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NEW HOST PLANT RECORDS AND HOST RANGE OF THE SPIRALLING WHITEFLY, *ALEURODICUS DISPERSUS* RUSSELL (HEMIPTERA : ALEYRODIDAE)

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ABSTRACT

The rich collection of diversified flora at the District Science Centre, Tirunelveli was screened for infestation by the spiralling whitefly, *Aleurodicus dispersus* Russell during 1997-98. The survey revealed that *A. dispersus* did not develop on all host plants on which oviposiiton occurrred. Of the 27 plants showing infestation, 19 were 'breeding hosts' while 8 were 'feeding hosts'. The following 14 are new host records : *Dillenia indica, Adenanthera pavonina, Caesalpinia pulcherrima, Hiptage bengalensis, Malpighia punicifolia, Solanum trilobatum, Grewia tilliaefolia, Lantana sp., Stenolobium stans, Ipomoea obscura, Bombax ceiba, Jatropa multifida, Sterculia sp.* A comprehension of list of host plants shows that the pest occurs on 187 plant species from 58 families.

KEY WORDS: Spiralling whitefly, *Aleurodicus dispersus*, host plants, new records

The entry into India of the spiralling whitefly, *Aleurodicus dispersus* Russell, has added a new dimension to the economic importance of the whiteflies. Though a native of Central America as first described by Russell (1965), this pest is fast invading several parts of the globe. In India, its occurrence was first reported from the Western Ghats area of Kerala and from Kanyakumari district of Tamil Nadu (David and Regu, 1995). Its mode of infestation on an increasingly wide range of host plants portends that this exotic pest is likely to spread to other parts of the world as predicted by Cherry (1980).

Highly polyphagous, *A. dispersus* has been recorded on many plant species from 27 familes (Weems, 1971 : Cherry, 1979). Over 100 species of plants, including vegetables, fruit trees, ornamentals and shade trees suffered from this whitefly infestation on all islands of Hawaii (Lai and Funasaki, 1990). Though several host plants have been recorded from India (David and Regu, 1995; Palaniswami *et al.*, 1995 ; Ranjith *et al.*, 1996 ; Prathapan, 1996 ; Douressamy *et al.*, 1997), no comprehensive list of its host range is available. In view of its economic importance and recent origin, a survey was made at the District Science Centre of Tirunelveli (TamilNadu) where a diversified collection of plants had infestation of *A. dispersus*. The results of the floral screening are presented in this paper along with a comprehensive revision of host plants of *A. dispersus*.

MATERIALS AND METHODS

All the flora at the District Science Centre at Tirunelveli were screened for the presence of *A. dispersus*. The pest load was noted host-wise by sampling 25 randomly selected leaves per host each month from May to September, 1997. The population count was made on a plant only when atleast the eggs of *A. dispersus* was present and the other plants were not considered for survey. Observations were made on the number of fresh egg wax spirals present on each leaf. Population per spiral was assessed after disposing the wax-cover off the eggs by using a palm-held blower. The eggs were then easily counted using a hand magnifier (10x). Population density of larvae (all instars combined) and adults (both sexes) was also recorded on each sample leaf.

RESULTS AND DISCUSSION

Aleurodicus dispersus infested 27 host plants among the diversified flora available at District Science Centre, Tirunelveli (Table 1). Of these, 14 species are new host plant records. Interestingly,

Table 1. Host range and population levels of *Aleurodicus dispersus* at District Science Centre, Tirunelveli.

Family	Botanical name	Mean no. of egg wax spirals/leaf	Mean no. of eggs/spiral	Mean no. of larvae/spiral/	Mean no. of adults/leaf
Apocynaceae	*Plumeria rubra*	0.20	0.12	0.08	0.04
Bixaceae	*Bixa orellana*	1.08	2.60	0.16	0.20
Dilleniaceae	*Dillenia indica**	0.02	0.40	0.10	0.08
Leguminosae	*Adenanthera pavonina**	0.16	0.88	0.24	0.08
Leguminosae	*Bauhinia* sp.	0.56	1.90	1.68	0.18
Leguminosae	*Caesalpinia pulcherrima**	0.18	0.20	0.18	0.10
Leguminosae	*Pithecellobium dulce*	0.02	0.20	0.10	0.10
Leguminosae	*Pongamia glabra*	0.08	0.60	0.50	0.40
Lythraceae	*Lagerstroemia* sp.	0.04	0.10	0.08	0.02
Moraceae	*Morus alba*	0.06	1.90	1.10	0.80
Myrtaceae	*Psidium guajava*	0.20	2.0	1.16	1.20
Punicaceae	*Punica granatum*	0.04	0.43	0.26	0.10
Rosaceae	*Rosa* sp.	0.06	0.78	0.02	0.02
Malphigiaceae	*Hiptage bengalensis**	0.04	0.10	0.00	0.00
Malphigiaceae	*Malpighia punicifolia**	0.05	0.16	0.10	0.08
Solanaceae	*Solanum trilobatum**	0.56	1.70	0.40	0.10
Tiliceae	*Grewia tilliaefolia**	0.30	0.10	0.50	0.20
Verbenaceae	*Lantana sp.**	0.04	0.10	0.30	0.07
Verbenaceae	*Tectona grandis*	0.01	0.50	0.06	0.08
Verbenaceae	*Vitex altissima*	0.84	2.04	0.08	0.10
Bignoniaceae	*Stenolobium stans**	0.08	0.30	0.00	0.00
Bombaceae	*Bombax ceiba**	0.08	0.28	0.00	0.00
Convolvulaceae	*Ipomoea obscura**	0.10	0.28	0.00	0.00
Euphorbiaceae	*Jatropa multifida**	0.08	0.10	0.00	0.00
Rutaceae	*Murraya exotica**	0.05	0.16	0.00	0.00
Santalaceae	*Santalum album*	0.10	1.30	0.00	0.00
Sterculiaceae	*Sterculia* sp*	0.06	0.01	0.00	0.00

* New records

cotton is an important cash crop that still perhaps finds no scientific record. The nature of infestation on these plants is suggestive of the fact that they were of two types, 'breeding hosts' and 'feeding hosts'. For instance, observations on population of egg, larva and adult revealed that 19 hosts were of the first category and eight were of the second category. Egg wax spirals and eggs could be observed on the leaves of *Stenolobium stans* Seem, *Bombax ceiba, Ipomoea obscura* Ker-Gawl, *Jatropha multifida* L., *Hiptage benghalensis* Kurz, *Murraya exotica* L., *Santalum album* L. and *Sterculia* sp. Closer examination of the eggs on sandalwood leaves showed that the crawlers perished after eclosion eventhough eggs were laid repeatedly. On 19 other host plants the crawlers developed into mature larvae and adults emerged from the pupal cases later. The number per leaf of egg wax spirals, eggs, larvae and adults averaged 0.01-1.08, 0.1-2.6, 0.06-1.68 and 0.02-1.20 respectively, on different host plants.

It is well known that *A. dispersus* is highly polyphagous infesting a very wide range of

Table 2. List of host plants of *Aleurodicus dispersus*

S.No.	Family	Botanical Name
1.	Acanthaceae	*Pseuderanthemum* spp.[6]
2.	Acanthaceae	*Sanchezia nobilis*[1,13]
3.	Anacardiaceae	*Anacardium occidentale* L.[11,14]
4.	Anacardiaceae	*Mangifera indica* L.[1,3,5,6,9,10,12]
5.	Anacardiaceae	*Schinus terebinthefolius*[1]
6.	Annonaceae	*Annona reticulata* L.[11,12,14]
7.	Annonaceae	*Annona squamosa* L.[1,13]
8.	Annonaceae	*Monodora tenuifolia* Benth.[9]
9.	Annonaceae	*Polyalthia longifolia* (Sonn.) Thwaites[14]
10.	Apocynaceae	*Beaumontia grandiflora*[1]
11.	Apocynaceae	*Plumeria acuminata* Ait.[14]
12.	Apocynaceae	*P.rubra* L.[6,9]
13.	Apocynaceae	*Plumeria* sp.[4,8]
14.	Araceae	*Aglaonema* sp.[9]
15.	Asclepiadaceae	*Calotropis gigantea* (L.) R.Br.ex.Ait.[14]
16.	Bsalsaminaceae	*Impatiens balsamina* L.[13]
17.	Begoniaceae	*Begonia* sp.[3]
18.	Bignoniaceae	*Stenalobium stans Seem.*[*]
19.	Bignoniaceae	*Tecomaria capensis* (Thunb.) Lindley[14]
20.	Bixaceae	*Bixa orellana* L.[14]
21.	Bombaceea	*Bombax ceiba*[*]
22.	Burseracea	*Bursera simaruba*[1]
23.	Cannaceae	*Canna* sp.[11]
24.	Cannaceae	*C. hybrida* Hort.[8]
25.	Cannaceae	*C. indica* L.[6,14]
26.	Caricaceae	*Carica papaya* L.[6,9,10,11,14]
27.	Combretaceae	*Bucida buceras* L.[3]
28.	Combretaceae	*Calyopteris floribunda* (Roxb.) Poiret[14]
29.	Combretaceae	*Conocarpus erectus*[1]
30.	Combretaceae	*Quisqualis sp.*[10]
31.	Combretaceae	*Q. indica*[12]
32.	Combretaceae	*Terminalia* sp.[10]
33.	Combretaceae	*Terminalia catappa* L.[1,2,11,14]
34.	Combretaceae	*T. indica*[*]
35.	Compositae	*Dahlia rosea*[13,14]
36.	Compositae	*Eupatorium adenophorum*[11]
37.	Compositae	*Lactuca indica* L.[8]
38.	Compositae	*Tridax procumbens* L.[13]
39.	Convolvulaceae	*Ipomoea muricata* Jacq.[14]
40.	Convolvulaceae	*I. obscura Ker*-Gawl.[*]
41.	Cucurbitaceae	*Coccinia indica* W. & A[14]

Contd..

Table 2. Contd.,

S.No.	Family	Botanical Name
42.	Dilleniaceae	*Dillenia indica* L.[*]
43.	Dilleniaceae	*D. pentagyna* Roxb.[15]
44.	Ebenaceae	*Diospyros philippensis* (Desr.) Gurke[8]
45.	Euphorbiaceae	*Acalypha* spp.[9,11]
46.	Euphorbiaceae	*A. godseffiana*[13]
47.	Euphorbiaceae	*A. hispida* Burm F.[1,14]
48.	Euphorbiaceae	*A. indica*
49.	Euphorbiaceae	*A. wilkesiana* Muell. Arg.[8,14]
50.	Euphorbiaceae	*Bridelia retusa* Spreng.[14]
51.	Euphorbiaceae	*Codiaeum* spp.[6]
52.	Euphorbiaceae	*Euphorbia fulgens*[14]
53.	Euphorbiaceae	*E. geniculata*[14]
54.	Euphorbiaceae	*E. pulcherrima* Wild. ex. Klotzsch[8,9,13,14]
55.	Euphorbiaceae	*Excoecara agallocha* L.[14]
56.	Euphorbiaceae	*Hura crepitans* L.[9]
57.	Euphorbiaceae	*Jatropha* sp.[14]
58.	Euphorbiaceae	*J. multifida* L.[*]
59.	Euphorbiaceae	*Macaranga peltata* (Roxb.) Muell. Arg.[13,14]
60.	Euphorbiaceae	*Manihot esculenta* Crantz[6,8,9,10,12]
61.	Euphorbiaceae	*M. glaziovii* Muell. Arg.[13,14]
62.	Euphorbiaceae	*M. utilisima* Pohl.[11,14]
63.	Euphorbiaceae	*Ricinus communis* L.[14]
64.	Euphorbiaceae	*Souropus andragynus* (L.) Merr.[13,14]
65	Goodeniaceae	*Scaevola taccada* Vahl[6]
66.	Guttiferae	*Calophyllum calophe* L.[6,12]
67.	Guttiferae	*C. inophyllum*[1]
68.	Guttiferae	*Garcinia indica* DC[15]
69.	Heliconiaceae	*Heliconia rostrata*[15]
70.	Labiatae	*Coleus* sp.[1]
71.	Labiatae	*Ocimum basilicum* L.[12]
72.	Labiatae	*O. sanctum* L.[11,12]
73.	Labiatae	*Salvia* sp.[14]
74.	Lauraceae	*Persea americana* Miller[6,10]
75.	Lecythidaceae	*Barringtonia speciosa*[1]
76.	Lecythidaceae	*Careya arborea* Roxb.[14]
77.	Leguminosae	*Acacia* sp.[10]
78.	Leguminosae	*Adenanthera pavonia* L.[*]
79.	Leguminosae	*Bauhinia* sp.[6]
80.	Leguminosae	*B. acuminata*[13]
81.	Leguminosae	*B. purpurea* L.[8,14]
82.	Leguminosae	*Caesalpinia pulcherrima* Swartz[*]

Contd..

Table 2. Contd..

S.No.	Family	Botanical Name
83.	Leguminosae	*Cajanus cajan* (L.) Millsp.[9,14]
84.	Leguminosae	*Calopogonium mucnoides* Desv.[14]
85.	Leguminosae	*Cassia bahamensis*[1]
86.	Leguminosae	*C.fistula*[1]
87.	Leguminosae	*C. siamea*[1]
88.	Leguminosae	*C. senna* L.[9,12]
89.	Leguminosae	*Centrosema pubescens* Benth[14]
90.	Leguminosae	*Clitoria ternatea* L.[11]
91.	Leguminosae	*Enterolobium saman* (Jacq.) F. Muell.[14]
92.	Leguminosae	*Gliricidia maculata* (Steudel.) Kunth[11]
93.	Leguminosae	*G. sepium* (Jacq.) Kunth ex. Walp[9]
94.	Leguminosae	*Glycine max* (L.) Merr.[8,9]
95.	Leguminosae	*Inga laurina*[1]
96.	Leguminosae	*Lablab niger*[11]
97.	Leguminosae	*Leucaena leucocephala* (Lam.) De Wit[9]
98.	Leguminosae	*Pithecellobium dulce* (Roxb.) Benth[14].
99.	Leguminosae	*Pongamia glabra* Vent.[14]
100.	Leguminosae	*Pterocarpus indicus* Willd[8]
101.	Leguminosae	*P. macrocarpus* Kurz.[6]
102.	Lythraceae	*Lagerstroemia indica* L.[8]
103.	Magnoliaceae	*Michelia champaca* L.[11]
104.	Malphigiaceae	*Hiptage benghalensis* Kurz[7]
105.	Malphigiaceae	*Malphigia punicifolia* L.[7]
106.	Malvaceae	*Abelmoschus esculentus* (L.) Moench[12,14]
107.	Malvaceae	*Abutilon* sp.[6]
108.	Malvaceae	*Gossypium hirsutum* L.[7]
109.	Malvaceae	*Hibiscus* sp.[4,6,9,12]
110.	Malvaceae	*H. rosasinensis* L.[8,11]
111.	Malvaceae	*Malavaviscus arboreus* Dillen. ex. Cav.[12]
112.	Malvaceae	*Sida acuta* Burm. F.[11]
113.	Malvaceae	*Urena lobata* L.[13,14]
114.	Meliaceae	*Dysoxylum alliaceum* Bl.[8]
115.	Moraceae	*Artocarpus heterophyllus* Lam[6,13]
116.	Moraceae	*A. gomezianus* Wall.ex.Trec.[8]
117.	Moraceae	*A. hirsutus* Lam.[1]
118.	Moraceae	*Castilloa cf. panamensis* O.F. Cock[8]
119.	Moraceae	*Ficus elasticoa*[14]
120.	Moraceae	*F. gibbosa* Blume[14]
121.	Moraceae	*F. glomerata* Roxb.[14]
122.	Moraceae	*F. grandis* Simonet[8,12]
123	Moraceae	*F. religiosa*[1]

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Table 2. Contd.,

S.No.	Family	Botanical Name
124.	Moraceae	*Morus alba* L.[11,14,15]
125.	Musaceae	*Ensete gilletii*[9]
126.	Musaceae	*Musa* sp.[6,10,14]
127.	Musaceae	*M. nana*[1]
128.	Musaceae	*M. paradisiaca* L.[1,11,12]
129.	Musaceae	*M. sapientum* L.[3,8]
130.	Musaceae	*M. sumatrana*[1]
131.	Myrtaceae	*Eucalyptus* sp.[10]
132.	Myrtaceae	*Eugenia buxifolia*[1]
133.	Myrtaceae	*E. jambolana* Lam.[14]
134.	Myrtaceae	*Melaleuca leucadendron*[1]
135.	Myrtaceae	*Psidium guajava* L.[1,4,5,6,8,9,10,11,12,14]
136.	Nyctaginaceae	*Bougainvillea* sp.[6,9]
137.	Oleaceae	*Jasminum* sp.[12]
138.	Orchidaceae	*Peristeria* sp.[1]
139.	Orchidaceae	*Spathoglottis* sp.[14]
140.	Palmae	*Chrysalidocarpus lutescens*[1]
141.	Palmae	*Cocos nucifera* L.[1,3,6,10,11,12,14]
142.	Palmae	*Pandanus* sp.[6]
143.	Piperaceae	*Piper nigrum* L.[13]
144.	Plumbaginaceae	*Plumbago zeylanica* L.[14]
145.	Polygonaceae	*Antigonon leptopus* Hook & Arn.[14]
146.	Polygonaceae	*Coccoloba uvifera* (L.) L.[2,3,4]
147.	Punicaceae	*Punica granatum* L.[6]
148.	Rhamnaceae	*Zizyphus jujuba* (L.) Gaertner, non Miller[14]
149.	Rhamnaceae	*Z. oenoplia* (L.) Miller[14]
150.	Rosaceae	*Prunus* sp.[1]
151.	Rosaceae	*Rosa* sp.[6,9,12,14]
152.	Rosaceae	*R. indica* L.[2,9]
153.	Rubiaceae	*Coffea* sp.[4]
154.	Rubiaceae	*Guettarda speciosa* L.[6]
155.	Rutaceae	*Citrus* spp.[9,10,12]
156.	Rutaceae	*C. aurantifolia*[1]
157.	Rutaceae	*C. paradisi* Macfad[1]
158.	Rutaceae	*C. sinensis* (L.) Osbeck[3]
159.	Rutaceae	*Murraya exotica* L.[*]
160.	Rutaceae	*M. koenigii* (L.) Sprengel[13]
161.	Salicaceae	*Salix babylonica* L.[6]
162.	Santalaceae	*Santalum album* L.[14]
163.	Sapindaceae	*Cardiospermum halicacabum* L.[14]
164.	Sapotaceae	*Achras zapota* L.[12]

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Table 2. Contd.

S.No.	Family	Botanical Name
165.	Sapotaceae	*Chrysophyllum cainito* L.[14]
166.	Simaroubaceae	*Ailanthus malabarica* DC[14]
167.	Solanaceae	*Capsicum* sp.[1]
168.	Solanaceae	*C. annum* L.[8,11,12,14]
169.	Solanaceae	*C. diurnum*[1]
170.	Solanaceae	*C. frutescens* L.[13,14]
171.	Solanaceae	*Cestrum* sp.*
172.	Solanaceae	*Datura* sp.[14]
173.	Solanaceae	*Lycopersicon esculentum Miller*[15]
174.	Solanaceae	*Physalia minima* L.[13]
175.	Solanaceae	*Solandra* sp.[1]
176.	Solanaceae	*Solanum* sp.[11]
177.	Solanaceae	*S. melongena* L.[8,12,13,14]
178.	Solanaceae	*S. nigrum* L.[14]
179.	Solanaceae	*S. trilobatum**
180.	Sterculiaceae	*Theobroma cacao* L.[9]
181.	Sterculiaceae	*Sterculia* sp.*
182.	Tiliaceae	*Grewia tiliaefoila* Vahl*
183.	Verbenaceae	*Clerodendrum thomsonia* Balf.[14]
184.	Verbenaceae	*Lantana* sp.
185.	Verbenaceae	*Tectona grandis* L. f.[13,14]
186.	Verbenaceae	*Vitex altissima* L. f[14]
187.	Verbenaceae	*V. negundo* L.[11]

1. Russell, 1965
2. Cherry, 1979
3. Cherry, 1980
4. Paulson and Beardsley, 1985
5. Anonymous, 1988
6. Anonymous, 1990
7. Gaud *et al.*, 1991
8. Kajita *et al.*, 1991
9. Akinlosotu *et al.*, 1993
10. M'Boob and van Oers, 1994
11. David and Regu, 1995
12. Palaniswami *et al.*, 1995
13. Ranjith *et al.*, 1996
14. Prathapan, 1996
15. Douressamy *et al.*, 1997.

* New records

cultivated and wild plants (Mound and Halsey, 1978). However, the magnitude of infestaion as well as the extent of damage vary with plant species, seasons and localities. Moreover, the host plants of *A. dispersus* often react differently from region to region. A host plant species which supports higher populations at one place or in a country may be relatively free from the whitefly on another location. For instance, mango, citrus and sapota have been reported as hosts from other countries (Anon., 1990 ; M'Boob and van Oers, 1994) as well as from India (Palaniswami *et al.*, 1995). However, these trees had neither any infestation nor any egg wax spirals during the samplings although they were in the pool of infested trees or nearby. Another example is papaya (*Carica papaya*) which has been widely reported as a host of *A. dispersus* (David and Regu, 1995 ; Prathapan, 1996 ; Akinlosotu *et al.*, 1993 ; M'Boob and van Oers, 1994). Though *A. dispersus* developed on papaya elsewhere, it did not infest papaya at Tirunelveli. Eventhough adults oviposited on papaya leaves, there was no further development. Similar behaviour in *B. tabaci* has been attributed to variations in agroecosystems and the possibiities of physiological races of *B. tabaci* (Basu, 1995). Though differences in

agroecosystems did exist in the present investigation, the probability of occurrence of physiological races of *A. dispersus* needs further examination. The hosts on which no immatures develop could not be treated as real 'hosts' of *A. dispersus*. This observation calls for further scrutiny while designating a host plant as 'breeding host' or 'feeding host'.

Prathapan (1996) also observed only eggs on sandal wood tree leaves. Another such example is *J. multifida*. Prathapan (1996) also made similar observations on *Jatropha* sp. this area needs more detailed research to find out the possible reasons for the mortality in immatures. Inhibitive host-insect interaction may be the cause. Morphological and physiological traits such as leaf toughness, hairiness, surface waxes, cell silicates and proliferation of wounded tissues would profoundly affect oviposition, locomotion and feeding as suggested by Ananthakrishnan (1992).

A comprehensive revision of the list of host plants of *A. dispersus* points out that *A. dispersus* occurs on 187 plants from 58 families, of which most susceptible plants occur in Leguminosae, Euphorbiaceae, Moraceae, Solanaceae, and Malvaceae including many economically important field, forest and horticultural crops (Table 2). The most reported host species is *Psidium guajava* which has been recorded in almost all reported locations. Being a perennial host, guava could well serve as a reservoir of the pest, facilitating its carry over between seasons as well as its spread. Denser canopy, continued flushing and the perennial character of guava would probably help sustain the severity of pest incidence.

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EFFECT OF MICRONUTRIENT ON THE PRODUCTIVITY AND QUALITY OF COTTON SEED cv.TCB 209 (*Gossypium barbadense* L.)

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ABSTRACT

Field experiments conducted during summer and winter 1996 seasons with 10 treatments involving zinc and boron in various combinations showed significant differences for yield attributing characters in cotton. The number of sympodia plant^{-1} (30.0%), number of bolls plant^{-1} (39.2 %), boll weight (49.8 %), seed weight boll^{-1} (36.8 %), number of seeds boll^{-1} (10.8 %) were significantly higher for plants given combined soil application of $ZnSO_4$ (50 kg ha^{-1}) and borax (10 kg ha^{-1}). The seed cotton yield and seed yield were 47.1 % and 19.2 % higher for the same treatment over control. The quality of resultant seeds in terms of 100 seed weight, germination, speed of germination, seedling growth, drymatter production, vigour index, dehydrogenase enzyme activity and oil content were also significantly higher for the seeds from plants received both $ZnSO_4$ and borax through soil or foliage.

KEY WORDS : Micronutrients, Zinc, Boron, Cotton

Premature floral abscission and failure to set seeds are the common problems in cotton seed production. These are to certain extent attributed to micronutrient deficiencies such as boron, zinc, copper and so on. The anthers and pollen grains accumulate relatively large amounts of zinc and get translocated to the resultant seed (Polar, 1970 : 1975). Sawan *et al.* (1989) reported increased seed yield plant^{-1}, seed viability and seedling vigour with increase in N rate and foliar application of Ca (50 mg lit^{-1}), Cu, Zn (1.25 mg lit^{-1}), Fe, Mn (25 mg lit^{-1}) in cotton. Lakshmi (1995) also reported that soil application of zinc sulphate followed by two foliar sprays increased the seed quality. The present study was undertaken to study the effect of soil, foliar and combined application of zinc and boron on the seed yield and seed quality of cotton cv. TCB 209.

MATERIALS AND METHODS

Field experiments were carried out at Agricultural College and Research Institute, Coimbatore in two seasons *viz.*, summer and winter in 1996. The experiment was laid out in black cotton soil in randomized block design using 20 m^2 plots with four replications. Seeds were dibbled at 60 x 45 cm spacing. Basal application of half the dose of N, full P and K (120:60:60 kg ha^{-1}) was done in all the plots, along with zinc sulphate (50 kg ha^{-1}) and borax (10 kg ha^{-1}) according to treatments. Remaining half dose of N was applied at square formation stage. Plant protection measures and cultural operations were followed as per the recommended package of practices.

Treatment particulars :

T_0 - Control

T_1 - Soil application of zinc sulphate (50 kg ha^{-1})

T_2 - Soil application of borax (10 kg ha^{-1})

T_3 - Soil application of zinc sulphate (50 kg ha^{-1} - borax (10 kg ha^{-1})

T_4 - Foliar application of zinc sulphate (0.5%) on 90 and 110 days after sowing (DAS).