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Thermal regimes: The key to phenological dynamics and productivity of fababean (*Vicia faba* L.)

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ABSTRACT

Field study was conducted to know the effect of thermal environment on different phenostages, grain yield andyield attributes of fababean (*Vicia fabaL.*) during *rabi* season of 2013-14 and 2014-15 at ICAR Research Complex for Eastern Region, Patna, (Bihar). Fababean was sown four dates (Nov. 1, 15 & 30, Dec. 15) with four varieties(Local, Vikranta, Gaurav and Suraksha).Yield of fababean varieties was strongly responsive to the thermal units/growing degree days (GDD) accumulated during emergence to maturity. Results revealed that duration of phenostages and thermal units varied with the dates of sowing. November 01 sown crop produced significantly higher number of seeds pod^{-1} (3.21), higher seed yield (3.13 t ha^{-1}) and biological yield (6.30 t ha^{-1}) compared to other sowing dates. Among varieties, Gaurav exhibited significantly higher total dry matter production, heat use efficiency (2.32 kg ha^{-1}°C day), more number of seeds pod^{-1} (3.03) and higher seed yield (3.47t ha^{-1}) followed by Suraksha, Vikranta and Local.

Key words : Fababean, varieties, heat use efficiency, thermal units and sowing dates

Fababean (*Vicia fabaL.*) is among the oldest crops in the world and third most important feed grain legume after soybean and pea. In India, it is grown for dual purpose primarily for its pod to be consumed as vegetables and also for its grain to be used as pulse. Fababean prefers cooler climate and mainly grown in winter (*rabi*) in plains and during rainy (*kharif)* season at hills in India (Singh *et al.*, 2013). They are sensitive to water stress, and irrigation is needed to improve yield and yield stability (Husain *et al.*, 1988). Where water is not limiting, temperature has a major effect on germination and initial growth of fababean. Optimum sowing temperature and selection of improved varieties plays a remarkable role in exploiting yield potential of crop under particular agro-climatic conditions. Due to variations in daily minimum and maximum temperatures from year to year and between location, number of days from planting to physiological maturity varies. Air temperature based agro-meteorological indices such as growing degree days (GDD), photothermal unit (PTU) and helio-thermal unit (HTU), are used to describe changes in phenological behavior, growth and yield of crops (Prakash *et al.,* 2017). Efficiency of conversion of heat in to dry matter depends upon genetic factors, sowing time and crop type. The concept of thermal use efficiency has been used by several workers to compare the performance of different varieties or of several dates in different crops (Mrudula, *et al.*, 2012)

MATERIALS AND METHODS

Field studies were conducted in 2013-14 and 2014-15 at ICAR Research Complex for Eastern Region, Patna (85° 35' 32" N, 85° 05' 08" E, 51 m above mean sea level) on clay loam soil with medium inherent fertility status *i.e.* medium in organic carbon, low in available nitrogen and medium in phosphorus, available in potassium and neutral in soil reaction. The treatment comprised of four dates of sowing (01st November, 15th November, 30th November and 15th December) in main-plot and four fababean varieties (Local Patna, Vikranta, Gaurav, Suraksha) as sub-plot were replicated thrice in a split plot design. The full recommended doses of nitrogen (20kg N ha^{-1}), phosphorus (50kg P_2O_5 ha^{-1}) and potassium (40kg K_2O ha^{-1}) were applied as basal through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively just below the soil (Singh *et al.*, 2013). Two irrigations were given during cropping period as per critical stages. Other cultural operations were followed as per the recommendations contained in package of practices. The occurrence of phenological event were recorded from each plot and average dates of these phenostages were calculated and used for analysis.The grain and biological yields were recorded as per treatments and expressed in kg ha^{-1}.

Growing degree days (GDD), helio-thermal units

Table1: Days taken to complete different phenostages of fababean varieties as affected by thermal environments (Pooled analysis over two seasons)

Treatment	Emergence	Branching	Anthesis	First podding	First green pod picking	First picking	Final picking
Sowing dates							
01 Nov	7	14	53	64	74	99	117
15 Nov	10	18	50	62	70	98	113
30 Nov	12	22	47	60	66	90	109
15 Dec	16	27	43	59	63	85	105
SEm±	0.2	0.4	01	1.2	1.4	1.9	2.3
CD (P=0.05)	0.7	1.3	3.5	4.3	4.8	6.7	8.1
Varieties							
Local	11	20	48	61	66	87	100
Vikranta	12	20	49	61	69	91	108
Gaurav	10	18	50	62	70	100	121
Suraksha	12.7	21	46	61	69	94	113
SEm±	0.2	0.3	0.6	0.8	0.9	1.3	1.5
CD(P=0.05)	0.5	0.9	1.9	2.41	2.70	3.75	4.5

Table 2: Yield and yield attributes of fababean varieties under different thermal environments (Pooled analysis over two seasons)

Treatment	Plant height (cm)	Seeds pod^{-1} (No.)	Seed yield (kg ha^{-1})	Biological yield(kg ha^{-1})
Sowing dates				
01 Nov	118.0	3.2	3134	6302
15 Nov	112.2	2.9	2804	5998
30 Nov	107.5	2.7	2549	5694
15 Dec	103.5	2.5	2375	5831
SEm±	0.7	0.02	19.4	61.6
CD(P=0.05)	2.6	0.07	67.5	197.1
Varieties				
Local	108.0	2.69	2332	6280
Vikranta	97.7	2.89	2584	5602
Gaurav	120.5	3.03	3046	5878
Suraksha	115.0	2.73	2898	6065
SEm±	1.43	0.04	35.31	93.2
CD(P=0.05)	4.17	0.11	103.06	291.5

(HTU), photo-thermal unit (PTU), heat use efficiency (HUE), and helio-thermal use efficiency (HTUE) were computed using daily meteorological data. The base temperature of 5 ˚C was used for computation of GDD on daily basis as per Nuttonson (1955). Heat use efficiency (HUE),which is a measure of amount of dry matter production/grain yield per unit of thermal unit, was worked as per procedures reported by Sahu *et al*. (2007).

All the collected data were subjected to analysis of variance (ANOVA) using OP state statistical package. The comparison of treatment means was made by critical difference (CD) at p=0.05. Pooled analysis of two years was

Table 3: Accumulated GDD (˚C days), HTU (˚C days hr) and PTU (˚C days day $^{-1}$) during different harvest stage of fababean varieties as affected by various treatments (Pooled analysis over two seasons)

Treatment	First green pod picking			First picking			Final picking		
	GDD	HTU	PTU	GDD	HTU	PTU	GDD	HTU	PTU
Sowing dates									
01 Nov	975	3721	10512	1232	4695	13315	1440	5912	15673
15 Nov	843	2557	9029	1139	4220	12324	1347	5424	14737
30 Nov	731	1861	7757	1009	3676	10993	1328	5949	14634
15 Dec	652	1877	7063	953	3554	10532	1319	6792	15029
SEm±	17	62	187	23	91	255	29	132	323
CD (P=0.05)	60	215	646	81	314	882	101	458	1117
Varieties									
Local	800	2535	8710	1181	4733	12920	1534	7382	17110
Vikranta	799	2477	8594	1002	3478	10858	1193	4855	13068
Gaurav	809	2534	8611	1057	3856	11489	1311	5575	14446
Suraksha	793	2470	8445	1093	4077	11898	1395	6266	15449
SEm±	11	34	116	15	56	162	19	85	209
CD(P=0.05)	31	98	337	43	164	472	55	247	609

done for presenting the data.

RESULT AND DISCUSSION

Crop phenology

It is observed that during initial stages (emergence and branching) the late (December15) sown crop required 11 to 13 days more than normal (November 1) sown crops, while during reproductive period the situation was reverse i.e. November 1 sown crop required 10-13 days more to attain the stages than late sown crop (Table 1). The late sowing hastened the growth process hence early occurrence of phenological events in late sowing than normal sowing. Among the varieties the occurrence of phenological events also found to vary significantly. Variety Local took minimum (110 days) to attain the final picking stage whereas Gaurav took maximum (121 days) to attain the same stage. In all the varieties, irrespective of year, there was reduction in the number of days taken for the crop to complete life cycle with the delay in the sowing.

Yield and yield attributes

Yield attributes and yield were significantly influenced due to different crop growing environments. Significant decrease in yield and yield attributing characters were observed with delay in sowing(Table 2). Significantly taller plant (118 cm)was recorded with November 01over rest of the treatments.This was probably due to better growth environment caused by slightly lower temperature and better soil moisture regime. Yield attributes viz. seeds/ pod was recorded markedly higher with November 01compared to rest of the sowing dates. Similar results are reported by Prasad *et al.,*(2017).

The higher seed yield (3134 kg ha^{-1}) and biological yields (6302 kg ha^{-1}) were recorded with November 01 sowing. The lowest seed yield was noted with December 15 (2375 kg ha^{-1}).Data revealed that fababean varieties differed markedly in respect of growth and yield attributes (Table 2). Significantly taller plant was recorded with Gaurav (120 cm) compared to rest of the varieties and the lowest with Vikranta (97.8 cm). Significantly higher seed yield (3047 kg ha^{-1}) was recorded with cv. Gaurav over rest of tested varieties.

Agrometeorological indices

Accumulated thermal unit of different phenostages during entire growth period of fababean decreased with delay in sowing (Table 3).This may be due to progressive decrease in temperature with delayed sowing.It was observed that higher GDD was accumulated in November 01 sown crop followed byNovember 15, November 30, and December 15 at all phenostages. Decrease in GDD due to late sowing was reported by Hariram *et al.* (2016) in mungbean.Total accumulated thermal unit during the entire growth period of the crop decreased from 1440GDD under November 01

Table 4: Heat use efficiency (HUE) and heliothermal use efficiency (HTUE) of fababean varieties as affected by various treatments (Pooled analysis over two seasons)

Treatment	HUE (kg ha^{-1}°C day)	HTUE (kg ha^{-1}°C day hr)
Sowing dates		
01 Nov	2.19	0.54
15 Nov	2.10	0.53
30 Nov	1.96	0.45
15 Dec	1.82	0.36
SEm±	0.04	0.01
CD (P= 0.05	0.14	0.03
Varieties		
Local	1.52	0.32
Vikranta	2.16	0.54
Gaurav	2.32	0.55
Suraksha	2.08	0.47
SEm±	0.03	0.01
CD (P= 0.05	0.08	0.02

sowing to 1347, 1319 and 1328 GDD under late sowings on November 15, November 30 and December 15, respectively. These findings are in confirmation with Singh *et al.,* (2012).

Among the varieties, Local Patna consumed the highest GDD (1534), HTU (7382) and PTU (17110) at final picking stages and the lowest GDD (1193), HTU (4855), and PTU (13068) were found in Vikrant.

The heat use efficiency (HUE) and heliothermal use efficiency (HTUE) for grain yield was highest (HUE 2.19 kg ha^{-1}°C day and HTUE 0.54 kg ha^{-1}°C day) for November 01 sown crop and the lowest (HUE 1.82 and HTUE 0.36) December 15 (Table 4). It was mainly due to less grain yield obtained under delayed sowing crop. Among the varieties, Gaurav had maximum HUE (2.32) and HTUE grain yield (0.55) followed by Vikranta, Suraksha and Local.

CONCLUSION

From this study it may be concluded that, the total crop duration, yield and yield attributes and even accumulated heat units decreased with delayed sowing.Among the varieties, Gaurav took maximum days to mature, produced highest yield as well as consumed maximum heat units.

REFERENCES

Hariram, Aggarawal, N., Singh, G. and Singh, S.P. (2016). Heat and water use efficiency in summer mungbean under different thermal and moisture regimes. *J. Agrometeorol.*, 18(2):196-200.

Husain, M. M., Hill, G. H. and Gallagher, J. N. (1988). The response of field beans to irrigation and sowing date. *J. Agric. Sci. Cambridge*, 111:233-254.

Mrudala, G., Ashok, R. Y. and Rao, S.B.S.N. (2012). Quantification of heat units for chickpea under coastal environment of Andhra Pradesh. *J. Agrometeorol.*, 14(1):82-84.

Nuttonson, M.Y. (1955). Wheat climatic relationship and use of phenology in ascertaining the thermal and photo-thermal requirements of wheat. *Am. Inst. Crop Ecol. WashingtonD.C.*

Prakash, V., Mishra, J.S., Kumar, R., Kumar, R., Kumar, S., Dwivedi, S.K., Rao, K.K., and Bhatt, B.P. (2017).Thermal utilization and heat use efficiency of sorghum cultivars in middle Indo-Gangetic Plains. *J. Agrometeorol.,* 19(1):29-33.

Prasad, S., Agrawal, K.K., Kumar, R., and Prakash, V. (2017).Heat unit requirement of wheat cultivars under varying thermal regimes at Jabalpur.*J. Agrometeorol.,* 19 (3): 283-285.

Sahu, D.D., Chopada, M.C. and Patoliya, B.M. (2007). Determination of sowing time for chichpea varieties in south Saurashtra. *J. Agrometeorol*., 9:68-73.

Singh, A.K, Bhatt, B.P, Sundaram, P.K., Gupta, A.K. and Singh, D. (2013). Planting geometry to optimize growth and productivity faba bean (*Vicia faba* L.) and soil fertility. *J. Environ. Biol*. 34 (1): 117-122.

Singh, A.K., Mishra, A.N. and Tripathi, P. (2012). Thermal regime requirement and plant responses of chickpea cultivars under variable weather conditions. *J.Agrometeorol*., 14(1):67-69.

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