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EFFECT OF PLANTING DATE ON DEVELOPMENTAL PHASES IN DETERMINATE AND INDETERMINATE SOYBEAN CULTIVARS

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Determinate and indeterminate soybean types (*Glycine max* (L.) Merr.) have different growth habits. The present investigations determined the behaviour of two determinate (Lee, MG VI and Essex MG V) and one indeterminate (Williams MG III) cultivars at latitude of 34.1 N at NWFP Agricultural University Peshawar, when planted from April to July at 15 days intervals. Number of days to vegetative and reproductive stages were reduced with late planting in determinates. In indeterminate number of days to reproductive stages were not affected by planting dates. In Williams reproductive phase initiated earlier than Lee and Essex. The number of days to maturity declined with each successive planting date for all cultivars. The maturity date of Williams was affected more by planting date than those of Lee and Essex.

Key words: *Glycine max* (L.) Merr., Planting date, Developmental phase.

Introduction

Soybean *Glycine max* (L.) Merr. is a highly complex photosensitive plant having determinate and indeterminate growing habits, with several maturity groups and many other morphological differenciations. Habit of growth is determined [1] by stem termination which has tremendous effect on plant development [2] flowering and podding patterns and periods maturity [3] distribution of yield components [4] and individual seed development [5]. Determinate cultivar Hobbit yielded less when planted on 7 May than on 29 May at 2.72 and 3.14 mg ha^{-1} respectively. Indeterminate cultivars including Williams 82 had similar yields for these two dates with 2.99 mg ha^{-1} [6]. Determinate soybean cultivars Davis and Braxton gave higher yield at the June date than at the July date under narrow row spacing [7]. Numerous equations and plots have been established for predicting the effects of photoperiod and temperature on soybean phenology of maturity group 000-VII, using the published data [8].

The major bulk of determinate cultivars are traditionally grown in Japan, Korea and Southern USA, while indeterminate cultivars are grown in Northern China and Northern United States of America. In NWFP the major soybean growing province, both determinate and indeterminate types are under cultivation. The present study was conducted to determine the response of prevailing cultivars to different planting dates in order to fix their suitability for different cropping patterns.

Materials and Methods

Inoculated seed of determinate (Lee Mg VI and Essex, MG V) and indeterminate (Williams MG III) cultivars were planted 6 cm deep in 3 x 1.8m plot with 6 rows, 3 meter long, 30 cm apart and 3 cm plant to plant in clay loam soil at NWFP Agricultural University, Peshawar. Planting was done from April 1 to July 15 at fort-nightly interval in replicated plots. Number of days to vegetative and reproductive phases and length of these periods were recorded. The period between the appearance of the first flower and the disappearance of the last flower was designated as blooming period. The first pod attaining 10 mm length was recorded as the beginning of pod formation. The beginning of seed filling period was recorded when the presence of seed within the pod was felt with fingers. At this stage the seed length ranged from 3.0 - 3.5 mm in size. The days between emergence and harvest maturity were known as period of maturity.

Results and Discussion

Planting date affected various stages of development in Lee, Essex and Williams, in a different way. In Lee and Williams the number of days to 7th triofoliate leaf decreased suddenly from 49 to 37 and 32 days respectively in May 15 planting. However the decrease was gradual after this date (Fig. 1) Essex demonstrated gradual decrease from 38 to 32 days. The period between unifoliate leaf and the fully expanded 7th triofoliolate leaf was considered as ground cover period (Fig. 2). In Lee and Williams this period decreased from 46 days in April to 26 and 27 days in July respectively. However the variation in Essex ranged between 38 and 26 days with distinct deviation on April 15.

Days to flowering Fig. 3 in Lee gradually decreased from 88 in April to 44 in mid of July. However in Essex the number of days to flowering from April to June ranged from 47-43 and then gradually decreased to 32 days in July. The indeterminate

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cultivar Williams maintained equal number of days to flowering only with two exceptions irrespective of the date of planting. The total bloom period Fig. 4 in each cultivar however decreased constantly with each successive planting date.

The number of days to pod formation followed some what the pattern of days to flowering Fig. 5. Lee exhibited a steady decrease from 120 days in April to 49 days in July. However in Essex and Lee this number first increased and then decreased to the minimum. The number of days between pod formation and filling were maximum in Williams ranging from 80 to 50 days Fig. 6. The two determinate cultivars Lee and Essex presented similar pattern. Cultivar Lee planted in April initiated pod filling 150 days after emergence, but this period was reduced to 64 days when planting was extended to mid July Fig. 7. Similar reduction was observed in Essex and Williams. However April planting did not take maximum days to pod filling in these cultivars as it did in Lee. Williams had the longest pod filling period as compared with Lee and Essex (Fig. 8). Williams being indeterminate initiated pod filling earlier which continued until the pods on top of the plant were fully filled. In determinate Lee and Essex, flower and pod formation initiated at one time and therefore filling was also completed in a shorter time because of its determinate nature. Though not very systematic however the pod filling period decreased when planting was extended from April to July. In all the cultivars under test the days from emergence to maturity decreased when planting was delayed from April to July. This reduction was from 207 to 106 in Lee, 181 to 112 in Essex and 140 to 87 in Williams respectively Fig. 9. The three cultivars decreased in height when planting was extended to mid July. However non of the cultivars attained the maximum height when planted in April. Lee and Williams were almost of the same height while Essex produced the shortest plants Fig. 10. Generally delay in planting reduced the vegetative as well as reproductive development stages. However each cultivar responded differently.

The effect of planting date on developmental phases of each cultivar is summarized in Fig. 11. Each subsequent date of planting proportionately reduced the developmental periods upto the 7th trifoliolate leaf stage. Lee and Essex initiated reproductive development after completing the vegetative growth. However Williams initiated reproductive development before the completion of vegetative growth and thus, vegetative and reproductive growths proceeded simultaneously. Each subsequent planting date also reduced the number of days to a specific reproductive phase and its duration, in Lee and Essex. In Williams, though the duration was reduced, yet

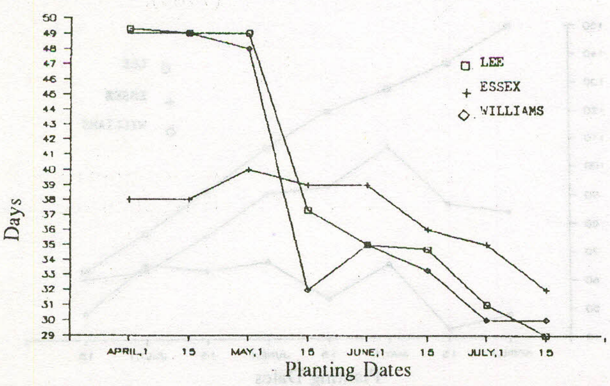

Fig. 1. Effect of planting date on days to 7th trifoliolate leaf in three soybean cultivars.

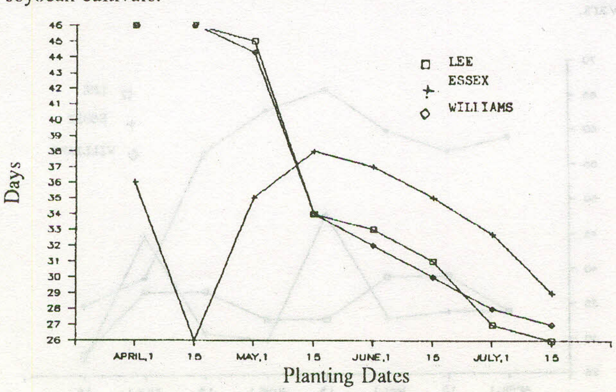

Fig. 2. Vegetative ground cover period affected by planting date and cultivars.

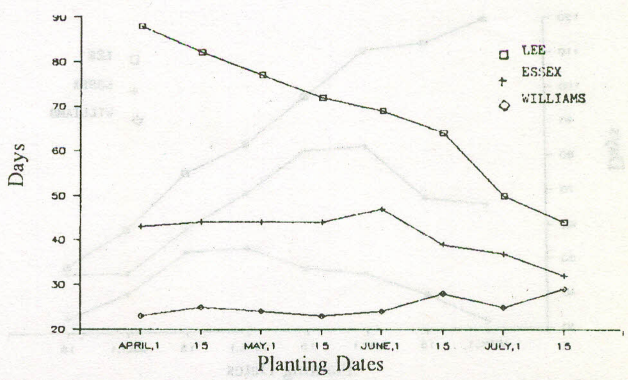

Fig. 3. Effect of planting date on days to flowering in three soybean cultivars.

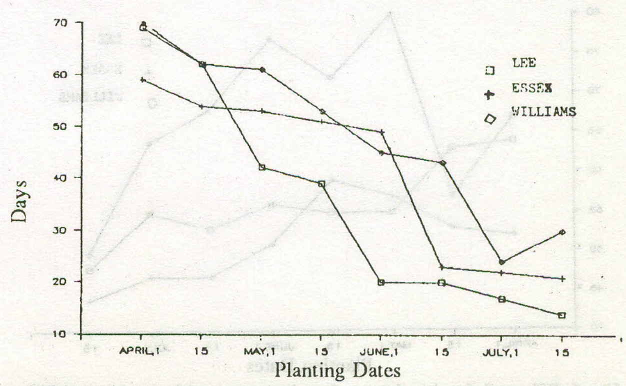

Fig. 4. Bloom period affected by planting date and cultivars.

the number of days to the initiation of the reproductive phase was not much affected, with the result that the developmental stages were overlapping each other. Each subsequent delay in planting reduced the period of maturity in all cultivars, however the date of maturity was least affected in Lee and Essex.

The greater number of days to emergence in April might be due to sub optimal temperature. Seeds planted [9] under sub optimal and optimal conditions required 10 to 14 and 5 to 7 days respectively to emerge. Leaf development was similar to that reported by Johnson *et al.* [10]. The length of vegetative period was reduced with late planting as a result of reduction in day length but leaf initiation was enhanced to complete the vegetative period. Williams initiated flowering, 16 and 41 days earlier than Essex and Lee respectively and had an extended bloom period (48 days) as compared with Essex (41 days) and Lee (35 days). The time of flowering was a varietal characteristic and thus dependent on maturity group as reported by Board and Hall [11] and Board [12]. However the reduction in the number of days to flowering and bloom period due to late planting was because of shorter day length. The time of flower initiation in Williams was insensitive to planting date, because of its indeterminate growth habit, where vegetative and reproductive growths proceeded simultaneously. Comparatively longer bloom period in Williams may be attributed to the indeterminate growth habit. Longer bloom period could be of significant importance under stress conditions. Advantages of indeterminates over determinates have been reported under defoliation Fehr *et al.*, [13,14] and water stress [15] conditions.

Greater differences existed in the number of days to pod filling stage and duration of pod filling among the cultivars particularly when planted early. Differences were reduced in later plantings. When Williams and Lee were planted in April and May, the former completed pod filling before its initiation in the latter. Short pod filling duration in Lee and Essex could be due to late initiation of filling in these cultivars. It is reported [16, 17] that yields were more closely associated with the duration of the filling period. Rate of accumulation of dry matter in seed was significantly affected by planting dates and cultivars [18]. Length of the seed filling period has been used for precise evaluation of strains and cultivars [19].

The number of days to maturity declined with each successive planting date for all cultivars. The reduction was from 207 to 106, 181 to 112 and 140 to 87 days in Lee, Essex and Williams respectively when planting was delayed from early April, to mid July. When planting was delayed by 105

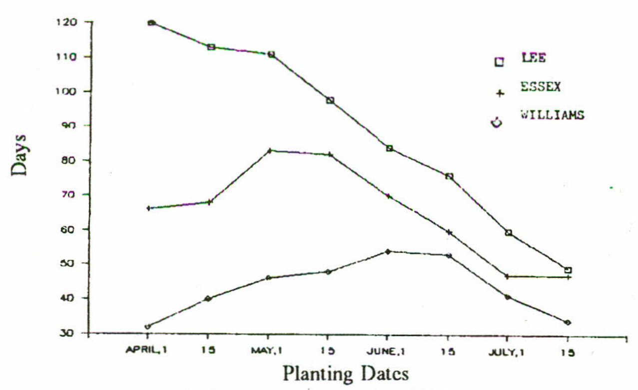

Fig. 5. Effect of planting date on days to pod formation in three soybean cultivars.

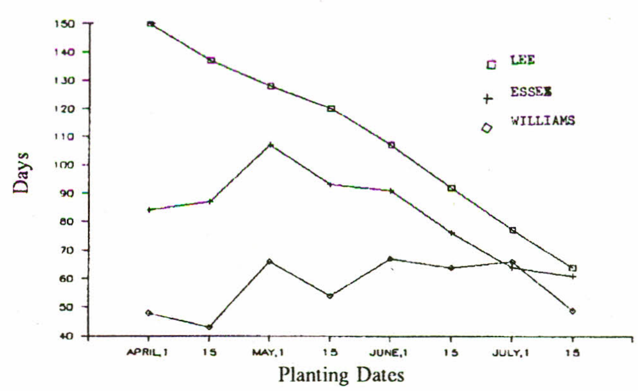

Fig. 7. Effect of planting date on days to pod filling in three soybean cultivars.

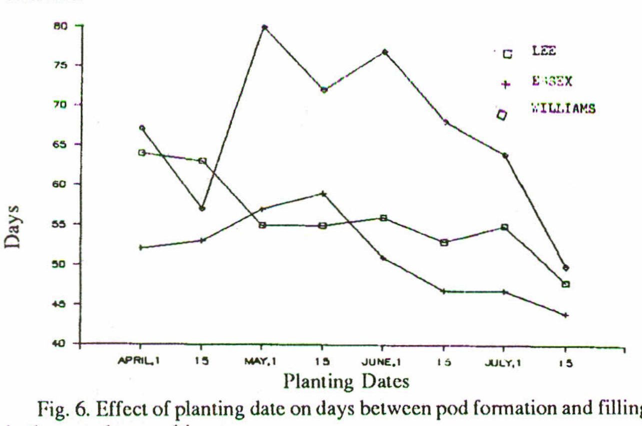

Fig. 6. Effect of planting date on days between pod formation and filling in three soybean cultivars.

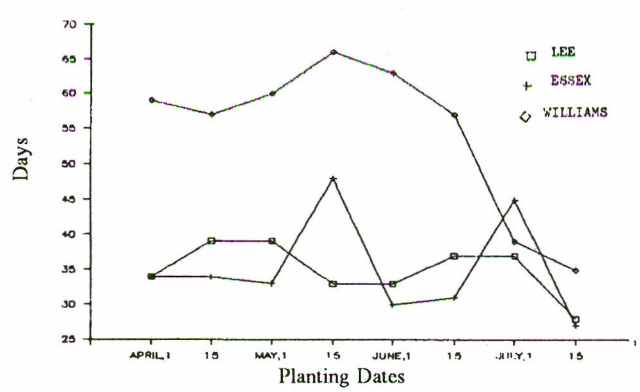

Fig. 8. Pod-filling period affected by planting date and cultivars.

days, Lee, Essex and Williams reduced its life cycle by 101, 69 and 53 days, but the date of maturity was delayed only 7, 37 and 48 days respectively. Each growth period was shortened because of short days. Reductions in growth periods have also been reported earlier [20, 21]. Maturity date of the early maturing cultivar, Williams was affected more by planting date than of the late maturing cultivar Lee and Essex. This is due to greater critical day length for initiation of blooming in Williams than in Lee and Essex. When planted on the same day, Williams changed from vegetative to reproductive growth earlier than Lee and Essex, because the length of day was enough to initiate blooming in Williams but not short enough to initiate blooming in Lee and Essex. The latter cultivars required a still shorter day to bloom and thus remained in vegetative phase until the days were shortened to their critical length of blooming. Maturity can be enhanced by planting Williams at an early date; whereas the early planting of Lee or Essex advances maturity by only a few days.

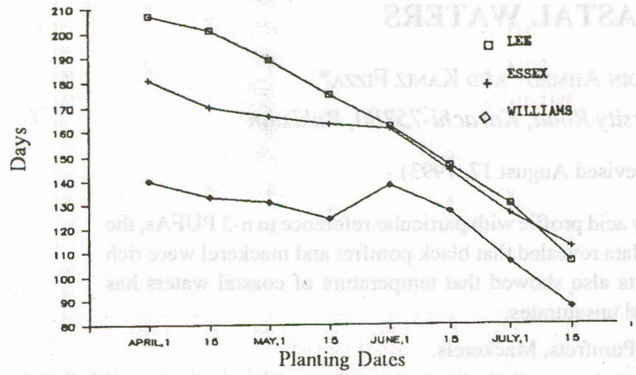

Fig. 9. Effect of planting date on days to maturity in three soybean cultivars.

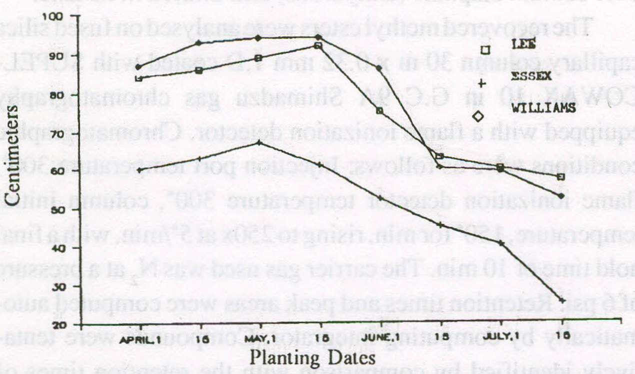

Fig. 10. Effect of planting date on plant height of three soybean cultivars.

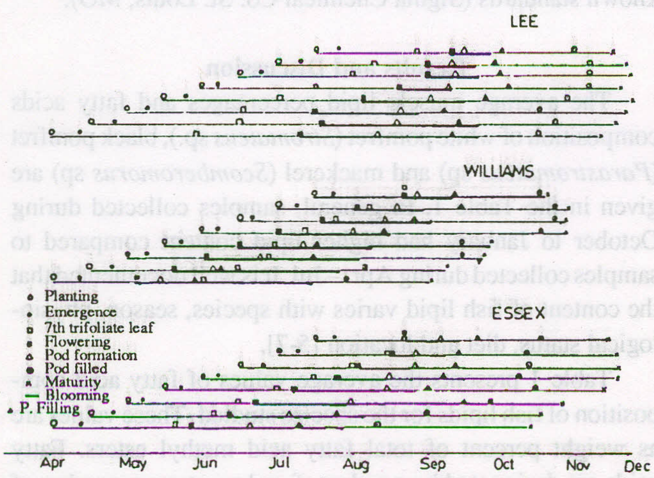

Fig. 11. Phasic development of three soybean cultivars under eight planting dates.

References

1. R.L. Bernard, Crop. Sci., **12**, 235 (1972).
2. Y.Z. Chang and L.H. Dong, Acta Agronomica Sinica, **8**(1), 41(1982), Soybean Abst., **5**(11), 289 (1982).
3. J. Gai, R.G. Palmer and W.R. Fehr, Agron. J., **76**, 979 (1984).
4. R.E. Carlson, M.K. Abadchi and R.H. Shaw, Agron. J., **74**, 531 (1982).
5. S.C. Spaeth and T.R. Sinclair, Agron. J. **77**(2), 207 (1985).
6. R.W. Elmore, Agron. J., **82**, 69 (1990).
7. D.J. Boquet, Agron. J. **82**, (1990).
8. J.B. Wang, A. McBeain, J.D. Hesketh, J.T. Wooley and R.L. Bernard, Biotronics, **16**, 25(1987).
9. E.C.A. Runge and R.T. Odell, Agron. J. **52**, 245 (1960).
10. H.W. Johnson, H.A. Borthwick and R.C. Leffel, Bot. Gaz., **122**, 77 (1960).
11. J.E. Board and W. Hall, Agron. J., **76**, 700 (1984).
12. J.E. Board, Agron. J., **77** 135 (1985).
13. W.R. Fehr, C.E. Caviness and J.J. Vorst, Crop. Sci., **17**, 913 (1977).
14. R.E. Carlson, M.K. Abadchi and R.H. Shaw, Agron. J., **74**, 531 (1982).
15. H.R. Boerma and D.A. Ashley, Agron. J., **74**, 995 (1982).
16. J.J. Hanway and C.R. Weber, Agron. J., **63**, 227 (1971).
17. D.B. Egli and J.E. Leggett, Crop. Sci., **13**, 220 (1973).
18. D.B. Egli, Canad, J. Plant Sci., **55**, 215 (1975).
19. D.A. Reicosky, J.H. Orf and Charles Poneleit, Crop Sci., **22**, 319 (1982).
20. E.E. Hartwig, Soybean Dig., **19** (7), 16 (1958).