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Radiation use efficiency and growth performance of Pigeonpea (*Cajanus cajan* L.) under rainfed condition

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Abstract
A research experiment was conducted in *Kharif*2024-25 at Research farm AICRP Agrometeorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to study radiation use efficiency on pigeon pe with respect to different dates of sowing and varieties during *Kharif* season. The field experiment was laid out in a split plot design with three replications. There were 36 treatment combinations comprising of four sowing dates *viz*., D1(25^{th}SMW), D2(26^{th}SMW), D3(27^{th}SMW) and D4(28^{th}SMW) as main plot treatments and three varieties *viz*., V1(BDN-711), V2(BDN-716) and V3(GODAVARI) as sub plot treatments. It was found that D1(25^{th}SMW) gave significant results in photosynthetically active radiation (PAR), radiation use efficiency (RUE), yield and yield components which were due to efficient GDD than other dates of sowing. Similarly, variety V2(BDN-716) performed significantly better than V1(BDN-711) and V3(GODAVAR in yield and radiation use efficiency.

Keywords: Photosynthetically Active Radiation (PAR), Radiation Use Efficiency (RUE), Pigeon pea varieties, dates of sowing.

Introduction
The pigeon pea (*Cajanus cajan* L.) is a perennial legume from thefamily Fabaceae. It is the second most important and very old pulse crop in India after chickpea. It is commonly knownasredgram/arhar/turinourcountry.Itiswelladaptedtothetropicalandsub- tropical regions of the world having arid and semi-arid climate (Rao *et al.* 2003) [6]. Agriculture plays a vital role in India's economy. The total Indian pulses production is 27.3 millionmetric tons. The average annual consumption of pulses in India is estimated to be 22 million metric tons. 4.80 million hectare area covered by pigeon pea in 2021-22 with an annual production of 4.28 million tonnes of grain with a productivity of 892 kg ha-1 Whereas, under Maharashtra, 1.24 million ha area, 1.28 million tonnes, and 1035 kg ha^{-1} were recorded; and under the Marathwada region, 3.86 lakh ha area, 3.10 lakh tonnes, and 1283 kg ha^{-1}. Maharashtra is the largest producer of pigeon pea, accounting for over 30% of the total production in the country, followed by Karnataka (17.00%), Madhya Pradesh (13.00%), and Andhra Pradesh (8.00%).

Photosynthetically active radiation and microclimate both played a vital role in determining the growth, development and yield of pigeon pea crop. The differences in biomass and seed yield among sowing dates were largely due to totals of PAR absorbed and dry matter produced, especially in the reproductive phase. The high LAI persistence and PAR interception, appeared to be mainly responsible for the increased yield in early sowing (Patel *et al.* 2000) [4]. Photosynthetic active radiation is a very small portion of the solar electromagnetic spectrum, wavelength ranging from 0.36 to 0.7µ, which actively participates in the process of photosynthesis, PAR incident at the crop canopy and that transmitted by the crop canopy were measured with the suns can canopy analyzing system (Kumar *et al*. 2008) [1].

Radiation use efficiency (RUE), also known as light use efficiency (LUE), is defined as the plant's ability to convert photosynthetically active radiation (PAR) into biomass on a per unit basis. This measurement of photosynthetic performance is important for crop growth modeling. RUE varies between species and even among cultivars, but generally, cultivar dependent RUE values are unavailable (Phillips *et al*. 2020) [5].

The radiation-use efficiency provides an estimate of the potential productivity of field grown crops. However, for many field situations the mean seasonal or base line radiation use efficiency seems inappropriate for modeling crop growth or assessing crops performance because of the effect of environmental factors which cause the radiation use efficiency for a particular crop varies during growth and aerial environments (Patel *et al.*1999) [3]. For pigeon pea, radiation use efficiency varies with phenology, moisture status, as well as the sowing dates to which the crop is exposed to different environments. Plant density may also influence the radiation use efficiency

Materials and Methods

A research experiment was conducted in *Kharif*2024-25 at Research farm AICRP Agrometeorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani to study radiation use efficiency on pigeon pe with respect to different dates of sowing and varieties during *Kharif* season. The field experiment was laid out in a split plot design with three replications. There were 36 treatment combinations comprising of four sowing dates *viz*., D1(25thSMW), D2(26thSMW), D3(27thSMW) and D4(28thSMW) as main plot treatments and three varieties *viz*., V1(BDN-711), V2(BDN-716) and V3(GODAVARI) as sub plot treatments. The gross and net plot sizes were 5.4 m x 5.0 m and 5.4 m x 4.2 m, respectively. A spacing of 90 cm x 20 cm was adopted by using 12 to 15 kg seed ha-1. A recommended dose of fertilizer (30:60:30 kg N, P, K ha-1) was applied uniformly to all the treatments. The data The number of days to attain various phenological stages was determined visually through the selection of five plants in all the plots, from emergence to maturity.

To calculate the Radiation Use Efficiency (Rani *et al*., 2012), the following formula was used:

$$\text{RUE (kgha}^{-1}\text{Mj}^{-1}) = \frac{\text{Biomassor Yield}}{\text{Radiation}}$$

The photosynthetically active radiations were recorded with the help of a line quantum sensor.

Table 1: Photosynthetic active radiation use efficiency (RUE) of different treatments of pigeon pea in the *Kharif* season 2024-25

Treatments	Yield (kgha^{-1})	Intercepted PAR (μ mol m^{-2}s^{-1})	Radiation use efficiency (RUE)(kg ha^{-1}Mj^{-1})
Dates of sowing			
D1(25thSMW)	8141.6	1807	4.50
D2(26thSMW)	7798.2	1773	4.40
D3(27thSMW)	7141.1	1713	4.17
D4(28thSMW)	2469.2	1688	1.46
Varieties			
V1(BDN-711)	6893.9	1743	3.96
V2(BDN-716)	7433.2	1794	4.14
V3(GODAVARI	6687.3	1701	3.93

Results and Discussion

The data presented in table 1 represents that the Radiation use efficiency significantly Influenced on different treatments on pigeon pea. The results found that the highest Radiation use efficiency (RUE) was found D1(25thSMW) (4.50 kg ha^{-1}Mj^{-1}) as compared to other dates of sowing; D2(26thSMW) (4.40 kg ha^{-1}Mj^{-1}), D3 (27thSMW) (4.17 kg ha^{-1}Mj^{-1}), D4(28thSMW) (1.46 kgha-1Mj-1) was almost similar with each other. The lowest RUE was seen in D4(28thSMW) (1.46 kg ha^{-1}Mj^{-1}) It was found that D1(25thSMW) (4.56 kg ha^{-1}Mj^{-1}) gave significant results in photosynthetically active radiation interception (PARi), canopy temperature, yield and yield components. The trend radiation was due to more spacing adjustment were available to plants to flourish themselves without any kind of hard competition for available resources. Similar results given by Kaur *et al*. (2020) [2].

Similarly, the highest Radiation use efficiency (RUE) was found in V2(BDN-716) (4.14 kg ha$^{-1.}$ Mj^{-1}) overall other varieties; V1(BDN-711) (3.96 kg ha^{-1}Mj^{-1}), V3(GODAVARI) (3.93 kg ha-1Mj-1) was almost similar with each other. The lowest RUE was seen in V3(GODAVARI) (3.93 kg ha^{-1}Mj^{-1}). It was found that V2 (BDN-716) (4.28 kg ha^{-1}Mj^{-1}) gave significant results in photosynthetically active radiation interception (PARi), canopy temperature, yield and yield components. Similar results given by Kaur *et al*. (2020) [2].

Conclusion

The findings revealed that the highest Radiation use efficiency (RUE) was observed in the D1(25thSMW) recording 4.50 kg ha^{-1}Mj^{-1}, whereas the lowest value of 1.46 kg ha^{-1}Mj^{-1}was noted in the D4 (28thSMW). Among the pigeon pea varieties, V2 (BDN-716) exhibited the greatest efficiency (4.14 kg ha^{-1}Mj^{-1}), while V3 (GODAVARI) showed the lowest (3.93 kg ha-1Mj^{-1}). These results highlight the significant effect of both sowing time and varietal selection on RUE performance.

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