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Primary production and respiration in the leaves of two varieties of *Zaleya govindia*

By

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Introduction

Net primary production represents the biomass or biocontent which is incorporated into the plant parts (Total photosynthesis less respiration) during a specified time interval. On the other hand, gross primary production represents gross photosynthesis or the total assimilation of organic matter or biomass during a specified time period.

According to Odum 1962: 80–87 in terrestrial situations, methods like harvest, gaseous exchange, disappearance of raw material, determination of radioactive materials and chlorophyll estimations are directly or indirectly employed for evaluating net primary production. Gaseous exchange method is used for measuring both net as well as gross productivity since both O_2 and CO_2 changes are measured simultaneously. However, this method is disadvantageous, for the experiment is carried out under unnatural conditions. Misra & al. 1968: 306 have measured the net production and respiration by the respective increase and decrease in the dry matter while the gross production from the sum total of these two values, a more advantageous, simple and precise method used by Denny 1930.

Materials and methods

Zaleya govindia N. C. Nair (= *Trianthema pentandra* auct. plur. – non L.) is a local perennial herb which prefers hard open grounds. According to Hooker 1879: 660–661, the plants grow in abundance in Rajasthan, Punjab and Uttar Pradesh (Distributed in India). The two varieties of

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this species, first distinguished by BLATTER & HALLBERG 1918—1921: 530—531, based on their colour differences in stem, leaf, flower and fruit, and referred as var. '*rubra*' var. nov. and var. '*flava*' var. nov. in the Flora of Indian Desert, have been selected for the estimation of net and gross primary production.

Sufficient leaves of both the varieties were plucked (opposite leaves at 3rd node from the distal end of the branch are taken for the physiological uniformity of the leaves). For each variety, 4 sets with 5 replicates of 50 discs each (1 disc = 0.65 cm^2) were separately treated as follows:

1. Leaf discs were floated in distilled water and exposed for 5 hours in sun and then oven dried.

2. Leaf discs were floated in distilled water and exposed for 5 hours in a closed dark chamber which contained 40% KOH solution in a separate phial, and then oven dried.

3. Leaf discs were immediately dried in oven for initial dry weight.

4. Leaf discs were crushed in acetone and the optical density of the extract was measured in a BL Spectronic 20 Colorimeter at 650 mu for total chlorophyll estimations following PANDEYA & al. 1968: 234.

The following values were calculated following the methods described by MISRA & al. 1968: 306.

Net production = Dry weight of discs exposed to light — Initial dry weight of discs (control).

Respiration = Dry weight of control — dry weight of discs placed in dark.

Gross production = Net production + Respiration.

Observations

The results (Table 1) indicate that the leaves of var. '*rubra*' contain 43.67 g/m^2 dry matter more than var. '*flava*'. In uniform conditions and time the var. '*rubra*' has assimilated 51.68 g/m^2 more photosynthate as compared to var. '*flava*'. Net and gross production values on $g/m^2/hr$ basis for var. '*rubra*' are 1.1 and 1.6 times respectively higher than that of var. '*flava*'. Though the values for net production on per hour basis in var. '*rubra*' and var. '*flava*' are very close but the var. '*rubra*' has incorporated 1.61 $g/m^2/hr$ more organic matter as compared to other one.

It is also evident from Table 1 that the dry matter per unit area for var. '*rubra*' is significantly higher as compared to var. '*flava*' ($P<0.1$). Though in dark the dry weights do not differ much in both the varieties but under identical light conditions, the production is significantly higher for var. '*rubra*' ($P<0.01$) than that of var. '*flava*'. The gross and respiration values when calculated on per hour and per day basis, are found statistically higher for var. '*rubra*' ($P<0.001$). The net production per hour does not differ but it differs statistically when calculated on per day basis. The

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difference in the chlorophyll content is also significant ($P<0.1$) between the two varieties. The correlation, however, between chlorophyll as net production were found significant for var. '*rubra*' when calculated on per hour and per day basis.

Discussion

The observations clearly indicate that the two varieties, though grow together in nature under identical habitat, differ in their physiology and metabolic set up. It is found that the var. '*rubra*' is capable of more gross photosynthesis as compared to var. '*flava*'. Since during photosynthesis as much as O_2 is lost the capacity of the photosynthetic system is increased to consume more CO_2 from the atmosphere in presence of light, thereby increasing the net assimilation. This fact goes hand in hand for var. '*rubra*' which, therefore, bears a higher productive efficiency. On the otherhand, a declined respiration in '*flava*' considerably enhances the accumulation of assimilates. The total chlorophyll content is also less in the leaves of var. '*flava*' so perhaps gross photosynthesis also declines. Leaves of var. '*rubra*'

Table 1

Initial dry matter and gross and net productivity in the leaves of *Zaleya govindia* var. '*rubra*' and var. '*flava*'

Parameters	var. '*rubra*' (Mean ± S. D.)	var. '*flava*' (Mean ± S. D.)	Variance ratio 'F'	Difference	Ratio
Control (g/m^2)	587.6±24.9	544.0±19.7	9.44*	43.67	
Exposed to light (g/m^2)	668.3±22.9	616.6±20.4	14.10**	51.68	
Exposed to dark (g/m^2)	533.5±14.2	532.9±19.1	0.05 NS	0.60	
Net production ($g/m^2/hr$)	16.1±2.01	14.5±0.33	3.09 NS	1.61	1.1
Respiration ($g/m^2/hr$)	10.8±2.66	2.2±0.55	50.05**	8.62	
Gross production ($g/m^2/hr$)	26.9±2.10	16.7±0.80	102.92***	10.22	1.6
Net production ($g/m^2/day$)	63.5±19.9	147.6±5.21	83.30***	84.17	2.3
Respiration ($g/m^2/day$)	259.9±64.0	53.0±13.2	50.05**	206.88	
Gross production ($g/m^2/day$)	323.4±25.2	200.7±9.60	102.92***	122.60	
Total Chlorophyll (g/m^2)	6.2±0.63	5.3±0.63	5.83*	0.90	

* $P< 0.1$; ** $P < 0.01$; *** $P < 0.001$.

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being high ($P<0.01$) in chlorophyll content, contribute more than var. '*flava*' towards the plant productivity. Further, it may also be concluded that the two varieties significantly differ for net and gross production and respiration values ($P<0.001$) in the 24 hours cycle. The net production per day in var. '*rubra*' is reduced on account of a greater respiratory loss in a 24 hours cycle. The higher gross production in var. '*rubra*' may be due to its high assimilative power in light condition and hence it may be called more productive than var. '*flava*'.

It has also been observed that the upper and lower leaves of the same age on same shrub and same branch differ in their physiology and production efficiency due to the availability of sunlight and their nodal position (Whittaker 1962: 121). Working with *Bougainvillea spectabilis*, Misra & al. 1968: 306 have found differential photosynthetic capacity in the leaves exposed to sun and shade and also when brought from sun to shade conditions and vice versa. The present investigation finds that even the varietal differences in the species are associated with different photosynthetic activity though growing together in uniform environment and exposure.

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Summary

Dry matter, net production and respiration in the leaves of var. '*rubra*' and var. '*flava*' of *Zaleya govindia*, belonging to family *Ficoideae*, have been estimated. Net production per day is highly significant in between var. '*rubra*' and var. '*flava*'. The leaves of equal area of var. '*rubra*' incorporate more dry matter and total chlorophyll than that of var. '*flava*'. However, per day net productivity is 2.3 times higher in var. '*flava*' than var. '*rubra*'.

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