Tabanidae. The distribution and abundance of these species are shown in figure 2.

Animals of estuarine environment acquire a certain degree of euryhalinity as an insurance against fluctuating environmental conditions[4]. The presence of *Culicoides pelliouensis*, *C. oxystoma*, *Notiphila* sp. and *Brachydeutera longipes* in this changing environment throughout the year indicates that these species are typically euryhaline, but the remaining species were found to occur in these habitats only during less saline periods.

Temperature is also an important factor for animal distributions[5]. The distribution and abundance of *C. pelliouensis*, *C. oxystoma*, *Notiphila* sp. and *B. longipes* were inversely proportional to temperature.

The change in the population densities of some species documented mainly during the monsoon and postmonsoon seasons seems to be directly associated with soil moisture and dissolved oxygen and inversely associated with pH.

Soils of the littoral zone of mangrove ecosystem are rich in organic nutrients[6]. These nutrients help the growth directly of algae and indirectly of meofaunal (specially nematode) population which provide food source for insect intruders[7]. The distribution and abundance of dipteran species were directly associated with organic nutrients (organic carbon and available phosphorus).

The authors are grateful to Dr W. W. Wirth and Dr. W. N. Mathias of U.S. National Museum; to Dr P. K. Choudhury of Burdwan University and to Dr M. Dutta and Mr P. Parui of Zoological Survey of India for identifying the ceratopogonid, ephydrid, chironomid, tabanid and psychodid specimens respectively.

17 November 1987; Revised 27 May 1988

1. Cheng, L. (ed.), *Marine insects*, North-Holland, Amsterdam and Oxford, 1976.
2. Davies, J. B. and Linley, J. R., *Mosq. News*, 1966, **26**, 440.
3. Strickland, J. D. and Parsons, T. R., *Fish Res. Bd. Canada*, Bull. No. 167, 1968.
4. Clements, A. N., *The physiology of mosquitoes*, Pergamon Press, Oxford, 1963.
5. Duff, S. and Teal, J. M., *Limnol. Oceanogr.*, 1965, **10**, 67.
6. Heald, E. J. and Odum, W. E., *Proc. Gulf Carib. Fish Inst.*, 1970, **22**, 130.
7. Chapman, V. J., In: *Scott Head Island*, (ed.) J. A. Steers, W. Heffer and Sons Ltd., Cambridge, 1960.

CONTRIBUTION OF EXOGENOUS FERTILIZER SOURCE TO PHOSPHORUS REQUIREMENT OF *CITRUS*

B. R. V. IYENGAR and S. V. KESHAVA MURTHY

Division of Soil Science, Indian Institute of Horticultural Research, Hessaraghatta, Bangalore 560 089, India.

PREVIOUS studies in *Citrus* using ^{15}N labelled fertilizer have shown that the exogenous fertilizer source accounted for 10–19% of total nitrogen in various new organs when applied in spring, whereas summer application accounted for 11% of total nitrogen in the new flush[1,2]. There is no such information with respect to phosphorus either in *Citrus* or in any other fruit crop. An attempt was, therefore, made to assess the same in *Citrus* species. *C. limon* Birm (Italian lemon) and *C. latifolia*, Tanaka (seedless lime) using ^{32}P labelled superphosphate in a rootstock experiment.

In this experiment, the two *Citrus* scion cultivars Italian lemon (*C. limon* Birm) and seedless lime (*C. latifolia*, Tanaka) had been budded on 7 rootstocks namely; (i) Rough lemon (*C. jambere*, Lush), (ii) Rangpur lime (*C. limonia*, Osbeck), (iii) Cleopatra mandarin (*C. reshni*, Tanaka), (iv) *Kodakithuli* mandarin (*C. reshni*, Tanaka), (v) *Trifoliate orange* (*Poncirus trifoliata*), (vi) Carrizo citrange (*P. trifoliata* × *C. sinensis*), and (vii) Citrumelo (*P. trifoliata* × *C. paradisi*). The study was carried out during July–August, when a major flush of new growth and flowering was occurring. The plants also had a sizable crop load of developing and developed fruits. Each plant received ^{32}P labelled single super phosphate at 350 g (with an activity of 3.12 mCi or 115.4 MBq) per plant which was applied to the soil in a circular band 75 cm away from the plant where the actively absorbing roots were located. Samples of newly developing organs such as shoot tips, flowers and immature fruits and old organs like mature leaves and developed fruits were collected 45 days after treatment, to determine the proportion of phosphorus derived from fertilizer in these organs. The samples were dried at 70°C, ground and wet digested in a diacid (nitric-perchloric) mixture. Total P in the digest was determined by the vanado molybdate method and ^{32}P activity was measured by

Table 1 *Phophorus derived from fertilizer (per cent PdfF) in newly developing and mature old parts in Citrus limonia (Italian lemon) as influenced by different rootstocks*

Rootstocks	Young developing parts			Mature leaves	Mature fruits	
	Shoot tip	Flowers	Fruits		Rind	Juice
Rough lemon	5.9	8.8	2.5	4.5	2.2	1.2
Rangpur lime	5.3	7.2	4.7	5.5	4.8	3.2
Cleopatra mandarin	5.4	5.7	6.2	4.7	2.2	2.8
Kodakithuli mandarin	10.2	12.6	5.1	8.4	1.5	3.2
Trifoliate orange	8.1	10.5	6.1	7.2	2.8	2.8
Carrizo citrange	11.7	16.2	13.0	10.2	3.2	5.7
Citrumelo	12.5	16.7	7.5	10.5	4.6	2.3

Cerenkov counting in a liquid scintillation counter (Packard Tricarb 460 CD).

The per cent of phosphorous derived from fertilizer (per cent PdfF) was calculated using specific activity of ^{32}P (dpm ^{32}P $mg^{-1}P$) in various organs as:

$$PdfF = \frac{\text{Specific activity of } ^{32}P \text{ in the plant}}{\text{Specific activity of } ^{32}P \text{ in the fertilizer}} \times 100$$

Both the rootstocks and the scion cultivars had very strong influence on the absorption of fertilizer phosphorus as evident from PdfF in both the newly developing and mature older parts (tables 1 and 2). In general, the newly developing parts had higher PdfF than the mature old parts possibly because the phosphorus absorbed from the exogenous fertilizer source was preferentially partitioned into the newly developing parts, since the application of fertilizer coincided with the flush of new growth and flowering. Previous studies with ^{15}N labelled fertilizer had also shown similar trends[2,3].

The results show that the new growth derived a maximum of 15–16% of its phosphorus content from the exogenous fertilizer source. Assuming that at least an equal proportion came from the soil source, the endogenous source of reserve phosphorus within the plant contributed at least 65–70% of the phosphorus requirement for the current growth of newly developing parts. Similar trends were observed in previous work with ^{15}N labelled fertilizer[2,4]. Other attempts to quantify the contribution of the endogenous source of nitrogen, indirectly by determining the total nitrogen content of various organs before and after new growth occurred, have also indicated that in Satsuma mandarin this source accounted for nearly 90% of the nitrogen in new growth[5].

This study has also shown that considerable amount of fertilizer phosphorus absorbed, also moved into the older parts (leaves and fruits), and in leaves it accounted for as much as 4.5–10.5 and 3.2–8.2% of the phosphorus content in *C. limon* and *C. latifolia* respectively. Even in fruits, the fertilizer phosphorus accounted for as high as 5.6 and 5.7% in the rind and juice respectively.

It thus becomes evident from this study that the endogenous reserve of phosphorus in the plant is far more important than the exogenous sources in

Table 2 *Phophorus derived from fertilizer (per cent PdfF) in young developing and mature old parts in Citrus latifolia (seedless lime) as influenced by different rootstocks*

Rootstocks	Young developing parts			Mature leaves	Mature fruits	
	Shoot tip	Flowers	Fruits		Rind	Juice
Rough lemon	10.8	12.2	7.8	8.2	4.9	2.7
Rangpur lime	4.5	4.4	2.6	3.3	5.6	2.0
Cleopatra mandarin	7.3	8.4	5.0	6.9	2.6	4.9
Kodakithuli mandarin	8.1	11.9	1.9	6.5	3.9	2.6
Trifoliate orange	14.1	9.3	5.1	7.1	2.1	1.2
Carrizo citrange	4.7	7.6	2.6	3.2	1.0	1.7
Citrumelo	6.2	6.6	2.5	4.1	1.9	1.1

meeting the phosphorus requirement of new growth in perennial fruit crops like *Citrus*.

7 April 1988; Revised 2 May 1988

1. Kubota, S., Kato, T., Akao, S. and Bunya, C., *Bull. Shikoku Agric. Expt. Stn.*, 1976, **29**, 49.
2. Kubota, S., Kato, T., Akao, S. and Bunya, C., *Bull. Shikoku Agric. Expt. Stn.*, 1976, **29**, 55.
3. Kato, T., Kubota, S. and Tsukahara, S., *Bull. Shikoku Agric. Expt. Stn.*, 1981, **36**, 1.
4. Takagi, N., Akamatsu, S. and Shimizu, M., *Proc. Autumn Meeting Japan Soc. Hort. Sci.*, 1982, p. 134.
5. Kato, T., Yamagata, M. and Tsukahara, S., *J. Jpn. Soc. Hort. Sci.*, 1984, **52**, 393.

NEW RECORD OF *HETEROPSYLLA CUBANA* CRAWFORD (PSYLLIDAE: HOMOPTERA) ON SUBABUL, *LEUCAENA LEUCOCEPHALA* (LAM) DE WIT IN INDIA

M. GOPALAN, S. JAYARAJ, M. ARIAVANAM KATHA PILLAI and P. V. SUBBA RAO
Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore 641 003, India.

LEUCAENA LEUCOCEPHALA (Lam) de Wit commonly known as subabul in India and Ipil-Ipil or Koahaeri in western countries is one of the fastest growing tree species and is capable of producing large biomass per unit area in a short time. This plant has multiple uses as fodder, green leaf manure, fuel and timber. Because of its high protein content, *L. leucocephala* is excellent as animal feed for all classes of animals. Its wood is useful in paper manufacture and the gum obtained from seeds is used as a thickener for ice-cream and also as a fixative in the manufacture of certain cosmetics. In view of its many uses, its extreme tolerance to drought, and the absence of pests and diseases, the Government of India and many State Governments in the country included this plant in agro-forestry and social forestry programmes.

Recently the psyllid (Homoptera), *Heteropsylla cubana* Crawford was noticed attacking tender shoots of *L. leucocephala* in different parts of Tamil Nadu, namely Livestock Research Station, Kattupakkam (Chengalpattu district), National Pulses Research Centre, Vamban and Anna Farm, Kudumianmalai (Pudukkottai district), farmers' holdings in Kulithalai (Trichy district), Thanjavur, and in Tamil Nadu Agricultural University Campus, Coimbatore.

The incidence of the psyllid was high in that large numbers of nymphs and adults (more than 300/ young shoot of 15 cm height) damaged the young shoots by sucking the sap and caused wilting and death of the tender shoots. Honey-dew excretion was also noticed on the upper surface of lower leaves. The expanded leaves showed chlorotic spots due to feeding but damage was not seen on dark-green older leaves. Pruned plants showed heavy attack compared to old trees which were not pruned (figure 1). Incidence was also recorded in the nursery and on self-sown plants under old trees. Irrigated plants growing in shade had large numbers of the pest.

The adult psyllids are pale green and measure 1.5 mm in length and 0.5 mm in width. The nymphs are yellow and dorso-ventrally flattened with prominent wing buds typical of psyllids.

This is the first report of the occurrence of the psyllid on subabul. The pest has been reported as

Figure 1. Branch of an old plant that was not pruned (left) and branch from a pruned plant showing damage caused by *H. cubana* (right).