tried to control fruit drop in Kinnow mandarin (*Citrus reticulata*) at this Research Station during 1986–87.

Twenty 15-year-old Kinnow trees growing on Jambhiri (Citrus jambhiri, Osbeck) rootstock and planted 6 × 6 m apart with uniform growth and vigour, were selected for the study. Four treatments, viz. foliar sprays of urea and zinc sulphate at 1% and 0.4% respectively alone and in combination keeping water spray as control were given. Each treatment was replicated five times in randomized block design, keeping a tree as a unit. Foliar applications of the chemicals were given twice a year, i.e. on 1st of April and September. On each tree (replicate), 5 branches were tagged at random for taking fruit count at monthly intervals starting from March 31 (before application of chemicals) to December 31 (a day earlier to fruit harvest).

Table 1 shows that the combined foliar sprays of urea (1.0%) and zinc sulphate (0.4%) proved significantly better than their individual sprays over the control in reducing both premature and pre-harvest fruit drops. Although separate foliar applications of urea and zinc sulphate checked premature fruit drop significantly, the results in respect of pre-harvest fruit drop were insignificant. The individual effect of nitrogen and zinc sulphate in reducing premature drop, might be due to their role in the retardation of formation of abscission layer in the fruit pedicels[3]. Besides, shortage of nitrogen has been considered as one of the reasons for periodic drop of immature fruits[4]. Further, zinc has been known to be necessary for the production of tryptophane, a precursor of auxin, the deficiency of which results in low auxin level causing fruits to drop prematurely[5]. The significant check on economically important pre-harvest fruit drop by the combined foliar sprays of these chemicals can be attributed to the activation of auxins responsible for inhibiting fruit drop by strengthening the fruit pedicels through their synergestic relationship between them[6].

Table 1 *Effect of sprays of urea and zinc sulphate and their combination on fruit drop*

Treatment	Premature drop (%)*	Pre-harvest drop (%)**
Urea (1%)	10.4 (18.78)	13.8 (21.81)
Zinc sulphate (0.4%)	9.2 (17.69)	12.6 (20.52)
Urea (1%) + zinc sulphate (0.4%)	5.2 (13.08)	2.1 (8.14)
Control (water spray)	23.4 (28.94)	13.9 (21.87)
CD at 5% level	2.72	1.43

Figures in parentheses are the values of angular transformation; *Total fruit drop for the months of July, August and September; **Total fruit drop for the months of October, November and December.

The above results suggest that combined foliar sprays of urea (1%) and zinc sulphate (0.4%) twice a year, i.e. in April and September would be most useful to substantially reduce both premature and pre-harvest fruit drops in Kinnow and other citrus crops.

16 June 1988; Revised 11 August 1988

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ON THE ASSOCIATION OF RICE TUNGRO VIRUS COMPONENTS WITH TUNGRO DISEASE

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TUNGRO is a composite disease caused by two morphologically and serologically unrelated viruses, namely rice tungro spherical virus (RTSV) and rice tungro bacilliform virus (RTBV). Though the rice tungro virus (RTV) components, RTSV and RTBV, have been described as distinct entities[1], further work is required to demonstrate their relationship with each other. The present investigation is one step in that direction.

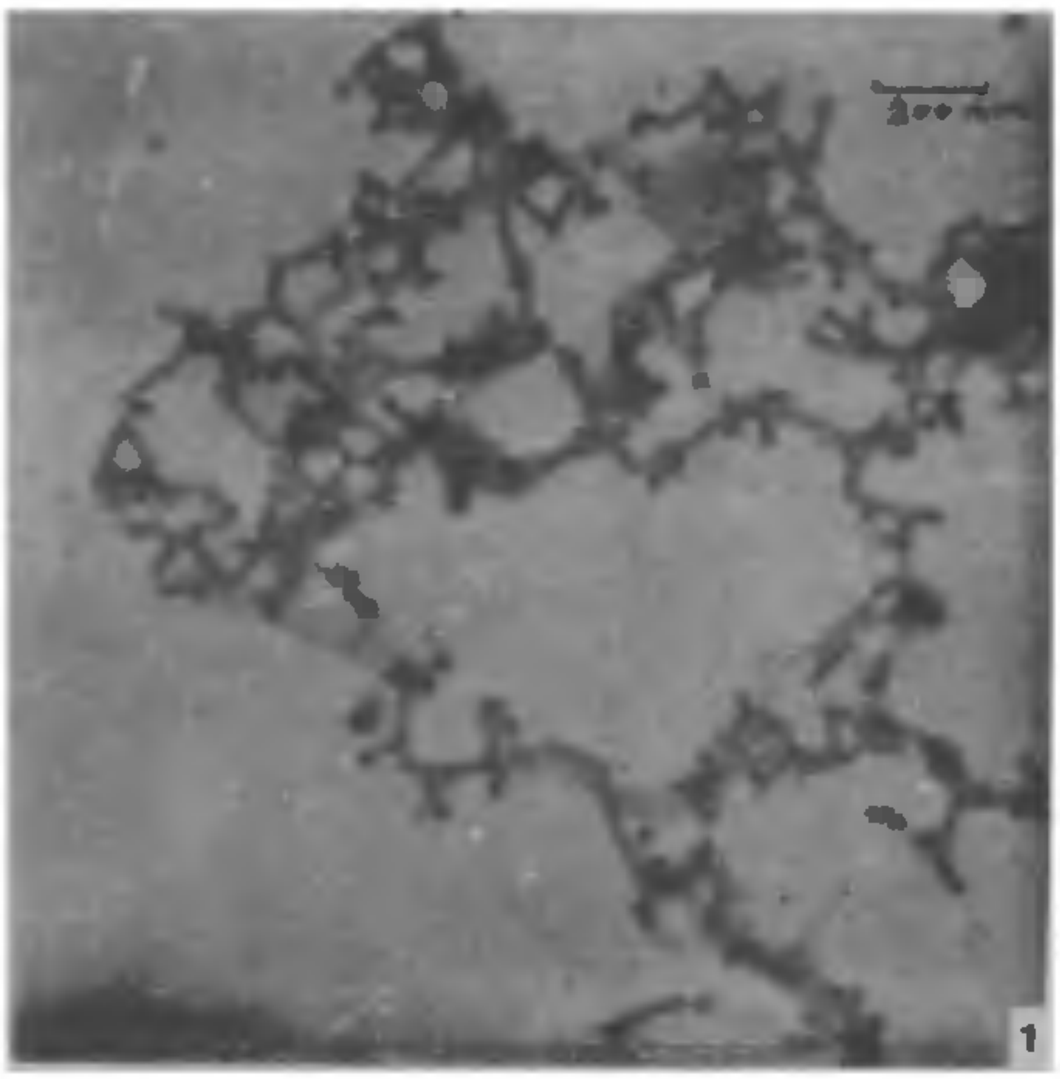
RTV components from tungro-infected leaves

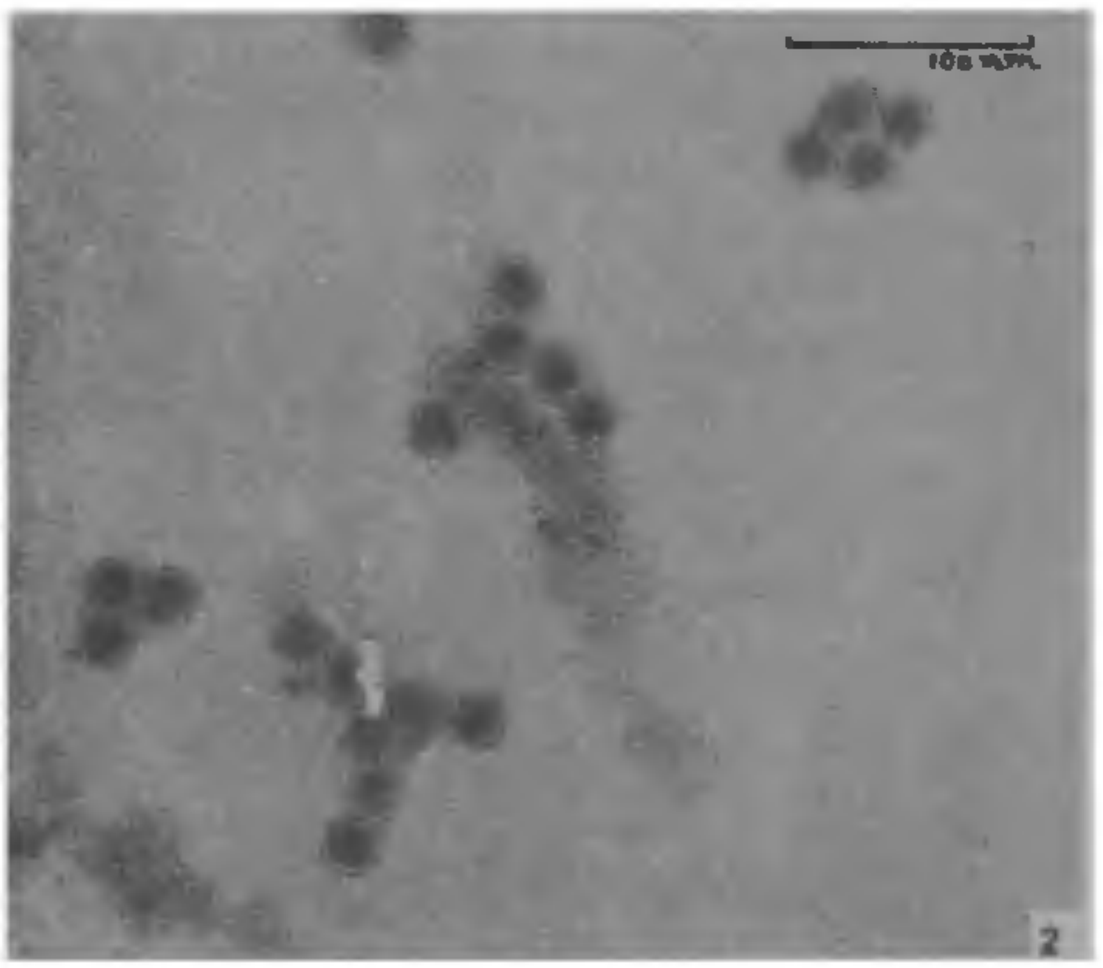
were purified following a procedure standardized by the authors (in press) and were separated on 10–40% (w v) sucrose gradients in 0.01 M EDTA buffer (pH 8) by centrifuging thrice at 100,000 *g* for 2 h each.

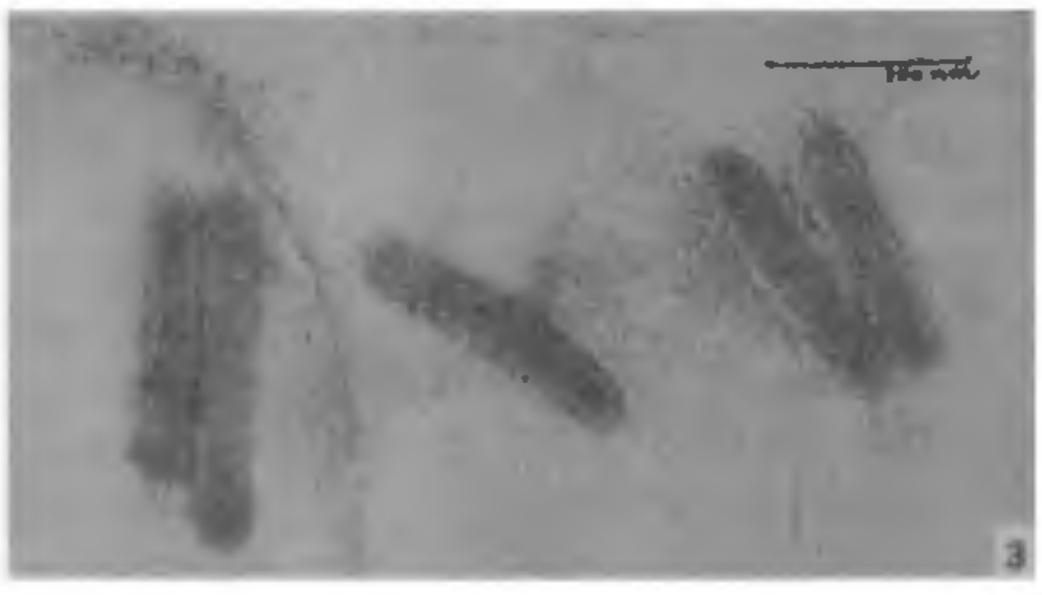
Electron microscopy of negatively stained (uranyl acetate, 1%, pH 4.2) purified preparations revealed the presence of two morphologically different particles, namely spherical (RTSV: 30 nm diam.) and bacilliform (RTBV: 18–23 × 103–224 nm), in various ratios ranging from 3:1 to 14:1 (figure 1). Close examination indicated the presence of an electron-dense core surrounded by an electron-dense layer in both the cases (figures 2 and 3). Spherical particles were coupled either along the sides or at the ends with bacilliform particles and the association remained even after density gradient centrifugation (figures 4 and 5). Both types of particles were denatured *in vitro* when heated at 60°C for 10 min or stored at 4 C beyond 15 days.

In vitro acquisition studies indicated that both types of particles were acquired together by the vector *Nephotettix virescens* from purified preparations through parafilm M membrane under similar acquisition feeding conditions. On subsequent transmission, typical tungro symptoms, such as interveinal chlorosis (IVC), yellowing and upward rolling (YR) and orange-yellow discoloration (OY) were developed. Such symptoms are elicited by the concomitant occurrence of the two particles[2]. The association has also been observed (i) at different periods of infection (15, 30 and 45 days post-inoculation), (ii) in different host cultivars (resistant, intermediate and susceptible), and (iii) in different host plant growth conditions (preferably temperature prevailing during July to January)[2].

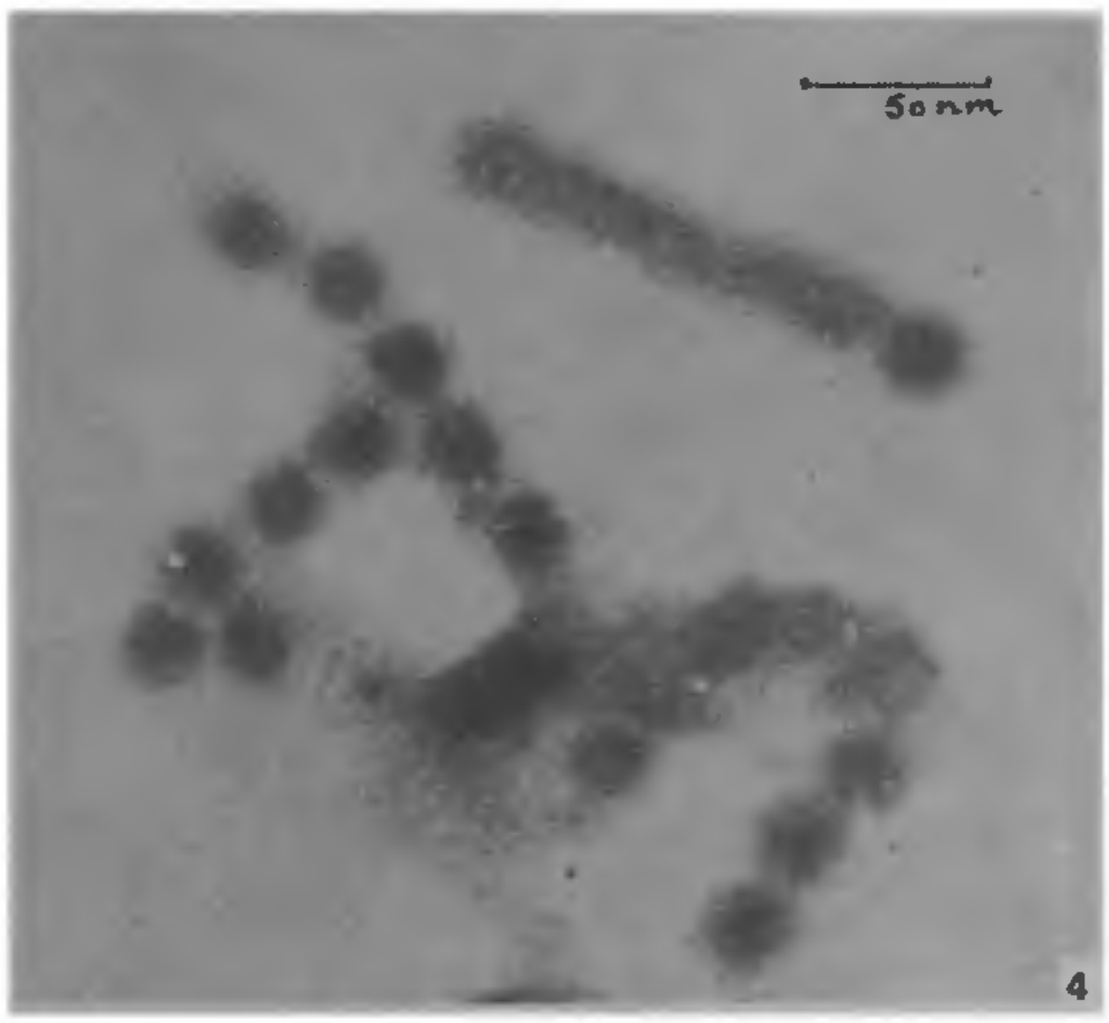
On the basis of the similarities between the two types of particles in their intrinsic and biological properties and their co-existence under varying conditions, it can be envisaged that the RTV components RTSV and RTBV are related entities. Admittedly, intensive genomic studies are required

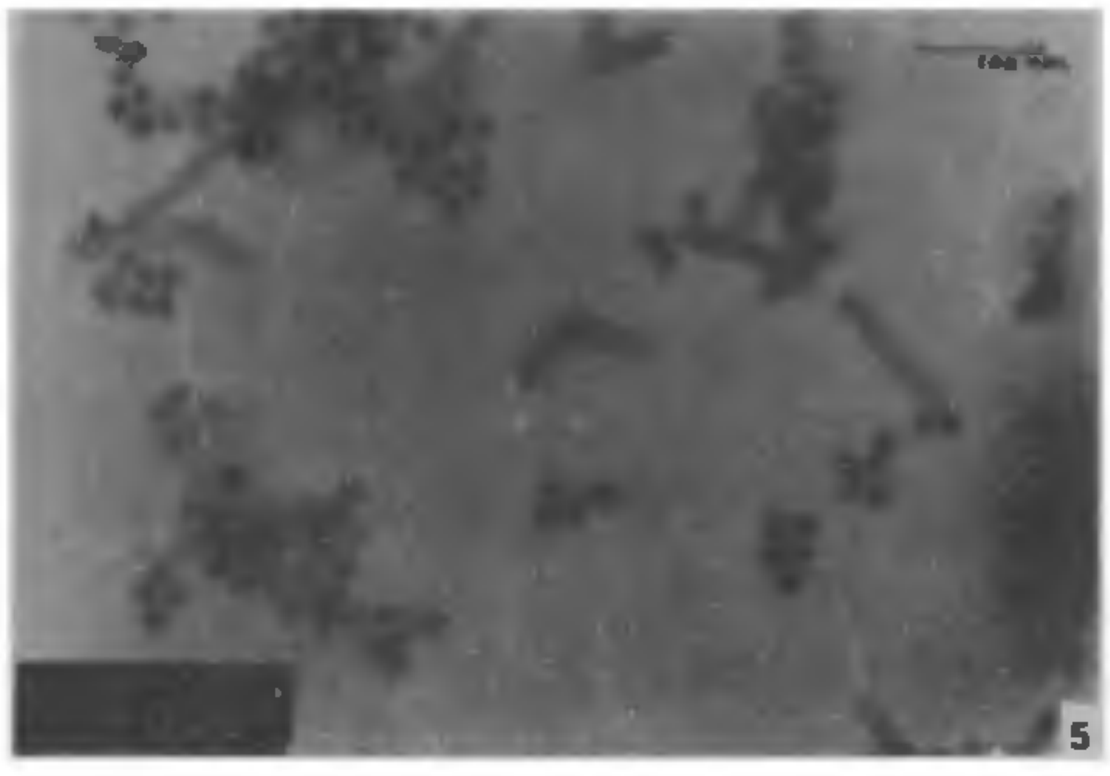






Figures 1–3. Transmission electron micrographs of RTV components from purified preparations. **1.** RTSV and RTBV particles aggregated to form a tangled mass; **2.** and **3.** RTSV and RTBV particles with an electron-dense core and a surrounding layer.





Figures 4 and 5. RTSV particles associated at the ends or along the sides of RTBV particles.

to further confirm the relationship between the two particles.

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VESICULAR-ARBUSCULAR MYCORRHIZAL ASSOCIATIONS OF CASTOR AND SAFFLOWER

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OCCURRENCE of vesicular-arbuscular mycorrhizas (VAM) is ubiquitous and they are known to increase the phosphorus and the moisture uptake in all agricultural crops[1-3]. Plants infected with mycorrhizal fungi exhibit significant increase in the yield as compared with non-mycorrhizal plants[4,5]. There are a few reports of VAM on groundnut[3], soybean[6], sunflower[7] and sesame[8]. As there were no studies of VAM in castor (*Ricinus communis* L.) and safflower (*Carthamus tinctorius* L.), the identity of the VAM, their development in the root-system and spore count in the corresponding rhizospheres are investigated.

Field sites of castor and safflower located in Rajendranagar (pH 7.3, MHC 20%) were selected for the study of VAM fungi. The rhizosphere soil samples, root pieces of castor and safflower were collected on days 30, 60 and 90 from seed sowing. The VAM spores in 100 g of rhizosphere soil were extracted by the wet-sieving and decanting methods[9], counted and identified[10]. The root bits were cleared, stained and examined for VAM fungi[11] and the percentage of mycorrhizal infection was calculated[12].

The study confirms the formation of VA mycorrhizas in castor and safflower grown in semi-arid tropical soils. The roots were found to be mycorrhizal (figure 1) from early to mature stages with a progressive increase in the number of spores in the rhizosphere having a direct correlation with the age of the host plant (table 1). Similar trend was observed earlier in peanut[13,14], sesamum[15] and sunflower[16]. The rapid development of VAM fungi in castor and safflower is related to the increased vegetative growth of the host plant and it may be due to the availability of adequate moisture, suitable pH, available nutrients and root exudates.

Qualitatively the castor supported eight VAM fungi while safflower has been found to be associated with four. Of the eight species reported on castor, *Glomus fasciculatum* (figure 2), *G. constrictum*, *Gigaspora* sp. (figures 3 and 4) with echinulated and smooth extra matrical vesicles were predominant