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Boll Retention (%) under Different Environments/Sowing Conditions in Upland Cotton (*Gossypium hirsutum* L.)

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A B S T R A C T

The present study was conducted to find out the Boll retention (%) under different environments/sowing quality in three varieties H 1098 – I, H 1300 and H 1316 under six environments (three sowing periods i.e. early, normal and late sown conditions in year 2015 and 2016). Observations were recorded for total flower tagged and total boll retained in different tagging period. Tagging period stared from June end when there were sizable amount of flowers. In early sown condition per cent boll retention was higher (59.1) and also produced more number of flowers as compared to normal sown (51.9%) and late sown conditions (58.7%) conditions. So, early sown condition was best for maximum boll retention.

Introduction

Cotton is an important commercial crop of India. Upland cotton dominates the world's cotton fiber production accounting for approximately 90% of the total production (Malagouda *et al.,* 2014). Different species and cultivars of plants respond differently to climatic factors depending basically on the growth stage. The influence of those factors is modified by other factors such as water or nitrogen stress. Other environmental factors vary simultaneously with climatic factors causing an association between individual climatic variables and plant responses, and, thus, it seems impossible to determine cause–effect relationships. There is limited information on the response of cotton plants to climatic factors.

Sowing time is the main factor affecting yield, and considered as key element to investigate the appropriate sowing period of crop cultivars under the particular agro climatic conditions. Sowing time linearly affects the seed cotton yield, because early maturing cultivars start flowering and boll formation well earlier as compared to late ones. Growth and yield contributing parameters including fibre quality traits are closely associated with environments

favourable for higher yields. The yield of cotton is mostly associated with sowing dates as boll weight and formation of bolls which are inter linked with the yield (Mahmood-ul-Hassan *et al.,* 2003).

However, by determining the relationship of climatic factors with flower and boll production and retention, the overall level of production can be possibly predicted. So, the present investigation was planned to find out the appropriate time period for maximum boll retention.

Materials and Methods

The experiment was conducted during *kharif* 2015 & 2016 having three cultivars H 1098-I, H 1300 and H 1316 of upland cotton grown at CCS Haryana Agricultural University, Hisar in randomized block design replicated six times each in eight rows of 6 m length with a spacing of 67.5 x 30 cm. These varieties were grown in six environments that comprises of three sowings periods (Early: first fortnight of April, normal: first fortnight of May and late: end of May/early June) during the year 2015 and 2016 (Table 1).

Data was recorded as in all the three replications in every week flowers were tagged and number of effective bolls formed from these flowers was counted and the week in which maximum and minimum bolls developed was identified. The data on total flower tagged and total boll retained was recorded from tagging period i.e. June, 24 to till the last picking of the experimental plots.

Results and Discussion

In early sown condition there were 10 flower tagging weeks from 24th June to 26th of August. In all the three varieties total flower tagged, total boll retained and (%) boll retention were different during this period. In the variety H 1098- I total flower tagged were 6720, boll retained were 3665 with 54.5% boll retention was 54.5. In variety H 1300 flowers tagged were 7078, boll retained were 4485 with 63.4 % boll retention and in variety H 1316 total flower tagged were 7047, boll retained were 4461 with 59 % boll retention.

In normal sown condition there were 8 tagging weeks from 8thJuly to 26th of August. In all the three varieties total flower tagged, total boll retained and (%) boll retention were different for these 8weeks. In the variety H 1098- I total flower tagged were 4435, boll retained were 2456 with55.4 % boll retention. In variety H 1300 total flower tagged were 4449, boll retained were 2628 with 59.1 % boll retention and in variety H 1316 total flower tagged were 4564, boll retained were 2718 with 59.6 % boll retention.

In late sown condition there were 8 tagging weeks from 8th July to 26th of August. In all the three varieties total flower tagged, total boll retained and % boll retention were different for these 8weeks. In the variety H 1098- I total flower tagged were 3720, boll retained were 2001 with53.8 % boll retention. In variety H 1300 total flower tagged were 3876, boll retained were 2373 with 61.2 % boll retention and in variety H 1316 total flower tagged were 3481, boll retained were 2126 with 61.1 % boll retention (Table 2–4).

Figure 1, 2 and 3 showing total flower tagged, total boll retained and % boll retention in early sown conditions, figure 4, 5 and 6 for normal and figure 7, 8 and 9 for late sown conditions.

Critical period for flowering and boll retention under different sown condition was presented in Table 5, 6 and 7. Total flower tagged, total boll retained and (%) boll retention in different sowing condition were different. In early sown condition there were 10 tagging weeks from 24th June to 26th of August.

Table.1 Sowing dates and different environments in 2015 and 2016

Environment		Date of Sowing	Environment Designation
Year	**Sowing period**		
2015	Early	10 April	E_1
	Normal	15 May	E_2
	Late	5 June	E_3
2016	Early	26 April	E_4
	Normal	5 May	E_5
	Late	2 June	E_6

Table.2 Flower tags and boll retention of different varieties in early sown condition

Early		H 1098-I			H 1300			H 1316		
Tagging week	**Tagging period**	**Flower tag**	**Boll retained**	**% boll retention**	**Flower tag**	**Boll retained**	**% boll retention**	**Flower tag**	**Boll retained**	**% boll retention**
1	**June 24- 30**	727	274	37.7	833	487	58.5	855	429	50.2
2	**July 1-7**	767	391	51.0	865	498	57.6	803	515	64.1
3	**July 8-14**	705	407	57.7	630	394	62.5	765	469	61.3
4	**July 15-21**	617	344	55.8	714	422	59.1	652	350	53.7
5	**July 22-28**	473	263	55.6	579	380	65.6	852	490	57.5
6	**July 29-4**	617	381	61.8	919	588	64.0	751	A479	63.8
7	**Aug 5-11**	787	410	52.1	835	529	63.4	607	363	59.8
8	**Aug 12-18**	630	377	59.8	569	401	70.5	679	414	61.0
9	**Aug 19- 25**	736	444	60.3	557	373	67.0	559	336	60.1
10	**Aug 26-1 sep**	661	374	56.6	577	413	71.6	524	316	60.3
		6720	3665	54.5	7078	4485	63.4	7047	4161	59.0

Table.3 Flower tags and boll retention of different varieties in normal sown condition

Normal		H 1098			H 1300			H 1316		
Tagging week	**Tagging period**	**Flower tag**	**Boll retained**	**% boll retention**	**Flower tag**	**Boll retained**	**% boll retention**	**Flower tag**	**Boll retained**	**% boll retention**
1	**July 8-14**	516	292	56.6	517	293	56.7	640	355	55.5
2	**July 15-21**	477	274	57.4	584	364	62.3	511	275	53.8
3	**July 22-28**	493	270	54.8	532	301	56.6	611	375	61.4
4	**July 29-4**	590	304	51.5	719	438	60.9	690	374	54.2
5	**Aug 5-11**	654	386	59.0	604	356	58.9	516	306	59.3
6	**Aug 12-18**	539	270	50.1	461	282	61.2	547	366	66.9
7	**Aug 19- 25**	609	361	59.3	525	296	56.4	488	325	66.6
8	**Aug 26-1 sep**	557	299	53.7	507	298	58.8	561	342	61.0
		4435	2456	55.4	4449	2628	59.1	4564	2718	59.6

Table.4 Flower tags and boll retention of different varieties in late sown condition

Late		H 1098			H 1300			H 1316		
Tagging week	Tagging period	Flower tag	Boll retained	% boll retention	Flower tag	Boll retained	% boll retention	Flower tag	Boll retained	% boll retention
1	July 8-14	437	226	51.7	426	257	60.3	535	347	64.9
2	July 15-21	425	225	52.9	559	351	62.8	444	281	63.3
3	July 22-28	395	211	53.4	462	250	54.1	420	261	62.1
4	July 29-4	521	269	51.6	607	366	60.3	548	314	57.3
5	Aug 5-11	539	277	51.4	514	333	64.8	423	262	61.9
6	Aug 12-18	443	256	57.8	440	279	63.4	386	230	59.6
7	Aug 19- 25	537	288	53.6	434	272	62.7	393	229	58.3
8	Aug 26-1 sep	423	249	58.9	434	265	61.1	332	202	60.8
		3720	2001	53.8	3876	2373	61.2	3481	2126	61.1

Table.5 Critical period for flowering and boll retention under early sown condition

Early		Flower tagged in different sowings				No. of bolls retained				
Tagging week	Tagging period	H 1098	H 1300	H1316	Total	H 1098	H 1300	H1316	Total	% boll retention
1	June 24- 30	727	833	855	2415	274	487	429	1190	49.3
2	July 1-7	767	865	803	2435	391	498	515	1404	57.7
3	July 8-14	705	630	765	2100	407	394	469	1270	60.5
4	July 15-21	617	714	692	2023	344	422	403	1169	57.8
5	July 22-28	473	579	652	1704	263	380	350	993	58.3
6	July 29-4	617	919	751	2287	381	588	479	1448	63.3
7	Aug 5-11	787	835	607	2229	410	529	363	1302	58.4
8	Aug 12-18	630	569	679	1878	377	401	414	1192	63.5
9	Aug 19- 25	736	557	559	1852	444	373	336	1153	62.3
10	Aug 26-1 sep	661	577	524	1762	374	413	316	1103	62.6
		6720	7078	6887	20685	3665	4485	4074	12224	59.1

Table.6 Critical period for flowering and boll retention under normal sown condition

Normal		Flower tagged in different sowings				No. of bolls retained				
Tagging week	Tagging period	H 1098	H 1300	H1316	Total	H 1098	H 1300	H1316	Total	% boll retention
1	July 8-14	516	630	765	1911	292	293	355	940	49.2
2	July 15-21	477	714	692	1883	274	364	374	1012	53.7
3	July 22-28	493	579	652	1724	270	301	275	846	49.1
4	July 29-4	590	919	751	2260	304	438	374	1116	49.4
5	Aug 5-11	654	835	607	2096	386	356	306	1048	50.0
6	Aug 12-18	539	569	679	1787	270	282	366	918	51.4
7	Aug 19- 25	609	557	559	1725	361	296	325	982	56.9
8	Aug 26-1 sep	557	577	524	1658	299	298	342	939	56.6
		4435	5380	5229	15044	2456	2628	2717	7801	51.9

Table.7 Critical period for flowering and boll retention under late sown condition

Late		Flower tagged in different sowings				No. of bolls retained				
Tagging week	Tagging period	H 1098	H 1300	H1316	Total	H 1098	H 1300	H1316	Total	% boll retention
1	July 8-14	437	426	535	1398	226	257	347	830	59.4
2	July 15-21	425	559	444	1428	225	351	281	857	60.0
3	July 22-28	395	462	420	1277	211	250	261	722	56.5
4	July 29-4	521	607	548	1676	269	366	314	949	56.6
5	Aug 5-11	539	514	423	1476	277	333	262	872	59.1
6	Aug 12-18	443	440	386	1269	256	279	230	765	60.3
7	Aug 19- 25	537	434	393	1364	288	272	229	789	57.8
8	Aug 26-1 sep	423	434	332	1189	249	265	202	716	60.2
		3720	3876	3481	11077	2001	2373	2126	6500	58.7

Table.8 Boll retention % in early, normal and late sown conditions

	Total flower tagged				Total boll retained				% boll retention
	H 1098	H 1300	H 1316	Total	H 1098	H 1300	H 1316	Total	% boll retention
Early	6720	7078	6887	20685	3665	4485	4074	12224	59.1
Normal	4435	5380	5229	15044	2456	2628	2717	7801	51.9
Late	3720	3876	3481	11077	2001	2373	2126	6500	58.7
Total	14875	16334	15597	46806	8122	9486	8917	26525	56.56667

Fig.1 Boll retention in H 1098-I in early sown condition

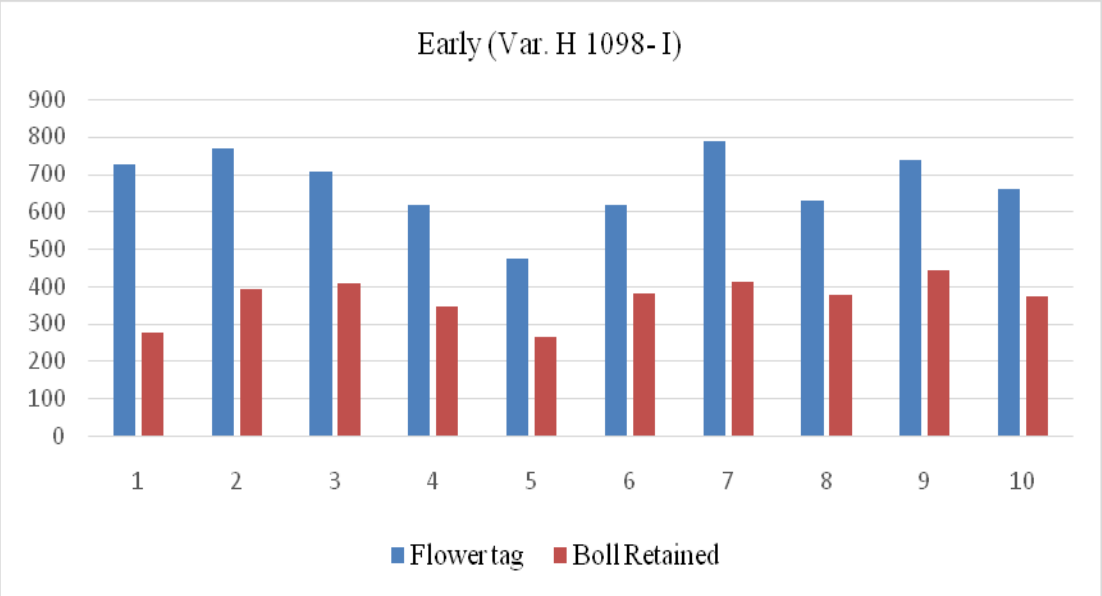


Fig.2 Boll retention in H 1300 in early sown condition

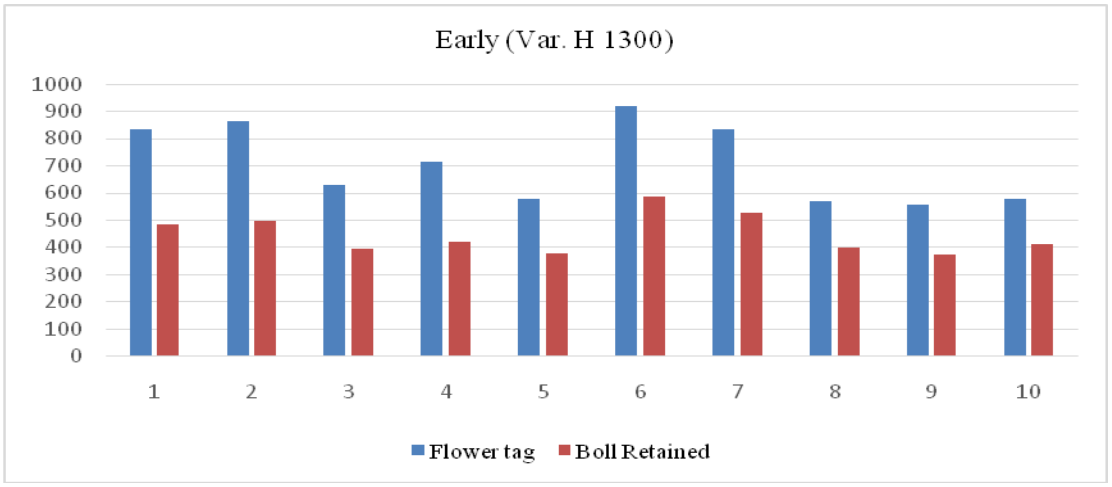


Fig.3 Boll retention in H 1316 in early sown condition

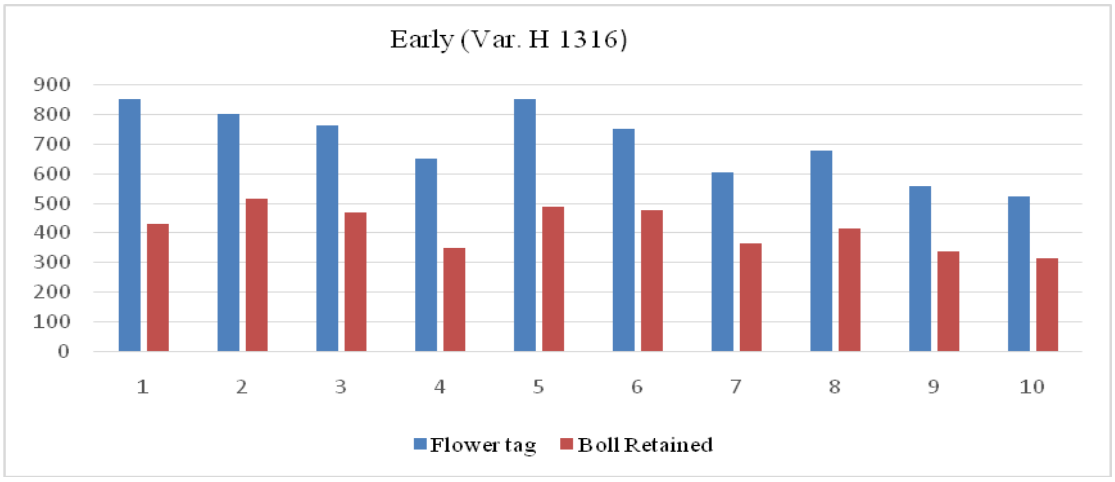


Fig.4 Boll retention in H1098 – I in normal sown condition

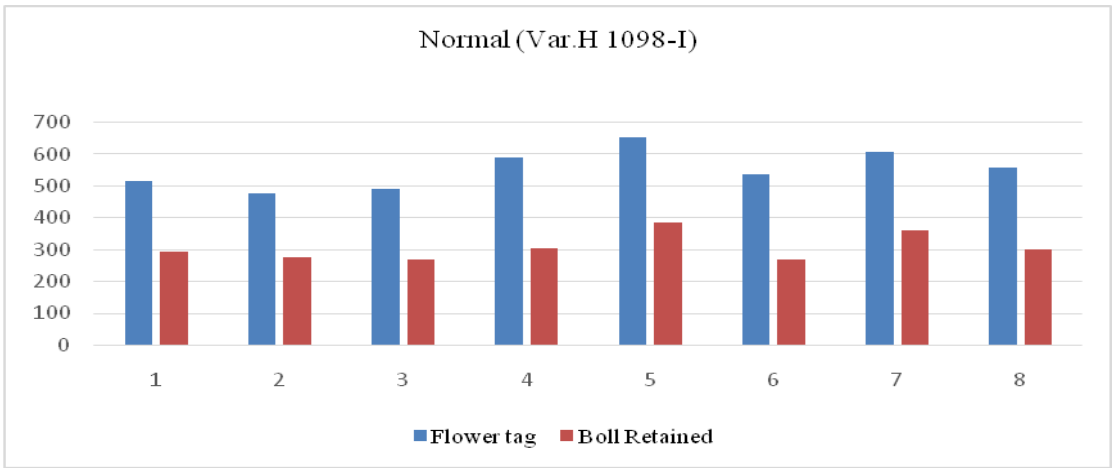


Fig.5 Boll retention in H 1300 in normal sown condition

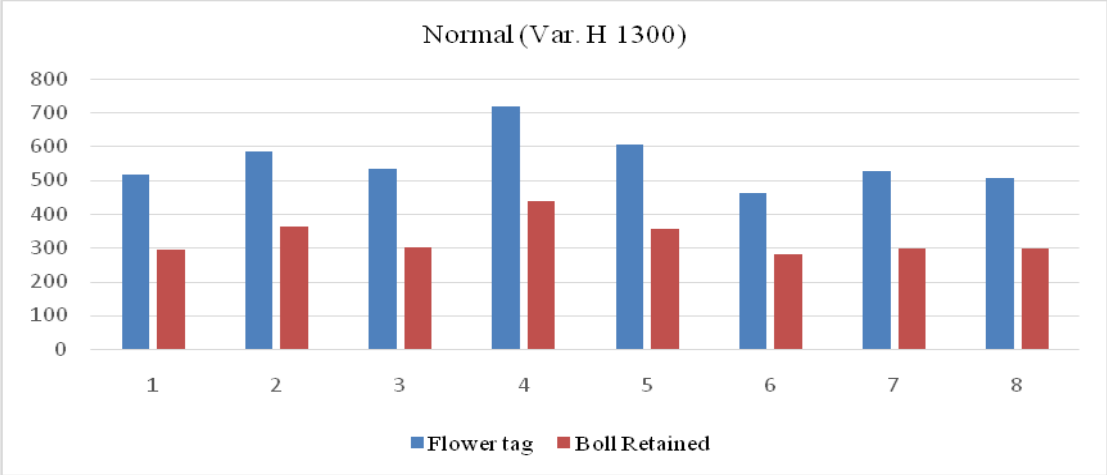


Fig.6 Boll retention in H 1316 in normal sown condition

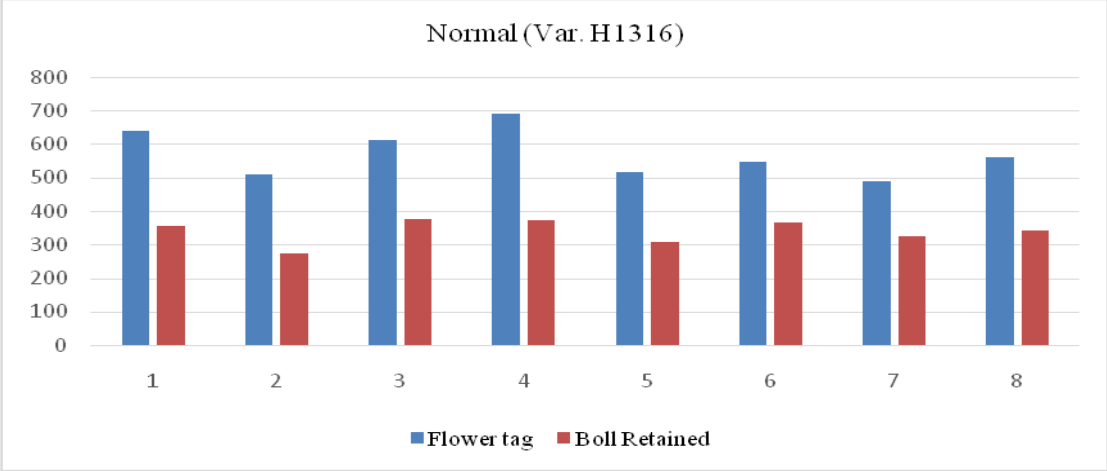


Fig.7 Boll retention in H1098 – I in late sown condition

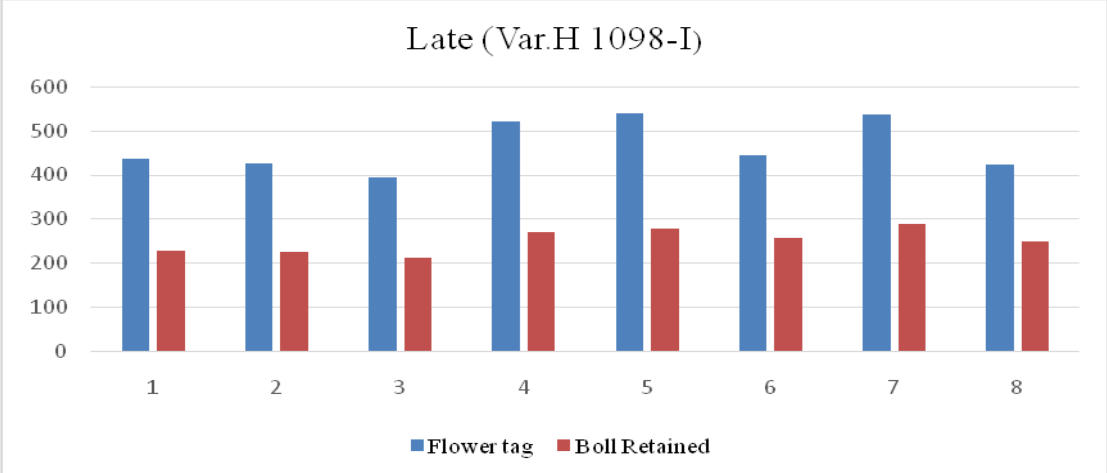


Fig.8 Boll retention in H 1300 in late sown condition

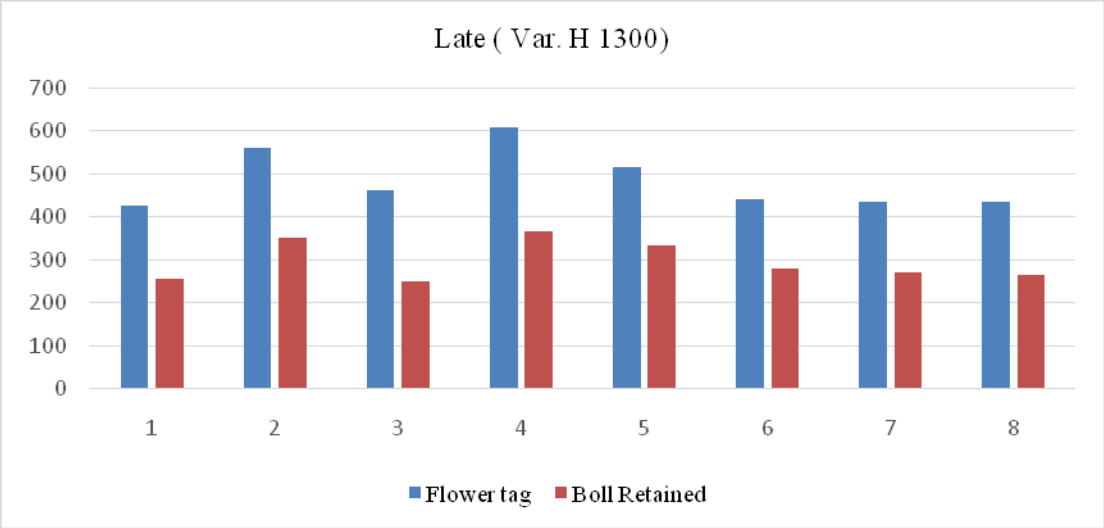
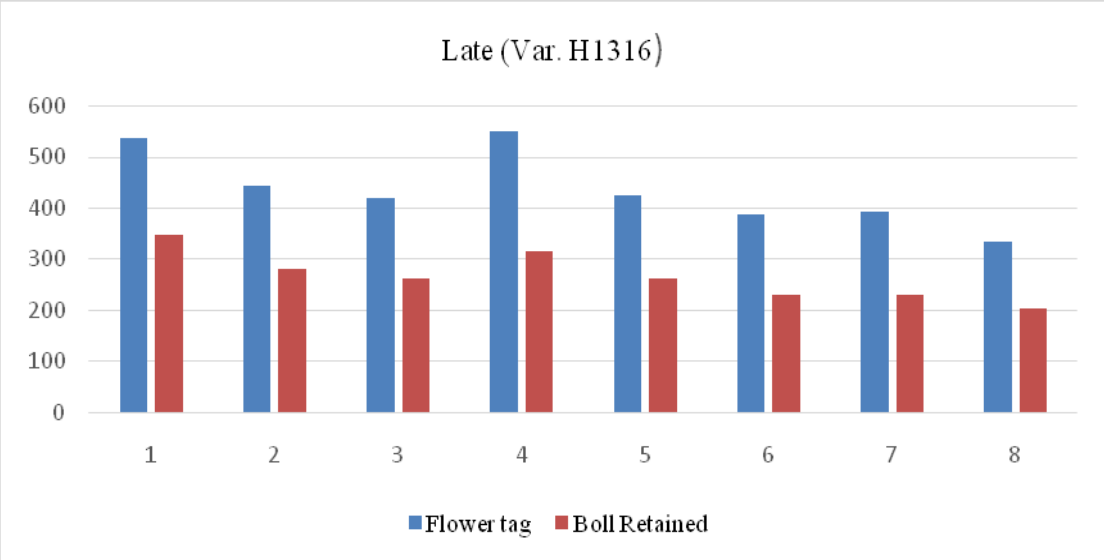


Fig.9 Boll retention in H1H 1316 in late sown condition



In early sown condition total flower tagged (H 1098-I, H 1300 and H 1316) were (6720, 7078 and 6887) 20685, total boll retained were (3665, 4485 and 4074) 12224 with 59.1 % boll retention.

In normal sown condition there were 8 tagging weeks from 8thJuly to 26th of August. In normal sown condition total flower tagged (H 1098-I, H 1300 and H 1316) were (4435, 5380 and 5229) 15044, total boll retained were (2456, 2628 and 2717) 7801 with 51.9% boll retention. In late sown condition there were 8 tagging weeks from 8th July to 26th of August. In late sown condition total flower tagged (H 1098-I, H 1300 and H 1316) were (3720, 3876 and 3481) 11077, total boll retained were (2001, 2373 and 2126) 6500 with 58.7 %.boll retention. However, when the data was pooled for all the three conditions the boll retention was 56.6 % (Table 8).

In early sown condition total flower tagged were 20685, total boll retained was 12224 and % boll retention was 59.1. In normal sown condition total flower tagged were 15044, total boll retained was 7801 and % boll retention was 51.9. In late sown condition total flower tagged were 11077, total boll retained was 6500 and % boll retention was 58.7. Total flower tagged in all three sown conditions were 46806, total boll retained were 26525 and % boll retention was 56.6%.

In early sown condition flower tagged were 20685, bolls retained were 12224 and % boll retention was 59.1. In normal sown condition flower tagged were 15044, picked bolls were 7801 and % boll setting was 51.9. In late sown condition flower tagged were 11077, bolls retained were 6500 and % boll retention was 58.7. Total flower tagged in all three sown conditions were 46806, bolls retained were 26525 and % boll retention was 56.6%. Thus per cent boll retention in early sown condition was higher (59.1%) as compared to normal (51.9%) and late (56.6%) sown conditions. It was because of high temperature during late sown condition. Similar results were reported by Sawan *et al.*, 2004. Temperature magnitude was the important climatic factor affecting flower and boll production as its correlation (negative) values were significant. In this respect, Warner and Burke (1993) indicated that the cool-night inhibition of cotton growth correlates with biochemical limitation on starch mobilization in source leaves, which results in a secondary inhibition of photosynthesis, even under optimal temperatures during the day. The second most important climatic factor in our study was minimum humidity, which was positively and highly correlated affecting number of flowers or harvested bolls in cotton. This means that high humidity rates during the 2 weeks preceding or succeeding initiation of flowers opening tended to significantly increased flower and boll production. The third most important climatic factor in our study was sunshine duration, which showed a significant positive relationship with boll production. The relationship between sunshine duration and boll retention might be due to the fact that species of the genus *Gossypium* are known to be short-day plants (Hearn and Constable 1984). Thus, an increase in sunshine duration above thresh hold resulted in decreased flower and boll production. Climatological factors and the boll load from the first fruiting cycle were evaluated as primary causes for low boll retention by cotton. The early prediction of possible adverse effects of climatic factors could help in minimizing their deleterious effects on cotton production through applying appropriate production practices, which would reduce any possible production shortage.

Sowing date, year and interaction (sowing date × year) all significantly affected the yield. Thus, sowing period was an important factor affecting the yield, biomass and reproductive duration and hence minimized the impact of temperature and duration of the reproductive growth stage. With climate change, an earlier planting date might be an efficient method of increasing yield in the future.

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