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Research Article

Light interception and radiation use efficiency (RUE) in maize (*Zea mays*. L) intercropping with greengram (*Vigna radiata* L.)

Govindaraj T
Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India
N. Maragatham*
Centre for Students Welfare, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India
S P. Ramanathan
Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India
V. Geethalakshmi
Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India
M. K. Kalarani
Directorate of Crop Management, Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu), India

*Corresponding author. E-mail: mm65@tnau.ac.in

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Abstract
Intercropping is growing two or more crop species simultaneously, different canopy architectures by row configuration, changing light interception, radiation utilisation, and increased yield. The present study aimed to evaluate different intercropping systems affected light interception per cent and radiation use efficiency in maize (*Zea mays* L.) intercropping with greengram (*Vigna radiata* L.) different ratios. Field experiments were conducted for *Kharif* 2022 and *Rabi* 2022-2023 seasons, which were laid out in a split-plot design and replicated three times. Three Nitrogen levels *viz*., N_1 - 75 % RDN (Recommended dose of Nitrogen), N_2 – 100% RDN, N_3-125% RDN had taken as the main plot and three intercropping treatments were taken as subplot *viz.,* M_2G_2 - replacement series (two row of maize and two row of Greengram), M_4G_2- replacement series (four rows of maize and two row of Greengram), M_2G_3-paired row system (two rows of maize and three rows of Greengram), and sole maize. Both light interception and radiation use efficiency were significantly affected by intercropping systems. Light interception per cent of the main crop (maize) was significantly higher (69.0, 75.5 and 71.0 % during *Kharif* and 60.1, 78.1 and 76.6 during *rabi*) at vegetative, flowering and maturity phases, respectively. The *Kharif* 2022 and *Rabi* 2022-2023 maximum Radiation Use Efficiency (RUE) of Maize intercropping with green gram (maize + greengram) was higher in T_{12} (M_2G_3 paired row with 125 % Recommended Dose of Nitrogen) recorded as 2.46 (*Kharif*) and 1.43 (rabi). The outcome might be utilised to optimise the row configuration of intercropping design, explain the mechanism of intercropping on light utilisation, and improve radiation use efficiency.

Keywords: Greengram, Intercropping, Light interception, Maize, Radiation use efficiency

INTRODUCTION

Maize is India's third most significant cereal crop after rice and wheat, and it is farmed in a variety of settings, ranging from extremely semi-arid to sub-humid and humid (which accounts for 82% of the land under cultivation during the *Kharif* season). It accounts for roughly 10% of total food grain production in the country (India Agristat, 2020). Due to its wider adaptability in different seasons and different agro-climatic conditions, maize is being intercropped with various crops. In addition, maize is a wider-spaced crop and offers abundant scope for intercropping adoption. Growing two or more crops adjacent to one another is known as intercropping.

The main objective of intercropping is to increase yield by utilising resources. In the intercropping system, a tall -statured crop is intercropped with a short-statured crop, such as the intercropping of cereal with legumes (Maitra *et al.*,2019). Intercropping also may be considered as being limited by the short-statured intercrop's low yield, which is mostly caused by a reduction in intercepted Photosynthetic Active Radiation (PAR). There is intense interspecific light competition between soybean and maize in intercropping Maize plants shade the legume plants. Furthermore, the maize plants miss PAR in the space between adjacent corn strips. The intercepted PAR of understory soybean is increased by the wide separation between adjacent maize strips (Wang *et al.*, 2015).

There are many different intercropping configurations, and the crop intercepted PAR varies significantly. It positively correlates with the crop dry matter. Radiation-use efficiency (RUE), defined as crop biomass produced per unit of total solar radiation or photosynthetically active radiation (PAR) intercepted by the canopy. It was applied in the avenues to genetically improve the yield and in the growth and yield responses to increased CO_2 concentration. The RUE varies significantly depending on the crop species and cropping strategy. Intercrops with tall statures have the same RUE as their sole crop (Wang *et al.*,2021). HOWEVER, the RUE of short-statured intercrop is higher than that of its sole crop because of the dispersed light effect and lower light saturation.

The replacement series of intercropping systems increase the PAR interception and Strip intercropping is growing as a popular method as a result of its high Radiation Use Efficiency (RUE) (Liu *et al.*,2017). In this context, the research is required to describe the intercepted PAR and RUE in maize and greengram intercropping systems. Hence, the present study was made for the maize-greengram intercrop with different ratios *viz*., paired row systems to find out: i) effects on light interception in monocropped maize and intercropping systems, ii) RUE in maize-green gram in different intercropping systems.

MATERIALS AND METHODS

Experimental site

The field study was conducted at *Kharif* 2022 and *Rabi* 2022- 2023 at the Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore. The experimental site was located between 11°83' North latitude and 76°71' E East longitude at an elevation of 426.7 m above the mean sea level. The climate of the region was semiarid tropical and mean annual rainfall of was 674.2 mm in 47 rainy days. The maximum and minimum annual mean temperatures were 31.5°C and 21°C, respectively. The mean relative humidity ranged from 49.1% (14:22 hours) to 84.9% (07:22 hours). The mean bright sunshine hour was 7.3 hours per day, with a mean solar radiation of 429.2 cal/cm. Daily weather data were converted into Standard Meteorological Weekly (SMW) data of the respective cropping season viz., *Kharif* (26 – 41st MSW) and Rabi (52 – 15th MSW). The maximum temperature of 28.8ºC to 32.3ºC, minimum temperature of 22ºC to 23.5ºC, total rainfall of 297 mm, wind speed of 3.7 to 17.6 km/hr prevailed during *Kharif* 2022, whereas it was prevailed during *rabi* 2022-2023 had a maximum temperature of 29.2 ºC to 36 ºC, minimum temperature of 17.7 ºC to 24.2 ºC , total rainfall of 41 mm, wind speed of 4.6 km/hr to 7.7 km hr^{-1}. The weather and climate data recorded from the Meteorological observatory (Class A) available at Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore, was used for this study. The experiment site contained sandy clay loam texture with a pH -value of 7.7, EC (dS m^{-1}) 0.17, Organic carbon (g kg^{-1}) 3.7, Available N (kg ha^{-1}) 137, Available P_2O_5 (kg ha^{-1}) 8, Available K_2O (kg ha^{-1}) 152, Bulk density (Mg cm^{-3}) 1.23, Particle density (Mg cm^{-3}) 2.54, Porosity (%) 51.6 in the top 30 cm soil layer.

Table 1. Treatment details for maize intercropping with greengram and nitrogen levels

Treatment No.	Treatment details
T_1	N_1+ Sole Maize
T_2	N_2+ Sole Maize
T_3	N_3+ Sole Maize
T_4	N_1+ M_2G_2
T_5	N_2+ M_2G_2
T_6	N_3+ M_2G_2
T_7	N_1+ M_4G_2
T_8	N_2+ M_4G_2
T_9	N_3+ M_4G_2
T_{10}	N_1+ M_2G_3
T_{11}	N_2+ M_2G_3
T_{12}	N_3+ M_2G_3

N_1-75% RDN; N_2-100% RDN; N_3-125% RDN; M_2G_2- (Maize + Green gram; 2:2), M_4G_2 - (Maize + Greengram; 4:2), M_2G_3 (Maize + Greengram; 2:3); RDN - Recommended Dose of Nitrogen

Experimental design and planting materials

The maize and greengram intercropping replacement series and paired row system with different ratios were used for this field experiment. Each plot size was 5m X 5m ($25m^2$). Moreover, this experiment was laid out in a split-plot design with three replications. The main plot consists of different Nitrogen levels (N_1-75% of RDN, N_2-100% of RDN, 125% of RDN) and the sub-plot consisted of maize intercrop with a greengram different ratio (M_2G_2, M_2G_3 and M_4G_2) where M_2G_2 (Maize + Greengram; 2:2) - replacement series 2 rows of maize with spacing 60 cm x 25 cm and 2 rows of greengram with spacing 30 cm x 10 cm, M_2G_3 (Maize + Greengram; 2:3) paired row system 2 rows of maize with spacing 45 cm x 25 cm and 3 rows of greengram with spacing 30 cm x 10 cm) and M_4G_2 (Maize + Greengram; 4:2) - replacement series 4 rows of maize with spacing 60 cm x 25 cm and 2 rows of greengram with spacing 30 cm x 10 cm. The maize hybrid COH (M) 8 and Greengram variety CO 8 were chosen for conducting the research. A Recommended dose of Fertilizer (RDF) was adopted at 250:75:75 N: P_2O5: K_2O kg ha^{-1}. The chemical fertilizers N, P, and K were applied in the form of urea, single super phosphate (SSP), and muriate of potash (MOP) respectively. The entire dose (100%) of P_2O_5, K_2O was applied basally before sowing. The N was applied in split doses 50:25:25 per cent at 0, 30, and 60 days after sowing, respectively.

Sampling and measurements

Light interception

The light interception is defined as light penetration through the plant canopy. The PAR measured at using EMCON Line quantum sensor vegetative stage, flowering stage and maturity stage of maize and intercrop. It measures the PAR in terms of Photosynthetic Photon Flux Density (PPFD) with the unit of μmol m^{-2} s^{-1}. The line quantum sensor was placed along the planting rows. The PAR was measured in the top (I_0) and bottom of the canopy(I) during bright sunshine hours at 1100 to 1200 noon clear sunny days.

$$\text{Light interception} = \frac{I_0 - I}{I_0} \quad (1)$$

$$\text{Light interception (\%)} = \frac{I_0 - I}{I_0} \times 100 \quad (2)$$

where,
I_0 – PAR at above the canopy
I – PAR at below canopy

Leaf Area Index (LAI) and Extinction Coefficient (k)

The leaf area of every single leaf was determined by multiplying the leaf length by the greatest leaf width by the crop-specific coefficient factors of maize and greengram.

$$LAI = \frac{Leaf \text{ area}}{Ground \text{ area}} \quad (3)$$

The Leaf Area Index (LAI) and light penetration relationship were used to determine the extinction coefficient (k) of a crop canopy using the equation proposed by (Subo *et al.*, 2001)

$$k = -\frac{\ln[I / I_0]}{LAI} \quad (4)$$

Estimation of the daily radiation interception

The first turbid layer contains sole maize turbid medium, while the second turbid layer has maize and greengram turbid mediums. The fraction of radiation intercepted by maize in the first turbid layer (Keating and Car berry,1993),
F_{M1}, is given by

$$F_{M1} = 1 - \exp^{(-K_M L_{M1})} \quad (5)$$

where,
K_M - extinction coefficient of maize
L_{M1} - maize LAI in the first turbid layer.
The fraction of radiation intercepted by maize and greengram in the second turbid layer (F_{M2} and F_G, respectively) is given by

$$F_{M2} = \frac{K_M L_{M2}}{K_M L_{M2} + K_G L_G} \times [1 - \exp^{(-K_M L_{M2} - K_G L_G)} \quad (6)$$

$$F_G = \frac{K_G L_G}{K_M L_{M2} + K_G L_G} \times [1 - \exp^{(-K_M L_{M2} - K_G L_G)} \quad (7)$$

$$LM1 = \frac{hM - hG}{hM}(LM) \quad (8)$$

$$LM2 = \frac{hG}{hM}(LM) \quad (9)$$

where,
K_M - extinction coefficient of maize
K_G - extinction coefficient of greengram
L_M – LAI of maize (second turbid layer)
L_G – LAI of greengram (second turbid layer)

Radiation use efficiency (RUE)

RUE (g MJ^{-1}) was calculated as above-ground biomass (g m^{-2}) divided by the amount of solar radiation intercepted (MJ m^{-2}) (Tsubo *et al.*,2002). The I_0 was the quantity of daily incident PAR (MJ m^{-2}). In order to convert total radiation to PAR, the daily total radiation data were multiplied by 0.5 (Gao *et al.*, 2010).

$$RUE_M = \frac{Above \text{ ground biomass}}{I_0(F_{M1} + F_{M2})} \quad (10)$$

$$RUE_G = \frac{Above \text{ ground biomass}}{I_0 F_G} \quad (11)$$

where,
I_0 - Cumulative incident PAR (MJ m^{-2})
F_{M1} and F_{M2} - fraction of intercepted PAR of the intercropped maize
F_G - fraction of intercepted PAR of the intercropped greengram

Statistical analysis

SPSS software was used to do all data analysis. ANOVA (Analysis of variance) was performed to assess significant differences, and the LSD (Least Significance Difference) test was employed to compare the means at a 5% probability level. The mean values were reported as mean SE (standard error), based on three replicates per treatment.

RESULTS AND DISCUSSION

Leaf area index (LAI)

The LAI was measured at vegetative, flowering and maturity stages during *Kharif* 2022 and *rabi* 2022-2023, as depicted in Table 2. LAI of maize and greengram intercropping system increased rapidly from the vegetative stage to the flowering stage and decreased at the maturity phase.

Among the *Kharif* 2022 and *Rabi* 2022-2023 cropping seasons, the main crop (maize) LAI had higher in T_{12} (M_2G_3 paired row inter-cropping system with 125 % RDN) which was 3.76, 6.01, 5.26 at vegetative, flowering and maturity phase, respectively during *Kharif* season and 3.38, 5.26, 5.07 during rabi season and followed by T_3 (sole maize with 125 % RDN). The lower LAI value was found in T_4 (M_2G_2 replacement intercropping system with 75 % RDN) in both *Kharif* and *rabi* seasons. The LAI of intercrop (greengram) had significantly higher in T_{12} (M_2G_3 paired row intercropping system with 125 % RDN) which was 0.96 and 3.61 at vegetative and flowering phase, respectively during *Kharif* and 0.89 and 3.49 during *rabi* season followed by T_6 and T_{-9} (M_2G_2 and M_4G_2 with 125% RDN) in both the seasons.

In sole maize at T_{12}, higher plant population had increased the LAI which was due to a higher number of leaves. In addition, physiological growth rates were found to be higher in high density planting which increased the leaf area and leaf area index. The LAI values were lesser in intercropping system when compared to the sole crop which was due to the shading effect by maize in the intercrop. Increased maize density increased the LAI in both sole crop and intercropping. The results support Valadabadi and Farahani (2010), who reported that increased plant density increased the LAI of maize. Wang *et al.* (2020) reported a similar result in a maize-peanut intercropping system and found that light interception in the maize-peanut intercropping was higher than in the sole groundnut. Even though the LUE of monocropped and intercropped maize was identical, peanut utilised light more effectively. The present study also indicated that intercropped maize's density influence on light interception was less pronounced than in monocropping. This supports the previously reported finding that the optimum plant density of dominating species in intercropping is lower than in monocropping (Wang *et al.,*2017).

Light interception (%)

The light interception (%) of maize were recorded at different growth stages *viz*., vegetative, flowering and maturity phase during *Kharif* 2022 and *rabi* 2022-2023, depicted in Table 2. The Light interception (%) increased gradually from vegetative to flowering stage and decreased during maturity phase in both seasons.

Main crop (maize) had a significantly higher light interception (%) at T_{12} (M_2G_3 paired row intercropping system with 125 % RDN), which was 69.0, 75.5 and 71.0 per cent during the vegetative, flowering and maturity phase, respectively during *Kharif* and 60.1, 78.1 and 76.6 per cent during *rabi*. It was followed by T_3 (sole maize with 125 % RDN). The lowest value of light interception (%) was significantly noticed in T_7 (M_4G_2 replacement intercropping system with 75 % RDN) during both *Kharif* and *rabi* seasons. The intercrop

Table 2. LAI dynamics of intercropped maize and greengram during the growing seasons of *Kharif* 2022 and *Rabi 2022-2023*

Treatment	*Kharif* 2022					*Rabi* 2022-2023				
	Vegetative stage		Flowering Stage		Maturity phase	Vegetative stage		Flowering stage		Maturity phase
	Main Crop	Inter crop	Main crop	Inter crop	Main Crop	Main crop	Inter crop	Main crop	Inter crop	Main crop
T_1	2.36	-	3.94	-	3.15	2.10	-	3.41	-	3.02
T_2	2.87	-	4.60	-	3.74	2.59	-	3.74	-	3.59
T_3	3.45	-	4.60	-	4.02	3.16	-	4.02	-	3.88
T_4	2.10	0.48	3.50	1.76	2.80	1.87	0.43	2.80	1.68	2.69
T_5	2.15	0.73	3.45	2.78	2.80	1.94	0.67	2.80	2.68	2.69
T_6	3.36	0.95	4.89	3.94	4.28	3.06	0.88	3.97	3.81	4.13
T_7	3.19	0.54	4.31	1.98	3.50	2.56	0.49	3.77	1.89	3.37
T_8	2.69	0.76	4.60	2.85	4.03	2.88	0.71	4.03	2.74	3.88
T_9	3.16	0.82	5.32	3.61	4.26	3.01	0.76	4.61	3.36	4.08
T_{10}	2.47	0.55	4.64	2.03	3.71	2.32	0.50	4.02	1.94	3.56
T_{11}	2.98	0.62	5.30	2.69	4.31	2.65	0.56	4.31	2.48	4.14
T_{12}	3.76	0.96	6.01	3.61	5.26	3.38	0.89	5.26	3.49	5.07
Mean	**2.87**	**0.71**	**4.59**	**2.80**	**3.82**	**2.62**	**0.65**	**3.89**	**2.67**	**3.67**
Cd (0.05)	0.12	0.03	0.21	0.13	0.15	0.09	0.03	0.17	0.14	0.16
Sed	0.06	0.01	0.10	0.06	0.07	0.04	0.01	0.08	0.06	0.08

Table 3. Light interception (%) of intercropped maize and greengram during the growing seasons of *Kharif* 2022 and *Rabi 2022-2023*

Treatment	*Kharif* 2022					*Rabi* 2022-2023				
	Vegetative stage		Flowering Stage		Maturity phase	Vegetative stage		Flowering stage		Maturity phase
	Main Crop	Inter crop	Main crop	Inter crop	Main Crop	Main crop	Inter crop	Main crop	Inter crop	Main crop
T_1	60.0	-	62.5	-	55.1	48.3	-	60.3	-	57.8
T_2	63.8	-	72.0	-	54.3	51.8	-	74.9	-	68.3
T_3	67.9	-	74.0	-	69.4	58.8	-	75.4	-	73.4
T_4	62.7	30.7	72.1	66.9	64.4	41.4	52.8	69.1	53.9	68.6
T_5	66.4	38.0	74.1	71.9	67.6	47.4	58.9	70.8	60.8	71.5
T_6	64.6	32.2	65.7	67.8	57.2	50.2	52.9	73.6	55.1	61.4
T_7	51.3	20.1	53.9	53.8	42.3	32.9	38.1	58.2	35.7	48.1
T_8	57.9	26.2	63.7	61.2	54.6	38.3	53.7	65.4	46.0	59.1
T_9	62.9	30.1	69.9	66.6	62.4	41.4	64.5	69.3	53.4	66.1
T_{10}	53.6	27.1	52.1	58.7	40.1	43.6	39.6	64.1	42.4	53.0
T_{11}	59.9	30.3	62.4	63.7	53.0	53.4	46.9	70.1	49.5	57.7
T_{12}	69.0	44.1	75.5	74.7	71.0	60.1	62.9	78.1	64.7	76.6
Mean	**61.6**	**30.9**	**66.5**	**65.0**	**57.6**	**47.2**	**52.2**	**69.1**	**51.2**	**63.4**
Cd (0.05)	2.7	0.95	3.3	2.63	2.8	2.16	2.4	2.01	2.58	3.3
Sed	1.3	0.44	1.6	1.24	1.3	1.04	1.17	0.97	1.22	1.6

(greengram) had significantly higher light interception in T_{12} (M_2G_3 paired row intercropping system with 125 % RDN), which was 44.1 and 74.7 at vegetative and flowering phase, respectively during *Kharif* and 62.9 and 64.7 during *rabi*. In both seasons, the light interception was followed by T6 and T9 (M2G2 and M4G2 with 125% RDN).

Leaf area development of the crops had been influenced by environmental factors such as temperature, rainfall and limited moisture *etc.,* where faster leaf area growth in T_{12} treatment had caused higher PAR interception during the vegetative stage. Similarly, T_{12} treatment had higher LAI, which influenced the light interception (%) during the different growth stages. Light interception had differed in intercropping system compared to sole crops due to vertical arrangements of dense crop canopy architecture under temporal and spatial complementarity. Compared to intercrop, maize light interception was high which was mainly due to high plant height and LAI at all the growing stages during both the cropping periods. The result was supported by Du *et al.* (2021) and Naher and Hossain (2021), who found higher PAR conversion efficiencies in maize and legume intercropping systems.

Extinction coefficient

The Extinction coefficient of maize intercrop with greengram at vegetative, flowering and maturity stages during *Kharif* 2022 and *rabi* 2022-2023 were depicted in Table 3. Extinction coefficient of maize and greengram intercropping system was increased rapidly from vegetative to flowering stage and then decreased at maturity phase. Among *Kharif* 2022 and *Rabi* 2022-2023 cropping seasons, Main crop (maize) had a significantly higher extinction coefficient in T_{12} treatment, which was and at vegetative, flowering and maturity phase, respectively, during *Kharif* (0.28,0.29 and 0.15, respectively) and, during *rabi* (0.29,0.16 and 0.18 respectively).

The lowest extinction coefficient was found at the M4G2 replacement intercropping system with 75% RDN in both cropping seasons. Extinction coefficient of inter crop (greengram) was significantly higher in M_2G_3 paired row intercropping system with 125 % Recommended dose of Nitrogen (RDN), which was 0.29 (*Kharif*) and 0.34 and 0.41,0.33 (*rabi*) during vegetative and flowering phase respectively followed by M_2G_2 and M_4G_2 with 125% RDN in both *Kharif* and *rabi* seasons. Among the main crop and intercrop, the extension coefficient of intercrop was less which was due to the shading effect by maize and thereby, increased the ratio of diffuse to direct radiation inside the intercrop canopy. These results are concordant with Raza *et al.* (2022), who found a higher extension coefficient in the intercrop due to the maize crop's erect nature and shading.

Radiation Use Efficiency (RUE)

The RUE of maize intercropping with greengram in *Kharif* 2022 and *rabi* 2022-2023 seasons were depicted in Table 4. Main crop and intercrop (maize + greengram) had higher RUE in T_{12} (M_2G_3 with 125 % (RDN which was 2.46 and 1.43 during *Kharif* and rabi, respectively. In both the cropping seasons, the lower value of RUE was recorded in T7 (M2G2 replacement intercropping system with 75 % RDN). The higher LUE

Table 4. Extinction coefficient of intercropped maize and greengram during the growing seasons of *Kharif* 2022 and *Rabi* 2022-2023

Treatment	*Kharif* 2022					*Rabi* 2022-2023				
	Vegetative stage		Flowering stage		Maturity Phase	Vegetative stage		Flowering stage		Maturity phase
	Main Crop	Inter crop	Main crop	Inter crop	Main Crop	Main crop	Inter crop	Main crop	Inter crop	Main crop
T_1	0.32	-	0.29		0.48	0.38	-	0.31	-	0.37
T_2	0.29	-	0.25		0.45	0.36	-	0.28	-	0.32
T_3	0.25	-	0.23	-	0.41	0.33	-	0.25	-	0.29
T_4	0.45	0.37	0.36	0.46	0.57	0.41	0.53	0.35	0.56	0.43
T_5	0.36	0.39	0.26	0.31	0.52	0.39	0.51	0.32	0.41	0.36
T_6	0.34	0.36	0.29	0.35	0.49	0.35	0.47	0.31	0.48	0.32
T_7	0.41	0.38	0.39	0.42	0.52	0.4	0.52	0.33	0.58	0.34
T_8	0.32	0.34	0.23	0.33	0.47	0.36	0.48	0.29	0.42	0.33
T_9	0.31	0.33	0.26	0.31	0.44	0.35	0.47	0.26	0.43	0.31
T_{10}	0.31	0.36	0.16	0.43	0.38	0.32	0.44	0.21	0.39	0.21
T_{11}	0.31	0.32	0.18	0.38	0.35	0.3	0.42	0.18	0.42	0.21
T_{12}	0.28	0.29	0.15	0.34	0.33	0.29	0.41	0.16	0.33	0.18
Mean	**0.33**	**0.35**	**0.25**	**0.37**	**0.45**	**0.35**	**0.47**	**0.27**	**0.45**	**0.31**
Cd (0.05)	0.013	0.014	0.009	0.013	0.009	0.01	0.021	0.012	0.014	0.012
SEd	0.006	0.006	0.004	0.006	0.004	0.005	0.009	0.006	0.006	0.006

Table 5. Radiation use efficiency (g MJ^{-1}) of intercropped maize and greengram during the growing seasons of *Kharif* 2022 and *Rabi 2022-2023*

Treatment	*Kharif* 2022	*Rabi* 2022-2023
T_1	1.75	1.23
T_2	2.12	1.24
T_3	2.23	1.31
T_4	1.7	0.89
T_5	1.8	1.03
T_6	1.84	1.09
T_7	1.82	1.02
T_8	2.14	1.24
T_9	2.32	1.41
T_{10}	1.76	1.00
T_{11}	2.38	1.31
T_{12}	2.46	1.43
Mean	**2.03**	**1.18**
Cd (0.05)	0.04	0.034
Sed	0.019	0.016

of inter crop (greengram) had recorded in M2G3 paired row intercropping system with 125 % Recommended dose of Nitrogen (RDN) during the *Kharif* and rabi seasons, followed by M_2G_2 and M_4G_2 with 125% RDN in both the cropping seasons. The RUE of maize intercrop with greengram (T_{12}) had higher values than sole maize crop due to the increased diffused light and less light saturation in intercropping. Also, intercropping was more efficient in utilizing solar radiation with denser populations than sole maize crop. The similar findings were also found by Raza *et al.* (2019) and reported that maintaining narrow, wide spacing in maize intercropping can increase dry matter accumulation and radiation usage efficiency.

Conclusion

The present study concluded that the maize hybrid COH (M) 8 intercropping with greengram variety CO 8 at different ratios showed higher LAI, light interception (%) and RUE in T_{12} treatment (M_2G_3 - paired row intercropping system with 125 % RDN) at all the crop growing periods during both the cropping seasons (*Kharif*, 2022 and *Rabi*, 2022-2023) than the sole maize and other intercropping systems *viz.*, M_2G_4, M_2G_2. The lowest values were found in the T_4 (M_2G_2 replacement intercropping system with 75 % RDN) at all stages during both the cropping seasons. In general, Light interception and RUE was higher in the intercropping system. The RUE in the replacement series was less influenced by the intercropping system resulting in higher light interception, and RUE, which could improve dry matter accumulation compared to the other intercropping methods.

Conflict of interest

The authors declare that they have no conflict of interest.

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