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Effect of row orientation under different environment on yield and RAU of pea cultivars in mid hills of Himachal Himalayas

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ABSTRACT

A field experiment was conducted during the *Rabi* seasons of 2017-18 and 2018-19 in the experimental farm of the Department of Environmental Science, Dr. YS Parmar University of Horticulture & Forestry Nauni (30°86'N, 77°16'E and 1275 m amsl) to assess the effect of row orientation on crop biometric parameters for different phenophases of three pea cultivars under different crop growing environments. Date of sowing played a very important role in determining the arrival of different phenological stages as well as crop biometric and yield parameters of Pea cultivars. Crop yield and yield attributes were observed better in NS orientation. The LAI and RAU were also higher under NS orientation for all the three cultivars. The RUE was observed highest in PB-89 followed by ESP-111 and Azad-P1. The RUE was higher in north-south direction sown crop as compare to east west direction sown crop. A strong direct

linear relationship was observed between LAI and IPAR & RUE in all the treatments. It was recommended that PB-89 may be sown in NS direction on or before 1st December in mid hills of Himachal Himalayas.

Keywords: pea cultivars, Crop yield, phenophases

1. INTRODUCTION

Every crop has its own definite requirements for particular environmental conditions for its proper growth and yield (Razzaq *et al*., 1986). Bishnoi *et al*. (1991) reported maximum grain yield in NS sown wheat crop of dry matter accumulation for plant growth, development and yield. Radiation use efficiency (RUE) indicates the amount of biomass accumulated per unit intercepted solar radiation (Sinclair *et al*., 1989) which varies under different environmental conditions. Direction wise, orientation in the north-south yielded more than in east-west Naresh (2005). To study the effect of row orientation on the crop biometric and yield parameter in pea the present experiment was planned.

2. MATERIAL AND METHODS

A field experiment was conducted during the *Rabi* seasons of 2017-18 and 2018-19 in the experimental farm of the Department of Environmental Science, Dr. YS Parmar University of Horticulture & Forestry Nauni (30°86'N, 77°16'E and 1275 m amsl) to assess the effect of row orientation on crop biometric parameters for different phenophases of three pea cultivars under different crop growing environments. The treatments comprised of two dates of sowing viz. D_1 (1st December) and D_2 (15th December) and three pea varieties (Azad-P1, PB-89 and ESP-111) under two row orientations O_1 (NS) and O_2 (EW) were replicated thrice in a randomized block design. The sowing was done manually in rows at 45 x 20 cm spacing with 4-6 cm depth @ two seeds per hill in two row orientation North-South and East-West.

Data recorded

The crop was monitored at alternative day and five phenological stages viz. Emergence, First node, Flowering, Pod formation and Maturity & days taken to complete them were recorded. The biomass accumulation, yield and yield attributes were also recorded at each phenophases and maturity.

$$\textit{Leaf area index} = \frac{\text{Total green leaf area of plant } (\text{cm}^2)}{\text{Ground area covered by the plant } (\text{cm}^2)}$$

Photosynthetically active radiation

IPAR = (I – e-KF) PAR

Where,

PAR = Incoming photo-synthetically active radiation

K = Crop coefficient

Radiation use efficiency (RUE)

$$\text{RUE} = \frac{\text{Crop dry matter } (\text{g}/m^2)}{\text{Cumulate IPAR } (\text{MJ}/\text{m}^2)}$$

3. RESULTS AND DISCUSSION

Leaf area Index

The higher leaf area index was observed in NS orientation compared to EW in all the three cultivars under both the dates of sowing for all the phenophases (Table 1). Among the varieties V_2 (PB-89) produced higher LAI followed by V_1 and V_3 under all the treatments and phenophases. The LAI was also observed higher in first date of sowing than second date. This indicated that the pea crop must be sown on or before 1st December in NS orientation.

Table 1 LAI in pea cultivars at different phenological stages in two orientations

Treatments			First node	Flowering	Pod formation	Maturity
V_1	D_1	NS	0.26	1.27	1.63	2.19
		EW	0.26	1.25	1.62	1.98
	D_2	NS	0.24	1.22	1.57	2.00
		EW	0.21	1.20	1.52	1.93
V_2	D_1	NS	0.27	1.30	1.63	2.37
		EW	0.27	1.29	1.56	1.95
	D_2	NS	0.24	1.25	1.67	2.27
		EW	0.18	1.23	1.60	1.86
V_3	D_1	NS	0.14	1.19	1.57	1.84
		EW	0.13	1.15	1.52	1.80
	D_2	NS	0.13	1.12	1.49	1.83
		EW	0.13	1.03	1.45	1.80
$CD_{0.05}$			0.02	0.03	0.02	0.06

Dry matter

The higher dry matter accumulation was observed in NS orientation compared to EW orientation in all the three cultivars under both the dates of sowing for all the phenophases (Table 1). Among the varieties V_2 (PB-89) produced higher dry matter followed by V_1 and V_3 under all the treatments and phenophases. The dry matter accumulation was also observed higher in first date of sowing than second date. The cultivar PB-89 produced highest dry matter (14.72 g/plant^{-1}) in NS direction under first date of sowing among all the treatments (Table 2).

Table 2 Dry matter accumulation (g plant^{-1}) in pea cultivars at different phenological stages in two orientations

Treatments			First node	Flowering	Pod formation	Maturity
V_1	D_1	NS	0.60	3.75	7.93	13.76
		EW	0.59	3.64	7.78	13.67
	D_2	NS	0.54	3.78	8.32	13.25
		EW	0.53	3.69	7.90	12.88
V_2	D_1	NS	0.53	3.94	8.72	14.72
		EW	0.51	3.87	8.41	14.70
	D_2	NS	0.54	3.93	8.73	13.79
		EW	0.52	3.87	7.54	13.59
V_3	D_1	NS	0.51	3.78	7.97	13.42
		EW	0.50	3.70	7.94	13.00
	D_2	NS	0.52	3.79	7.73	12.60
		EW	0.50	3.70	7.57	12.59
$CD_{0.05}$			0.02	0.15	0.26	0.34

Photosynthetically active radiations

Intercepted PAR was observed higher in NS orientation than EW direction for all the cultivars under different environments. The growth stage from first node to flowering incepted the maximum PAR under all the treatments followed by flowering to pod formation and maturity stage but, minimum was observed from sowing to emergence followed by emergence to first node, respectively (Table 3 & fig. 1). The pea cultivars V_2 (PB-89) intercepted highest PAR followed by V_3 (ESP-111) and V_1 (Azad-P1) under NS row direction and varying environment.

Table 3 IPAR (%) in pea cultivars at different phenological stages in two row orientations

Treatments			Emergence	First node	Flowering	Pod formation	Maturity
V_1	D_1	NS	17.8	18.7	95.7	45.8	47.2
		EW	17.5	18.2	93.0	41.9	41.4
	D_2	NS	18.1	19.1	98.5	49.6	35.6
		EW	17.9	18.9	96.6	47.5	32.3
V_2	D_1	NS	17.5	19.6	95.1	46.2	47.6
		EW	17.1	18.1	94.2	44.6	44.5
	D_2	NS	16.7	16.6	94.1	47.9	41.4
		EW	16.2	16.1	92.8	47.3	40.7
V_3	D_1	NS	20.3	20.0	100.9	55.4	43.5
		EW	19.9	18.1	99.6	54.7	40.2
	D_2	NS	19.5	21.8	102.2	53.9	37.0
		EW	19.0	20.9	101.3	52.8	36.5
$CD_{0.05}$			0.02	0.04	0.02	0.06	0.04

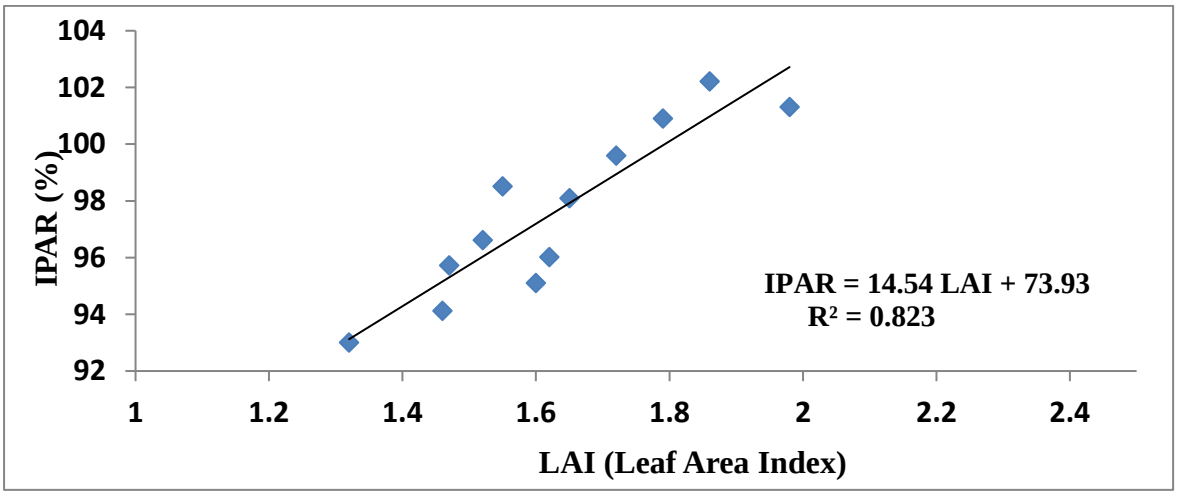

Figure 1 Relationship between IPAR and Leaf Area Index

Radiation use efficiency (RUE)

The radiation use efficiency (RUE) decreases with the delayed sowing of pea crop (Table 4). The highest radiation use efficiency was attained at pod formation and maturity stage in first date of sowing as compared to second date of sowing. Among variety V_2 (PB-89) gave highest (4.49) radiation use efficiency followed by V_1 (Azad-P1) and V_3 (ESP 111). Among the row orientation, the highest radiation use efficiency was recorded in NS direction than EW direction sown crop.

Table 4 Radiation use efficiency (g MJ^{-1}) of pea cultivars at different phenological stages in two orientations

Treatments			First node	Flowering	Pod formation	Maturity
V_1	D_1	NS	0.37	0.48	2.09	3.94
		EW	0.35	0.46	1.94	3.21
	D_2	NS	0.31	0.46	1.94	4.03
		EW	0.29	0.45	1.89	3.43
V_2	D_1	NS	0.36	0.48	2.18	4.49
		EW	0.32	0.46	2.15	3.80
	D_2	NS	0.33	0.46	2.05	3.72
		EW	0.31	0.45	1.87	3.60
V_3	D_1	NS	0.36	0.43	1.68	3.68
		EW	0.31	0.42	1.60	3.44

	D_2	NS	0.31	0.43	1.68	3.63
		EW	0.26	0.42	1.60	3.43
$CD_{0.05}$			0.01	0.02	0.03	0.05

Radiation use efficiency is depending up on the effective utilization of light during their crop growing period. Crop having higher leaf area has more light use efficiency which leads to production of more dry matter. The linear equation of positive relation (Fig 2) was obtained between RUE and leaf area index (LAI) in pea cultivars under different environment in which 70.7 per cent variation in radiation use efficiency was due to the leaf area index.

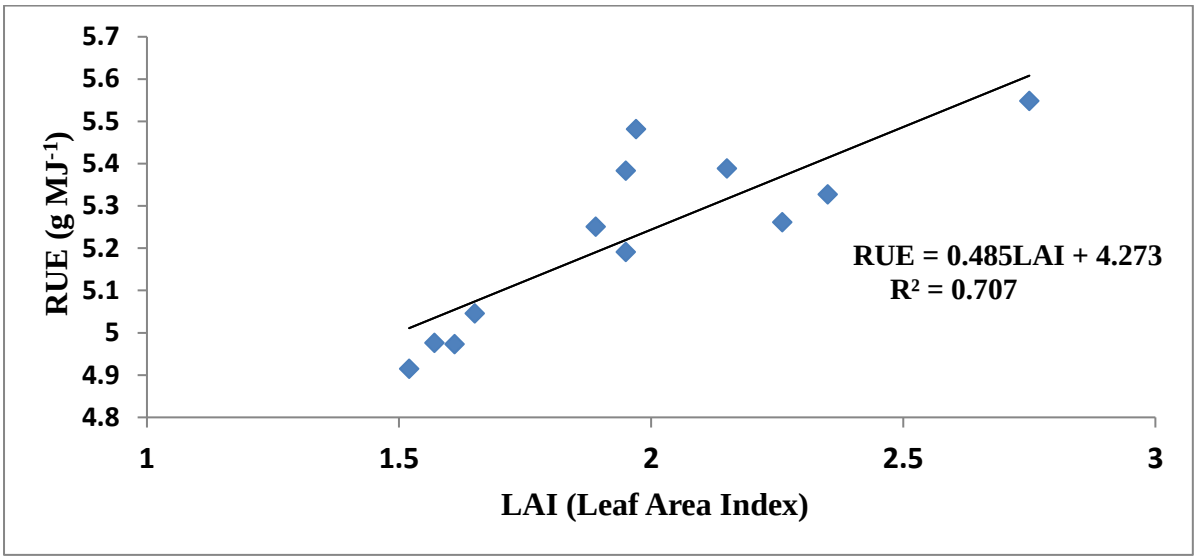

Figure 2 Relationship of RUE with leaf area index of pea cultivars under varying environment

4. CONCLUSION

Date of sowing played a very important role in determining the arrival of different phenological stages as well as crop biometric and yield parameters of Pea cultivars. Crop biometric parameters and yield was better in NS orientation. The LAI and RAU were also higher under NS orientation. The RUE was highest in PB-89 followed by ESP-111 and Azad-P1. The RUE was higher in north-south direction sown crop as compare to east west direction sown crop. A strong direct linear relationship was observed between LAI and IPAR & RUE in all the treatments. It can conclude that PB-89 may be sown in NS direction on or before 1st December in mid hills of Himachal Pradesh.

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Data and materials availability: All data associated with this study are present in the paper.

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