# DYNAMIC SYSTEM IN THE SIEVE TUBES OF *HEVEA BRASILIENSIS*

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A chaotic and linear spatial display of movement of globular objects is reported for the first time in the myctoplasm of sieve tubes of *Hevea brasiliensis* where a large number of globular objects occur in a dynamic system.The sieve tubes recently differentiated from the phloem mother cells of the cambial zone showed a near uniform distribution of globular objects in a continuous state of motion. The objects measured an average diameter of 1.6μm with a density of 200 per 1000$\mu m^2$ in the viscous medium. Speed of the moving particles recorded through the video graphs was reduced to five per cent and found that these objects develop spatial patterns with respect to both loci and time within the sieve tubes. At a time, the pattern of movement at different loci is different and are not repeating and hence across the loci the displays are chaotic. In each locus as the time proceeds, a linear pattern develops that exists for about 152 milliseconds which are considered as a block. The pattern in a block remains stationery except at 52$^{nd}$ and 102$^{nd}$ milliseconds in which two intermittent oscillating vibrations develop. The intermittent oscillations remain for one millisecond and are identical in display but differ from the predominant pattern of the block. There are blocks where the oscillating vibration repeats more than what is common for all the blocks and displayed in the 50$^{th}$ and 100$^{th}$ milliseconds. As the patterns are repeating intermittently in a regular manner within a block, the motion along the block is linear. The direction of the moving objects to form the intermittent oscillations in a block gives an indication on the direction of spatial pattern to be formed in the forthcoming block. The patterns are chaotic as far as blocks are concerned where the spatial patterns are not repeated. The timing for both linear and chaotic spatial pattern in the sieve tube is the same for more than 250 subsequent patterns studied indicating that these features seem to be predetermined and specific for a plant.

**Key words**: Dynamic system, *Hevea brasiliensis,* Linear and chaotic patterns, Sieve tubes, Starch grains

In the recent decades, Chaos theory resolved some of the long standing problems in astro-physics, quantum mechanics, chemistry, medicine and biology (Hall,1992; Elbert *et al*., 1994; Bagdoev *et al*., 2011). However, inadequate attention has been extended towards these studies in plants (Haken, 1982; Shabala *et al*., 1997). Shabala *et al*. (1997) observed chaotic oscillations in certain higher plants related to plant physiological responses to rhythmical light. Occurrence of moving objects in the myctoplasm of sieve tubes in the bark of higher plants have already been reported and designated as cellular inclusions like mitochondria or starch grains, marker

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