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Effect of Accumulated Heat Units on Sowing Window of *Mucuna pruriens* (L.) DC.

GA.DHEEBAKARAN, R.JAGANNATHAN AND N.K.SATHYAMOORTHY
Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore -641003, India

Abstract : *Mucuna pruriens* an ayurvedic medicinal plant was studied for time of sowing at Tamil Nadu Agricultural University, Coimbatore, India from August 2003 to July 2004. The treatments were ten different month of sowing from August '03 to July '04. Days required for germination, flower initiation, 50 percent flowering and final harvest were recorded. Heat units such as Growing Degree Days (GDD), Photo Thermal Units (PTU), Helio Thermal Units (HTU), Relative Temperature Disparity (RTD), Relative Humidity Disparity (RHD) and Seasonal efficiency were worked out for different sowing months. The results revealed that, there was positive relationships between heat units like GDD/PTU/HTU at 50 percent flower initiation and DMP/yield/Harvest Index (HI), whereas it was negative between RTD/RHD and yield. The mucuna which received 50 per cent of its total accumulated heat units before its 50 per cent flowering did yield heavily (June to Aug). The mucuna which received higher accumulated heat units during its earlier stages had attained the flower initiation and 50 percent flowering stage earlier and the extended post flowering duration resulted in increased yield. It could be concluded that, relatively higher seed yield can obtained from June sowing and the mucuna require more accumulated heat units during its flowering phase for higher yield.

Key words – Heat Units, GDD, mucuna, yield.

Introduction

Mucuna pruriens (velvet bean) belongs to Leguminaceae family and is indigenous to tropical countries. It is a climbing legume with long thin branches and opposite, lanceolate leaves 15 to 30 cm in length. The flowers grow in racemes. The fruit of the plant is pod, which is thick and leathery. It is covered with long stiff hairs that are responsible for itching to the workers involved in collection of the pods. The pods are used in ayurvedic to treat nervous and sexual diseases. From phytochemistry point of view, the drug contains L-dopa, tryptamine alkaloids, lecithin and tannins. All these compounds are known to exist in the seeds. From an agronomist point of view this velvet bean is a very good cover crop against soil erosion and also green manure crop that fixes 70-120 kg of atmospheric nitrogen in the soil per hectare. Temperature plays a vital role affecting it's growth, phenology and yield (Adam *et al*., 1994,.Chakravarty and Sastry, 1983; Rajput *et al*., 1987; Bishnoi *et al.,* 1995). Enough information is not available for a crop to introduce for commercial cultivation in the tropics and hence this study was made to understand best time for sowing.

Materials and Methods

A field experiment was conducted under irrigated condition at Tamil Nadu Agricultural University, Coimbatore, India from August 2003

Table 1 Effect of Heat Units (HTU) on phenophases of mucuna with different date of sowing

Month of sowing	Aug	Sep	Oct	Nov	Dec	Jan	Feb	June	July
DAS to different phenological stages									
Germination	4	4	4	5	5	5	5	4	4
Flower initiation	44	45	46	48	47	47	42	42	43
50% Flowering	62	64	67	65	62	61	62	60	61
Harvest	120	123	125	123	122	118	115	129	124
Growing Degree Days (GDD) - Base temperature assumed is 10°C									
Germination	79	89	76	90	84	84	74	81	79
Flower initiation	927	879	771	757	766	805	786	901	938
50% Flowering	1273	1186	1097	1017	1035	1071	1201	1291	1319
Harvest	2219	2111	2064	2050	2191	2269	2343	2626	2355
Photo Thermal Unit (PTU)									
Germination	1223	1361	1106	1205	1064	1089	1043	1243	1212
Flower initiation	14238	13021	10707	9804	9870	11029	11664	13882	14523
50% Flowering	19320	17193	14857	13181	13636	15075	18136	19925	20373
Harvest	32232	29164	27681	27810	31053	33695	35940	40165	35426
Relative Temperature Disparity (RTD)									
Germination	1.3	1.5	1.4	1.6	2.0	2.7	2.1	0.9	1.1
Flower initiation	15.7	15.6	13.6	17.3	18.9	19.2	17.6	12.7	13.1
50% Flowering	21.8	20.6	21.7	24.6	24.2	24.6	24.5	18.2	18.8
Harvest	40.1	43.0	44.4	47.5	48.0	43.9	40.8	39.2	35.7
Dry Matter Production (DMP kg/ha), Yield (kg/ha) and yield indices									
DMP-Flower initiation	1120	1045	966	840	934	985	1084	1255	1234
DMP-50% flowering	2342	2122	1980	1661	1840	2006	2089	2530	2607
DMP-At harvest	6868	6718	6366	5807	5946	6014	6444	6648	6686
Seed yield	2922	2700	2022	1478	1917	2100	2339	3233	3017
Harvest index	0.43	0.40	0.32	0.25	0.32	0.35	0.36	0.49	0.45
Seasonal Efficiency	121.0	111.8	83.8	61.2	79.4	87.0	96.9	133.9	125.0

Table 2. Correlation of Heat Units of different phenophases of mucuna with its yield and Harvest Index (HI)

Heat units	Yield			Harvest Index		
	FI	F50	Harvest	FI	F50	Harvest
GDD	0.93**	0.95**	0.70*	0.91**	0.93**	0.77*
HTU	0.60	0.51	-0.03	0.65	0.58	0.08
PTU	0.96**	0.94**	0.65	0.92**	0.92**	0.72*
RTD	-0.59	-0.81**	-0.88**	-0.54	-0.79**	-0.86**
RHD	-0.06	-0.26	-0.71*	0.02	-0.17	-0.61

FI - Flower Initiation F50 - 50% flowering

** - Significant at 1% level; * - Significant at 5% level

to July 2004. The experimental site is located at 11°N latitude, 77° E longitude with an altitude of 426.7 m above MSL. The soil of the experimental area was sandy clay loam with neutral in pH, low in organic carbon, medium in available N & P and high in available K.

The velvet bean (Mucuna) used in the study was a local variety obtained from Department of Medicinal and Aromatic plants, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore and is of 120-130 days in duration. The mucuna seeds were planted in ridges with 30 cm between plants. A spacing of 60cm between ridges was maintained. The NPK fertilizer applied @ 40-25-50 kg ha^{-1} as basal. Irrigation was given one day after drying of top soil and the plant protection measures were followed as per requirement. Observations were made on randomly selected 10 plants per replication. The treatments were ten different month of sowing from August '03 to July '04 and replicated thrice.

The date of occurrence (when 50 per cent of the plants in each replication reached the respective stage) of different phonological events (germination, flower initiation, 50% flowering and last harvest) were recorded. The daily data on temperature (maximum and minimum) and bright sunshine hours during the crop season were obtained from Department of Agricultural Meteorology, TNAU, Coimbatore. The day length details were obtained from Rastriya Panchang (Anon., 2003 and 2004) Published by Positional Astronomy Centre, IMD, Kolkata.

Various heat units were calculated as follows.

$$GDD = \sum_{i=1}^{n} \frac{[T\,max + T\,min]}{2} - Tb \quad \text{(Iwata,1984)}$$

$$HTU = \sum_{i+1}^{n} GDD \times SSH \quad \text{(Rajput, 1980)}$$

$$PTU = \sum_{i=1}^{n} GDD \times Daylength \quad \text{(Major } \textit{et al.,} \text{ 1975)}$$

$$RTD = \sum_{i=1}^{n} \frac{T\,max - T\,min}{T\,max} \times 100$$ (Rajput,1980)

$$RHD = \sum_{i=1}^{n} \frac{Rh\,max - Rh\,min}{Rh\,max} \times 100$$ (Rajput,1980)

Seasonal Efficiency =

$$\frac{\text{Yield of a season}}{\text{Mean yield of all season}} \times 100$$

Where,

GDD - Growing Degree Days
HTU - Helio Thermal Units
PTU - Photo Thermal Units
RTD - Relative Temperature Disparity
RHD - Relative Humidity Disparity
Tmax - Maximum temperature (°C)
Tmin - Minimum temperature (°C)
Rh max - Maximum Relative Humidity (%)
Rh min - Minimum Relative Humidity (%)
Tb - Base temperature (°C) = 10°C
SSH - Bright sunshine hours

Correlation between the heat units and mucuna yield was worked out as suggested by Gomez and Gomez (1984).

Results and Discussion

In general, the result indicated that among the different months of sowing the *Mucuna* had recorded higher seed yield (3233 kg ha^{-1}) when sown on the month of June. The peak yield that obtained in June sowing found decreasing up to November in subsequent monthly sowings and again there was slight increase in yield from December and this continued up to February. The seasonal yield efficiency of mucuna was higher from June to September sown mucuna crops (134 to 111%) (Table 1).

Correlation between the heat units and mucuna yield was worked out and presented in Table 2. There was significant positive relationships between heat units like GDD / PTU accumulated up to 50 per cent flowering and DMP/yield/Harvest Index (HI), whereas it was negative between RTD and yield. The mucuna, which received more than 45 per cent of its total accumulated heat units before its 50 per cent flowering did yield more (June to Aug sown crop). The results inferred that mucuna which received higher accumulated heat units during its earlier stages had attained the flower initiation and 50 percent flowering stage earlier. Variation of phenophases of wheat during different time of sowing was reported earlier (Rajput *et al.*, 1987 and Haider *et al.*, 2003).

The temperature after flowering has say over the yield. The results also indicated that the longer duration between the 50 percent flowering and maturity resulted in increased mucuna seed yield. The crop reached 50 percent flowering in hot period was affected by temperature and reduced duration, inturn resulted in lower yield. It could be concluded that, relatively higher seed yield can obtained from June sowing and the mucuna require more accumulated heat units during its flowering phase for higher yield.

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