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Study on agrometeorological indices for soybean crop under different growing environments

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ABSTRACT

Field experiments were conducted during *kharif* seasons of 2004 and 2005 to study the influence of different environments created through different sowing time on soybean cultivars at Hisar. The early sown crop (1st week of June) accumulated higher GDD, HTU and resulted in maximum RUE and HUE. Among the cultivars highest RUE and HUE was found in PK-416 cultivar due to more dry matter production and LAI.

Key words : Soybean, environment, GDD, HTU, RUE and HUE

Soybean (*Glycine max* L.) is an important source of protein and oil in human diet. Optimum temperature for germination of soybean is approximately 30°C with base temperature of 10° C (Ghadekar, 2001). Soybean is one of the classical short day plants and most of the genotypes respond as quantitative short day plant (Lawn, 1989). The variation of photoperiod sensitivity among soybean genotypes allows the crop to grow successfully across a wide range of latitudes. Photoperiod influences the rate of development in pre- and post flowering stages. Changes in photoperiod and temperature are reported to alter the happening of growth stages, the growth and partitioning of dry matter of this photoperiod and thermo-sensitive short day C_3 crop (Lawn, 1989).

MATERIALS AND METHODS

The investigation was carried out during two consecutive *kharif* seasons. (2004 and 2005) at the research farm of Department of Agricultural Meteorology, CCSHAU, Hisar, (29° 10' N, 75° 46' E and 215.2 mamsl). The experiment was laid out in split plot design with four replications keeping three dates of sowing *viz.*, 1st and 3rd week of June and 1st week of July in main plots and four soybean cultivars *viz.* SH 40, DS 9814, PK 416 and PS 1042 in sub plots. The crop was raised following the recommended package of practices for the region. The methods used to calculate the agro-micrometeorological indices are as given below:

Growing degree day was worked by using a base temperature of 10 °C. The sums of HTU for particular phenophase of interest were determined by multiplying degree days with actual bright sun shine hours.

Radiation use efficiency (RUE, g MJ^{-1}) was calculated by using the following formula:

Radiation use efficiency = Biomass yield / Radiation intercepted

Heat use efficiency (HUE kg ha^{-1} °C day^{-1}) was computed by using the following formula:

Heat use efficiency = Biomass yield / Heat units required

RESULTS AND DISCUSSION

Accumulated growing degree days

The accumulated growing day degrees (AGDD) to reach various growth stages showed appreciable variation among the dates of sowing and cultivars in both crop seasons (Table 1).The early sown crop accumulated highest growing degree days to reach various phenophases (2733 and 2655°C day) followed by 3rd week of June sowing. This was due to the availability of longer growth period for early sown crop. Among the cultivars the highest growing degree days were accumulated by cultivars PK 416. Similar results were earlier reported by Dhingra *et al.* (1995) and Sunil (2005).

Accumulated helio-thermal units

The accumulated helio-thermal units (AHTU) accumulated by the crop to attain different growing are shown in Table 2.The 1st week of June sown crop accumulated highest AHTU (36476 and 35447°C day in 2004 and 2005, respectively). Minimum units were accumulated in July sown crop. Among the cultivars the highest helio-thermal units required to reach physiological maturity were observed in PK 416 during both the crop seasons.

Radiation use efficiency (RUE)

Radiation use efficiency (RUE) values of soybean cultivars showed appreciable variations (Table 3). RUE based on biological yield was the highest (2.38 and 2.54 g MJ^{-1}) in 1st week of June sowing followed by 3rd week of June sown crops respectively. Among cultivars, highest RUE were recorded in PK 416 followed by DS 9814 and were lowest RUE in PS 1042 during both years. The variation in RUE arose because of the differential dry matter production in four cultivars because of variation in canopy structure and the LAI. RUE depends mainly on three factors, *viz*., architecture of the canopy intercepting the radiation, photosynthetic efficiency of the leaves in utilizing the intercepted radiation used in production of dry matter and loss of dry matter due to respiration. Similar results have been reported by Sunil (2005).

Heat use efficiency (HUE)

Heat use efficiency (HUE) of soybean cultivars for biomass production and seed yield under three dates of sowing based on two year study are given in Table 4. Heat use efficiency was the highest for 1st week of June followed by 3rd week of June sown crop during both years of study. Among the cultivars highest RUE were recorded in PK 416 followed by DS 9814 and lowest RUE in PS 1042 during both crop growing season.

Table 1: Accumulated growing degree day (AGDD ° C day) to attain various phenophases in soybean cultivars

Phenophases	2004					2005				
	SH 40	DS 9814	PK 416	PS 1042	Mean	SH 40	DS 9814	PK 416	PS 1042	Mean
Sowing: 1st week of June										
Emergence	162	186	162	186	174	137	162	162	137	149
50% Flowering	1738	1777	1778	1733	1758	1706	1760	1746	1706	1729
Pod Development	2283	2321	2321	2283	2302	2258	2308	2292	2258	2279
Physiological Maturity	2707	2759	2759	2707	2733	2655	2655	2668	2645	2655
Sowing: 3rd week of June										
Emergence	117	141	141	117	129	159	152	165	134	145
50% Flowering	1630	1651	1651	1603	1635	1604	1646	1646	1625	1630
Pod Development	1949	1949	1986	1986	1967	2114	2146	2142	2114	2130
Physiological Maturity	2221	2254	2254	2221	2237	2312	2342	2552	2431	2404
Sowing: 1st week of July										
Emergence	106	132	127	106	123	75	117	117	96	101
50% Flowering	1287	1347	1347	1667	1413	1479	1522	1522	1501	15069
Pod Development	1718	1774	1774	1713	1746	1849	1884	1885	1867	1871
Physiological Maturity	2170	2184	2184	2157	2174	2256	2281	2268	2256	2265

Table 2 : Accumulated helio- thermal units (AHTU ° C day hrs) to attain various phenophases in soybean cultivars

Phenophases	2004					2005				
	SH 40	DS 9814	PK 416	PS 1042	Mean	SH 40	DS 9814	PK 416	PS 1042	Mean
Sowing: 1st week of June										
Emergence	2266	2598	2266	2598	2432	2233	2971	2971	1876	2512
50% Flowering	24078	24595	24545	24078	24324	23625	24413	24413	24152	24150
Pod Development	31035	31528	31528	31053	31291	30693	31311	31112	30696	30952
Physiological Maturity	36176	36776	36776	36176	36476	35449	35449	35595	32294	35447
Sowing: 3rd week of June										
Emergence	1652	18987	1987	1652	1820	1910	2257	2257	1910	2083
50% Flowering	17543	18319	18319	17545	17932	22155	22708	22708	22424	22498
Pod Development	22734	22734	23445	23445	23090	28648	29053	29053	28648	28851
Physiological Maturity	28201	28349	28349	28081	28245	33487	33749	33867	33628	33683
Sowing: 1st week of July										
Emergence	1652	1987	1987	1652	1819	1064	1645	1645	1357	1428
50% Flowering	17345	13319	13319	17545	15432	20312	20871	20871	20595	20662
Pod Development	22734	23445	23445	22735	23090	25027	25463	25463	25251	23301
Physiological Maturity	28201	28349	28349	28081	28245	29928	30219	30064	29228	29866

Table 3: Radiation use efficiency (g MJ^{-1}) of soybean cultivars under different growing environments

Treatments	2004				2005			
	1st week of June	3rd week of June	1st week of July	Mean	1st week of June	3rd week of June	1st week of July	Mean
	Biological				Biological			
SH 40	2.17	2.00	1.92	2.03	2.15	2.09	1.98	2.07
DS 9814	2.53	2.25	2.15	2.31	2.63	2.38	2.15	2.38
PK 416	2.63	2.30	2.26	2.40	2.69	2.45	2.24	2.46
PS 1042	2.10	1.95	1.87	1.97	2.05	2.00	1.90	1.98
Mean	2.35	2.12	2.05		2.38	2.23	2.06	
	Grain				Grain			
SH 40	0.92	0.87	0.82	0.87	0.91	0.88	0.84	0.87
DS 9814	1.04	0.95	0.90	0.96	1.12	1.05	0.97	1.04
PK 416	1.13	1.04	0.98	1.05	1.15	1.08	1.00	1.07
PS 1042	0.91	0.85	0.80	0.85	0.92	0.90	0.86	0.89
Mean	1.00	0.91	0.87		1.04	0.97	0.92	

Table 4: Heat use efficiency (kg ha^{-1} ^0C day^{-1}) of soybean cultivars under different growing environments

Treatments	2004				2005			
	1st week of June	3rd week of June	1st week of July	Mean	1st week of June	3rd week of June	1st week of July	Mean
	Biological				Biological			
SH 40	0.862	0.901	0.900	0.882	0.940	0.953	0.974	0.955
DS 9814	0.940	0.970	0.942	0.950	1.016	1.057	1.040	1.037
PK 416	1.021	0.991	0.970	0.994	1.128	1.129	1.061	1.106
PS 1042	0.856	0.821	0.821	0.832	0.916	0.84	0.916	0.895
Mean	0.920	0.918	0.908		1.013	0.984	0.997	
	Grain				Grain			
SH 40	0.351	0.370	0.360	0.360	0.397	0.401	0.407	0.401
DS 9814	0.394	0.405	0.381	0.393	0.433	0.450	0.438	0.440
PK 416	0.452	0.430	0.410	0.430	0.476	0.488	0.454	0.472
PS 1042	0.380	0.370	0.360	0.370	0.402	0.383	0.405	0.396
Mean	0.397	0.391	0.377		0.427	0.430	0.426	

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