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Use of chemicals for improving earliness in cotton

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Abstract

Many kinds of harvest-aid chemicals have been evaluated and some are practically used for accelerating boll opening in cotton. Among those, most effective proved to be the ethylene-releasing ones. **Prep** *in USA,* **Ethrel** *in Greece,* **Flordimex** *in Bulgaria are the most widely used boll-openers. The proper timing of their application is very important for taking the full advantage of the enhanced boll opening rate. The results of a two-year field experiment showed that treatments with ethylene-releasing chemicals caused an increase in the weight and accelerated the opening of the bolls which were aged more than 0.75 of the boll period. For the younger bolls (boll period accomplished 65 to 75%) the acceleration was 3 to 4 days with no significant effect on boll weight. When the boll age was less than 0.6 the 4 to 8-days acceleration of boll opening was accompanied by a marked (0.4 to 0.8 g) decrease in the boll weight. This must be taken into account when the application of ethylene-releasing compounds is being timed. Boll period (within 2-3 days) for every boll can be predicted well in advance by using its dependance on temperature during first three weeds of boll development.*

One of the methods for improving earliness in cotton is using chemicals for plant growth modification and/or acceleration of boll opening. Among the compounds evaluated, several (mainly synthetic growth inhibitors) are reported to increase the boll opening rate (2, 4, 6, 8), but they are not practically used because of the inconsistency of the results or the high cost of the chemicals.

For commercial use of a chemical to be economically sound, the effect of its application must exceed its price and application costs. Cycocel and Pix are sucessfully used in many countries to prevent the late growth and flowering and also to accelerate boll opening, thus increasing the percentage of first pickings. The most widely used as typical boll openers are the ethylene-releasing chemicals (Prep, Cafgro, Ethrel, Flordimex, Hydrel and other commercial formulations of ethephon) which, when applied to crop plants, evolve and ethylene gas promote biosynthesis of endogenous ethylene. The increased concentrations of ethylene in cotton bolls and leaf peduncles stimulate the development of the separation layer and hasten the leaf drop and boll opening.

These are natural processes which normally proceed in the maturing cotton plants and increased concentration of ethylene just enhances their rates. This results in more complete and more rapid defoliation and conditioning the crop for machine picking, in increased first pickings. The proper timing of application of these chemicals is of prime importance for taking the full advantage of their effect on cotton. Too early application may cause yield and quality losses while the effect of the too late application may be negligible. The time of harvest-aids application is often assessed as number of days prior to defoliation or harvesting ; sometimes, it is based on the counts of open bolls (12) or sympodia/fruiting points formed (8).

The recommendations sound true when the development of the crop to be treated resembles the development of the crop in the experimental plots from which the recommendations are drawn. Some authors refer the stage of maturity of the youngest harvestable bolls as most important single factor to be considered in timing harvest-aid application. We failed to find publications concerning the effect of exogenous ethylene on cotton bolls of different ages. That is why a special investigation was undertaken in the Cotton Research Institute in Chirpan for assessment of this effect.

I - Materials and methods

White flowers were tagged daily during the entire flowering period in 1982 and 1984 on 320-360 plants grown under rainfed conditions in a field where conventional cultural practices were followed during the growing season. Date of flowering and late date of boll opening were written on the tags. In the first week of boll opening, the plots were divided in half and chemical treatment was applied on the one half with a hand spayer adjusted to deliver 600 liters of water solution of Flordimex per ha (500 g a.i. per ha). The other part was the check. The open bolls were harvested separately and grouped into samples according to date of flowering and date of maturing. Boll age on the day of treatment, the number of days required for the boll to mature, and the weight of seedcotton per boll were assessed for every group from the date collected on an individual boll basis. Five-day running averages were used to eliminate the occasional fluctuations. Approximately 5000 flowers per plot were tagged and up to 1600-1700 bolls were collected and analysed.

II - Results and discussions

Flowering lasted longer and was more prolific in 1982 (Figure 1a). The difference between the flowering patterns of the seasons were more pronounced when the slopes of the bloom accumulation curves during pick of flowering were compared. In 1982, 90% of all flowers were produced during the first three weeks of flowering and the flowering period was 28 days whereas in 1984, the flowering period was 24 days with 90% of the flowers produced in two weeks (Table 1). The weather was warmer in 1982 and the boll period was shorter (56,1 days, cf. 60, 1 days in 1984). The rates of boll opening resembled the rates of flowering. In 1982, the last 10% of the bolls (set on the upper sympodia) were slow in opening thus additionally extending the period of maturing.

The treated plants were faster in boll opening than the check due to reduced boll period (an average decrease of 2.1 days in 1982 and 2.5 in 1984). The period of maturity was reduced by 4 days in 1982 and by 8 days in 1984.

According to their response to the treatment, the bolls fell into three classes (Figure 2). Boll period in the first class was decreased by 2 to 3 days (i.e. about 4%) and boll weight was materially not affected (slight decrease in 1982 and more pronounced trend to increase in 1984). The bolls of this class were 44 to 46 days old on the day of treatment and yielded 60-64 per cent of seedcotton. For the bolls of the second group (comprising 23 to 26 per cent of the total yield), boll period was reduced by 3.5 to 4 days (5 to 7%) and boll weight was decreased by 0.2 g. The age of these bolls was 38 to 44 days in 1982 and 40 to 46 days in 1984. The third class comprised 17% of the total yield in 1982 and about 10% in 1984. The bolls were aged less than 38 days in 1982 and less than 40 days in 1984 ; their opening were accelerated by 40 to 9 days with an up to 0.8 g (*i.e.* 18 to 20%) reduction in boll weight. The bolls set 2-3 days later suffered even worse weight losses.

A fact which is worth noticing in the very close resemblance in the performance of the bolls falling in the same groupes in both seasons. They share equal parts of the total yield and respond essentially equal to treatment. The only more significant difference is in their age measured as days after flowering. When the relative age (measured as a part of the entire boll period or as per cent elapsed boll period) is used instead of number of days post anthesis the results are much more comparable. Boll periods may differ greatly depending on temperature, variety, cultural practices, etc... Because of such difference, bolls of the same calendar age may be very different in physiological stage of maturity, *e.g.* in 1976, the summer temperatures were 2.5 to 5° C lower than normally and the boll period was 83 days. In 1985, the warm days accelerated the boll development and the boll begun to open 44 days post anthesis. It is obvious that there can be no comparison between the physiological stages of maturity of the bolls aged 42 days in 1985 (with 95% boll

period elapsed) and in 1976 (with only 50% elapsed boll period). The 42-days old bolls in 1976 were as much developed as 22-days old bolls were in 1985 and needed 37 more days to attain the stage of maturity corresponding to that of 42-days old bolls in 1985. It follows from this that appropriate timing of any treatment must be based on the stage of development instead of days after flowering. In our experiment, the bolls of the above mentioned classes were matured more than 75%, 65 to 75%, and less than 65% respectively (averaged for both seasons). For the bolls in 1976, to attain the same stages of maturity, they would have to be 62 days old to fall into the first group and 53 days old to fall into the second group. The first group escapes completely the adverse effect to the treatment, in the second one, the higher grade of the early harvested cotton compensates for the slight decrease in yield. The great acceleration of boll opening in the third group and hence the shortening the harvesting period is on the expense of a significant (up to 15-20%) yield loss which normally totals approximately 1% of the entire crop. Such effect of ethephon on bolls of different age should be considered in determining when to treat. Table 2 presents a model of timing Flordimex application. In this instance, 1% the late low grade crop is sacrificed to save several days of harvesting period (beginning it 3 days earlier and completing 4 days earlier). If zero yield loss is desired, application several days later should be needed. Conversely, if bas weather is expected which can interfered with harvesting, application should be hasten.

Thus, the formula for appropriate timing application of boll openers involves several factors, such as stage of plant development, planed harvest date, weather forecast, number and productivity of the machine harvesters, skilfulness of the operators, etc.., the physiological age of the youngest harvestable bolls being the most important ones.

Trait	1982		1984	
Days required to form 60% of the blooms	11		8	
" " " next 30% of the blooms	9		5	
" " " last 10% of the blooms	8		11	
Flowering period (days)	28		24	
Boll period - average (days)	56,1		60,1	
" " - effet of treatment	-2,1		-2,5	
	Check	Treated	Check	Treated
Days required to mature 60% of bolls	12	9	7	4
" " " next 30% of bolls	9	10	7	6
" " " last 10% of bolls	11	9	10	6
Maturing period (days)	32	28	24	16

Table 1: Development of the coton plants in 1982 and 1984

Traits	Boll age				
	0,85	0,77-0,84	0,65-0,76	0,60-0,64	0,60
Without chemical treatment					
Date of boll opening	16,09	21,09	28,09	30,09	11,10
% of total yield	33	27	23	9	8
% of total yield - accumulated	33	60	83	92	100
Predicted effet of treatment					
Acceleration of boll opening (days)	2	3	4	4	4
Date of boll opening	14,09	18,09	24,09	26,09	7,10
Boll weight	7%	-	-5%	-9%	-18%
% of total yield	35	27	22	8	7
% of total yield - accumulated	35	62	84	92	99

Table 2: Timing the boll openers application

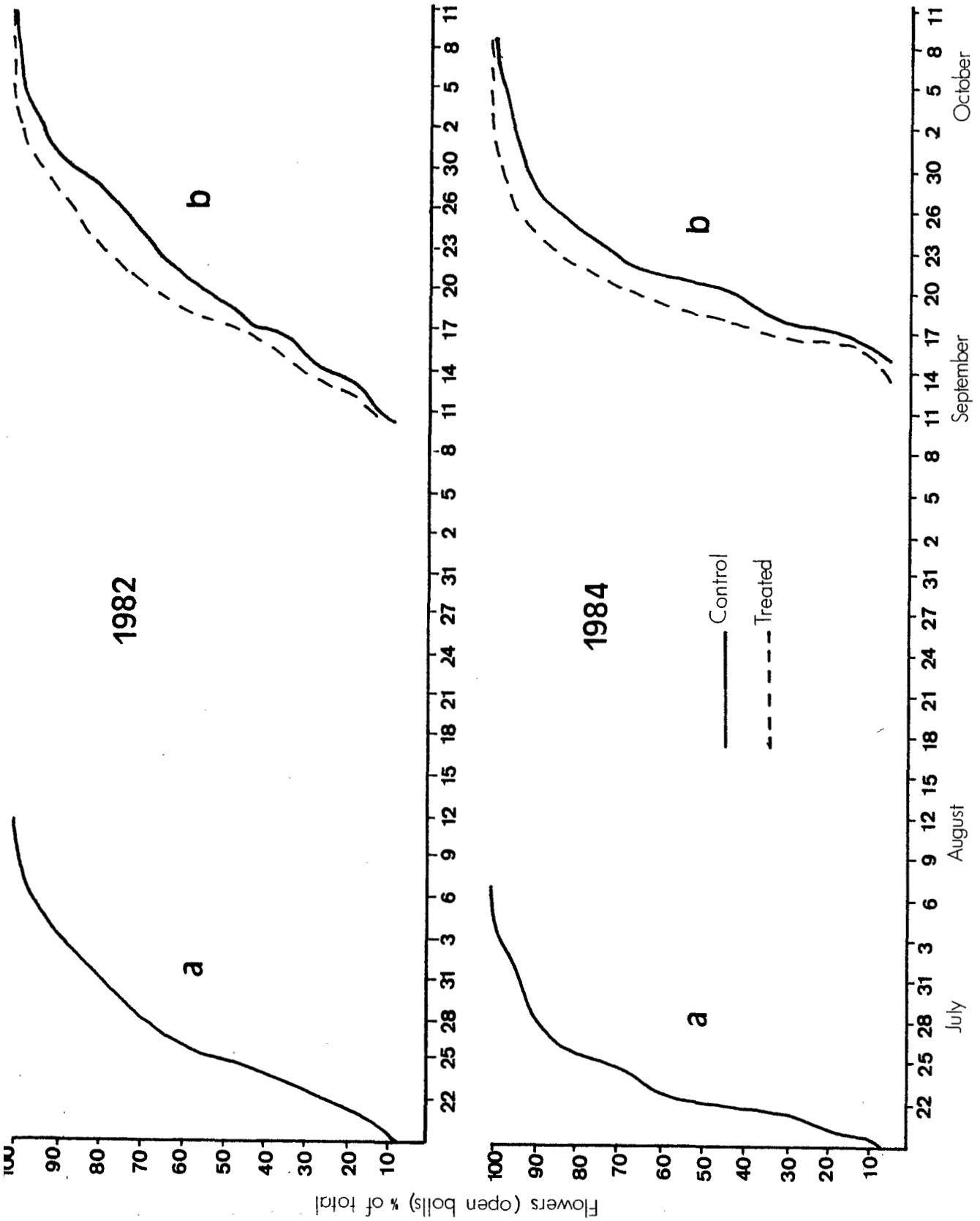

Figure 1 : Patterns of flowering (a) and boll opening (b) in 1982 and 1984

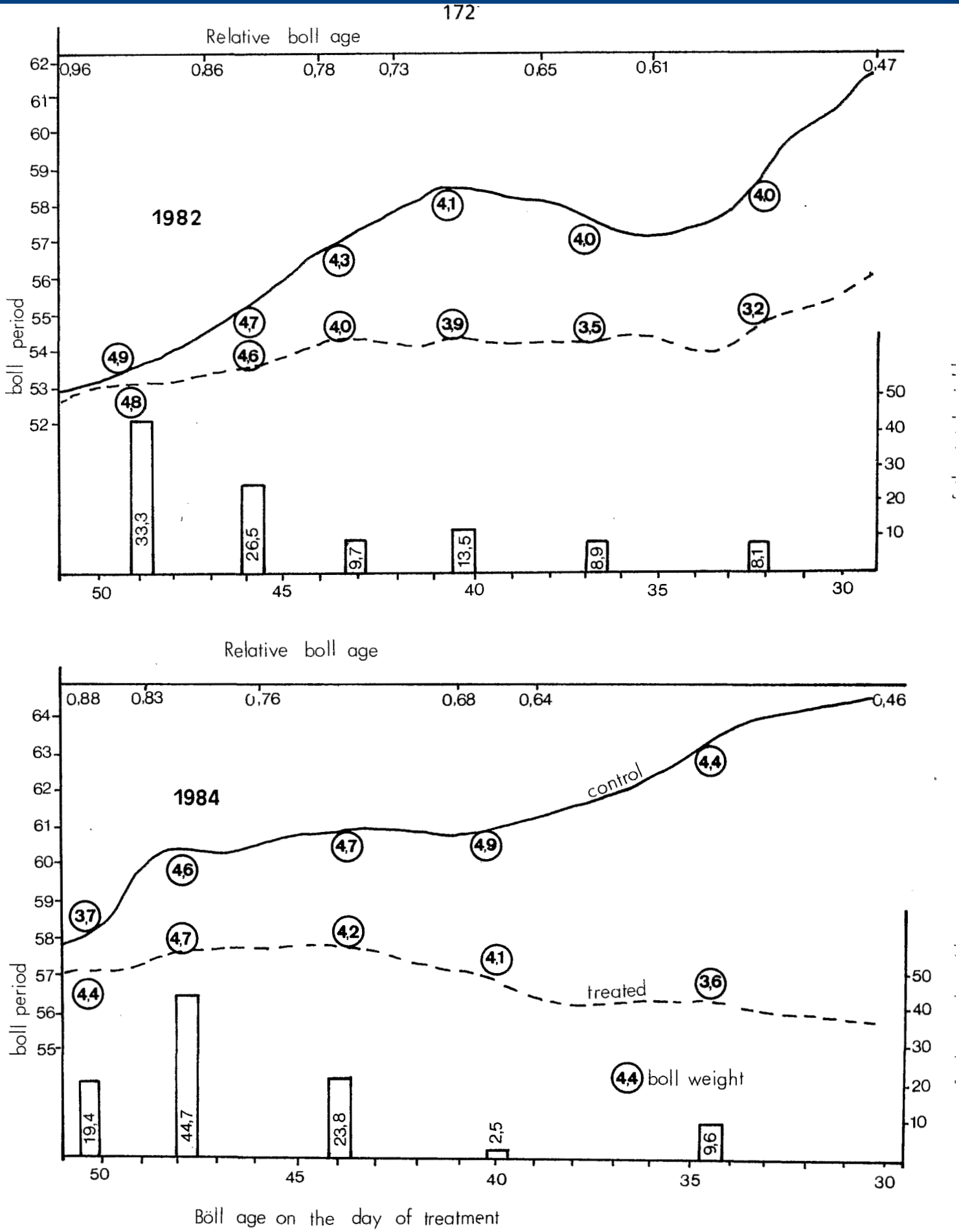

Figure 2 : Effects of treatment on boll period and weight of bolls of different age on the day of treatment