A STUDY OF THE EFFECTS OF HARDENING OF CHRYSANTHEMUM PLANTS

THESIS FOR THE DEGREE OF M. S.

George W. Woodbury

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THESIS

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A Study of the Effects of Hardening Of Chrysanthemum Plants

Thesis

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INTRODUCTION

Since the end of the 19th century the chrysanthemum has been improved, grown extensively, exhibited and admired until today it stands among the foremost cut flowers raised by florists as well as amateurs. Its wide range of color, form, size and shape, together with the comparative ease of culture have placed it toward the top of the list of herbaceous ornamentals. It responds readily to propagation by cuttings, and offers many interesting variations when propagated by seed.

Under ordinary greenhouse conditions chrysanthemums are propagated by cuttings. Such cuttings are taken from the old plants, beginning, in some instances, as early as December and continuing through May. Unless one is growing plants for exhibition or specimens, March or April is suitably early for taking cuttings. When so handled, and after rooting in from three to four weeks time, they may be immediately potted and will be ready to bench as good sized plants during the early part of June or later. Cuttings which are taken during the latter part of April or early May are usually the last ones to be benched. Plenty of first quality chrysanthemums are grown from plants benched in late June, and with the smaller sorts -- pompoms, anemones, and singles, suitable

flowers are produced from plants benched in July. However, it is the general opinion of most florists that, whatever the benching time may be, the plants should be in first class condition when benched; not necessarily large plants, but good healthy plants which have been kept growing and which show no signs of having been checked in any way.

The months of April, May and early June are the busiest in the year for the florists. The greenhouses are filled to capacity. Bedding plants, snap-dragons and other annuals grown by the average florist must be disposed of or put in the field before chrysanthemums may be benched. As a consequence, it frequently happens that the young chrysanthemum stock is neglected. Plants in small pots soon grow too large for the pots and dry out rapidly, unless given very careful attention. Cuttings taken late are sometimes not potted, being allowed to remain in the sand long after they become rooted. Room will not always permit putting the plants in pots large enough for proper growth, even if the time were available. Plants so handled will soon become hard. Lower leaves fall off in extreme cases and the stem has an appearance of woodiness. Concensus of opinion among men of the trade holds that such hardening, caused by one factor or another, is never completely overcome by the plants during the growing season, and that the subsequent crop is affected.

The purposes of this investigation were : (1) to determine to what degree the plants are affected by hardening, and (2) to devise some treatment by which the effects (if any) of such hardening can be reduced to a minimum.

It should be borne in mind that chrysanthemums, unlike the cabbage, tomato and other vegetable plants, are not purposely hardened, inasmuch as there is no reason for doing so in view of the almost ideal conditions under which they are transplanted. Hardening in chrysanthemums exists as a result of improper cultural conditions and is purely unintentional on the part of the grower. However, when the plants once become hard, efforts are usually made to overcome effects of this condition as soon as possible.

REVIEW OF LITERATURE

Regardless of the fact that the chrysanthemum has been in cultivation for some time, very few accurate studies have been made on ultimate results of hardening. Wiggin (11) conducted a series of experiments on the culture of greenhouse chrysanthemums and Laurie (5) has obtained some interesting facts in regard to fertilizers best suited to them. However, neither of these men, except in a passing way, mentions effects of hardening processes on final results.

A survey of some of the gardening periodicals, in which chrysanthemum growing is mentioned more as a

garden art than as a commercial undertaking, leads one to believe that there is a distinct prejudice against allowing plants to become checked at any time during the growing season. Two anonymous (1) (2) articles read in part as follows: "The shifting of plants in the earlier part of summer should be well attended to. If this is neglected, no good after management will save them from losing their leaves and looking badly in autumn and winter"; and "-----place them in small pots, keeping them at a temperature of not less than 50° Fahrenheit. Shift as needed." One can find a considerable number of similar articles, all of which enunciate the same principle; namely, that the plants should not be allowed to become checked at any period during their growth. Except in the general manner quoted above, no one states explicitly the degree or exact nature of damage resulting from such a check. It seems evident that no one has determined quantitatively the ultimate effects of such a treatment.

Studies on the hardening process -- its cause and effects -- have been made with the cabbage, tomato and various other vegetable plants. Important among these are the works of Rosa (9) (10) and Harvey (4). Lott (7) in working with brambles made chemical studies to determine composition in relation to hardiness. Maximov (8) has made an extensive study

of the internal factors which bring about both frost and drought resistance in plants. He makes note of the fact that cacti and certain other xerophytic plants are able to withstand extreme conditions of drought, but are easily injured by low temperatures.

The above citations include work somewhat different from that explained in this paper. The chief aim of these workers was to determine the changes of conditions induced by the hardening processes, and also the relation of such changed conditions to hardiness of plants -- either to withstand low temperatures, water loss by transpiration, or desiccation by drying winds.

Crist (3) working with indoor tomatoes, studied the ultimate effects of hardening processes as regards earliness of crop and quantity of marketable fruits. He concluded that "When tomato plants were hardened and then forced in the greenhouse their early yield of marketable fruits was greatly diminished and their total yield not materially increased." He states further that "The application of nutrient salts to the hardened plants prior to setting them in beds and forcing them did not relieve the check suffered in the hardening process."

MATERIALS AND METHODS

The plants used in this experiment were good quality rooted cuttings, all of which were taken from Woodbury's greenhouse at St. Johns, Michigan, with the exception of the Nellie T. Ross which were supplied by Elmer D. Smith of Adrian, Michigan. Except in a few cases indicated in a latter paragraph, the plants were approximately the same age. Most of the cuttings were taken during the early part of April.

Previous to the hardening process, a larger number of plants in each variety were chosen than was needed in the actual experiment so that a choice could be made to secure uniformity of plants and degree of hardening. Ninety-six of each variety were used, and from 110 to 125 plants were potted when the work was started.

On May 5, 63 plants of Pink Chieftain were potted in 2¼ inch pots and an equal number in 3 inch pots. The latter plants were shifted from the smaller pots to the 3's, and the former were allowed to remain in the 2¼ inch pots for further hardening treatment. Plants of this particular variety had been started during February and consequently were somewhat larger than those which had been started in April. Also on May 5, an equal number of variety Gladys Pearson were potted in 2¼ pots, one half in a soil of four-fifths compost and one-fifth peat; the other half in clean, dry sand.

The latter were to be hardened at a later date. The remaining four varieties -- Dr. Enguehard, Rager, Nellie T. Ross and Major Bonnaffon -- were potted up in four-fifths compost and one-fifth peat in 2½ inch pots. Half of each variety were taken later to be hardened.

THE HARDENING PROCESS

Inasmuch as the main object of this experiment was to overcome, if possible, the effects of hardening caused by neglect, it was thought better not to subject the plants to conditions which would bring about the maximum hardened condition. With this in mind the following hardening was done.

On May 30, one half of the plants of each variety were placed aside to be hardened. It will be remembered that the hardening process had really begun on varieties Pink Chieftain and Gladys Pearson, the former by allowing them to become root bound in the smaller pots and the latter by potting them in the infertile sand.

The hardening process consisted only of withholding water from the plants. It so happened that considerable cloudy weather prevailed during this time with the result that the plants did not suffer so much as they would have otherwise. For the most part, however, the treated plants were kept continually dry, with only an infrequent light sprinkling with a rose

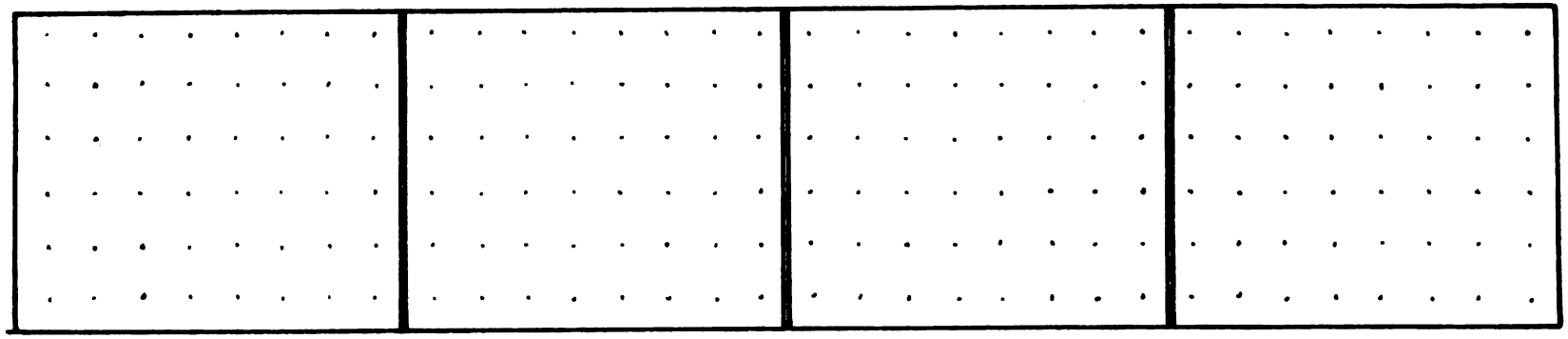
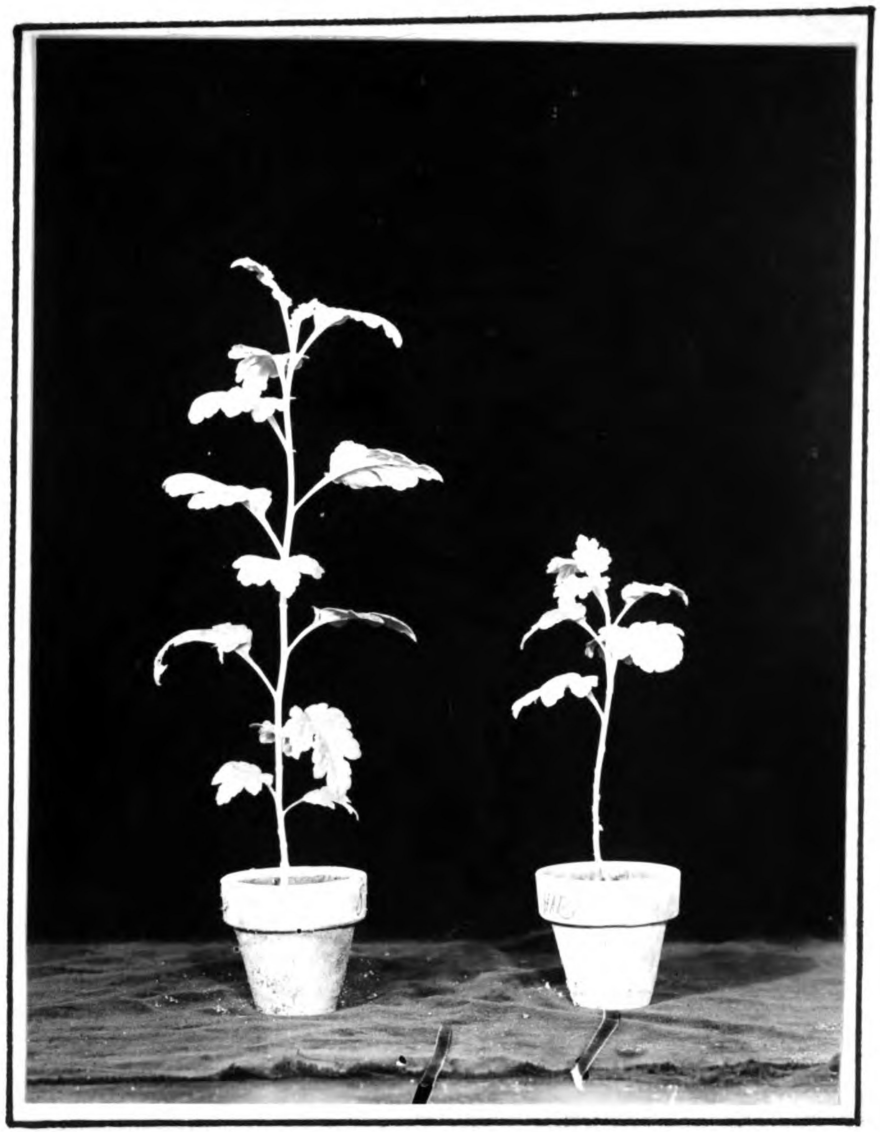


Fig. 1. Plan of One Bench of Chrysanthemums. Three such benches were used. Varieties were set the long way of the plots with the hardened plants on one end of the plots and the unhardened on the other.

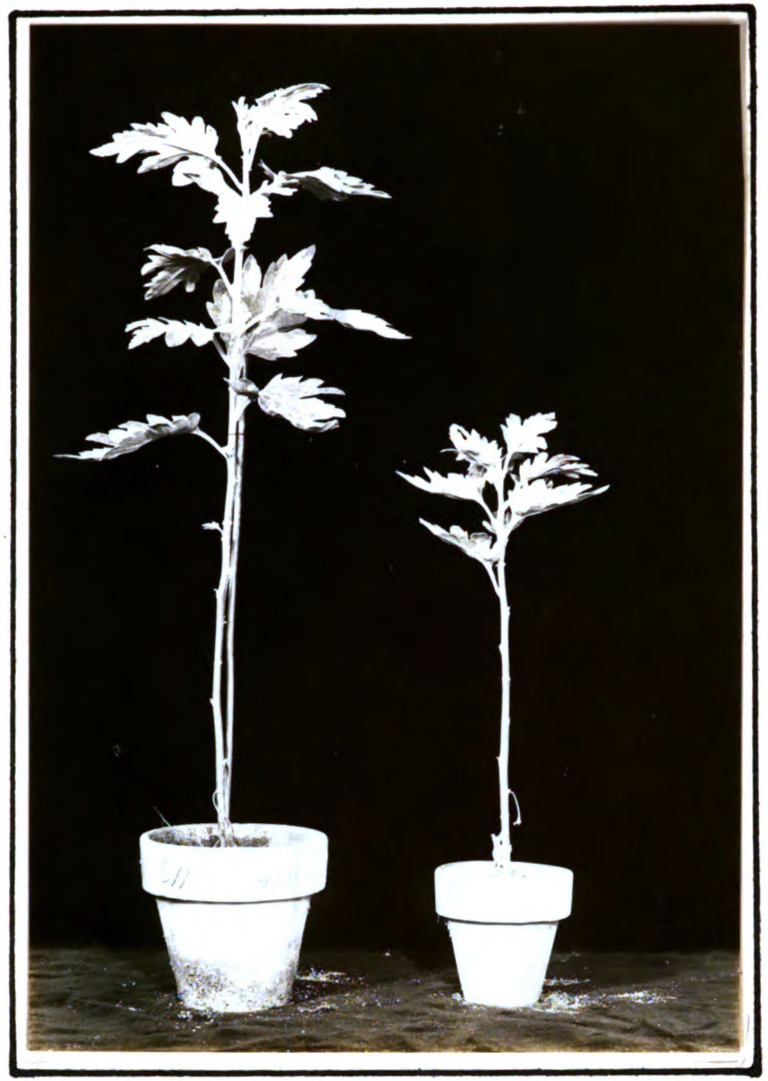
Gladys Pearson



Bonnaffon

Plants at Benching Time.
Unhardened plants on Left; Hardened
plants on Right.

Charles Rager



Chieftain

Plants at Benching Time
Unhardened plants on Left; Hardened plants on Right.

Nellie T. Ross

Dr. Enguehard

Plants at Benching Time.
Unhardened plants on Left; Hardened plants on Right.

sprayer. Meanwhile, the remaining (unhardened) plants were kept at as near optimum moisture conditions as was possible by frequent waterings and syringings.

The accompanying photographs show the comparative size and condition of the plants at the time of benching. In all cases there was a marked difference in the growth of the plants. From the standpoint of the problem it should be borne in mind that this check in the plant growth is of greater importance than the difference in size.

All of the plants used in the experiment were benched June 24, as is shown in Fig. 1. It will be seen that the hardened and unhardened plants were checked against each other in each plot, and that each plot could be checked against any or all of the remaining plots. This made possible a large number of comparisons.

Inasmuch as the houses in which the plants were grown run north and south, it was not thought important to change the location of the varieties from one plot to another or from one bench to another. For the sake of convenience and to avoid confusion in later determinations, each variety maintained its same position with respect to the bench throughout the entire three benches and twelve plots.

Three benches were used, each 22 feet long and 4½ feet wide. One such bench accommodated four plots,

each with 48 plants, 8 of each of the six varieties running lengthwise of the plot. Two pine boards one inch apart separated one plot from another. A glance at the accompanying diagram affords a definite idea of how the plots were arranged. Each plot represents an area of 24.75 square feet.

Six standard varieties of chrysanthemums were used. These represent a period of bloom of about a month, the latest one, Nellie T. Ross, a rather late mid-season bloomer maturing about November 21 and the earliest, Pink Chieftain, maturing its first blooms on October 23. It will be noted that neither the early nor late extreme of the season was represented. The varieties at hand, however, show enough difference in time of blooming to be representative. Pompoms, anemones and singles were not included in this experiment and owing to the difference in growth of various sorts, experimental data at hand might not be representative of all sorts as a whole. However, these varieties are all good commercial sorts that are regularly included in varietal lists by florists who raise chrysanthemums for profit.

Twelve different treatments given on the twelve respective plots were as follows:

1. One pound 2-16-2 commercial fertilizer incorporated in the soil at benching time, followed by a one inch German peat mulch one week later.

2. One pound bone meal worked into the compost at benching time, with a one inch manure mulch applied one week after benching.

3. One pound 2-16-2 commercial fertilizer mixed into compost at benching time. In this plot the hard plants were notched with a sharp knife at a point above the hardest portion of the plant.

4. One pound of "Vigoro" was incorporated into the compost at benching time.

5. One pound 2-16-2 commercial fertilizer was mixed with the compost at benching time.

6. One half pound of ammonium sulphate was worked into the compost at benching time, followed on July 17 by two ounces of ammonium sulphate in solution and applied at the time of watering.

7. This plot contained half German imported peat and half soil by volume, mixed together. The hard plants in this plot were set deep so that the hardest portion was below the surface.

8. Half peat and half soil were mixed together in this plot.

9. No treatment was given except that the hardened plants were injured as in plot three.

10. No soil treatment was used, but the hardened plants were set deep as in plot seven.

11. All plants in this plot were pinched back two or three nodes one week following benching.

12. No treatment was given either soil or plants in this plot.

The compost used in the benches was taken from the compost pile at the greenhouse, and was made up of stable manure and sod, and was of a loamy nature. It should not be understood that the above treatments represent ordinary commercial methods of soil treatment for chrysanthemums. In years past, and also at the present time, mulching with manure has been a common practice among many growers of chrysanthemums. Such mulching, however, is rarely done until after the bud is taken and is often substituted for or supplemented by regular feedings with manure water until color shows in the buds. Manure mulch used in plot 2 would not serve to "feed" the plot, but more as merely a mulch that supplied some additional plant food. Edmonds and Laurie (5) from rather extensive experiments with chrysanthemums report that a peat mulch promotes a marked increase in growth over those plants where no application is made. They go further to state that peat supplies desired acidity suitable for chrysanthemums. They also state that super-phosphate applied at benching time is very useful in starting growth and inducing earliness. Bone meal was found by them to be of little value for such a short season crop.

The mechanical treatments resorted to in this experiment were with the idea in mind to dispose, as far as is possible, of the hard wood. It was thought that roots might develop on the stems at the point of injury. If this occurred, resulting growth would be unhardened. Where no injuring was done, the idea was to dispose of the hardened tissue by submerging it.

Practically the same thing is true in the case of the pinched plants, except that the new "breaks" resulting from the pinching process would be unhardened, the resulting difference, if any, would be in the time required for such "breaks" to appear and develop.

The check plot (no. 12) represents treatment usually given to plants at benching time. In commercial work, however, feeding would follow after the bud had been taken. In none of the twelve plots was feeding done. It seems probable that larger blooms of perhaps better quality might have resulted if feeding had been done, but there is no reason to believe that comparative results would have been altered by such treatment.

A study of the pH values was made in each plot. Results are shown in table 1. In the peat plots the pH is somewhat lower. In these two plots the early growth seemed more succulent and a lighter green in color. Wiggin (11) reported 6.5 as the pH at which chrysanthemums do

best. Wildon* reports a somewhat lower pH of 5.6 as being best suited.

Table 1.- Showing pH of soil in each plot. Determinations were made several weeks after the plants had become established.

Plot No.	pH
1	7.2
2	7.8
3	7.6
4	7.6
5	7.4
6	7.6
7	6.8
8	6.8
9	7.8
10	7.4
11	7.3
12	7.4

*Unpublished data obtained from experiments at Rhode Island State Agricultural College.

EXPERIMENTAL RESULTS

Data were obtained on rate of growth, quality of bloom, date of maturity and final height of hardened plants as compared with the unhardened plants. Quality of bloom depends on size, color, substance, form, keeping quality, foliage and length of stem. Of these, size of bloom and length of stem are most conveniently measured. Color, form, keeping quality and substance were observed and suitable notes made.

EFFECT OF HARDENING UPON LENGTH OF STEM

Table 2 shows the average length of stems of all hardened and unhardened plants in each plot, irrespective of variety, at the beginning of the experiment. Similar averages are shown for the same plants at its end. In general the figures are representative of those for any one of the six varieties used.

It will be seen from these data and the accompanying photographs that the unhardened plants had a distinct advantage in height over the hardened plants. It was important in this experiment to note the rate and total increase in growth, as well as weekly increment, to determine whether or not the hardened plants overcame this check in growth, and if so, at what time during their season of growth. If, on certain plots, the difference

between the hardened and unhardened plants soon becomes less, then that particular treatment obviously was beneficial, as compared with any plot where this difference persisted throughout the experiment. The figures in Table 2 show that in only one case, plot 5, did the average of the hardened plants come up to or exceed the average for the soft plants. In the variety Gladys Pearson the hardened plants had caught up with the soft plants on August 22, and growth proceeded at about the same rate from then on. In Chieftain, where there was more difference to start with, the hardened plants were practicallyequal to the soft plants at the end of the season. Major Bonnaffon plants were on a parity by September 8. Dr. Enguehard, where difference was slight at the beginning of the experiment, showed the hard plants catching up early -- about the end of July. In Nellie T. Ross and Charles Rager, growth in the hard and soft plants was at about the same rate pretty much throughout the entire season.

Table 2.- Showing Average Height of Hardened and Unhardened Plants on each plot at benching time and at maturity. At the right is shown average size of bloom of these plants.

Plot No.	Ave.Height at beginning		Ave.Ht. at end of experiment		Ave. diam. of bloom.	
	Unhardened inches	Hardened inches	Unhardened	Hard-ened. inches	Unhard-ened inches	Hard-ened inches
1	8.67	5.04	47.8	45.9	5.22	5.07
2	7.56	4.78	44.88	42.00	4.81	4.61
3	7.71	3.50	42.00	41.23	5.01	4.63
4	9.07	4.58	44.00	41.50	5.28	5.10
5	8.20	5.60	40.79	41.37	4.89	4.75
6	9.06	5.22	43.25	40.33	5.19	4.85
7	8.96	4.21	44.52	42.79	4.80	4.88
8	9.38	5.41	45.62	42.17	4.97	4.83
9	8.86	4.69	47.37	41.16	5.19	4.88
10	7.86	7.59	41.37	39.54	4.97	4.82
11	6.31	4.32	37.41	34.00	4.94	5.15
12	9.21	6.95	42.50	39.17	5.06	4.95

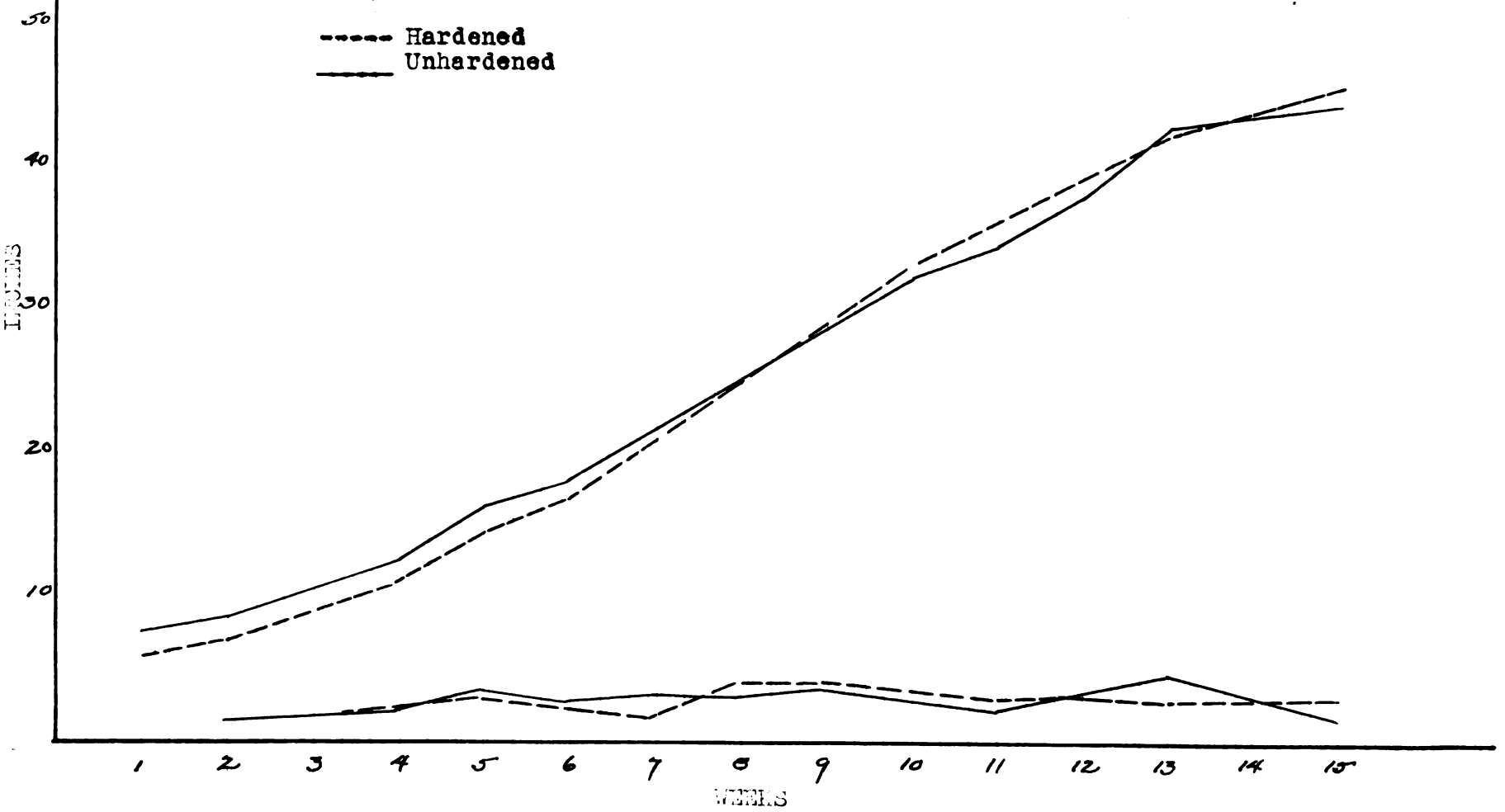
As previously stated, no other plot showed average height of the hardened plants exceeding that of the unhardened plants in the course of the growing season. In a few instances, i.e., with certain varieties in certain plots this took place, but not consistently enough to change the order for the plot.

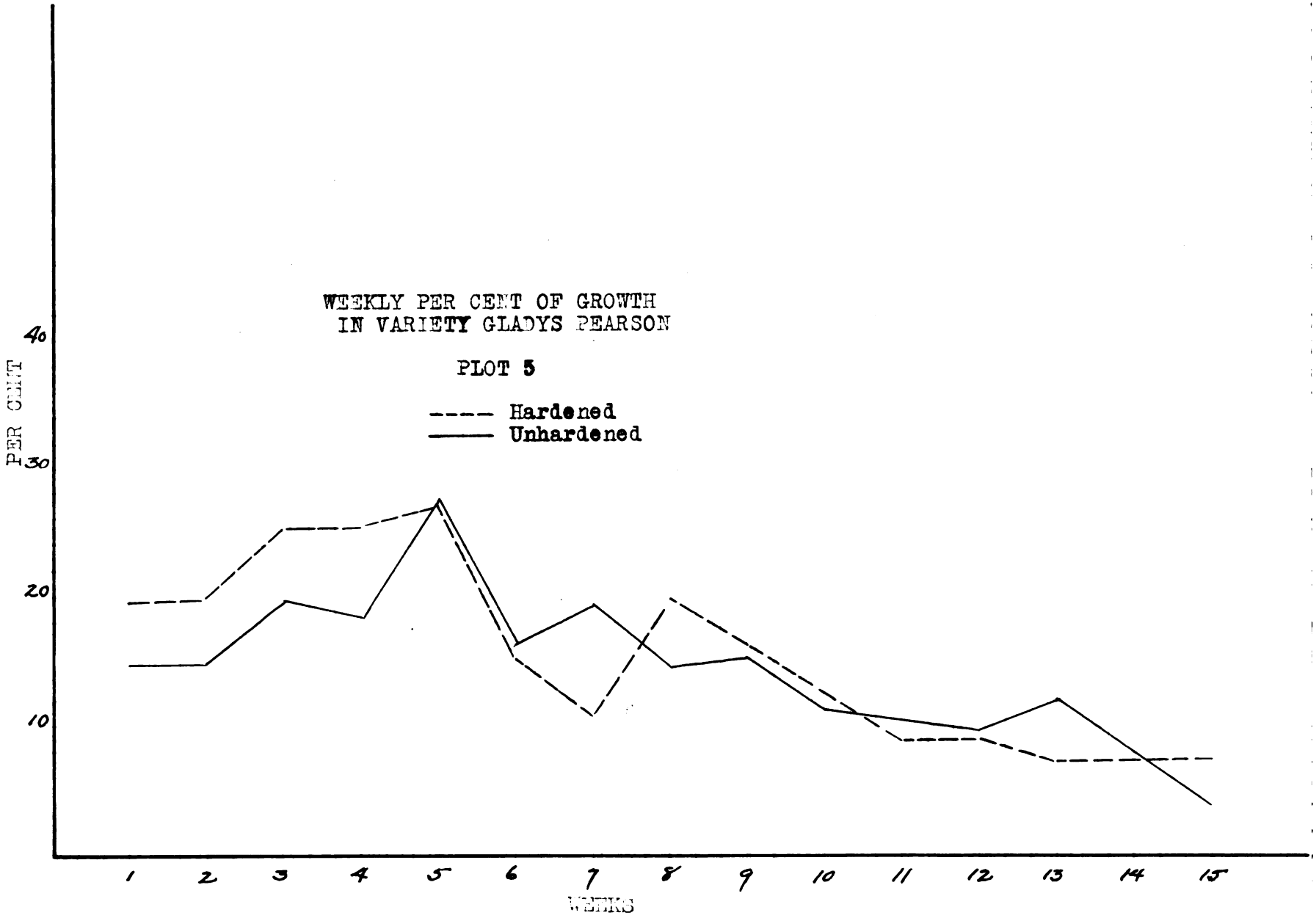
Growth, percentage of growth, and weekly increments were plotted for each variety so as to show the averages for all the individuals of both hardened and unhardened plants in each plot. The resulting curves show graphically what happened to all lots during the experimental period. The curves are consistent. Percentage of growth was calculated by dividing the weekly increment, averaged from the four unhardened and four hardened plants of each variety in each plot, by the previous weekly measurement averaged in the same way, and multiplying the quotient by 100. These particular curves were irregular, but paralleled each other rather closely. As might be expected, they showed that the rate of growth in the hardened exceeded that of the unhardened plants rather markedly at the beginning of the season, but much less markedly as the season progressed. In other words, as the plants became more nearly equal in height, rate of growth was more uniform. Weekly increment varied with the greenhouse conditions prevailing throughout the week, with little difference being apparent between the treated and untreated plants.

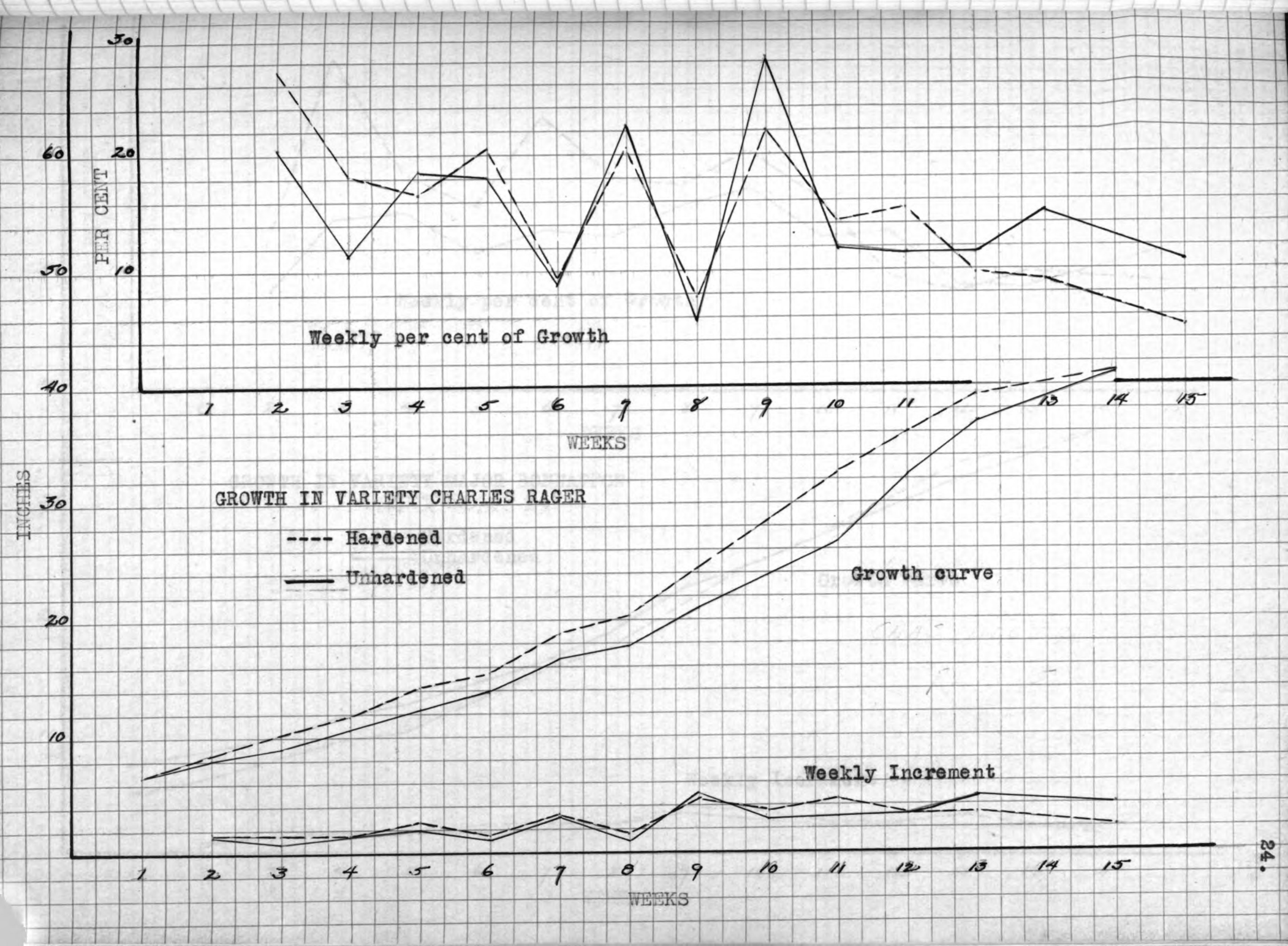
GROWTH IN VARIETY GLADYS PEARSON
GROWTH CURVE
WEEKLY INCREMENT

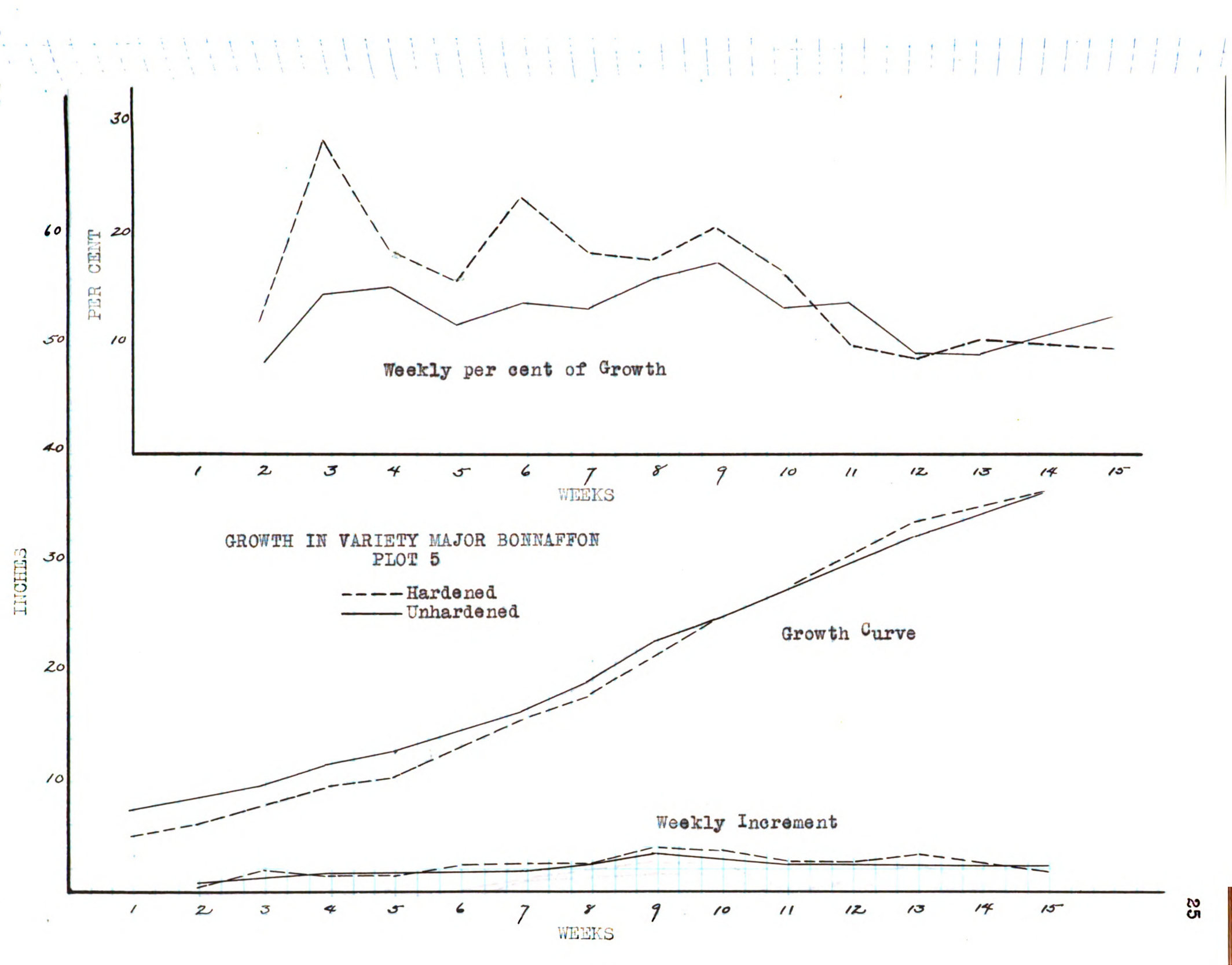
PLOT 5

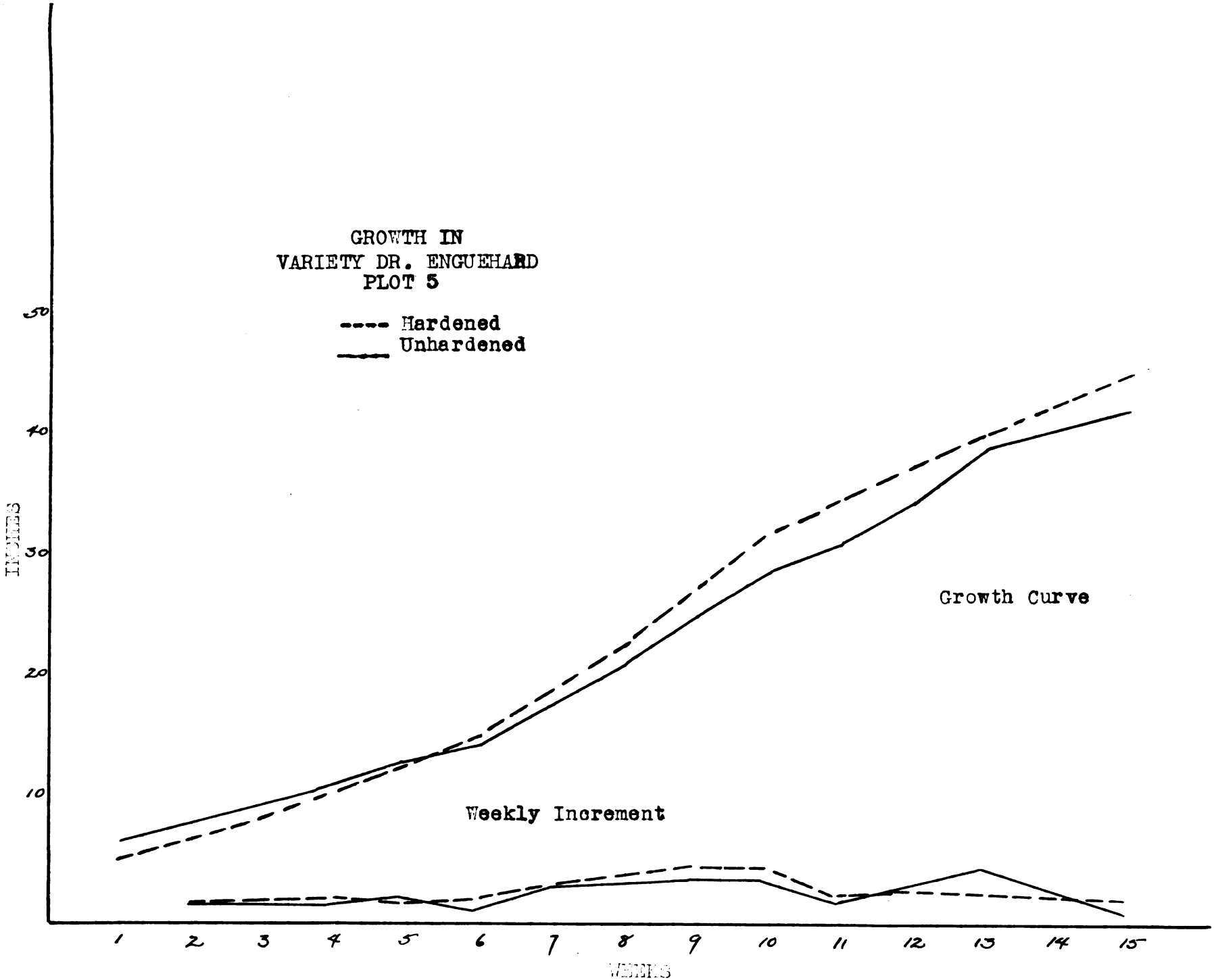
----- Hardened
_____ Unhardened




WEEKLY PER CENT OF GROWTH
IN VARIETY GLADYS PEARSON
PLOT 5
Hardened
Unhardened
PER CENT
40
30
20
10
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
WEEKS


30
20
10
PER CENT
Weekly per cent of Growth
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
WEEKS
GROWTH IN VARIETY CHARLES RAGER
---- Hardened
—— Unhardened
Growth curve
Weekly Increment
INCHES
60
50
40
30
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
WEEKS


PER CENT
30
20
10
Weekly per cent of Growth
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
WEEKS
GROWTH IN VARIETY MAJOR BONNAFFON
PLOT 5
Hardened
Unhardened
INCHES
60
50
40
30
20
10
Growth Curve
Weekly Increment
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
WEEKS


GROWTH IN
VARIETY DR. ENGUEHARD
PLOT 5
---- Hardened
____ Unhardened
50
40
30
20
10
INCHES
Growth Curve
Weekly Increment
1
2
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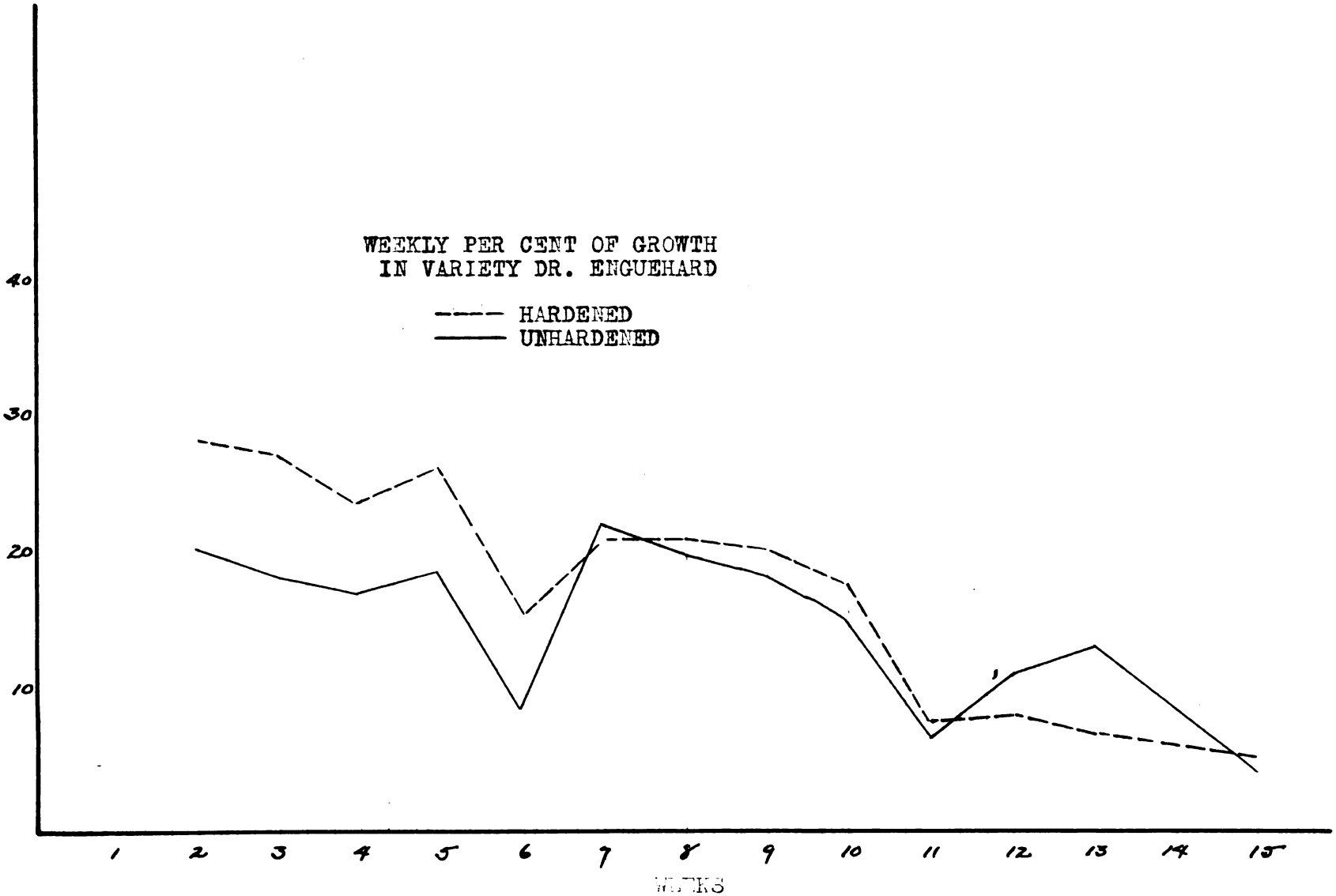
WEEKS


WEEKLY PER CENT OF GROWTH
IN VARIETY DR. ENGUEHARD
HARDENED
UNHARDENED
40
30
20
10
1
2
3
4
5
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7
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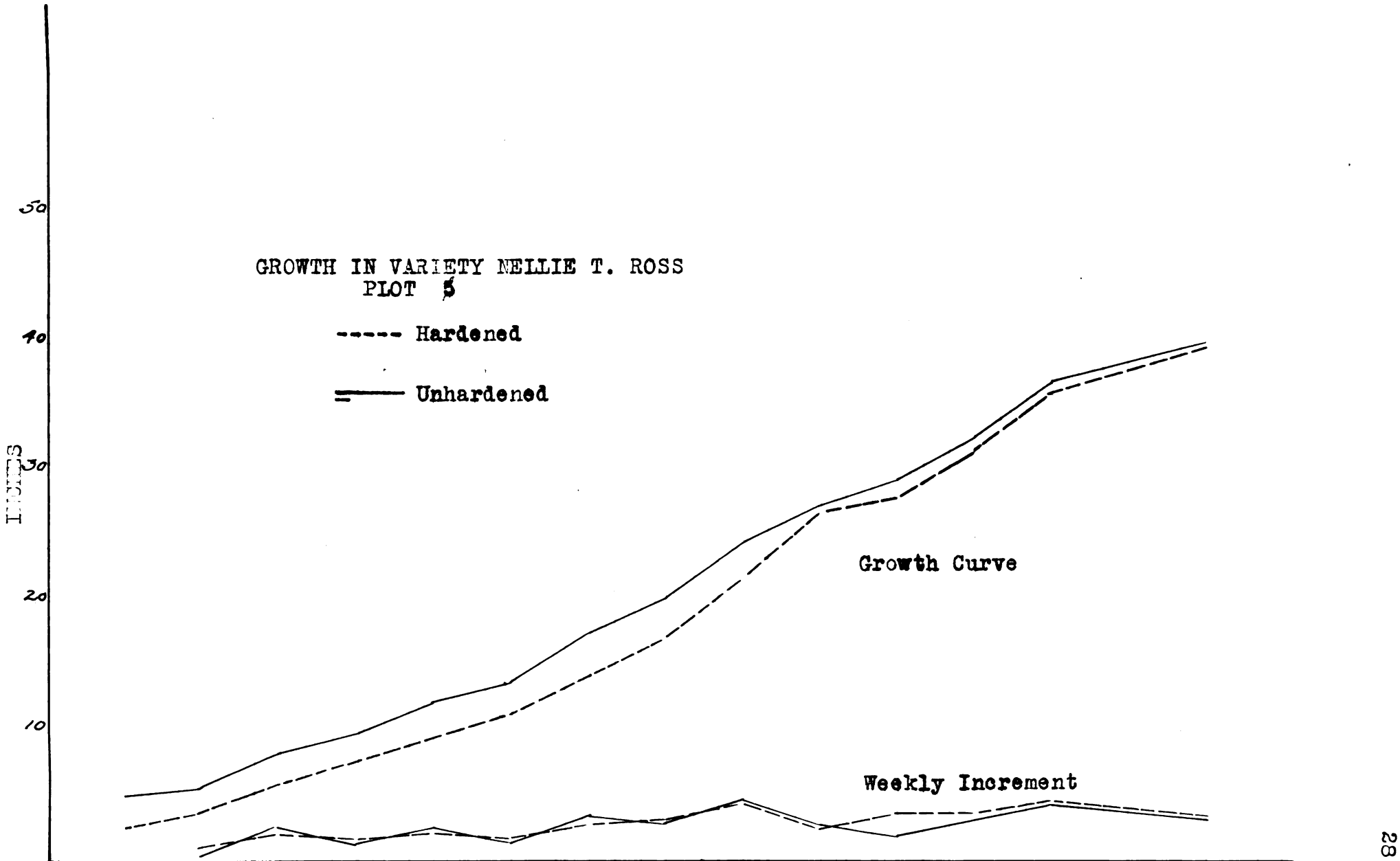
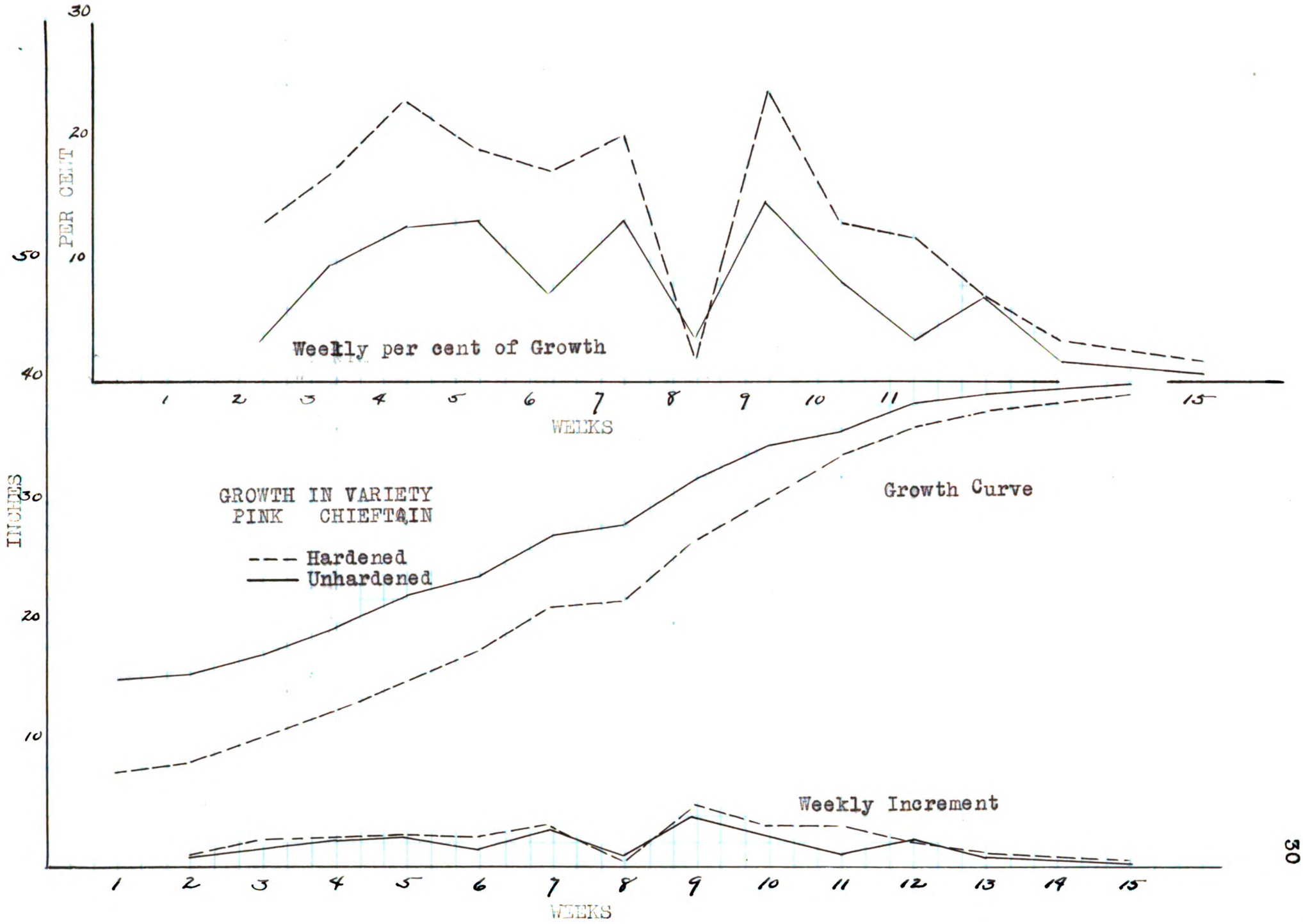
14
15
WEEKS


GROWTH IN VARIETY NELLIE T. ROSS
PLOT 5
----- Hardened
——— Unhardened
50
40
30
20
10
INCHES
Growth Curve
Weekly Increment


30
20
10
PER CENT
Weekly per cent of Growth
1 2 3 4 5 6 7 8 9 10 11 15
WEEKS
GROWTH IN VARIETY
PINK CHIEFTAIN
--- Hardened
—— Unhardened
Growth Curve
INCHES
30
20
10
Weekly Increment
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
WEEKS

The important feature brought out by the figures is that, though in general the hardened plants did not catch up with the soft plants in height, there was none of them without stem of sufficient (and in many cases more than sufficient) length for first class marketable blooms. Furthermore, though no exact correlation coefficients between length of stem and size of bloom were calculated, there would be little reason for assuming that such a correlation existed. Wiggin (12) in experimenting with cultural methods for chrysanthemums on varieties William Turner and Yellow Turner, found that no correlation existed between length of stem and size of bloom. "In only 3 out of 30 plots was the coefficient of correlation equal to four times the probable error." He states further that any stem beyond what is good commercial length has no advantage.

EFFECTS OF HARDENING UPON SIZE OF BLOOMS.

Terminal buds were taken on all of the plants in all plots. With all other things being equal, this should bring about a uniformity of bloom as regards date of maturity, size, color and quality.

The only measurement made of the blooms was the diameter. A square piece of card board, graduated with

different sized concentric circles, with a slit on one side for the insertion of the stem, provided the most convenient method for making these measurements. Diameter alone should not be used as a criterion for determining size, as depth and fullness are also important factors. However, in making measurements, where extreme cases were in evidence, some consideration was accorded these other factors, and the figures as recorded were comparable.

Table 3.- Showing number of blooms in various sizes from hardened and unhardened plants of six varieties.

	Hard-ened 3-4 in.	Unhard-ened 3-4 in.	Hard-ened 4-5 in.	Unhard-ened 4-5 in.	Hard-ened 5-6 in.	Unhard-ened. 5-6 in.	Hard-ened. 6-7 in.	Unhard-ened 6-7 in.
G. Pearson	1	1	18	13	17	24	4	4
Dr.Enguehard	21	16	21	26	0	2		
Chieftain	8	2	24	34	10	11		
Bonnaffon	9	3	23	25	11	16		
Nellie T.Ross	0	0	6	4	32	39	6	4
Chas. Rager	7	6	31	33	3	9		

Table 2 shows average size of bloom from unhardened and hardened plants in each plot, regardless of variety. Table 3 shows size prevailing in varieties regardless of plot, and table 4 gives average size of bloom from hardened and unhardened plants irrespective of plots. Where buds had been injured by one agency or another, necessitating the taking of a lateral bud, the blooms from such buds were discarded and not used in computation of results. Consequently, in almost every instance, the number of unhardened plants producing blooms was not the same as the number of hardened plants producing blooms. Total number of blooms used is recorded in each instance. From these data a slight tendency toward larger blooms among the soft plants is apparent. As is natural, size varied to a considerable degree from one variety to another. In all instances, however, these differences, apparently brought about by treatment, are too slight to be significant to the commercial producers.

Table 4.- Showing average size of blooms from Unhardened and Hardened plants in each variety covering all twelve plots.

Variety	Average size of Bloom Inches	
	Unhardened plants	Hardened plants
Major Bonnaffon	5.03	4.80
Dr. Enguehard	4.29	4.08
Charles Rager	4.82	4.63
Chieftain	4.96	4.67
Nellie T. Ross	5.68	5.71
Gladys Pearson	5.36	5.38

EFFECT OF HARDENING UPON TIME OF MATURITY OF BLOOM

From a study of Table 3 it will be seen that the earliest variety, Pink Chieftain, showed a wider variation between the two treatments than did any of the others. Nellie T. Ross and Gladys Pearson, among the last varieties to bloom, showed the least difference in size of bloom from one treatment to another. It would seem natural to expect this to be the case. The earlier plants had reached a greater degree of maturity at time of hardening than had the late plants, hence the check would be more lasting in effect. Loomis (6) found that injury from transplanting increased with maturity. If one considers transplanting itself as a hardening process to some extent, the above results would seem in order.

All blooms were measured at a time when they were apparently at their maximum as regards size, and at the time they would have been cut for commercial use as first class flowers. With such a standard as a basis, all blooms were measured at a time when they had attained the same degree of maturity. Table 5 shows number of blooms of both hardened and unhardened plants cut on the dates given. Here, as with size of bloom, the greatest differences are noted in the Pink Chieftain, which covered a blooming period of about twenty days, as against Nellie T. Ross, all blooms of which had reached the same degree of maturity on a single day.

Table 5.- Time of maturity of blooms in each variety from Unhardened and Hardened plan.

Date	10 - 23		10 - 24		10 - 27		10 - 28		10 - 30		11 - 3		11 - 5		11 - 11	
Treatment	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened.	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened
Gladys Pearson																
Dr. Enguehard																
Chieftain	2	0	3	2	9	9	6	6	14	9	4	8	5	2	3	3
Bonnaffon											1	1	3	2	2	15
Nellie T. Ross																
Charles Rager													3	1	39	30

Date	11 - 13		11 - 16		11 - 17		11 - 18		11 - 21	
Treatment	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened	Unhard-ened	Hard-ened.	Unhard-ened	Hard-ened
Gladys Pearson	3				31	26			8	14
Dr. Enguehard	2						40	39	2	3
Chieftain			1	3						
Bonnaffon	15	15			2	5			1	5
Nellie T. Ross								47	44	
Charles Rager	6	11								

In Gladys Pearson, unhardened plants came into bloom earlier, but several plants of this variety were lost and the results, therefore, are not so reliable.

EFFECT OF HARDENING ON QUALITY OF BLOOMS.

The commercial grower desires flowers of fairly good size, uniform throughout, with a strong stem, good substance and color of both foliage and flower. Conditions which favor production of such chrysanthemums are the conditions the florist seeks to establish.

Fig. 5 shows eight blooms of Nellie T. Ross from plot 8. Stem lengths and size of blooms are given. To facilitate photographing, a portion of the stems was removed previous to taking the picture. Certainly, if these four blooms from hardened plants were mixed with the accompanying four blooms from soft plants, no expert on chrysanthemums would be able to distinguish one from the other. In quality of foliage, flower and stem there is no discernible difference. Fig. 6 shows blooms of Gladys Pearson from Plot 7, but their identity had been lost before photographing. Stems were cut off here as is explained above. These varieties were chosen for photographing only because the flowers matured at the same time. In view of the figures at hand, and in light of observations made, it is safe to say that the same results would have been obtained from any other variety in any other plot, except for the irregularity in reaching maturity.

Variety Nellie T. Ross Plot 8
Left: Blooms from Hardened Plants.
Right: Blooms from Unhardened Plants.

Variety Gladys Pearson Plot 7
Identity of Blooms Unknown.

EXTREME HARDENING.

Shortly after September 15, a few plants of varieties Gladys Pearson and Major Bonnaffon were taken from the propagating bench in the greenhouse. These were surplus stock which had not been used, and there being no use for the propagating bench during the summer, the cuttings were allowed to remain in the sand after they had rooted. The only water that they had received was that which had splashed on them when nearby plants had been watered. As a result, these plants had reached an extreme state as regards hardness. To supplement the data being obtained by experimental treatments, 50 or 75 of these plants were potted in 3 inch pots in fertile compost with some sodium nitrate added. No data were taken, but the plants showed but few signs of recovery, sent out a terminal bud, and bloomed when about one foot high. The blooms were small and inferior. This shows that when hardening has reached an advanced stage, recovery cannot be expected.

DISCUSSION OF RESULTS.

From data obtained in this work and from a careful study of the various features involved, it can be said that chrysanthemum plants which were hardened by one process or another produce marketable blooms of as good quality as do plants which have been given the best of treatment. The differences between them are too small

to be significant. At least this holds true for such degrees of hardening as were obtained in this experiment. There are, however, a few reservations which should be made. In growing chrysanthemums, there are several important features which are very likely to have a bearing upon the crop. Important among these is the time of benching. This usually has a direct bearing upon the conditions of the plants when benched as regards maturity, hardening, and size. It seems reasonable to believe that, as time goes on, plants left in pots will become harder than if placed in the bench at the proper time. June 24, the date on which the plants of this experiment were benched is not late ----neither is it very early. It represents a time at which many florists are starting to bench, some of the most progressive, perhaps, have benching almost completed, and a lagging few have not yet started preparations.

The writer has had opportunity to observe, on several occasions plants benched late that had become very much hardened by remaining too long in the small pots. Such plants lose most of their lower leaves, have every appearance of being checked in growth, and finally produce small blooms and poor quality stems and foliage. This took place where no treatment was given to invigorate the hard plants and benching was done from two to four weeks after June 24.

SUMMARY

1. This experiment was carried out to observe effects of hardening on chrysanthemums. Various treatments were used to reduce other differences to a minimum.

2. Six mid-season varieties were used which blossomed over a period of about a month. Twelve different treatments were given; in each plot half of the plants had been hardened and half well grown.

3. The hardening process, which consisted primarily of withholding water, brought about a distinct check in growth, as indicated by comparative size of hard and soft plants.

4. Only one plot, No. 5, where 2-16-2 commercial fertilizer was applied at benching time, showed an average height of the hardened plants greater than the average of the soft plants. The difference was not great enough to be considered significant.

5. Hardening of plants had no significant effect upon time of flowering, size, nor quality of bloom. All stems were of more than sufficient length for marketable blooms.

6. It is possible that a longer period of hardening, followed by later benching, would have produced different results, although no data are available to substantiate such a statement.

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