

Sensitivity of Leaf Type of Soybean (Glycine max L.) to Photoperiodic Induction

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Abstract

The presented research focused to examine the Sensitivity of Leaf type of Soybean (*Glycine max* L.) to Photoperiodic Induction. The study was conducted at the Upper Sanraymundo Shiek Mustafa compound, Jolo, Sulu Philippines from May 19, 2024 to June 6, 2024. Table 1 shows the number of days to flowering and node position of the first flower of soybeans (*Glycine max*). Results revealed that sensitivity of different leaf type to photoperiodic induction significantly affected the number of days to flowering of soybeans. Cotyledonary stage (T1) significantly prolonged the days to flowering for 16 days. Meanwhile comparable effects were observed on unifoliate stage (T2), first trifoliate leaf stage (T3) and intact plant with no removal of foliage (T4) which floral induction were exhibited on (11, 12.33 and 10.33 days).

This study was conducted to determine the sensitivity of the different leaf types of soybeans to photoperiodic induction in terms of: Number of days to flowering, Node position of the first flower, Number of flowering nodes, Number of flowers per plants and Percent fruit set. This study was limited in determining whether sensitivity of the different leaf types to photoperiodic induction significantly affects the flower induction of soybeans.

This study was made through the Analysis of variance (ANOVA) and treatment mean comparison by the Least Significant Difference (LSD) was performed using STAR (Statistical Tool for Agricultural Research) program.

The findings showed for T1 is shown in Table 1 shows the number of days to flowering and node position of the first flower of soybeans (*Glycine max*). Results revealed that sensitivity of different leaf type to photoperiodic induction significantly affected the number of days to flowering of soybeans. Cotyledonary stage (T1) significantly prolonged the days to flowering for 16 days.

The findings showed for T2 is shown in Table 2. Number of flowers as influenced by sensitivity of different leaf types of soybeans (*Glycine max* L.) to photoperiod induction (May 19-June 6, 2024). Results demonstrated significant difference on the 2nd, 3rd, 4th, 5th and 6th data gathering on the number of flowers in soybeans as affected by different sensitivity of leaf type on photoperiodic induction. Treatment 4 (intact plant with no removal of foliage) significantly produce the highest number of flowers in soybean which were comparable with treatment 2 (unifoliate stage) and the control.

The findings showed for T3 is shown in Table 3 showed the number of flowering nodes of

soybean (starting from May 19- June 6, 2024). Results indicated that number of flowering nodes of soybean in the 3rd and 4th gathering was significantly affected by the sensitivity of different leaf type on photoperiodic induction. Treatment 4 (intact plant with no removal of foliage) significantly produced the highest number of flowering nodes which were comparable with Treatment 2 and the control.

The findings showed for T4 is shown in Table 4 shows the percent fruit set of soybeans. Results

revealed that sensitivity of different leaf type on photoperiodic induction significantly affects the percent fruit set of soybean. Control obtained the highest percentage of fruit setting which were comparable with Treatment 4,2 and 3).

Results suggested that removal of the soybean leaves subjected to 10 hours' photoperiodic induction had significantly affected horticultural characteristics of soybeans. Further studies should be conducted to validate the results.

Keywords: *soybean, photoperiodism, floral induction, leaf development, flowering time*

INTRODUCTION

Soybean (*Glycine max* L.) is a facultative short-day (SD) plant and is highly sensitive to photoperiod. It is one of the most extensively cultivated and consumed crops in the world, since it serves not only as a good source of protein and oil for the human diet and livestock feeding, but also as a biofuel. Photoperiodism is defined as the response to changes in daylength that enables plants to adapt to seasonal changes in their environment (Jackson, 2008). The effects of photoperiod on flowering in soybean have been well documented since early 20th century (Garner and Allard, 1920, 1923; Borthwick and Parker, 1938). Moreover, photoperiod has been found to play a major role in flower induction (Borthwick and Parker, 1938), floral organ differentiation (Zhang et al., 2001), microsporogenesis (Nielson, 1942), post flowering development (Johnson et al., 1960; Fisher, 1963; Thomas and Raper, 1976; Raper and Thomas, 1978; Guamet and Nakayama, 1984; Morandi et al., Han and Wang, 1995; Kantolic and Slafer, 2001), and yield formation of soybean (Mann and Jaworski, 1970; Raper and Thomas, 1978; Kantolic and Slafer, 2001).

Aside from photoperiod, temperature has a strong influence in plants' flowering behavior (Ha & Johnston, 2013). Each plant species or a cultivar requires a suitable temperature range for flower induction and development as demonstrated in a study by King et al. (2008). Temperature significantly influenced time to flowering in soybeans. In addition, significant interactions effect was observed between temperature and photoperiod (Summerfield and Wien, 1980). Steinberg and Garner (1936) found that warmer mean temperatures hastened the flowering of soybean up to an optimum of 28 °C and above which flower induction was delayed. Hence, responses to both photoperiod and temperature affect the growth, development, and yield formation of soybean. Thus, a study was conducted to determine the sensitivity of the different leaf types of soybeans to photoperiodic induction.

Research Problem

This study was conducted to determine the sensitivity of the different leaf types of soybeans to photoperiodic induction in terms of:

1. Number of days to flowering

2. Node position of the first flower
3. Number of flowering nodes
4. Number of flowers per plants
5. Percent fruit set

METHODOLOGY

Preparation of Planting Material

Soybean seeds used in the study were procured from Ramgo Seed Company. Seeds were sown in seedling trays filled with vermicast as planting media. After two weeks, healthy seedlings were transplanted in a plastic pot (9x9x11). Initially the plants were maintained under natural daylength conditions.

Seedling Care and Treatment Administration

The seedlings were watered regularly, and removal of weeds were done to avoid competition. From the time of transplanting until flowering, soybeans were exposed continuously under a short-day photoperiod at 10 hours/day, (from 7am to 5pm) upon the appearance of the required leaf. This was obtained by covering the plants with black cover from 5pm to 7am.

Experimental Design and Treatments

A study was laid out using Randomized Complete Block Design (RCBD) with one (1) sample per treatment replicated three (3) times. The treatments were designated as follows:

T0 - Control. The seedlings were with foliage intact and exposed to natural day (ND) length until flowering.

T1 - Cotyledonary stage. Seedlings' unifoliate leaf were removed leaving the cotyledons intact and exposed to short day (SD) condition. The cotyledons were maintained by cutting the succeeding shoots that emerged starting from the removal of the unifoliate leaf until flowering.

T2 – Unifoliate leaf stage. Seedlings' cotyledons and unifoliate leaf were left intact while the first trifoliate leaf were removed after its appearance and exposed to short day (SD) condition. Succeeding shoots that emerged after treatment were cut back.

T3 - First trifoliate leaf stage. Seedlings' cotyledons, unifoliate leaf and first trifoliate leaf were left intact and exposed to short day (SD) condition. The succeeding trifoliate leaf that emerged after treatment were cut back to maintain the condition until flowering.

T4 – Intact plant with no removal of foliage. The seedlings were exposed to short day (SD) condition after the appearance of the first trifoliate

RESULTS AND FINDINGS

Meteorological data

The daily photoperiod and noctoperiod hours throughout the duration of the study were taken from the records of Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) website (Figure 1a and 1b). Data showed gradual increased in photoperiodic hours with a corresponding decreased in noctoperiodic hours, all throughout the duration of the study. The mean minimum and maximum photoperiodic hours throughout the conduct of study were 12.26 and 12.35, respectively which were within the optimum requirement of soybean flower induction (Garner & Allard, 1930)

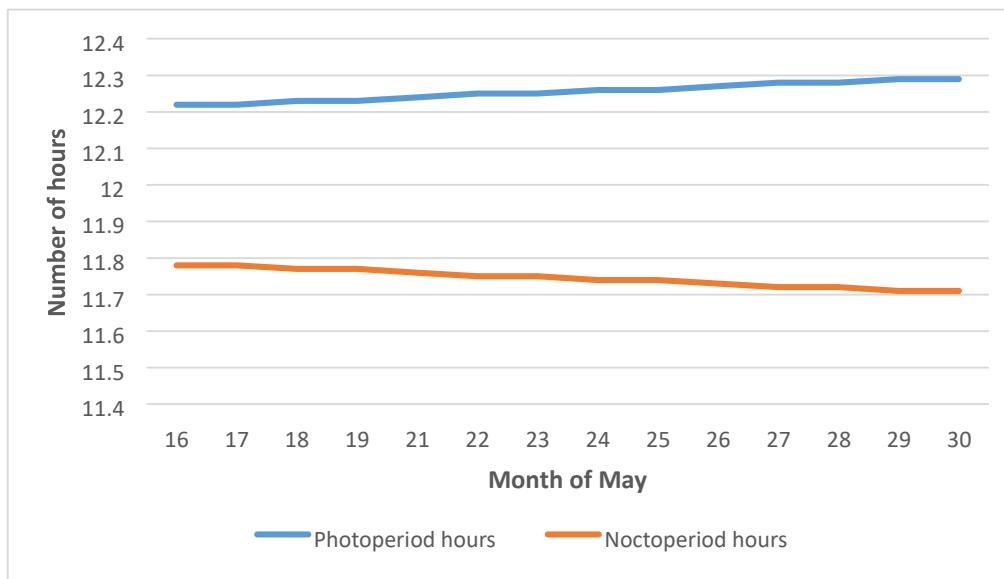


Figure 1a. Number of photoperiod and noctoperiod hours on the month of May.

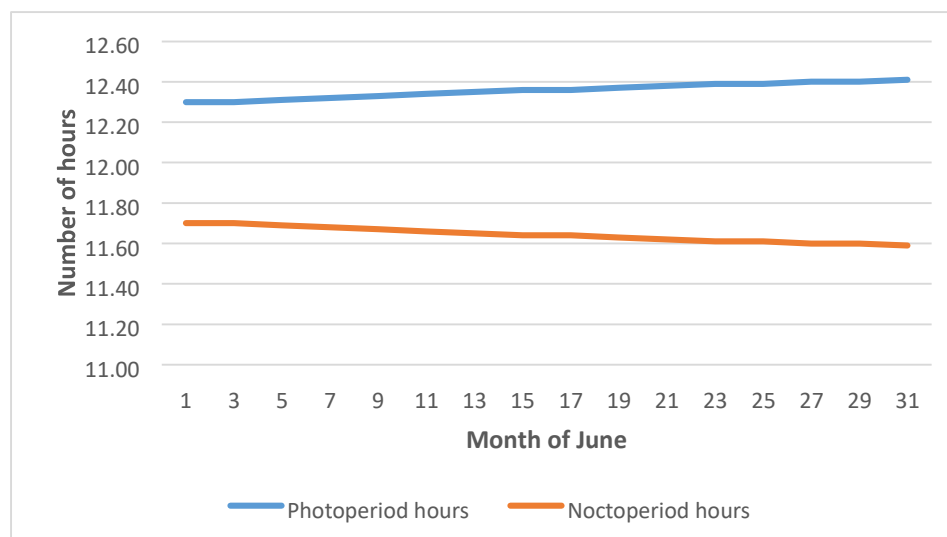


Figure 1b. Number of photoperiod and noctoperiod hours on the month of June.

Conclusions

Sensitivity of the different leaf types of soybean to photoperiodic induction significantly affected the number of days to flowering, number of flowers per plant, number of flowering nodes and percent fruit setting. Intact plant with no removal of foliage (T4) significantly induced earlier days to flowering, produced the greatest number of flowers as well as flowering nodes and flowering nodes and obtained a high percentage of fruit setting of soybeans. Comparable effects were also observed with the control in which it significantly induced the earliest days to flowering for at least 7.67 days, produced larger number of flowers as well as flowering nodes and obtain a high percentage of fruit setting in soybean. On the other hand, cotyledonary stage (T1) significantly prolonged the days to flowering, produce the least number of flowers, flowering nodes as well as fruit setting in soybean. Photoperiod is the major environmental factor regulating flowering, fruit setting and development of soybean.

Recommendations

Results suggested that removal of the soybean leaves subjected to 10 hours' photoperiodic induction had significantly affected horticultural characteristics of soybeans. Further studies should be conducted to validate the results.

REFERENCES

- Allen, L. H., Zhang, L. X., Boote, K. J., & Hauser, B. A. (2018). Elevated temperature intensity, timing, and duration of exposure affect soybean internode elongation, main stem node number, and pod number per plant. *The Crop Journal*, *6*(2), 148–161.
- Amasino, R. (2010). Seasonal and developmental timing of flowering. *The Plant Journal*, *61*(6), 1001–1013.
- Batley, N. H., & Lyndon, R. F. (1990). Reversion of flowering. *The Botanical Review*, *56*(2), 162–189.
- Borthwick, H. A., & Parker, M. W. (1938). Influence of photoperiods upon the differentiation of meristems and the blossoming of Biloxi soybeans. *Botanical Gazette*, *99*(4), 825–839.
- Borthwick, H. A., & Parker, M. W. (1938). Photoperiodic perception in Biloxi soybeans. *Botanical Gazette*, *100*(2), 374–387.
- Borthwick, H. A., & Parker, M. W. (1939). Photoperiodic responses of several varieties of soybeans. *Botanical Gazette*, *101*(2), 341–365.
- Borthwick, H. A., & Parker, M. W. (1940). Floral initiation in Biloxi soybeans as influenced by age and position of leaf receiving photoperiodic treatment. *Botanical Gazette*, *101*(4), 806–817.
- Cai, Y. P., Wang, L. W., Chen, L., Wu, T. T., Liu, L. P., Sun, S., Wu, C. X., Yao, W. W., Jiang, B. J., Yuan, S., Han, T. F., & Hou, W. S. (2019). Mutagenesis of GmFT2a and GmFT5a mediated by CRISPR/Cas9 contribute for expanding the regional adaptability of soybean. *Plant Biotechnology Journal*, *18*(1), 298–309.

- Cober, E. R., & Morrison, M. J. (2010). Regulation of seed yield and agronomic characters by photoperiod sensitivity and growth habit genes in soybean. *Theoretical and Applied Genetics*, *120*(5), 1005–1012.
- Fernández, V., Takahashi, Y., Le Gourriec, J., & Coupland, G. (2016). Photoperiodic and thermosensory pathways interact through CONSTANS to promote flowering at high temperature under short days. *The Plant Journal*, *85*(6), 1011–1012.
- Fisher, J. E. (1963). The effect of short days on fruitset as distinct from flower formation in soybeans. *Canadian Journal of Botany*, *41*(6), 871–873.
- Garner, W. W., & Allard, H. A. (1920). Effect of the relative length of day and night and other factors of the environment on growth and reproduction in plants. *Journal of Agricultural Research*, *18*(11), 553–606.
- Garner, W. W., & Allard, H. A. (1923). Further studies in photoperiodism, the response of the plant to relative length of day and night. *Journal of Agricultural Research*, *23*(12), 871–920.
- Garner, W. W., & Allard, H. A. (1933). Comparative responses of long-day and short-day plants to relative length of day and night. *Plant Physiology*, *8*(2), 347–356.
- Gaynor, L. G., Lawn, R. J., & James, A. T. (2011). Agronomic studies on irrigated soybean in southern New South Wales. I. Phenological adaptation of genotypes to sowing date. *Crop and Pasture Science*, *62*(12), 1056–1066.
- Guamet, J. J., & Nakayama, F. (1984). The effects of long days upon reproductive growth in soybeans, *Glycine max*, L. Merr. cv. Williams. *Japanese Journal of Crop Science*, *53*(1), 35–40.
- Ha, T. M., & Johnston, M. E. (2013). The effect of low temperature on flowering of *Rhodanthe floribunda*. *Asian Journal of Agriculture and Food Sciences*, *1*(5), 205–209.
- Hamakareem, F. H., Ali, S. H. H., Hamahasan, B. M., Omerhammar-Umin, B., Hussain, S. A., & Mohammed, K. A. (2015). Comparison of some growth and yield performance of soybean varieties (*Glycine max* L.). *International Journal of Plant, Animal and Environmental Sciences*, *5*(4), 1–7.
- Hamner, K. C., & Bonner, J. (1938). Photoperiodism in relation to hormones as factors in floral initiation and development. *Botanical Gazette*, *100*(2), 388–431.
- Han, T. F., & Wang, J. L. (1995). Studies on the post-flowering photoperiodic responses in soybean. *Acta Botanica Sinica*, *37*(11), 863–869. (in Chinese)
- Han, T. F., Gai, J. Y., Wang, J. L., & Zhou, D. X. (1998). Discovery of flowering reversion in soybean plants. *Acta Agronomica Sinica*, *24*(2), 168–171. (in Chinese)
- Han, T. F., Wang, J. L., Fan, B. B., Yao, W. Q., & Yang, Q. K. (1996). Effect of post-flowering daylength on agronomic characters of soybean. *Chinese Journal of Applied Ecology*, *7*(2), 169–173. (in Chinese)
- Han, T. F., Wu, C. X., Tong, Z., Mentreddy, R. S., Tan, K. H., & Gai, J. Y. (2006). Postflowering photoperiod regulates vegetative growth and reproductive development of soybean. *Environmental and Experimental Botany*, *55*(1–2), 120–129.

- Howell, R. W., & Cartter, J. L. (1953). Physiological factors affecting composition of soybeans. I. Correlation of temperatures during certain portions of the pod filling stage with oil percentage in mature beans. *Agronomy Journal*, *45*(11), 526–528.
- Howell, R. W., & Cartter, J. L. (1958). Physiological factors affecting composition of soybeans. II. Response of oil and other constituents of soybeans to temperature under controlled conditions. *Agronomy Journal*, *50*(12), 664–667.
- Jackson, S. D. (2009). Plant responses to photoperiod. *New Phytologist*, *181*(3), 517–531. <https://doi.org/10.1111/j.1469-8137.2008.02681.x>
- Jiang, B. J., Nan, H. Y., Gao, Y. F., Tang, L. L., Yue, Y. L., Lu, S. J., Ma, L. M., Cao, D., Sun, S., Wang, J. L., Wu, C. X., Yuan, X. H., Hou, W. S., Kong, F. J., Han, T. F., & Liu, B. H. (2014). Allelic combinations of soybean maturity loci E1, E2, E3, and E4 result in diversity of maturity and adaptation to different latitudes. *PLoS ONE*, *9*(8), e106042.
- Jiang, Y., Wu, C. X., Zhang, L. X., Hu, P., Hou, W. S., Zu, W., & Han, T. F. (2011). Long-day effects on the terminal inflorescence development of a photoperiod-sensitive soybean [*Glycine max* (L.) Merr.] variety. *Plant Science*, *180*(3), 504–510.
- Johnson, H. W., Borthwick, H. A., & Leffel, R. C. (1960). Effect of photoperiod and time of planting on rates of development of the soybean in various stages of the life cycle. *Botanical Gazette*, *122*(2), 77–95.
- Kantolic, A. G., & Slafer, G. A. (2001). Photoperiod sensitivity after flowering and seed number determination in indeterminate soybean cultivars. *Field Crops Research*, *72*(2), 109–118.
- Kantolic, A. G., & Slafer, G. A. (2005). Reproductive development and yield components in indeterminate soybean as affected by post-flowering photoperiod. *Field Crops Research*, *93*(2–3), 212–222.
- King, R. W., Worrall, R., & Dawson, I. A. (2008). Diversity in environmental controls of flowering in Australian plants. *Scientia Horticulturae*, *118*(2), 161–167.
- Krishnan, H. B. (2000). Biochemistry and molecular biology of soybean seed storage proteins. *Journal of New Seeds*, *2*(3), 1–25.
- Mann, J. D., & Jaworski, E. G. (1970). Comparison of stresses which may limit soybean yield. *Crop Science*, *10*(6), 620–624.
- Mao, T. T., Li, J. Y., Wen, Z. X., Wu, T. T., Wu, C. X., Sun, S., Jiang, B. J., Hou, W. S., Li, W. B., Song, Q. J., Wang, D. C., & Han, T. F. (2017). Association mapping of loci controlling genetic and environmental interaction of soybean flowering time under various photo-thermal conditions. *BMC Genomics*, *18*(1), 415.
- Morandi, E. N., Casano, L. M., & Reggiardo, L. M. (1988). Post-flowering photoperiodic effect on reproductive efficiency and seed growth in soybean. *Field Crops Research*, *18*(4), 227–241.
- Nielson, C. S. (1942). Effects of photoperiod on microsporogenesis in Biloxi soybean. *Botanical Gazette*, *104*(1), 99–106.
- Pan, T. F., Zhang, D. R., Zhang, W. G., & Li, C. R. (1982). Agricultural climatic ecologic factor of soybean in Northeast China. *Journal of Jilin Agricultural Sciences*, *2*, 17–28. (in Chinese)
- Pan, T. F., Zhang, D. R., & Zhang, W. G. (1985). Agricultural climatic ecologic factor of soybean in China. *Soybean Science*, *4*(2), 105–116. (in Chinese)

- Parker, M. W., Hendricks, S. B., Borthwick, H. A., & Scully, N. J. (1946). Action spectrum for the photoperiodic control of floral initiation of short-day plants. *Botanical Gazette*, *108*(1), 1–26.
- Rahman, M. M., Hampton, J. G., & Hill, M. J. (2006). Soybean development under the cool temperate environment of Canterbury, New Zealand. *Journal of New Seeds*, *7*(4), 17–36.
- Raper, C. D., Jr., & Thomas, J. F. (1978). Photoperiodic alteration of dry matter partitioning and seed yield in soybean. *Crop Science*, *18*(4), 654–656.
- Roberts, R. H., & Struckmeyer, B. E. (1939). Further studies of the effects of temperature and other environmental factors upon the photoperiodic responses of plants. *Journal of Agricultural Research*, *59*(10), 699–709.
- Shurtleff, W., & Aoyagi, A. (2007). *The soybean plant: Botany, nomenclature, taxonomy, domestication and dissemination*. Soyinfo Center.
- Srikanth, A., & Schmid, M. (2011). Regulation of flowering time: All roads lead to Rome. *Cellular and Molecular Life Sciences*, *68*(12), 2013–2037.
- Steinberg, R. A., & Garner, W. W. (1936). Response of certain plants to length of day and temperature under controlled conditions. *Journal of Agricultural Research*, *52*(12), 943–960.
- Summerfield, R. J., & Wien, H. C. (1980). Effects of photoperiod and air temperature on growth and yield of economic legumes. In R. J. Summerfield & A. H. Bunting (Eds.), *Advances in legume science* (pp. 17–36). HMSO.
- Thomas, B., & Vince-Prue, D. (1997). *Photoperiodism in plants* (2nd ed.). Academic Press.
- Thomas, J. F., & Raper, C. D., Jr. (1976). Photoperiodic control of seed filling for soybeans. *Crop Science*, *16*(5), 667–672.
- Upadhyay, A. P., Ellis, R. H., Summerfield, R. J., Roberts, E. H., & Qi, A. (1994). Characterization of photothermal flowering responses in maturity isolines of soybean [*Glycine max* (L.) Merrill] cv. Clark. *Annals of Botany*, *74*(1), 87–96.
- US Soybean Export Council. (2008). *How the global oilseed and grain trade works*. Soyatech, LLC.
- Washburn, C. F., & Thomas, J. F. (2000). Reversion of flowering in *Glycine max* (Fabaceae). *American Journal of Botany*, *87*(10), 1425–1438.
- Wong, C. E., Singh, M. B., & Bhalla, P. L. (2013). The dynamics of soybean leaf and shoot apical meristem transcriptome undergoing floral initiation process. *PLoS ONE*, *8*(6), e65319.
- Wu, C. X., Ma, Q. B., Yam, K. M., Cheung, M. Y., Xu, Y. Y., Han, T. F., Lam, H. M., & Chong, K. (2006). In situ expression of the GmNMH7 gene is photoperiod-dependent in a unique soybean (*Glycine max* [L.] Merr.) flowering reversion system. *Planta*, *223*(4), 725–735.
- Xu, M. L., Yamagishi, N., Zhao, C., Takeshima, R., Kasai, M., Watanabe, S., Kanazawa, A., Yoshikawa, N., Liu, B. H., Yamada, T., & Abe, J. (2015). The soybean-specific maturity gene E1 family of floral repressors controls night-break responses through down-regulation of FLOWERING LOCUS T orthologs. *Plant Physiology*, *168*(4), 1735–1746.
- Zhang, L., Wang, R., & Hesketh, J. D. (2001). Effects of photoperiod on growth and development of soybean floral bud in different maturity. *Agronomy Journal*, *93*(4), 944–948.