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Impact of planting dates on incident and absorbed photosynthetically active radiation of potato crop under different irrigation frequencies

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Abstract
A farm level experiment was carried out with two (i.e. *Jyoti* and *Ashoka*) different potato cultivars (i.e. *Ashoka* and *Jyoti*) at "C" block farm of the Bidhan Chandra Krishi Viswavidyalaya during November-March (2009-2010) to assess the incident (IPAR) and absorbed (APAR) photosynthetically active radiation of potato under three different irrigation levels (I_1, I_2 and I_3) with 3 cm irrigation depth. The experiment was conducted under two planting dates (D_1: 20/11/2009 and D_2: 29/11/2009) during the above period. The plot size was 4.5 m × 3.7 m. The soil was sandy-loam with medium land situation. In a particular day, readings were taken four times with two hours interval (9:00, 11:00, 13:00 and 15:00 h). Throughout the period, it was observed that the maximum IPAR and APAR values were at 11:00 h irrespective of the irrigation frequency, planting date and variety of potato.

Keywords: Active radiation, planting date, potato

Introduction
Agriculture is the major water utilization sector. Hence, the efficient utilization of water is utmost important to conserve it for future. For sustainable agricultural production, more judicious water use is needed, particularly in dry season (Onder *et al*., 2005) [8]. During dry season, irrigation water availability is not uniform throughout the world. Per capita per year surface water availability which was 1902 m^3 in 2001 will be declined to 1492 and 1345 m^3 by the year 2025 and 2050 respectively. Shortage of this fresh water resource makes irrigated agriculture in an alarming situation during dry season (Sharma and Dixit, 1992) [9]. Agricultural scientists should come forward to meet the challenge and plan to progress the irrigation potential (Abdelghany, 2009; Nasare *et al*., 2009) [1, 7]. It is also essential to develop new technique particularly those designed to meet the needs of the water and as such, a significant amount of water could be saved.
The food production target of India will be 457 million tonnes by the year 2050 to feed 1413 million populations. After wheat, rice and corn, potato is most valuable agricultural product from production point of view (Fabeiro *et al*., 2001) [3]. The potato is sensitive to water scarcity (Shock *et al*., 1998) [10]. According to Harris (1978) [5], the minimum soil moisture content at the root zone depth should be 50% of maximum available water for better productivity. A little water stress may cause a decrease in interception of canopy radiation and photosynthesis (van Loon, 1981; Hassanpanah, 2010) [11, 6]. The systemic utilization and timing of irrigation have the capability to improve photosynthesis as well as potato productivity (Foti, 1999) [4]. But, the efficient utilization of water saving irrigation needs a precise scientific knowledge of potato response to drought stress because drought tolerance level changes with phonological stage as well as genotype (Unlu *et al*., 2006) [12]. Keeping these in view, the present investigation on potato under furrow systems of irrigation, 3 irrigation levels were planned to work out incident and absorbed photo synthetically active radiation of two potato cultivars under two different planting dates.

2. Materials and Methods
The experiment was carried out at "C" block farm (lat - 22.5^0 N, long - 89^0 E and altitude 9.75 m above msl) at Kalyani during November-March, 2009-10. The soil of the study site is sandy-loam with medium land situation.

2.1 Experimental design and treatments
The treatments were distributed in a split plot design, where the date of planting was

considered as the main plot treatment, the irrigation levels as sub plot treatment and varieties as sub-sub plot (Biswas and Roy, 2020) [2].

The treatment combinations were as follows
Main plot treatment (Dates of planting; D)
D_1 – 20th November
D_2 – 29th November

Sub plot treatment (Irrigation level; I)
IW/CPE
$I_1 = 1.40$
$I_2 = 1.20$
$I_3 = 1.00$

Total plot size was 4.5 m × 3.7 m. In a particular plot, the spacing is 45 cm × 15 cm.

Sub-sub plot treatment (Potato variety; V)
V_1 – *Ashoka*
V_2 – *Jyoti*

2.2 Methods and Observation
2.2.1 Net radiation
It is the differences between upward and downward radiation fluxes. It is the measure of energy available at the ground surface. With the help of net Pyrradiometer (Pyrradiometer Sl. No. 090001), net radiation above the potato crop canopy was measured.

The equations are as follows
RN = RSWBAL + RLWBAL
RSWBAL = RSW ↓ - RSW ↑
RLWBAL = RLW ↓ - RLW ↑

Where
RN = Net radiation; RSWBAL = Short wave radiation balance; RLWBAL = Long wave radiation balance; RSW ↓ = Incoming short wave radiation; RSW ↑ = Outgoing short wave radiation; RLW ↓ = Incoming long wave radiation; RLW ↑ = Outgoing long wave radiation

2.2.2 Absorbed photosynthetic active radiation (APAR):
It is measured by the following formula:

APAR = (PARO + RPA RS) – (TPAR + RPARC)

Where
PARO = the portion of the incident PAR; RPA RS & RPARC = Reflected portion from soil & crop respectively; TPAR = Transmitted portion of the incident PAR through the canopy to the soil surface.

2.2.3 Photosynthetic active radiation (PAR):
It was measured by Quantum sensors in terms of photosynthetic photon flux density. The output of the instrument was given in μ E m $^{-2}$ s $^{-1}$ which was then converted to the unit w m^{-2} by a conversion factor of 4.5 μ E m $^{-2}$s $^{-1}$ per w m^{-2}.

2.2.4 Intercepted photosynthetically active radiation (IPAR):
It is measured by the following formula:

IPAR = PARO – TPAR

Where
PARO = the portion of the incident PAR
TPAR = Transmitted portion of the incident PAR through the canopy to the soil surface

3 Results and Discussion
3.1 Incident photosynthetically active radiation (IPAR) of potato crop: Irrespective of dates of planting, irrigation level and variety of crops, incident photosynthetically active radiation (IPAR) was increased from 9:00 h to 11:00 h when it reached at the highest value and then decreased from 11:00 h to 15:00 h in a particular day. On 14th January, the IPAR value was decreased linearly at increasing rate. On 28th January and 11th February, the value was decreased at decreasing rate at first and then it was decreased at increasing rate. Among those three days, the highest 11:00 h value took place on 28th January followed by 11th February and 14th January.

3.2 Absorbed photosynthetically active radiation (APAR) of potato crop: The APAR is the balance of the difference between the incident and crop reflected portion of PAR and the difference between the transmitted portion of the IPAR through the canopy to the soil surface and the reflected portion of PAR from soil. The different PAR values were measured by Quantum sensors in terms of photosynthetic photon flux density. The APAR values for various treatments were tabulated below:

Table 1: Diurnal variation of absorbed PAR (APAR μ E m^{-2} s^{-1}) on 14/01/2010

APAR	Time of observations			
Treatment	9:00 h	11:00 h	13:00 h	15:00 h
D_1	499.30	778.50	601.80	423.20
D_2	543.50	750.40	624.10	454.90
I_1	537.20	759.80	624.10	439.10
I_2	505.60	722.30	594.40	444.40
I_3	524.60	806.70	616.70	439.10
V_1	530.90	750.40	616.70	433.80
V_2	505.60	778.50	609.30	444.40

Irrespective of planting dates, irrigation level and crop variety, the APAR was increased from 9:00 h to 11:00 h and then decreased from 11:00 h to 15:00 h. In different types of treatment, it reached at the highest value at 11:00 h. Among the planting dates, on an average D_2 absorbed (593.23 μ E m^{-2} S^{-1}) the highest photosynthetic radiation which was 3% higher than D_1. Among the irrigation level, I_3 absorbed the highest level of PAR (596.78 μ E m^{-2} S^{-1}) which was 1.13% higher than I_1 and 5.3% higher than I_2. Therefore, the lowest irrigation level absorbed the higher PAR. Among two varieties, the highest APAR value (584.45 μ E m^{-2} S^{-1}) was noted under *Jyoti* which was 0.26% higher than the *Ashoka* (Table 1).

Table 2: Diurnal variation of absorbed PAR (APAR μ E m^{-2} s^{-1}) on 28/01/2010

APAR	Time of observations			
Treatment	9:00 h	11:00 h	13:00 h	15:00 h
D_1	296	986.33	954.67	517
D_2	394	956.33	968	540.50
I_1	318	983	965.50	541.75
I_2	285	958	945.50	518.50
I_3	432	973	973	526
V_1	284	966.33	951.33	525
V_2	406	976.33	971.33	532.50

Irrespective of planting dates, irrigation level and crop variety, the APAR was increased from 9:00 h to 11:00 h and then decreased from 11:00 h to 15:00 h. In different types of treatment, it reached at the highest value at 11:00 h. Among the planting dates, on an average D_2 absorbed the highest photosynthetic radiation which was 3.80% higher than D_1. Among the irrigation level, I_3 absorbed the highest level of PAR which was 3.4% higher than I_1 and 7.3% higher than I_2. Therefore, the lowest irrigation level absorbed the higher PAR. Among two varieties, the highest APAR value was noted under *Jyoti* which was 5.90% higher than the *Ashoka* (Table 2).

Table 3: Diurnal variation of absorbed PAR (APAR μ E m^{-2} s^{-1}) on 11/02/2010

APAR	Time of observations			
Treatment	**9:00 h**	**11:00 h**	**13:00 h**	**15:00 h**
D_1	566.33	818.50	759.67	486.50
D_2	631.33	888.50	774.67	494.50
I_1	578.00	869.00	758.00	493.50
I_2	605.50	808.25	798.00	493.50
I_3	613.00	883.25	745.50	484.50
V_1	593.00	866.50	763.00	489.50
V_2	604.67	840.50	771.33	491.50

Irrespective of planting dates, irrigation level and crop variety, the APAR was increased from 9:00 h to 11:00 h and then decreased from 11:00 h to 15:00 h. In different types of treatment, it reached at the highest value at 11:00 h. Among the planting dates, on an average D_2 absorbed the highest photosynthetic radiation which was 6% higher than D_1. Among the irrigation level, I_3 absorbed the highest level of PAR which was 1% higher than I_1 and 0.77% higher than I_2. Therefore, the lowest irrigation level absorbed the higher PAR. Among two varieties, the highest APAR value was noted under *Ashoka* which was 0.15% higher than the *Jyoti* (Table 3).

4. Conclusions

The cultivar selection of a crop should be such that minimum water can make maximum production, making the slogan 'more crop per drop' successful. The annual demand of potato in West Bengal is quite high. The potato is sensitive to water scarcity. A little water stress may cause a decrease in interception of canopy radiation and photosynthesis. Keeping these things in mind, the study concentrated on the assessment of incident and absorbed photo synthetically active radiation of two potato cultivars with three different irrigation frequencies under two different planting dates. The study concluded that the maximum IPAR and APAR values were at 11:00 h irrespective of the irrigation frequency, planting date and variety of potato. However, this result may vary from one region to another. Therefore, more research on this issue should be throughout the world.

References

1. Abdelghany A. Study the performance of pulse drip irrigation in organic agriculture for potato crop in sandy soils (Doctoral dissertation, Ph.D., Thesis faculty of agriculture Cairo University Egypt), 2009.
2. Biswas A, Roy S. Effect of Irrigation Frequencies and Date of Planting on Water Productivity of Two Potato Cultivars. International Journal of Current Microbiology and Applied Sciences. 2020; 9(9):978-983.
3. Fabeiro C, Martin de Santa Olalla F, De Juan JA. Yield and size of deficit irrigated potatoes. Agricultural Water Management. 2001; 48:255-266.
4. Foti S. Early potatoes in Italy with particular reference to Sicily. Potato Research. 1999; 42:229-240.
5. Harris PM. Water. P.M. Harris (Ed.), The Potato Crop, Chapman & Hall, London, 1978, 244-277.
6. Hassanpanah D. Evaluation of potato cultivars for resistance against water deficit stress under in vivo conditions. Potato Research. 2010; 53:383-392.
7. Nasare MD, Dhonde MB, Gaikwad CB. Response of sweet potato to pressurized irrigation under varying irrigation regimes and planting methods. Journal of Maharashtra Agricultural Universities. 2009; 34(1):109-111.
8. Onder S, Caliskan ME, Onder D, Caliskan S. Different irrigation methods and water stress effects on potato yield and yield components. Agricultural Water Management. 2005; 73:73-86
9. Sharma SK, Dixit RS. Effect of irrigation and planting techniques on tuber yield of potato (Solanum-Tuberosum). Indian Journal of Agronomy. 1992; 37(4):763-768.
10. Shock CC, Feibert EBG, Saunders LD. Potato yield and quality response to deficit irrigation. Horticulture Science. 1998; 33:655-659.
11. Van Loon CD. The effect of water stress on potato growth, development and yield. American Potato Journal. 1981; 58:51-69.
12. Unlu M, Kanber R, Senyigit U, Onaran H, Diker K. Trickle and sprinkler irrigation of potato (*Solanum tuberosum* L.) in the middle Anatolian region in Turkey. Agricultural Water Management. 2006; 79:43-71.