ISSN NO. 2320-5407

*Journal homepage: http://www.journalijar.com*

*INTERNATIONAL JOURNAL OF ADVANCED RESEARCH*

**RESEARCH ARTICLE**

# Photoperiodic Dynamics alters biomass accumulation and its Partitioning in Soybean (*Glycine max*. L. Merrill) Genotypes Under Sub-Tropical Punjab Conditions

*** Anil K Dogra[1], Jagmeet Kaur[2] and B S Gill[3]**

1. PhD Scholar, Department of Botany , Punjab Agricultural University, Ludhiana- 141004, India
2. Senior Botanist, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141004, India.
3. Plant Breeder, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141004, India

## Manuscript Info

***Manuscript History:***

Received: 12 December 2013
Final Accepted: 19 January 2014
Published Online: February 2014

***Key words:***
Soybean, Photoperiod, Planting date, Dry Matter Accumulation

****Corresponding Author***

**Anil K Dogra**

## Abstract

Soybean is a quantitative short-day plant and is very sensitive to photoperiod that is the reason it does not change from vegetative to reproductive growth until a critical day length is met. Our objective was investigation of photoperiodic changes effect on important physiological traits such as dry matter production and harvest index that affected grain yield. A field experiment was carried out in randomized block design with three replications. Fifteen divergent genotypes of soybean (*Glycine max*. L. Merrill) were grouped into three categories on the basis of maturity dates; early, medium and late were planted on two planting dates (normal and late). Grain yield increased with increasing biomass and its proper utilization under optimal planting date and decreased with delaying in planting date due to improper accumulation of photosynthate between vegetative to reproductive phase. Compared with the normal sowing, the delayed sowing genotypes had the lower dry matter which indicated that the photoperiodic changes would affect the duration of growth under different sowing dates. Finally, the results depicted that in early (EC 457161), medium, (SL 983) and late (SL 958) maturity date genotypes produce maximum dry matter accumulation and gave higher yield in normal sowing due to better environmental conditions as compared to late sown conditions.

.



## Introduction

Soybean (*Glycine max*. L. Merrill) has a prominent position among the legumes that supplement nearly one-third of the world population and popularly known as “Miracle Bean” because of its versatility. Soybean is a highly nutritive and energy rich monocarpic legume crop with proteins (40 %) and edible oil (20 %). Soybean genotypes respond much differently to sowing date than other crops because flowering is closely related to photoperiod. Raising soybean production is possible through a more effective use of resources by appropriate sowing time adjustments. Dry matter accumulation during the reproductive period strongly influences the yield and yield components (Liu *et al*., 2004). Variations in biomass and harvest index were strongly associated with the amount of intercepted radiation during grain filling stage. Change in both biomass accumulation and harvest index were crucial in determining yield reductions associated with late planting dates in a subtropical environment. In response to shorter day lengths the soybean plant flowers earlier and is shorter, thus reducing biomass production and yield. The two main environmental factors controlling classification of soybean genotypes into maturity groups are the photoperiod and temperature. Premature flowering induced by short days was a major seed yield-reduction factor at late planting dates (Board and Harville, 1996, Anderson and Vasilas, 1985; Trostle and Bean, 2001). Yield of soybean crop is a function of light interception, dry matter production, and partition of dry matter into the plant's seed. The total dry matter level required for optimum seed number and yield per area is a useful growth criterion to predict optimal yield. Soybean growth is measured by the amount of total dry matter accumulating in the plant. The soybean plant produces 95% of its total dry matter through photosynthesis (Taiz and Zeiger, 2002). It has been reported that timely sowing of soybean under Indian conditions (second fortnight of June) showed superiority over the late planting with respect to all the parameters along with grain yield (Billore *et al.*, 2009). Early sowing (end May to early June) provides long vegetative and reproductive growth periods thereby, facilitating the crop to produce more biomass, enhancing the number of pods per plant, grains per pod and 100-grain weight (Kumar *et al.*, 2005). Late sowings may produce lower grain yields due to shortening of growth period and less accumulation of photosynthetically active radiation (Purcell *et al.*, 2002). The importance of maximum utilization of environmental parameters during the growth of crop is important to choose an appropriate sowing date for any crop anywhere.

## Materials and Methods

The field experiment was conducted at the research area of the Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, between June and November 2012. Ludhiana is situated in the sub-tropical zone of Punjab at about 247m above sea level on latitude 30° 54'N and longitude 75° 48'E. The experimental design was a randomized block design with three replications and the soil at the experimental site is sandy loam. Each block consisted of 15 plots, each of which measured 5m x 4m, giving a total of 45 plots, and the spacing between plants and rows were 5cm and 45cm with one meter alleys between the blocks. Fifteen divergent genotypes of soybean grouped into three categories on the basis of maturity dates; five early (SL 688, SL 778, SL 795, EC 457161and EC457286), five medium (SL 525, SL 744, SL 955, SL 983 and SL 1123) and five late (SL 900, SL 958, DS 12-5, DS 26-13 and DS 26-14) maturing genotypes were planted on two planting dates are 12 June (normal) and 12 July (late). Germination and emergence of seedlings took place five to 8 days after sowing. The dry matter was taken at the vegetative, flower initiation, pod initiation and harvest stage. Five sampled plants from each plot were put in labelled envelopes and oven dried at $90^{o}$C for 48 hours, and then weighed, and the average weight calculated.

## Data Analysis

All data was analyzed using the Analysis of Variance (ANOVA) and genotypes differences among early, medium and late maturity date were compared using the Least Significant Difference (LSD) procedure at 5% level of probability.

## Results and Discussion

Analysis of variance pooled over planting dates under variable photoperiods revealed significant differences among genotypes, environments and genotype x environment interaction for leaf dry matter, stem dry matter, dry matter at harvest, harvest index and seed yield (Table 2). The data regarding the leaf and stem dry matter under both the sowing of different maturity date genotypes in response to variable photoperiods is presented in Table 1. Leaf and stem dry matter decreased with delay in sowing. Significantly maximum leaf and stem dry matter were recorded by early (EC 457161), medium (SL 983) and Late (SL 958) genotypes under both the sowing. The genotype SL 958 (late) had significantly higher dry matter accumulation at harvest stage than medium (SL 958) and early (EC 457161) in normal sown conditions because of more accumulation of photosynthates under relatively longer photoperiods. Soybean genotypes differed significantly in respect of harvest index (Table 1). There was also a significant interaction between genotypes and planting dates for harvest index. Harvest index showed opposite trend as found in dry matter production and seed yield producing lower value of HI at normal sowing and higher in late sown conditions due to lower vegetative growth and results in less accumulation of dry matter. Genotypes under different maturity dates showed significant differences in their harvest index during both the sowing. The genotype early (EC 4571 61), medium (SL 983) and late (SL 958) had maximum harvest index value in normal sowing. Higher seed yield under normal sowing is due to more dry matter production and its proper utilization by the crop in response to photoperiods. Genotype SL 958 (late) produced the highest seed yield (2,370 kg/ha) followed by medium maturity date genotype SL 983 (2,345 kg/ha) and EC 457161 early maturity genotype (2,054 kg/ha). Results of correlation analysis showed that seed yield had significant and positive correlation with majority of traits in both the conditions (normal and late). The highest significant and positive correlations were observed between stem dry matter at vegetative, flower initiation and pod initiation stages and seed yield at 0.01 and 0.05% level of probability (Table 3). Results showed that all other parameters were statistically at par but no significantly positive correlations were observed with yield. Significantly positive correlations were also observed for dry matter at harvest stage, harvest index and yield in medium and late genotypes in normal sowing. However, negative correlation was found among certain characters in medium and late maturity date genotypes with yield because of shorter photoperiod during late sown crop season. These findings were also reported by (Algan, 2011, Patil *et al*, 2003). Soybean genotypes differed significantly among themselves in respect to leaf and stem dry matter upto harvest at all the stages. Dry matter in response to photoperiods also showed significant interaction between genotypes and planting date (Table 2). Similar results were noticed by (Samant *et al*, 1999 and Miah *et al*, 2009). The crop sown under late planting conditions could not accumulate sufficient dry matter because of lesser vegetative growth and reproductive period due to shorter day length. The proper mobilization of dry matter production towards the sink (seed yield) is an important factor for economic yield. The capacity of plant to produce more dry matter depends upon the leaf size and duration of day length (photoperiod), but some genotypes have more potential to translate assimilates towards economic yield due to differential response of genotypes. Similar results were reported by (Patil *et al*, 2003, Reddy, 2009). The higher dry matter production under normal sowing conditions indicates the role of longer photoperiods in terms of more vegetative growth and development and their positive association with seed yield of soybean (Sadeghipour, 2008). The lower harvest index under normal sown conditions was due to higher temperature and longer photoperiods that enhanced the vegetative growth of crop and also increase canopy (Reddy, 2009 and Singh *et al*, 2010). Genotypes of soybean do differ in grain yields (Veni *et al.*, 2003; Billore *et al.*, 2009; De Bruin and Pedersen 2009). The results were in agreement with (Isler and Caliskan, 1998; Arshad, 2006).

## Conclusion

From the present investigation it is concluded that to improve the soybean production and productivity under Punjab conditions, timely sowing in the first fortnight of June would be beneficial. Selection of suitable genotypes also plays an important role in soybean production. However from the present day genotypes, only SL 958 (late), SL 983 (medium) and EC 457161(early) showed improved yield under normal and late planted conditions.

**Table 1: Biomass production and its partitioning in diverse soybean genotypes as influenced by planting dates under variable photoperiods.**

| Maturity group | Genotypes | LDMV (g) | | LDMF (g) | | LDMP (g) | | SDMV (g) | | SDMF (g) | | SDMP (g) | | DMH (g) | | HI (%) | | Seed Yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Normal | Late | Normal | Late | Normal | Late | Normal | Late | Normal | Late | Normal | Late | Normal | Late | Normal | Late | Normal | Late |
| EARLY | SL 688 | 2.66 | 2.65 | 4.06 | 2.48 | 8.57 | 5.34 | 2.28 | 1.07 | 3.58 | 2.41 | 8.21 | 5.45 | 29.17 | 25.01 | 30.87 | 38.66 | 1111 | 852 |
| | SL778 | 3.43 | 2.53 | 3.74 | 2.32 | 8.46 | 4.52 | 2.68 | 2.48 | 5.74 | 2.78 | 10.74 | 7.29 | 44.17 | 30.84 | 37.37 | 42.36 | 1648 | 1398 |
| | SL 795 | 2.48 | 2.36 | 4.65 | 3.53 | 9.55 | 7.36 | 2.74 | 2.85 | 5.95 | 2.29 | 12.84 | 10.31 | 46.86 | 31.67 | 30.04 | 35.91 | 1704 | 1611 |
| | EC 457161 | 4.05 | 3.42 | 6.68 | 2.78 | 11.58 | 9.42 | 3.99 | 3.95 | 7.86 | 3.11 | 13.54 | 11.19 | 49.16 | 37.51 | 38.67 | 52.51 | 2054 | 1778 |
| | EC457286 | 3.85 | 3.53 | 6.54 | 2.63 | 11.28 | 7.63 | 3.82 | 2.33 | 7.83 | 3.01 | 12.91 | 11.09 | 32.51 | 30.84 | 37.37 | 43.07 | 1981 | 1639 |
| | MEAN | 3.29 | 2.90 | 5.13 | 2.75 | 9.89 | 6.85 | 3.11 | 2.54 | 6.19 | 2.72 | 11.65 | 9.07 | 40.37 | 31.17 | 34.86 | 42.50 | 1700 | 1456 |
| MEDIUM | SL 525 | 2.75 | 2.68 | 6.41 | 3.54 | 11.48 | 5.68 | 3.22 | 2.75 | 7.97 | 3.79 | 13.21 | 7.73 | 35.01 | 27.51 | 33.11 | 40.95 | 1528 | 1425 |
| | SL 744 | 3.51 | 3.21 | 7.62 | 3.76 | 11.74 | 6.14 | 3.24 | 2.76 | 8.03 | 4.06 | 15.39 | 9.63 | 44.66 | 33.67 | 38.77 | 41.22 | 2169 | 1685 |
| | SL 955 | 2.28 | 2.01 | 5.48 | 2.94 | 10.12 | 4.86 | 2.85 | 2.48 | 5.29 | 2.54 | 13.43 | 6.32 | 39.17 | 26.66 | 35.11 | 32.26 | 1935 | 1294 |
| | SL 983 | 3.96 | 3.93 | 7.96 | 4.05 | 13.93 | 7.28 | 4.52 | 3.56 | 9.11 | 5.11 | 19.55 | 12.12 | 45.17 | 36.17 | 39.04 | 42.61 | 2345 | 2157 |
| | SL1123 | 2.51 | 2.29 | 5.71 | 2.08 | 11.41 | 4.35 | 2.72 | 2.56 | 7.09 | 3.06 | 16.71 | 6.42 | 34.34 | 29.34 | 35.44 | 29.43 | 1370 | 972 |
| | MEAN | 2.98 | 2.82 | 6.64 | 3.27 | 11.74 | 5.66 | 3.31 | 2.82 | 7.50 | 3.71 | 15.66 | 8.44 | 39.67 | 30.67 | 36.29 | 37.29 | 1869 | 1507 |
| LATE | SL900 | 2.84 | 2.69 | 3.76 | 2.11 | 9.51 | 5.89 | 3.04 | 2.23 | 4.67 | 2.66 | 12.11 | 9.99 | 30.17 | 30.84 | 27.11 | 34.39 | 1768 | 1667 |
| | SL 958 | 4.49 | 4.16 | 6.64 | 5.09 | 12.79 | 9.53 | 5.07 | 2.94 | 7.98 | 4.82 | 23.73 | 11.74 | 51.66 | 41.01 | 42.34 | 38.12 | 2370 | 2208 |
| | DS 12-5 | 3.86 | 3.52 | 4.77 | 5.06 | 10.05 | 8.52 | 3.74 | 3.13 | 5.64 | 2.31 | 13.56 | 9.31 | 40.84 | 40.01 | 35.44 | 36.35 | 1935 | 1657 |
| | DS 12-13 | 3.45 | 2.85 | 5.52 | 4.29 | 11.78 | 7.02 | 4.84 | 2.65 | 6.99 | 4.70 | 15.48 | 11.46 | 32.51 | 31.67 | 32.53 | 37.43 | 1843 | 1667 |
| | DS 26-14 | 3.68 | 3.56 | 6.29 | 3.23 | 11.63 | 7.48 | 3.72 | 2.47 | 7.34 | 3.59 | 15.41 | 10.43 | 43.51 | 30.67 | 36.84 | 32.22 | 1954 | 1863 |
| | MEAN | 3.65 | 3.36 | 5.40 | 3.96 | 11.15 | 7.69 | 4.08 | 2.68 | 6.52 | 3.62 | 16.06 | 10.59 | 39.74 | 34.84 | 34.85 | 35.70 | 1974 | 1812 |
| | LSD (0.05%) | 0.56 | 0.61 | 1.09 | 0.76 | 1.52 | 1.61 | 0.52 | 0.84 | 1.81 | 1.06 | 1.39 | 2.03 | 15.39 | 9.53 | 3.18 | 3.83 | 302.82 | 287.45 |
| | CV (%) | 17.28 | 11.89 | 11.46 | 13.57 | 8.29 | 14.25 | 9.01 | 18.03 | 16.11 | 19.10 | 5.76 | 12.98 | 20.87 | 17.76 | 5.37 | 5.96 | 10.05 | 10.31 |

LDMV=Leaf dry matter at vegetative LDMP=Leaf dry matter at flower initiation, LDMP=Leaf dry matter at pod initiation, SDMV= Stem dry matter at vegetative, SDMF= Stem dry matter at flower initiation, SDMP= Stem dry matter at pod initiation stage, DMH= Dry matter at harvest, HI=Harvest index.

**Table 2: Mean squares for analysis of variance pooled over planting dates for dry matter accumulation and yield.**

| Source of Variance | d.f. | LDMV | LDMF | LDMP | SDMV | SDMF | SDMP | DMH | Harvest index (%) | Plot Yield (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| Rep (within Env) | 4 | 0.53 | 0.55 | 0.848 | 0.18 | 0.11 | 0.2 | 284.44 | 2.475 | 401664.1 |
| Planting date | 1 | 0.04* | 127.68* | 393.72* | 10.09* | 258.43* | 582.73* | 1946.95* | 224.73* | 707237.4* |
| Genotypes | 14 | 2.79* | 4.16* | 6.71* | 1.90* | 6.01* | 98.28* | 192.95* | 35.55* | 232522.6* |
| Interaction | 14 | 0.38* | 4.07* | 7.20* | 0.93* | 3.61* | 46.99* | 91.05* | 17.97* | 31128.5* |
| Error | 56 | 0.43 | 0.31 | 0.86 | 0.17 | 0.78 | 4.42 | 61.25 | 1.08 | 20124.14 |

Note: * indicates significant at 0.05 level of significance

**Table 3: Correlation coefficients of different parameters with grain yield.**

| Parameter Studied | Normal Sowing | | | Late Sowing | | |
|---|---|---|---|---|---|---|
| | Early Maturity Genotypes | Medium Maturity Genotypes | Late Maturity Genotypes | Early Maturity Genotypes | Medium Maturity Genotypes | Late Maturity Genotypes |
| LDMV | 0.63 | 0.75 | 0.84 | 0.47 | 0.92 | 0.83 |
| LDMF | 0.79 | 0.72 | 0.75 | 0.43 | 0.91 | -0.18 |
| LDMP | 0.83 | 0.52 | 0.74 | 0.74 | 0.98** | 0.71 |
| SDMV | 0.98** | 0.79 | 0.66 | 0.82 | 0.89* | -0.20 |
| SDMF | 0.99** | 0.34 | 0.72* | 0.56 | 0.89* | 0.60 |
| SDMP | 0.95* | 0.44 | 0.95* | 0.94* | 0.96** | 0.63 |
| DMH | 0.55* | 0.97** | 0.92* | 0.89* | -0.03 | -0.25 |
| HI | 0.72 | 0.82* | 0.91* | 0.50 | 0.85 | 0.27 |

Note: ** indicates significant at 0.01 and * at 0.05 level of significance

## References:

Algan, N. and Celen, A.E. (2011). Evaluation of mungbean (Vigna radiata L.) as green manure in Aegean conditions in terms of soil nutrition under different sowing dates. Afri. J. Agril. Res., 6: 1744-1749.

Anderson, L.R. and Vasilas, B.L. (1985). Effects of planting date on two soybean cultivars: seasonal dry matter and seed yield. Crop Sci., 25: 999-1004.

Arashad, M., Ali, N. and Ghafoor, A. (2006). Character correlation and path coefficient in soybean Glycine max (L.) Merrill. Pak. J. Bot., 38(1): 121-130.

Billore, S. D., Ramesh, A., Vyas, A. K. and Joshi, O. P. (2009). Potassium-use efficiencies and economic optimization as influenced by levels of potassium and soybean (Glycine max) genotypes under staggered planting. Indian J agric Sci., 79: 510-14.

Board, J. E. and Harville, B. G. (1996). Growth dynamics during the vegetative period affects yield of narrow-row, late-planted soybean. Agron. J., 88: 567-572.

De Bruin, J.L. and Pedersen, P. (2009). New and old soybean cultivar responses to plant density and intercepted light. Crop Sci., 49: 2225-32.

Isler, N. and Caliskan, M.E. (1998). Correlation and path coefficient analysis for yield and some yield components of soybean (Glycine max L. Merr.) grown in south eastern Anatolia. Turkish J. Agri. and Forestry., 22:1-15.

Kumar, M. S., Singh, D. and Rao, V. U. M. (2005). Effect of planting dates on yield and yield components of soybean genotypes. Haryana J Agron., 21: 202-05.

Liu, F., Andersen, M.N. and Jensen, C.R. (2004). Root signal controls pod growth in drought-stressed soybean during the critical, abortion-sensitive phase of pod development. Field Crops Res., 85: 159–166.

Miah, M.A.K., Anwar, M.P., Begum, M., Juraimi, A.S. and Ialam, M.A. (2009). Influence of sowing date on growth and yield of summer mungbean varieties. J. Agric. Soc. Sci., 5: 73-76.

Patil, B.L., Hedge, V.S. and Saliath, P.M. (2003). Studies on genetic divergence over stress and non stress environment in mungbean. Indian J. Gent. Plant Breed., 63: 77-76.

Purcell, L.C., Ball, R. A., Reaper, J. D. and Vories, E.D. (2002). Radiation use efficiency and biomass production in soybean at different plant population densities. Crop Sci., 42: 172-77.

Reddy, A. A. (2009). Pulses production technology: Status and way forward. Eco.Polt. Weekly, 44: 73-80.

Sadeghipour, O. (2008). Response of mungbean varieties to different sowing dates. Pak. J. Biol.Sci., 11: 2048-50.

Samant, S.C., Rashid, M. H., Biswas, P. and Hasan, M.A. (1999). Performance of five cultivars of mungbean under different dates of sowing. Bangladesh J. Agric. Res., 24: 521-527.

Singh, Guriqbal., Sekhan, H.S., Ram, Hari., Gill, K.K. and Sharma, P. (2010). Effect of date of sowing on nodulation, growth, thermal requirement and grain yield of Kharif mungbean genotypes. J. Food Legumes., 23: 132-134.

Taiz, L. and Zeiger, E. (2002). Plant physiology.3rd edition. Sinauer Associates Publisher, 690 pages.

Trostle, C. and Bean, B. (2001). Effect of planting date and maturity group on soybean yield in the Texas south plains in 2001. [Online]. Texas Cooperative Extension. Available at http://lubbock.tamu.edu/othercrops/soybeandat.htm (verified 6 Nov 2006).

Veni, B. L., Murthy, V. R. K., Shaik, M. and Ramesh, G. I. (2003). Performance of soybean varieties to different sowing dates under rainfed conditions of southern Telangana Region of Andhra Pradesh. Res Crops., 4: 52-55.