

Potential of SAR activators and natural products against *Oidium erysiphoides* f. sp. *ziziphi* causing powdery mildew disease in Indian jujube

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Indian jujube (*Ziziphus mauritiana* Lamk.) locally also known as Ber, is the hardiest among the cultivated fruit trees, generally grown in arid regions of India and belongs to the family *Rhamnaceae*. Powdery mildew of Indian jujube is caused by *Oidium erysiphoides* f.sp. *ziziphi* and it is the most important disease that causes maximum reduction in yield and quality of Indian jujube fruits. To study the potential as well as comparative analysis of systemic acquired resistance (SAR) activators and natural products against *O. erysiphoides* f. sp. *ziziphi* causing powdery mildew disease for producing pesticide free fruits in the lieu of organic demand by consumers. Among SAR inducers, the highest disease control (58.75%) was recorded with salicylic acid (3 litre solution per tree of 200 ppm strength) followed by isonicotinic acid (48.04%) while in natural products, two foliar applications of Panch gavya (30%) at 15 days' interval was recorded highly effective with maximum disease reduction (55.20%) followed by cow urine (30%) (52.94%). Looking to the present-day requirement of toxin-free diet, our goal was to produce "zero residues" foods. For this, SAR activator (salicylic acid, 200ppm) and natural products (cow urine and panchgavya, 30%) have proved to be a great potential to check this disease ecofriendly and it is the first type of study conducted on ber using SAR activators to boost plant defense mechanism. Therefore, these findings may be helpful for growers to earn income by producing organic fruits of Indian jujube in lieu of consumer health consciousness.

Keywords : Indian jujube, natural products, powdery mildew, systemic acquired resistance activators, *Ziziphus mauritiana*

INTRODUCTION

Jujube or ber (*Ziziphus mauritiana* Lamk.) is a nutritionally important fruit of arid region of India which belongs to the family *Rhamnaceae*. Ber is a hardy fruit plant and prefers hot and dry climate and requires adequate moisture during the fruiting period and can tolerate adverse conditions like salinity, drought and water logging with the least maintenance, cost and care with the wider adaptability to adverse conditions which act as a xerophytic tree.

The fruits are rich in vitamin A, C and B complex and the composition of nutrients are varying in different varieties. Ber is the most important and nutritious fruit and its pulp contain 11.2 to 19.4

per cent total soluble solids (TSS) depending upon the ber varieties. Fruits are good source of calcium, phosphorus, protein and minerals. Although the ripened fruits contain amino acids like aspergine, aspartic, arginine, glutamic acid, glycine, serine, threonine, á- alanine, methionine, leucine and isoleucine.

India ranks first among the ber growing countries of the world. The total area under ber cultivation is 52,230 hectares with the annual production of 5,30,640 million tonnes. In Rajasthan, major production regions for Indian jujube are Bharatpur (mostly Deeg area), Alwar (Tijara and Ramgarh area), Barmer, Sri Ganganagar, Jodhpur, Jaipur (Chomu area), Pali, Chittorgarh and Hanumangarh. In Rajasthan, total area under ber cultivation is 1158 hectares with an average

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annual production of 9869 metric tonnes (Anon. 2022-23).

The ber plants are prone to many fungal and other pathogenic agents such as powdery mildew (*Oidium* spp.), sooty mold (*Isariopsis indica*), leaf spot (*Colletotrichum* spp. and fruit rot (*Alternaria* spp.), and among these, powdery mildew is one of the most important, widespread and easily recognizeable diseases. Powdery mildew is incited by *Oidium erysiphoides* f.sp. *ziziphi*, (Yan and Wang) and it is the most important disease that causes maximum reduction in yield and quality of ber fruits grown under semi-arid and arid regions of India. The typical symptoms of powdery mildew disease were noticed on flowers, stem and newly set fruits. The emerging young leaves show a whitish powdery mass, which led to shrink and defoliate. The disease also acts in the form of white powdery spots on the surface of the fruits and later covers the entire fruit surface. The spots turn into light brown to dark brown discolouration. The infected area becomes slightly raised and rough. Affected fruits either drop off prematurely or become corky, cracked, misshapen and remain immature. Sometimes the whole crop is rendered unmarketable.

In many ber orchards of our country, the disease intensity of powdery mildew has been assessed up to 71 per cent at fruit development stage with 50-60 per cent fruit yield loss that reduces the market value of the produce (Jamadar *et al.* 2009) and currently, it is the most severe disease of the ber that causes significant yield losses (Misra *et al.* 2013).

In the present time, fungicides are under recommendations for managing this disease, starting from pea size of fruit development to immature stage. After immature stage, fruits are harvested at mature stage for selling in market and consumption and at this time fruits may have residual effect of fungicides that may be hazardous to the health. In lieu of this, some unhazardous green chemicals as well as natural products were applied to reduce disease through exogenous application of synthetic elicitors to activate systemic acquired resistance (SAR) as the area of research is also untouched. Systemic

acquired resistance (SAR) and induced systemic resistance (ISR) are two types of resistance and by application of resistance inducers before infection, plant became ready to defend against the pathogen through the mechanism of disease resistance/tolerance (Ragab *et al.* 2009). Many efforts have been taken over the last two decades in comprehension the physiological and biochemical basis of SAR and ISR. In lieu of this, planting of resistant varieties and spray of natural products and green chemicals may be options for growers, because they are safer, healthier and eco-friendly; as green chemicals are not antimicrobial but they are just boosting plant defense against stresses to protect them against pathogens well.

MATERIALS AND METHODS

Efficacy of SAR inducers

The experiment was conducted in orchard to find out the comparative performance of four SAR inducers like salicylic acid (200 ppm), isonicotinic acid (100 ppm), fosetyl-Al (0.1%) and ethylene (100 ppm) for controlling disease in a randomized block design with four replications. Foliar application of these SAR inducers was applied once on 10-year-old healthy plants of *Z. mauritiana* var. Gola which is susceptible to *O. erysiphoides* in orchard before appearance of the disease (second week of October) under natural conditions. One hundred fruits (25 from each direction) of a tree were picked up randomly and per cent disease intensity was recorded by examining at peak of the disease (mid of December) and calculated as per 0-5 disease rating scale of McKinney (1923).

$$\text{Percent disease intensity (PDI)} = \frac{\text{Sum of individual rating}}{\text{Total No. of observations} \times \text{Maximum disease rating}} \times 100$$

Disease rating scale for assessing intensity against powdery mildew of ber are as follows.

Efficacy of natural products

In respect of organic produce for consumer, the natural products like cow urine of Gir breed (10, 20 and 30%) and Panchgavya (10, 20 and 30%)

Grade/ Numerical scale	Description
0	0%- No infection
1	1-10%- Fruit area covered with pathogen
2	11-25%Fruit area covered with pathogen-
3	26-50%- Fruit area covered with pathogen
4	51-75%- Fruit area covered with pathogen
5	76-100%- Fruit area covered with pathogen

were tested on 10-year-old *Z. mauritiana* var. Gola which is susceptible to *O. erysiphoides* with three replications under randomized block design (RBD). Two sprays of each natural product were sprayed (3 l solution on each tree), at just appearance of the disease and second spray at 20 days' interval under natural conditions. PDI (Per cent disease intensity) was noted at 20th day of last spray.

Preparation of Panchgavya

Basically, *Panchagavya* is a Sanskrit word means "mixture of five cow products". It is prepared by mixing five ingredients i.e. three are direct constituents (cow dung, cow urine and milk) while two are derived products (curd and ghee).

Panchgavya was prepared with slight modification which includes nine products viz. cow dung, cow urine, milk, curd, ghee, jaggery, banana, tender coconut and water. Initially, fresh cow dung (350 g) of Gir breed and cow ghee (50 g) were added and a thorough mixing was done two times in a day during morning and evening hours. The mixed composition was kept for 3 days. At the end of 3rd day, cow urine (500 ml) and water (500 ml) were added and again a thorough mixing was done twice once during morning and secondly during evening hours. This mixture was kept for 15 days under undisturbed condition. At the end of 15 days, 150 ml of cow milk, 100 ml of curd, 150 ml of tender coconut water, 150 ml jaggery and one well ripened banana fruit (120 g) (*Musa paradisiaca*) were added and mixed. Panchgavya was ready for use after 15 days. The total duration required for preparation of Panchgavya was 30 days (Sivapragasam, 2019). This was considered as 100 per cent concentration (stock solution) and

solution was prepared as per desired concentration (10, 20 and 30%) and sprayed on ber trees (3 l solution per tree).

RESULTS AND DISCUSSION

Disease management through SAR inducers

Results (Table 1) indicated that all SAR inducers like salicylic acid (200 ppm), isonocotinic acid (150 ppm), fosetyl-Al (1000 ppm) and ethylene (100 ppm) were found significantly superior over control. The highest disease control (58.75%) was recorded with salicylic acid (@ 200ppm) followed by isonicotinic acid (48.04%) and fosetyl-Al (46.30%) while ethylene (35.70%) was found least effective. Statistically, isonicotinic acid was found at par with fosetyl-Al. Systemic acquired resistance is the spreading of resistance to other cells and tissues after a plant sense an invasion (Prell and Day, 2000). It is also well known that salicylic acid is involved in several defense function as well as in normal development process such as plant thermo-genesis, flower development and allelopathy. Our results also are parallel to the findings of researchers who concluded that spraying of salicylic acid alone was more effective in reducing the powdery mildew diseases of strawberry (Fouly, 2004), okra (Vimala and Suriachandraselvan 2009) and cantaloupe (Ashour, 2009) caused by *Erysiphe* sp. Awad *et al.* (2011) also evaluated the efficiency of some saleable resistance inducer chemicals (RICs) like salicylic acid and Bion (acibenzolar-S-methyl) in managing cucumber powdery mildew, caused by *Sphaerotheca fuliginea* under field conditions and found that RICs caused major decrement in the disease severity with significant increment in the fruit yield compared with check

Table 1 : Efficacy of foliar application of SAR inducers against powdery mildew of ber under natural conditions in orchard

SAR inducers	Conc. (ppm)	% disease intensity*	% disease control
Salicylic acid	200	16.34 (23.84)	58.75
Isonicotinic acid	150	20.58 (26.98)	48.04
Fosetyl-Al	1000	21.27 (27.46)	46.30
Ethylene	100	25.47 (30.31)	35.70
Check	-	39.61 (39.00)	0.00
SEm ±		0.25	
CD (p=0.05)		0.77	
CV (%)		6.33	

Table 2: Efficacy of foliar application of natural products against powdery mildew of ber under natural conditions in orchard

Natural products	Conc. (%)	% disease intensity*	% disease control
Cow urine	10	28.82 (32.47)	30.60
Cow urine	20	22.77 (28.50)	45.25
Cow urine	30	19.57 (26.26)	52.94
Panch gavya	10	25.86 (30.57)	37.82
Panch gavya	20	22.20 (28.11)	46.62
Panch gavya	30	18.63 (25.57)	55.20
Control	-	41.59 (40.16)	0.00
SEm±	-	1.04	-
CD (p=0.05)	-	1.62	-
CV (%)	-	5.63	-

treatments. On the average, application of Bion recorded the highest values, either in reducing the disease severity or in raising the average fruit yield followed by Bion. Hamza *et al.* (2017) have also been assessed the efficacy of certain chemical inducers such as potassium dihydrogen phosphate, potassium monohydrogen phosphate, oxalic acid, salicylic acid, sodium salicylate, ferrous sulfate and magnesium sulfate in comparison to flusilazole fungicide against powdery mildew of cucumber (*Sphaerotheca fuliginea*) and concluded that the flusilazole was the best treatment against powdery mildew followed by salicylic acid.

Disease management through natural products

It was emphasized that out of three levels of two natural products (cow urine 10%, cow urine 20%, cow urine 30%, panchgavya 10%, panchgavya 20% and panchgavya 30%) sprayed against powdery mildew of ber in orchard (Table 2), the minimum disease intensity was observed with panchgavya 30% (18.63%) followed by cow urine 30% (19.57%), panchgavya 20% (22.20%) and cow urine 20% (22.77%), panchgavya 10% and cow urine 10% was found least effective with high disease intensity (25.86 and 28.82%, respectively). It is well known fact that natural

products are safe to the consumer and eco-system. In lieu of this, present study was undertaken to evaluate the efficacy of cow urine and panchgavya with different concentrations for minimizing the loss and it was recorded that two foliar applications of panchgavya (@30%) at 15 days' interval was found highly effective with maximum disease reduction (55.20%) followed by cow urine @30% (52.94%). Our results are in conciliation with the findings of (Pawar and Chavan, 2010) who sprayed cow urine (@15%) and butter milk (@15%) and found effective against powdery mildew of cucurbits. Meena *et al.* (2019) has also been concluded that panchgavya (@15%) was found effective in inhibition of spore germination of *Erysiphe polygoni* causing powdery mildew of black gram. Patel *et al.* (2020) have also been finalized that spray of 15 per cent cow urine on bottle gourd plants in the early morning was found most effective in reducing powdery mildew disease intensity.

CONCLUSION

Looking to the present-day requirement of toxin-free diet, our goal was to produce "zero residues" fruits. For this, systemic acquired resistance inducer (salicylic acid @ 200ppm) and natural products (cow urine and panchgavya @30%) was found highly effective in reducing disease intensity ecofriendly. To the novelty of work, use of systemic acquired resistance inducers in perennial and arid fruit crops that carried out in orchard in Rajasthan, India through boosting plant defense, is the first study on ber for controlling powdery mildew disease that also opens the future outlook of further studies. Therefore, these findings may be helpful for growers to earn income by producing organic fruits of India jujube in lieu of consumer health consciousness.

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DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

REFERENCES

- Anonymous. 2022-23. Indian Horticulture Database. National Horticulture Board, Gurgaon
- Ashour A.M.A. 2009. Effect of Application of some systemic fungicides and resistance inducing chemicals on management of cantaloupe powdery mildew disease. *Egyptian J. Phytopathol.* **37**:1-8
- Awad, M.E.M., Abo-Elyousr, K.A., Abdel-Monaim, M.F. 2011. Management of cucumber powdery mildew by certain biological control agents (BCAs) and resistance inducing chemicals (RICs). *Arch. Phytopathol. Plant Protect.* **45**: 652-659
- Fouly, H.M. 2004. Effect of some micronutrient and the antioxidant salicylic acid on suppressing the infection with strawberry powdery mildew disease. *Bull. Faculty of Agric., Cairo Univ.* **55**: 475-486
- Hamza, A., Mohamed, A., Derbalah, A. 2017. Chemical inducers for resistance induction against powdery mildew of cucumber under greenhouse condition. *Acta Phytopathologica et Entomologica Hungarica* **52** :49"60
- Jamadar, M.M., Balikali, R.A., Sataraddi, A.R. 2009. Status of diseases on ber (*Ziziphus mauritiana* Lamk.) in India and their management options. *Acta Horticultur.* **840**:383-390
- Meena, S., Bunker, R.N., Choudhary, L., Kumari, P. 2019. *In vitro* evaluation of fungicides, botanical and organic amendments against *Erysiphe polygoni* DC in blackgram. *Inter. J. Curr. Microbiol. Appl. Sci.* **8**: 2477-2481
- Misra, D.K., Saha, J., Devidas, P.V., Buri, F.K. 2013. Diseases of ber (*Ziziphus jujube*) in Eastern India. *J. Plant Protect. Sci.* **5**:65-69
- Patel, A, Tatarwal, M.L., Meena, R.L. 2020. Management of powdery mildew of bottle gourd (*Lagenaria siceraria*) through fungicide and natural products. *Inter. J. Curr. Microbiol. Appl. Sci.* **9**: 644-648
- Pawar, V.P., Chavan, A.M. 2010. Incidence of powdery mildew on cucurbit plants and its ecofriendly management. *J. Ecobiotechnol.* **2**: 29-43
- Prell, H.H., Day, P.R. 2000. Plant fungal pathogen interaction. *A Classical and Molecular View Springer USA*
- Ragab, M.M.M., Saber, M.M., El-Morsy, S.A., Abd El-Aziz, A.R.M. 2009. Induction of systemic resistance against root rot of basil using some chemical inducers. *Egyptian J. Phytopathol.* **37**: 59-70
- Sivapragasam, C., Selva, R.K., Vanitha, S., Kowsiga, A., Lidwin, J., Jeraldine, G. 2019. Effect of different combinations of Panch gavya on plant yield. *International J. Innov. Technol. Exploring Engineer.* **9**:8-11
- Vimala, R., Suriachandraselvan, M. 2009. Induces resistance in bhindi against powdery mildew by foliar application of salicylic acid. *J. Biopesticides* **2**:111-114