176

Anonymous. 2021. Year Book of Agricultural Statistics of Bangladesh, 2019-20. Statistics Division, Ministry of Planning, Dhaka.

Bhaskar, A. V., A. M. Parakhia and S. V. Patel. 2012. Compatibility of fungicides and insecticides for management of groundnut tikka disease (Early leaf spot and late leaf spot) in Saurashtra region. *Indian J. Plant Prot.* **40**(3): 191-194.

Cohen, R., Y. Burger and N. Katzir. 2004. Monitoring physiological races of *Podosphaera xanthii* (syn. *Sphaerotheca fuliginea*), the causal agent of powdery mildew in cucurbits: Factors affecting race identification and the importance for research and commerce. *Phytoparasitica.* **32**: 174-183.

Glawe, D. A. 2008. The powdery mildews: a review of the world's most familiar (yet poorly known) plant pathogens. *Ann Revi Phyto.* **46**: 27–51. https : // doi. org/ 10.1146/annurev .phyto .46 .081407.104740

Gullino, M. L., P. Leroux and C. M. Smith. 2000. Uses and challenges of novel compounds for plant disease control. *Crop Prot.* **19**(1): 1-11. https://doi.Org/10.1016/ S02612194(99)00095-2

Horsfield, A., T. Wicks, K. Davies, D. Wilson and S. Paton. 2010. Effect of fungicide use strategies on the control of early blight (*Alternaria solani*) and potato yield. *Aus. Plant Path.* **39**(4): 368. https://doi.org/10.1071/ap09090

Jones, J. P. 1978. Disease thresholds for downy mildew and target leaf spot of cucurbits and late blight of tomato. *The Plant Dis. Rep.* **62**(7-12): 798.

Keinath, A. P. and V. B. DuBose. 2004. Evaluation of fungicides for prevention and management of powdery mildew on watermelon. *Crop Prot.* **23**(1): 35-42. https://doi.org/10.1016/S0261-2194(03)00165-0

Lisa, S. A., M. A. Kabir and S. Khan. 2022. Utilization of seed from Cucurbita maxima, a pumpkin variety of Bangladesh, converting into refined oil and oilcake. *Discover Food.* **2**(1): 19. https://doi.org/10.1007/s44187-022-00021-9

Madhuri, V. and G. K. Sagar. 2020. Management of foliar diseases in Blackgram. *J. Phar. Phytoche*. **9**(1): 101-103.

Malviya, D., R. Thosar, N. Kokare, S. Pawar, U. B. Singh, S. Saha, J. P. Rai, H. V. Singh, R. G. Somkuwar and A. K. Saxena. 2022. A Comparative Analysis of Microbe-Based Technologies Developed at ICAR-NBAIM Against Erysiphe necator Causing Powdery Mildew Disease in Grapes (*Vitis vinifera* L.). *Fronti. Microbio.* **13**: https://doi.org/10.3389/fmicb.2022.871901

Maryam,Y., A. Romana, A. Nadeem, M. A. Zeshan, A. Safdar and M. U. Ghani. 2020. Evaluation of fungicides and nutri tional amendments against powdery mildew of pumpkin. *Asian J. Agri. Bio.* **8**: 69-74.

Matheron, M. E. and M. Porchas. 2008. Examination of fungicides for management of powdery mildew on cantaloupe in 2007. Vegetable report. College of Agriculture and Life Sciences, University of Arizona (Tucson, AZ), USA.

McGrath, T. Margaret and LaMarsh, Karen. 2015. Efficacy of Fungicides for Managing Powdery Mildew in Pumpkin-2014. Midwest Vegetable Trial Reports. Paper 129. https://docs.lib.purdue.edu/mwvtr/129

Meena, N. K., S. Zacharia and N. B. Patil. 2016. Management of green gram powdery mildew (*Erysiphe polygoni* DC.) by foliar spray of fungicides and *Trichoderma* spp. *Ecol. Envi. Cons.* **22**: 251-255.

Perez-Garcia, A., D. Romero, D. Fernandez-Ortuno, F. Lopez-Ruiz, A. de Vicente and J. A. Tores. 2009. “The powdery mildew fungus *Podosphaera fusca* (synonym *Podosphaera xanthii*), a constant threat to cucurbits.” *Mol.Plant Path.* **10**(2): 153-160. Portico. https://doi.org/10.1111/j.1364-3703.2008.00527.x

Rhouma, A., H. Bedjaoui, M. I. Khrieba and M. S. Mehaoua. 2021. Technical document on powdery mildew of cucurbits. *J. Global Agri. Ecol.* **11**: 1-6. https://www.ikprress.org/index.php/JOGAE/article/view/6715

Rhouma, A., M. S. Mehaoua, I. Mougou, H. Rhouma, K. K. Shah and H. Bedjaoui. 2023. Combining melon varieties with chemical fungicides for integrated powdery mildew control in Tunisia. *European J. Plant Path.* **165**(1): 189-201.

Tisserat, N. 2006. Powdery mildew of pumpkin. Extension Bulletin, Department of Plant Pathology, Kansas State University, USA.

Van den Bosch, F., N. Paveley, F. van den Berg, P. Hobbelen and R. Oliver. (2014). Mixtures as a Fungicide Resistance Management Tactic. *Phytopath.* **104**(12*)*: 1264-1273. https://doi.org/10.1094/phyto-04-14-0121-rvw

Yasmin, L., M. Afroz, M. S. Nahar, M. A. Rahman and N. N. Khanam. 2008. Management of powdery mildew in sweet gourd (*Cucurbita moschata*). *Int. J. Sust. Crop Prod.* **3**(6): 21-25.