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Management of sucking pests of tapioca

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Abstract
Tapioca (*Manihot esculenta* Crantz), a key crop in the Euphorbiaceae family, was domesticated in Neotropical America and is now cultivated in over 80 tropical countries. Its adaptability to diverse environments, drought tolerance and low input requirements make it a crucial food security crop in many developing regions. However, tapioca productivity is significantly constrained by pests, particularly sucking pests such as whiteflies, mealybugs, scales, thrips and mites. These pests not only extract plant sap, reducing vigor and yield, but also serve as vectors for viral pathogens. The persistent and multifaceted nature of pest pressure necessitates the development of integrated pest management (IPM) strategies tailored to tapioca agroecosystems. Emphasis on monitoring, biological control, and environmentally sustainable practices is essential for mitigating pest impact and ensuring long-term crop resilience.

Keywords: Tapioca, sucking pests, whiteflies, mealybugs, mites, management

Introduction

Tapioca (*Manihot esculenta* Crantz), a member of the Euphorbiaceae family, originated in the Neotropical America, where it was domesticated approximately 7,000 to 9,000 years ago. Today, it is cultivated widely across tropical regions worldwide. It is a major root crop cultivated in more than 80 tropical countries. It is a rich source of energy and can be grown with minimal effort and low agricultural inputs. For many populations in the tropics, tapioca serves as either a staple or complementary food. Its adaptability to different environments, resistance to drought, and the ability to harvest at various stages make it a dependable crop for enhancing food security in vulnerable regions. However, tapioca cultivation is often challenged by a variety of insect pests, which can significantly affect crop yield and quality if not properly managed. Tapioca is attacked by a range of pests, with major ones including mites, whiteflies, thrips, mealybugs, lace bugs, stemborers, hornworms, and subterranean burrower bugs. In addition, pests such as scales, leafhoppers, white grubs, cutworms, leaf-cutting ants, fruit flies, shoot flies, and termites may inflict occasional or localized damage (Bellotti *et al*., 1994) [3]. Sucking pests pose a major threat to tapioca causing serious damage by extracting plant sap, spreading viral infections, and reducing the plant's overall health and productivity. Effective management of sucking pests in tapioca is essential to protect crop health, prevent yield losses, and reduce the risk of disease transmission.

Major sucking pests complex in tapioca

1.Whitelfly

The whitefly *Bemisia tabaci* is widespread across tropical regions and feeds on cassava in Africa as well as parts of Asia, including India and act as a vector for Cassava Mosaic Virus Disease (Lal & Pillai, 1981) [19].

Spiralling whitefly (*Aleurodicus* sp) nymphs and adults typically gather on the lower sides of host plant leaves, though they may also be found on upper surfaces. By feeding on plant sap, they cause symptoms such as yellow speckling, leaf curling, and crinkling, especially in severely infested tapioca plants. Nymphs release large amounts of white, waxy, flocculent matter that disperses through wind and their secretion of sticky honeydew supports sooty mould growth, which disrupts photosynthesis. In India, heavy infestations have been reported to reduce tapioca yields up to 55% (Geetha, 2000) [11].

2. Mealybug

Mealybugs cluster densely on the underside of leaves, forming waxy mats. They feed by injecting toxins that cause leaf curling, twisting and distortion. Their honeydew promotes sooty mould growth, reducing photosynthesis. Infestation starts from lowerside of the leaves and petioles, spreading to stem and causing leaf drop and yield loss (Sakthivel and Qadri, 2010) [39].

3. Scales

Several scale insect species have been identified in major tapioca growing regions, including *Aonidomytilus albus* Cockerell, *Saissetia miranda* Cockerell & Parrott, *Hemiberlesia diffinis* (Newstead), and species of *Ceroplastes*. Scale infestations in young tapioca plants cause yellowing, leaf drop, stunted growth that can lead to plant death, especially during dry seasons. Early attacks reduce yields and affect planting material, as infested cuttings show poor sprouting and root development. *A. albus* infests tapioca stems, shoots and severe attacks cause stem desiccation, breakage, bushy growth, poor root development, and unpalatable roots (Lal & Pillai, 1981) [19].

4. Mite

Tetranychus urticae is a globally distributed mite and regarded as a major pest in parts of Asia.Over 40 mite species have been identified as tapioca foliage feeders (Byrne *et al*., 1983) [6], with the most common being *Mononychellus tanajoa* (formerly *M. progresivus*), *M. caribbeanae*, *Tetranychus cinnabarinus*, and *T. urticae* also known by other names such as *T. bimaculatus* and *T. telarius* (Bellotti, 2000a, 2000b) [4, 5]. Mites feed by using their long stylets to pierce and extract the contents of individual plant cells, resulting in cell death. This feeding creates yellow or white specks on the leaves, and with continued damage, the leaves lose their green color, dry out, and eventually drop. The type of leaf damage caused by mites varies based on the severity of infestation and their distribution on the plant leaves and stem. Mite damage on tapioca varies by species. *Mononychellus* species feed near the plant's growing tips, causing apical damage. *Tetranychus* sp, *Eutetranychus orientalis*, and *Oligonychus biharensis* attack lower leaves, creating stippling that spreads from the base and veins. *Oligonychus peruvianus* forms colonies under white webs on basal leaves and feeds leading to yellow or brown spots on the upper surface (Byrne *et al*., 1983) [6].

Management

Physical control

Light traps have been identified as an effective tool for monitoring *Aleurodicus dispersus*. Srinivasan and Mohanasundaram (1997) [41] proposed a simple technique using light traps coated with vaseline to capture large number of whiteflies. Similarly, Marium (1999) [24] reported that fluorescent lights smeared with castor oil were successful in attracting and trapping a substantial number of adult whiteflies. Whiteflies are attracted to wavelengths around 550 nm, which corresponds to the green or yellow light commonly reflected by plants. The effectiveness of trap attraction also depends on the height at which the traps are placed (Ekbom & Xu, 1990) [8].

Wen *et al*. (1995) [43] reported that applying water sprays at a rate of 12.5 liters per minute every two days over the course of a month resulted in the control of 78.5% of nymphs and 86.4% of adult whiteflies.

Host Plant Resistance

Fry (1983) observed that *P. manihoti* showed a lower preference for tapioca varieties containing high levels of phenolic acids in their extracellular fluids.

Palaniswami *et al*. (1995) [34] examined the host response to *Aleurodicus dispersus* and found that the varieties H 226 (with high cyanogen content), Sree Sahya, and Sree Visakam (with low cyanogen content) were among the most preferred hosts. Their study indicated that cyanogen content did not influence host preference by *A. dispersus*. Therefore, morphological traits like hairiness, leaf shape, and cuticle thickness along with biochemical components, may contribute to the moderate resistance of *Manihot esculenta* genotypes to *A. dispersus* infestation.

Biological Control

The introduction of exotic natural enemies has been a fundamental strategy in biological control, playing a key role in effectively managing pest populations. One notable success in recent years is the classical biological control of the cassava mealybug (*Phenacoccus manihoti* Matile-Ferrero) in Africa, which significantly reduced pest pressure on tapioca crops (Neunschwander, 2001) [29].

In 1994, *Neozygites fumosa* (Speare) Remaudiere & Keller (Zygomycetes: Entomophthorales) was reported for the first time in Brazil as a fungal pathogen affecting the cassava mealybug, *Phenacoccus herreni* Cox & Williams (Hemiptera: Pseudococcidae). Infection levels in tapioca fields at Cruz das Almas and São Gonçalo, Bahia, ranged from 9.30% to 64.60% (Junior *et al*., 1997) [16]. Although insecticides are commonly used to control mealybugs, their effectiveness is often limited due to the concealed life cycle, protective waxy coating, and tendency to form dense colonies (Ujjan *et al*., 2015) [42]. The use of entomopathogenic fungi (EPF) as a biological pesticide offers a promising alternative for pest management (Khan *et al*., 2012) [18]. These fungi, comprising several genera, are capable of effectively infecting and killing insect hosts. Nevertheless, a thorough understanding of EPF biology and their mode of action is crucial for their successful application as biocontrol agents (Islam *et al*., 2021) [14].

Nasruddin *et al*. (2020) [26] carried out a study to evaluate the bioefficacy of four locally isolated fungal entomopathogens-*Purpureocillium* sp. *Beauveria bassiana*, *Fusarium* sp. and *Trichoderma* sp. against the cassava mealybug, *P. manihoti*. Among these, *Fusarium* sp. demonstrated the highest effectiveness in laboratory conditions, achieving a mortality rate of 62.3%.

Symnus coccivora was reported as a predator on *P. marginatus* on Tapioca (Vidya and Bhasker, 2017) [45].

Gaikwad *et al*. (2017) [10] carried out a laboratory study to assess the effectiveness of *Lecanicillium lecanii*, *Metarhizium anisopliae*, and *Beauveria bassiana* against second instar nymphs of the papaya mealybug, *Paracoccus marginatus*. The results showed that insect mortality increased with higher doses and longer exposure times. Among the tested fungi, *L. lecanii* produced the highest mortality rate, reaching 73.33% at 144 hours after treatment.

According to Singh and Beera (2010) [40], the papaya mealybug is naturally controlled by several generalist predators, including *Cryptolaemus montrouzieri* (commonly known as the mealybug destroyer), lacewings, and hoverflies, all of which have the potential to reduce mealybug population. Alongside predatory insects, several parasitoid species have been identified as promising biological control agents. Among the most significant are *Acerophagus papayae* (Noyes & Schauff, 2003) [30] and *Anagyrus loecki* (Noyes & Hayat, 1994) [31].

In India, a total of 45 predator species primarily generalists with a few host-specific ones have been documented feeding on whiteflies. Among these, 22 species were reported by Mani *et al*. (2004), 15 by Geetha (2000) [11], and 40 species by Ramani (2000) [35] as predators of *Aleurodicus dispersus*. Previous observations reported the presence of four coccinellid species, one drosophilid, and several chrysopid predators attacking spiraling whitefly (SWF) nymphs in Bangalore (Mani & Krishnamoorthy, 1999c) [23], whereas in Coimbatore, four coccinellid species and one chrysopid predator were noted (Mariam, 1999) [24]. *C. sexmaculatus* and *C. nigritus* showed higher predation rates on *Aleurodicus dispersus* nymphs when feeding on *Manihot esculenta* and *Psidium guajava* compared to other host plants. Several researchers have also investigated the predatory efficiency of *C. sexmaculatus* and *Scymnus* species on *A. dispersus* infesting tapioca (Palaniswami *et al*., 1995) [34].

Boopathi *et al*. (2015) [2] evaluated the effectiveness of *Isaria fumosorosea*, *Lecanicillium lecanii*, *Beauveria bassiana*, and *Metarhizium anisopliae* for managing the invasive spiralling whitefly (*Aleurodicus dispersus*) on tapioca over two seasons (2011-2013). Among the tested entomopathogenic fungi, *I. fumosorosea* and *L. lecanii* showed promising results, achieving over 70% mortality of the whitefly population. The mortality rate increased over time in both seasons, with *I. fumosorosea* demonstrating the highest pathogenicity compared to other fungi. Additionally, seasonal variation significantly influenced the fungal effectiveness against *A. dispersus*.

Botanicals

In a study conducted by Mourier (1997) [25], tapioca plants were treated twice with neem seed kernel extract at concentrations of 1.0%, 10.0%, and 15.0% for controlling cassava mealybug, all of which resulted in phytotoxic effects on the plants. Similarly, previous research has reported phytotoxicity in tapioca following application of 5.0% neem oil with an emulsifier concentrate (Olaifa & Adenuga, 1988) [32]. Olaifa *et al*. (1993) [33] also observed phytotoxic symptoms in tapioca plants exposed to a 2.5% neem oil emulsion.

Venkatesan and Palanisamy (2010) [44] followed an eco friendly management for tapioca whiteflies. For that first they conducted bio-ecological studies on cassava mealybug and results showed that sweetflag rhizome powder *Acorus calamus* 10D with 2% concentration has antifeedent, repellant and moult inhibitor action against whiteflies.

Spraying the leaves using insecticidal soap/horticultural oil (made from petroleum), is another, environment friendly option. The spray will suppress the sucking pest population enough to allow predator and parasitoid numbers to build up and start to control them (Geetha and Manickam, 2013) [12].

Fish Oil Rosin Soap (FORS) has been shown to be effective in controlling *Bemisia tabaci* (Rao *et al*., 1990) [37]. In a study by Natarajan *et al*. (1991) [27], FORS was evaluated in combination with chemical treatments, and plots treated with FORS recorded the lowest whitefly nymph population at 15.3 per leaf, followed by neem oil with 18.0 per leaf, in contrast to 60.6 nymphs per leaf observed with monocrotophos treatment. Additionally, the combination of FORS and phosalone also contributed to a reduced whitefly population.

Chemical control

Neonicotinoids have emerged as the most rapidly expanding class of insecticides in contemporary crop protection, offering broad-spectrum control primarily against sucking pests and some chewing insects (Jeschke & Nauen, 2008) [15]. Nath and Sinha (2010) [28] found that thiamethoxam and acetamiprid, both neonicotinoid insecticides, were able to control whitefly populations. Insecticide use leads to a short-term decline in whitefly populations (Ranjith, 1998) [36].

Triazophos alone at a concentration of 0.03% also reported to be highly effective in managing spiralling whitefly (*Aleurodicus dispersus*) (Kambrekar & Awaknavar, 2004). Similarly, chlorpyrifos at 0.04% proved to control *A. dispersus* (Dubey & Sundararaj, 2004) [7].

Rodolphe (1984) observed that insecticides are most effective when applied targeting the later nymphal stages. The use of chemical insecticides such as thiometon, dimethoate, and phosphamidon can moderately reduce pest populations(Mani & Krishnamoorthy, 1997a) [22].

Wen *et al*. (1995) [43] previously demonstrated that deltamethrin exhibited strong ovicidal properties, with the egg stage experiencing the highest mortality compared to other developmental stages. Similarly, Ishaaya *et al*. (1987) [13] reported that buprofezin, at a concentration of 125 mg/L, had significant ovicidal effects on *Bemisia tabaci*. Asia Mariam (1999) [24] also documented a high level of ovicidal activity for malathion, recording 93.10% mortality against *Aleurodicus dispersus*.

According to Baskaran *et al*. (1999) [1], dimethoate and malathion were found to be the most effective insecticides for managing *Ferrisia virgata* (Cockerell).

Lal and Pillai (1984) [20] found that dicofol at a concentration of 0.03% was not effective against *Tetranychus cinnabarinus* and *Tetranychus neocaledonicus* on tapioca and also noted that monocrotophos, a systemic insecticide, may occasionally act as an effective acaricide against *Tetranychus cinnabarinus* and *Tetranychus neocaledonicus* on tapioca.

Conclusion

Tapioca is a widely cultivated tropical root crop valued for its resilience, low input requirements, and importance as a staple food in many developing countries. Despite its adaptability, the crop is highly susceptible to damage from sucking pests such as whiteflies, mealybugs, mites and scales. These pests reduce plant vigor and act as vectors for viral diseases, leading to substantial yield losses. Sustainable management demands an integrated approach, combining cultural practices, biological control, resistant cultivars, and judicious pesticide use. Continued research and farmer education are essential to enhance pest control strategies and secure the future of tapioca cultivation.

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