

## EXPERIMENT: 15

### MEASUREMENT OF PHOTOSYNTHETIC CO<sub>2</sub> ASSIMILATION BY INFRA-RED GAS ANALYZER (IRGA)

#### PRINCIPLE:

In all the gas exchange equipments designed to measure the photosynthetic rates, the Infra-Red Gas Analyzer (IRGA) is a major component and the primary role of this component is to measure the CO<sub>2</sub> concentration. The IRGA is very sensitive to detect even a change of 1 ppm of CO<sub>2</sub>. A leaf or a plant is enclosed in an air tight chamber and the CO<sub>2</sub> fluxes are determined by measuring the CO<sub>2</sub> concentration changes in the chamber atmosphere.

Infra-Red Gas Analyzers (IRGA) are used for the measurement of a wide range of Heteroatomic gas molecules including CO<sub>2</sub>, H<sub>2</sub>O, NH<sub>3</sub>, CO, SO<sub>2</sub>, N<sub>2</sub>O, NO and gaseous hydrocarbons like CH<sub>4</sub>. Heteroatomic molecules have characteristic absorption spectrum in the infrared region. Therefore, absorption of radiation by a specific Heteroatomic molecule is directly proportional to its concentration in an air sample.

The major absorption peak of CO<sub>2</sub> is at 4.25 μm with secondary peaks at 2.66, 2.77 and 14.99 μm. The only heteroatomic molecule normally present in the air with an absorption spectrum overlapping with that of CO<sub>2</sub> is water vapour. Both molecules absorb IR radiation in the 2.7 μm range. However, this interference does not pose any serious problem at 4.25 μm range.

#### Measurement of Photosynthesis

Two different kinds of photosynthesis systems (IRGA) are generally used for the measurement of photosynthetic rates i.e. closed system and open system.

#### Closed system

In this system, a leaf is clamped in a leaf chamber and air is circulated around the leaf repeatedly. The decrease in CO<sub>2</sub> concentration over time is measured to determine the photosynthetic rate. The major disadvantage in this system is that the measurements of photosynthetic rates are done under constantly depleting CO<sub>2</sub> concentrations around the leaf. Further, since the leaves transpire

simultaneously there will be a constant build up of humidity in the chamber. Increase in humidity alters the vapour pressure difference (VPD) between the leaf and its ambient air. Small changes in VPD have been shown to significantly alter the stomatal opening and hence the gas exchange rates. These disadvantages are overcome in the open system measurements.

### Open system

Here the leaf is clamped in a chamber through which ambient air is passed continuously. The change in CO<sub>2</sub> concentration before the air enters the leaf chamber and in the air leaving the leaf chamber is determined to compute the photosynthetic rates. If photosynthetic rate is high, then the air leaving the leaf chamber will have less CO<sub>2</sub>, than the air entering it. The difference between the CO<sub>2</sub> concentrations at a given flow rate is determined to compute the photosynthetic rate.

The major advantage in the open system is that, the measurement of photosynthetic rates can be achieved at a constant CO<sub>2</sub> concentration. Further, by altering the flow rate of dry air into the leaf chamber, it is also possible to maintain a specific relative humidity in the chamber and hence the gas exchange parameters can be measured at a constant set of conditions. This renders the comparison more realistic and acceptable.

