AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: AGRICULTURE

B. SECONDARY: LEGUME CROPS

2. TITLE AND SUBTITLE

Photoperiod response in mungbeans (Vigna radiata /L./ Wilczek)

3. AUTHOR(S)

Bashandi,M.M.H.; Poehlman, J.M.

4. DOCUMENT DATE: 1974

5. NUMBER OF PAGES: 7p.

6. ARC NUMBER: ARC 635.65-B299a

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Missouri University
Department of Agronomy
Columbia, Missouri 65201

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

(In Euphytica,v.23,p.691-697)

9. ABSTRACT

Five strains of mungbeans were grown at 8-,12-,14-,15-, and 16-hour photoperiods in plant environmental chambers. The strains did not differ in 'days to flower' at the 8- and 12-hour photoperiods, but flowering was delayed and plant height increased differentially when the photoperiod was increased beyond 12 hours. Two strains exhibited only slight sensitivity over the range of photoperiods studied. Two strains failed to flower within 180-day period at the 16-hour photoperiod. The results corroborate observations in the First International Mungbean Nursery in which 28 strains grown at low latitudes (short photoperiods) had a narrow range in days to flowering, with the range becoming wider at the higher latitudes (longer photoperiods). The results provide evidence that response to photoperiod is important in the adaptation of mungbean strains in different latitudes.

10. CONTROL NUMBER: PN-AAB-100

11. PRICE OF DOCUMENT:

12. DESCRIPTORS: Plant Environmental Chambers, Days to Flower, Plant Height, Latitudes

13. PROJECT NUMBER: 931-11-130-103

14. CONTRACT NUMBER: CSD-1921 211(d)

15. TYPE OF DOCUMENT: Research Bulletin

AID 590-1 (4-74)

Euphytica 23 (1974) 691–697

PHOTOPERIOD RESPONSE IN MUNGBEANS (*VIGNA RADIATA* (L.) WILCZEK)[1]

MOHEB M. H. BASHANDI and J. M. POEHLMAN

Department of Agronomy, University of Missouri, Columbia, Missouri 65201, USA

Received 5 February 1974

SUMMARY

Five strains of mungbeans were grown at 8-, 12-, 13-, 14-, 15-, and 16-hour photoperiods in plant environmental chambers. The strains did not differ in 'days to flower' at the 8- and 12-hour photoperiods, but flowering was delayed and plant height increased differentially when the photoperiod was increased beyond 12 hours. Two strains exhibited only slight sensitivity over the range of photoperiods studied. Two strains failed to flower within a 180-day period at the 16-hour photoperiod. The results corroborate observations in the First International Mungbean Nursery in which 28 strains grown at low latitudes (short photoperiods) had a narrow range in days to flowering, with the range becoming wider at the higher latitudes (longer photoperiods). The results provide evidence that response to photoperiod is important in the adaptation of mungbean strains in different latitudes.

INTRODUCTION

Little information has been published on the response of the mungbean (*Vigna radiata* (L.) WILCZEK) to different photoperiods. ALLARD & ZAUMEYER (1944) classified the mungbean as a short-day crop because long photoperiods delayed flowering. They reported the average number of days to flowering to be 30 with a photoperiod of 10 through 13.5 h, 35 with photoperiods of 14 through 14.5 h, and 77 with photoperiods of 18 h. The heights of the plants were also increased in the longer photoperiods. HARTMANN (1969) reported that a strain of mungbeans, PI 291366 from China, was day neutral. YOHE & POEHLMAN (1972), in a study at Columbia, Missouri, involving 321 strains of mungbeans originating from a wide range of latitudes, reported a range of 57 to 117 days from planting to date of first ripe pods, with a mean of 81 days. Three strains, PI205137 from India, PI207655 from the Philippines, and PI-305077 from Thailand, failed to flower before frost (135 days after planting).

The research reported here was initiated to study differences in the photoperiod response of individual strains of mungbeans. The results provide evidence that response to photoperiod is important in the adaptation of particular mungbean strains to production areas at different latitudes and seasons.

MATERIALS AND METHODS

Five experimental strains of mungbeans with an average range in days to flowering of 46 to 63 days in a three-year study at Columbia, Missouri, were chosen for the experiment. The strains, their country of origin, and days to flowering in the field at Colum-

[1] Contribution No. 6890 from the Missouri Agricultural Experiment Station.

Table 1. USDA PI number, UMC accession number, country of origin, and days to flower in the field at Columbia, Missouri, of mungbean strains used in the experiment.

USDA PI number[1]	UMC accession number[2]	Country of origin	Days to flower[3]
PI368291	M28	India	63
PI 31290	M140	Unknown	46
PI271401	M101	India	52
PI180311	M118	India	63
PI374150	M370	Korea	57

[1] Plant Introduction number of the United States Department of Agriculture.
[2] Accession number of the University of Missouri, Columbia.
[3] Average of three-years (1970–1972).

bia are listed in Table 1. PI368291 was obtained from the Pulses Research Station, Nayagarh (Orissa State), India; PI271401 and PI180311 from the Oklahoma Agricultural Experiment Station, Stillwater; PI31290 from the U. S. Department of Agriculture, Plant Introduction Station, Experiment, Georgia; and PI374150 from the Crop Experiment Station, Suwon, Korea.

The photoperiod studies were conducted in three Sherer plant environmental chambers (model 25-7-HL). The light sources in each chamber were a combination of ten 40-watt fluorescent bulbs (Sylvania cool white, VHO, reflectorized) and twelve 25-watt incandescent bulbs. The light intensity of the combined fluorescent and incandescent bulbs measured approximately 3200 f.c. at 30 cm below the light source. The temperatures were programmed to increase from 18 °C at the midpoint of the dark period to 28 °C at the midpoint of the full light period, and then to decrease to 18 °C again, giving a mean daily temperature of 23 °C.

The study was divided into two parts (A and B). In part A the combined fluorescent and incandescent bulbs burned for a period of 8 h in each chamber. One chamber was maintained at this photoperiod of 8 h; in the second chamber the photoperiod was extended to 12 h by burning the incandescent bulbs only for two hours preceding and after the full light period; and in the third chamber the photoperiod was extended to 16 h by burning the incandescent bulbs for four hours preceding and four hours after the full light period. Part A was repeated to provide for replication of data.

This initial study indicated to us that effective photoperiods were in the 12- to 16-hour range and that the 8-hour photoperiod was less than the photoperiod needed to initiate a differential flowering response. Part B was then set up with 13-, 14-, and 15-hour photoperiods. The light regimes were similar to those in part A except that the combined fluorescent and incandescent bulbs were permitted to burn for 12 h and the light period extended to 13, 14, and 15 h by burning the incandescent bulbs for equal periods before and after the full light period as before. Replication was obtained by repeating the experiment as with A.

The mungbeans were grown in a mixture of equal parts soil, peat, and vermiculite in 15 cm plastic pots. Seeds were sterilized in 1.5% sodium hypochlorite solution, washed, soaked overnight, and inoculated with a commercial culture of *Rhizobium* before planting. Four pots with two plants in each were grown for each strain in the

first replication of A, but the number of plants were incraesed to four per pot in the second replication of A and to eight plants per pot in B. Emergence was uniform, occurring on the 6th or 7th day after planting the imbibed seeds. Plants were watered with distilled water and a nutrient solution containing N, P, and K was added weekly.

Days to flower were recorded as number of days from planting to opening of the first flower on each plant. Height of plant was recorded at the time of flowering. Data for plants, which varied in number from 4 to 16, were averaged to give a replication mean. An analysis of variance for days to flower could not be run over the entire experiment since two varieties failed to flower with the 16-hour photoperiod. Therefore analyses have been run separately for each strain (among photoperiods) and for each photoperiod (among varieties), for both days to flower and height.

RESULTS

The days to flower for the five mungbean strains at 12-, 13-, 14-, 15-, and 16-hour photoperiods are shown in Fig. 1. Mean squares and coefficients of variation from an analyses of variance, calculated separately for each photoperiod (among strains) and for each strain (among photoperiods), are presented in Table 2.

In the 8-hour photoperiod (not included in Fig. 1), first flowers were observed in all

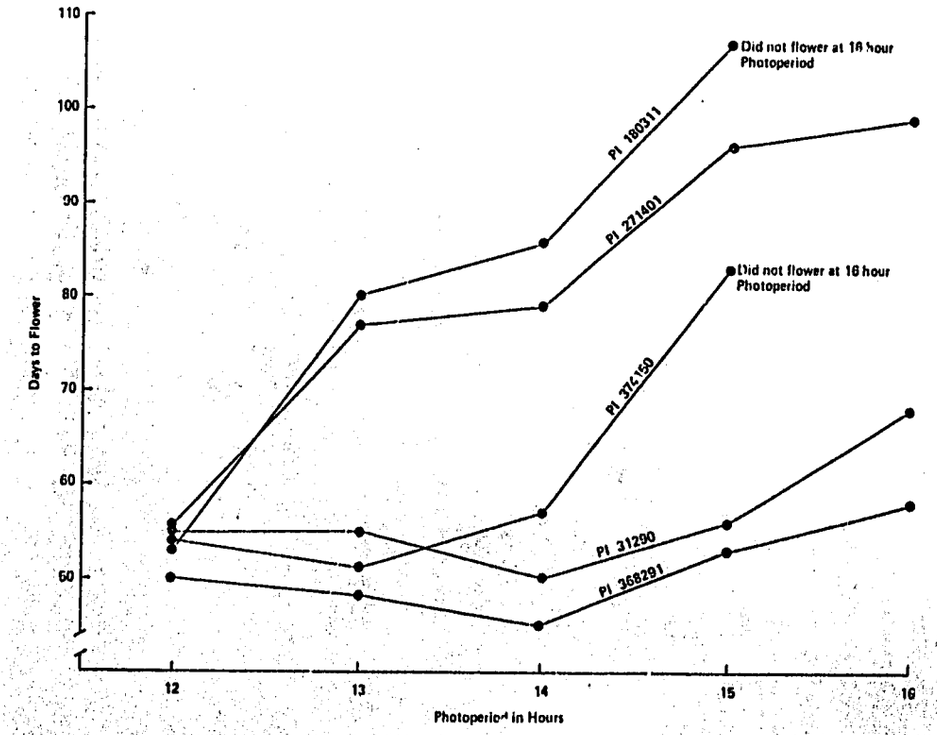

Fig. 1. Days to flower for five mungbean strains grown in photoperiods of 12-, 13-, 14-, 15-, and 16-hours.

Table 2. Mean squares and coefficients of variation for 'days to flower' and plant height for five mungbean strains grown in 12-, 13-, 14-, 15-, and 16-hours photoperiods.

Source of variance	D.F.	'Days to flower' mean squares	C.V.	Height (cm) mean squares	C.V.
Among strains					
12-hour photoperiod	4	1.7ns	0.042	19.5*	0.064
13-hour photoperiod	4	453.9**	0.070	39.9*	0.130
14-hour photoperiod	4	676.5**	0.093	125.6ns	0.069
15-hour photoperiod	4	1215.7**	0.152	130.7*	0.111
16-hour photoperiod	4	n.f.		286.0**	0.027
Among photoperiods					
PI368291	4	54.0ns	0.140	33.5**	0.074
PI 31290	4	93.2ns	0.072	329.9**	0.097
PI271401	4	615.8*	0.117	278.2*	0.187
PI180311	4	n.f.		121.5ns	0.243
PI374150	4	n.f.		364.8**	0.083
Strains × photoperiods	16	n.f.		48.8*	0.016
Replications	1	62.4ns		20.4ns	

*, ** = Significant at 0.05 and 0.01 levels of probability, respectively.
n.f. = non-flowering (strains PI180311 and PI374150 did not flower at 16-hour photoperiod).

strains during the 51 to 59 day period after planting. In the 12-hour photoperiod all strains flowered during the 50 to 55 day period after planting. Differences among strains were not statistically significant at the 8-hour and the 12-hour photoperiods. As the photoperiod was increased the spread in days to flowering among strains increased and the differences among strains exceeded the 0.01 level of significance at each the 13-, 14-, and 15-hour photoperiods. At the 16-hour photoperiod two strains failed to flower within 180 days after which the experiment was discontinued.

Examining the flowering response of individual strains over the five photoperiods it may be noted that over the 12- through 15-hour range of photoperiods, PI368291 varied from 45 to 53 in days to flower and that PI31290 varied from 50 to 56 days. Days to flowering were further increased by five for PI368291 and by 12 for PI31290 in the 16-hour photoperiod; however, the analysis of variance indicated that differences in days to flower over the entire range of photoperiods were not significant for either variety. Days to flower for PI374150 varied from 51 to 57 days for the photoperiod range of 12- through 14-hours. In the 15-hour photoperiod, flowering of PI374150 was delayed until 83 days, at 16-hours it did not flower within 180 days. Flowering of PI271401 was delayed in the 13-hour photoperiod by 22 days compared to the 12-hour photoperiod, and by 27 days for PI180311. The latter, like PI374150, did not flower at the 16-hour photoperiod within a 180-day period.

With the delay in flowering in the longer photoperiods, there was also an increase in height of the mungbean plants. This is illustrated in Fig. 2 and 3. Analysis of variance of the height data is included in Table 2. Height measurements were made at the time of flowering except for PI180311 and PI374150 in the 16-hour photoperiod which were measured 180 days after planting. PI368291, which was the earliest strain to

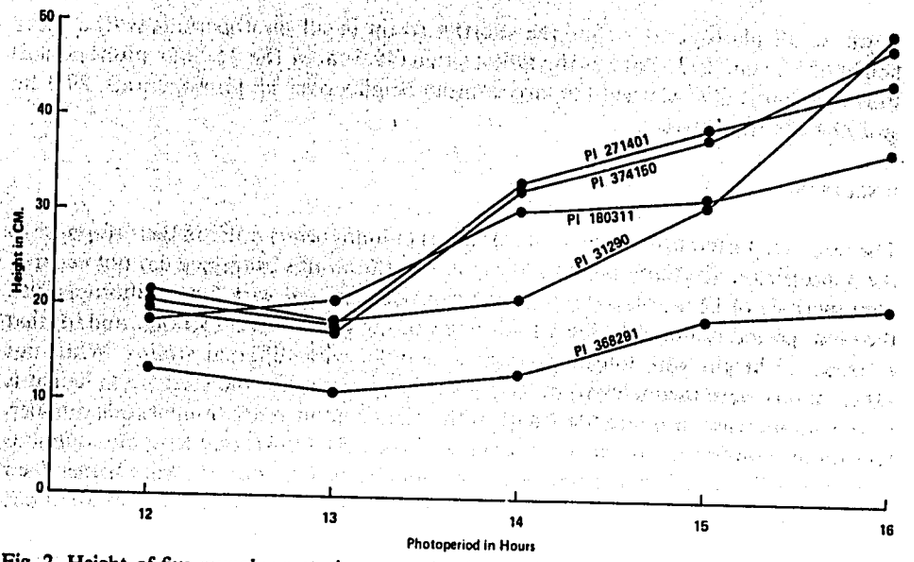

Fig. 2. Height of five mungbean strains grown in photoperiods of 12-, 13-, 14-, 15-, and 16-hours.

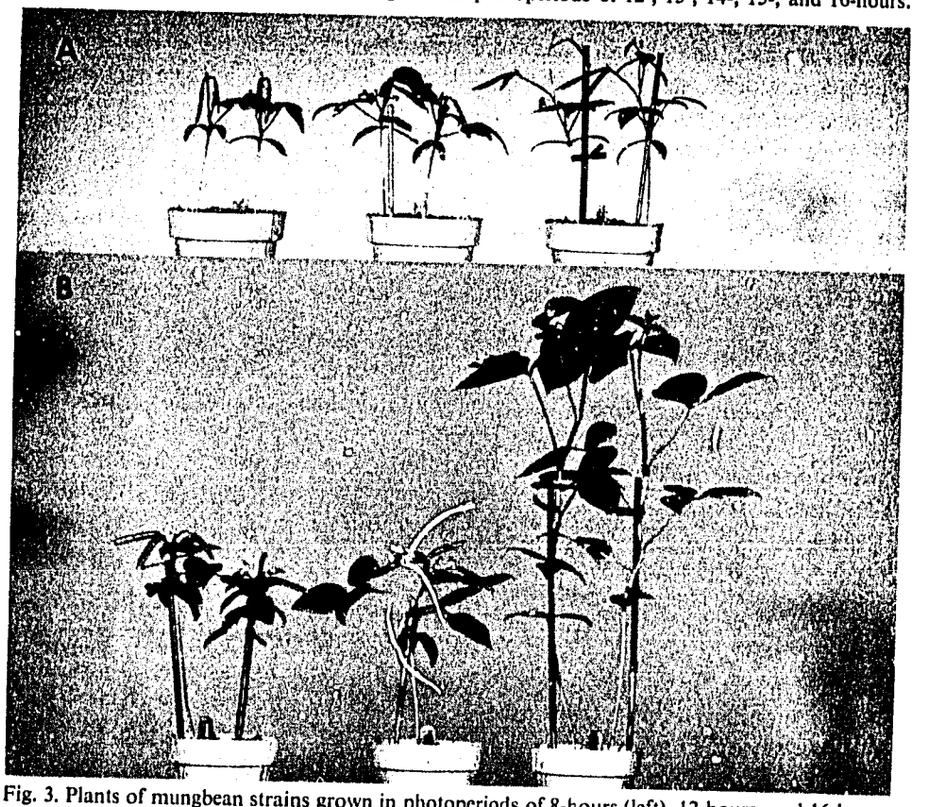

Fig. 3. Plants of mungbean strains grown in photoperiods of 8-hours (left), 12-hours, and 16-hours. A. PI368291. B. PI271401. Photos taken at 78 days after planting.

flower in all photoperiods, was the shortest strain in all photoperiods with a mean height of 14.9 cm. PI31290 was the tallest strain (49.5 cm in the 16-hour photoperiod) PI374150 and PI271401 had the largest mean heights over all photoperiods, 29.9 cm and 29.1 cm, respectively.

DISCUSSION

The results reported here affirm that (a) strains of mungbeans differ in their response to the photoperiod, (b) that differential response in the strains examined did not occur at photoperiods of 12 h or less, (c) that flowering was delayed with longer photoperiods, the photoperiod required to delay flowering varying with different strains, and (d) that increases in height with longer photoperiods differ with different strains. While our observations were inconclusive on this point, it appears that the increase in height is largely an increase in internode length with little or no increase in internode number. Our results confirm the report of ALLARD & ZAUMEYER (1944) that long photoperiods delay flowering and increase height in the mungbean. It is not known whether their experiments were limited to a single strain or whether they examined more than one strain, since varieties or strains examined by them are not identified.

HARTMAN (1969) reported the PI291366 strain of mungbeans to be day neutral. Our results affirm strains PI368291 and PI31290 to be less sensitive than the other strains examined, and indeed the statistical analysis of the data for these two strains indicates that there were no significant differences in date of flowering over the range of photoperiods used. There were significant differences in height. We believe the terms day-neutral or insensitive should be used cautiously unless the strain has been tested over a wide array of photoperiods. In our experiment, PI368291 and PI31290 were relatively uniform in days to flowering over the 8- through 15-hour photoperiod range, and might be classed day-neutral if we looked only at that portion of the data. However, flowering was delayed slightly in both strains when the photoperiod was increased to 16-hours. Height in PI368291 also increased slightly in the 15- and 16-hour photoperiods.

It may be noted that PI368291 was one of the two latest to flower in the field at Columbia over a three-year period (Table 1). PI368291 originated in Orissa, India, where local strains are normally grown during December and January when the photoperiod is less than 12 hours. Late flowering in the field at Columbia may be due in part to virus injury which may delay flowering or cause abortion of the flower buds. These virus symptoms were never observed in the plant environment chambers.

The data reported here were supported in the report of the performance of the First International Mungbean Nursery. POEHLMAN et al. (1973) reported flowering and height observations on 28 mungbean strains grown at six locations which lie between 8° and 16° N latitude and at 3 locations between 37° and 47° N latitude. In the lower latitudes the range in days to flower for the 28 strains varied from 2 to 15 with a mean range for the six locations of 7 days. In the higher latitudes the range in days to flower varied from 22 to 49 with a mean range for the three locations of 35 days. Mean plant height at the low latitudes was 40.3 cm and at the high latitudes 63.5 cm. Data from both the plant environment chambers and the First International Mungbean Nursery emphasize that strain differences in photoperiod response will not be observed, or

certainly it will be less evident, when mungbeans are grown in the short days of the tropics as compared to growing them in the longer days of the temperate climates.

The photoperiod response of mungbean strains reported here does not differ in substance from the kind of photoperiod response reported among soybean (*Glycine max* (L.) MERRILL) strains by van SCHAIK & PROBST (1958), BYTH (1968), and CRISWELL & HUME (1972). BYTH used extremely late cultivars and CHRISWELL & HUME used very early cultivars. Both showed variability among strains in optimum photoperiod but very little insensitivity to photoperiod.

ACKNOWLEDGMENTS

This research was taken in part from an M.S. thesis presented to the University of Missouri graduate school by Mr Moheb M. H. Bashandi. Financial support for this research has been given by the United States Agency for International Development.

REFERENCES

ALLARD, H. A. & W. J. ZAUMEYER, 1944. Responses of beans (*Phaseolus*) and other legumes to length of day. U.S. Dept. of Agric. Tech. Bull. 867.

BYTH, D. E., 1968. Comparative photoperiodic responses for several soya bean varieties of tropical and temperate origin. Aust. J. agric. Res. 19:879–90.

CRISWELL, J. G. & D. J. HUME, 1972. Variation in sensitivity to photoperiod among early maturing soybean strains. Crop Sci. 12:657–660.

HARTMANN, RICHARD W., 1969. Photoperiod response of *Phaseolus* plant introductions in Hawaii. J. Amer. Soc. hort. Sci. 94:437–440.

POEHLMAN, J. M., DALE T. SECHLER, JOHN M. YOHE, EARL E. WATT, RICHARD E. SWINDELL & MOHEB M. H. BASHANDI, 1973. Performance of the first international mungbean nursery. Missouri agric. Exp. St. Special Report No. 184.

SCHAIK, P. H. VAN & A. H. PROBST, 1958. Effects of some environmental factors on flower production and reproductive efficiency in soybeans. Agron. J. 50:192–197.

YOHE, JOHN M. & J. M. POEHLMAN, 1972. Genetic variability in the mungbean, *Vigna radiata* (L.) WILCZEK. Crop Sci. 12:461–464.