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Biochemical Defences Approaches Against Purple Blotch (*Alternaria porri)*: Resistance in Onion Varieties

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Abstract

Purple blotch (*Alternaria porri*) cause disease in onions and reduce the yields (30-70% losses) through foliar damage, wilt and reduce the size of onion bulb. Resistant varieties over the susceptibles varities having high amounts of defence compounds like phenols, flavonoids and tannins, defense enzymes such as PAL, PO, PPO, SOD and catalase, inhibiting spore germination, fungal growth and oxidative stress while reinforcing cell walls. To understand the biochemical defence of the onion against the disease and approach ecofriendly and suitable management practices. These biochemical approaches need in onion varieties against fungicide Consequently, the farmer will require less spraying with fungicides to manage purple blotch. Breeders can target these traits for sustainable cultivars, empowering farmers with resilient, profitable, eco-friendly onion production in disease-prone tropics.

Key words: *Alternaria porri,* Flavonoids, Oxidative stress, Fungicide

Introduction

Purple blotch, a disease caused by the fungus *Alternaria porri*, is considered one of the most damaging leaf spot diseases of onions. The fungus infects the leaves and flower stalks of onions, creating purple-brown elliptical spots with a yellow halo. As the disease progresses, the leaves of infected plants begin to wither prematurely, thereby reducing the photosynthetic area of the plant. This, in turn, impacts the size, maturity, and storage life of the onions. In extreme cases, yield losses of 30-70% have been recorded, especially in tropical and subtropical areas where the spores of the fungus multiply rapidly (Khandagale *et al*., 2022).

Purple blotch is not a sudden disease that kills plants quickly. Wide varieties of onions that are resistant or moderately resistant through crop screening in the field and it will be more cost-effective, useful, and ecologically safe to cultivate purple blotch resistant or tolerant types. It takes time to develop, and by the time farmers realize the extent of the infection, it is already too late and that is why it is considered a “silent” threat to onion crops. To understand the biochemical defence of the onion against the disease, we have to approach ecofriendly and suitable management practices.

Why all onion varieties don’t suffer equally?

Field experiments and observations have revealed that the susceptibility of onion varieties to purple blotch is quite different Sandip and Sona-40. While some onion varieties are seriously affected by leaf blight, others remain unaffected even when exposed to the same conditions (Chauhan *et al*., 2023). This is not a mere coincidence. The reason for this difference is largely genetic and biochemical differences among the varieties. While resistant or moderately resistant varieties possess strong internal defenses that resist the growth of the fungus, others are weak and take time to react, allowing the fungus to grow rapidly.

Practically, varietal resistance is one of the most economical, suitable and sustainable methods of disease management by farmers. It does not need repeated used as fungicides since it is effective all through the crop season.

The onion’s internal defense system

Onion does not have an immune system like animals, but it has a very efficient biochemical defense system. When the fungal spores come into contact with the leaves of the onion plant and begin to germinate, the plant recognizes these foreign bodies.

This leads to a series of reactions within the plant cells to defend against the foreign bodies. These include:

1. Production of antimicrobial compounds
2. Activation of defensive enzymes
3. Strengthening of cell walls
4. Accumulation of phenolic compounds

These mechanisms hinder the pathogen's ability to enter tissues and obtain nutrients.

Some phenolic compounds also observed some responses which are seen in resistant varieties like

- Higher basal phenol content before infection
- Rapid accumulation of phenols after infection
- Localized deposition of lignin around infection sites

Natural chemicals that slow down the disease

One of the most important biochemical resistance mechanisms in onion is the accumulation of phenolic compounds, flavonoids and sulpur containing compounds. These natural compounds are toxic as well as inhibitory to fungal growth.

Resistant onion varieties contain higher amounts of:

- Total phenols
- Tannins
- Flavonoids

These compounds have the main function of the following-

- Damage fungal cell membranes
- Inhibit spore germination
- Inhibit mycelial growth

Defense enzymes: the onion's first line of defense

Another important defense mechanism is happen in the resistance varieties are the action of defensive enzymes such as:

- Peroxidase (PO)
- Polyphenol oxidase (PPO)
- Catalase and Superoxide dismutase (SOD)
- Phenylalanine ammonia-lyase (PAL)

These enzymes play a important role such as:

- The production of toxic compounds against pathogens
- The reinforcement of plant cell walls through lignification
- The detoxification of harmful compounds produced during infection

Table 1. Biochemical differences between resistant and susceptible onion varieties

Parameter	Resistant Varieties	Susceptible Varieties
Total phenol content	High (before and after infection)	Low to moderate
PAL activity	Rapid and strong induction	Slow and weak induction
Peroxidase activity	High	Low
PPO activity	High	Low
Antioxidant balance	Well regulated	Poorly regulated
Disease severity	Mild	Severe

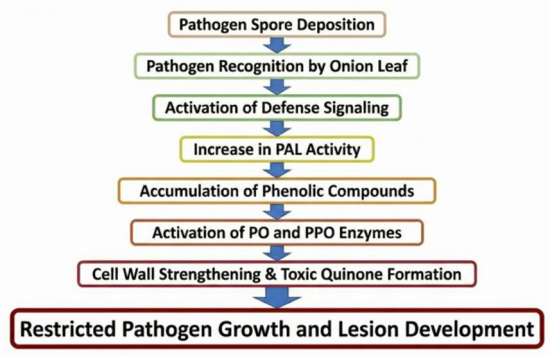

Fig. 1 Biochemical defense response in onion against Purple blotch (*Alternaria porri)*

Less disease, less spraying: a sustainability edge

If onion varieties possess high biochemical resistance, the disease will progress slowly and will be of lower intensity. Consequently, the farmer will require less spraying with fungicides to manage purple blotch.

There are several advantages to this:

- Lower production cost
- Less chemical residue in the bulbs
- Less pollution of the environment
- Less development of resistance to fungicides in the pathogens

Therefore, biochemical resistance plays an important role in sustainable onion production.

What this mean for farmers and future onion breeding?

Knowledge of biochemical defense mechanisms can aid breeders in developing onion varieties that are more resistant to purple blotch disease.

Breeders can choose genotypes with:

- Higher phenol concentration
- Stronger enzyme activity
- Better antioxidant systems

To develop disease-tolerant onion varieties without using chemicals extensively.

For farmers, cultivating disease and tolerant onion varieties means:

- Ensured yield
- Reduced disease incidence
- Increased profit

- Environment-friendly production

Conclusion

Purple blotch caused by *Alternaria porri*, poses a serious and devastating threat to onion production for farmers, and causes 30-70% yield losses through infection, foliar damage and reduced bulb quality. Biochemical approaches in varieties like higher basal phenols, rapid enzyme activation (PAL, PO, PPO, SOD) and flavonoid accumulation increase the defense response in plant but also arrest fungal infection and development in onion plant. For breeders, targeting to increase phenolic and antioxidant compounds which promises durable and tolerant cultivars and farmers getting yields, profitability and eco-friendly practices.

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