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Studies on yield limiting meteorological factors for production of rabi pigeon pea in West Bengal*

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ABSTRACT

Winter pigeon pea can be considered as an alternative to *boro* rice cultivation particularly in the places where over exploitation of ground water is a potential threat to sustainability. The present experiment was aimed at quantifying the meteorological factors that limit the cultivation of *rabi* pigeon pea particularly in the upland and medium land condition. The experiment was conducted for three consecutive years during 2003-06 in the University Farm at (BCKV) Kalyani W.B. The treatments comprised different dates of sowing at seven days interval between 20 September and 7 December. The influence of meteorological factors on phenological development and yield was statistically analysed. The results revealed that the length of vegetative phase was inversely correlated to the afternoon vapour pressure deficit, average BSH and diurnal variation in temperature. On the other hand, night temperature and daylength were negatively correlated with the reproductive duration. The regression analysis showed that bright sunny days with high atmospheric vapour demanded not only induced early flowering but they also had suppressed the grain yield. Higher accumulation of GDD and PTU during vegetative phase resulted in higher grain production. On the other hand, the average day temperature, night temperature and day length during reproductive phase had negative correlation with grain yield of pigeon pea. These parameters may be considered as limiting factors for higher production. Besides that, rainfall during March had severely hampered pod formation when sown late.

Key words : Grain yield, meteorology, phenophase, pigeon pea

Pigeon pea is one of the important pulse crops of India. In world scenario, India contributes 75% of global production of pigeon pea (Ali and Kumar, 2005). It has high production potentiality under dry condition. Though the production technology of pigeon pea is not new to the farmers of West Bengal, large emphasis on rice both in monsoon and post-monsoon (*boro*) season under assured irrigation system has left very little scope for pulse cultivation. However, short duration winter pigeon pea varieties can be considered as an alternative to *boro* rice cultivation particularly in the places where over exploitation of ground water is a potential threat to sustainability. The present experiment was aimed at quantifying the meteorological factors that limit the cultivation of *rabi* pigeon pea in the Gangetic alluvial zone of West Bengal.

MATERIALS AND METHODS

The experiment on pigeon pea was conducted during 2003-06 for three consecutive years at the University Farm (BCKV) at Kalyani located at 22° 57′ (N) latitude, 88°20′ (E) longitude and at an elevation of 9.75 m above mean sea level. The climate is sub-humid tropical with major part of rainfall concentrated June to September (SW Monsoon period) followed by almost dry winter. Again there is a chance of rain during end of March due to *Kalbaishakhi*. The soil was sandy loam with neutral reaction (pH 7.3) with medium fertility (0.052% total nitrogen, 22.24 and 145 kg ha^{-1} available P_2O_5 and K_2O, respectively). The treatments comprised different dates of sowing during 20 September to 7 December during the three years of study period. The dates of sowing differed from year to year to match with the occurrence of rainfall events. A general dose of NPK @ 20 : 80 : 30 kg ha^{-1} was applied to all the treatments. The crop was grown with one light irrigation at sowing for each treatment to facilitate germination and to maintain uniform initial soil moisture. The influence of meteorological factors on phenological development and yield was statistically analysed based on the combined data of three years. The day (photo-) and night (Nycto-) temperatures were computed following the method of Venkataraman (1968).

Photo-temperature = Tmax - 0.4 (Tmax – Tmin)

Nycto-temperature = Tmin + 0.4 (Tmax – Tmin)

RESULTS AND DISCUSSION

Phenophasic development

The analysis of three years' data (2003-06) revealed that *rabi* pigeon pea required an average 110 days for completion

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Table 1: Accumulated meteorological indices for expression of phenophases

Crop phenophase		Accumulated meteorological indices			Duration
		GDD	HTU	PTU	
Vegetative period	Mean	1810.6	14124.5	20244.3	109.6
	Std. Dev.	180.7	637.5	2034.2	9.6
	C.V. (%)	9.98	4.51	10.05	8.77
Reproductive period	Mean	938.67	8090.13	11202.4	42.14
	Std. Dev.	159.85	1516.18	1820.08	8.82
	C.V. (%)	17.03	18.74	16.25	20.93

GDD in ^{0}C day, HTU and PTU in °C day h, duration and day length in h.

Table 2: Relation of average meteorological parameters during vegetative and reproductive phases with grain yield

Date of sowing	Acc. GDD (Veg.)	Acc. PTU (Veg.)	Nycto temp. (Reprod.)	Day-length (Reprod.)	Vegetative duration	Reproductive duration	Yield (q ha^{-1})
2003-04							
20 Sep.	2319	26103	23.82	11.74	132	58	18.76
1 Oct.	2115	23651	24.66	11.79	126	55	13.20
13 Oct.	1894	21047	25.56	11.86	118	53	7.11
24 Oct.	1707	18909	26.01	11.91	111	49	3.80
2004-05							
17 Oct.	1908	21160	25.43	11.82	116	47	12.55
25 Oct.	1889	20941	25.45	11.88	115	40	10.11
2 Nov.	1778	19696	25.68	11.92	109	40	4.97
9 Nov.	1826	20318	26.38	12.00	111	33	4.45
16 Nov.	1876	21017	-	-	112	-	-
23 Nov.	1791	20118	-	-	107	-	-
30 Nov.	1773	20040	-	-	104	-	-
7 Dec.	1792	20441	-	-	103	-	-
2005-06							
12 Oct.	1925	21400	25.14	11.78	119	43	13.17
2 Nov.	1864	20753	26.24	11.98	115	36	8.55
9 Nov.	1809	20163	26.70	12.02	112	36	6.38
16 Nov.	1770	19816	27.24	12.09	108	33	4.72
23 Nov.	1681	18872	27.48	12.13	102	35	3.67
30 Nov.	1698	19167	27.75	12.18	101	32	1.11
Correlation with yield	0.92	0.91	-0.89	-0.86	0.90	0.70	

GDD in °C day, HTU and PTU in °C day h, temperature in ^{0}C, duration and day length in h.

of its vegetative duration (emergence to 50% flowering), whereas the reproductive phase (50% flowering to maturity) required about 42 days (Table 1). From the analysis over three years' period, it appears that accumulated HTU was consistent during vegetative period of *rabi* pigeon pea. The crop attained 50% flowering after accumulation of an average of 14456 degree day hour of HTU with very small variation (CV=4.5%). However, defining reproductive duration in terms of meteorological indices was not consistent as implied by higher coefficient variation. One important reason for such variation was that the crop was harvested at different stages of maturity to avoid the rain events that would have damaged the matured

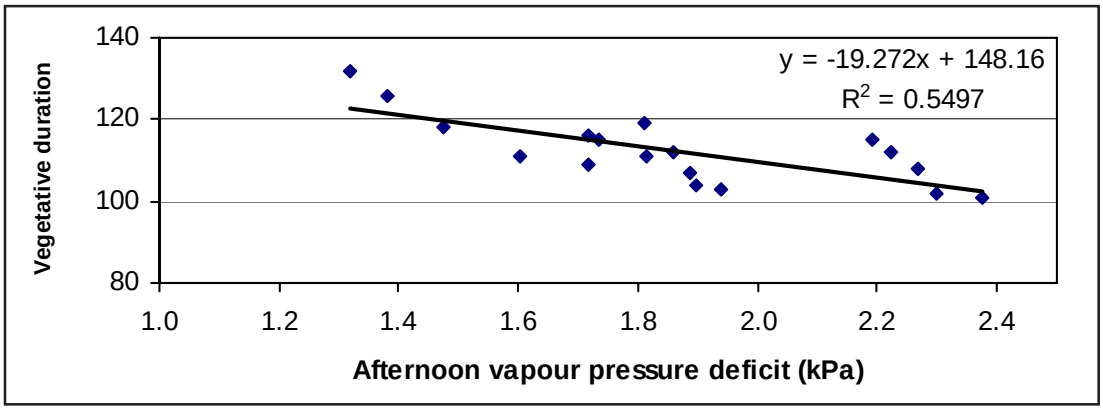

Fig. 1: Vegetative duration (emergence to 50% flowering) as a function of afternoon VPD (kPa).

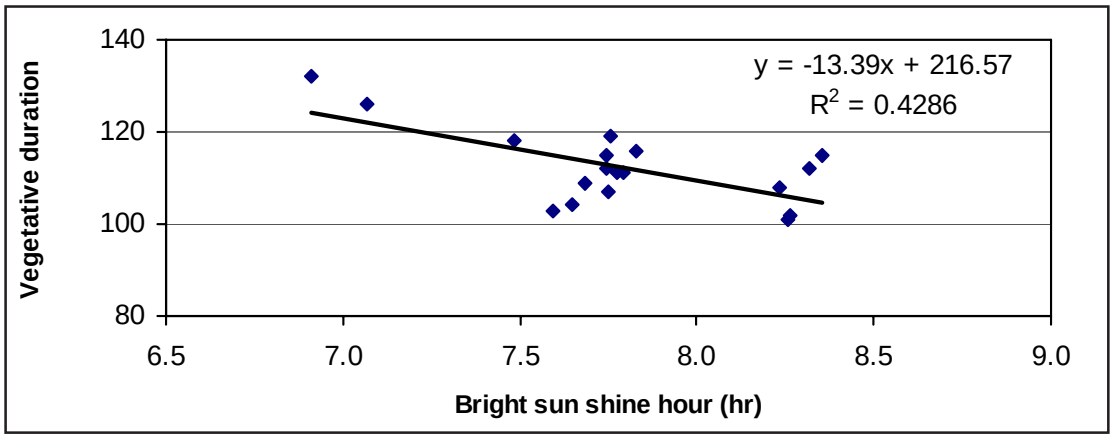

Fig. 2: Vegetative duration (emergence to 50% flowering) as a function of bright sun shine hour.

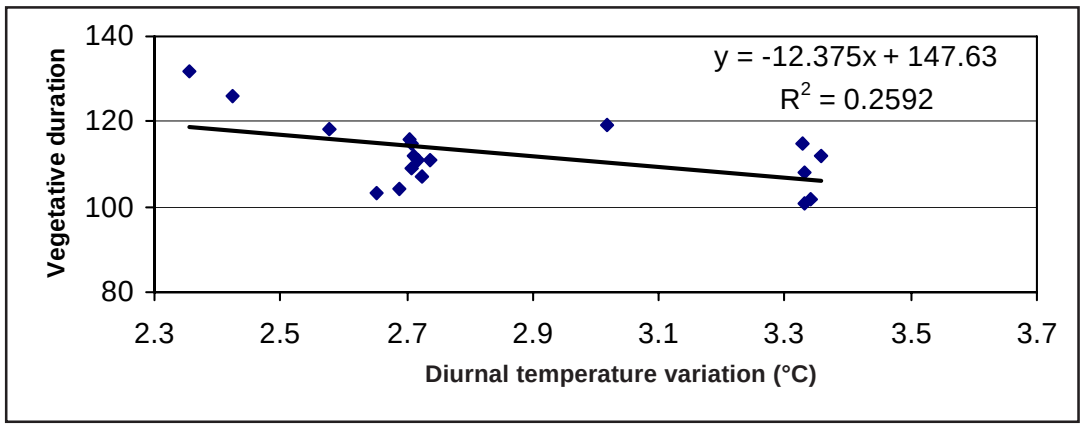

Fig. 3: Vegetative duration (emergence to 50% flowering) as a function of DTV.

pods in the field. Both vegetative and reproductive duration reduced with delay in sowing (Table 2). It was observed in the year 2004-05 that delay in sowing after 16 November could not attain proper reproductive phase. Although flowering started in those treatments, the pod formation could not take place due to rainfall (*Kalabaisakhi*) during flowering. Under West Bengal condition, Reddy *et al*. (1991) reported that 5th October was the optimum sowing time for *rabi* pigeon pea. In a detailed study, Laxminaryanana (2003) found that the growth and yield of pigeon pea decreased gradually with delay in

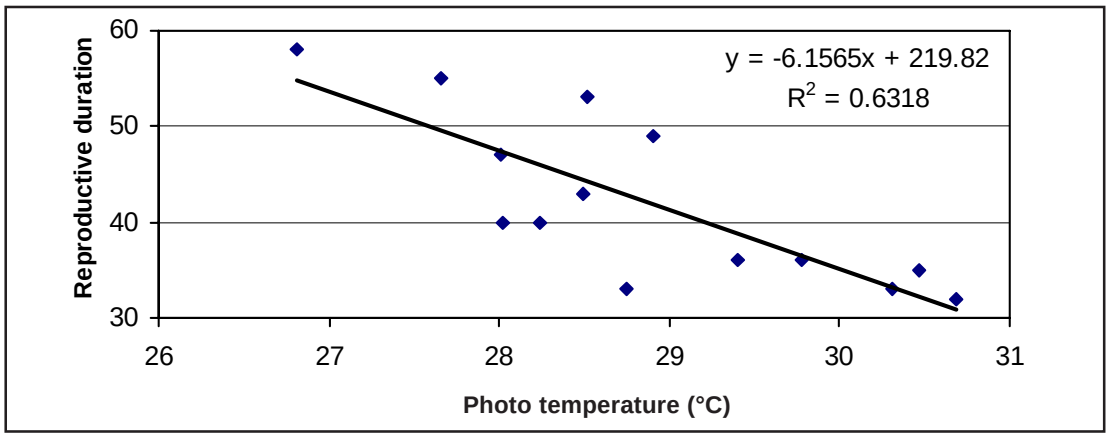

Fig. 4: Reproductive duration (50% flowering to maturity) as a function of photo temperature.

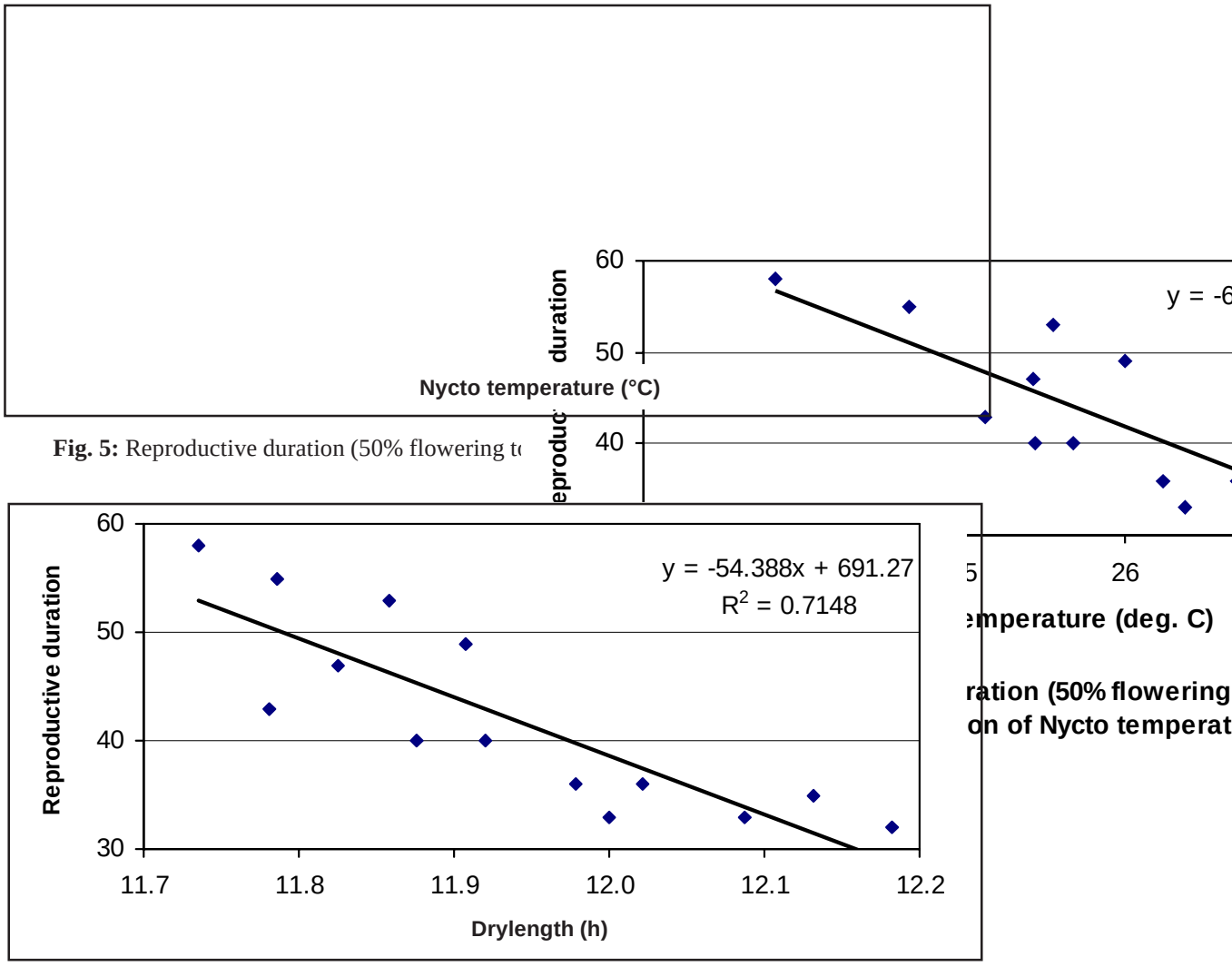

Fig. 5: Reproductive duration (50% flowering t

Fig. 6. Reproductive duration (50% flowering to maturity) as a function of daylength.

sowing after 30 September.

Effect of meteorological parameters on phenophasic duration

The meteorological parameters during the growth period had good correlation with the duration of phenophases. The regression analysis is presented in Figs. 1 to 3 for vegetative duration and in Figs. 4 to 6 for reproductive duration. It was evident that the vegetative duration was negatively correlated with afternoon average vapour pressure deficit (r=-0.741), bright sunshine hour (r=-0.655) and average diurnal variation of temperature (r=-0.509). This implied that bright sunny days with dry atmospheric condition induced earlier flowering.

It is observed from Figs. 4 and 5 that both the photo temperature and nycto-temperature were negatively correlated with the reproductive duration (r=-0.795 and -0.850, respectively). This implied that high day and night temperature shortened the reproductive duration. However, the impact of night temperature was stronger than that of day temperature as shown by higher correlation coefficient.

Similarly, day length also showed negative correlation (r=-0.845) with the reproductive duration that implied long day condition induced early maturity.

Effect of meteorological parameters on crop yield

The grain yield of pigeon pea showed, in general, a decreasing trend with delay in sowing in both the three years' of study (Table 2). Increasing vegetative duration and accumulated growing degree day and photothermal unit during vegetative phase had strong positive correlation with the grain yield.

It was also noticed that the average day temperature, night temperature and day length during reproductive phase had negative correlation with grain yield of pigeon pea. These parameters may be considered as limiting factors for higher production.

CONCLUSION

From the three years' study, it was concluded that under West Bengal condition the *rabi* pigeon pea should be sown early by the end of September. There was risk of complete damage of crop if rainfall occurs during flowering under delayed sowing. The flowering was enhanced by bright sunny days and dry atmospheric condition. However, longer vegetative duration was favourable for higher grain production. Low day and night temperature during reproductive phase favoured higher crop production.

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