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Importance of PAR interception and radiation use efficiency on growth and yield of Potatoes under different microclimates in the upper Brahmaputra valley zone of Assam

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सार – **भिन्न-भिन्न सूक्ष्मजलवायु के अंतर्गत आलू की किस्म कुफरीज्योति में** PAR **अवरोधन और विकिरण उपयोग दक्षता का आकलन करने के लिए और रबी की फसल के लिए** 2018-19 **के दौरान असम कृषि विश्वविद्यालय, जोरहाट, असम में एक क्षेत्रीय प्रयोग आयोजित किया गया था, जिसे दस दिनों के अंतराल पर और तीन मल्चिंग अभिक्रिया अर्थात जलकुंभी, काली पॉलिथीन और बिना मल्चिंग के** 10 **नवंबर से (पी**1) **से आरम्भ करके चार अलग-अलग तारीखों पर अलग-अलग प्लॉट में रोपित किया गया। इस घटना, परावर्तित और संचरित** PAR **को समय-समय पर एक लाइन क्वांटम सेंसर के साथ फसल पर मापा गया और दैनिक घटना विकिरण की गणना घटना** PAR **और तेज धूप के घंटों से की गई। विभिन्न अभिक्रिया के बीच** PAR (iPAR) **का अवरोधन काफी अलग-अलग था, जबकि जलकुंभी के साथ रोपण और मल्चिंग अभिक्रिया की पहली तारीख को उच्चतम** iPAR **दर्ज किया गया। जलकुंभी गीली घास (मल्च) के साथ पहली रोपण तिथि पर लगाई गई फसलों में पत्ती फलक सूचकांक (एलएआई) और बायोमास उत्पादन सबसे अधिक था। कंद उपज के लिए** RUE **जलकुंभी** (2.35 **ग्राम** MJ^{-1}) **में सबसे अधिक था, उसके बाद काली पॉलिथीन** (2.03 **ग्राम** MJ^{-1}) **और गैर-मल्चेड** (1.67 **ग्राम** MJ^{-1}) **स्थिति में था, जबकि रोपण तिथियों में यह रोपण की पहली तिथि में सबसे अधिक था। एलएआई, बायोमास उत्पादन और आलू की उपज को** iPAR **और** RUE **के साथ महत्वपूर्ण रूप से सहसंबद्ध पाया गया।** iPAR **और** RUE **से कंदके पैदावार का पूर्वानुमान करने के लिए चरणबद्ध प्रतिगमन विधि का उपयोग करके अनुमान करने वाले मॉडल विकसित किए गए, जिनमें** R^2 **के मान क्रमशः** 0.96 **और** 0.99 **हैं।**

ABSTRACT. A field experiment was conducted at Assam Agricultural University, Jorhat, Assam, during rabi 2018-19 to assess the PAR interception and radiation use efficiency in potato variety Kufri Jyoti under different microclimates, which was planted in split plot design with four dates of plantings starting from 10 November (P1) at ten days interval and three mulching treatments, *viz*., water hyacinth, black polythene and without mulching. The incident, reflected and transmitted PAR was measured periodically over the crop with a line quantum sensor and daily incident radiation was calculated from incident PAR and bright sunshine hours. The interception of PAR (iPAR) varied considerably among different treatments, while the highest iPAR was recorded under the first date of planting and mulching treatment with water hyacinth. The leaf area index (LAI) and biomass production were highest in crops planted on first planting date with water hyacinth mulch. The RUE for tuber yield was highest in water hyacinth (2.35 g MJ^{-1}) followed by black polythene (2.03 g MJ^{-1}) and non-mulched (1.67 g MJ^{-1}) condition, while among planting dates, it was highest in first date of planting. The LAI, biomass production and yield of potatoes were found to be significantly correlated with iPAR and RUE. The predictive models were developed using the stepwise regression method to predict tuber yield from iPAR and RUE, which have R^2 values of 0.96 and 0.99, respectively.

Key words – Potato, Kufri Jyoti, Microclimate, Mulching, PAR interception, Radiation Use Efficiency.

1. Introduction

Potato (*Solanum tuberosum* L.) is considered one of the important non-grain food crops due to its ability to produce high-value food in a short duration and amenability to fit into different cropping systems. This makes the crop a preferred choice of farmers worldwide. Though different meteorological parameters influence the

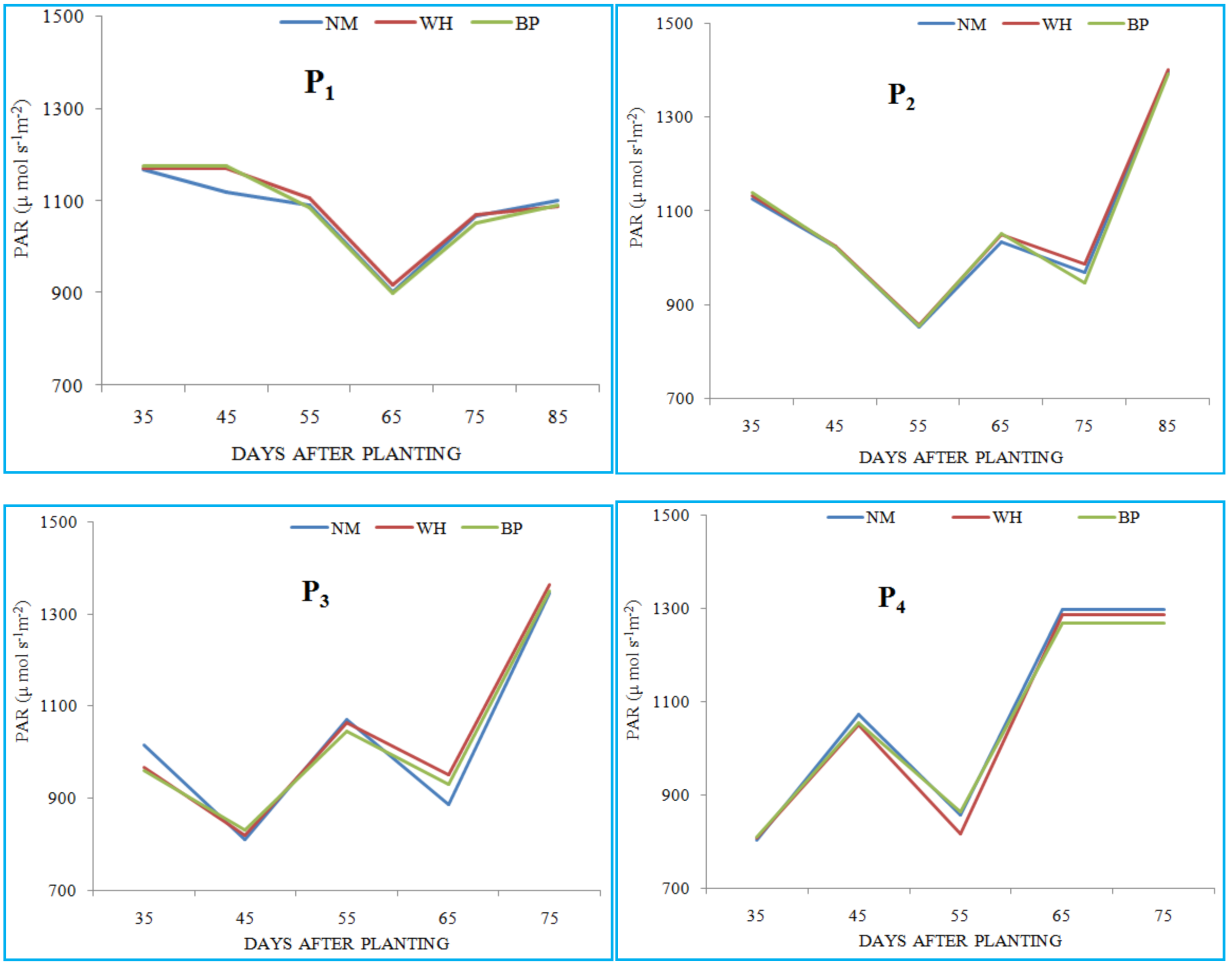
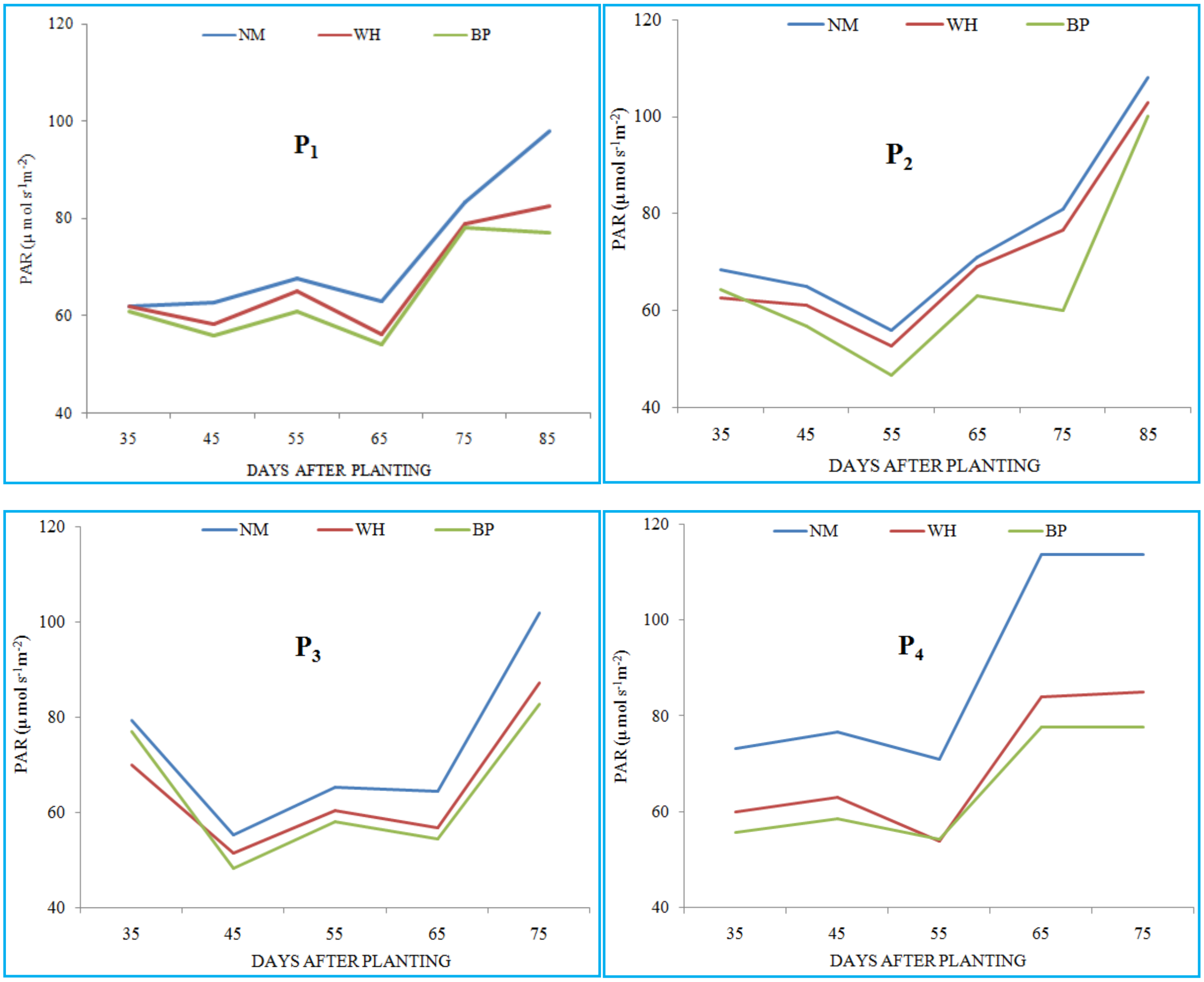


Fig.1(a-d). Variation of Incident PAR under different planting dates and mulching treatments in Potato during *rabi*, 2018-19

growth and development of the crop, temperature is the main limiting factor that affects the performance of the crop during its growing season. The potato crop is essentially a "cool weather crop". A temperature around 25 °C is suitable for early growth stages, while a temperature lower than 20 °C favours the tuber development of the crop (Annoymous, 2003). The crop is also sensitive to water stress as shallow and fibrous roots are primarily confined in the upper 30 cm soil layer (Tanner *et al.*, 1982). Excellent and continuous aeration and maintenance of soil moisture content above 65 per cent of field capacity are essential for crop success (Chandra *et al.*, 2002). The hydrothermal regime influences the growth and development and thereby, interception of Photosynthetically Active Radiation (PAR) and Radiation Utilization Efficiency (RUE), which ultimately reflects in the tuber production of the crop.

In Assam, growing rice (*Kharif)* and potato (*rabi*) in the sequence are identified as one of the most profitable double cropping system (Neog *et al*., 2018). However, soil moisture depletion and increasing soil temperature, particularly in the later part of the *rabi* season, are two limiting factors hindering the growth, development and tuber yield if the planting of the crop is delayed beyond 15 November (Begum and Saikia, 2014). However, this specific problem can be successfully dealt with by modification of microclimate in the crop field by altering planting times and mulching the crop with organic material. Mulching not only improves soil hydrothermal regimes in the root zone but also enhances the radiation interception by potato canopy, which plays a significant role in deciding the conversion efficiency of incident PAR to tuber yield (Kaur and Gill, 2014; Panging *et al.*, 2019).

The present study aims to relate radiation interception and radiation utilization efficiency with potatoes' growth, development and yield under varying microclimatic conditions obtained by manipulating planting times and using different mulch materials.

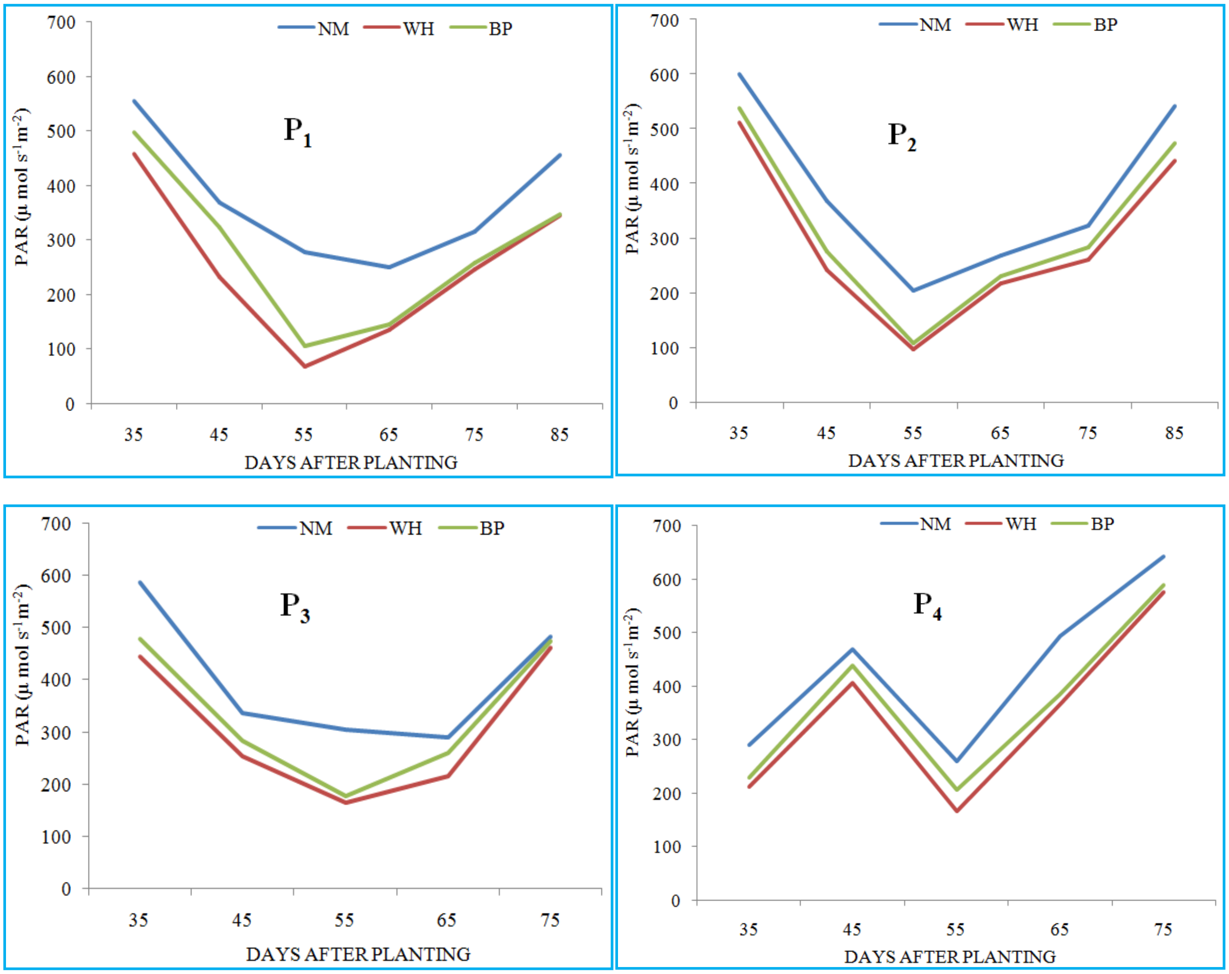


Figs. 2(a-d). Variation of Reflected PAR (µ mol s^{-1} m^{-2}) under different planting dates and mulching treatments in potato during *rabi*, 2018-19

Generally, the growth of the crop canopies under mulches is vigorous with a higher leaf area index and allowing the crop to absorb the maximum amount of PAR results in higher biomass production and crop yield (Saikia *et al.*, 2014; Wang *et al.*, 2015 and Dhaliwal *et al.*, 2019). Thus, the hypothesis for present field trial is mulching and altering planting dates can help in combating the ill effect of heat and moisture stresses and create a pleasant microclimate for better PAR interception and radiation utilization efficiency in the case of rainfed potatoes.

2. Materials and methods

The field experiment was conducted during the *rabi* season of 2018-19 at Instructional – Cum - Research Farm of Assam Agricultural University, Jorhat, Assam (26° 74' N, 94.20° 46' E and 87 m above mean sea level). The potato variety *Kufri Jyoti* was planted in a split-plot design with four dates starting from 10 November (P_1) at ten days interval in main plots and three mulching treatments with water hyacinth (M_1), black polythene (M_2) and without mulching (M_0) in sub-plots following recommended agronomic practices suggested by Assam Agricultural University, Jorhat. Daily bright sunshine hours were recorded in the Agrometeorological observatory near the experimental field. Plant samples for leaf area were taken periodically at 15 days intervals starting from the 30 DAP and leaf area was measured using Leaf Area Meter (Biovis PSM - leaf Version: 4.56). The plant samples were obtained randomly from one square meter area from two different sites of each individual plot for working out tuber yield and total biomass production at harvest. The components of PAR, *viz.*, incident PAR (IPAR), reflected PAR (RPAR) and transmitted PAR (TPAR) were measured on each plot at an interval of 10 days starting from 35 DAP with the help of line quantum sensor (Model LQM 70-10) at the local solar noon hours



Figs. 3(a-d). Variation of Transmitted PAR (TPAR) (µ mol $s^{-1}m^{-2}$) under different dates of planting and mulching treatments in *Kufri Jyoti* during *rabi*, 2018-19

(around 1130 am) in order to eliminate the effect of solar elevation following Sivakumar and Virmani (1984). The per cent intercepted PAR (iPAR) in the crop canopy was calculated using the formula below following Kumar *et al.* (2008) and Dhaliwal *et al.* (2019).

$$\text{iPAR}(\%) = \frac{\text{IPAR} - [\text{TPAR} + \text{RPAR}]}{\text{IPAR}} \times 100$$

Where, IPAR = Incident Photosynthetically Active Radiation, RPAR = Reflected Photosynthetically Active Radiation, TPAR = Transmitted Photosynthetically Active Radiation.

The conversion efficiency or quantity of dry matter produced per unit of incident PAR is known as Radiation Use efficiency (RUE). RUE for total biomass production and tuber yield of potatoes under different treatment combinations were computed using the following formula (Gallo and Daughtry, 1986).

$$\text{RUE} = \frac{\text{Amount of dry matter produced}\left(g\,m^{-2}\right)}{\text{Amount of cumulative IPAR}\left(\text{MJ}\,\text{m}^{-2}\right)}$$

The average IPAR (µmol s^{-1} m^{-2}) values were converted to daily PAR (MJ m^{-2} day^{-1}) using the following formula as suggested by Kumar *et al.* (2008) and Kaur and Gill (2014).

1 MJ m^{-2} day^{-1} = 0.0007826 × PAR (µmol $s^{-1}m^{-2}$) × BSS (Bright sunshine hours).

Simple regression and correlation analysis between intercepted PAR and RUE with biomass and tuber yield were calculated and best-fitted model equations were developed.

TABLE 1

Percentage of PAR interception by potato canopy in different stages of the crop under different microclimatic regimes during *rabi*, 2018-19

Dates of Planting	Mulching treatments	35 DAP	45 DAP	55 DAP	65 DAP	75 DAP	85 DAP
P1	M_0	47.2	61.4	68.3	65.4	62.6	49.7
	M_1	55.5	75.2	88.0	79.2	69.7	60.7
	M_2	52.5	67.7	84.7	77.9	68.0	61.1
	Mean	**51.8**	**68.1**	**80.3**	**74.1**	**66.8**	**57.1**
P2	M_0	44.9	57.6	69.4	67.2	58.3	53.5
	M_1	54.6	70.3	82.4	72.7	65.8	61.1
	M_2	52.6	67.5	81.9	72.1	63.7	58.8
	Mean	**50.7**	**65.1**	**77.9**	**70.7**	**62.6**	**57.8**
P3	M_0	43.4	51.7	65.5	60.2	56.6	-
	M_1	54.4	63.2	79.0	71.6	60.2	-
	M_2	49.6	59.6	77.2	65.8	58.5	-
	Mean	**49.1**	**58.2**	**73.9**	**65.9**	**58.4**	**-**
P4	M_0	40.2	49.2	61.5	53.1	41.7	-
	M_1	51.5	55.8	73.0	65.6	49.2	-
	M_2	49.4	52.5	69.8	63.0	46.8	-
	Mean	47.3	52.5	68.1	60.6	45.9	-
Overall Mean		**49.7**	**61.0**	**75.1**	**67.8**	**58.4**	**57.5**

3. Results and discussion

3.1. *Photosynthetically active radiation Components*

Irrespective of planting dates and mulching treatments, IPAR varied from 794 to 1401 µmol s^{-1} m^{-2} with a mean value of 1058 µmol s^{-1} m^{-2} during the crop growth season [Figs. 1(a-d)].No considerable difference in IPAR was observed on the same day among the treatment combinations. However, it varied considerably when the observation was recorded on different days, irrespective of planting dates and mulching treatments. IPAR is a function of season, time of the day and cloudiness. The reflected PAR (RPAR) varied between 47 and 116 µmol s^{-1} m^{-2} in different planting dates and mulching treatments [Figs. 2(a-d)]. Irrespective of planting dates, the RPAR increases in the later growth period of the crop in all treatments. Irrespective of mulching treatments, the highest RPAR (75 µmol s^{-1} m^{-2}) was recorded on the last planting date (P_4), which might be due to more exposure to soil surface owing to poor canopy growth under late planted conditions. Among the mulching treatments, the highest and lowest RPAR with mean values of 77 and 65 µmol s^{-1} m^{-2} were recorded under non-mulch (M_0) and black polythene (M_2) mulch treatment, respectively. The highest RPAR recorded under non-mulched conditions was attributed to poor canopy coverage, which resulted in more reflection of PAR from the soil. On the other hand, the lowest reflection of PAR under black polythene mulch was probably due to more excellent absorption of solar radiation incident on black polythene as sun flecks.

Similarly, the transmitted PAR (TPAR) varied from 68 to 642 µmol s^{-1} m^{-2} in different treatment combinations [Figs. 3(a-d)]. Irrespective of mulching treatments and dates of planting, the minimum value of TPAR was recorded on 55 DAP, which might be attributed to the maximum canopy coverage at that point of time that restricts PAR transmission through the crop foliage portion. Irrespective of mulching treatments, the highest and the lowest TPAR was recorded under P_4 and P_1, which ranged from 166 to 642 and 68 to 554 µmol s^{-1} m^{-2}, respectively. The highest and the lowest TPAR were recorded in the case of the crop planted with non-mulch (M_0) and water hyacinth (M_1), which ranged from 205 to 642 and 68 to 575 µmol s^{-1} m^{-2} with mean values of 594

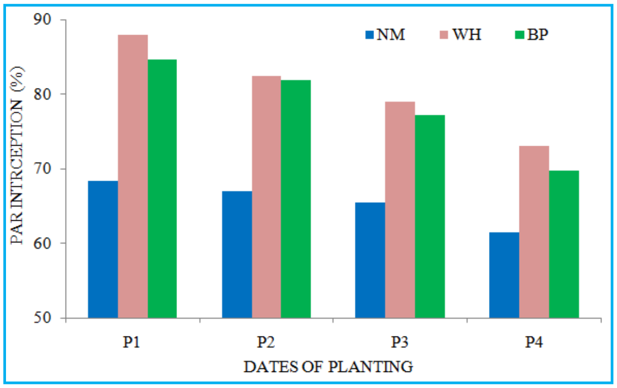


Fig. 4. Maximum PAR interception by potato canopy in different stages of the crop under different microclimatic regimes during *rabi*, 2018-19

to 296 μmol s^{-1} m^{-2}, respectively in different planting dates. Under non-mulched conditions (M_0), crop growth was less in terms of foliage development as compared to crop grown with either water hyacinth or black polythene. Comparatively, more foliage development coupled with lesser RPAR recorded under water hyacinth (M_1) as compared to other mulching treatments (M_0 and M_2) might cause reduction of TPAR in case crop grown with water hyacinth mulch (M_1).

The data pertaining to the interception of Photosynthetically Active Radiation (iPAR) of potatoes as influenced by different planting dates and mulching treatments during 2018-19 are presented in Table 1. Among the different treatments, the maximum PAR interception recorded at 55 DAP varied from 61.5 (P_4 M_0) to 81.0 (P_1 M_1) per cent, with a mean value of 75.0 per cent under different planting dates and mulching treatments (Fig. 4). Irrespective of mulching treatments, the maximum PAR interception under different planting dates was recorded under P_1 (80.0%), and decreases gradually with successive delay in planting and became a minimum of 68.1 per cent in the last planting date (P_4). Irrespective of dates of planting, maximum iPAR was recorded in the crop grown with water hyacinth (80.6%), followed by black polythene (78.4%) and non-mulch treatment (66.2%). Thus, PAR interceptions were increased from 18.7 to 28.7 and 13.5 to 24 per cent in the case of crops grown under water hyacinth (M_1) and black polythene (M_2), respectively, as compared to non-mulch treatment (M_0).

Comparatively higher PAR interception recorded on the first date of planting was probably due to a higher rate of foliar expansion with more leaves per plant, as early growth stages of the crop (up to 60 DAP) planted on 10 November was exposed to the better thermal environment with a mean air temperature of 18.4 ºC. Moreover, lesser reflection and transmission of PAR in the case of the crop planted on 10 November was attributed to higher iPAR than other planting dates. On other hand, the lowest iPAR on the last planting date (10 December) might be due to less vegetative growth of the crop. Likewise, better vegetative growth of the crop grown with water hyacinth (M_1) and black polythene (M_2) as compared to non-mulched condition (M_0) might be the basis of higher PAR interception under water hyacinth mulch (M_1) as compared to other mulching treatments. The observed results are in close agreement with the findings of Saikia *et al.* (2014), who reported that better crop growth influences PAR interception and use of mulching enhances PAR interception by 7.2 to 114.1% compared to non-mulch plots. Similar results of increasing PAR interception in the mulched crop as compared to non-mulched crop were also reported by Apotikar *et al.* (2012) and Dhaliwal *et al.*, (2019) from their field experiments.

3.2. *Crop growth and tuber yield of potato*

The maximum LAI, total biomass and tuber yield of potato cultivar *Kufri Jyoti* during *rabi*, 2018-19, along with accumulated iPAR in respective crop duration under different treatment combinations are presented in Table 2. The maximum LAI recorded under different dates of planting and different mulching treatments ranged from 1.75 to 3.31. Irrespective of mulching treatments, the maximum LAI under different planting dates were recorded under P_1 (2.86) and it decreased gradually with successive delays in planting. Among mulching treatments, maximum LAI was recorded in the crop grown under water hyacinth (2.77), followed by black polythene (2.44) and non-mulch treatment (2.14). Relatively higher leaf area index recorded in first date of planting might be due to higher PAR interception resulting from the maximum accumulation of incident PAR (557.5 MJ m^{-2}) in the crop planted on 10 November as compared to other planting dates. With the successive delay in planting, the crop was exposed to decreasing accumulated IPAR, resulting from lesser PAR interception that affected vegetative growth of the crop and resulted in lower LAI. Comparatively higher LAI under water hyacinth as compared to black polythene and non-mulched condition was attributed to the ability of water hyacinth mulch to retain more soil moisture. Moreover, higher PAR (80.6%) interception and higher accumulation of incident PAR (490.9 MJ m^{-2}) resulted higher LAI under the crop grown with water hyacinth than other mulching treatments.

The maximum biomass was recorded under water hyacinth (453.68 g m^{-2}), followed by black polythene (372.2 g m^{-2}) and non-mulched treatment (292.03 g m^{-2}),

TABLE 2

Radiation components (IPAR, iPAR and RUE) and yield and yield attributes (maximum LAI, total biomass and tuber yield) of *Kufri Jyoti* during *rabi*, 2018-19

Date of planting	Mulching treatments	LAI	Yield (g m^{-2})		Accumulated incident PAR (MJ m^{-2})	Intercepted PAR (%)		RUE (g MJ^{-1})	
			Total dry matter	Tuber yield		Average	Maximum	Total dry matter	Tuber yield
P_1	M_0	550.0	379.3	1031.0	550.0	68.3	59.1	0.69	1.87
	M_1	561.6	565.0	1673.8	561.6	88.0	71.4	1.01	2.98
	M_2	561.1	451.2	1373.8	561.1	84.7	68.7	0.80	2.45
	Mean	**557.5**	**465.2**	**1359.5**	**557.5**	**80.3**	**66.4**	**0.83**	**2.44**
P_2	M_0	508.9	337.8	928.6	508.9	69.4	58.5	0.66	1.82
	M_1	521.2	535.1	1392.9	521.2	82.4	67.8	1.03	2.67
	M_2	516.8	422.0	1228.6	516.8	81.9	66.1	0.82	2.38
Mean		**515.6**	**431.6**	**1183.4**	**515.6**	**77.9**	**64.1**	**0.84**	**2.29**
P_3	M_0	440.4	246.7	800.0	440.4	65.5	55.5	0.56	1.82
	M_1	450.5	372.3	914.3	450.5	79.0	65.7	0.83	2.03
	M_2	445.3	309.7	876.2	445.3	77.2	62.2	0.70	1.97
Mean		**445.4**	**309.6**	**863.5**	**445.4**	**73.9**	**61.1**	**0.70**	**1.94**
P_4	M_0	418.5	204.3	485.75	418.5	61.5	49.3	0.49	1.16
	M_1	428.3	342.3	742.9	428.3	73.0	59.0	0.80	1.73
	M_2	424.5	307.9	571.4	424.5	69.8	56.3	0.73	1.35
Mean		**423.8**	**284.8**	**600.0**	**423.8**	**68.1**	**54.9**	**0.67**	**1.42**
Overall mean		485.6	372.8	1001.6	485.6	75.1	61.6	0.8	2.0
SD		55.5	100.1	339.1	55.5	8.3	6.5	0.14	0.49
CV (%)		11.5	26.8	33.9	11.5	11.1	10.5	18.6	24.5

irrespective of planting dates. The biomass production at maturity was the highest on the first planting date (465.2 g m^{-2}), and it decreased gradually on subsequent planting dates (Table 2). The decrease in biomass production with delay in planting was probably due to lesser interception of PAR in case of crop planted on later dates (P_2 to P_4).

The tuber yield (g m^{-2}) in all planting dates and mulching treatments varied from 485.75 to 1673.8 g m^{-2} with an overall mean of 1001.6 g m^{-2} (Table 2). Significant reduction of tuber yield in the case of late-planted crops (P_2, P_3 and P_4) as compared to the first date of planting (P_1) was probably due to lower LAI, biomass production and lower interception of PAR. Significant increase in yield under water hyacinth (42.2%) and black polythene (21.6%) as compared to non-mulched treatment might be due to an increase in LAI, biomass production and higher PAR interception as compared other mulching treatments.

3.3. *Radiation Use Efficiency*

Radiation use efficiency (RUE) for total biomass production and tuber yield, as influenced by the dates of planting and mulching treatments, varied from 0.49 to 1.03 g MJ^{-1} and 1.16 to 2.98 g MJ^{-1} with mean values of 0.76 and 2.02 g MJ^{-1} and coefficient of variation 18.6% and 24.5% for total biomass production and tuber yield, respectively (Table 2). Irrespective of mulching treatments, the maximum RUE both for biomass production and tuber yield were observed in two early plantings (P_1 and P_2); however, decreased gradually from 0.84 to 0.67 g MJ^{-1} and 2.29 to 1.42 g MJ^{-1} in case of biomass production and tuber yield, respectively as planting was delayed beyond 20 November. On the other hand, irrespective of planting dates, RUE for total biomass production as well as tuber yield was observed to be highest when grown with water hyacinth (0.91 and 2.35 g MJ^{-1}) followed by black polythene (0.76 and 2.03 g MJ^{-1}) and non-mulched condition (0.60 and 1.67 g MJ^{-1}). The

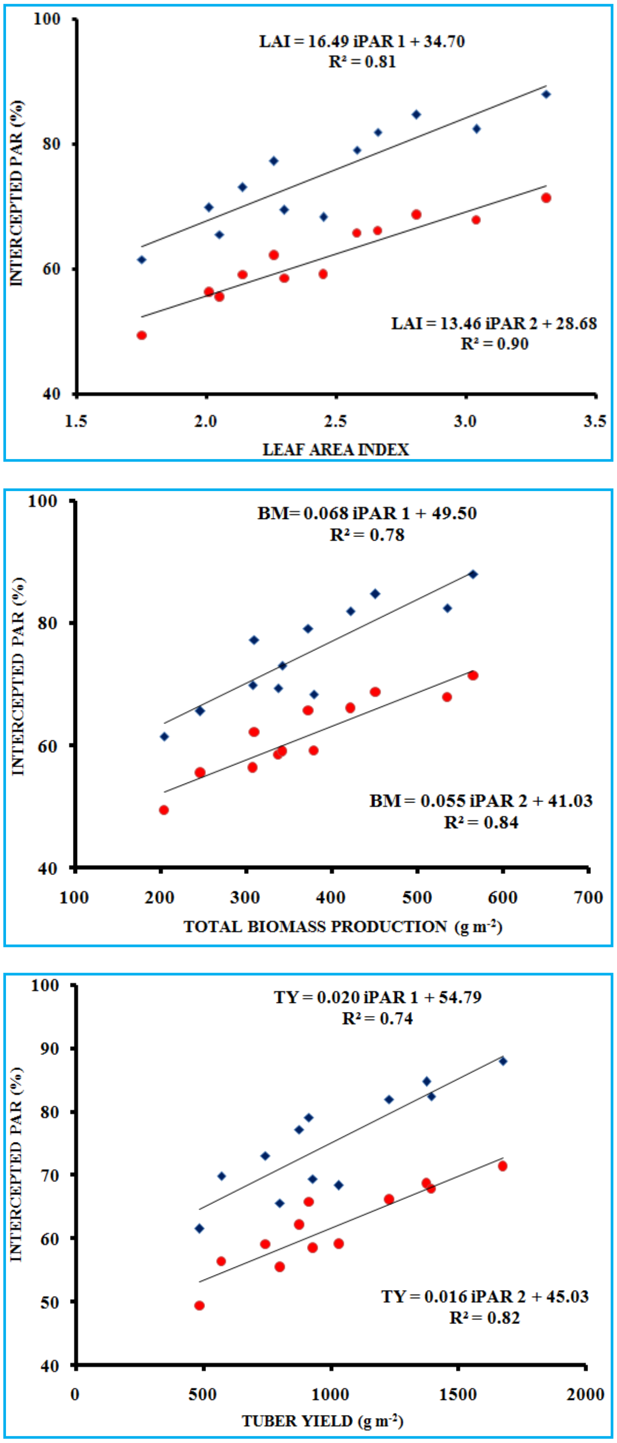


Fig. 5. Relationship of intercepted PAR (%) with leaf area index, biomass production and tuber yield of potato variety *kufrij yoti* during rabi, 2018-19

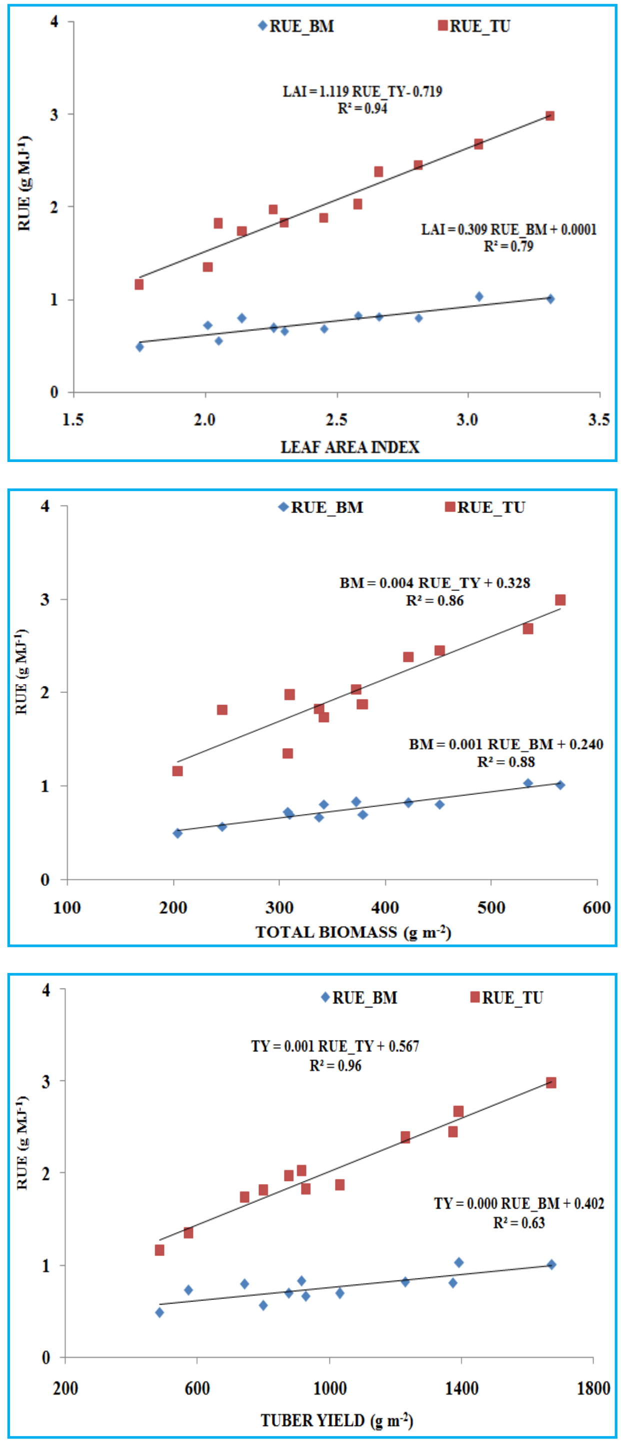


Fig. 6. Relationship of Radiation Use Efficiency (RUE) with leaf area index, biomass production and tuber yield of potato during *rabi*, 2018-19

higher value of RUE in the 10^{th} November planting was attributed to maximum accumulation and interception of PAR, higher LAI, biomass production and biomass partitioning towards tuber and finally, higher tuber yield compared to later planting dates (20 November, 30 November and 10 December).

TABLE 3

Association of maximum LAI, total biomass and tuber yield of *Kufri Jyoti* with maximum and average iPAR and RUE

Variables	PAR interception (%)		RUE(g MJ^{-1})	
	Maximum	Average	Biomass	Tuber yield
Biomass production (g m^{-2})	0.88**	0.91**	0.94**	0.93**
Tuber yield (g m^{-2})	0.86**	0.91**	0.79**	0.98**
LAI	0.89**	0.94**	0.86**	0.97**

*Significant at 5% level & ** Significant at 1% level

3.4. *Relationship of iPAR and RUE with crop growth and tuber yield*

The regression relationships of interception of PAR (%) with maximum leaf area index, total biomass production and tuber yield of potato were developed and presented in Fig. 5. The regression relationships of PAR with crop growth parameters and tuber yield was positive and linear. The coefficient of determination (R^2) explained 81, 78 and 74 per cent variation in leaf area index, biomass production and tuber yield with the maximum iPAR, respectively. Like intercepted PAR, A linear, positive and significant relationships between crop growth parameters and tuber yield, and radiation use efficiency (RUE) computed for biomass production and tuber yield were also observed in potato crops planted under different dates and mulching treatments (Fig. 6). The results of present study conform with earlier findings of Khurana and McLaren (1982), Kumar *et al*., (2008) and Kaur and Gill (2014).

The maximum LAI, biomass and tuber yield were positively and significantly correlated with maximum iPAR, average iPAR, RUE for total biomass and RUE for tuber yield (Table 3). The best-fitted predictive models were developed using the stepwise regression method for predicting crop growth parameters and tuber yield from the radiation parameters listed below.

Parameters	*Model equations*	R^2	*F*
Maximum LAI	LAI = 0.811 + 0.816 * RUE_TY	0.94**	158.94
Total biomass (g m^{-2})	Total biomass = -99.47 + 366.95 * RUE_BM + 95.78 * RUE_TY	0.94**	76.93
Tuber yield (g m^{-2})	Tuber yield = - 331.26 + 660.10 * RUE_TY	0.96**	219.23

The model equations explained the relationships with a high determining factor (R^2) of 0.94 and 0.96 for maximum LAI, total biomass production, and tuber yield, respectively.

4. Conclusion

Increase iPAR in *Kufri Jyoti* grown with water hyacinth mulch endowed with a favourable crop growth environment, reflected in increased LAI, biomass production and tuber yield. The yield of potato variety was increased by 35.8 and 25.1 per cent under water hyacinth and black polythene mulch, respectively when compared with non-mulched conditions. It was found that the conversion efficiency of incident PAR to dry matter production and tuber yield in all planting dates was the maximum when grown with water hyacinth, followed by black polythene and non-mulched condition.

Authors' contribution

The research concept was developed by P. Neog; and under his guidance R. J. Saikia performed the field trial during his Master degree programme. R. J. Saikia, P. Neog and R. L. Deka collectively drafted the research manuscript based on the data generated from one year of field experiment and K. Medhi actively involved in designing the final version of the said manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

Disclaimer: The contents and views expressed in this study are the views of the authors and do not necessarily reflect the views of the organizations they belong to.

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