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# THE WEATHER AND HONEY PRODUCTION

AGRICULTURAL EXPERIMENT STATION  
IOWA STATE COLLEGE OF AGRICULTURE  
AND MECHANIC ARTS



Ames, Iowa

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# THE WEATHER AND HONEY — PRODUCTION

BY L. A. KENOYER\*

The weather and its changes exert a marked influence on honey production.

That fact stands out clearly in the daily records of the weight of a hive of bees and of the accompanying weather conditions, kept for 29 years by J. L. Strong, a successful beekeeper of Clarinda, Page county, Iowa, and furnished for study to the Iowa Agricultural Experiment station.

The month of June, these records show, is preëminently the honey month of the year, with 56 percent of the entire production of the hive for the period to its credit. Moreover, the honey production in June is an index for the production for the entire year, which is large or small according as the June gain is relatively large or small. Rather abundant rain is favorable for large honey production and especially if the rainfall in May is rather heavy, altho excessive rain is likely to result in a poor honey year. South winds are apparently more favorable for good gains than winds from the other directions. The period of a rain is generally a time of depression in honey flow, and the clear days just preceding a rain show slightly greater increase than the days immediately following. Higher temperatures are accompanied by larger honey gains than lower, and a low barometer is favorable for good yields. A cold winter seems not to cut the yield of the succeeding session, but a cold March does.

In these and various other ways the records point to a direct relationship between weather and honey production, and they confirm many of the extended observances of experienced bee keepers.

## SOURCE OF THE DATA

The presentation in this bulletin of detailed data on the influence of weather on honey yield is made possible thru the coöperation of J. L. Strong, who placed his extended records at the service of the Iowa Agricultural Experiment station.

\* Acknowledgements are due not only to J. L. Strong for furnishing the daily records on which the hulletin is based, but also to F. C. Pellet, hee inspector for Iowa, for securing it, to A. S. Van Sandt, G. M. Chappell and L.A. Welch for additional weather data, and to Dr. E. F. Phillips of the U. S. Department of Agriculture, Drs. L. H. Pammel and C. E. Bartholomew of Ames, Mr. Pellett, and C. P. Dadant for valuable suggestions in the use of the data.

These records were carefully made from day to day, thru the period of 29 years from 1885 to 1914. Each day's entry records the weight of one hive and also gives notes on weather conditions for the day. Other meteorological data for the locality of Mr. Strong's apiary, including barometer readings, were obtained from A. S. Van Sandt, the U. S. coöperating weather observer for that vicinity. The mean monthly temperatures and rainfalls before 1890 were furnished by the U. S. weather bureau office at Omaha, Nebraska, because prior to 1890 no local records were kept at Clarinda.

Mr. Strong's apiary at Clarinda, Page county, is located in southwestern Iowa. In that region, as in most of the north Mississippi valley, white clover is the leading honey plant. Mr. Strong names as outstanding honey plants of his section, white clover, alsike clover, basswood, and smartweed; as those of secondary importance, he gives buckwheat and Spanish needle; as those which bees visit for nectar, but which probably produce a negligible amount of honey, he mentions willow, pear, apple, plum, red raspberry, black raspberry, blackberry, white and yellow clover, sweet clover, catnip, coral berry, golden rod and dandelion. Some would differ with him as to the relative value of some of these plants, yet it is probable that his judgment is in the main correct for the region and the period under observation.

#### JUNE IS BEST HONEY MONTH

That June is preëminently the honey month of the year is one of the most outstanding facts attested by this 29 year record of daily honey gains. Fifty-six percent of the entire gain in weight of the hive during the time recorded is credited to this month.

The average monthly distribution of increase in pounds is shown in table I.

TABLE I. AVERAGE MONTHLY INCREASE IN HONEY FOR 29 YEARS

April .....	1.2 lbs.
May .....	4.8 lbs.
June .....	59.6 lbs.
July .....	25.7 lbs.
August .....	9.9 lbs.
September .....	5.0 lbs.
Annual .....	106.2 lbs.

It will be seen that except in June and July, the honey crop is almost negligible.

Furthermore, the June flow is an index of the crop for the year. Of the ten best Junes, eight agree with the ten best years, likewise eight of the ten poorest Junes fall in the ten

poorest years. It is still more remarkable that the July flow is largely determined by that of June. Of the ten best Julys of the record, eight follow Junes of the leading ten, while seven of the ten poorest Julys follow poorest Junes.

A good honey crop tends to be preceded and followed by a poor one, very much as is known to be the case with the apple crop. The facts are shown in table II:

TABLE II. RELATION OF GOOD AND POOR PRODUCTION YEARS

Average for year preceding ten best years.....	74.6 lbs
Average for year following ten best years.....	71.9 lbs.
Average for year preceding ten poorest years.....	136.5 lbs.
Average for year following ten poorest years.....	126.3 lbs.

A random arrangement of the annual yields would not show this contrast. Evidently there is in a year of heavy yield exhaustion of the honey plants from which they do not quite recover in the following year.

#### RAIN AND HONEY PRODUCTION

Rather abundant rain seems essential to stimulate plants to the vigor necessary to nectar production and to furnish the water contained in the secretion.

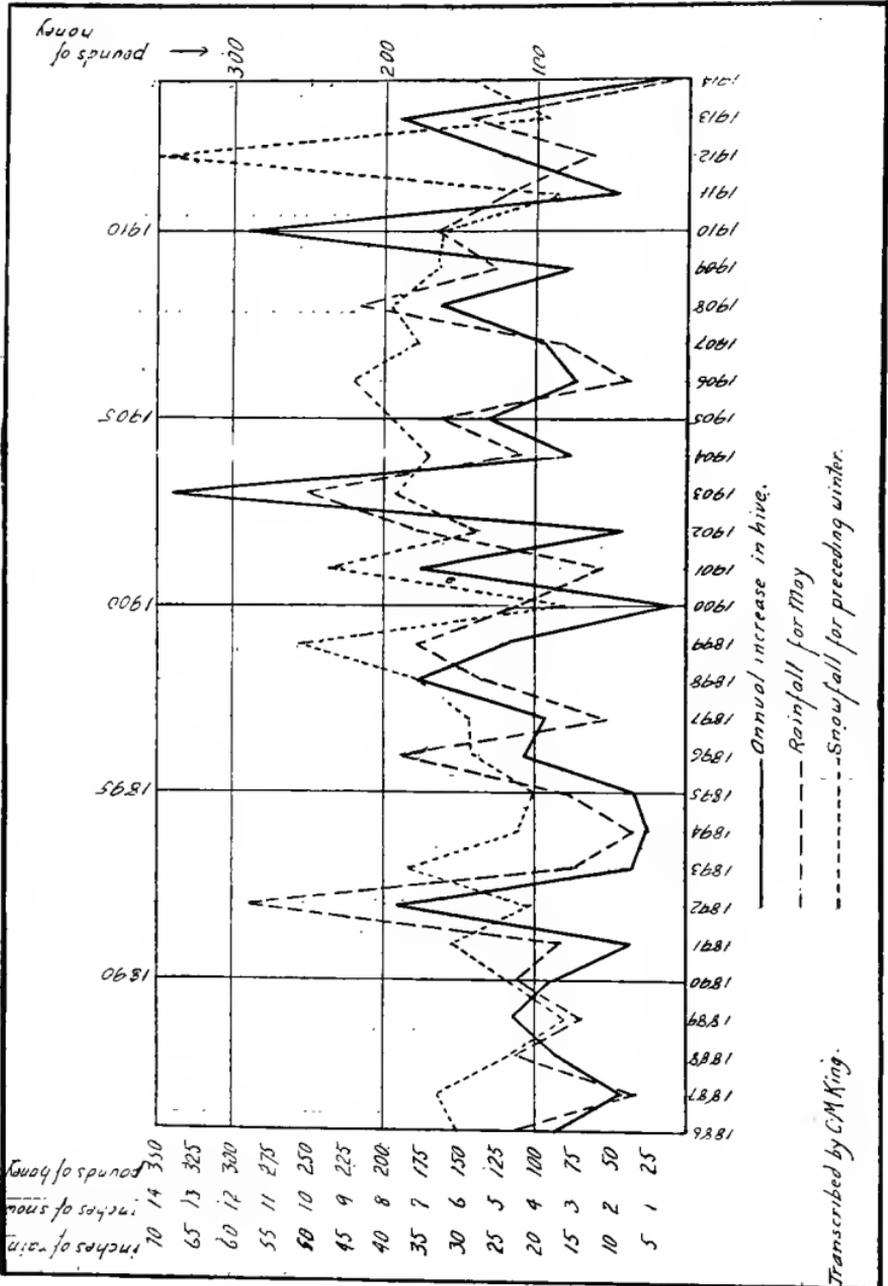
The important time for rains is indicated in table III.

TABLE III. RAINFALL IN GOOD AND POOR YEARS OF HONEY PRODUCTION

	Av. for 10 Best Years	Av. for 10 Poorest Years
Precipitation for year.....	33.49 inches	30.32 inches
Precipitation for preceding year.....	35.09 inches	30.39 inches
Precipitation for preceding July-September..	11.75 inches	10.12 inches
Precipitation for preceding October-December	6.63 inches	4.71 inches
Precipitation for preceding January-March..	3.97 inches	3.64 inches
Precipitation for April.....	2.99 inches	2.59 inches
Precipitation for May.....	6.51 inches	3.02 inches
Precipitation for June.....	4.07 inches	4.87 inches

Some poor honey years are poor because of excessive rain; for example in one of them, 1902, June had 11.64 inches of rainfall. June, 1911, goes to the other extreme with .76 inch, and is also poor.

But the value of rain prior to the season is shown by all the sets of figures in the table, particularly those for May. Of the 10 Mays on our list having a rainfall of 5 inches and above, only two fail to be precursors of honey years falling in the "10 best" group, and one of these falls but little short of reaching



Chart, I. The curves show the relation of May rainfall and preceding winter's snowfall to honey production thru a 29 year period

the group. This is doubtless due to the fact that the honey plants, particularly the clovers, become established by humid weather in May.

A rain seems in general to be a time of depression in the honey flow. A comparison was made of the increase on rainy days with that on the few days preceding and following a rain, when these days were themselves not rainy. The averages embrace all suitable periods in our record, the number of days averaged in each case being given also.

TABLE IV. HONEY INCREASE ON RAINY DAYS AND PRECEDING AND FOLLOWING DAYS

	No. of days averaged	Average Increase
2nd day before rain.....	61	4.3 lbs.
1st day before rain.....	76	4.2 lbs.
Day of rain.....	80	2.2 lbs.
1st day after rain.....	80	3.7 lbs.
2nd day after rain.....	65	3.9 lbs.
3rd day after rain.....	49	3.7 lbs.
4th day after rain.....	34	4.6 lbs.
5th day after rain.....	18	3.6 lbs.
6th day after rain.....	35	3.3 lbs.
7th day after rain.....	30	2.8 lbs.
8th day after rain.....	21	3.7 lbs.
9th day after rain.....	16	3.8 lbs.
10th day after rain.....	14	3.5 lbs.
11th day after rain.....	14	3.4 lbs.
12th day after rain.....	9	3.1 lbs.
13th day after rain.....	8	3.9 lbs.
14th day after rain.....	7	3.7 lbs.
15th day after rain.....	6	2.3 lbs.
16th day after rain.....	5	1.8 lbs.
17th day after rain.....	5	1.6 lbs.

The climax occurs about the fourth day following rain. It will be seen that the daily decrease after this point is quite gradual.

#### INFLUENCE OF WINDS ON HONEY FLOW

The direction of the wind has been thought by some to have an influence upon the honey flow—one Iowa beekeeper in a questionnaire recently conducted replying that south winds are favorable. Hence the data in table V from 200 days each of high and low gain selected in about equal number from the same producing periods, will be of interest:

TABLE V. RELATION OF WIND TO DAILY HONEY INCREASE  
IN 200 DAYS OF HIGH AND LOW GAIN, RESPECTIVELY

Wind direction	Percentage of days of high increase	Percentage of days of low increase
South .....	56 percent	43 percent
East .....	9 percent	17 percent
North .....	14 percent	14 percent
West .....	3 percent	3 percent
Southeast .....	9 percent	12 percent
Northeast .....	4 percent	3 percent
Southwest .....	4 percent	5 percent
Northwest .....	1 percent	3 percent

The slight advantage indicated for south winds is doubtless due to the warmer and clearer weather which generally accompanies them; the slight disadvantage for east winds, to the clouds and rain which they frequently bring.

#### TEMPERATURE AFFECTS HONEY INCREASE

Several beekeepers have told us the best weather for honey production is sultry weather, of the sort that precedes rain. In our table the days just preceding rain do show a slightly greater increase than the days just following. However, the honey gain on these days is greater when they are clear than when they are cloudy or partly so, there being for the day before rain an average gain of 4.7 lbs. if this day is clear and of 3.8 if it is cloudy, and for the second day before, just about the same average.

Most beekeepers on being asked as to the temperature desirable for best honey production will answer that hot weather is best. So it seems desirable to compare the mean temperatures of good months with those of poor months. Such temperatures together with rainfall are given in table VI.

It will be seen that the good months average warmer than the poor, except in the case of August, where there is practically no difference. The most remarkable difference is shown by those border months, May and September, which are ordinarily too cool in Iowa for much honey production. A low rainfall in these months seems advantageous, because rainy conditions are most likely to be associated with low temperature averages. June, the wet month of the year, should be a little drier than the average for a good yield, while July, often too dry, should be a little wetter than the average.

A study of all the cases in which the gain for single days is undoubted (for part of our record has days grouped in twos and threes) shows that 61% of the entire gain in weight was made on clear days, 13% on partly cloudy, 13% on cloudy, and 13% on

TABLE VI. RELATION OF TEMPERATURE, RAINFALL, AND HONEY YIELD, WITH BEST YIELDING MONTHS AND POOREST COMPARED

	Best				Poorest			
	No. of months	Mean temp.	Rainfall	Av. yield honey	No. of months	Mean temp.	Rainfall	Av. yield honey
May ....	10	62.5°	4.07 in.	13.2 lbs.	15	60.4°	5.55 in.	0 lbs.
June ....	10	71.4°	3.78 in.	109.8 lbs.	10	70.9°	5.55 in.	18.3 lbs.
July ....	10	77.0°	4.54 in.	61.8 lbs.	10	76.0°	2.99 in.	.8 lbs.
Aug. ....	10	74.3°	3.71 in.	32.6 lbs.	15	74.4°	3.75 in.	0 lbs.
Sept. ....	8	66.0°	1.90 in.	16.3 lbs.	15	64.9°	4.11 in.	0 lbs.

rainy. Clear days are preëminently the days for honey production. For June, clear days average 4.3 lbs. increase per day, partly cloudy days 3.6 lbs., cloudy days 3.8 lbs., and rainy days 2.7 lbs. On some rainy days the increase was so slight that the weight was not recorded, so the average just given for such days is rather too high.

An examination of the same data shows that the morning temperature ranges between 40° and 70° as a rule, there being only one day on the record in which there was a gain in weight on a day that begins with a lower temperature than 40°. F. L. Sladen, however, states that the best honey day in a two-year record kept in England was from the heather plant following a morning of heavy frost. The Iowa record shows little relation between the average morning temperature and yield. For as table IX indicates, the days of good yield have practically the same minimum or morning average as the days of poor yield chosen from the same period, no matter from what months of the year the period is chosen.

Table VII shows the relation between maximum temperature and yield from all single days recorded.

TABLE VII. RELATIVE TOTAL YIELDS OF HONEY AT DIFFERENT TEMPERATURES FOR ALL SINGLE DAYS RECORDED 1885 TO 1914

Temperatures	Percentage of total honey produced 1885-1914
Less than 70°	1%
70-80°	8%
80-90°	53%
90-100°	37%
Over 100°	1%

TABLE IX. TEMPERATURE AND BAROMETER RECORD FOR GOOD AND POOR HONEY YIELDING DAYS, 1885-1914

Period	Good yielding days							Poor yielding days							Excess of temp. range good days	Excess of barom. poor days
	No. of days	Av. gain lbs.	Av. min. temp. (°)	Av. max. temp. (°)	Av. temp. range (°)	Range clear days (°)	Barom.	No. of days	Av. gain lbs.	Av. min. temp. (°)	Av. max. temp. (°)	Av. temp. range (°)	Range clear days (°)	Barom.		
Sept., 1885.....	6	8	57.8	85.3	27.5			7	1.5	54.7	77	22.3			5.2	
June, 1886.....	9	6.1	63.0	90.6	27.6	28.0		10	2.2	59.6	81.3	21.7	20.8		5.9	
June, 1887.....	4	3.4	63.5	87.5	24.0			4	.5	65.0	83.0	18.0			6.0	
June, 1888.....	2	3	64.0	92.0	28.0			3	1	64.0	84.6	20.6			7.4	
Aug.-Sept., 1888.....	10	5.3	52.0	82.7	30.7	31.8	30.11	7	1.3	57.6	82.1	24.5	29.7	30.09	6.2	
June-July, 1889.....	14	5.3	57.8	86.3	28.5	29.0	30.08	14	1	61.0	84.2	23.2	28.2	30.04	5.3	
May-June, 1890.....	5	4.8	60.6	87.4	26.8		29.72	9	.2	60.9	80.0	19.1		29.78	7.7	
July, 1890.....	6	2.7	71.7	95.8	24.1	27.3		9	.5	67.4	92.8	25.4		26.1	-1.3	
June, 1891.....	10	2.2	62.7	85.0	22.3			20	0	61.0	75.0	14.0			8.3	
June-July, 1892.....	16	6.7	61.0	88.2	27.2	29.6	30.03	11	1.6	60.8	87.4	26.6	27.6	29.98	.6	
June-July, 1893.....	8	2.1	65.2	83.6	18.4		29.90	20	.4	63.4	82.1	18.7		29.96	-.3	
June, 1895.....	3	5	59.7	82.4	22.7	24.0	29.93	4	0	58.5	79.0	20.5	20.0	30.02	2.2	
June-July, 1896.....	9	5.1	63.4	87.0	23.6	21.1	29.93	9	1.8	58.1	77.4	19.3	22.7	30.05	4.3	
May, 1897.....	6	2.5	53.2	75.7	22.5		20.06	7	0	50.3	73.6	23.3		30.04	-.8	
June, 1897.....	13	4.8	69.0	88.5	19.5	21.1	29.84	9	.7	53.2	72.4	19.2	24	29.94	.3	

June, 1898.....	15	5.7	67.5	83.4	15.9	29.92	12	.6	65.7	82.1	16.4	29.96	-.5	.04
Aug., 1898.....	9	2.5	73.3	95.9	22.6	29.90	9	1	75.1	92.8	17.7	29.92	3.1	.02
June-July, 1899.....	8	6.8	61.5	90.4	28.9	30.00	12	3	60.2	87.1	26.9	30.04	2.0	.04
June, 1900.....	6	2.5	58.7	88.5	29.8	29.93	10	0	59.1	83.6	24.5	29.97	5.3	.04
June, 1901.....	14	6.7	64.9	88.5	23.6	29.86	16	.7	60.9	82.4	21.5	29.90	2.1	.04
Aug., 1901.....	9	3.4	59.9	95.8	35.9	30.00	9	.1	60.3	93.8	33.5	30.01	2.4	.01
June, 1902.....	3	4.3	59.0	88.8	29.8	29.83	12	0	55.3	75.5	20.2	29.95	9.6	.12
July, 1902.....	8	3.6	64.0	87.2	23.2	29.94	8	0	63.1	87.9	24.8	30.04	1.7	.10
June-July, 1903.....	24	8.1	57.1	87.7	30.6	29.90	15	1.5	57.7	81.1	23.4	29.95	7.2	.06
Aug., 1903.....	7	6.8	62.9	89.7	26.8	29.87	7	1.9	60.3	83.6	23.3	29.95	3.5	.08
May, 1904.....	8	1.4	41.0	67.5	26.5	25.8	8	0	47.4	70.4	23.0	23.2	3.5	
June-July, 1904.....	16	3.8	56.8	81.0	24.2	25.7	16	0	57.8	82.3	24.5	21.4	4.0	
June-July, 1905.....	16	6.3	58.6	84.6	26.0	31.8	11	0	60.6	82.6	22.0	27.5	.8	
June, 1906.....	5	4	52.0	83.8	31.8	27.0	6	1.5	56.2	87.2	31.0	30.0	-3.1	
June-July, 1907.....	10	3.9	61.8	88.6	26.8	27.0	13	1.1	59.1	89.0	29.9	29.0	1.5	
Aug., 1907.....	11	2.6	58.7	86.3	27.6	27.0	11	.4	62.3	88.4	26.1	25.2	-.6	
June-July, 1908.....	16	5.2	59.4	82.6	23.2	26.0	18	1.3	61.8	85.6	23.8	25.2	-.9	
Sept., 1908.....	5	5.6	57.6	86.2	28.6	25.7	7	2.7	54.8	84.3	29.5	25.7	-.7	
June-July, 1909.....	7	5.7	64.7	86.1	21.4	25.7	7	.6	60.5	82.6	22.1	25.7	.6	
June-July, 1910.....	20	9.2	60.2	85.9	25.7	25.7	13	2.1	56.9	82.6	25.1	25.7	-1.6	
Aug., 1910.....	7	4.9	68.0	85.3	17.3	25.7	7	.2	56.0	74.9	18.9	25.7	-2.8	
June, 1911.....	6	4.2	62.5	84.5	22.0	25.7	12	1.3	61.6	86.4	24.8	25.7	-2.7	
June-July, 1912.....	5	7	61.7	93.0	31.3	25.7	5	8	61.8	95.8	34.0	25.7	-.3	
Aug., 1912.....	3	4	61.3	90.3	29.0	25.7	7	1.1	63.6	92.9	29.3	25.7	-.3	

All the days of June, July, and August for the period are grouped in table VIII.

TABLE VIII. RELATIVE TOTAL YIELDS OF HONEY AT DIFFERENT TEMPERATURES FOR ALL DAYS OF JUNE, JULY, AND AUGUST, 1885-1914

Temperatures	Percentage of total honey produced
All days less than 80°	17.3%
All days from 80° to 90°	45.4%
All days over 90°	37.3%

Hence it appears that the days attaining a maximum between 80° and 90° are the best yielding days, being even slightly superior to those of higher temperatures for 45.4% of the days yield 53% of the honey. This may be due to the fact that dry weather is so often associated with 90° days.

Table IX shows that good days as a rule have a maximum temperatures higher than that of the poor days from the same period.

This table includes all the continuous periods of increase of the 29-year record, and the days of high and low gain are in all cases about equally distributed through the period. Twenty-six such periods with an aggregate difference in range of 106.7° have the greater range on the good yielding days, while on the other hand 13 with an aggregate difference of 15.9° have it on the poor yielding days. This strongly indicates that days with a wide range are the best days for honey production.

The indication is borne out even more fully if, instead of using the figures of the U. S. observer as has been done by the author from 1893 onward, Mr. Strong's data be used. The latter data are based on early morning and midafternoon temperatures, which are more to the point than daily maximum and minimum temperatures, inasmuch as the author has shown experimentally that low temperatures favor the accumulation of sugar and high temperatures the secretion of the accumulated sugar.\* If Mr. Strong's figures are used thruout, we find favoring the theory 32 periods with an aggregate difference of 149.8°, opposing it 6 periods with an aggregate difference of 10.1°.

To be sure cloudy and rainy days are apt both to be days of low production and to have low temperature ranges. So it was thought well to give, besides the general average range, the average range for clear days. It will be seen that this generally agrees with the statement we have made.

In the same table are given the averages of barometric read-

\* Environmental influences on nectar secretion. Res. Bull. Iowa Agric. Expt. Sta. 37.

ings, taken three times daily during each period and corrected to sea level. Sixteen cases with an aggregate difference of 1.03 in., against 3 cases with an aggregate difference of .08 in., show that a low barometer favors honey production.

There is but one case in which the figures for temperature range and pressure both disagree with what has been stated, and this is a period in May of not very great yield. It may be worth while, then, to introduce a rule for honey production, stating that it is theoretically equal to  $1/5$  the daily temperature range, measured in degrees Fahr. minus excess corrected barometric pressure over 30 in., measured in tenths of an inch.

#### COLD WEATHER AND HONEY YIELD

One matter that has aroused the curiosity of bee-men is the possible relationship of cold weather the previous winter to yield for the summer. Hence the facts in table X are submitted:

TABLE X. RELATION OF WINTER TEMPERATURES TO SUCCEEDING HONEY YIELDS

	Winter preceding	
	Ten best years	Ten poorest yrs.
Av. mean temp. for Dec., Jan., Feb....	23.3°	24.4°
Av. mean temp. for March.....	38.7°	33.1°
Average number days below 0°.....	15.6°	12.0°
Average lowest temperature.....	21.3°	16.8°

It would perhaps be straining the point to argue that a cold winter has been beneficial, but we certainly cannot hold that it is detrimental. A warm March, however, seems to make more certain a good year. This is doubtless due both to the more rapid building up of the bee colony and the greater vigor given to the clover by lack of severe weather in March.

Investigation of the relation of the yield to snowfall the previous winter gives interesting results. The average for the winter preceding the ten best honey years is 38.92 inches while that for the winter preceding the ten poorest is 27.08 inches, the difference being 11.84 inches in favor of the good years. For the earlier years of the period the snowfall record for Clarinda is not at hand and it was necessary to substitute that for Omaha, which, of course, would be quite the same. If these years are omitted the difference in favor of the good years becomes increased to 16.51 inches. While 8 of the 9 good years in this portion of the period are preceded by snowfalls of over 30 inches, only one poor year is so preceded, and this is the best year of the 7 in this portion. Evidently a heavy snowfall the preceding winter is decidedly beneficial to the honey yield. In the benefit are doubtless involved both the increased amount of available moisture, and protection afforded the clover plant by the snow covering.

*CONCLUSIONS\**

1. June yields 56% of the annual hive increase, July about half of the remainder.
2. A large June increase is indicative of a good honey year.
3. There is an evident alternation between good and poor years.
4. A good year has a rainfall slightly above the average, the honey season being preceded by an autumn, winter, and spring with more than the average precipitation.
5. A rainy May scarcely fails to precede a good honey season.
6. South wind seems favorable and east wind unfavorable.
7. The yield shows a gradual depression preceding and a gradual increase until about the fourth day following a rainy day, after which it remains fairly constant until about the fourteenth day following the rain.
8. Good honey months average slightly higher in temperature than poor, this being especially true of the spring and fall months.
9. Clear days are favorable to production of honey.
10. Yield is best on days having a maximum of 80 to 90° Fahr.
11. A wide daily range of temperature is favorable for a good yield.
12. A low barometer is favorable for good yield.
13. The fluctuations in yield for a producing period seem to be closely correlated with the temperature range and the barometric pressure, acting jointly.
14. A cold winter has no detrimental effect on the yield of the succeeding season, but a cold March reduces it.
15. A winter of heavy snowfall is in the great majority of cases followed by a larger honey yield.

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\* C. P. Dadant, who is one of the veteran American bee keepers, says that the conclusions numbered 4, 5, 6, 9, 11, and 15 agree with his experience.





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