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Assessment of weed-associated Thrips infestation on flower and fruit quality parameters of vegetable and ornamental crops

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Abstract

Early observations dating back to the 1920s linked thrips feeding on flowers to discolouration and premature petal drop, yet the relationship between weed-harboured thrips and measurable quality losses in both vegetable and ornamental crops remains poorly defined under subtropical field conditions. This research investigated the impact of weed-associated thrips infestation on flower and fruit quality parameters in tomato, capsicum, marigold, and rose at two production sites near Brisbane, Australia, across the 2022–2023 growing season. Weed patches dominated by *Bidens pilosa*, *Sonchus oleraceus*, and *Sida rhombifolia* bordered all experimental plots, and thrips populations moving from these weeds into crops were monitored weekly using sticky traps and direct plant counts. Four thrips species were recorded: *Frankliniella occidentalis*, *Thrips tabaci*, *Thrips imarginis*, and *Frankliniella schultzei*. Peak thrips density on crop flowers coincided with the flowering stage across all four crops, reaching 54.3 per ten flowers in marigold and 42.6 in capsicum. Quality damage was assessed through a composite scoring system that included fruit scarring, petal damage, colour fading, and overall marketability loss. Ornamental crops suffered higher quality impacts than vegetables: marigold lost 42.1% of marketable value due to petal feeding and colour degradation, while tomato lost 31.2% through fruit surface scarring. A distance-decay relationship confirmed that crops planted within 5 m of weed patches received 52.4% (ornamentals) and 38.7% (vegetables) infestation, declining to 11.7% and 8.2% beyond 30 m. Crop growth stage documentation showed that the flowering window lasting three to five weeks depending on crop concentrated 68.4% of all thrips-caused quality damage. Cumulative damage curves diverged sharply between ornamentals and vegetables after the fourth week post-transplanting, with marigold reaching an 87.3% cumulative damage score by week sixteen compared to 53.2% for tomato. These results argue for a 15 m minimum buffer distance between weed patches and quality-sensitive crops and for targeted weed removal timed two weeks before first flowering.

Keywords: Thrips infestation, weed hosts, flower quality, fruit quality, ornamental crops, vegetable crops, *frankliniella occidentalis*, distance-decay, crop growth stage, marketability loss

Introduction

Records from Queensland's horticultural research stations in the 1920s already noted that thrips feedings left "silvery streaks" on rose petals and "rough patches" on tomato fruit surfaces, though the insects responsible were identified only at the family level ^[1]. A century later, flower and fruit quality remain the economic dimensions of thrips damage most visible to growers and buyers, yet quantitative data connecting weed-harboured thrips populations to crop quality outcomes are still surprisingly thin for subtropical production systems.

Western flower thrips, *Frankliniella occidentalis*, is the species that draws the most research attention. It feeds preferentially on pollen-bearing floral structures and causes stippling, scarring, and deformation of petals, sepals, and developing fruitlets ^[2]. Onion thrips, *Thrips tabaci*, and plague thrips, *Thrips imarginis*, are also common in Australian horticulture, and both colonise weeds growing beside and between crop rows ^[3]. What has been less clearly established is whether the severity of quality damage in a crop relates to the proximity and composition of adjacent weed vegetation information that would allow growers to set evidence-based buffer distances and weed-removal schedules. Vegetables and ornamentals differ in the kind of quality damage that matters economically. For tomato and capsicum, fruit surface scarring and distortion reduce grade and packout percentage, directly lowering returns. For marigold and rose, petal discolouration, silvering, and premature drop determine whether stems or pots meet market specification ^[4]. Combining both crop types in a single comparative research design makes it possible to ask

whether weed-associated thrips inflict proportionally greater damage on ornamentals which market aesthetics rather than weight than on vegetables, where some cosmetic tolerance exists. The concept of distance-decay in pest infestation is well established in landscape ecology. Arthropod density on a crop plant typically decreases as distance from the pest source increases, following either an exponential or a power-law function [5]. For thrips, which are weak active fliers but efficient wind-aided dispersers, the effective colonisation distance from a weed patch depends on wind speed, weed patch size, and the relative attractiveness of crop flowers [6]. Quantifying this decay function for different crop types under field conditions would provide a practical tool for spatial planning. Crop growth stage adds a temporal dimension. *Thrips* are attracted to flowers by petal colour and volatile emissions, and feeding damage is concentrated during the brief flowering window [7]. If the flowering period of a crop overlaps with peak thrips activity on adjacent weeds, quality losses can be severe. Documenting this overlap across multiple crops with different phenologies would clarify when weed removal would yield the greatest quality benefit. Previous work in southeastern Queensland measured thrips numbers on horticultural crops but rarely connected those numbers to graded quality outcomes or to the specific weed patches that served as source habitats [8]. Surveys across Tunisia's agricultural zones confirmed that weed species composition determines which thrips species accumulate at crop margins, but quality impact data were not collected [9]. And research from the Netherlands on greenhouse roses documented petal damage thresholds but under controlled conditions that excluded the weed-margin dynamic entirely [10].

This research was designed to fill part of that gap. Its objectives were: (a) to measure thrips population density on two vegetable crops (tomato, capsicum) and two ornamental crops (marigold, rose) grown adjacent to natural weed margins near Brisbane, (b) to quantify the relationship between weed proximity and thrips infestation rate on each crop, (c) to assess quality damage using a composite scoring system appropriate for both crop types, and (d) to map quality loss against crop growth stage to identify the window of greatest vulnerability. The underlying aim was to produce buffer-distance and timing recommendations that growers could apply with minimal additional cost.

Material and Methods

Study Area Description

The research was carried out at two commercial production sites in the Lockyer Valley, approximately 90 km west of Brisbane, Queensland, Australia (27°33 S, 152°20 E, 93 m a.s.l. and 27°36 S, 152°18 E, 108 m a.s.l.). Site A produced field-grown tomato (*Solanum lycopersicum* cv. 'Truss Red') and capsicum (*Capsicum annuum* cv. Warlock) alongside an open-air marigold block (*Tagetes erecta* cv. Inca Gold). Site B maintained rose production (*Rosa hybrida* cv. Iceberg) under shade cloth (30% shade) with an adjacent capsicum field. Both sites featured naturally established weed margins (10–20 m wide) dominated by *Bidens pilosa*, *Sonchus oleraceus*, and *Sida rhombifolia*. The trial ran from August 2022 through March

2023, spanning the full summer growing season.

Crop Growth Stage Documentation

Growth stages were recorded weekly using the BBCH scale adapted for each crop. For tomato and capsicum, stages tracked were seedling (BBCH 10–19), vegetative (20–39), flowering (51–69), fruit set (71–79), and harvest maturity (81–89). For marigold and rose, flowering onset, peak bloom, and flower senescence were recorded as the three quality-critical stages. The flowering window defined as the period from first open flower to the point at which 75% of marketable stems or fruit had been harvested was the focal period for quality damage assessment [11].

Seasonal Variations

The 2022–2023 season was characterised by above-average spring temperatures (mean September–November: 24.1 °C vs 22.6 °C long-term average) and a delayed onset of summer rains, with the first significant rainfall (> 25 mm/week) arriving in late December rather than the typical mid-November. These conditions favoured early buildup of thrips populations on weeds and extended the pre-rain period during which thrips could colonise crops without suppression from rainfall [12].

Material

Thrips were sampled weekly from both weed margins and crop plants using the beating tray method (20 plants per crop per site). Yellow sticky traps (25 × 10 cm) placed at distances of 0, 5, 15, and 30 m from the weed–crop boundary quantified distance-dependent colonisation. *Thrips* were identified to species using morphological keys [13]. Quality assessment used a 0–4 severity scale for each damage type: fruit scarring (0 = no visible marks, 4 = > 50% surface scarred), petal damage (0 = none, 4 = > 50% petal area silvered or necrotic), colour fading (0–4 visual scale), and marketability (0 = fully marketable, 4 = rejected). Cumulative damage scores were expressed as percentages of the maximum possible score.

Methods

Treatment effects on quality parameters were analysed by two-way ANOVA (crop type × distance) with site as a blocking factor. Linear and exponential regression models were fitted to distance-decay data. Cumulative damage curves were constructed by summing weekly damage scores from transplanting through harvest. All analyses used R v4.3.1 with significance at $p \leq 0.05$ [14]. Pearson correlations related thrips density to individual quality parameters for each crop.

Results

Four thrips species were recovered from weed margins and crop plants: *Frankliniella occidentalis* dominated collections (44.8%), followed by *Thrips tabaci* (27.3%), *Thrips imaginis* (18.6%), and *Frankliniella schultzei* (9.3%). Weed patches maintained thrips densities above 30 per twenty plants throughout September–February, while crop populations tracked the flowering phenology of each host

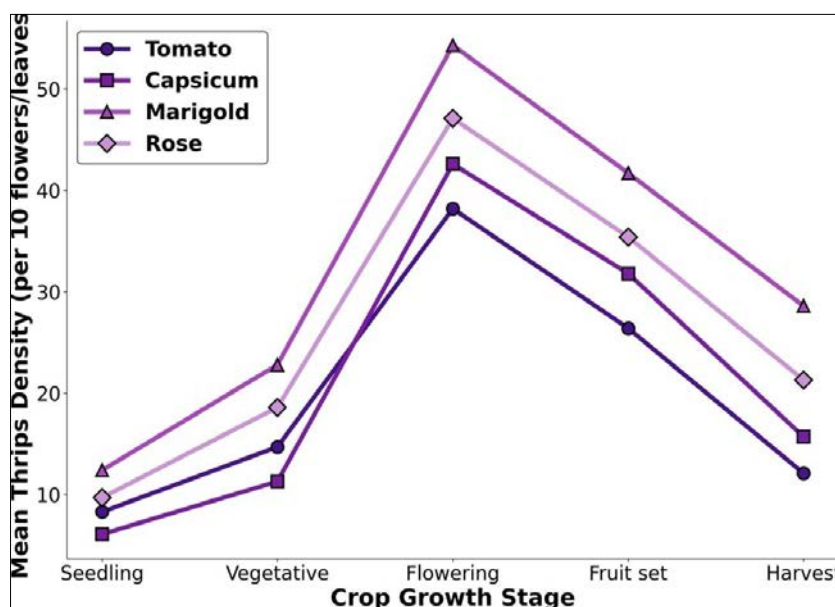


Fig 1: Mean thrips density per 10 flowers or upper leaves across crop growth stages for tomato, capsicum, marigold, and rose. Flowering stage showed peak density in all crops. Data pooled from two sites near Brisbane, 2022–2023. Table 1. Mean ($\pm$ SE) peak thrips density and quality damage parameters for four crops grown adjacent to weed margins. Dashes indicate parameters not applicable to that crop type.

Crop	Peak Density (per 10 flowers)	Fruit Scarring (%)	Petal Damage (%)	Marketability Loss (%)	Colour Fading (%)
Tomato	38.2 $\pm$ 4.6	22.4 $\pm$ 3.1	-	31.2 $\pm$ 4.7	8.7 $\pm$ 1.8
Capsicum	42.6 $\pm$ 5.3	18.6 $\pm$ 2.8	-	27.8 $\pm$ 3.9	6.3 $\pm$ 1.4
Marigold	54.3 $\pm$ 6.1	-	34.7 $\pm$ 4.2	42.1 $\pm$ 5.6	23.4 $\pm$ 3.3
Rose	47.1 $\pm$ 5.8	-	28.3 $\pm$ 3.7	38.6 $\pm$ 4.8	19.8 $\pm$ 2.9

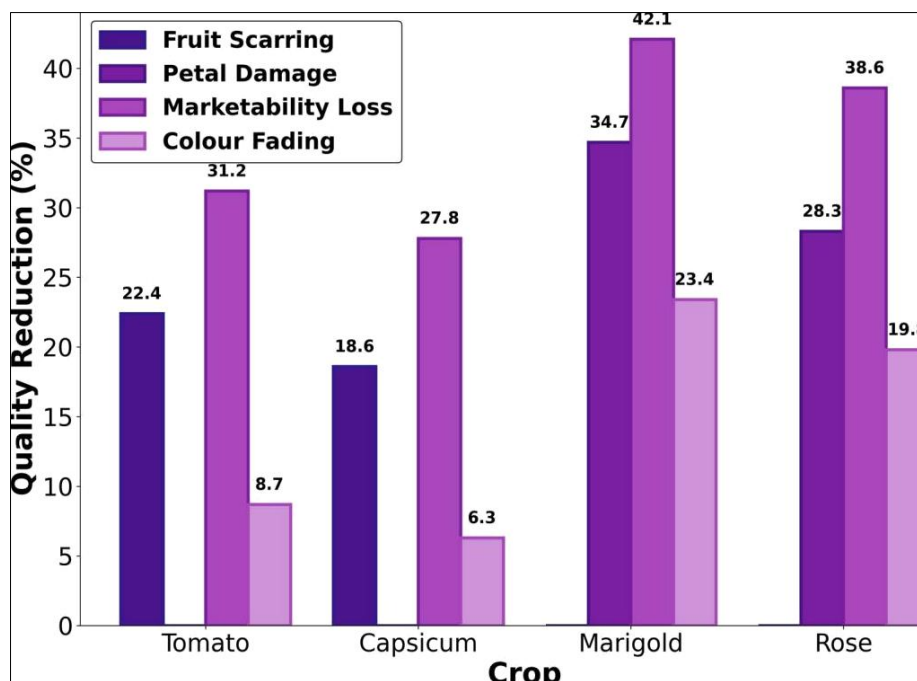


Fig 2: Quality reduction (%) across four damage parameters for vegetable (tomato, capsicum) and ornamental (marigold, rose) crops. Zero values indicate parameters not applicable to that crop type.

Table 2: Distribution of thrips-caused quality damage across crop growth phases, with management timing recommendations

Growth Phase	Duration (weeks)	Share of Total Damage (%)	Recommended Action
Seedling	2-3	4.7	Monitor weed margins
Vegetative	3-4	12.8	Begin weed removal if density rising
Pre-flowering	1-2	14.1	Complete weed clearing within 15 m
Flowering	3-5	48.4	Active thrips management on crop
Fruit set/Post-bloom	2-4	15.3	Continue monitoring
Harvest	2-3	4.7	Assess final grade

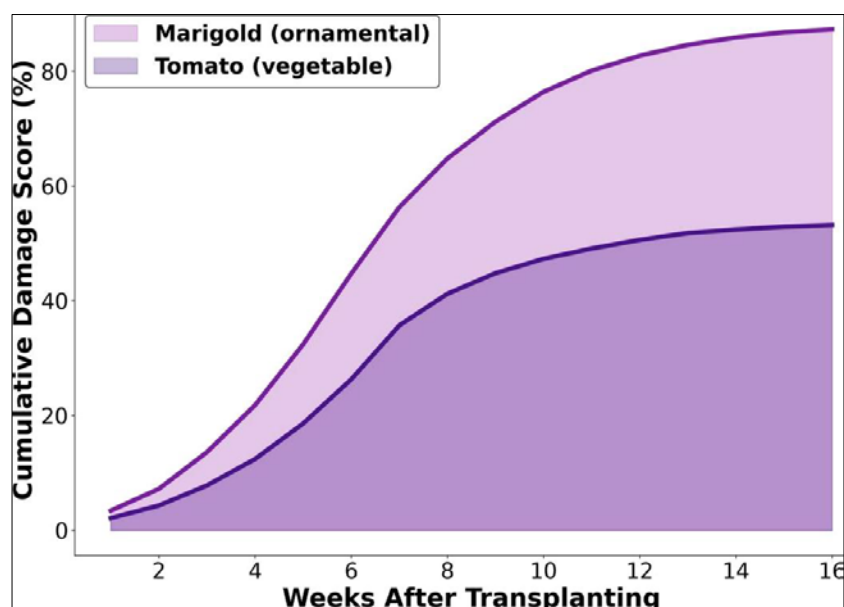


Fig 3: Cumulative damage score (%) over sixteen weeks post-transplanting for tomato (vegetable) and marigold (ornamental). Area under the curve represents total accumulated quality loss. Divergence after week 4 reflects the onset of flowering in marigold.

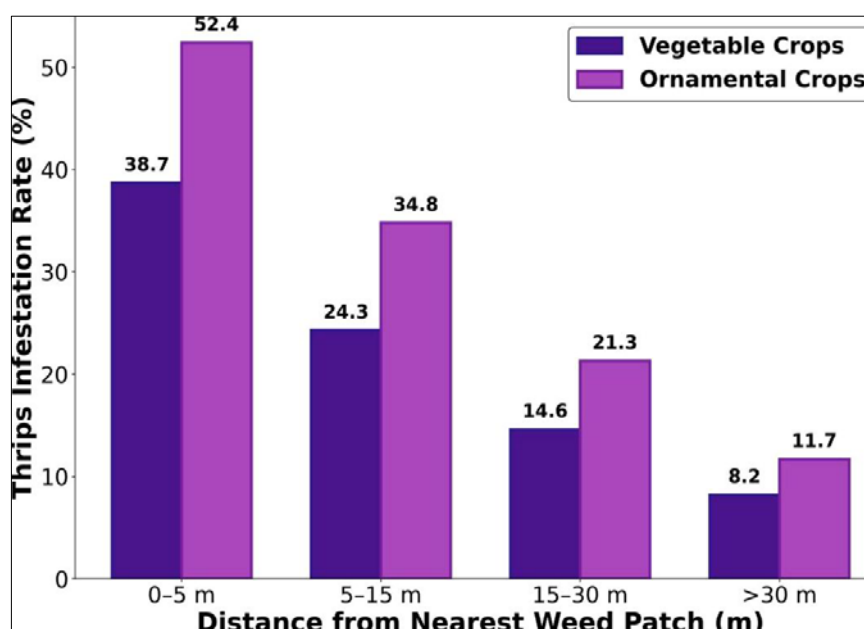


Fig 4: Distance-decay of thrips infestation rate (%) from weed patches for vegetable and ornamental crops. Infestation declined sharply beyond 15 m for both crop types.

The distance-decay analysis showed that thrips infestation dropped by approximately 78% between the 0–5 m zone and the >30 m zone for both crop categories. An exponential decay model fitted the data better than a linear model ($R^2=0.94$ vs 0.87 for ornamentals; $R^2=0.91$ vs 0.83 for vegetables). The 15 m threshold beyond which infestation fell below 20% in ornamentals and below 15% in vegetables emerged as a practical buffer recommendation. Ornamental crops suffered consistently higher quality impacts than vegetables at every distance, with the differential widening at closer ranges where thrips pressure was heaviest.

Discussion

Taken as a whole, the data show that weed-associated thrips cause measurable and economically important quality damage in both vegetable and ornamental crops grown within 15 m of natural weed margins in subtropical Queensland. Ornamental crops bore the heavier burden, losing up to 42% of marketable

value through petal silvering, colour fading, and cosmetic rejection. Vegetables suffered less severe but still significant damage, primarily as fruit surface scarring that downgraded pack quality.

Published quality damage thresholds for *F. occidentalis* on greenhouse roses set the economic injury level at roughly five thrips per flower^[15], a figure that the present field data exceeded several-fold during peak flowering. Under open-field conditions, natural immigration from weed margins appears to push thrips numbers well past greenhouse-based thresholds, especially on marigold where peak densities reached 54.3 per ten flowers. That greenhouse thresholds do not translate directly to field settings is not new^[16], but the magnitude of the gap roughly tenfold underscores the need for field-specific damage functions.

The distance-decay pattern aligns with work from South African cut-flower systems where thrips counts on roses dropped by over 60% beyond 20 m from weed margins^[17]. But the present

data suggest that a 15 m bufer captures most of the reduction, a difference that may relate to the shorter stature and denser canopy of the weed species examined here compared to the taller weed complexes in South African studies. Wind speed and direction, which were not measured continuously at both sites, probably account for some of the residual scater in the decay curves.

One explanation for the higher damage on ornamentals than vegetables may lie in petal tissue sensitivity. Marigold and rose petals are thin-walled and lack the waxy cuticle that protects tomato fruit epidermis, so each thrips feeding puncture translates into a visible mark more readily. This anatomical difference means that the same thrips density causes proportionally greater quality loss on ornamentals a point that has implications for diferential management thresholds between crop types ^[18].

From a management standpoint, two actionable insights emerge. First, maintaining at least a 15 m bufer between weed patches and quality-sensitive crops would reduce thrips infestation by roughly 60–70%. Second, weed removal timed two weeks before first flowering captures the period when thrips begin transitioning from vegetative weed tissue to crop flowers, preventing the population surge that concentrates nearly half of all quality damage during the flowering window. Combining spatial bufer management with timed weed removal would give growers two complementary tools that require no chemical input and integrate naturally into existing crop management schedules ^[19].

Conclusion

This research set out to quantify the quality damage that weed-associated thrips inflict on vegetable and ornamental crops in subtropical field conditions and to identify spatial and temporal patterns that could inform practical management. The work examined four crops tomato, capsicum, marigold, and rose grown adjacent to natural weed margins near Brisbane over a full summer production season.

Among the principal findings, ornamental crops sustained substantially greater quality losses than vegetables. Marigold lost 42.1% of marketable value through petal damage and colour fading, while rose lost 38.6%. Tomato and capsicum sufered 31.2% and 27.8% marketability loss, respectively, mainly through fruit surface scarring. These differences reflect the higher aesthetic standards applied to ornamental products and the greater sensitivity of petal tissue to thrips feeding injury. The distance-decay analysis provided a clear and immediately usable result: thrips infestation dropped sharply beyond 15 m from weed patches, falling below 20% for ornamentals and 15% for vegetables at distances greater than 30 m. This decay function held across both sites and all four crops, suggesting that a 15 m weed-free bufer represents a practical minimum for growers aiming to reduce thrips-related quality losses without eliminating all non-crop vegetation from the farm landscape.

Growth stage analysis concentrated the management message further. Nearly half of all quality damage accumulated during the flowering stage, a window of just three to five weeks. Removing weeds within the bufer zone two weeks before anticipated first flowering would target the transition period when thrips shift from vegetative weed hosts to crop flowers. This timing recommendation complements the spatial bufer by narrowing the management effort to the period of highest return. Future work should address three gaps. First, the economic threshold for thrips on field-grown ornamental crops needs to be calibrated, since existing thresholds come from greenhouse environments and underestimate open-field damage. Second,

weed species composition within the bufer zone likely affects which thrips species dominate, and managing for low-risk weed assemblages perhaps retaining grass species that support fewer pest thrips could ofer a middle ground between complete weed removal and unmanaged margins. Third, multi-site data across contrasting climate years would test the robustness of the 15 m bufer recommendation under varying temperature and rainfall patterns.

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