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**Adesh Kumar**
Punjab Agricultural University, Fruit Research Station, Jallowal-Lesriwal, Jalandhar, Punjab, India

**Tanjeet Singh Chahal**
Punjab Agricultural University, Fruit Research Station, Jallowal-Lesriwal, Jalandhar, Punjab, India

**Correspondence**
**Adesh Kumar**
Punjab Agricultural University, Fruit Research Station, Jallowal-Lesriwal, Jalandhar, Punjab, India

# Studies on diseases and disorders of different citrus germplasm under natural condition

**Adesh Kumar and Tanjeet Singh Chahal**

**Abstract**
Citrus research block of Punjab Agricultural University, Fruit Research Station Jallowal-Lesriwal was surveyed during 2016 and incidence of disease and disorder was recorded. Ten cultivars of sweet orange, 3 mandarin, 3 lime, 3 lemon, 5 grapefruit and 1 kumquat (Fortunella) cultivars screened naturally with respected to citrus gummosis, fruit cracking, canker, nutrient deficiency and fruit dropping. Highest fruit cracking mean was observed in sweet orange and mandarin with 4%. However highest citrus cankers incidence was observed in lime and grapefruit with 81.66% and 78% respectively. It was also observed that Kumquat (Fortunella) showed an immune type of response to canker disease. Fruit dropping was observed greatest in mandarin (23.35%), it was not observed in lime, lemon and Kumquat (Fortunella). Nutrients deficiency was more common in sweet orange. However no citrus gummosis symptom was observed in any cultivars of citrus germplasm.

**Keywords:** cultivar, citrus, germplasm, incidence and disease

## Introduction
Citrus is grown at a commercial level in more than 50 countries of sub-tropical and tropical regions with total production of 115.52 million tonnes. India is the fourth largest producer of citrus with average productivity 9.69 tonnes/ha. Punjab state secured more than 50,000 hectares, kinnow, a hybrid between king and willow Leaf mandarin contributes to more than 90 percent of this area and production. Citrus is suffering from various diseases and disorders including fruit cracking and dropping, citrus canker, caused by the bacterium *Xanthomonas axonopodis* pv. *citri*, Gummosis/Foot Rot (*Phytophthora parasitica*). These are serious diseases of most commercial citrus cultivars and some citrus relatives. Citrus canker disease is prevalent in many countries in Asia, South America, Oceania and Africa as well as in Florida, United States [3]. The disease caused tremendous losses in citrus cultivars and some citrus relatives [18, 17]. The pathogen produces necrotic lesions on all aerial parts of the plant and severs infection causes premature fruit dropping in many citrus cultivars. Wounds generated by wind and mechanical damage assist infection of mature tissues. Citrus leaf miner also increases the infestation of citrus canker [2]. Citrus gummosis affected trees show symptoms of foot rot with profuse gumming, trunk girdling, pale green foliage, stunted growth flushes and twig die-back. The gummy les ions may extend downwards as well as upwards to the tree trunk and may also appear on branches/limbs. Disease incidence and severity is depending on citrus germplasm that allow infection or not. Susceptible germplasm allow infection of different pathogens. In this study, we screen out the different disease incidence level on different citrus germplasm under natural condition.

## 2. Materials and methods
Citrus research block of Punjab Agricultural University, Fruit Research Station was surveyed during 2016 and disease incidence was recorded. Ten cultivars of sweet orange, 3 mandarin, 3 lime, 3 lemon, 5 grapefruit and 1 Kumquat (Fortunella) cultivars were screened naturally with respected to citrus gummosis, fruit cracking, canker, nutrient deficiency (symptoms on leaf) and fruit dropping. Pathogen isolations and purification from the infected canker leaf samples were done on King's B medium. Koch's postulates was proved by inoculating 48 hours old broth cultures of *Xanthomonas citri* into a citrus plant by syringe in susceptible citrus cultivars (lime). Three virulent bacterial colonies belonging to individual isolates were selected and stored in 15% glycerol at -20 $^{0}$C for subsequent use. The disease incidence on different germplasm was recorded by following formula.

## 3. Results

The citrus group wise surveys conducted during 2016 revealed that the disease was invariably present in all the groups of citrus (sweet orange, mandarin, grapefruit, lime, lemon and Kumquat). In sweet orange out of 10 cultivars, Midknight showed highest fruit cracking 20% and Westin and Itaborai showed only 10%. It was also observed that no fruit cracking remaining cultivars (Rhode Red, Olinda, Hamlin, Trovita, Vernia and Ruby nucellar and Early gold) (Table-1). Canker disease incidence was highest in Trovita (80%) and Ruby nucellar (70%) cultivars, while fewer incidences were observed in Westin, Itaborai and Midknight with 30, 20 and 5% respectively. Five cultivars namely Rhode Red, Olinda, Hamlin, Vernia and Early gold showed resistance reaction to *Xanthomonas citri*. Almost all cultivars demonstrated fruit dropping incidence except Midknight. Highest fruit dropping per cent was observed in early gold with 20% while minimum was in Rhode red and Westin. Citrus nutrients deficiency (leaf symptoms) complex was more preeminent in all sweet orange cultivars. Midknight presented highest per cent 45 of nutrients deficiencies while Rhode red, Hamlin, Early gold, Westin, Itaborai, Olinda, Trovita, Ruby nucellar and Vernia showed 40, 40, 40, 40, 40, 35, 30, 30, 25 and 20% respectively. Citrus gummosis incidence in sweet orange cultivars was 0%. All the three mandarin cultivars namely kinnow, Daisy and W. Murcott also showed 0% infection of citrus gummosis (Table-2). Kinnow contributed more than 90 percent in citrus area and production under Punjab state, therefore it's a major crop of this state. Daisy and W. Murcott is also new developing cultivars of mandarin. Highest fruit cracking was observed in Daisy 10% as compared to Kinnow and W. Murcott. Canker incidence was highest in Kinnow with 25% while Daisy and W. Murcott secured 5 and 6% respectively (Table-2). Fruit dropping was maximum 25% in two cultivars namely Daisy and W. Murcott while Kinnow was dropping 20% fruits. Nutrients deficiency (symptoms on leaf) incidence was less as compared to sweet orange. All the cultivars of grapefruit were present 0% incidence of citrus gummosis, citrus fruit dropping and nutrients deficiency (Table-3). Canker was the more severe disease caused upto 90% incidence in grapefruit. Marsh Seedless was showing 90% disease incidence similarly Star Ruby showed 85% incidence while Flame, Red blus and Rio red presented 80, 70 and 65% respectively. Fruit dropping have positive correlation with the canker incidence reported in Marsh Seedless which dropped 20% fruits. Lime and lemon showed resistance reaction to all the diseases except canker, which is more dominant disease in lime as compared to lemon. Maxican lime was presented highest 85% disease incidence while Bearss lime and Local lime showed 80% disease incidence (Table-4). Lemon showed less incidence as compared to lime. Eureka lemon secured highest canker disease incidence 60%, Lisbon lemon also showed 50% incidence while Baramasi lemon, Improved meyer lemon and Punjab galgal presented equal 20% incidence (Table-5). It was also observed that Kumquat (Fortunella) presented no diseases. Mean of canker disease incidence was observed in lime 81.66% while highest fruit dropping was observed in mandarins 23.33% (Table-6).

## 4. Discussion

Citrus fruit peel cracking is a serious pre-harvest physiological disorder. This phenomenon almost occurs on all citrus cultivars. The range of the fruit-cracking incidence is 10%-35%, which severely affects fruit quality and yield **[12]**. In the present study, highest fruit cracking was noticed in sweet orange and mandarins, while grapefruit, lime, lemon and Kumquat (Fortunella) were not having fruit cracking. Many factors that might affect citrus fruit cracking which include cultivar characteristics [1] weather conditions [5], rootstock [19], peel thickness [9], peel hardness and growth regulators [11]. Canker was more dominant in lime and grapefruit as compared to sweet orange, mandarins, lemon and Kumquat (Fortunella). It was also studied that the canker disease more severe on acid lime and less on mandarin and sweet orange [15]. Similarly, Kaghzi lime was more susceptible as compared to grape fruit and sweet oranges in Karnakhata [14]. Mandarins and lemons are resistant while Kumquats cultivar showed an immune response under Uttar Pradesh conditions [4]. Nutrient deficiency disturbs the production of plant growth regulators controlling size, color and premature fruit dropping. Excessive premature fruit dropping in fruit crops is also dependent on other factors like high temperatures and water deficits, insect/pest attack, and wind velocity of the area [16]. Highest fruit dropping was observed in mandarins with 23.33%. Nutrients deficiency was more common in sweet orange. The fruit dropping can be manage by application of nutrients or plant growth regulators. Many other authors also studied susceptible and the resistance reaction of citrus cultivars against this pathogen [6, 7, 8, 10, 13].

**Table 1:** Disease incidence % of Sweet orange cultivars

| Cultivars | Gummosis % | Fruit cracking % | Citrus canker incidence % | Fruit dropping % | Nutrients deficiency (leaf symptoms) % |
|---|---|---|---|---|---|
| Rhode Red | 0 | 0 | 0 | 5 | 40 |
| Olinda | 0 | 0 | 0 | 10 | 30 |
| Hamlin | 0 | 0 | 0 | 15 | 40 |
| Trovita | 0 | 0 | 80 | 10 | 30 |
| Midknight | 0 | 20 | 5 | 0 | 45 |
| Vernia | 0 | 0 | 0 | 12 | 20 |
| Ruby Nucellar | 0 | 0 | 70 | 10 | 25 |
| Early Gold | 0 | 0 | 0 | 20 | 40 |
| Westin | 0 | 10 | 30 | 5 | 40 |
| Itaborai | 0 | 10 | 20 | 10 | 35 |

**Table 2:** Disease incidence % of mandarins cultivars

| Cultivars | Gummosis % | Fruit cracking % | Citrus canker incidence % | Fruit dropping % | Nutrients deficiency (leaf symptoms) % |
|---|---|---|---|---|---|
| Daisy | 0 | 10 | 5 | 25 | 5 |
| Kinnow | 0 | 0 | 25 | 20 | 6 |
| W. Murcott | 0 | 2 | 6 | 25 | 5 |

**Table 3:** Disease incidence % of Grapefruit cultivars

| Cultivars | Gummosis % | Fruit cracking % | Citrus canker incidence % | Fruit dropping % | Nutrients deficiency (leaf symptoms) % |
|---|---|---|---|---|---|
| Marsh Seedless | 0 | 0 | 90 | 20 | 0 |
| Flame | 0 | 0 | 80 | 18 | 0 |
| Star Ruby | 0 | 0 | 85 | 15 | 0 |
| Rio Red | 0 | 0 | 65 | 12 | 0 |
| Red Blush | 0 | 0 | 70 | 15 | 0 |

**Table 4:** Disease incidence % of lime cultivars and Kumquat (Fortunella)

| Cultivars | Gummosis% | Fruit cracking % | Citrus canker % | Fruit dropping | Nutrients deficiency (leaf symptoms)% |
|---|---|---|---|---|---|
| Bearss lime | 0 | 0 | 80 | 0 | 0 |
| Maxican lime | 0 | 0 | 85 | 0 | 0 |
| Local lime | 0 | 0 | 80 | 0 | 0 |
| Kumquat (Fortunella) | 0 | 0 | 0 | 0 | 0 |

**Table 5:** Disease incidence of lemon cultivars

| Cultivars | Gummosis | Fruit cracking % | Citrus canker incidence % | Fruit dropping | Nutrients deficiency (leaf symptoms) % |
|---|---|---|---|---|---|
| Punjab galgal | 0 | 0 | 20 | 0 | 0 |
| Eureka lemon | 0 | 0 | 60 | 0 | 0 |
| Baramasi lemon | 0 | 0 | 20 | 0 | 0 |
| Improved meyer lemon | 0 | 0 | 20 | 0 | 0 |
| Lisbon lemon | 0 | 0 | 50 | 0 | 0 |

**Table 6:** Mean disease incidence % of sweet orange, mandarin, lime, lemon, grapefruit and Kumquat

| Germplasm | Gummosis % | Fruit cracking % | Citrus canker incidence % | Fruit dropping % | Nutrients deficiency (leaf symptoms) % |
|---|---|---|---|---|---|
| Sweet Orange | 0 | 4 | 20.5 | 9.7 | 34.5 |
| Mandarins | 0 | 4 | 12 | 23.33 | 5.33 |
| Grapefruit | 0 | 0 | 78 | 16 | 0 |
| Lime | 0 | 0 | 81.66 | 0 | 0 |
| Lemon | 0 | 0 | 34 | 0 | 0 |
| Kumquat | 0 | 0 | 0 | 0 | 0 |

## 5. Conclusion

Citrus germplasm was screens with respected to citrus gummosis, fruit cracking, canker, nutrient deficiency and fruit dropping. Highest fruit cracking mean was observed in sweet orange and mandarin with 4%. However highest citrus cankers incidence was observed in lime and grapefruit with 81.66% and 78% respectively. Fruit dropping was observed maximum in mandarin (23.35%), it was not observed in lime, lemon and Kumquat (Fortunella). Nutrients deficiency was more common in sweet orange.

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