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SEASONAL PATTERN OF NODAL AND DIURNAL REPRODUCTIVE ABSCISSION IN THREE SOYBEAN CULTIVARS

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Abstract

The nodal and diurnal abscission patterns in two determinate (Lee, MG Vi and Essex MgV) and one indeterminate (Williams MG III) cultivars of soybean (*Glycine max* (L.) Merrill) were examined. Lee, Essex and Williams aborted 15.4, 6.7 and 3.2 flowers and 4.8, 1.8 and 1.6 pods per node, respectively. Total flower and pod abortion was 57.9 and 38.1% in Lee, 59 and 31.8% in Essex and 42.8 and 36.7% in Williams, respectively. Flower and pod abortion in the lower two-third canopy accounted for 77 and 83.4% in Lee, 83.8 and 61% in Essex and 88 and 84.6% in Williams, respectively. The period of blooming, pod setting and pod filling differed for different cultivars and even within the same cultivar. In Lee and Essex maximum reproductive abscission occurred during the first two-third of the period and in Williams during the middle.

Introduction

Soybean (*Glycine max* (L.) Merrill) unlike other crops has both determinate and indeterminate types. Two major genes have been reported (Bernard, 1972) to be responsible for genetic variation in vegetative growth (Hanway & Weber, 1971), flowering and pod formation patterns (Gai *et al.*, 1984; Wiebold, 1982, Mc- Blain & Hume, 1981) in the two types. Several investigators (Domenguez & Hume, 1978; Mosca *et al.*, 1983; McBlain & Hume, 1981; Wiebold *et al.*, 1981; Wiebold, 1982; Josephine & Brun, 1984; Hansen & Shibles, 1978; Brevedan, 1983) have reported the total flower and pod abortion in various cultivars. Recently it has been confirmed that flower and pod abortion in soybean is affected by root and canopy competition (Marvel *et al.*, 1993), shade (Jaing & Egli, 1993), environment (Egli & Yu 1991) and heridity (Sharma *et al.*, 1990). However, no systematic study has been made to compare the daily rate of flower and pod abortion on each node in determinate and indeterminate soybeans. The present investigations aim to study in detail the seasonal pattern of nodal and diurnal rate of abortion in two determinate and one indeterminate soybean cultivars.

Materials and Methods

Seeds of soybean cultivars Lee, Essex and Williams maturity group vi, v and iii, respectively were planted on June, 15, 1985 in rows 30 cm apart in 3x1.8 m plots on clay loam soil at NWFP Agricultural University, Peshawar, Pakistan. Five central adjacent representative plants in the middle row of each plot were labelled for observations. From the onset of first flower onward, the number of new flowers were recorded on each node every alternate day until the end of flowering. To mark flowers that had been counted once, the standard petal was marked with a permanent black marker. Blooming charts were drawn for each plant, in order to keep a detail account of the number of flowers on each node and each day, for the entire blooming period. The node from which the first trifoliolate leaf developed was considered as first node. Similarly pod setting and pod filling charts were developed to maintain a record of the nodal and diurnal pod setting and pod filling period. Pods less than 10 mm in size were not taken into account

Table 1. Nodal distribution of flower abortion in three soybean cultivars.

Node number	Lee	Essex	Williams	Mean
		Flowers/plant		
1.	0.3 l	2.0 l	---	0.8 g
2	1.0 l	4.0 jkl	1.0 l	2.0 q
3	1.7 kl	2.3 kl	1.0 l	1.7 g
4	5.3 i-l*	17.0 cde	2.3 kl	8.2 def
5	20.3 c	19.7 c	8.7 f-k	16.2 ab
6	28.0 b	14.3 c-g	4.3 jkl	15.5 bc
7	35.3 a	12.3 d-i	7.7 f-l	18.4 a
8	36.7 a	10.7 e-j	6.7 g-l	18.0 a
9	26.7 b	7.3 g-l	8.0 f-l	14.0 bc
10	19.7 c	8.0 f-l	6.7 g-l	11.4 cd
11	19.3 cd	3.0 kl	7.0 g-l	9.8 de
12	15.3 c-f	6.0 h-l	4.7 i-l	8.7 def
13	14.7 c-f	5.0 i-l	4.3 jkl	8.0 def
14	13.3 c-h	4.3 jkl	2.7 kl	6.8 ef
15	13.3 c-h	3.3 kl	2.0kl	16.2 ef
16	11.7 d-i	3.0 kl	0.7 l	5.1 f
17	12.0 c-h	2.7 kl	2.0 kl	5.6 ef
18	13.0 c-h	1.0 l	2.3 kl	5.4 f
19	13.0 c-h	1.3 l	1.3 l	5.2 f
20	5.3 i-l	---	0.7 l	2.0 g
21			1.7 kl	0.6 g
22			2.0 kl	0.7 g
23			1.3 l	0.4 g
24			1.0 l	0.3 g
25			0.3 l	0.1 g
Mean	15.4 a	6.7 b	3.2 b	

Mean values or interactions followed by a common letter are not significantly different ($P = 0.05$) according to Duncan's New Multiple Range Test. *(i-1) includes all letters between i and l and similarly for others. Node i is the 1st trifoliate leaf node.

for pod setting. Beginning of seed filling was determined by feeling the first developing pod on the plant every alternate day and when noticeable increase in the size of the first seed in a pod was detectable. The average length of the seed at begining of seed fill ranged from 3.0 to 3.5 mm as described by Fehr & Caviness (1977). The total number of flowers, pods and filled pods per plant in each cultivar were noted. The number of flowers

Table 2. Nodal distribution of pod abortion in three soybean cultivars.

Node number	Lee	Essex	Williams	Mean
		Flowers/plant		
1	---	---	---	---
2	1.0 d	0.7 d	0.3 d	0.7 efg
3	1.3 d	1.3 d	1.0 d	1.2 defg
4	3.7 cd	3.0 d	1.0 d	2.6 defg
5	5.0 cd	2.3 d	2.7 d	3.3 def
6	8.7 bc	2.0 d	2.7 d	4.4 abc
7	12.3 b	3.7 cd	3.7 cd	6.6 ab
8	16.7 a	1.7 d	2.7 d	7.0 a
9	8.7 bc	1.7 d	2.3 d	4.2 bcd
10	4.3 cd	1.0 d	3.7 cd	3.0 defg
11	5.0 cd	2.7 d	3.7 cd	3.8 cde
12	4.3 cd	1.7 d	2.0 d	2.7 defg
13	1.3 d	0.7 d	2.7 d	1.6 defg
14	4.3 cd	0.7 d	1.3 d	2.1 defg
15	4.7 cd	0.3 d	1.3 d	2.1 defg
16	1.7 d	4.7 cd	2.0 d	2.8 defg
17	1.7 d		1.3 d	1.0 efg
18	1.0 d		0.3 d	0.4 fg
19			0.7 d	0.2 fg
20			0.7 d	0.2 fg
21			1.0 d	0.3 fg
22			1.0 d	0.3 fg
23			0.3 d	0.1 g
24			0.7 d	0.2 fg
Mean	4.8	1.8	1.6	---

Mean values or interactions followed by a common letter are not significantly different (P=0.05) according to Duncan's New Multiple Range Test. Node 1 is the 1st trifoliate leaf node.

and pods on a branch were added to the node from which the branch originated. Flower and pod abortion were calculated by subtracting the number of pods from the number of flowers and the number of filled pods from the number of pods, respectively. Flower and pod abortion per node per day was calculated from the blooming and pod setting charts. Statistical analysis were carried out according to the appropriate design and means were compared using New Duncan's Multiple Range Test.

Results and Discussion

Significant variation in flower abortion occurred in cultivars, nodes and cultivars x nodes (Table 1). The cvs. Lee, Essex, and Williams aborted 15.4,6.7 and 3.2 flowers per node. Flower abortion followed the pattern of flower development and was directly related with flower number. Abortion on the average was 57.9, 59.0 and 42.8% in Lee, Essex, and Williams, respectively. Maximum flowers aborted in the zone of maximum flower production. Wiebold *et al.*, (1981) have reported 58.71% flower abortion and poor pod development in determinate cultivars. These percentages are higher than reported by Hansen & Shibles (1978), McBlain & Hume (1981). Beckmann (1983) because of inclusion of small pods with aborted flowers. Low flower abortion in Williams may be due to uniform leaf area, flowering and podding distribution through the canopy in a unit period. Uniform leaf area may allow uniform interception of irradiance. Uniform flower initiation through the flowering period resulted into uniform distribution of photosynthates and nutrients. Brun *et al.*, (1985) associated flower abortion with failure of sink intensity to increase accordingly while Dominguez & Hume (1978) believed that abortion is the result of inability of flowers to compete for available carbohydrates. Water stress and low nitrogen content are also reported to be responsible for flower abortion (Mosca *et al.*, 1983; Brevedan, 1983). The two-third bottom canopies accounted for 77, 83.8 and 88.1% abortion respectively in Lee, Essex and Williams. Maximum abortion in lower canopy was because of low penetration of irradiance. Mann & Jaworski (1970) reported that a 63% decrease in irradiance through shading increased abortion more than 50%.

Pod abortion and pod development had similar pattern (Table 2). Total number of pods aborted were 85.7, 28.2 and 39.1 respectively in Lee, Essex and Williams which were 38.1, 31.8 and 36.7% of the pods in these cultivars. Abortion in Lee and Williams was greater in the middle (60.4 and 48.6%), than bottom (23.1 and 36.1%) or top (16.6 and 15.4%) of the canopies. In Essex pod abortion was 25.6, 35.4 and 39% in the bottom, middle and upper canopy. High percentage of abortion in upper canopy of Essex was because of heavy pod abortion on node 16. More flowers were retained on this node during flower abortion, but were ultimately aborted as pods. The lower two-third canopies accounted for 83.4, 61.0 and 84.6% of pod abortion in Lee, Essex and Williams.

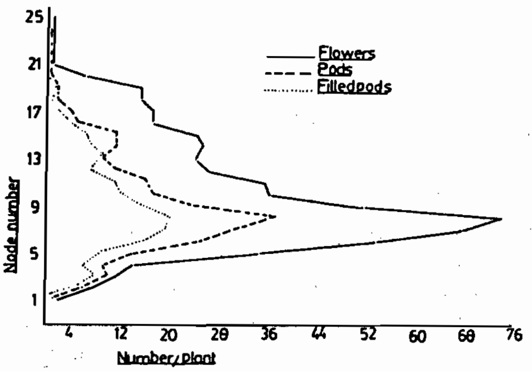

Fig.1. Nodal distribution of flowers/pods and filled pods in soybean cultivar Lee.

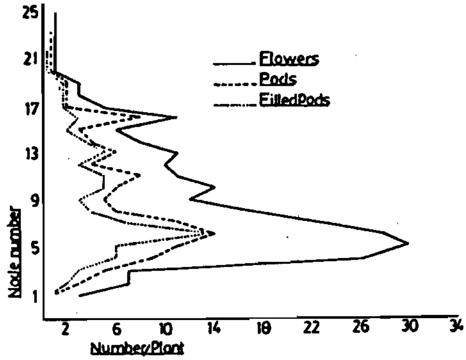

Fig.2. Nodal distribution of flowers/pods and filled pods in soy bean cultivar Essex.

Low irradiance at the lower canopy level decreased photosynthesis. Most of the photosynthate produced by a leaf is utilized by the pods borne on the same node and little is transported to pods higher or lower on the stem. Due to photosynthate limitation, competition among the pods is developed. Pods unable to compete for available photosynthate absciss. Thus localized abscission is increased.

Nodal distribution of flowers and pods in Lee, Essex and Williams is illustrated in Fig.1,2 and 3, respectively. Flowers and pods demonstrated a close and direct relationship with each other. Flower and pod abortion occurred at each node in each cultivar. Complete flower and pod abortion occurred on the upper most nodes. Flower abortion was persistently greater than pod abortion. Determinate and indeterminate types presented different patterns. Flower and pod abortion peaks were higher for determinates than indeterminate.

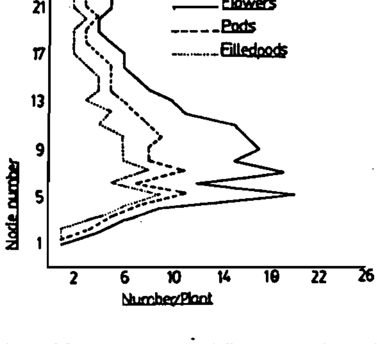

Fig.3. Nodal distribution of flowers/pods and filled pods in soybean cultivar Williams.

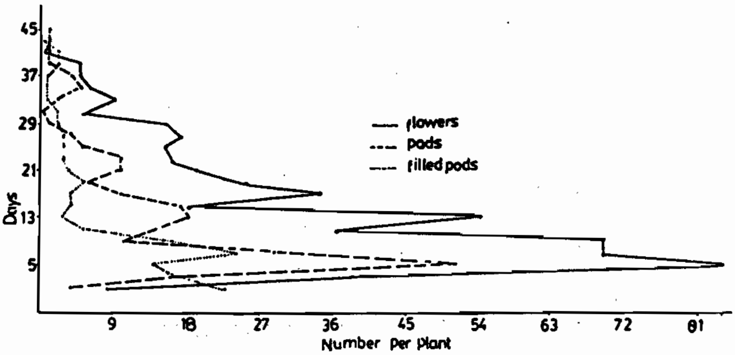

Fig.4. Diurnal distribution of flowers/pods and filled pods in soybean cultivar Lee.

Diurnal distribution of flowers, pods and filled pods in each cultivar is shown in Fig.4,5 and 6. Williams presented different pattern than Lee and Essex, which had similar patterns. Peak blooming period in Lee and Essex occurred during the first 2 weeks and in Williams during the 3rd week of blooming. Pod formation period was always greater than the blooming and pod filling period. In Lee and Essex pod filling started in a greater number of pods in the beginning of the period and decreased gradually towards the end. However, Williams demonstrated a gradual increase from the beginning, reaching a maximum during the 2nd week and then a gradual decrease towards the end.

Flower and pod abortion information can be used for predicting ultimate seed yield. The three cultivars had considerable reproductive potential but nearly half of the flowers and pods aborted. It will be difficult to incorporate high flower number and low abortion

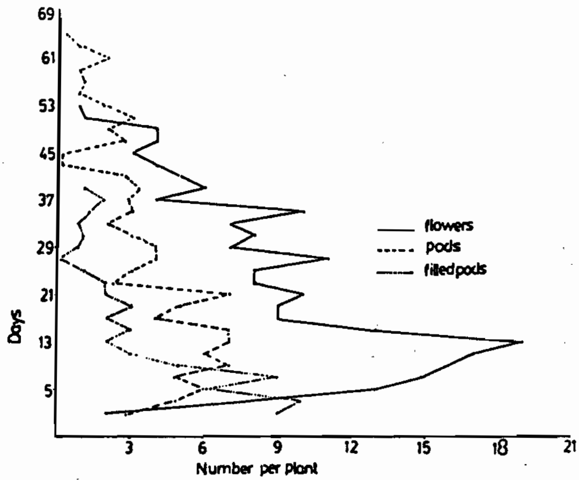

Fig.5. Diurnal distribution of flowers/pods and filled pods in soybean cultivar Essex.

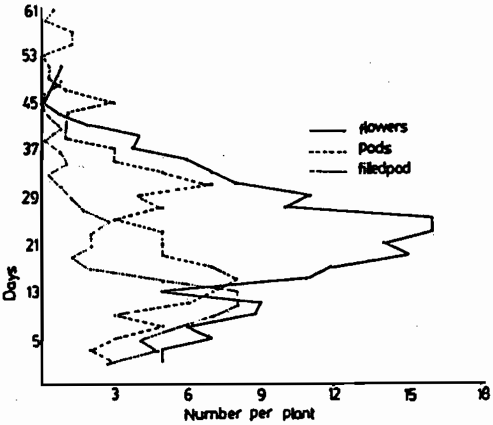

Fig.6. Diurnal distribution of flowers/pods and filled pods in soybean cultivar Williams.

into a single genotype, because flower number and abortion are positively correlated. However, increasing potosynsthesis at the lower canopy level is one of the promising possibility in reducing reproductive abortions.

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