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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (8): 940-944, 2001

The Flowering and Fruiting Behaviour of Some Commercial Varieties of Cotton *Gossypium hirsutum* L.

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Abstract: The flowering and fruiting behaviour of some commercial varieties of cotton was studied for proper planning of insect pest management and application of other inputs like fertilizer and irrigation. The results revealed that total flowering and boll formation period was longer in early maturing varieties than in late maturing. Boll formation period of each variety did not exactly coincide in different years. The varieties CIM-482, Karishama and CIM-109 produced more number of flowers but due to higher shedding percentage their total mature bolls per plant were on lower side. CIM-446 and CIM-473 completed 75-90% of their flowering up to 1st week of September while most of others completed their maximum flowering up to the week ends on 23rd September. CIM-446 and CIM-473 completed their maximum boll formation in the week of 15th to 30th September. Boll opening started slowly in earlier weeks and the earliest was observed in genotype CIM-473. Varieties CIM-240, CIM-109 and CIM-482 had maximum shedding during the week ends on 31st August and earlier September. From these observations it was concluded that variety CIM-446 and genotype CIM-473 were early maturing with lower shedding percentage and maximum boll retention ability as compared to other varieties under Multan conditions.

Key words: *Gossypium hirsutum* L., cultivars, genotypes, flowering, fruiting, Pakistan

Introduction

The silver fiber along with its products continues to remain as a single largest source of foreign exchange (60%) in Pakistan. Cotton plant is very sensitive to environment and other management practices, so it makes a challenging crop to manage successfully. Flower buds are the first organs that lay the foundations for development of boll. It fruits over a period requiring continued vigilance for insect pest management. Drought stress may trigger undesirable flower and fruit abortion whereas excessive moisture coupled with available nitrogen, particularly at flowering and fruiting stage may induce excessive vegetative growth (David, 1986) resulting in poor yield. Therefore, knowledge about the fruiting behaviour of cotton is very essential for proper planning of insect pest management and application of fertilizer and irrigation. Moreover this information can be helpful for selecting the best genotypes suited in particular environment for general cultivation and also for explaining the variation in yield from year to year. Therefore an attempt was made to quantify the flowering, boll formation, boll opening, and shedding percentage of some commercial varieties of cotton under Multan conditions. Khan and Khan (1966) and Afzal and Ali (1969) concluded that the first fortnight of September was the most crucial period for boll setting. Salam *et al*. (1979) observed that flowering period in early maturing varieties was longer than that of late ones. Guinn (1982) again reported that cloudy weather results in poor pollination and reduced the number of fertilized ovules in small bolls and caused abscision. It also reduced photosynthesis and cause low boll retention. Kerby (1984) reported that rapid boll setting at the beginning of the season not only helps in earliness but in controlling rank growth. Guinn, (1985) reported that active boll load influenced the boll retention and that boll retention started to decrease almost as soon as the first boll set and fruit shedding is primarily related to nutrition. Pegelow and Fisher (1986) observed using flower tagging, that maturation period varied from 56-84 days. There was a distinct trend towards an increase in boll maturation period at later flowering dates in line with the relationship between mean daily atmospheric temperature. Constable (1991) reported that the branches at the middle of the plant had the greatest boll survival and fruit was more likely shed as young squares or as young bolls . Benson and Borland (1993) reported variation in plant structure and fruiting behaviour in cotton cultivars. Cook and El-Zik (1993) observed that cultivars differed significantly for flower and boll production, lint yield and earliness in crop maturity. Reddy *et al*. (1993) concluded that modern cultivars developed squares faster than 20-30 years older ones, when grown at the same temperature. Temperature responses of different varieties for time to first square, squaring to flowering, main stem and fruiting branch node formation and duration of leaf and internode expansion were non-linear. Johanson (1997) conducted study to compare fruiting and maturity pattern of six cotton varieties with contrasting maturity and found that fruiting and growth pattern were inconsistent across environments, but the general expectations of relative maturity among cultivars were found. Latter maturity was related to lower yield.

Materials and Methods

These studies were conducted at CCRI, Multan during three (1998-2001) crop seasons. Five commercial varieties of cotton viz., CIM-240, CIM-I09, CIM-446, CIM-482, Karishama and one newly developed improved strain CIM-473 were selected. The crop was planted during 1st week of June in randomized complete block design with three replications under normal inputs. The data on flower production, boll formation, boll opening and shedding percentage was recorded on ten consecutive plants per plot in each replication. The fresh white flowers were tagged daily with dates. The data of weekly boll formation was calculated from the flowers retained on the plants during respective weeks. The weekly average of number of flowers and bolls produced were utilized for the determination of flowering, and boll setting periods. "Active flowering and boll setting period" was the period when the flower production or boll setting remained above 10% level of total flowers produced or boll set and "period of 90% flowering or boll setting"denoted the period from appearance of first flower or setting of the first boll to the date of formation of 90% flowers and bolls respectively. Shedding percentage was calculated on the basis of total flowers produced and boll set in the respective week The data thus collected was subjected to statistical analysis of variance (Steel and Torrie, 1980) and Factorial analysis of variance was

conducted to determine the interaction between the factors.

Results and Discussion

Flower Production: The analysis of variance (Table 2) showed highly significant level of variation among all the parameters for treatments (varieties). These results are in accordance with the earlier findings of Al-Enani and Eid (1985) who studied the imperative flowering behaviour and reported that flower production started slowly, it increases gradually to a peak and then decreased. They also reported that all the varieties varied significantly in flower production per plant and in time of peak flowering. Factorial analysis (Table 3) also showed highly significant level of variation in both two factors I-e varieties and weeks and the interaction of two factors. From factorial analysis of variance it is evident that there is a significant interaction between varieties and their corresponding weeks of flowering. The data in Table 1 showed that CIM-482 (83.40) and Karishama (80.39) produced more number of flowers per plant followed by CIM-109 (80.17). These are comparatively late maturing varieties than the others. Similar results were also concluded by Memon and Kazi (1965) that late maturing varieties produced more flowers per plant than early maturing varieties.

It is evident from Fig.1 that CIM-473, CIM-446 and Karishama started maximum flowering at the earliest stage. CIM-473 and CIM-446 completed 75-90% of their flowering from 1st week of August to first week of September. While other varieties started flowering in the first week of August and completed their maximum flowering i.e 75-90% from 1st week of August to 23rd September, as observed by Khan (1960), that effective flowering period in upland cotton varieties was the month of September.

CIM-446, CIM-473 and Karishma increased flowering steadily and then decline gradually. The total flowering period was longer in early maturing then in late maturing varieties. There were seasonal effects on total flowering period of different varieties. Similar results were recorded earlier by Salam *et al.* (1979)

The peak flowering period for varieties CIM-109, CIM-446, and Karishama was from 23rd to 31st August, whereas in case of CIM-240, CIM-473, and CIM-482 was from 23rd to 31st August, 7th to 15th August and 31st August to 7th September respectively.

Active flowering period for the varieties CIM-446 and Karishama was from 7th August to 15th September, whereas in varieties CIM-240, CIM-109, CIM-473 and CIM-482 were 15th August to 7th September, 15th August to 15th September, 7th August to 7th September and 15th August to 23rd September respectively (Fig.1).

On the basis of three years average, about 90% of the flowers were produced in varieties CIM-240, CIM-446, and Karishama up to 15th September, whereas, in varieties CIM-109, and CIM-482 was up to 23rd September and in CIM-473 was up to 7th September (Fig. 1).

This indicates that varieties CIM-109, CIM-482, and CIM-240 has longer flowering period and due to this reason these varieties can compensate if there is any stress during their developmental stages. CIM-446 and CIM-473 are short duration and fit in cotton-wheat-cotton rotation area

Boll Formation: Analysis of variance showed (Table 2) that all varieties had highly significant differences among weekly boll formation period. Factorial analysis of variance showed (Table 4) that weeks differences were significant. The interaction between the two factors I-e varieties and weeks was highly significant.

It is evident from Table 1 that CIM-446 produced maximum number of bolls (41.25) per plant closely followed by CIM-473 (38.73) and Karishama (38.23). The total boll formation period was longer in early maturing varieties than in late maturing ones (Fig. 2). The total boll formation period for each variety did not exactly coincide during different years due to seasonal variations in climatic conditions. Similar results were also recorded earlier by Salam *et al.* (1979)

The varieties CIM-446, and CIM-482 reached their peak boll formation from 7th to 23rd September, whereas CIM-473 reached their peak boll formation in 3rd and 4th week of August and Karishama from 7th to 23rd September. While the varieties CIM-240, and CIM-109 reached their peak boll formation from 15th to 23rd August and 31st August to 7th September respectively.

Active boll formation period of the varieties CIM-240 and CIM-109 was 15th August to 15th September, whereas, 31st August to 30th September was in varieties CIM-446 and CIM-473. In varieties CIM-482 and Karishama the active boll formation period was from 15th August to 23rd September and 23rd August to 23rd September respectively (Fig. 2).

The period of 90% boll formation was longer in early maturing varieties than in late maturing. Similar results were also reported by Salam *et al.* (1979). On the basis of three years average the 90% boll formation was up to 23rd September in varieties CIM-240, CIM-109, and CIM-482, whereas it was up to 30th September in varieties CIM-446 and CIM-473.

The virus resistant variety CIM-446 and newly developed virus resistant and early maturing strain CIM-473 starts flowering gradually by forming a slope and reached its maximum boll formation in the weeks up to 15th-30th September. Kerby (1984) reported that the rapid boll setting at beginning of the

Table 1: Average No. of flowers, bolls formed, bolls opened and shedding percentage of six commercial varieties.

Varieties	No. of flowers per plant	No. of bolls formed per plant	No. of bolls opened per plant	shedding percentage.
CIM-240	77.26	30.10	28.10	63.63
CIM-109	80.17	35.0	33.97	57.63
CIM-446	68.21	41.25	39.73	41.76
CIM-473	69.42	38.73	35.73	48.53
CIM-482	83.40	35.10	33.96	59.28
Karishama	80.39	38.23	37.23	53.69

Table 2: ANOVA. Mean Squares and Level of Significance of Four Characters.

SOV	d.f	Total flower produced	Weekly boll formation	Boll opening	Shedding (%)
Treat.	5	117.47**	1645.04**	46.71**	188.27**
Rep.	2	2.50 NS	360.71 NS	110.85 NS	1.69 NS
Error	10	4.75	320.46	20.23	3.03
Totals	17				

NS= Non significant **= Significant at P<0.01

Table 3: ANOVA. Factorial analysis of Flower Production per week of 10 Plants Average

SOV	d.f	S.S	M.S	F. ratio
Rep	2	34.71	17.36	1.90 NS
Main(Weeks)	7	4686.04	669.43	73.31**
S.Plot(varieties)	5	231.30	46.26	5.07**
M X S	35	1231.01	34.66	3.80**
Error	94	858.36	9.13	
Total	143			

NS= Non significant **= Significant at P<0.01

Table 4: ANOVA. FACTORIAL analysis of %age of boll formation per week of 10 plants average.

SOV	d.f	S.S	M.S	F. ratio
Rep	2	0.086	0.043	0.11 NS
Main(weeks)	9	200.01	22.22	56.21**
S.Plot(varieties)	5	1.14	0.227	0.58 NS
M x S	45	114.43	2.54	6.43**
Error(I)	118	46.65	0.39	
Total	179			

NS= Non significant **= Significant at P<0.01

Table 5: ANOVA. FACTORIAL analysis of %age of weekly boll Opening of 10 plants average.

SOV	d.f	S.S	M.S	F. ratio
Rep.	2	5.53	2.76	1.43 NS
Main(weeks)	10	202.80	20.28	10.46**
S.Plot(varieties)	5	0.640	0.13	0.07 NS
M x S	50	23.25	0.47	0.24 NS
Error(I)	130	251.96	1.94	
Total	197			

NS= Non significant **= Significant at P<0.01

Table 6: ANOVA. FACTORIAL Analysis of weekly Shedding %age of 10 plants Average.

SOV	d.f	S.S	M.S	F. ratio
Rep.	2	26.97	13.48	0.16 NS
Main(weeks)	7	3957.28	565.33	6.86**
S.Plot(varieties)	5	7528.57	1505.72	18.27**
M x S	35	9132.60	260.94	3.17**
Error(I)	94	7745.81	82.40	
Total	143			

NS= Non significant **= Significant at P<0.01

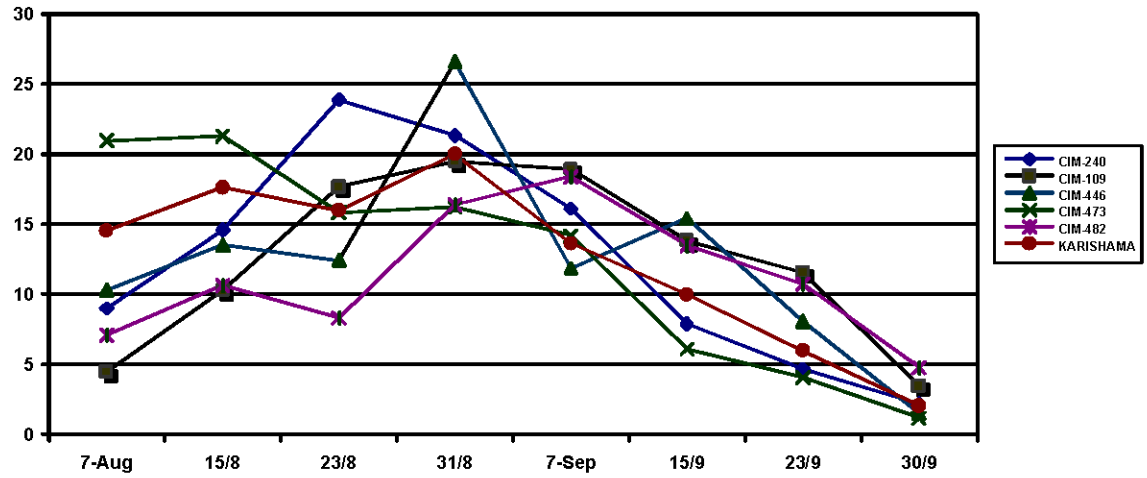

Fig. 1: Percentage of flower production per week of ten plants average.
* X-axis: Week ends ** Y-axis: Percentage of flower production

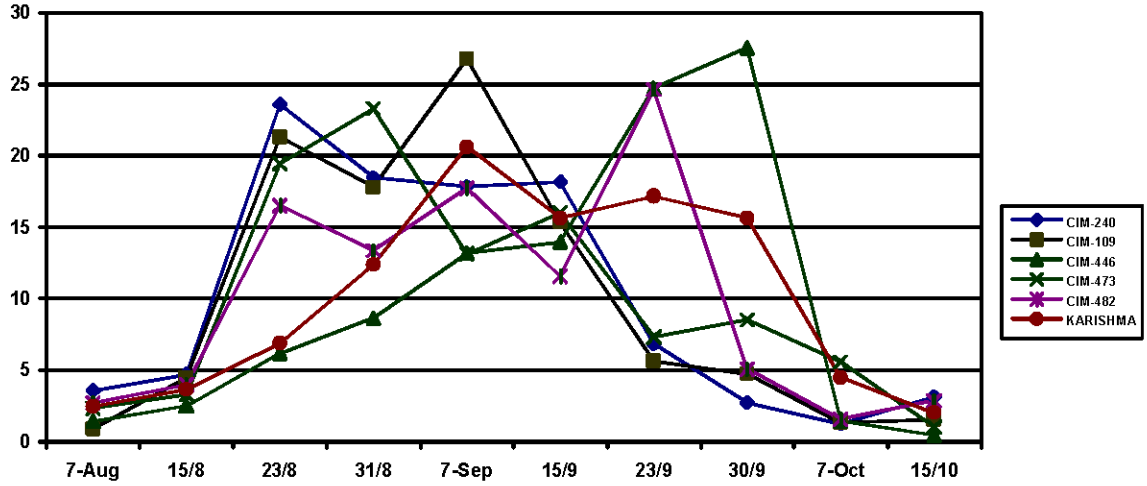

Fig. 2: Percentage of boll formation per week of ten plants average
X-axis = Week ends Y-axis = Percentage of boll formation

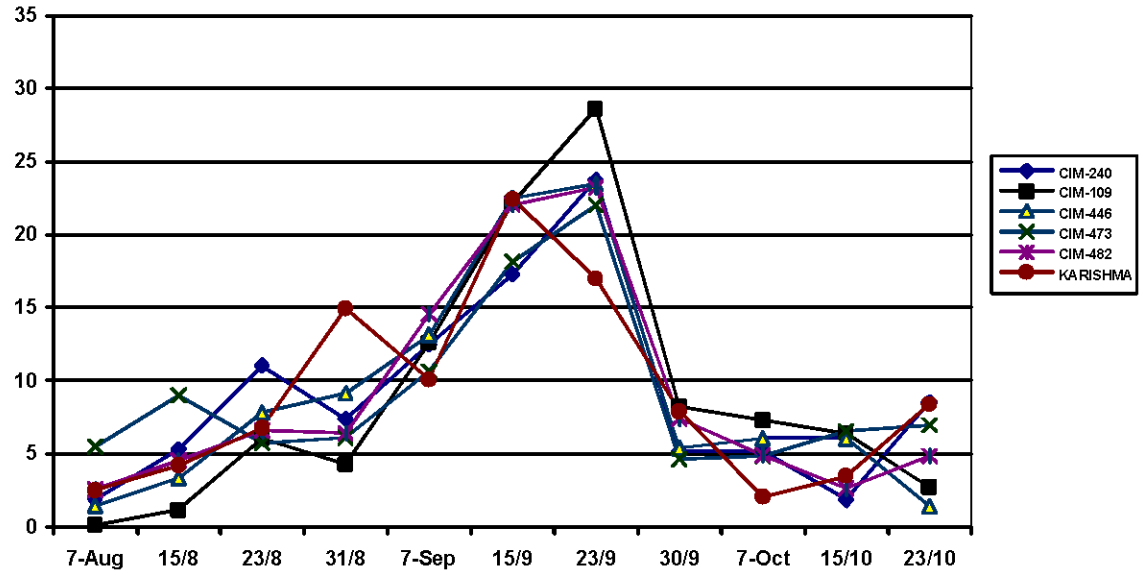

Fig. 3: Percentage of weekly boll opening of ten plants average.
*X-axis: Week ends **Y-axis: Percentage of boll opening

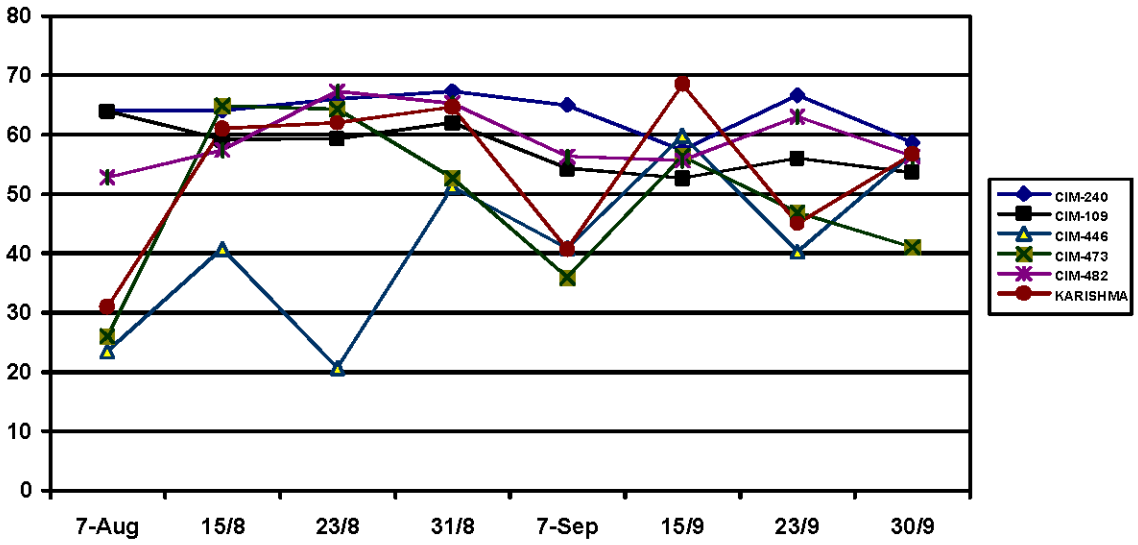

Fig. 4: Weekly shedding percentage of ten plants average.
* X-axis: Week ends ** Y-axis: Shedding percentage.

season not only helps in earliness but in controlling rank growth as well.

Boll Opening: Table 2 shows that all the varieties differed significantly in boll opening percentage per week basis as reported earlier by Cook and El-Zik (1993). Factorial analysis (Table 5) revealed that varieties differed significantly but time period I-e week's difference was non-significant. The interaction between the weeks and varieties was also non-significant. From this analysis it is concluded that all varieties have specific period for their boll opening and boll maturation. Maximum opened bolls were in CIM-446 (39.73) followed by Karishama (37.23) and CIM-473 (35.73) (Table 1).

Fig. 3 shows that in all varieties boll opening was slow in earlier weeks. Maximum earlier boll opening took place in CIM-473. There were two maximum boll opening periods: First was the week ends on 23rd to 31st August and the second was week ends from 7th to 23rd September. This data suggests that CIM-446 and CIM-473 are early maturing varieties.

Shedding percentage: There was significant difference in all varieties with respect to shedding percentage (Table 2). The Table 6 shows that varieties, weeks and interaction between these two factors were highly significant in all the cases.

Table 1 showed that maximum shedding percentage was in CIM-240 (63.63%) followed by CIM-482 (58.28%) and CIM-109 (57.63%). These varieties developed higher number of flowers but due to shedding their boll number per plant were on lower side. Most of the shedding was of young squares or as young bolls. Similar results were earlier observed by Constable (1991). The lowest shedding was in CIM-446 (41.76%) and newly developed CIM-473 (48.53%). Both varieties are early flowering and due to lower shedding percentage their boll retention was maximum I-e, 39.73 and 35.73 % respectively.

Fig. 4 shows that varieties CIM-240, and CIM-109 had maximum shedding right from the beginning of flowering period and nearly similar trend till the end of flowering period ranging maximum in the week ends on 31st, August and earlier September. CIM-446 and genotype CIM-473 had lower shedding percentage initially in the month of August and fluctuation in shedding percentage occurred onward till 15th, September due to environmental fluctuations and nutrients availability. In these varieties maximum shedding was in the week ends on 15th, September. Guinn (1985) reported that fruit shedding is primarily related to nutritional imbalance between supply and demand because at the fruiting time nutritional requirement of plants increases (Afzal and Ali, 1969) Karishama and CIM-482 initially had lower shedding percentage as compared to CIM-240 and CIM-109 but then there was a smooth and continuous shedding period ranging from 15th to 30th September. From these observations it is concluded that variety CIM-446 and genotype CIM473 are early maturing and have lower shedding and maximum boll retention ability as compared to other varieties under Multan conditions.

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