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Evaluation of conservation agriculture practices for radiation interception and biophysical properties in rice-mustard cropping system

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सार – संरक्षण कृषि पर सौर विकिरण अंतर्ग्रहण और विकिरण उपयोग क्षमता का प्रभाव तथा उसका संवर्द्धन वृद्धि, जैव भार संचय, धान, सरसों फसल प्रणाली के साथ संबंध पर अध्ययन किया गया। 2014-15 के दौरान धान (*ओरीजा सतीव एल.*) तथा सरसों (*ब्रासिका जूनसीए एल.*) लगाया गया तथा प्रयोग में रेन डोमाइज्ड ब्लॉक डिज़ाइन का उपयोग कर 8 अलग-अलग विधियों का उपयोग किया गया। मौसम मापदंडों, प्रकाश संश्लेषणीय सक्रिय विकिरण, पत्ती क्षेत्र सूचकांक, जैवभार संचयन, फसल सूचकांक और उपज इस फसल प्रणाली के लिए नियमित अंतराल पर दर्ज किए गए। इस फसल प्रणाली में, उपचार 8 (प्रतिरोपित धान तथा इसके बाद पारंपरिक जुताई द्वारा उगाया गया सरसों) के दौरान अधिकतम पत्ती क्षेत्र सूचकांक, जैवभार संचयन तथा विकिरण उपयोग क्षमता का पता चला। हालांकि, अधिकतम फसल सूचकांक संरक्षण उपचार 6 (मूंग के अवशेषों का मृदा सम्मिलन से शून्य जुताई द्वारा प्रत्यक्ष बुआई धान तथा इसके बाद धान अवशेषों के मृदा में सम्मिलन से शून्य जुताई सरसों) पता चला। सरसों में उपचार 6 द्वारा अधिकतम आंशिक अंतरग्रहित प्रकाश संश्लेषणीय सक्रिय विकिरण, विकिरण उपयोग क्षमता, पत्ती क्षेत्रफल सूचकांक,जैवभार संचयन, उपज तथा सूचकांक का पता चला। अत: संरक्षण कृषि द्वारा बाद में लगाए गए सरसों के विकिरण अंतर्ग्रहण, विकिरण उपयोग क्षमता, वृद्धि तथा उपज पर सकारात्मक प्रभाव पड़ा परंतु धान में प्रभाव सार्थक नहीं पाए गए।

ABSTRACT. A study was conducted to know the effects of conservation agriculture on solar radiation interception and radiation use efficiency and its relationship with growth, biomass accumulation, harvest index and yield of rice-mustard cropping system. Rice (*Oryza sativa L.*) – mustard (*Brassica juncea L.*) cropping system was followed during the year 2014-15 with eight different treatments each following randomised block design. Weather parameters, photosynthetically active radiation, leaf area index, biomass accumulation, harvest index and yield were recorded at the regular intervals for this cropping system. Results showed treatment 8 (transplanted rice followed by conventional till mustard) having maximum LAI (leaf area index), biomass accumulation and RUE (radiation use efficiency). However, maximum harvest index was shown by conservation treatment 6 (mung bean residue incorporated zero tillage direct seeded rice followed by rice residue incorporated zero tillage mustard). In mustard, treatment 6 showed maximum fIPAR (fractional intercepted photosynthetically active radiation), RUE, LAI, biomass accumulation, yield and harvest index. Thus, conservation agricultural practices showed significant amount of positive effects on radiation interception, radiation use efficiency, growth and yield in follow up crop mustard but did not have any appreciable effects in case of rice.

Key words – Biophysical parameters, Conservation agriculture, Radiation interception.

1. Introduction

Burgeoning world population (8.9 billion in 2050) with degrading natural resources is the primary cause of concern for today's world leaders (FAO, 2015). Various measures are being adopted to increase food production in a sustainable manner with minimal increase in crop area. Conservation agriculture (CA) which includes reduced tillage, crop residue incorporation and crop rotation offers vast potential in this respect. As the soil quality is improved, utilization of natural resources is also enhanced. Retention of crop residue on the soil surface in combination with no-tillage initiates processes that lead to improved soil quality and overall enhancement of resource use efficiency (Ghosh *et al*., 2010). Much work has been done on photosynthetic efficiency and harvest index but there is dearth of literature on modification of microclimate by change in management practices that affects yield.

Rice-mustard cropping system is a popular cropping system after rice-wheat cropping system in northern India. This cropping system is followed in regions of low availability of irrigation water during *rabi* season. Rice-wheat cropping system, continuously being followed for last 15-20 years in Indo-Gangetic plains has encountered a

TABLE 1

Treatments adopted in the experiment

S. No.	Treatment description	Treatment short form	Treatment code
1.	Zero Tillage Direct Seeded Rice – Zero Tillage Mustard	ZT DSR – ZTM	T1
2.	Zero Tillage Direct Seeded Rice + Brown Manuring – Zero Tillage Mustard	ZT DSR + BM – ZTM	T2
3.	Zero Tillage Direct Seeded Rice + Mustard Residue – Rice Residue + Zero Tillage Mustard	ZT DSR + MR – RR + ZTM	T3
4.	Zero Tillage Direct Seeded Rice + Mustard Residue + Brown Manuring – Rice Residue + Zero Tillage Mustard	ZT DSR + MR + BM – RR + ZTM	T4
5.	Zero Tillage Direct Seeded Rice + Mungbean Residue – Zero Tillage Mustard	ZT DSR + MBR – ZTM	T5
6.	Zero Tillage Direct Seeded Rice + Mungbean Residue – Rice Residue + Zero Tillage Mustard	ZT DSR + MBR – RR + ZTM	T6
7.	Transplanted Rice – Zero Tillage Mustard	TPR – ZTM	T7
8.	Transplanted Rice – Conventional Till Mustard	TPR – CTM	T8

Treatments T1 to T7 were considered conservation agriculture (CA) treatments and treatments T8 was considered conventional treatments

TABLE 2

Leaf Area Index (LAI) and above ground biomass in rice and mustard at 100 DAS in conservation and conventional practices

Treatments	Rice		Mustard	
	LAI	Biomass (t/ha)	LAI	Biomass (t/ha)
T1	3.40	8.90	2.65	4.36
T2	3.31	8.25	3.36	5.32
T3	3.42	8.76	3.14	5.30
T4	3.45	8.80	3.79	6.08
T5	3.36	8.57	3.49	5.91
T6	3.49	9.10	4.11	6.13
T7	3.79	9.70	3.09	5.16
T8	4.11	11.75	3.04	4.55
LSD ($p < 0.01$)	0.164	0.162	0.164	0.195

host of problems such as heavy mining of nutrients, micronutrients deficiency, water scarcity, deterioration of water quality, water table depletion, weed flora shift and resistance, heavy energy and labour consumption, greenhouse gas emissions and pest insurgence. Thus, rice-wheat cropping system needs to be diversified towards higher productivity and resource use efficiency. Since, rice and wheat are staple food crops of India, both can’t be replaced altogether.

This study was carried out in an experimental area where a conservation agriculture (CA) system was being practised since last five years (2009-2015). It included rice (rainy season, June-October)-maize (winter season, November to April) for two years (2009-2011) and was then followed by rice-mustard for next three years (2012-2015). Hence, in this study wheat has been replaced with mustard for diversification of rice-wheat system under CA based crop production system. Our objectives were to study the productivity, radiation interception, biophysical aspects for winter and rainy season (2014-15) under five years of continued CA system compared with conventional transplanted rice-mustard system. Our CA systems included direct seeded rice with different CA practices like double and triple zero tillage system with or without crop residue in both the season.

TABLE 3

fIPAR of rice and mustard at 40 and 100 DAS in conservation and conventional practices

Treatments	Rice		Mustard	
	40 DAS	100 DAS	40 DAS	100 DAS
T1	0.24	0.95	0.26	0.68
T2	0.17	0.88	0.42	0.83
T3	0.21	0.90	0.33	0.83
T4	0.23	0.92	0.46	0.84
T5	0.17	0.89	0.41	0.84
T6	0.31	0.86	0.49	0.83
T7	0.27	0.91	0.34	0.82
T8	0.32	0.95	0.42	0.78
LSD ($p < 0.05$)	0.121	0.071	0.093	0.032

2. Materials and method

2.1. *Experimental details*

The experiment was conducted in a field area of 1.5 ha on rice-mustard (cultivars PRH-10 and Pusa Mustard-25, respectively) cropping system (Table 1) during the year 2014-15 at the ICAR-Indian Agricultural Research Institute, New Delhi (28°35′ N, 77°12′ E and with an altitude of 228.16 m above the mean sea level). Rice was sown on 28th June, 2014 and mustard was sown on 11th November, 2014. The climate of the site is semi-arid type with an average annual rainfall of 710 mm. The surface soil (0-30 cm) is sandy loam in texture. The average bulk density was 1.48 Mgm^{-3}; pH (1:2.5 soil: water suspension) 8.0; organic C, 0.57%; available N, 170.6 kg ha^{-1} and available P and K, 18.6 and 275 kg ha^{-1}, respectively.

2.2. *Schedule of observations*

2.2.1. *Weather parameters*

Data on weekly rainfall and weekly mean minimum and maximum temperatures, morning and evening relative humidity, wind speed, bright sunshine hours, pan evaporation were collected from the agrometeorological observatory of the Division of Agricultural Physics, ICAR-IARI, New Delhi.

2.2.2. *Crop biomass*

Three plants were selected randomly in each plot and cut at ground level at fifteen days interval for this study. Those plants were oven dried at 65 °C for 48 hours or more and weighed by using electrical digital balance. Dry biomass produced was expressed in t ha^{-1}.

2.2.3. *Leaf area index (LAI)*

Measurements of LAI were carried out in the field at weekly intervals using LAI- 2000 Plant Canopy Analyzer (LI-COR, USA) with a configuration of four below and one above canopy measurements to estimate the LAI.

2.2.4. *Yield and harvest index*

An area of 1 m × 1 m was harvested manually from each plot and were oven dried at 65 °C for 48 hours followed by weighing using electrical digital balance. Then plant samples were thrashed in the laboratory and the seeds were separated. Finally, average seed yield and stover yield was calculated. Also, Harvest index (HI) was calculated as ratio of seed yield and final above ground biomass and later multiplying by 100.

2.2.5. *Radiation characteristics*

Photosynthetically active radiation (PAR) values were measured weekly at the top and bottom of rice and mustard throughout the season on clear days (between 11:30 and 12:00 hrs IST) using line quantum sensor LI-191SA (LICOR Inc., Lincoln, NE, USA). These measurements were used to derive fraction Intercepted PAR (fIPAR). Daily global radiation recorded by pyranometer was used to calculate incoming PAR by multiplying with a factor of 0.48. Daily incoming PAR values were multiplied by corresponding daily fIPAR values to compute daily Intercepted PAR (IPAR). The daily IPAR were accumulated corresponding to the period

TABLE 4

Extinction coefficient of rice and mustard in conservation and conventional practices

Treatments	Rice (k)	Mustard (k)
T1	0.49	0.47
T2	0.45	0.45
T3	0.46	0.48
T4	0.41	0.44
T5	0.43	0.45
T6	0.43	0.39
T7	0.41	0.46
T8	0.38	0.45
LSD (P < 0.05)	0.03	0.04

for which crop biomass was recorded. RUE was calculated as the slope of the regression of accumulated biomass on cumulative intercepted radiation.

2.2.6. *Statistical analysis*

The data sets were processed for analysis of variance to test differences among the various treatments and their interactions using Statistical Analysis System (SAS, 2006).

3. Results

3.1. *Effect on crop growth variables*

The seasonal progress of leaf area index (LAI) of rice and mustard for different treatments showed a rapid increase during vegetative phase (seedling to flowering) then reached a peak around 90-100 DAS and it decreases thereafter due to leaf fall and maturity. In rice (Table 2), at 100 days after sowing maximum LAI (4.11) was recorded in T8 (TPR+CTM) and least (3.31) in T2 (ZT DSR + BM - ZTM). Among conservation agriculture plots, maximum LAI was observed (3.49) in T6 (MBR + ZT DSR – RR + ZTM). Initial growth in T6 was found to be better but in later stages T8 and T7 showed higher LAI. Rainfall was deficit during rainy season (2014-15), so, during this year conventional practices produced more LAI due to timely application of adequate moisture through irrigation. But in case of mustard, maximum value at 100 DAS of LAI (4.11) was observed in T6 (MBR+ ZT DSR- RR+ ZTM) followed by T4 (3.79) (MR+ ZT DSR + BM- RR+ ZTM). Least LAI was observed in T1 (ZT DSR- ZTM) of 2.65 at 100 DAS. In rice crop, the highest biomass accumulation was observed in T8 (11.75 t ha^{-1}) after 100 DAS (Table 2) but T2 had

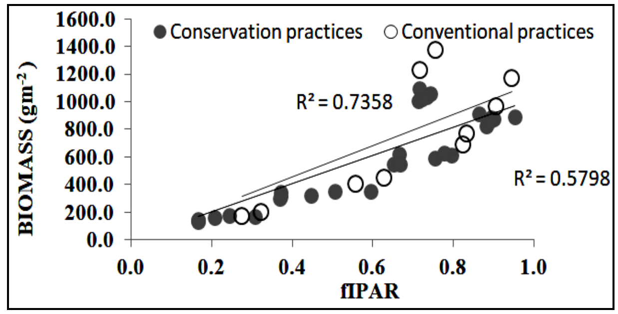

Fig. 1. Relationship between Biomass and fIPAR in conservation and conventional treatments in rice

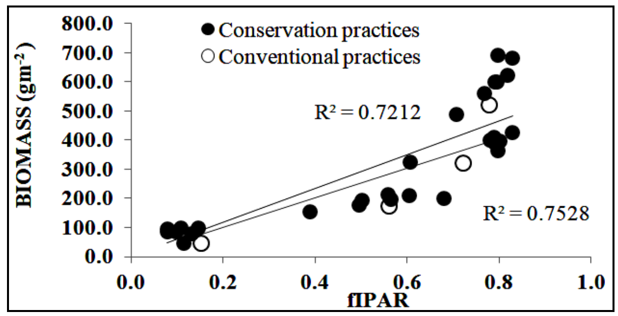

Fig. 2. Relationship between Biomass and fIPAR in conservation and conventional treatments in mustard

least biomass accumulation (8.25 t ha^{-1}). Biomass accumulation followed the trend of LAI representing direct effect of LAI over biomass accumulation. Among conservation agricultural practices, T6 had maximum biomass accumulation (9.10 t ha^{-1}). In mustard, maximum biomass accumulation (6.13) t ha^{-1} was recorded in T6 (MBR+ ZT DSR- RR+ ZTM) while least (4.36 t ha^{-1}) was observed in T1 (ZT DSR + ZTM).

3.2. *Effect on radiation interception*

In all the cases, initially an increasing trend was observed, then it was plateauing and later decreasing as the season progresses. Many observations were taken throughout the growing season of rice and mustard. The peak values of fIPAR for rice and mustard at 100 DAS is shown in Table 3 for all treatments. The value of fIPAR was consistently higher in T8 (TPR – CTM) and at 100 DAS peak (0.95) was observed. The lowest value of peak fIPAR at 100 DAS was observed in T2 (ZT DSR + BM – ZTM) (0.88). T8 was consistently showing higher fIPAR throughout the growing season and thereby can be considered as the best among all treatments while T2 showed the lowest fIPAR among all treatments throughout the growing season. Variation of fIPAR for mustard showed similar pattern like that of rice. However, T6 (MBR+ ZT DSR- RR+ ZTM) showed better radiation interception due to more LAI. The lowest

TABLE 5

Variation of total IPAR (TIPAR), final above ground biomass and radiation use efficiency (RUE) in rice and mustard in conservation and conventional practices

Treatments	Rice			Mustard		
	Biomass (g/m^2)	TIPAR (MJ/m^2)	RUE (g/ MJ)	Biomass (g/m^2)	TIPAR (MJ/m^2)	RUE (g/ MJ)
T1	1055	511	2.1	550	274	2.0
T2	1003	430	2.3	650	342	1.9
T3	1037	476	2.2	640	337	1.9
T4	1050	491	2.1	755	355	2.1
T5	1021	435	2.3	683	353	1.9
T6	1092	518	2.1	780	367	2.1
T7	1223	523	2.3	603	331	1.8
T8	1377	554	2.5	563	329	1.7
LSD ($p < 0.01$)	136	81	0.4	162	17	0.3

TABLE 6

Final biomass, yield and harvest index of rice and mustard in different treatments under conservation and conventional practices

Treatments	Rice			Mustard		
	Final Biomass (t/ha)	Yield (t/ha)	Harvest Index (%)	Final Biomass (t/ha)	Yield (t/ha)	Harvest Index (%)
T1	10.55	4.11	39	5.50	1.54	28
T2	10.03	3.91	39	6.50	1.64	25
T3	10.37	3.42	33	6.40	2.04	31
T4	10.50	4.41	42	7.55	2.18	29
T5	10.21	4.49	44	6.83	1.89	28
T6	10.92	5.02	46	7.80	2.57	33
T7	12.28	4.91	40	6.03	1.63	27
T8	13.77	5.18	38	5.63	1.67	28
LSD ($p < 0.05$)	0.74	0.69	5.70	1.20	0.32	7.23

value of fIPAR at 100 DAS was observed in T1 (ZT DSR- ZTM) (0.68). Highest TIPAR in rice (Table 4) was observed in T8 (TPR – CTM) (554 MJ m^{-2}) than other treatments for the whole crop growing period since it had more LAI. Among conservation agriculture practices, T6 (MBR + ZT DSR – RR + ZTM) showed higher TIPAR (518 MJ m^{-2}) and least TIPAR was observed in T2 (ZT DSR + BM – ZTM) (430 MJ m^{-2}) (Table 5). This clearly indicates that conservation practices did not show significant effect in case of rice but its follow up effect was found in mustard.

3.3. *Radiation use efficiency, extinction coefficient and biomass accumulation*

In rice, higher radiation use efficiency (Table 5) was obtained in T8 (2.5 g MJ^{-1}) which means that intercepted radiation was efficiently converted to biomass. In mustard, highest radiation use efficiency (2.1 g MJ^{-1}) was obtained in T6 (MBR+ ZT DSR- RR+ ZTM) and T4 (MR+ ZT DSR + BM- RR+ ZTM). In rice, T8 accounted for the highest (1377 g m^{-2}) final above ground biomass, so, conventional practices showed better biomass accumulation. The lowest final above ground biomass was obtained in T2 (1003 g m^{-2}). Among the conservation agriculture treatments, T6 showed higher above ground biomass (1092 g m^{-2}) than other treatments. Extinction coefficient (k) was observed to be lowest in T8 in case of rice (0.38) and in T6 (0.39) in case of mustard. Biomass production is a function of fIPAR and it is linearly related to fIPAR. The fIPAR showed good correlation with above-ground biomass yield ($R^2 = 0.64$) (Fig. 1) indicating that fIPAR can account 91% variability for above ground biomass accumulation in conventional treatments (T7and T8) of rice whereas conservation treatments had R^2 of 0.83 only. Although in mustard, better correlation was observed in conservation practices (T1-T7) between fIPAR and above ground biomass (R^2 = 97) while conventional practice (T8) showed less R^2 (0.89) (Fig. 2). The highest final above ground biomass (Table 5) was observed in T6 (MBR+ ZT DSR- RR+ ZTM) (780 g m^{-2}) while the lowest above ground biomass was obtained in T1 (ZT DSR- ZTM) (550 g m^{-2}). Radiation use efficiency (RUE) which was calculated from final biomass and TIPAR was found to be the highest in T6 (MBR+ ZT DSR- RR+ ZTM) and T4. While, the lowest RUE was obtained in T8 (TPR- CTM) (1.7 g MJ^{-1}).

3.4. *Harvest index and seed yield*

T8 (TPR – CTM) produced maximum grain yield (Table 6) in (5.18 t ha^{-1}) followed by T6 (MBR + ZT DSR – RR + ZTM) (5.02 t ha^{-1}) in rice which could be attributed to more biomass accumulation. The lowest seed yield was obtained in T3 (MR + ZT DSR – RR + ZTM) (3.52 t ha^{-1}). Harvest Index (HI) was lowest in T3 (33%). Biomass is partitioned into grain as reflected by the harvest index (HI) (Kiniry *et al*., 2001). The highest harvest index (46%) was observed in T6 (MBR + ZT DSR – RR + ZTM) which suggests that most of the biomass accumulated in this treatment was converted to yield compared to other treatments. The HI was lower in case of T7 (40%) followed by T8 (38%). In case of mustard, final above ground biomass was observed significantly higher in T6 (MBR+ ZT DSR- RR+ ZTM) (7.80 t ha^{-1}). T1 (ZT DSR- ZTM) and T8 (TPR- CTM) showed the lowest values (5.50 and 5.63 t ha^{-1} respectively). Mustard yield and harvest index was highest in T6 (MBR+ ZT DSR- RR+ ZTM) (2.57 t ha^{-1}) while lowest seed yield was observed in T1 (ZT DSR - ZTM) (1.54 t ha^{-1}). Conventional tilled plot T8 (TPR- CTM) showed a seed yield of 1.67 t ha^{-1} only. Thus, T6 (MBR+ ZT DSR- RR+ ZTM) showed better conversion efficiency of biomass into yield in both rice and mustard.

4. Discussions

Maximum LAI in conventional treatment T8 (TPR-CTM) in rice can be attributed to sufficient availability of moisture through irrigation while conservation treatments faced water stress due to deficit rainfall. In general, rice crop water demand is quite high compared to other crops which could not be met by conservation practices. Aerobic rice showed lower grain yield in comparison to flooded rice since it was subjected to water stress (Alberto *et al*., 2011). Thus, the conservation treatments did not perform well. However, very low performance of T2 (ZT DSR+ BM-ZTM) with respect to other conservation treatments is difficult to explain which could be an area of further investigation. In case of mustard, conservation agriculture treatment, T6 (MBR+ ZT DSR- RR+ ZTM) exhibited the highest LAI due to incorporation of mungbean (legume crop) residues which had fixed nitrogen in its nodules and higher nitrogen content in leaves resulted in more nutrient supply to the crop as well as effect of these residues in conserving more soil moisture. T6 (MBR+ ZT DSR- RR+ ZTM) was also found to be better than rest of the conservation treatments in case of rice. In case of mustard, follow up effect of conservation practices was clearly observed and T6 (MBR+ ZT DSR- RR+ ZTM) showed the highest LAI among all the treatments. Mulches increased leaf area and crop growth rates and the leaf area indices of cassava and sweet potato were increased (21% in cassava and 10% in sweet potato) by incorporation of legume leaf mulch (Sangakkara *et al*., 2004). Better plant growth could again be related to the nitrogen supply of the rapidly decaying legume leaves and retention of soil moisture by residues which resonates with our findings.

Significantly higher fIPAR were found in T8 (TPR-CTM) of rice crop and T6 (MBR+ ZT DSR- RR+ ZTM) of mustard. Higher PAR conversion efficiencies may be due to distribution of light over greater leaf area, and more efficient distribution of light in their canopies during early stages of growth (Addo-Quaye *et al*., 2011). Bonhomme (2000) suggested that crop canopy could intercept 85% PAR only when crop had larger Leaf Area Index and this concurs to our findings that less fIPAR was observed in treatments which had less LAI T2 (ZT DSR+ BM-ZTM) and T3 (MR+ ZT DSR-RR+ZTM) for rice and T1 (ZT DSR-ZTM) and T3 (MR+ ZT DSR-RR+ZTM) for mustard). These treatments showed slow initial growth which produced lower LAI resulting in lesser PAR interception.

Biomass accumulation trends were similar to LAI results till flowering stage, thereby, implying that more LAI led to more PAR interception which resulted in more biomass accumulation. Residue retention increased shoot biomass yields of both the summer (average of 20%) and winter crops (average of 9%) (Shah *et al*., 2003). In this study also, conservation treatments containing mungbean residue produced more biomass. Significantly higher grain yield in case of conventional treatment T8 (TPR-CTM) of rice and conservation agriculture treatments in mustard is due to luxuriant growth in those treatments. Mungbean residues conserved moisture and supplied it to mustard crop leading to good crop growth. In this study crop rotation was followed. Earlier, rice-wheat cropping system was followed at this experimental site, but for two years (2013-14 and 2014-15) it was replaced by rice-mustard. So, increase in yield of mustard could be also attributed to different crop rotation across the year. Maize after wheat out-yielded continuous maize under all conditions of tillage, residue and nitrogen fertilization (Fischer *et al*., 2002). Conventional treatment T8 (TPR-CTM) and conservation treatment T6 (MBR+ ZT DSR- RR+ ZTM) showed accelerated leaf expansion, enabling the crop to more rapidly attain maximum green leaf area index respectively. This led to a better synchronisation of time of peak radiation interception and peak radiation incidence.

RUE differences among treatments have been ascribed to differences in LAIs and consequently fIPAR. RUE is often used to assess management impacts such as irrigation (Dercas and Liakatas, 2007), planting density (Purcell *et al*., 2002), planting dates (Rosenthal *et al*., 1993) and weed competition (Kiniry, 1994) among others. Thus, RUE can be a useful metric by which to compare the productivity among treatments. Lesser RUE in other conservation treatments resulted due to water stress during growing period of rice. T8 was conventional plot and was periodically irrigated unlike conservation treatments which were mostly based on rainfall. Our results agree with the previous studies on crop radiation interception under water stress (Blum 1996; Tesfaye *et al*., 2006). For mustard conservation treatment T6 performed well. Squire (1990) reported that the plants with the rapid canopy closure, has less light extinction coefficient than those are slowly expanding which is in tune with our findings where lower k was observed in T8 and T6 in rice and mustard respectively. Reduced k values (more upright leaves) are important for allowing better light penetration into leaf canopies, thus illuminating more leaf area at a lower intensity of PAR (Kiniry *et al*., 2001). This would be expected to increase the RUE.

5. Conclusions

This study suggests that conservation agriculture modified the microclimate which resulted in increased TIPAR, fIPAR and RUE and biophysical parameters including LAI, dry biomass accumulation, in case of mustard. In rice, conservation treatments had no major impacts on fIPAR, RUE, LAI, above ground biomass and yield. Conventional practice T8 (transplanted rice-conventional till mustard) showed more fIPAR, TIPAR, RUE, LAI, Biomass and yield due to high demand of water of lowland rice which could not be met by conservation practices. In mustard, conservation treatment T6 (MBR+ZTDSR-RR+ZTM) showed best performance in terms of fIPAR, RUE, TIPAR, LAI, above ground biomass and yield. Thus, conservation practices did not show positive impacts in rice but its positive effects occurred in following mustard crop's radiation characteristics and biophysical parameters.

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