

B.Sc. III (Botany Honours)
Paper - VII, Group 'A',
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Productivity of the Ecosystem

The productivity of an ecosystem is the rate at which solar energy is fixed by the vegetation of an ecosystem. The energy is generally measured in terms of units of energy (calories), produced in a unit area (usually one square metre) per unit time (one year). The productivity is variable in different ecosystems. A tropical wet evergreen forest gets intense sunlight throughout the year and hence has much greater productivity than an alpine tundra ecosystem which is photosynthetically active for only two months in a year. Productivity which is thus equal to the rate of photosynthesis is called gross productivity. The rate of gross productivity is therefore, limited by the number and activity of the producer organisms and by the amount of solar energy available (Whittaker 1970).

Net productivity or Net primary productivity, on the other hand, is equal to the rate of gross productivity minus the rate of plant respiration. The amounts of energy available to other trophic levels are called secondary productivity.

Measurement of Primary Productivity

The amount and rate of energy fixation (Primary production) can be measured in a number of ways. HARVEST METHODS - The harvest method is a common method for measuring the primary

production. The vegetation along with roots is removed at periodic intervals and is weighed. The vegetation is dried to constant weight and first the biomass and then the standing crop is determined. The standing crop is converted to energy, if the exact caloric content of the material is known. Generally a gram of dried terrestrial plant material is known. Generally, a gram of ~~has~~ has an energy content of about 4.5 kilocalories.

In this method the amount of energy present in the plants is measured only at the time of harvest. Since the primary productivity is concerned with storage of energy over time the harvest method may not give us an exact value of primary productivity.

Carbon Dioxide Assimilation.

CO₂ assimilation is a good indication of photosynthetic activity. The amount of CO₂ entering and coming out of a closed stomata in a enclosure is measured to determine the amount of CO₂ used up and also the amount and rate of photosynthesis. Since CO₂ is also released in respiration such measurements of primary production are incomplete. The amount and rate of respiration is, therefore, measured separately by covering the chamber in black cloth so that photosynthesis does not take place. This value is added to that obtained in the illuminated condition to obtain the gross production of the system.

O₂ production

In aquatic situations measuring O₂ released in photosynthesis is indicative of primary productivity.

Organisms are taken inside two bottles one of which is blackened to prevent photosynthesis. The bottles are suspended for sometime in water at a depth from where the samples are taken. The difference in the amount of O_2 collected in the illuminated bottle is calculated to determine the amount and rate of net photosynthesis. The decrease in the amount of O_2 in the black bottle indicates the respiratory consumption of O_2 . This value if added to the value obtained from light exposed bottle gives total of gross production.

Radioisotopic Methods -

Radioisotopes particularly ^{14}C is used widely to measure the net productivity in a more accurate manner. Water samples are taken in 'light' and 'dark' bottles and a known quantity of ^{14}C in the form of sodium bicarbonate is taken into them. The amount of radioactive carbohydrate synthesized is determined by finding out the level of radioactivity in a counting chamber.

Other methods

A number of other methods have been used. Two of them are mentioned here.

Chlorophyll estimation - It is believed that the amount and rate of photosynthesis is proportional to the amount of chlorophyll. If the chlorophyll content is known and assuming the rate of photosynthesis per unit of chlorophyll, the production of a sampled area can be calculated.

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pH estimation - In aquatic plants photosynthetic utilization of CO_2 as well as release of respiratory CO_2 alters the pH of water. pH measurement is, therefore, one of the indirect methods to measure the photosynthetic production.

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