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Short Communication

Radiation-use Efficiency of Gram, Raya and their Intercrops

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An important aspect of crop development affecting dry matter production and economic yields concerns the development of leaf canopy and radiation interception. Interception depends mainly on leaf area index (LAI) and canopy architecture. A close relationship was observed between biomass production and photosynthetically active radiation intercepted by the crop canopy. The purpose of this study was to compute RUE for gram, raya and their intercrops.

A field experiment was conducted on the research farm of CCS Haryana Agricultural University, Hisar (29°10′N, 75°46′E and height above MSL 215.2 m) during rabi season of 1995-96 on sandy loam soil. The varieties of raya (RH-30) and gram (C-235) were sown on 26th October, 1995. The experiment was planned in randomized block design with three replications and five treatments: T_1- pure gram, T_2- pure raya, T_3- 4 rows of gram alternated with one row of raya, T_4- 6 rows of gram alternated with 1 row of raya, and T_5- 12 rows of gram alternated with 1 row of raya. All inputs were supplied as per the package of practices for these crops. Leaf area and dry matter samples were taken from 1 m^2 area at 15-day interval. The leaf area was measured with leaf area meter (LICOR). The plant samples were dried in oven till constant weight to determine dry matter. Observations on leaf area index (LAI), dry matter production and photosynthetically active radiation (PAR) were taken on same day. PAR was measured with the help of line quantum sensor after 30 days of sowing (DAS) at 15-day interval during 1200 to 1300 hrs. PAR was also measured at bottom of the crop canopy by keeping the sensor along and across the rows and 1 meter above the crop canopy. The reflected PAR was measured by inverting the sensor over the crop canopy.

Extinction coefficient (K) was determined using the field data as follows:

$$K = \{\log_e(I/I_0)\}/LAI$$

where,

I = PAR intensity at bottom of the canopy,

I_0 = PAR at top of the crop canopy.

Daily solar radiation was computed by using the equation:

$$R_s = R_a\ (1-r)\ (a+b\ n/N)$$

where,

Ra = solar constant,
r = albedo of the crop (0.25),
n = actual sunshine hours,

Table 1. Regression equation between cumulative dry biomass and cumulative photosynthetically active radiation

Treatment	Regression equation	R^2
Gram	$Y = 0.000262(0.996)^x.x^{2.72}$	0.99
Raya	$Y = 0.0000029(0.995)^x.x^{3.75}$	0.99
4 gram : 1 raya	$Y = 0.000158(0.997)^x.x^{2.75}$	0.99
6 gram : 1 raya	$Y = 0.000131(0.998)^x.x^{2.78}$	0.99
12 gram : 1 raya	$Y = 0.000085(0.997)^x.x^{2.75}$	0.98

Y = Dry biomass, x = IPAR.

a, b = constants (0.256, 0.61), and
N = maximum sunshine hours.

The daily incoming PAR was calculated as per the procedure adopted by Rosenthal and Gerik (1991). The daily observed values of PAR were calculated using the extinction coefficient (K), incoming and reflected PAR and interpolated leaf area index. Radiation-use efficiency (RUE) was calculated as:

$$\text{RUE (g MJ}^{-1}) = \text{DM (g m}^{-2})/\text{PAR (MJ m}^{-2})$$

where,
DM = cumulative dry matter,
PAR = photosynthetically active radiation.

Results show that the RUE was low initially and increased with the crop growth and season to a maximum value, and declined thereafter up to harvest in all the treatments. It indicates that at maximum leaf area index with maximum radiation interception, RUE was the highest. At 75 DAS the RUE was maximum (3.23 g MJ^{-1}) in T_2 treatment and the lowest in T_5. At maturity of raya (T_2), the RUE was the lowest among all the treatments. The mean value of RUE for the whole season was maximum (1.91 g MJ^{-1}) in T_2 and was followed by T_1, T_3, T_4 and T_5 treatments. Regression between dry matter and accumulated PAR interception and R^2 values (Table 1) show their significant ($p<0.01$) association. A Hoerl function ($y = a.b^x.x^c$) was observed between dry biomass and PAR. Biomass production was found to be closely related to the PAR intercepted in many crop species (Monteith, 1977; Biscoe and Gallagher, 1977). Crop attenuation coefficient (K) varied between 0.73 and 0.85 in all treatments (Table 2) with a maximum (0.85) in T_1 and a minimum in T_2 (0.73) treatments.

In conclusion, results show that RUE of raya crop is maximum among the two crops and their intercrops. Intercropping of

Table 2. Maximum observed value of radiation-use efficiency (RUE), leaf area index (LAI) and extinction coefficient (K) in pure and intercrops of gram and raya

Treatment	RUE (g MJ^{-1})	LAI	K
Gram	2.49	2.67	0.85
Raya	3.23	3.93	0.73
4 gram : 1 raya	2.88	2.88	0.82
6 gram : 1 raya	2.78	2.81	0.83
12 gram : 1 raya	2.69	2.72	0.84

raya in gram (4:1) increased the RUE over sole gram crop and other intercropping treatments (6:1 and 12:1).

References

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