

T H E S I S

On

THE INFLUENCE OF THE ANGLE OF SHOOTS UPON THE DEVELOPMENT
OF THEIR BUDS, SPURS, AND BRANCHES.

Submitted to the

O R E G O N A G R I C U L T U R A L C O L L E G E

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INTRODUCTION

One of the objects which the orchardist of to-day endeavors to accomplish is to get his trees into such a condition that they will bear an optimum crop annually. A large number of factors, such as pruning, cultivation, and fertility, determine the size and character of the crop. Any one condition may be a limiting factor, and reduce the quantity or the quality of the crop. There must be a proper balancing of all the factors concerned to produce a satisfactory yield.

No one will deny the important part that judicious pruning plays in securing larger and better crops. Summer pruning, especially, induces fruitfulness. But along with pruning one associates, more or less, training. There are two main systems of training trees, such as the open head type, where the branches form a low, spreading head, admitting considerable light to the fruit; and also the leader type where the branches come from one central leader forming a higher and more compact type. From the viewpoint of ease of performing certain orchard operations each has its advantages and its disadvantages, but the question arises,--Which form will produce the more fruit? Or, in other words, which is the more productive, a tree that has been trained to form an upright growth, or one that has been trained to an open or horizontal type?

It has been the general impression among fruit growers that a horizontal or downward growing branch is more productive than a vertical or upward growing branch. As early as 1815 John Maher¹ carried on an experiment along this line in an old orchard which he had severely pruned, and in which as a result he had secured a vigorous

growth of from three to five feet. He writes: "About the end of June, or a little sooner and later, according to the growth of the branches, I applied oval balls of grafting clay towards their extremity, sufficiently heavy to incline them downwards in a pendulous direction. The sap being thus diverted from its natural mode of ascending and descending, every bud almost became a blossom bud, and in several trees this disposition to produce blossom buds was carried down to the very lowest spurs on the stem and thicker branches. The crop of fruit is not only improved in size and flavour by having so much sun and air, but it is more easily gathered, and suffers much less from the autumnal winds; for branches in this direction are more pliable, and bend more easily to the storm."

In 1833 William Kenrick² in speaking of the practice of bending limbs, says: "This appears to be the most simple, easy, and effectual mode of rendering trees productive. When judiciously performed, its effects are extraordinary. The effects appear to be perfectly understood by the Chinese in training their dwarfs. Its effects are also exemplified in the mode of training trees "en quenouille." Also on the vine, by which means prodigious crops are produced. Also in the fig, for by this mode Mr. Knight has obtained eight crops in a year. The system is equally applicable to every species of fruit tree. It consists in bending every limb, or twig, to a position below the horizontal, while it is yet in a vigorously growing state, generally the last of June; with some kinds which have a prolonged vegetation, it may perhaps with more advantage be deferred till July, as in the case of the peach. The effect produced in the first instance is a momentary stoppage in their growth; the juices are concentrated and form fruit buds for the pro-

duction of fruit in the following year. But the growth of all parts of the tree must at the same time be restrained, and if shoots burst forth in other parts of the tree they must be nipped in to a few eyes as soon as they have advanced a few inches."

Many of these statements are not based on any experimental evidence, and are nothing more than opinions with little to substantiate them. An unknown writer³ in the Horticulturist for 1856 in an article on "Pruning of Pear Trees" says:-- "That a shoot ought to be cut clean, just above a bud, which bud must be on the under, or outside part of the shoot, rarely or never in a vertical position, because it would tend to bring in the construction of the tree more of those vertical or upright shoots, every one of which ought to be carefully cut away, as absorbing, by a natural privilege of its vertical position, all the sap, and destroying the harmony of the tree. It follows that a limb inclined at an angle of 45°, or a lower bend, is more fitted to make spurs, and go over to bearing by the deprivation of superabundant sap." He goes on to state that while bent or inclined shoots make a tree bear, they are injurious to its growth, and unless immediately pruned in a proper manner they "give up at once, and linger or die."

Shirly Hibberd⁴ in 1888 states in the Journal of the Royal Horticultural Society that many fruitful trees often acquire a half weeping habit due to the effect of the weight of the fruit pulling down the branches. This reverse position checks growth, and exposes the wood and fruit more completely to the sun and air. The half weeping habit enforced by the law of gravitation "exactly suits its

constitution as a fruit producer."

E. A. Bunyard⁵ in an article on the physiology of pruning states that the well known practice of "bending down a branch to make it more fruitful, owes its success to the fact that it would be more difficult for the elaborated sap to flow out of the branch into the stem and thence to the roots."

Sir Thomas A. Knight⁶ experimented in training peach twigs at different angles. While he does not report any observations in regard to the production of fruit buds, he states that he found that when the shoots were not of equal luxuriance, by depressing the strongest shoots and elevating the weakest ones, they could both be made to acquire and retain an equal amount of vigor.

OBJECT OF THIS INVESTIGATION

To answer or at least obtain some statistical evidence on this problem, an investigation was conducted to determine whether the direction of a shoot exerts any influence upon the character of its buds and the growth that springs from them.

METHODS AND MATERIALS EMPLOYED

The apple was chosen as the kind of tree to be studied, primarily because of its great commercial importance, and also because of the wide range of material that was near at hand. Four varieties of apples were studied--Fameuse, Shiawassee, Wagener, and Yellow Newtown, allowing an opportunity to see whether any difference exists between trees which grow upright naturally, and those which are fairly open and horizontal. Fameuse and Shiawassee being in the same pomological group also offered a chance for a group study. Young

and old trees were included, the Wagener being five years old, and the Fameuse, Shiawassee, and Yellow Newtown about twenty-five. A block of Yellow Newtowns six years of age was also studied, to make possible a comparison of old and young trees of the same variety.

Twigs for three years; namely, 1913, 1912, and 1911, were measured to serve as checks upon each other to show whether results were uniform or only due to seasonal variations. The angle of each twig was measured by a home-made contrivance, consisting of a dial with the angles upon it, ranging from 0° to 180° , the latter degree pointing up vertically. From the dial at the 90° mark there extended a short arm upon which there was a small spirit level, which thus made it possible to always make the 90° mark perfectly horizontal to the ground. A pointer attached to the middle of the dial and laid along the twig being measured, marked off the angle. The length of each twig was measured in inches, the diameter determined in millimeters, and the number of buds counted,--those that were dormant, those that had formed vegetative shoots, and those that had broken and produced fruit spurs.

It was of course impossible to determine which of the spurs bore actual fruit buds at the time the measurements were made. A microscopical examination would have been necessary to determine this accurately. The term fruit spur was therefore given to those buds which had ^{remained} not dormant, had not formed vegetative shoots, and which might at any time develop into actual fruit buds.

The record of each twig was of course kept separate. In all, measurements of nine thousand twigs were taken, distributed among the different varieties as follows:-

Wagener	- - - - -	1500
Fameuse	-- - - -	2000
Shiawassee	- - - - -	2000
Yellow Newtown (old)	- -	2000
Yellow Newtown (young)	-	1500

The records secured in the field were grouped according to the angle. From these the average twig was determined in each group by adding up separately the length, diameter, and number of buds, and dividing by the number of twigs measured. For each angle the per cent of buds that break was calculated, and also the per cent that form fruit spurs. The difference between these two represents the per cent of buds that break into vegetative shoots or branches. Tables III, V, VII, IX, and XI show the results, secured in this way, for the 1913 growth of wood.

The observations made show considerable varietal variation. In the case of Yellow Newtown the curves (Fig. 1, 2, 3, 4, and 5), representing the per cent of buds breaking and the per cent forming fruit spurs show very clearly the relationship between such percentages and the angle of the shoot.

Thus the percentages of buds breaking at an angle of 80° is as low as 21.7, while at 170° it is as high as 79.4. At 50° , 60° and 70° the per cent of buds breaking is 55.6, 30.8, and 50.0, respectively, but the number of shoots considered at these angles is very small, and too much value cannot be given to these figures, as they may not be truly representative. In several cases where the frequency was small, being confined to one to five measurements, there was a greater irregularity in that portion of the curve, showing that large numbers are necessary to secure accuracy. In order to determine the number of frequencies represented by any point on one of

the curves, reference can be made to the proper column or row in the corresponding frequency distribution table.

In the case of Wagener, which were also young trees, the curve again shows the marked relationship between the angle of the shoot and the per cent of buds that break, and the per cent that forms fruit spurs. In this case the per cent of buds breaking at the lower angles is higher than in the Yellow Newtown.

Both 1913 and 1912 growth was grouped together to give a larger frequency.

Coming now to the old Yellow Newtown, while it is found that there is still the tendency for the per cent of buds breaking to increase with the greater angle, it is noticed that the curve is very gradual, lying chiefly between 40 and 60 per cent until it reaches 180° when it takes a sudden turn to 72.2 per cent. As the trees have grown older there seems to have been somewhat of a balancing in the tree. The shoots at the greater angles have not been quite so productive of vegetative shoots and fruit spurs as in the young trees, and the shoots at the lower angles have been a little more so, but yet not so productive as the more upright ones.

The curves for Shiawassee and Fameuse run very much alike. Here but very little correlation is shown, comparing them with the other varieties. In the case of Shiawassee there seems to be a rise in the curve from 0 per cent at 0° to as high as 67.5 per cent at 110° in the per cent of buds breaking, with a dropdown to 36.6 per cent at 140° , and then a rise again to 59.8 per cent at 180° . In the case of Fameuse there is a rise from 0 per cent at 00° to 56.0 per cent at 70° , and then the curve runs close to the 50 per cent

mark through the remaining degrees. The curves of both, with the exception of the last half of the Fameuse, are rather irregular. The frequency of the first three or four angles in each variety is small, and as was mentioned before, too much dependence cannot be placed upon the resulting curves.

In order to determine the relationship between angles and the percentage of buds breaking correlation tables were made. In this way means and standard deviations were found for both the percentage of buds breaking, and for the angles. Correlation coefficients corresponded quite closely to those secured with the curves. Young Yellow Newtowns gave the highest coefficient, with Fameuse the smallest. One will observe in the curves for Shiawassee and Fameuse for 1913, 1912, and 1911 that there seems to be a tendency for the buds on the shoots representing the angles of greatest frequency to break in correspondingly larger numbers. This would naturally have a tendency to lower the correlation coefficient and make it appear that there is no apparent relation between the angle of shoots and the shoot and spur growth developing from their buds. In reality there is a relation and by means of a curve the optimum angle can be shown. The following table shows the means and standard deviations of the per cent of buds breaking and of the shoot angles, and the correlation coefficients between shoot angles and per cent of their buds that break, for the five varieties for 1913 growth.

:Variety : Mean Percentage:Standard :Mean shoot: Standard :Correlation:
: : of buds breaking:Deviation: angle :Deviation :Coefficient:
:-----+-----+-----+-----+-----+-----:

Yellow Newtown (Young)	61.11	21.07	135.68	23.50	.574
Wagener (1913 and 1912 growth)	51.57	22.78	101.48	15.20	.106
Yellow Newtown (old)	46.78	22.90	130.19	26.79	.124
Shiawassee	34.23	27.63	117.13	32.57	.079
Fameuse	45.37	29.03	110.89	32.31	.047

Frequency tables may be found in Tables I, IV, VI, VIII and X, showing how the different twigs in the different varieties were distributed between different angles. The figures in the column at the extreme left beginning with zero and running down to 100 represent the percentages of buds that break, while the top row of figures represent the angles. This makes it possible to determine the number of twigs at a certain angle, with a certain per cent of buds breaking; e.g., in the Yellow Newtown (young trees) at an angle of 120° there were 11 twigs that had 50% of their buds breaking.

The above correlation coefficients were determined to find the relation between the angle and the per cent of buds that break. In the case of the old Yellow Newtowns, Shiawassee, and Fameuse, the per cent of buds that formed fruit spurs or buds was so nearly identical with the total number of buds breaking that it was not necessary to determine coefficients for them. However, for the young Yellow Newtowns and the Wageners, varieties in which there was a considerable number of buds

breaking into vegetative shoots or branches, coefficients as follows were determined:-

:Variety :	Mean Percentage:	Standard :	Mean shoot:	Standard :	Correlation:
:	:of buds breaking:	Deviation:	angle :	Deviation :	Coefficient:
:-----:-----:-----:-----:-----:-----:					
Yellow New-	56.98	19.52	135.68	24.10	.554
towns (young)					
Wagener	52.33	16.11	149.32	28.04	.347
(Shoots headed)					

Comparing these figures with those indicating the total per cent of buds to break it is found that there is but little difference. In the case of Yellow Newtown there is only a difference of .02, and in the Wagener of .082. It seems, therefore, that there is a little closer relation between the angle and the number of buds breaking, than between angle and those that form fruit spurs. However, the relation between the latter and the angle is very marked in both cases.



Figure 1.

TABLE I.

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING AND
ANGLES OF SHOOTS IN YOUNG YELLOW NEWTOWN**1913 GROWTH.

		Shoot Angles															Frequency
		50	60	70	80	90	100	110	120	130	140	150	160	170	180	Frequency	
Percentage of Buds Breaking	0	1		2	8	7	4	7	3	2						34	
	5																
	10				1		1									2	
	15		1	1	3	3	3	7	3	4						25	
	20			1	3	3	5	1		1		1				15	
	25			2	2	1		1	1	1						8	
	30			1	4	2	3	1	1	2				1		15	
	35			1	4	5	5	6	3	5		4				33	
	40				2	8	7	15	9	4		1			1	47	
	45				3	7	14	13	10	9		3	4	1		64	
	50		1		3	2	8	11	12	8		5	2	1		53	
	55	1		1	1	8	6	9	8	10		10	7	2		63	
	60			2	4	4	7	7	15	15		15	7	3		79	
	65				3	4	9	8	18	31		18	17	6		114	
	70					4	5	9	17	16		33	35	9	3	131	
	75					5	4	6	15	20		29	30	10	1	120	
80					1	4	3	9	20		22	20	11	4	94		
85						2			4	6		14	15	15	56		
90								1	2	1		5	11	11	31		
95												2	4	5	11		
100																	
Frequency		1	2	4	8	41	64	87	105	130	155	156	158	75	9	995	

TABLE II

CORRELATION TABLE FOR PER CENT OF FRUIT
SPURS FORMED AND ANGLES OF SHOOTS IN
YOUNG YELLOW NEWTOWN--1913 GROWTH.

	Shoot Angles																Frequency
	50	60	70	80	90	100	110	120	130	140	150	160	170	180			
0		1		2	8	7	4	7	3	2						34	
5																	
10				1			1									2	
15			1	2	3	3	3	7	3	4						26	
20				1	3	3	5	1	1	1		1				16	
25				1	2	1		2		1						7	
30				1	4	2	3	1	1	2			1			15	
35				1	4	5	7	7	5	7		4				40	
40					2	8	8	14	8	4	1	4		1		50	
45					4	9	12	14	10	7	4	3	1			64	
50		1			3	3	9	10	16	14	7	10	4	1		78	
55	1		1		1	6	6	8	11	11	11	11	5			72	
60			2		4	3	6	8	14	21	21	21	11	3		114	
65					2	6	10	12	20	30	22	35	15	2		154	
70						3	5	7	16	20	38	31	9	2		131	
75						4	4	4	11	11	25	14	12			85	
80						1	3	2	8	17	17	14	8			70	
85							1		1	2	5	8	4			21	
90								1	2	1	3	2	4			13	
95											1		1			2	
100																	
Frequency	1	2	4	8	41	64	87	105	130	155	155	158	75	9		994	

KEY TO TABLES SHOWING AVERAGE
BRANCHES FOR THE GIVEN ANGLES

1. Angles of average shoots.
2. Number of shoots represented in the average.
3. Length of average shoot in inches.
4. Diameter of average shoot in millimeters.
5. Total number of buds per average shoot.
6. Dormant buds.
7. Buds having developed into branches.
8. Fruit Spurs.
9. Per cent of buds breaking.
10. Per cent of buds forming fruit spurs.

TABLE III..

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN YOUNG YELLOW NEWTOWN--1913 GROWTH

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
: 50 :	1 :	9.00 :	3.7 :	9.0 :	4.0 :	0 :	5.0 :	55.6 :	55.6 :
: 60 :	2 :	5.50 :	4.8 :	6.5 :	4.5 :	0 :	2.0 :	30.8 :	30.8 :
: 70 :	4 :	7.75 :	4.6 :	9.0 :	4.5 :	0 :	4.5 :	50.0 :	50.0 :
: 80 :	8 :	8.25 :	3.8 :	10.9 :	8.5 :	.25 :	2.1 :	21.7 :	19.5 :
: 90 :	41 :	8.08 :	3.8 :	9.5 :	6.3 :	.05 :	3.2 :	33.8 :	33.3 :
: 100 :	64 :	11.90 :	4.4 :	12.7 :	6.7 :	.10 :	5.9 :	47.4 :	46.7 :
: 110 :	87 :	15.05 :	4.8 :	15.8 :	7.4 :	.22 :	8.1 :	52.9 :	51.5 :
: 120 :	105 :	15.14 :	4.7 :	15.4 :	7.4 :	.14 :	7.8 :	51.9 :	50.9 :
: 130 :	130 :	19.16 :	5.4 :	18.9 :	7.3 :	.31 :	11.2 :	61.2 :	59.2 :
: 140 :	155 :	24.17 :	6.3 :	23.3 :	8.2 :	.62 :	14.5 :	64.7 :	62.0 :
: 150 :	156 :	29.06 :	7.4 :	27.5 :	7.6 :	1.00 :	18.8 :	71.9 :	68.6 :
: 160 :	158 :	32.63 :	8.2 :	29.8 :	8.0 :	2.11 :	19.8 :	73.6 :	66.5 :
: 170 :	75 :	33.90 :	8.6 :	31.9 :	6.6 :	3.17 :	22.2 :	79.4 :	69.5 :
: 180 :	9 :	31.65 :	8.9 :	29.0 :	7.4 :	3.78 :	17.8 :	74.3 :	61.3 :

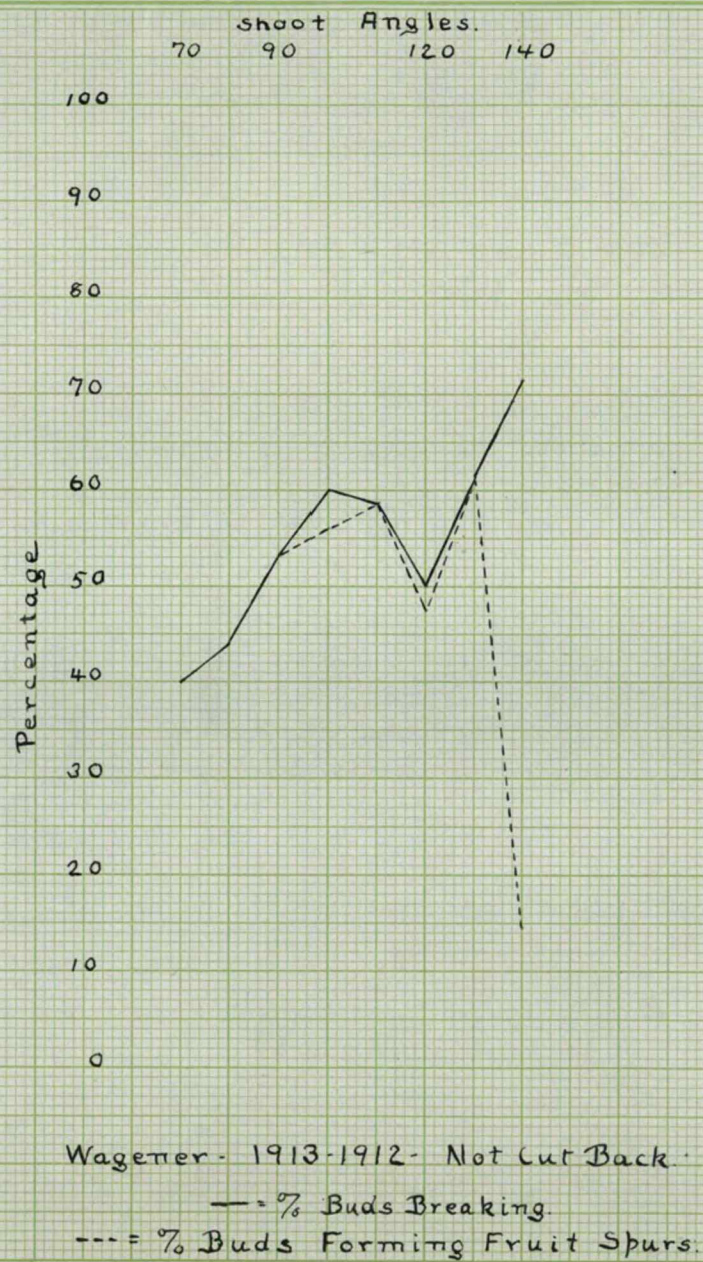


Figure 2.

1000 1000 1000 1000 1000

1

Per cent of buds breaking

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

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[illegible]



Figure 5.

TABLE VI

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING AND
ANGLE OF SHOOTS IN OLD YELLOW NEWTOWN--1913 GROWTH.

		Shoot Angles													Frequency	
		50	60	70	80	90	100	110	120	130	140	150	160	170	180	Frequency
Per cent of buds breaking	0	1		2	3			5	4	4	5	9	8	3		44
	5															
	10						1	3				1		1		6
	15				4		4	4	2	3	4	1	3	1		26
	20	1		4	4	7	6	3	7	8	4	5	2			51
	25	1		2	1	5	4	5	4	6	4	1	2			35
	30				2	2	3	1	3	2	2	1				16
	35				1	1	6	5	6	6	8	4	7	3		47
	40	1		4	4	4	8	5	6	5	12	6	3			58
	45	2		1	3	4	2	4	4	6	10	2	2	1		41
	50	3	1	2	2	8	9	7	13	12	3	11	3	2		76
	55			2		2		5	3	7	3	6	2			30
	60	1	1		1	5	7	6	1	5	9	17	3	5	1	62
	65			1	1	4	5	6	10	12	10	11	9	4	2	75
	70				1	2	2	6	4	3	6	6	4			34
75				1	1	1	1	4	5	1	4	3	2	2	75	
80			1	1		2	2	4	5	5	6		3	3	32	
85				1		3	1	2	2	3	4	2	3		21	
90						1	1	1			3	1	1	1	9	
95											1		1		2	
100																
Frequency		10	3	27	31	64	68	70	86	94	105	74	45	12	690	

0750 0840 0930

0000 0100 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

1

1	2	3	4	5	6	7	8	9	10
: 50 :	1 :	4.37 :	4.6 :	7.0 :	3.0 :	0 :	4.0 :	57.2 :	57.2 :
: 60 :	10 :	4.39 :	3.3 :	6.6 :	4.1 :	0 :	2.5 :	37.9 :	37.9 :
: 70 :	3 :	8.08 :	3.8 :	8.7 :	3.0 :	0 :	5.7 :	65.4 :	65.4 :
: 80 :	27 :	5.86 :	3.5 :	6.9 :	4.0 :	.1 :	2.8 :	42.2 :	41.7 :
: 90 :	31 :	4.96 :	3.5 :	6.2 :	3.5 :	.1 :	2.6 :	44.0 :	43.4 :
: 100 :	64 :	6.06 :	3.7 :	7.1 :	3.6 :	.01 :	3.5 :	48.6 :	48.5 :
: 110 :	68 :	5.61 :	3.6 :	6.8 :	4.0 :	0 :	2.8 :	41.9 :	41.9 :
: 120 :	70 :	7.80 :	3.9 :	8.6 :	4.0 :	.1 :	4.5 :	52.9 :	51.9 :
: 130 :	86 :	6.57 :	3.9 :	7.8 :	3.7 :	.1 :	4.0 :	52.3 :	51.4 :
: 140 :	94 :	7.76 :	4.1 :	9.1 :	4.6 :	0 :	4.5 :	49.7 :	49.7 :
: 150 :	105 :	8.56 :	4.3 :	9.7 :	4.1 :	.1 :	5.5 :	57.8 :	56.8 :
: 160 :	74 :	8.89 :	4.3 :	10.2 :	5.0 :	0 :	5.2 :	51.3 :	51.3 :
: 170 :	45 :	10.03 :	4.6 :	11.0 :	4.4 :	.1 :	6.5 :	60.6 :	59.3 :
: 180 :	12 :	10.18 :	4.8 :	10.8 :	3.0 :	.3 :	7.5 :	72.2 :	70.0 :

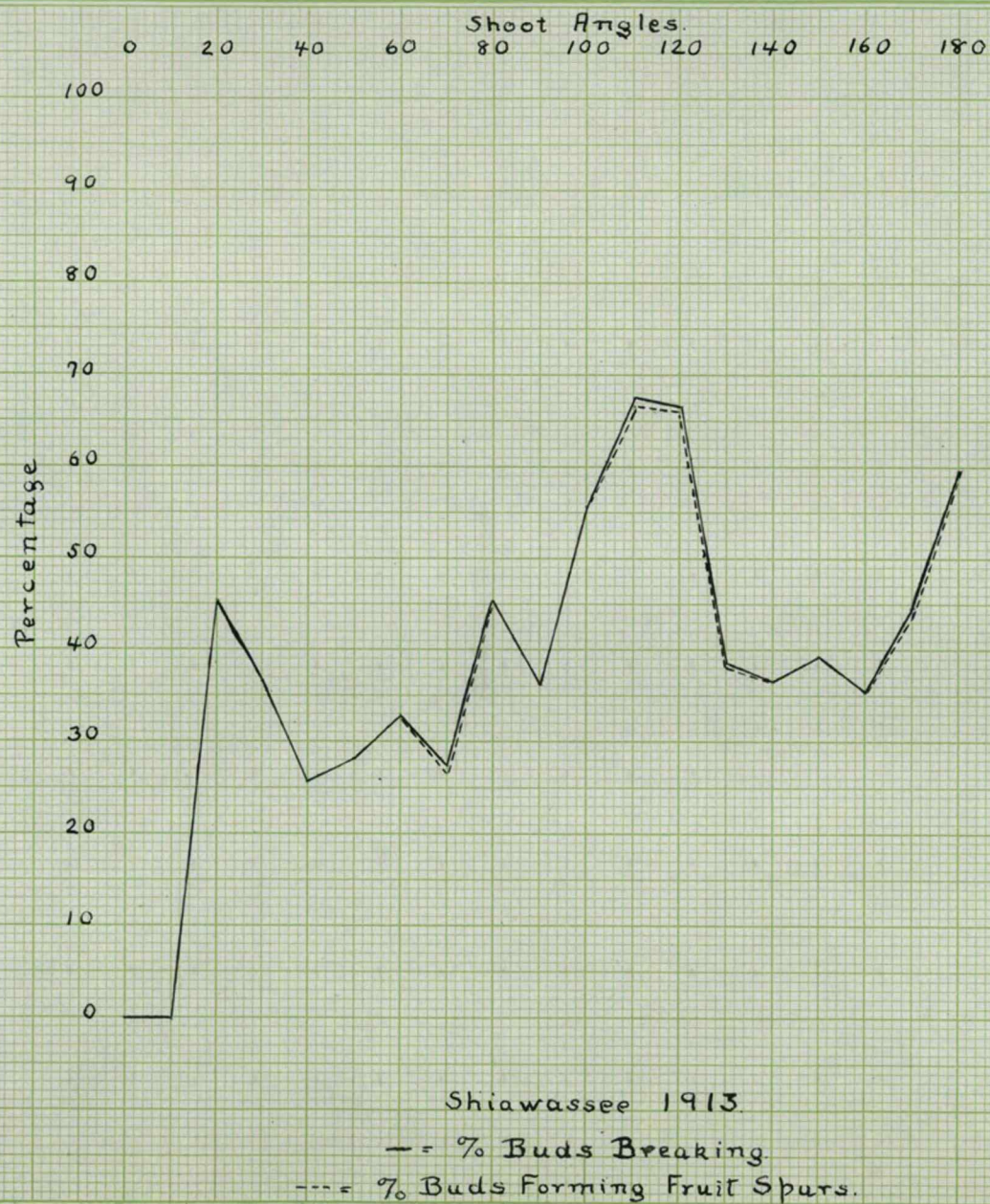


Figure 4.

1998 1999 2000 2001 2002

1913 GROWTH

		Shoot Angles																	Frequency		
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of Euds breaking	0:1	2	1	2	6	7	11	19	16	25	29	29	27	34	27	20	20	15		291	
	5:												1		2	2	2			7	
	10:									2	4	3	1	4	6	4	2	1		27	
	15:					1	2	2	3	5	6	9	9	9	7	4	4	3		64	
	20				1	1		5	3	2	4	11	5	7	6	5	2	2		54	
	25:			1		1	1	1	4	1	10	7	3	3	3	2	2	1	1	41	
	30:				1	1		1		2	1	3	1	1	4	4	5	1		25	
	35:			2		2	1	3	5	6	7	8	6	7	7	1	6	2	1	64	
	40:				1			1	7	3	4	3	4	2	9	6	4	2	1	47	
	45:					1	1	1	4	7	6	6	5	8	5	5	6	4	2	61	
	50:				1			3	8	9	7	3	10	9	15	7	7	8	4	91	
	55:				1					1	1	1	3	6	3	3	1	4	3	1	28
60:					2	2	1	3	5	6	8	11	11	5	6	8	5	2	3	78	
65:						1	2	3	4	2	5	11	11	17	6	10	5	3	2	82	
70:									3	2	3	5	3	4	2	2	1	2		27	
75:							1	1	2	2	4	6	5	2	6	5		4	1	39	
80:									7	4	4	8	5	3	2	3	3	2		41	
85:			1						1	2	1	2	1	3	3			1	1	16	
90:							1				1	1	2	3		1		1		10	
95:																					
100:																					
Fre-		1	2	2	7	11	18	24	48	74	79	101	136	115	130	111	90	79	53	13	1094
quency																					

TABLE IX

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN SHIAWASSEE, -- 1913 GROWTH.

For key to columns see Page 11.

:1	2	3	4	5	6	7	8	9	10 :
:									:
0	1	1.75	4.1	3.0	3.0	0	0	0	0
10	2	2.75	2.4	3.5	3.5	0	0	0	0
20	1	8.75	4.7	11.0	6.0	0	5.0	45.4	45.4
30	7	3.11	3.7	4.3	2.7	0	1.6	36.7	36.7
40	11	3.89	4.0	4.9	3.6	0	1.3	25.9	25.9
50	18	3.62	3.9	4.9	3.5	0	1.4	28.1	28.1
60	24	4.24	3.8	5.2	3.5	0	1.7	33.0	33.0
70	48	4.78	4.0	6.0	4.4	.1	1.5	27.4	26.7
80	74	4.56	4.1	5.9	3.2	0	2.7	45.2	45.2
90	79	4.98	4.1	6.3	4.0	.1	1.2	36.2	36.2
100	101	5.18	4.4	6.8	4.4	.1	2.3	55.8	55.2
110	136	5.72	4.5	7.5	4.5	.1	2.9	67.5	67.0
120	115	6.23	4.6	7.8	4.7	.1	3.0	66.6	66.1
130	130	5.98	4.6	7.4	4.6	.1	2.7	38.5	38.3
140	111	7.10	4.6	8.7	5.5	0	3.2	36.6	36.6
150	90	8.59	5.1	10.3	6.3	.1	4.0	39.1	39.0
160	79	8.76	5.2	10.9	7.1	.1	3.7	35.2	35.1
170	53	10.30	5.4	11.5	6.6	.1	4.8	44.7	44.2
180	13	9.92	5.1	10.5	4.2	0	6.3	59.8	59.8



Figure 5.

TABLE X

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOTS IN FAMEUSE,--1913 GROWTH

		Shoot Angles																		Frequency	
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of buds breaking	0:	1	1	1	1	1	8	12	7	14	13	14	23	17	20	15	10	2	7	3	170
	5:									1	1		1	1							4
	10:							1	1		2	1	1	4	2	2	2	3	2	1	22
	15:					2	2	1		2	9	7	3	5	6	4	1	2		1	45
	20:				1	3	2	2	2	2	3	5	2	6	2	7	4	1	2	1	43
	25:				2		5	4	5	5	3	5	4	6	2	5		5	1		47
	30:				1	1	1				5	4	3	8	3	2	3	1			32
	35:		1			1	1	5	6	5	7	4	8	7	5	5	7	2			64
	40:						2	2	5	4	7	9	6	10	4	5	8	2	2	1	67
	45:							1	2	3	6	5	5	6	6	6	3	3	1	1	48
	50:				1	6	4	10	11	9	5	12	9	8	9	9	4	4	1	1	94
	55:								1	1	3	3	3	6	3	2	3	1	2		28
	60:				1			2	5	9	2	7	4	9	3	4	3	2	2	1	54
	65:				1	1	3	5	12	7	12	14	9	8	5	6	2	3	1		89
	70:					2	1	1	2	1	4	1	5		3	2	2			1	25
	75:				1	1	4	6	6	9	9	5	12	13	7	9	2	3	1		88
80:				1		1	7	4	8	8	10	9	8	5	6	10				77	
85:					1	1	3	4	5	3	6	11	5	4	3	1	2	3		52	
90:						1	3	3	2	3	4	2	1	3	2	1				25	
95:										1	1			1	1					4	
100 :						1		3	2		4	2	2	4	1		1			20	
Frequency		1	2	1	2	12	28	48	65	92	101	107	123	140	107	97	75	52	29	16	1098

TABLE XI

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN FAMEUSE,-- 1913 GROWTH

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
0	1	1.25	4.2	3.0	3.0	0	0	0	0
10	2	1.88	4.4	3.5	3.0	0	.5	14.3	14.3
20	1	2.87	5.8	6.0	6.0	0	0	0	0
30	2	3.63	3.9	5.5	3.5	0	2.0	36.7	36.7
40	12	5.70	4.1	7.0	4.2	.25	2.5	39.7	37.4
50	28	4.57	4.3	5.9	3.9	.04	1.9	33.3	32.7
60	48	4.57	4.5	6.1	3.6	.08	2.4	40.7	39.3
70	65	5.64	4.5	6.9	3.0	.10	3.8	56.0	54.7
80	92	5.37	4.5	6.7	3.3	.06	3.4	51.2	50.2
90	101	6.25	4.8	7.9	4.3	.19	3.4	45.7	43.2
100	107	6.75	4.7	8.2	4.1	.07	4.0	49.8	49.2
110	123	6.88	5.2	8.3	4.4	.12	4.2	49.3	47.8
120	140	9.67	5.0	9.7	4.8	.08	4.7	49.8	48.9
130	107	7.95	4.8	9.3	4.7	.07	4.5	49.3	48.5
140	97	8.45	5.1	9.8	5.1	.11	4.6	47.9	46.8
150	75	9.44	5.4	11.1	5.2	.24	5.7	53.3	51.2
160	52	10.18	5.6	11.6	5.6	.19	5.9	43.4	40.9
170	29	9.88	5.5	11.0	6.2	.17	4.6	52.2	50.6
180	16	8.89	5.5	10.7	4.9	.19	5.6	52.7	52.0

A STUDY OF THE 1912 GROWTH.

In the case of the twigs of 1912 we find the same tendency but not to so great a degree. Both young and old Yellow Newtowns have quite striking curves. The largest percentages of break in buds of Shiawassee and Fameuse are again found at those angles at which the greatest number of shoots are found. This would apparently show that for these varieties the angles nearest the mean have the greatest influence upon the breaking of buds, but the data here is hardly sufficient to prove it.

Correlation coefficients were determined in each case. For every variety the coefficient was smaller than in the case of the 1913 growth, but in the young and old Yellow Newtowns it was large enough to be indicative of a relationship. In Shiawassee there was a negative coefficient ($-.004$, practically zero, indicating no relationship), and $.058$ in the Fameuse. The peculiar structure of the curve in these two varieties will help to explain why these results were obtained.

The coefficients determined for the relation of the fruit spurs to the shoot angles were considerably lower than those for the total break, being in the case of Yellow Newtown $.28$ lower, leaving it only $.077$, a coefficient that is none too strong. The following table shows the results for all varieties for the 1912 growth:-

TABLE XII

Variety	Mean Percentage of buds breaking.	Standard Deviation	Mean Shoot Angle	Standard Deviation	Correlation coefficient
Yellow New-town -Young	66.50	17.74	139.40	22.47	.357
Yellow New-town -Old	55.40	17.63	121.18	24.93	.119
Shiawassee	31.95	26.89	95.32	35.17	-.004
Fameuse	43.25	27.05	95.81	33.19	.058

TABLE XIII

Variety	Mean Percentage of buds forming fruit spurs	Standard Deviation	Mean Shoot Angle	Standard Deviation	Correlation coefficient.
Yellow New-town -Young (fruit spurs)	30.22	16.15	139.40	22.47	.077
Wagener (fruit spurs) (headed back)	44.20	13.59	162.5	14.86	.137

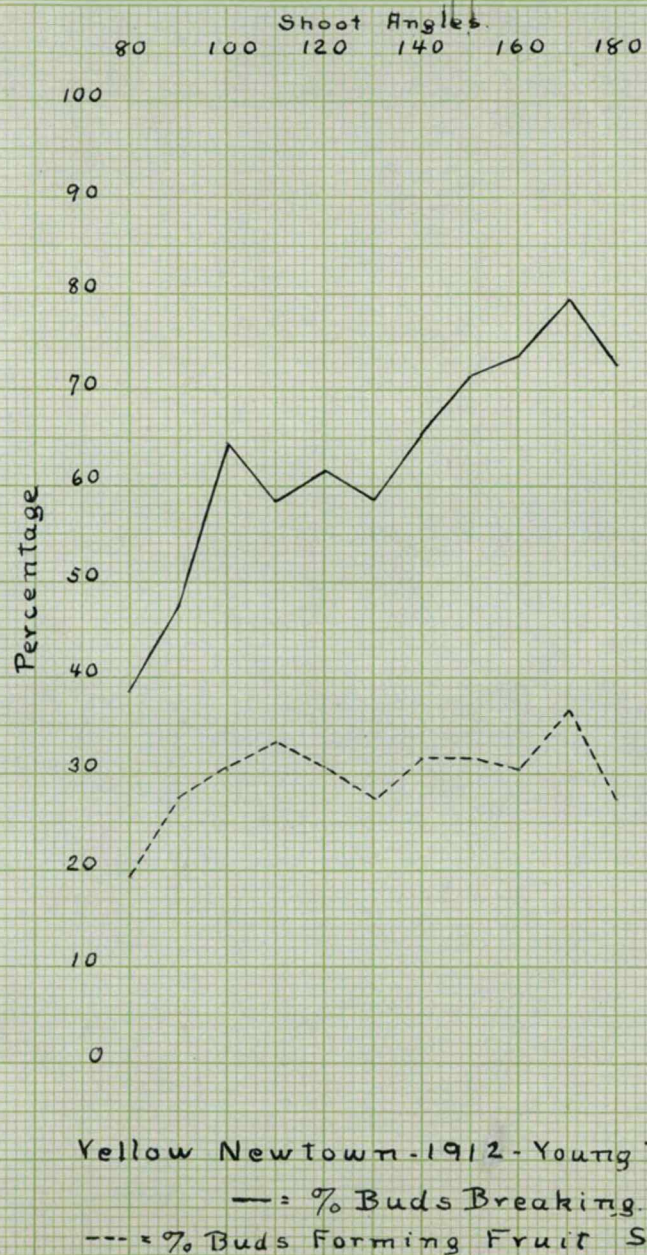


Figure 6.

TABLE XIV

CORRELATION TABLE FOR PER CENT OF BUDS
BREAKING AND ANGLE OF SHOOTS IN YOUNG
YELLOW NEWTOWN-- 1912 GROWTH.

	Shoot Angles											Frequency
	80	90	100	110	120	130	140	150	160	170	180	
0	1											1
5												
10												
15					1							1
20					1	1						2
25												
30				2								2
35	1		1	1		3	2	2				10
40	1	1		1	1	1	4			1		10
45	3	2		2	3	1		1	4		1	17
50		1	2	1	5	10	6	7	2			34
55					3	4	2	3	1	1		14
60		1	4	2	1	7	7	2	5	1	1	31
65	1		1	1	9	3	6	8	4		1	34
70					1	3	4	4	3	4		19
75			1	1	3	2	6	8	4	5		30
80			3	2	1	2	4	5	9	3		29
85			2	1	3	3	4	7	1	11	1	33
90						1	2	4	8	4	1	20
95								1	2	1	1	5
100				1	1	2	1	2	1			8
Frequency	7	5	14	15	33	43	48	54	44	31	6	300

TABLE XV

CORRELATION TABLE FOR PER CENT OF BUDS
FORMING FRUIT SPURS AND ANGLES OF SHOOTS
IN YOUNG YELLOW NEWTOWN,--1912 GROWTH.

	Shoot Angles											Frequency
	80	90	100	110	120	130	140	150	160	170	180	
0	2	1	1	2	3	5	5	4	1	2		26
5												
10				1		3	2	4	5	2	1	18
15	2		1	2	3	4	3	1	3	1		20
20		1	3	1	6	7	5	9	7	2	2	43
25	1		1		3	3	3	5	4		1	21
30			2	2	2	3	5	6	4	5		29
35	1	1	1		3	5	8	9	6	4		38
40		2	2	1	4	2	7	3	5	4	1	31
45			2	2	6	4	2	5	4	4	1	30
50	1		1	1	2	6	4	3	3	6		27
55						1	1	1		1		4
60				1	1		1	1	2			6
65				2			1	2				5
70												
75								1				1
80							1					1
85												
90												
95												
100												
Fre- quency	7	5	14	15	33	43	48	54	44	31	6	300

TABLE XVI

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN YOUNG YELLOW NEWTOWN,--
1912 GROWTH.

For key to columns see Page 11

1	2	3	4	5	6	7	8	9	10
80	7	6.48	11.6	6.7	4.1	1.3	1.3	38.6	19.3
90	5	8.35	11.9	8.8	4.6	1.8	2.4	47.7	27.5
100	14	6.72	12.2	6.9	2.4	2.4	2.1	64.6	30.4
110	15	8.45	11.8	8.9	3.7	2.3	2.9	58.6	33.1
120	33	7.87	13.1	8.1	3.1	2.5	2.5	61.7	30.9
130	43	8.71	13.2	8.5	3.5	2.6	2.4	58.8	27.5
140	48	9.54	13.7	9.4	3.3	3.2	3.0	65.4	31.6
150	54	9.98	14.7	9.6	2.8	3.9	3.0	71.3	31.7
160	44	11.76	16.8	11.0	2.9	4.8	3.2	73.5	30.5
170	31	13.38	17.3	12.3	2.5	5.3	4.5	79.4	36.6
180	6	12.21	15.3	10.3	2.8	4.7	2.8	72.6	27.4



Figure 7.

TABLE XVIII

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN OLD YELLOW NEWTOWN.,--1912 GROWTH.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
10	1	2.00	3.0	4.0	3.0	0	1.0	25.0	25.0
20									
30	1	3.75	3.7	5.0	4.0	0	1.0	20.0	20.0
40	1	4.25	4.7	7.0	5.0	0	2.0	28.6	28.6
50	2	5.68	5.4	6.5	3.0	.5	3.0	53.8	45.1
60	5	6.10	4.1	8.6	4.2	0	4.4	51.2	51.2
70	8	5.99	4.4	8.7	4.5	.25	4.0	48.6	45.7
80	25	6.45	4.7	8.8	4.4	.1	4.3	49.6	48.7
90	41	6.50	4.5	8.1	3.8	.1	4.2	53.6	52.4
100	68	6.38	4.6	8.0	3.5	.2	4.3	56.1	53.5
110	104	6.61	4.6	8.3	3.7	1	4.5	56.3	54.2
120	104	6.62	4.8	8.1	3.6	.2	4.3	56.0	53.4
130	96	7.45	4.8	8.9	3.5	.3	5.1	60.5	57.1
140	68	7.49	5.0	9.3	3.6	.4	5.3	60.6	56.4
150	57	6.94	5.1	8.8	3.5	.3	5.0	60.5	57.1
160	26	9.55	5.5	11.1	4.3	.6	6.2	60.8	55.5
170	19	5.71	4.6	7.7	3.5	.2	4.0	55.1	52.4
180	8	5.95	4.2	8.5	5.4	.1	3.0	36.8	35.3

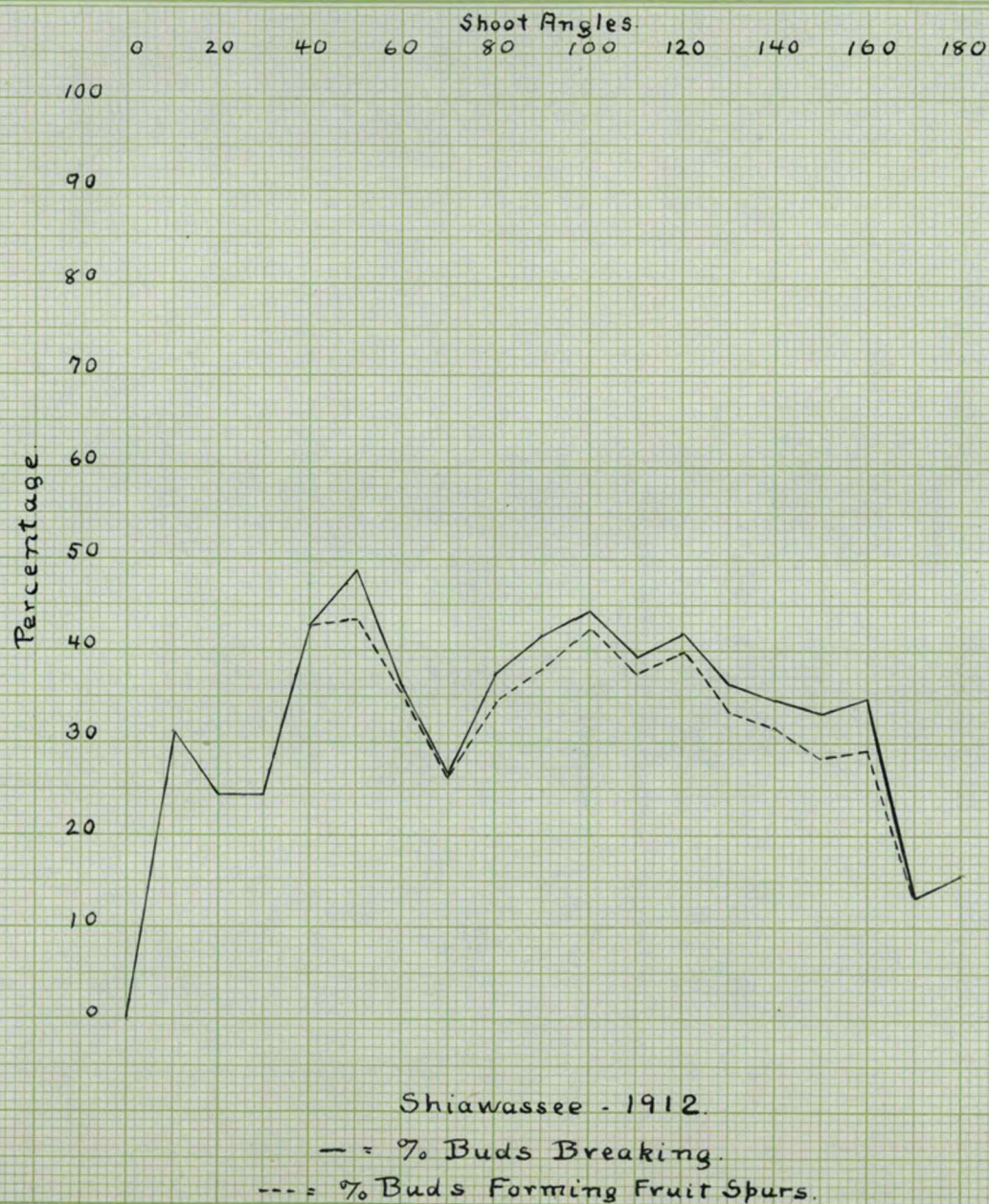


Figure 8.

TABLE XX

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN SHIAWASSEE, 1912 GROWTH.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
0	1	2.50	5.5	3.0	3.0	0	0	0	0
10	2	6.49	4.5	8.0	5.5	0	2.5	31.2	31.2
20	5	5.05	4.4	6.6	5.0	0	1.6	24.2	24.2
30	10	5.17	4.9	6.6	5.0	.1	1.5	24.3	24.3
40	12	6.19	4.7	7.6	4.3	0	3.3	42.8	42.8
50	21	6.94	5.5	8.7	4.4	.5	3.8	48.9	43.4
60	37	5.56	4.8	7.2	4.6	.1	2.5	36.2	35.5
70	40	4.86	5.4	6.9	5.0	.1	1.8	26.9	26.1
80	45	5.75	5.5	8.1	5.0	.3	2.8	37.7	34.4
90	35	5.50	5.7	7.5	4.4	.3	2.8	41.8	38.0
100	47	4.23	6.0	8.2	4.6	.2	3.4	44.2	42.3
110	47	6.72	5.9	8.8	5.4	.2	3.3	39.3	37.6
120	31	5.79	5.9	7.8	4.6	.2	3.1	42.0	39.9
130	28	5.42	5.8	7.4	4.5	.2	2.7	36.2	33.3
140	25	6.85	6.3	8.1	5.1	.2	2.7	34.7	31.9
150	17	6.19	6.9	8.5	5.7	.4	2.4	33.1	28.3
160	11	5.91	6.4	7.8	5.1	.5	2.2	34.9	29.1
170	6	2.48	5.4	3.8	3.3	0	.5	13.1	13.1
180	3	3.04	6.3	4.3	3.6	0	.7	15.8	15.8

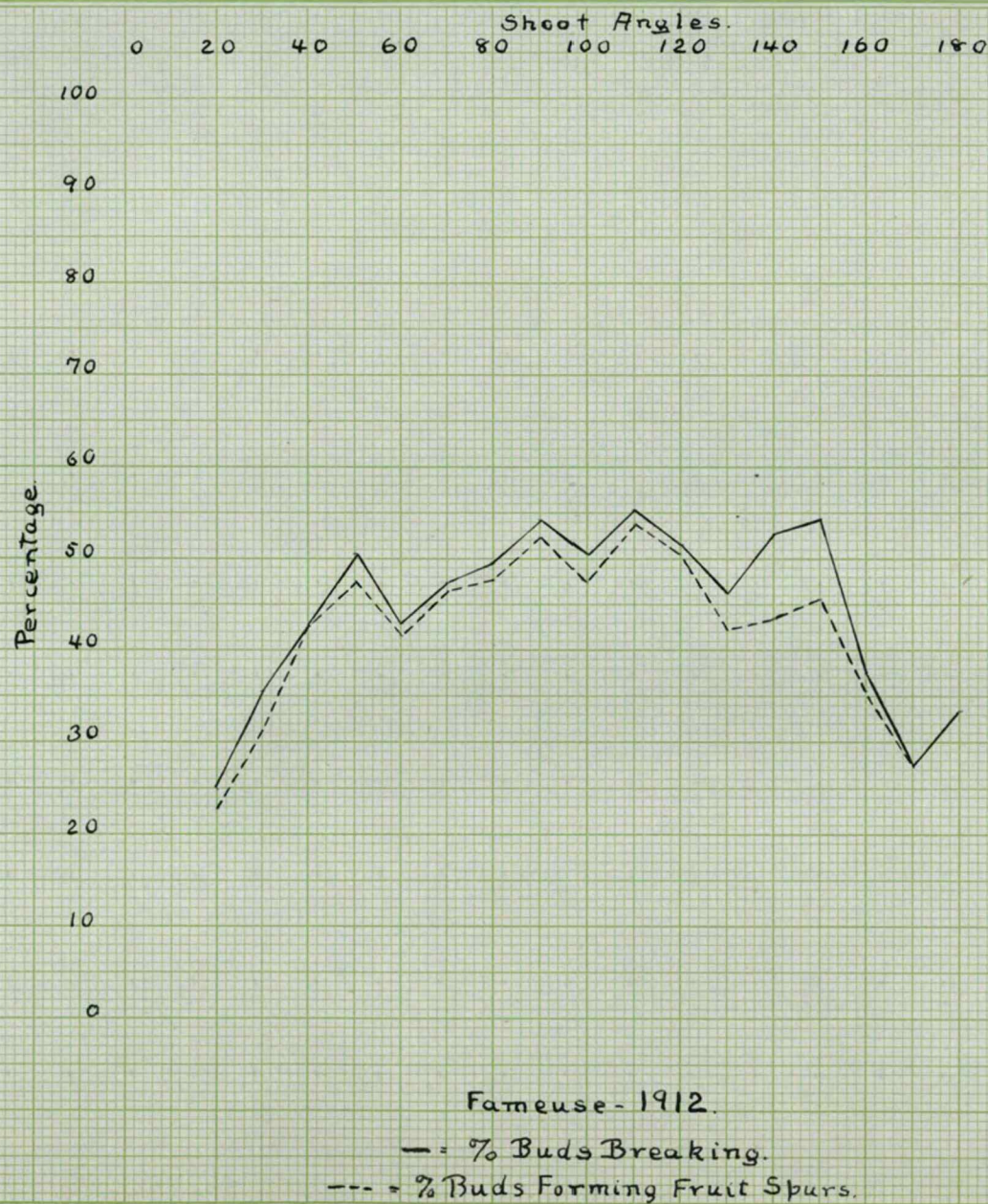


Figure 9.

TABLE XXI

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLES OF SHOOTS IN FAMEUSE, ---1912 GROWTH

		Shoot Angles.																		Frequency	
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of buds breaking	0:	3			1	2	5	3	5	4	5	4	1	3	3	1	2	1			43
	5:																				0
	10:								1	1			1	1		1					5
	15:	1	1	1	1	3	2	2	1	1	1	6	2	1			1	1			25
	20:				1	1		3	6	1		2	3	1	3	1					22
	25:	1			1		1	3	4	2	1	5		3	3	1			1		26
	30:	1			2	1	1	5	3	1	1	4	3	1	1	1	1				25
	35:			2	1	1	2	2	3	3	5	3	5	3	3	3	2	1		1	37
	40:	1					3	3	1	2	2	2		1	1	1	2				18
	45:	1	1	1	3	3	4	1	1	1	4	2	1		1	1	1	1			25
	50:			1	1		2	4	2	8	5	4	3			4	1				35
	55:						2	1	1	1	2	1		2		3					13
	60:						2	4			2	1	2	1				1	1		14
	65:								3	5	4	3	2	2	2	3					24
	70:							1		1	1	1		1				1			6
75:				2	2		2	4	2	2		1	2	2					1	20	
80:						2		3	3	5	7	3	2	1						26	
85:							3	1	1			1	1	2	2					11	
90:					1		1		1				2							5	
95:												2	1							3	
100:						1	2	1	1	1	1	2	2							11	
Frequency		8	5	13	16	30	39	46	38	38	42	39	23	32	14	6	4	1		394	

TABLE XXII

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN FAMEUSE,--1912 GROWTH

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
0	0								
10	0								
20	8	4.67	4.2	6.0	4.5	.12	1.37	25.0	22.9
30	5	6.32	5.3	9.0	5.8	.40	2.80	35.6	31.1
40	13	6.59	5.5	9.5	5.9	.00	3.60	42.7	42.7
50	16	5.03	6.1	7.9	3.9	.25	3.75	50.4	47.2
60	30	5.66	5.7	7.8	4.5	.10	3.27	43.0	41.7
70	39	7.19	5.8	9.4	4.8	.15	4.4	47.3	46.5
80	46	6.38	6.0	7.8	4.1	.15	3.7	49.7	47.8
90	38	5.87	5.8	8.1	3.7	.16	4.2	54.1	52.2
100	38	7.37	6.2	9.1	4.3	.42	4.3	51.4	47.5
110	42	7.45	6.1	9.3	4.2	.14	5.0	55.3	53.7
120	39	7.87	5.8	9.9	4.8	.10	5.0	51.6	50.5
130	23	4.8	6.1	6.7	3.6	.6	2.8	46.1	42.2
140	32	7.51	6.1	9.5	5.0	.41	4.1	47.7	43.4
150	14	7.80	5.7	9.6	4.9	.36	4.4	49.2	45.5
160	6	7.37	5.9	9.8	6.1	.17	3.5	37.6	35.6
170	4	4.34	4.5	7.2	5.2	.00	2.0	27.6	27.6
180	1	.5	6.8	3.0	2.0	.00	1.0	33.3	33.0

A STUDY OF THE 1911 GROWTH

Records of the 1911 growth were taken for only three varieties--old Yellow Newtown, Shiawassee and Fameuse. The curves for this year in general closely parallel those of the two previous years, but are not quite as marked. That for Yellow Newtown shows an increase in the break and in the fruit buds until 130° is reached and then it begins to drop a little. The curve for Shiawassee is rather irregular, pointing out no definite relationship between angle of shoot and per cent of buds breaking. The Fameuse curve again rises and falls, reaching its highest point very close to its mean angle.

The correlation coefficients again become smaller, being approximately .10 in the Yellow Newtown, and both negative, but very close to zero, in the Shiawassee and Fameuse. They are as follows:-

Variety	Mean per- cent of buds breaking	Standard Deviation	Mean Shoot Angle	Standard Deviation	Correlation coefficient.
Yellow New- town	41.84	24.24	111.61	26.48	.1003
Shiawassee	37.69	27.14	82.05	34.88	-.036
Fameuse	48.16	25.59	88.04	32.38	-.058

An interesting point to note here is the fact that in mature trees the mean angle of the younger wood is higher than that of the older wood. This of course does not hold for the younger trees because the first limbs of a young tree are generally quite upright with the succeeding years' limbs branching out from them.

Von Sachs⁷ in speaking of observations along this line in his "Lectures on the Physiology of Plants" writes:

"If the foliage is abundant a marked alteration of the form of the bent branch is produced by it. Thus the older branches of orchard trees are seen to be bent by the weight of the leaves and fruit, and to sink more and more the older they become."

The following table will bring out this point, as well as show the relation of the mean angle to the habit of the tree.

Variety	1913 mean	1912 mean	1911 mean
Yellow Newtown--young	135.68	139.40	---
Wagener	149.32	162.5	---
Yellow Newtown--old	130.19	121.18	111.61
Shiawassee	117.13	95.32	82.05
Fameuse	110.89	95.81	88.04

HEADED versus NON-HEADED SHOOTS.

While by far the larger part of the measurements of all the varieties except Wagener were of shoots that had not been cut back, a certain number had been headed back. The growth for the three years was put into one group and averages secured as before from which curves were plotted. In the case of the Wagners nearly every branch had been headed back, but what few were not cut back were grouped together and handled as mentioned above.



Yellow Newtown - 1911 - Old Trees.
— = % Buds Breaking.
--- = % Buds Forming Fruit Spurs.

Figure 10.

TABLE XXIII

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOT IN OLD YELLOW NEWTOWN,--
1911 GROWTH

		Shoot Angles																	Fre-
		30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	quency	
0				2	1	1	2	8	10	7	7	4	4	4		1	1	52	
5									1		1				1			3	
10							1	1	2	1	2				1			8	
15				1	2	1	3	2	6	4	9	1	4					33	
20				1	1	2	3	4	6	6	2	2	2	2	1	3		35	
25					2	1	2	4	4	5	3	3	2		2	2	1	31	
30					1	1	2	6	5	4	3	2	2	1		1	1	29	
35					1	1	4	4	7	8	7	4	6	3	1			46	
40		1			1	2	3	4	7	8	7	4	2	3	1	2		45	
45				1			3	2	3	6	7	2	5	6	3	1	1	40	
50				1				1	5	8	4	6	2	3	2	1	1	34	
55						2	1	1		5	4	4	3	2	1	1	1	26	
60						2	4	3		1	4	4	2	3		1		24	
65						1	7	1		5	9	7	4	7		3		44	
70							1	3		3	3	4	2	4		2	2	1	25
75							5	3		3	2	4	4	4		2			27
80							1	1		5	2	2	4	1			1		17
85								2		1	3	1	1	4		1			13
90											1	1	3		1		1		7
95								1							1				2
100																			
Fre-	quency	1	0	6	9	17	42	56	85	82	76	50	56	26	16	14	5	541	

TABLE XXIV

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN OLD YELLOW NEWTOWN,--1911
GROWTH.

For key to columns see Page 11

1	2	3	4	5	6	7	8	9	10
30	1	15.0	5.4	18.0	11.0	0	7.0	38.9	38.9
40	0								
50	6	4.92	4.7	7.0	5.3	0	1.7	23.8	23.8
60	9	4.69	4.5	6.2	4.8	0	1.4	23.4	23.4
70	17	8.52	5.4	11.9	7.5	.1	4.3	36.9	36.4
80	42	9.04	5.5	10.4	5.4	.1	5.0	48.6	47.7
90	56	9.06	5.4	11.3	6.2	.0	5.1	45.3	45.1
100	85	8.63	5.6	11.1	6.7	.1	4.3	39.6	38.5
110	82	9.32	5.9	11.9	6.5	.1	5.3	45.4	44.5
120	76	9.20	5.8	11.8	6.3	.2	5.3	46.3	44.7
130	50	10.46	6.2	12.9	5.9	.3	6.7	54.2	51.9
140	56	8.47	6.2	11.4	5.4	.2	5.8	52.6	50.8
150	26	9.13	5.8	12.5	6.7	.1	5.8	46.6	46.0
160	16	8.61	6.1	12.9	7.3	0	5.6	43.9	43.9
170	14	7.90	5.6	11.2	6.7	0	4.5	40.1	40.1
180	5	6.80	5.4	9.8	5.4	0	4.4	44.9	44.9

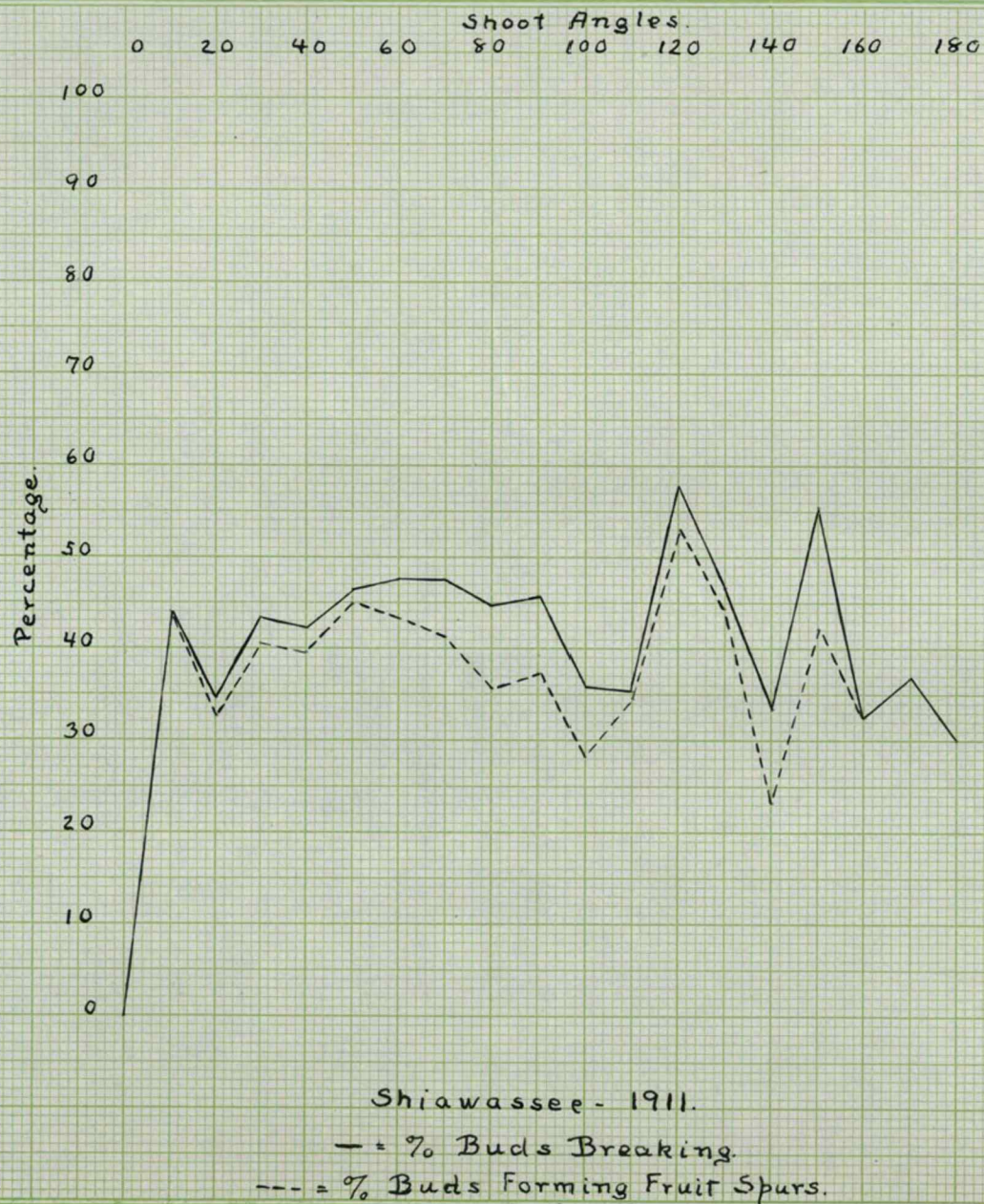


Figure 11.

TABLE XXV

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOTS IN SHIAWASSEE,--1911 GROWTH

		Shoot Angles																		Frequency	
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of buds breaking	0:	1	1	2	4	5	3	2	6	8	6	7	7	4	4	2	1	3	1		67
	5:																				0
	10:					1			1	1		2	1								6
	15:					2			3	2	3		4			1					15
	20:			1		2	1	2	3	4	2		1		3		1				20
	25:						2	2	1		1	1	1	2	2						12
	30:			1		1	1	1		2	2				1				1	1	11
	35:	1			2		3	2	3		1	2						1			15
	40:				1	1	3	2	1		5	2	1		1				1		18
	45:				1		2	3	1	2	7	3			1		1				21
	50:			2	1	2	5	6	1	2	1	1	1	1			2				25
	55:				1		4		2		2		1					1	1		12
	60:	1			1		5	1		4	4		1					2			19
	65:				1	1	1	3	6	6	2		2	1	4		1				28
	70:					3		1		2					2						8
	75:							2	2	3	2				1			1			11
80:			1	1	2	1		2	1	1	2	1	2	1						15	
85:							1	1		1	1			2						6	
90:												1								1	
95:																				0	
100:								1							1					2	
Fre-	1	3	7	13	20	31	28	34	37	40	21	22	14	19	6	6	5	4	1	312	
quency																					

TABLE XXVI

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN SHIAWASSEE,--1911 GROWTH

For key to columns see Page 11

:	1	2	3	4	5	6	7	8	9	10	:
0	1	3.12	7.3	6	6	0	0	0	0		
10	3	6.70	4.7	8.3	4.7	0	3.6	44.0	44.0		
20	7	6.46	5.5	7.8	5.1	.1	2.6	34.6	32.7		
30	13	4.74	5.0	5.7	3.2	.2	2.3	43.3	40.6		
40	20	6.61	5.8	8.3	4.8	.2	3.3	42.2	39.8		
50	31	7.39	5.4	8.7	4.7	.1	3.9	46.5	45.0		
60	28	7.02	6.1	8.7	4.6	.4	3.7	47.6	43.2		
70	34	7.97	6.4	9.5	5.0	.6	3.9	47.6	41.3		
80	37	7.23	6.4	8.4	4.7	.7	3.0	44.9	35.9		
90	40	7.42	7.4	9.4	5.1	.8	3.5	45.9	37.2		
100	21	7.21	7.4	8.6	5.5	.7	2.4	35.9	28.2		
110	22	6.13	5.9	7.8	5.0	.1	2.7	35.1	34.5		
120	14	7.97	6.7	9.3	3.9	.4	4.9	57.7	53.0		
130	19	7.23	6.6	8.8	4.7	.2	4.0	46.7	44.3		
140	6	5.92	8.1	6.5	4.3	.7	1.5	33.3	23.1		
150	6	10.66	9.4	10.8	4.8	1.3	4.7	55.4	42.1		
160	5	4.62	8.7	6.8	4.6	.0	2.2	32.4	32.4		
170	4	8.72	9.4	9.5	6.0	.0	3.5	36.9	36.9		
180	1	9.5	3.7	10.0	7.0	.0	3.0	30.0	30.0		



Figure 12.

TABLE XXVII

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOT IN FAMEUSE,--1911 GROWTH.

		Shoot Angles.																		Frequency	
		0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of buds breaking	0:	1			1	1	1	1	4	4	1	2	3		1			2	1	1	24
	5:																				0
	10:																				0
	15:								1	2	4			2	1			1			11
	20:		1				1	1	1	1	1		1	1	1		1		1		11
	25:					2		2	1			1	1		1		1				9
	30:			1	2					3	1				2		1				10
	35:						2	1	8	2	2	1	2	1		2		1			22
	40:						2	1			1	1	2	1		1	1				10
	45:						1		3	2	1	3	4	1		2	1				18
	50:			1	3	1	6	1	4	2			1	3		1					23
	55:						3	1	1	2	2			1							10
	60:			1	2	1	1			5	3	2	2	1	1						19
	65:			1			2		4	1	4	1	3		1	2	1				20
	70:							2	2	1				1	1	1					8
	75:						1	2	4	4	4	1	3		2			1	1		23
80:				1	1	1	1	3	2	4			1	2						15	
85:			2				2	1	1		1	2					1			10	
90:										1		1								2	
95:											1									1	
100:						1			2	1										4	
Frequency		1	1	7	11	17	21	34	36	32	14	27	16	9	9	7	5	2	1	250	

TABLE XXVIII

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN FAMEUSE,--1911 GROWTH

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
0	1	3.5	4.8	6	6	0	0	0	0
10	0								
20	1	3.12	3.8	5.0	4.0	0	1.0	20.0	20.0
30	7	7.19	5.9	8.4	3.1	0	5.3	62.7	62.7
40	11	6.02	5.4	7.8	4.4	.01	3.4	44.2	43.0
50	17	7.02	6.4	8.4	3.8	.23	4.3	54.2	51.4
60	21	7.43	6.6	9.4	3.9	.28	5.2	58.8	55.8
70	34	7.83	6.2	9.3	4.3	.20	4.8	53.5	51.2
80	36	8.05	6.9	9.5	4.5	.42	4.6	52.5	48.1
90	32	7.77	6.6	9.3	3.7	.59	5.0	60.5	54.1
100	14	9.48	6.5	10.3	4.1	.28	5.9	60.0	57.2
110	27	8.01	7.0	9.7	4.3	.37	5.0	55.2	51.3
120	16	8.94	7.3	10.9	5.3	.69	4.9	51.5	44.8
130	9	5.79	6.1	8.0	4.4	.22	3.3	44.5-	41.7
140	9	13.44	8.4	14.2	6.6	.77	6.9	53.1	47.6
150	7	7.18	5.9	9.1	4.4	0	4.7	51.6	51.6
160	5	4.57	4.4	6.6	4.2	0	2.4	36.4	36.4
170	2	1.88	4.3	5.0	4.5	0	.5	10.0	10.0
180	1	.37	6.6	2.0	2.0	0	0	0	0

The curves for the group as a whole are somewhat irregular. There seems to be only a slight tendency toward a relationship. See figures 13, 14, 15, 16, and 17. The correlation coefficients obtained were rather small. The coefficient for Fameuse was .082, or higher than it was in any year for shoots that had not been headed back.

It is interesting to note the effect of heading upon the behavior of the buds. In every case there was an increase in the number which broke into vegetative shoots. Particularly was this true in the case of Wagener. While there was a great increase in the number of branches, the same cannot be said of fruit spurs. In the case of Wagener again the branches that had not been headed had the greatest per cent of buds forming fruit spurs. Figs. 19 and 20 show in the case of Fameuse that the per cent of buds breaking in headed shoots is considerably higher, than in non-headed shoots, but that the per cent of fruit buds formed is practically the same in each instance, with the advantage, if any, on the side of the non-headed. This may be partially explained at any rate. A branch only has a certain number of buds. If it is cut back severely and a number of buds are forced out into branches, the number that can form fruit spurs is naturally reduced, as compared with the total number.

The following table gives the mean, standard deviations, and correlation coefficients found:-

Variety	Mean	Standard Deviation	Mean	Standard Deviation	Correlation Coefficient.
Wagener (1913)	71.47	15.99	149.32	28.04	.429
Wagener (1912)	75.88	12.08	162.5	14.86	.181
Yellow New- town --old trees(headed)	66.32	15.08	121.98	24.22	-.004
Shiawassee	62.99	14.21	99.08	28.18	.065
Fameuse	64.82	18.46	114.32	30.36	.082

A STUDY OF CURVED SHOOTS

In order to obtain as correct a measurement as possible of the curved twigs two readings were made. A twig was divided into two portions--the upper, or extreme end of the shoot, and the lower, or part nearest the center of the tree. A twig was considered curved when the angle of the upper portion differed by at least 20° from that of the lower portion. In determining the influence of the angle upon the buds, the upper and lower portions were treated separately, and curves were plotted and correlation coefficients determined as in the other cases.

The curves for the upper portions of the branches are rather interesting. Although they are somewhat irregular in many cases, their general trend is from a small per cent of buds breaking to a larger one., with the approach to a vertical direction of growth. Shiawassee showed probably the smallest relationship of any. In the Wagener shoots of 1912 it is found that the per cent of fruit spurs slightly decreases with the increase in the angle,

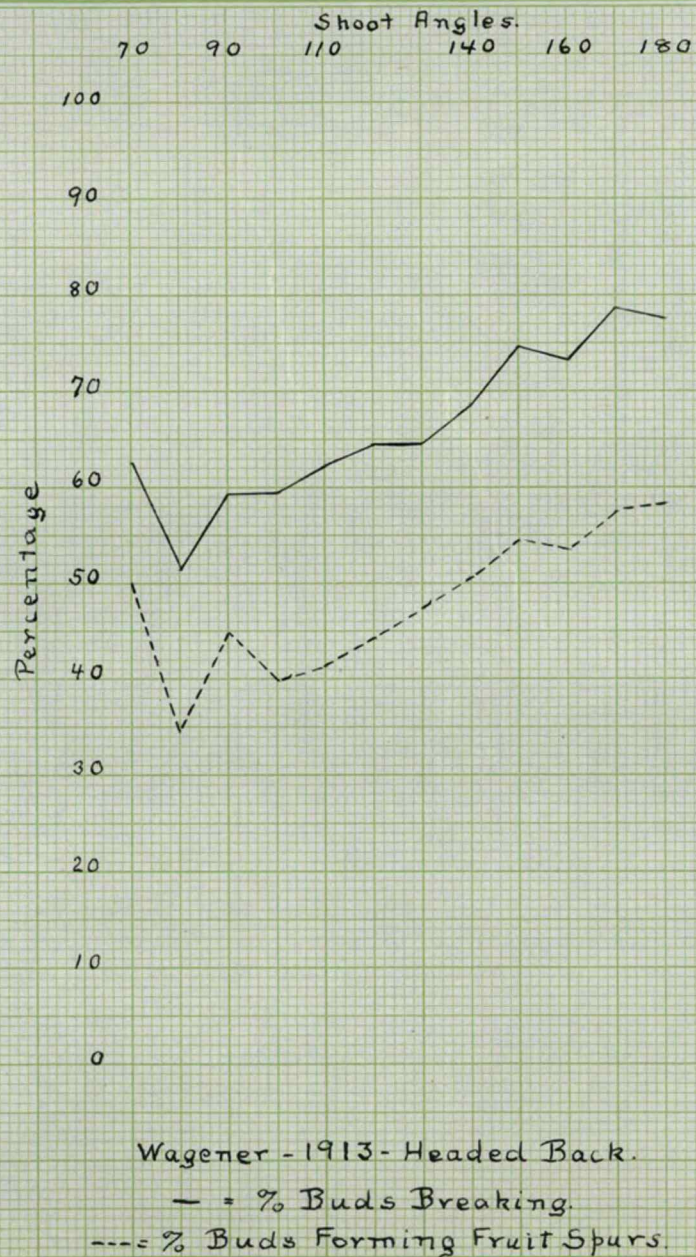


Figure 13.

1000 1000 1000 1000

[illegible]

		Shoot Angles												
		70	80	90	100	110	120	130	140	150	160	170	180	Frequency
Per cent of buds breaking	0													
	5													
	10			1				1						2
	15													
	20													
	25		1	1		1	2	2					1	8
	30				1	1	1		1	1				5
	35		2	1	1	4	2	2				1		13
	40		1	1	2	2	2	1	1	1	1			12
	45		1	3	2	2	4	1	2	2	1	3	4	25
	50		1	6	3	14	7	9	2	3	6	6	4	61
	55			1	1	1	5	3	5	3	4	7	3	33
	60		2	1	8	5	11	4	3	5	10	12	7	68
	65	1		5	6	19	17	8	13	5	14	16	13	117
	70				2	1	3	1	8	3	9	17	15	59
	75			6	5	4	9	9	9	7	15	32	33	129
80		1	2		2	9	5	3	12	12	25	27	98	
85				1	5	1	6	4	10	18	31	24	100	
90			2	1	4	4	2	3	4	12	36	15	83	
95								2	4	12	23	14	45	
100						2	1	1	1	1	6	2	14	
Frequency	1	9	30	33	65	79	55	57	61	105	215	162	872	

TABLE XXX

 CORRELATION TABLE FOR PER CENT OF BUDS FORMING
 FRUIT SPURS AND ANGLE OF SHOOT SIN WAGENER, --
 1913 GROWTH. SHOOT HEAD BACK.

		Shoot Angles											Frequency	
		70	80	90	100	110	120	130	140	150	160	170	180	
Per cent of buds forming fruit spurs	0				1									1
	5													
	10			1	2	2		3	1			1		10
	15			2		2	2	1						7
	20	3			3	4	1	2	1	3	1	4	1	23
	25	1	3	1	3	6	1			1	2	2	3	23
	30	2	3		4	3	8	1		5	4	5	4	39
	35	1	2			14	12	11	9	5	5	5	3	67
	40	1	2	7	4	11	5	4	2	7	13	7		63
	45		1	3	2	9	5	13	4	15	20	16		88
	50	1		5	3	8	9	4	7	3	14	24	26	104
	55			2	3	3	5	1	6	10	19	28	17	94
	60			1	3	5	6	6	4	8	11	26	30	100
	65			5	1	6	5	3	7	6	16	34	21	104
	70					1	1	4	1	6	7	25	16	61
	75			2	1	1	1	4	2	5	2	20	12	50
	80		1	1	1		2	2	1	3	2	7	9	29
	85					2	1	2	1			1	2	9
	90								1					1
	95													
	100													
Frequency		1	9	30	33	60	79	55	58	61	105	215	167	873

TABLE XXXI

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN WAGENER,--1913 GROWTH. SHOOTS HEADED
BACK.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
70	1	6.25	9.3	8	3	1	4	62.5	50.0
80	9	8.83	8.6	8.7	4.2	1.4	3.0	51.3	34.6
90	30	7.61	8.9	7.8	3.2	1.2	3.4	59.2	44.8
100	33	10.02	9.5	9.8	3.9	2.0	3.9	59.6	40.0
110	65	9.58	8.6	8.4	3.2	1.8	3.4	62.2	41.1
120	79	11.79	9.9	10.1	3.6	2.0	4.5	64.3	44.1
130	55	12.56	10.0	10.5	3.8	1.8	5.0	64.5	47.3
140	57	15.98	12.0	13.0	4.1	2.4	6.5	68.9	50.9
150	61	17.47	11.6	14.0	3.5	2.8	7.7	74.7	54.5
160	105	18.10	12.8	14.9	4.0	3.1	7.9	73.2	53.6
170	215	22.52	14.6	18.1	3.8	4.3	10.5	78.8	57.7
180	162	27.21	16.4	22.3	5.0	4.3	13.0	77.6	58.3



Figure 14.

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOTS IN WAGENER,--1912 GROWTH.
SHOOTS HEADED BACK

		Shoot Angles									
		100	110	120	130	140	150	160	170	180	Frequency
Per cent of buds breaking	45				2				1		3
	50							2			2
	55			1	1		1	2	1	3	9
	60			2			2	1	6	1	12
	65		1	1	2	2	3	4	4	4	21
	70				1			6	8	3	18
	75			1	1	1	6	8	7	8	32
	80				1		2	6	11	6	26
	85					1	4	6	13	6	30
	90			1	1			3	7	2	14
95								3	2	5	
100	1					2	1	4		8	
Frequency	1	1	6	9	4	20	39	65	35	180	

TABLE XXXIII

 CORRELATION TABLE FOR PER CENT OF BUDS FORMING
 FRUIT SPURS AND ANGLE OF SHOOTS IN WAGENER,--
 1912 GROWTH. SHOOT HEADS BACK.

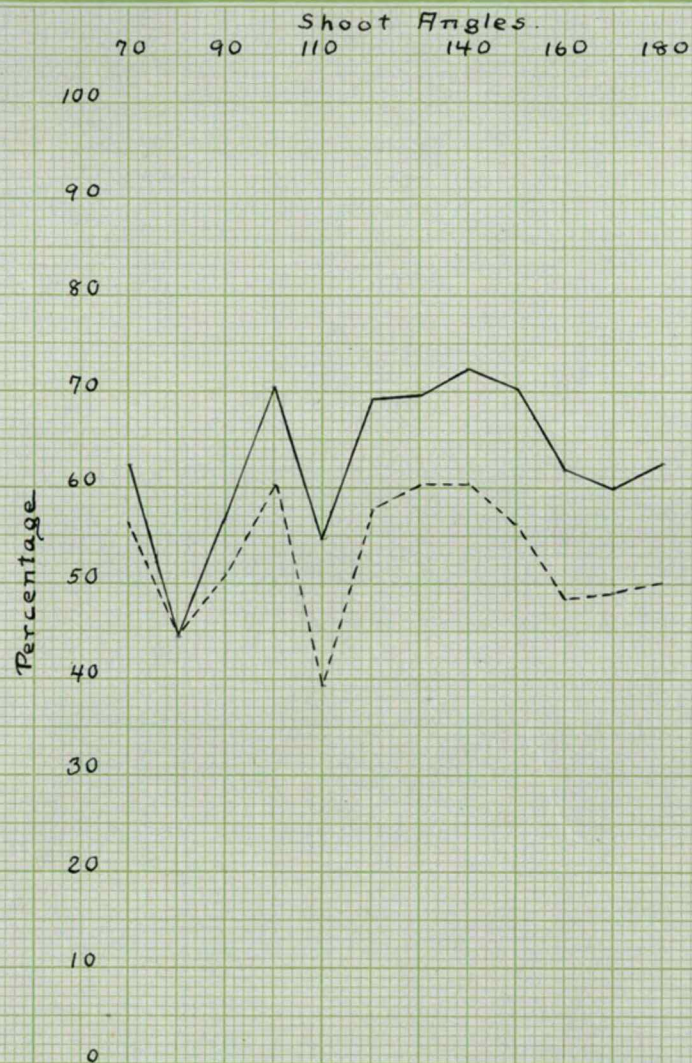
		Shoot Angles.									
		100	110	120	130	140	150	160	170	180	Frequency
Per cent of buds forming fruit spurs	0:									1	1
	5:										0
	10:						1	3			4
	15:				1		1		1	1	4
	20:			1			2	2			5
	25:			1	1	1		2	1		6
	30:				1		1	2	4		8
	35:		1	1		1	2	6	6	6	23
	40:				2		4	4	6	4	20
	45:			1	3	1	3	11	13	9	41
	50:			1		1		3	8	5	18
	55:			1			2	3	9	2	17
	60:	1			1		2	2	10	5	21
	65:						2	2	4	2	10
	70:						1	1			2
	75:								1		1
80:										0	
85:										0	
90:										0	
95:										0	
100:										0	
Fre- quency		1	1	6	9	4	20	39	66	35	181

TABLE XXXIV

 TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN WAGENER,--1912 GROWTH. SHOOTS
 HEADED BACK.

 For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
100	1	5.75	17.4	5	0	2	3	100	60
110	1	14.25	24.5	12	4	4	4	66.7	33.3
120	6	12.35	20.0	11.3	3.8	3.1	8.3	66.2	38.5
130	9	13.08	20.9	11.5	4.2	3.1	4.2	63.4	36.5
140	4	16.81	22.8	13.8	3.8	4.8	5.2	72.7	38.4
150	20	15.72	23.2	12.9	3.3	3.9	5.7	74.3	44.3
160	39	19.50	24.4	15.3	4.1	4.7	6.5	73.5	42.5
170	65	19.99	25.7	16.1	3.7	4.9	7.5	76.9	46.5
180	35	19.75	25.8	16.1	3.9	4.8	7.3	75.5	45.5



Yellow Newtown - Old Trees - 1913 - 1912 - 1911 - Headed Back.

— = % Buds Breaking.

--- = % Buds Forming Fruit Spurs.

Figure 15.

TABLE XXXV

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOTS IN OLD YELLOW NEWTOWN, 1913-
1912-1911 GROWTH. SHOOTS HEADED BACK.

	Shoot Angles.												Frequency.
	70	80	90	100	110	120	130	140	150	160	170	180	
0													
5													
10													
15			1		1								1
20					1								1
25													
30													
35													
40					1		1	1	1				4
45		1		1			2		2		2		8
50						4		2	2	4	4		16
55	1						1	1					3
60			1	2	1	4		4	1	4	1		18
65				3	2	4	6	4	3	3	3	1	29
70			1	1			1	1	1				5
75						5	1	3	2	1			12
80	1		1	2		1	2	7	3	1			18
85				1		5	2	1	1		1		11
90				1	1		2	3	2				9
95													
100								1					1
Frequency	2	1	4	11	6	23	18	28	18	13	11	1	136

TABLE XXXVI

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN OLD YELLOW NEWTOWN,--1913-1912-1911
 GROWTH. SHOOT'S HEADED BACK.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
70	2	7.37	4.8	8.0	3.0	.5	4.5	62.5	56.2
80	1	8.0	5.2	9.0	5.0	0	4.0	44.5	44.5
90	4	9.31	6.3	12.8	5.5	.8	6.5	56.9	51.0
100	11	8.17	6.0	9.8	2.9	1.0	5.9	70.4	60.1
110	6	6.37	6.0	8.5	3.8	1.3	3.4	54.9	39.2
120	23	8.51	5.9	10.1	3.1	1.1	5.9	69.1	57.9
130	18	8.85	6.3	10.0	3.0	1.0	6.0	69.7	60.1
140	28	9.13	6.6	10.3	2.9	1.2	6.2	72.5	60.4
150	18	8.17	6.3	9.5	2.9	1.3	5.3	70.2	56.1
160	13	8.10	6.4	9.1	3.5	1.2	4.4	61.9	48.3
170	11	9.12	5.9	9.1	3.6	1.0	4.5	60.0	49.0
180	1	7.12	5.0	8.0	3.0	1.0	4.0	62.5	50.0

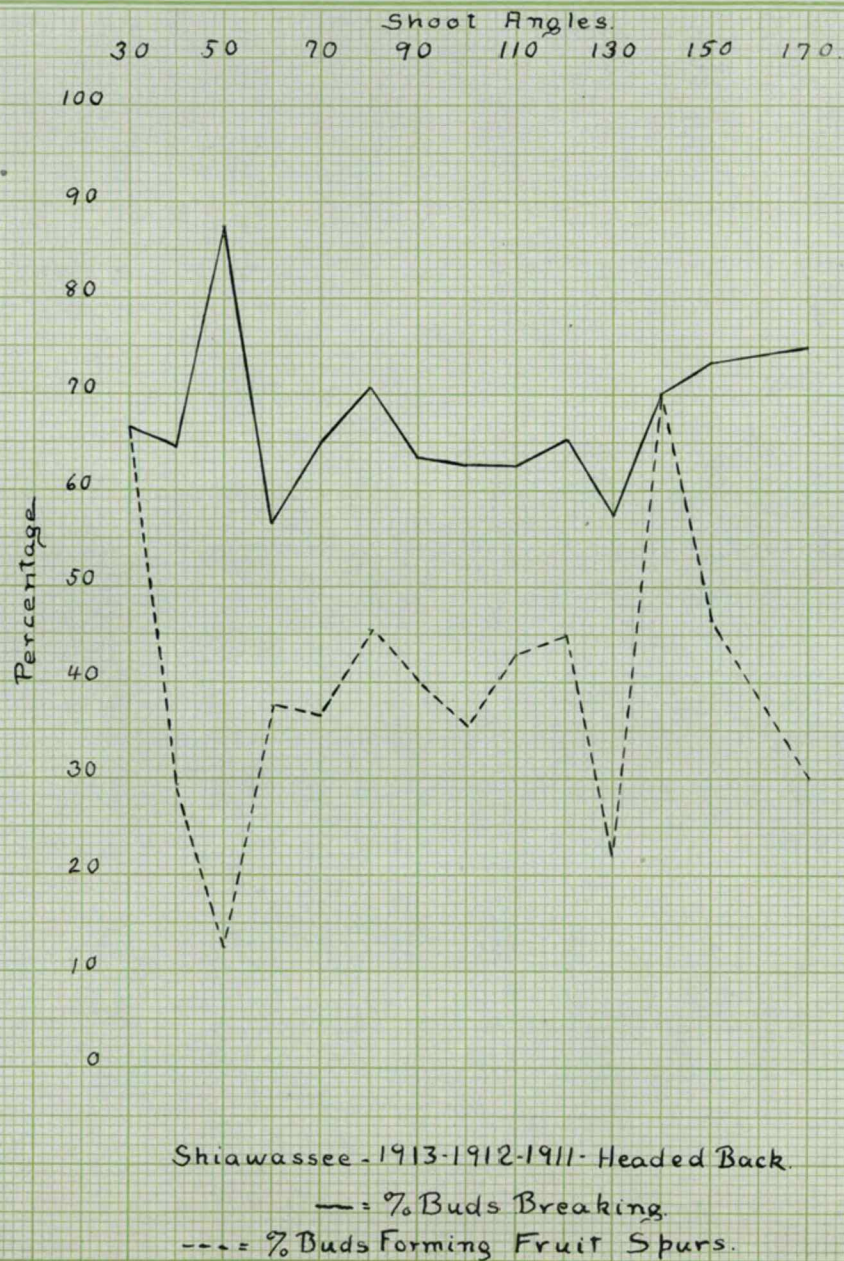


Figure 16.

TABLE XXXVII

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOTS IN SHIAWASSEE, 1913-1912-1911
 GROWTH. SHOOTS HEADED BACK.

		Shoot Angles																	
		30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	Frequency	
Per cent of buds breaking	35:							1				1						2	
	40:							2		1								3	
	45:										1							1	
	50:				2	4	4	1	4	4	2	1						22	
	55:				1	1		1					1					4	
	60:				3			1		5	1	2						12	
	65:	1	2			1	1		3	3	4	2						17	
	70:						1		2									3	
	75:					1	1	1	2					2		2		9	
	80:						1	1		1	1							4	
	85:						1	1			2					1		5	
90:			1		1								1				3		
95:																	0		
100:						1			1								2		
Frequency	1	2	1	6	9	9	9	11	15	11	6	2	2	0	3			87	

TABLE XXXVIII

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN SHIAWASSEE,--1913-1912-1911 GROWTH.
 SHOOTS HEADED BACK.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
30	1	2.0	4.1	3.0	1	0	2.0	66.6	66.6
40	2	7.94	7.7	8.5	3	3	2.5	64.7	29.4
50	1	8.5	7.5	8.0	1	2	5.0	87.5	12.5
60	6	9.44	6.9	11.5	5	2.2	4.3	56.6	37.7
70	9	8.22	6.4	6.6	2.3	1.9	2.4	65.0	36.7
80	9	5.22	6.2	6.1	1.8	1.6	2.8	70.9	45.4
90	9	6.12	7.0	6.6	2.4	1.5	2.7	63.4	40.0
100	11	5.68	7.8	6.4	2.4	1.6	2.3	62.8	35.7
110	15	5.68	7.0	6.2	2.3	1.2	3.7	62.4	43.0
120	11	7.17	7.8	8.1	2.8	1.7	3.6	65.2	45.0
130	6	6.85	6.8	7.5	3.2	2.5	1.8	57.8	22.0
140	2	8.94	5.4	10.0	3.0	0	7.0	70.0	70.0
150	2	5.78	8.2	7.5	2.0	2.0	3.5	73.4	46.6
160	-	-	-	-	-	-	-	-	-
170	3	5.83	10.6	6.7	1.7	3.0	2.0	75.0	30.0

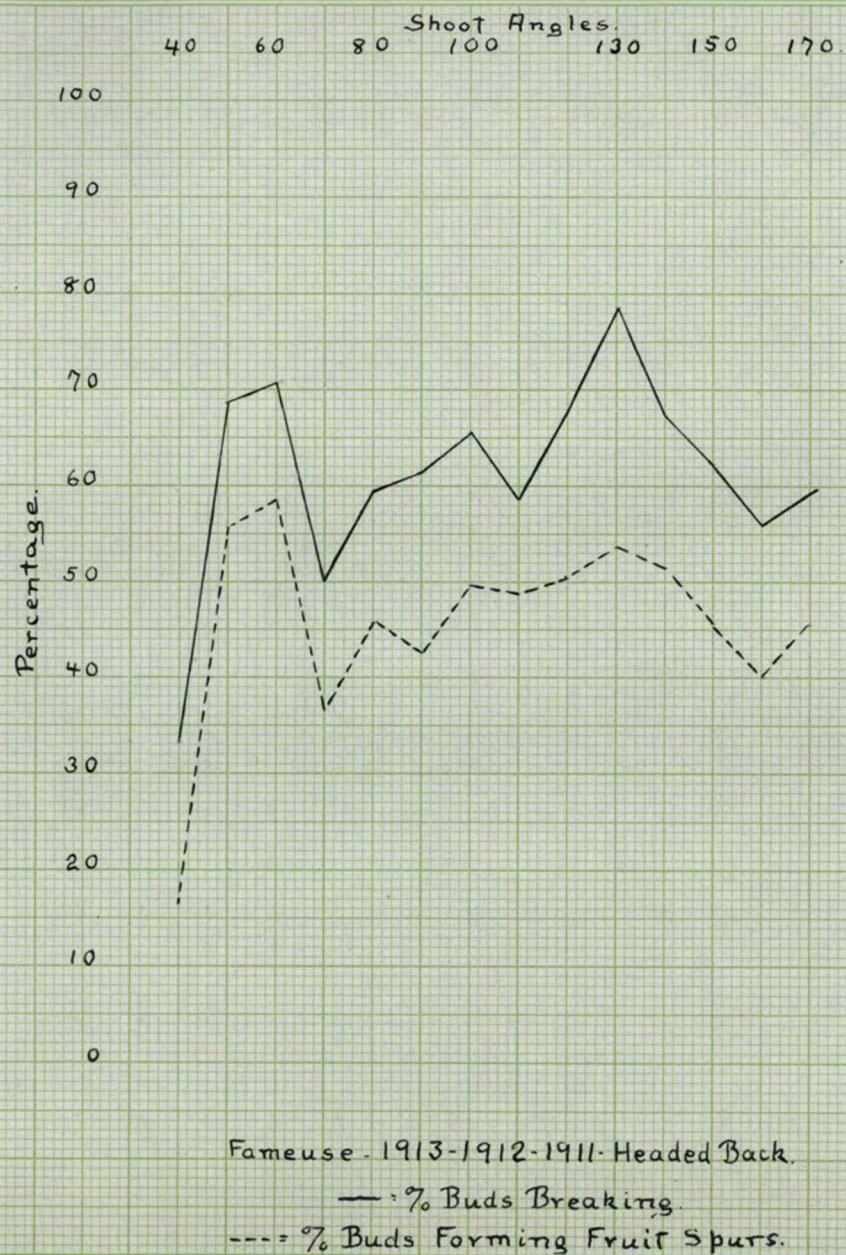


Figure 17.

TABLE XXXIX.

 CORRELATION TABLE FOR PER CENT OF BUDS
 BREAKING AND ANGLE OF SHOOTS IN FAMEUSE,--
 1913-1912-1911 GROWTH. SHOOTS HEADED BACK.

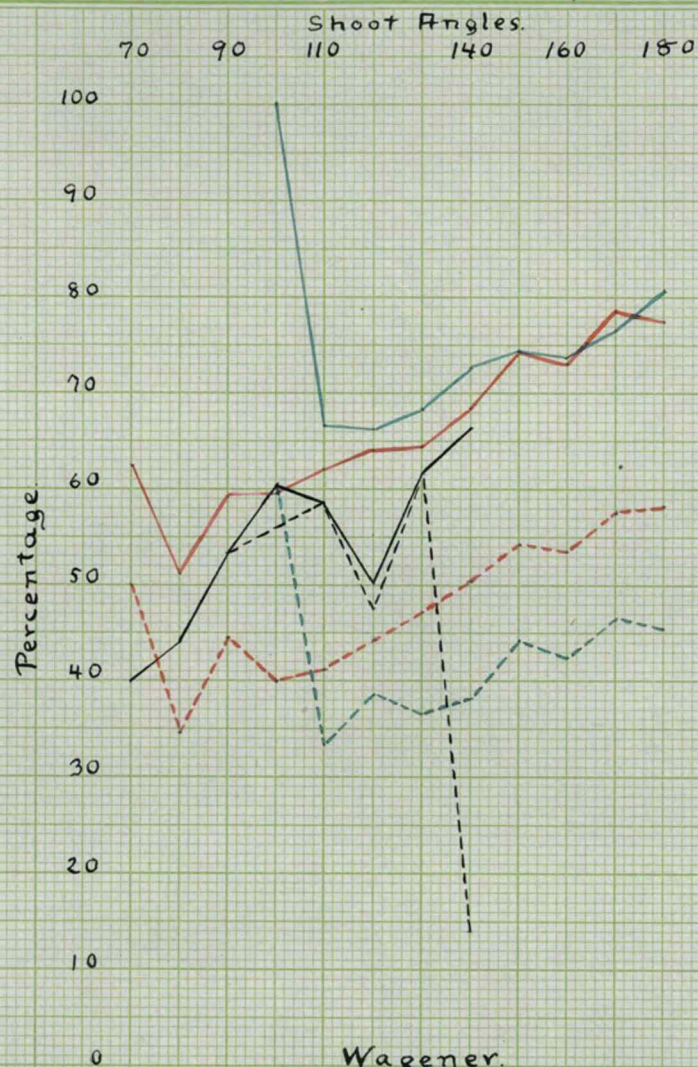
		ShootAngles.																	Frequency
		40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	Frequency		
Per cent of birds breaking	25							2									2		
	30						1			1				1			3		
	35	1				1			1			1		1	1		6		
	40			1	1	1		1	1								5		
	45						1	1	1	2		1	2				8		
	50				3		1			1		1	1				7		
	55								3	1					1		5		
	60		1	1				2		2	1	1	2		1		11		
	65					2	1	4	2			1	2				12		
	70							1				1					2		
	75		1		1	1	4	4	2	3	1	1	1	3			22		
	80			1		1		1		1	2	2	1				9		
	85				1		1	1		5			1		1		10		
90						1	1		1		1					4			
95																			
100			1						1	1	1		1				5		
Frequency		1	2	4	6	6	10	18	10	18	5	11	10	6	4		111		

TABLE XL

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN FAMEUSE, --1913-1912-1911 GROWTH.
 SHOOTS HEADED BACK.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
40	1	5.37	6.2	6	4	1.0	1.0	33.3	16.7
50	2	6.50	8.5	8	2.5	1.0	4.5	68.8	55.6
60	4	5.09	5.5	6	1.75	.75	3.5	70.8	58.3
70	6	7.58	7.1	7.3	3.7	1.0	2.6	50.0	36.7
80	6	7.08	7.3	9.8	4.0	1.3	4.5	59.3	45.8
90	10	6.79	7.9	7.5	2.9	1.4	3.2	61.3	42.7
100	18	5.84	6.8	6.7	2.3	1.0	3.3	65.3	49.6
110	10	8.19	6.7	9.0	3.7	.9	4.4	58.9	48.9
120	18	8.26	7.4	7.8	2.5	1.4	3.9	68.0	50.3
130	5	5.72	7.5	5.5	1.2	1.4	3.0	78.6	53.6
140	11	8.51	7.6	8.4	2.7	1.3	4.3	67.4	51.5
150	10	9.39	7.6	9.8	3.7	1.6	4.5	62.2	45.9
160	6	8.12	8.4	8.3	3.6	1.3	3.3	56.0	40.0
170	4	12.19	7.05	11.0	6.5	1.5	4.0	59.1	45.5



1913-1912
Not Headed Back.

Wagener.
1913
Headed Back.

1912
Headed Back.

— = % Buds Breaking.
--- = % Buds Forming Fruit Spurs.

— = % Buds Breaking.
--- = % Buds Forming Fruit Spurs.

— = % Buds Breaking.
--- = % Buds Forming Fruit Spurs.

Figure 18.

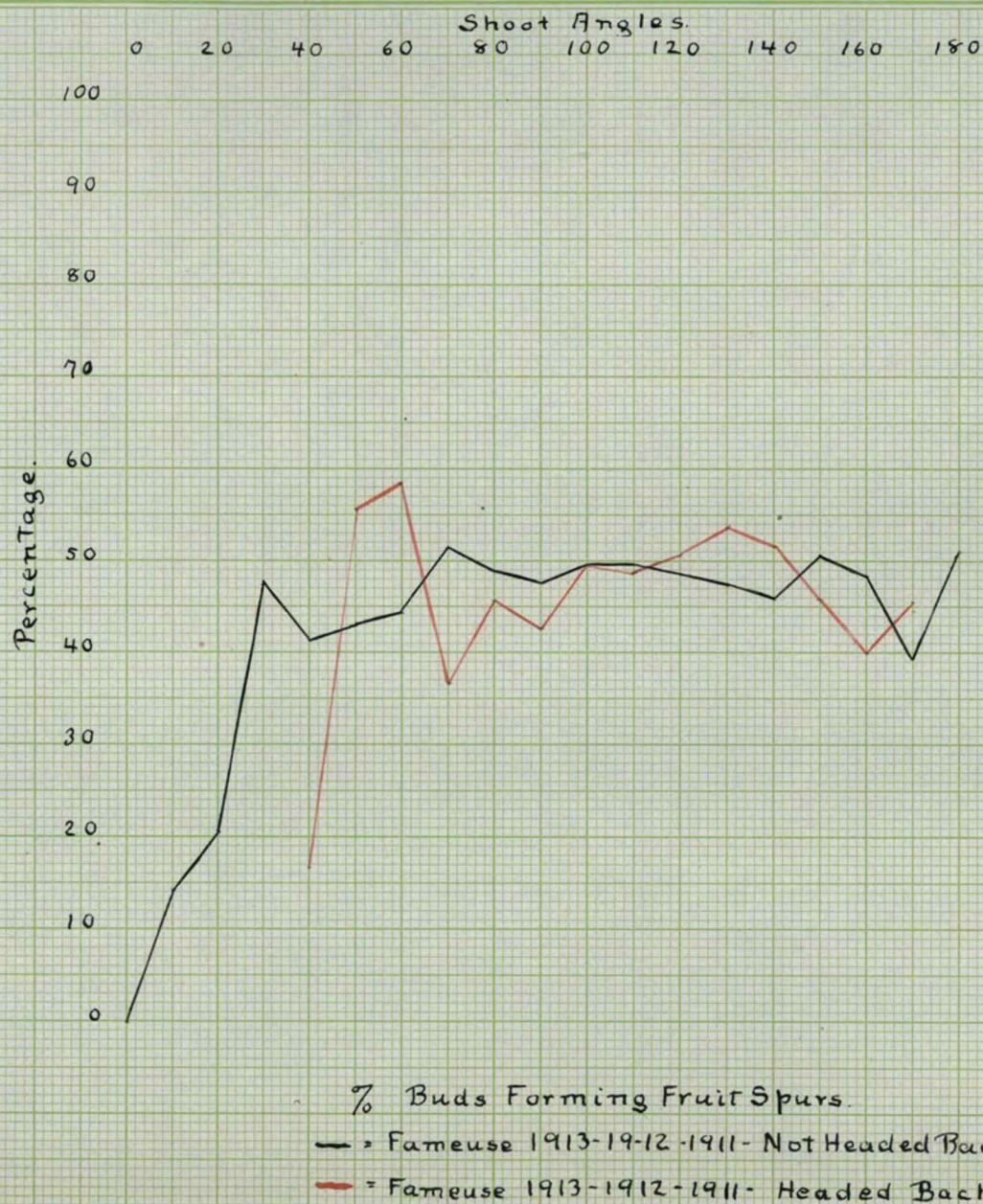


Figure 19.

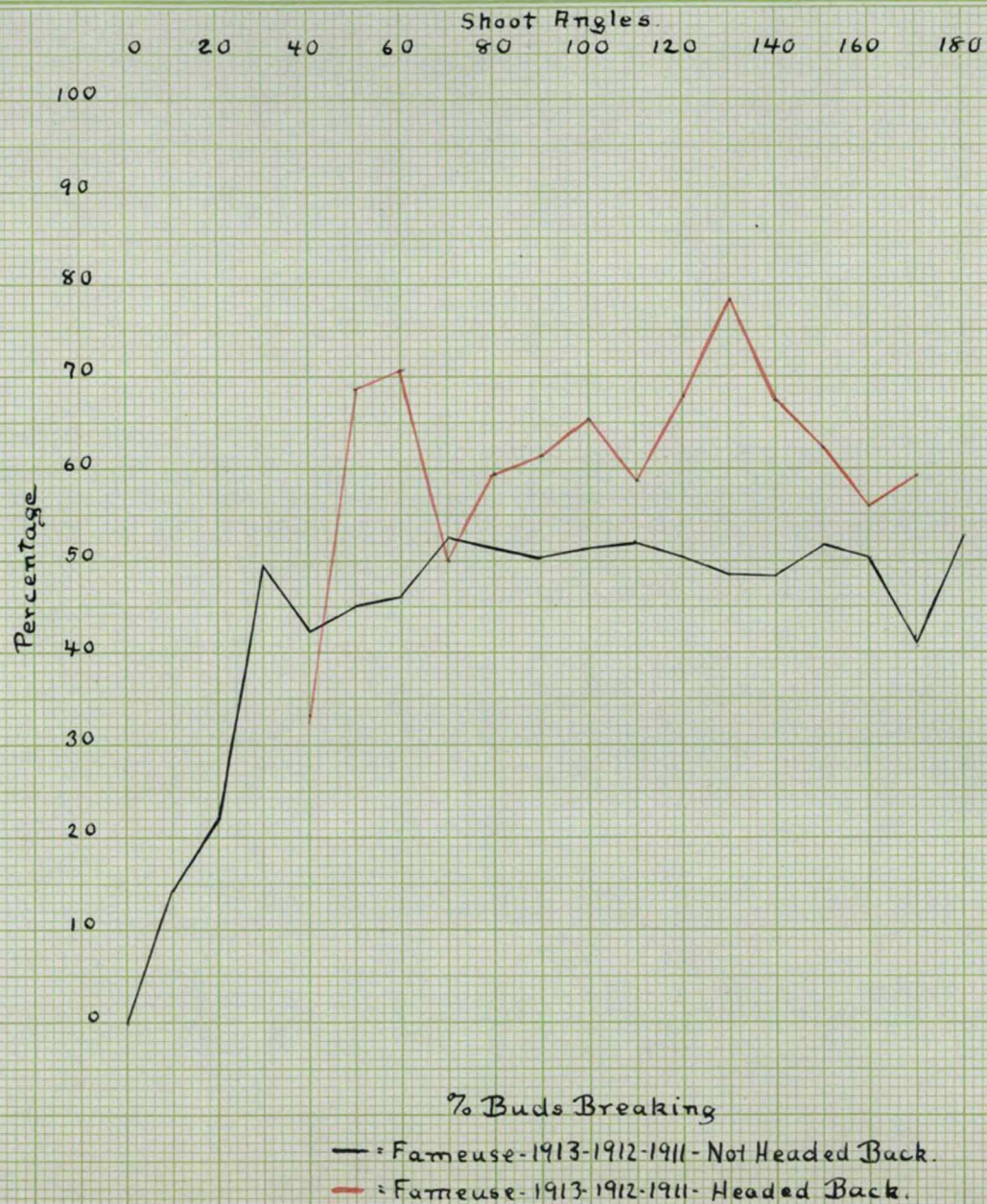


Figure 20

this being due to the larger number of vegetative branches that are formed at these angles, at least with cut back shoots. It will be noticed that while the per cent of fruit spurs decreases, the per cent of buds breaking increases, the difference between these two being the per cent of shoots.

As has been noted, the per cent of buds that break into vegetative branches is considerably higher than was the case in any of the previous tables. On comparing the upper portion curves with those for the lower portion of the shoots a marked difference is seen. In the latter the per cent of branches is very small, often being nearly zero for the variety. This only goes to prove what Bunyard⁵ says in his article on the physiology of pruning, to the effect that dormant buds are found at the base of the shoot. These were to a certain extent nourished by leaves which were shaded by those above and which were therefore not capable of forming sufficient food products for large strong buds. The leaves above these being the most favorably situated and being produced at an optimum time, as regards sunlight and heat, produce buds of great activity, or buds that later develop into fruit spurs. The leaves still higher are produced in the autumn, or during unfavorable conditions, and therefore wood buds are formed. In other words, shoots will be found at the extremity of a branch, fruit spurs along the central portion, and the dormant buds near the base.

Correlation coefficients are not large but bear practically the same relation to each other as in the other tables. They are as follows:-

TABLE XLI

Variety	Mean per- centage of buds breaking	Standard Deviation	Mean Shoot Angle	Standard Deviation	Correlation coefficient
Yellow New- town, young trees, 1913	70.53	22.34	134.81	20.59	.187
Wagener, 1913	88.38	14.52	149.66	19.69	.135
Wagener, 1912	90.17	12.33	164.43	12.60	.101
Shiawassee, 1913	37.00	34.50	125.00	31.81	.068
Fameuse, 1913	60.60	33.74	110.33	29.02	.208
Fameuse, 1912	49.26	28.88	105.15	34.72	.251

In the case of the lower portion of the branches we find that the curves for Yellow Newtown and Wagener rise in favor of the greater angles, showing considerable relationship in the case of the Yellow Newtown. Fameuse (1913) shows no evidence in either direction, while Shiawassee and Fameuse (1912) show quite opposite results.

Considering the group as a whole there is not so much relationship shown between the per cent of buds breaking and the angle of the shoot as there is in the case of the upper portions of the shoots. A striking point to notice, however, is the large

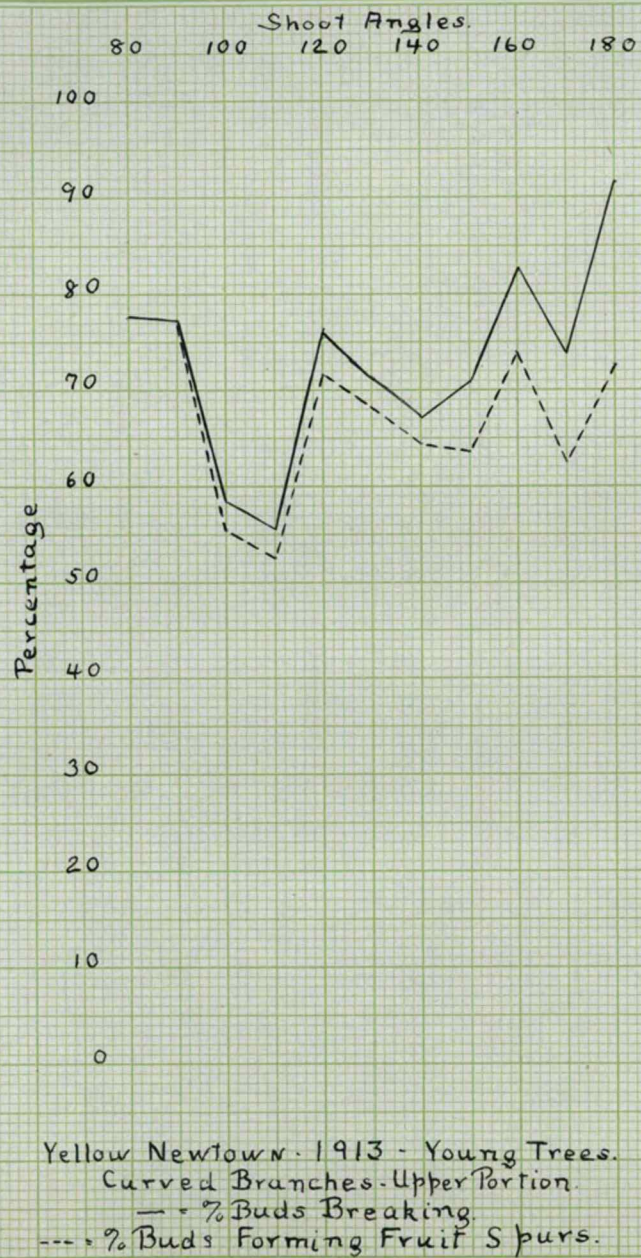


Figure 21.

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING AND
ANGLE OF SHOOTS IN YOUNG YELLOW NEWTOWN,--1913 GROWTH.
UPPER PORTIONS OF CURVED SHOOTS.

Shoot Angles.												
	80	90	100	110	120	130	140	150	160	170	180	Frequency
0				1								1
5												
10						1	1			1		3
15					1			1				2
20			1	1				1			1	4
25				1					1			2
30				1		1	1					3
35				1		3						4
40				2	1		2	1				6
45				1	1	1	1					4
50					3	3						6
55				1	2	2	1	2				8
60	1		1			3	1	2	1			9
65				3		5	4		2	1		15
70			1	4	1	1	5	2				14
75	1	1	1	1	6	2	6	3		1		22
80	1	1		1	3	6	6	4	2		1	25
85		1		2	4	3	3	2	1			16
90					2	4	2	2	2	2		14
95					3	5	1	1	2	2	3	17
100					3	3	2	1	1		4	14
Frequency	3	3	4	20	30	43	36	22	11	8	9	189

TABLE XLIII

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN YOUNG YELLOW NEWTOWN,--
1913 GROWTH. UPPER PORTIONS OF CURVED
SHOOTS.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
80	3	6.17	5.1	6.0	1.3	0	3.7	77.7	77.7
90	3	11.92	5.5	11.7	2.7	0	9.0	77.2	77.2
100	4	8.59	5.4	9.0	3.8	.2	5.0	58.4	55.6
110	20	10.72	6.2	12.3	5.5	.3	6.5	55.7	52.8
120	30	13.19	6.6	12.8	3.1	.5	9.2	75.5	71.8
130	43	14.10	7.0	13.9	4.0	.4	9.5	71.4	68.1
140	36	15.72	7.2	15.5	4.7	.4	10.4	67.1	64.5
150	22	16.12	7.9	15.7	4.5	1.2	10.0	71.0	63.7
160	11	19.67	8.4	18.5	3.3	1.5	13.7	82.3	74.0
170	8	19.23	8.3	18.8	4.9	2.1	11.8	74.0	62.6
180	9	22.43	9.4	20.0	1.7	3.8	14.5	91.6	72.8

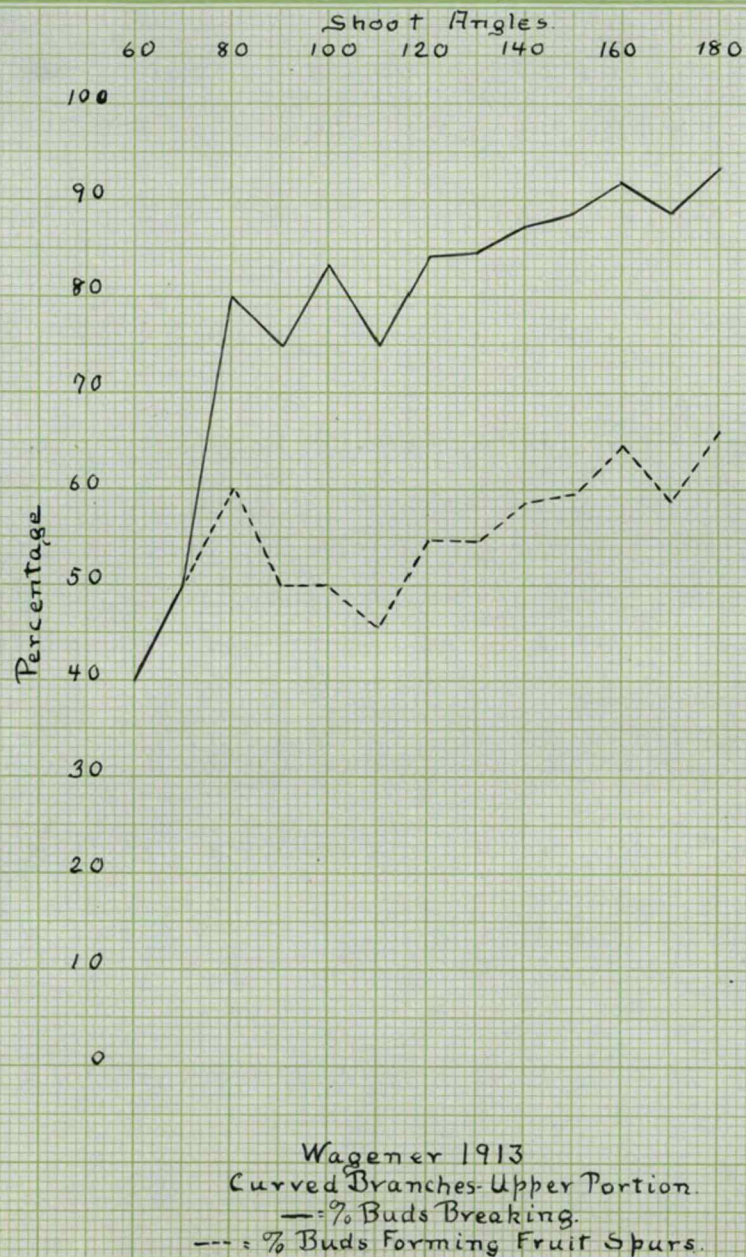


Figure 22.

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLES OF SHOOTS IN WAGENER,--1913. UPPER
PORTIONS OF CURVED SHOOTS THAT HAVE BEEN HEADED
BACK

Shoot Angles.														Frequency
	60	70	80	90	100	110	120	130	140	150	160	170	180	
0														
5														
10														
15														
20														
25														
30								1						1
35														
40	1													
45								1		1			1	3
50		1					1		1	1	2			6
55							1	1						2
60						1		1	1	4	1	1		9
65						1	2		4	1		6		14
70						1		2	3	2		2		10
75				1				1	3	2	2	3	1	13
80			1			1	2	2	2	3	6	2	1	20
85					1	1	4	5	2	6	4			23
90							6	3	7	11	8	9	5	49
95								1	1	1	4	2	2	11
100						1	3	14	26	28	28	21	14	135
Frequency	1	1	1	1	1	6	19	31	51	60	55	46	24	297

TABLE XLV

 TABLE SHOWING AVERAGE BRANCHES FOR THE
 GIVEN ANGLES IN WAGENER,--1913 GROWTH.
 UPPER PORTIONS OF CURVED SHOOTS THAT HAVE
 BEEN HEADED BACK.

 For key to columns see page 11.

1	2	3	4	5	6	7	8	9	10
60	1	4.50	10.5	5.0	3.0	0	2.0	40.0	40.0
70	1	2.50	8.6	4.0	2.0	0	2.0	50.0	50.0
80	1	4.75	13.0	5.0	1.0	1.0	3.0	80.0	60.0
90	1	5.00	7.0	4.0	1.0	1.0	2.0	75.0	50.0
100	1	5.75	13.2	6.0	1.0	2.0	3.0	83.3	50.0
110	6	10.10	12.1	8.0	2.0	2.3	3.7	75.0	45.8
120	19	8.46	12.4	7.6	1.2	2.2	4.2	84.0	54.8
130	31	10.07	12.4	8.3	1.2	2.6	4.5	84.7	54.7
140	51	10.12	12.9	8.6	1.1	2.5	5.0	87.3	58.6
150	60	12.59	12.8	10.1	1.1	3.0	6.0	88.9	59.3
160	55	13.22	13.6	10.5	.9	2.9	6.7	91.9	64.5
170	46	13.38	13.9	10.5	1.2	3.1	6.2	88.6	58.8
180	24	16.32	15.3	12.2	.8	3.3	8.1	93.2	66.0

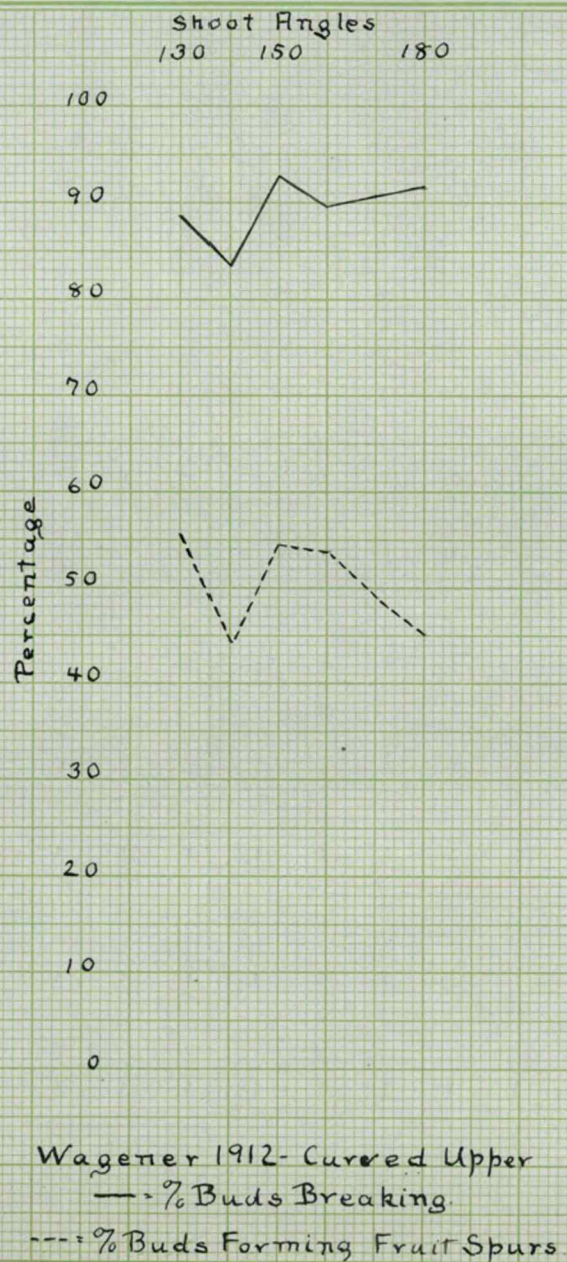


Figure 23.

TABLE XLVI

CORRELATION TABLE FOR PER CENT OF BUDS
BREAKING AND ANGLE OF SHOOTS IN WAGENER,
1912 GROWTH. UPPER PORTIONS OF CURVED
SHOOTS THAT HAVE BEEN HEADED BACK.

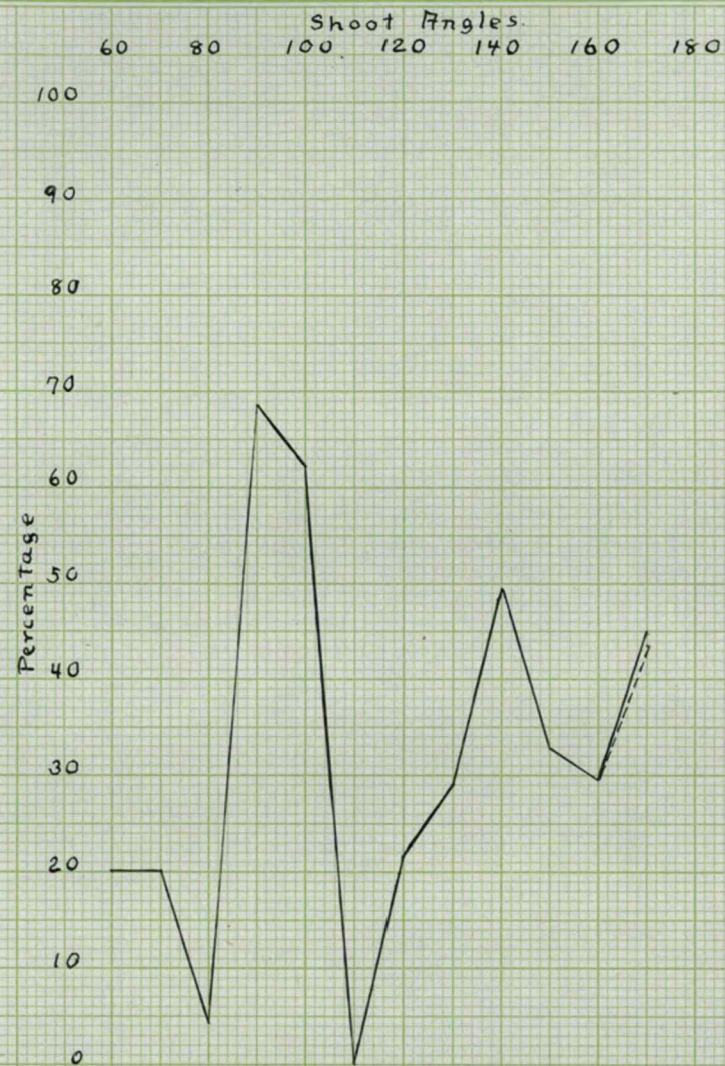
	Shoot Angles.						Frequency
	130	140	150	160	170	180	
0							
5							
10							
15							
20							
25							
30							
35							
40						1	1
45							
50		1		1	1		3
55							
60							
65					1		1
70		1					1
75				1	2	1	4
80			1		1		2
85		3		3	5	1	12
90	1	4	2	5	8	6	26
95					1	1	2
100		1	4	7	18	6	36
Fre-	1	10	7	17	37	16	88
quency							

TABLE XLVII

 TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN WAGENER,--1912 GROWTH. UPPER POR-
 TIONS OF CURVED SHOOTS THAT HAVE BEEN HEADED
 BACK

 For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
130	1	10.25	28.9	9.0	1.0	3.0	5.0	88.88	55.6
140	10	8.44	22.2	.4	1.2	2.9	3.3	83.8	44.6
150	7	12.05	22.7	9.7	.7	3.7	5.3	92.7	54.4
160	17	11.68	24.0	9.7	1.0	3.5	5.2	89.7	53.9
170	37	13.34	24.6	10.4	1.0	4.3	5.1	90.8	49.0
180	16	14.20	27.6	10.9	1.0	5.0	4.9	91.4	45.1



Shiawasse 1913
 Curved Branches - Upper Portion.
 — = % Buds Breaking.
 --- = % Buds Forming Fruit Spurs.

Figure 24.

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOTS IN SHIAWASSEE,--1913 GROWTH.
UPPER PORTIONS OF CURVED SHOOTS.

		Shoot Angles.													
		60	70	80	90	100	110	120	130	140	150	160	170	Frequency	
Per cent of buds breaking	0		1	5	1	1	1	2	2	3		1	2	19	
	5										1			1	
	10										1	1		2	
	15					1								1	
	20	1									1	1	1	4	
	25			1										1	
	30		1											1	
	35							1		1			1	3	
	40											1		1	
	45								1	1				2	
	50				1			1		2	2	1	1	8	
	55														
	60				1					1				2	
	65					1								1	
	70									1	1			2	
	75					1				1			1	3	
80															
85				1								1	2		
90									1				1		
95															
100				2	2				1	1				6	
Fre- quency		1	2	6	6	6	1	4	4	2	6	5	7	60	

TABLE XLIX

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN SHIAWASSEE,-- 1913 GROWTH. UPPER
 PORTIONS OF CURVED SHOOTS.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
60	1	2.50	4.9	5.0	4.0	0	1.0	20.0	20.0
70	2	5.13	4.3	5.0	4.0	0	1.0	20.0	20.0
80	6	3.85	4.1	4.0	3.8	0	.2	4.2	4.2
90	6	4.41	4.8	5.8	1.8	0	4.0	68.6	68.6
100	6	4.56	4.7	4.8	1.8	0	3.0	62.1	62.1
110	1	6.25	3.0	5.0	5.0	0	0	0	0
120	4	4.78	4.5	5.8	4.5	0	1.3	21.7	21.7
130	4	6.75	5.8	7.8	5.5	0	2.3	29.0	29.0
140	12	6.08	5.7	8.6	4.3	0	4.3	49.5	49.5
150	6	8.16	5.8	12.7	8.5	0	4.2	32.9	32.9
160	5	7.52	5.9	10.8	7.6	0	3.2	29.6	29.6
170	7	9.68	6.4	11.1	6.1	.1	4.9	44.9	43.6

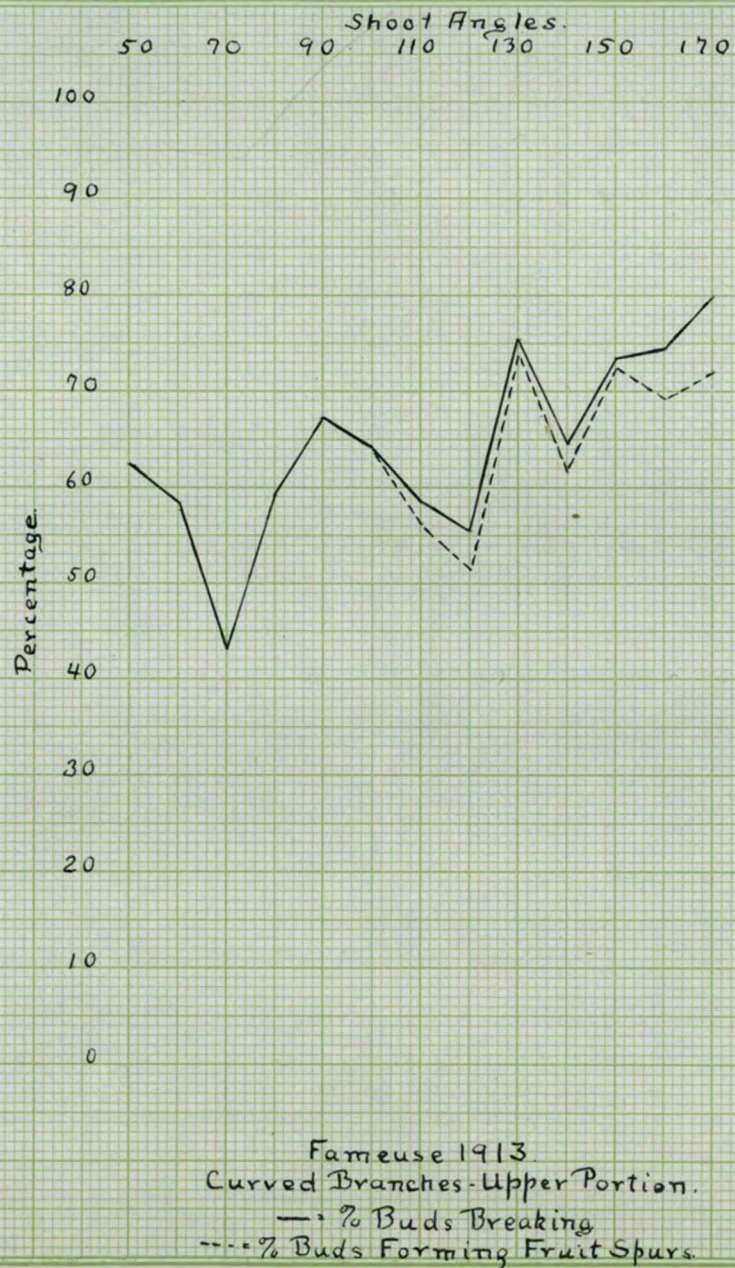


Figure 25.

TABLE L.

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOT IN FAMEUSE,--1913 GROWTH.
 UPPER PORTIONS OF CURVED SHOOT.

		Shoot Angles.															Frequency.
		50	60	70	80	90	100	110	120	130	140	150	160	170			
Per cent of buds breaking.	0			3		1			2	2					8		
	5																
	10				1				1	1					3		
	15			2					1	1		2			6		
	20								1						1		
	25			1	1		1								3		
	30					1									1		
	35	1				1			1						3		
	40				1					1					2		
	45				1								1	1	3		
	50		1				1		1	2		2			7		
	55										2		1		3		
	60						1		2						3		
	65		1	1		1		3	1						7		
	70																
	75									1	1				2		
	80	1				1	1	2	1			1			7		
	85			1		1			1	2					5		
	90			1		1		2	1	1					6		
	95											2	1		3		
	100			1	3	2	1	3	2	2	2		2	1	19		
Frequency		2	2	10	7	9	5	16	13	9	7	5	5	2	92		

TABLE LI

 TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN FAMEUSE,--1913 GROWTH. UPPER POR-
 TIONS OF CURVED SHOOTS.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
50	2	3.00	4.1	4.0	1.5	0	2.5	62.5	62.5
60	2	7.62	5.7	8.5	3.5	0	5.0	58.8	58.8
70	10	6.17	5.0	6.5	3.7	0	2.8	43.1	43.1
80	7	5.37	4.9	6.3	4.6	0	3.7	59.1	59.1
90	9	7.98	6.1	8.8	2.9	0	5.9	67.1	67.1
100	5	4.6	5.3	5.0	1.8	0	3.2	64.0	64.0
110	16	8.18	5.8	8.8	3.6	.2	5.0	58.6	56.4
120	13	6.52	5.8	7.8	3.5	.3	4.0	55.4	51.5
130	9	7.58	6.0	7.7	1.9	.1	5.7	75.4	73.9
140	7	7.89	6.4	10.9	3.9	.3	6.7	64.5	61.8
150	5	16.02	7.9	18.0	4.8	.2	13.0	73.4	72.2
160	5	8.40	6.1	7.8	2.0	.4	5.4	74.3	69.2
170	2	8.93	6.6	12.5	2.5	1.0	9.0	80.0	72.0

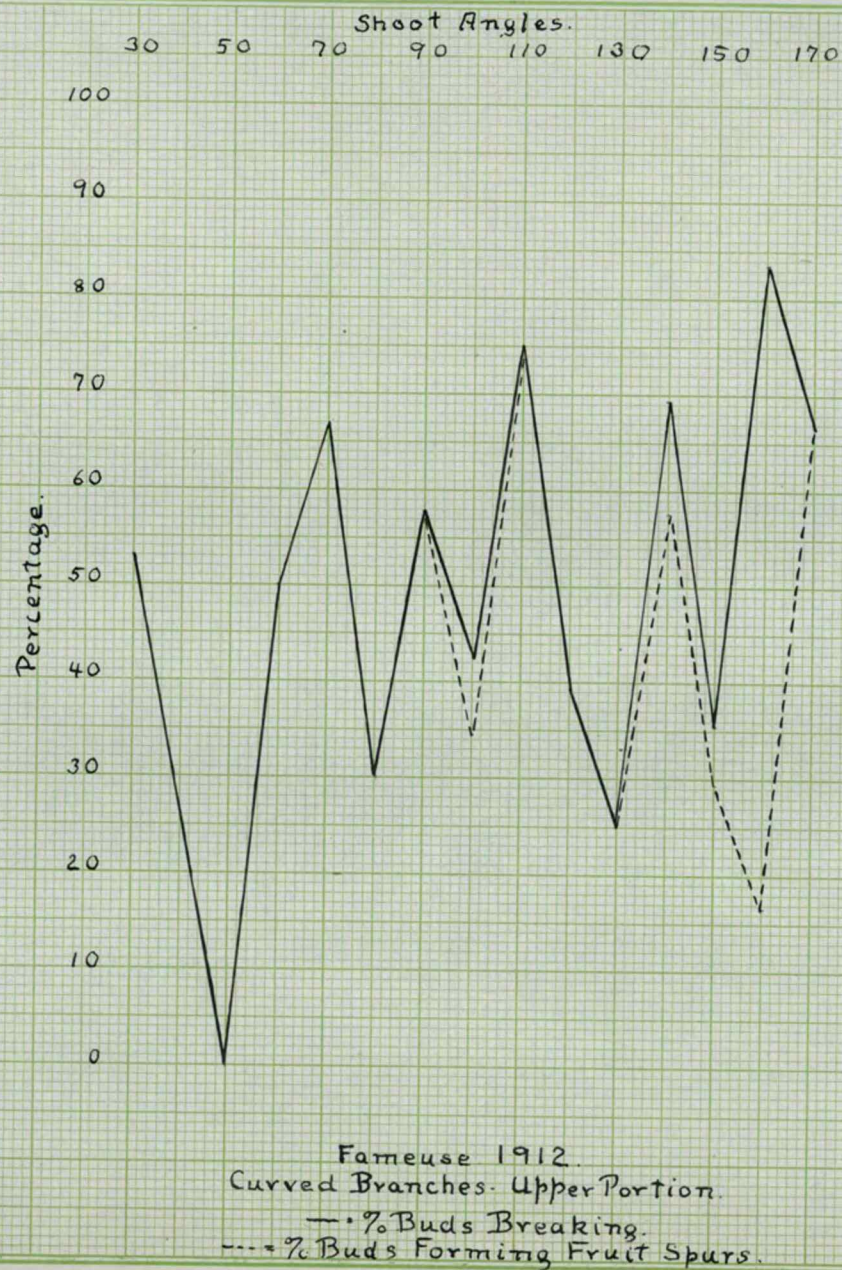


Figure 26.

TABLE LII

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOTS IN FAMEUSE,--1912 GROWTH.
 UPPER PORTIONS OF CURVED SHOOTS.

		Shoot Angles.																
		30	50	60	70	80	90	100	110	120	130	140	150	160	170	180	Frequency	
Per cent of buds breaking	0		1			1		1									3	
	5																	
	10																	
	15					1											1	
	20							1		1		1					3	
	25										1						1	
	30																	
	35					1				1							2	
	40													1			1	
	45				1												1	
	50			1													1	
	55	1					1										2	
	60								1								1	
	65						1			1				1		1	4	
	70																	
	75																	
	80				1	1							1				3	
85							1					1		1		3		
90																		
95																		
100									1								1	
Frequency		1	1	1	2	4	2	3	2	3	1	3	2	1	1		27	

TABLE LIII

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN ANGLES
IN FAMEUSE.-- 1912 GROWTH. UPPER PORTIONS OF
CURVED SHOOTS.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
30	1	14.47	5.9	15.0	7.0	0	8.0	53.4	53.4
50	1	2.12	7.3	4.0	4.0	0	0	0	0
60	1	8.12	5.3	8.0	4.0	0	4.0	50.0	50.0
70	2	8.25	6.1	9.0	3.0	0	6.0	66.6	66.6
80	4	4.22	5.1	5.0	3.5	0	1.5	30.0	30.0
90	2	8.37	5.7	9.5	4.0	0	5.5	57.9	57.9
100	3	6.50	8.3	8.7	5.7	.7	3.0	42.3	34.6
110	2	6.25	6.0	8.0	2.0	0	6.0	75.0	75.0
120	3	7.17	5.3	7.6	4.6	0	3.0	39.1	39.1
130	1	4.25	4.3	4.0	3.0	0	1.0	25.0	25.0
140	3	8.17	8.4	8.6	2.6	1.0	5.0	69.3	57.7
150	2	9.37	7.9	8.5	5.5	.5	2.5	35.3	29.4
160	1	6.25	9.5	6.0	1.0	4.0	1.0	83.4	16.7
170	1	19.12	9.3	15.0	5.0	1.0	9.0	66.6	60.0

percentage of dormant buds, and the almost total absence of vegetative shoots.

The coefficients correspond quite closely to the general trend of the curves and are as follows:-

TABLE LIV

Variety	Mean percentage of buds breaking	Standard Deviation	Mean Shoot Angle	Standard Deviation	Correlation Coefficients
Yellow Newtown, young. 1913	45.05	21.24	112.16	30.57	.339
Wagener, 1913	45.59	24.14	121.88	19.35	.049
Wagener, 1912	47.00	22.9	133.75	14.08	.058
Shiawassee, 1913	14.42	20.29	117.00	29.12	-.231
Fameuse, 1913	39.35	28.99	102.17	34.54	-.005
Fameuse, 1912	25.92	28.58	112.22	24.39	-.316

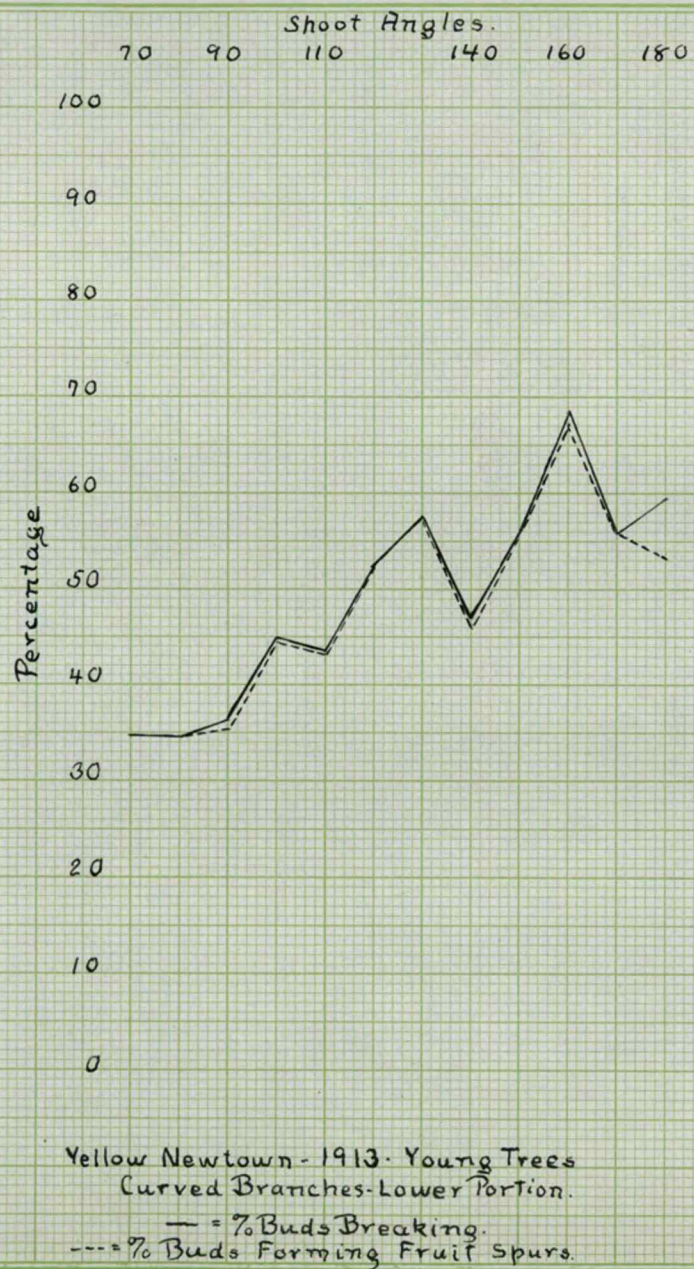


Figure 27.

1995 1996 1997 1998

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

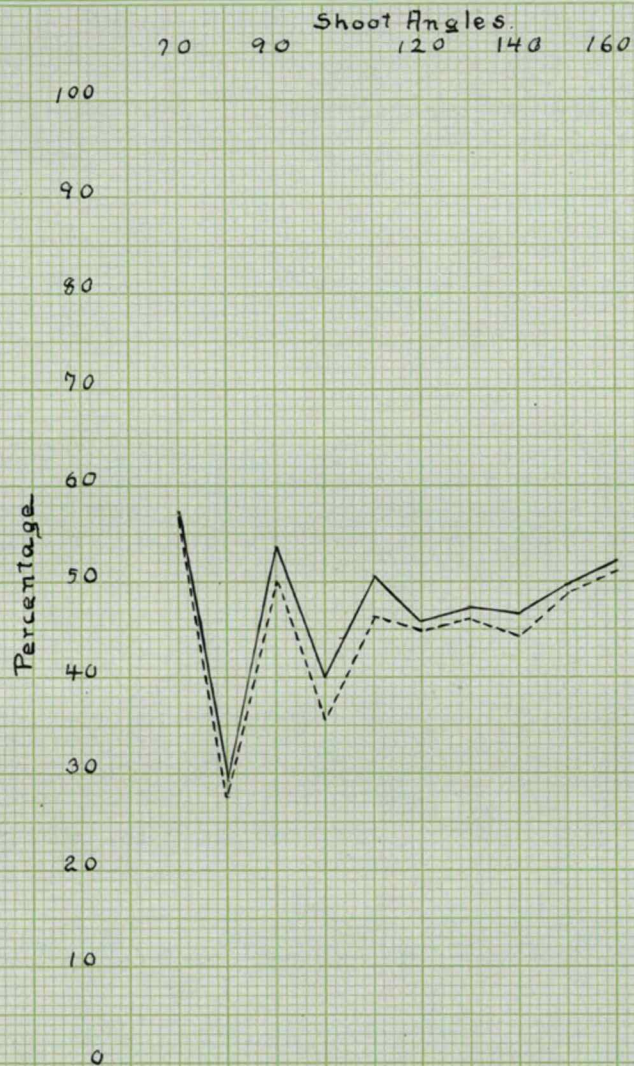
		Shoot Angles.													Frequency.
		70	80	90	100	110	120	130	140	150	160	170	180		
Per cent of buds breaking	0			1	1	2	1	1		1	1	1		9	
	5														
	10			1										1	
	15	1	1	1	2	2	1		1	1				10	
	20	2	1	4	3	1						1		12	
	25			1			2		3					6	
	30	2	2	2	3	2				1	1			13	
	35	3	3	1	2	5		1	2	1	1		1	20	
	40	2	2	2	2	4								12	
	45			2	5	5	5	1		2			1	21	
	50	1		3	3	1	3	1	2		1	1		16	
	55	1		2		3	1	2	1	1	2	1		14	
	60			1	1	4	1	1	1	1		1	2	13	
	65			2	2		3	1	1	1		3	2	15	
	70		1		1	2			1	1	2	1		9	
	75				1		1	1		3	1			7	
80				1		2				4		1	8		
85				1									1		
90										1			1		
95															
100				1							1		2		
Frequency	Fre-	12	11	23	30	30	20	8	13	14	14	8	7	190	

TABLE LVI

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN YOUNG YELLOW NEWTOWN,--1913 GROWTH.
LOWER PORTIONS OF CURVED SHOOTS.

For key to columns see Page 11.

1	2	3	4	5	6	7	8	9	10
70	12	9.34	6.3	9.6	6.3	0	3.3	34.8	34.8
80	11	8.71	7.0	9.2	6.0	0	3.2	34.7	34.7
90	23	9.79	7.0	9.6	6.1	.1	3.4	36.2	35.3
100	30	9.22	6.9	9.1	5.0	.03	4.1	44.9	44.7
110	30	10.41	7.1	9.9	5.6	.03	4.3	43.6	43.3
120	20	10.84	7.5	10.2	4.8	0	5.4	52.7	52.7
130	8	14.70	7.6	12.4	5.3	0	7.1	57.6	57.6
140	13	10.57	6.5	9.2	4.8	.1	4.3	47.0	46.2
150	14	12.62	7.8	11.2	4.9	0	6.3	56.1	56.1
160	14	13.45	7.9	12.6	4.0	.1	8.5	68.3	67.2
170	8	11.75	6.9	10.7	4.7	0	6.0	55.9	55.9
180	7	13.02	7.8	11.6	4.7	.7	6.2	59.3	53.1



Wagener 1913.
Curved Branches - Lower Portion.
— = % Buds Breaking.
--- = % Buds Forming Fruit Spurs.

Figure 28

CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
AND ANGLE OF SHOOTS IN WAGENER,--1913 GROWTH.
LOWER PORTIONS OF CURVED SHOOTS.

		Shoot Angles.												
		70	80	90	100	110	120	130	140	150	160	170	Frequency.	
Per cent of buds breaking	0		4		6	3	7	3	2	1	2		28	
	5													
	10				1								1	
	15				3	3	6	3	5	2			22	
	20				3					1			4	
	25			1	1	2	2	1	1	3			11	
	30			1	2		4	4	1	2			14	
	35			1	2	6	4	4	3	2			22	
	40		1		2	5	9	4	5	1			27	
	45		1	1	1	2	5	1	3	2	1		17	
	50		2	4	4	5	6	3	2	5	1		32	
	55				1		2	2	2		1		8	
	60	1		3	7	5	3	4	5	4	3		35	
	65				2	5	5	8	2		1		23	
	70			1	1	1	2	2	2	3	1		13	
	75				2	4	3	1	1	2			13	
	80			2		1	5	1	3	1	1		14	
85				2	2	3	1					8		
90							1					1		
95														
100					2	1			1			4		
Fre- quency	1	8	14	40	46	67	43	37	30	11		297		

TABLE LVIII

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN WAGENER,-- 1913 GROWTH.
LOWER PORTIONS OF CURVED SHOOTS.

For key to columns see Page 11

1	2	3	4	5	6	7	8	9	10
70	1	6.75	13.8	7.0	3.0	0	4.0	57.2	57.2
80	8	6.45	12.7	6.9	4.9	.1	1.9	29.2	27.6
90	14	5.16	12.3	5.6	2.6	.2	2.8	53.8	50.0
100	40	6.38	12.8	6.4	3.8	.3	2.3	40.0	35.7
110	46	7.01	12.5	6.8	3.4	.3	3.1	50.6	46.2
120	67	7.99	12.8	7.2	3.9	.1	3.2	46.0	45.0
130	43	8.71	13.8	7.3	3.9	.1	3.3	47.3	46.0
140	37	8.96	14.0	7.3	4.0	.1	3.2	46.7	44.1
150	30	8.89	19.3	10.5	5.3	.1	5.1	49.8	48.9
160	11	11.20	14.9	8.7	4.2	.1	4.4	52.1	51.1

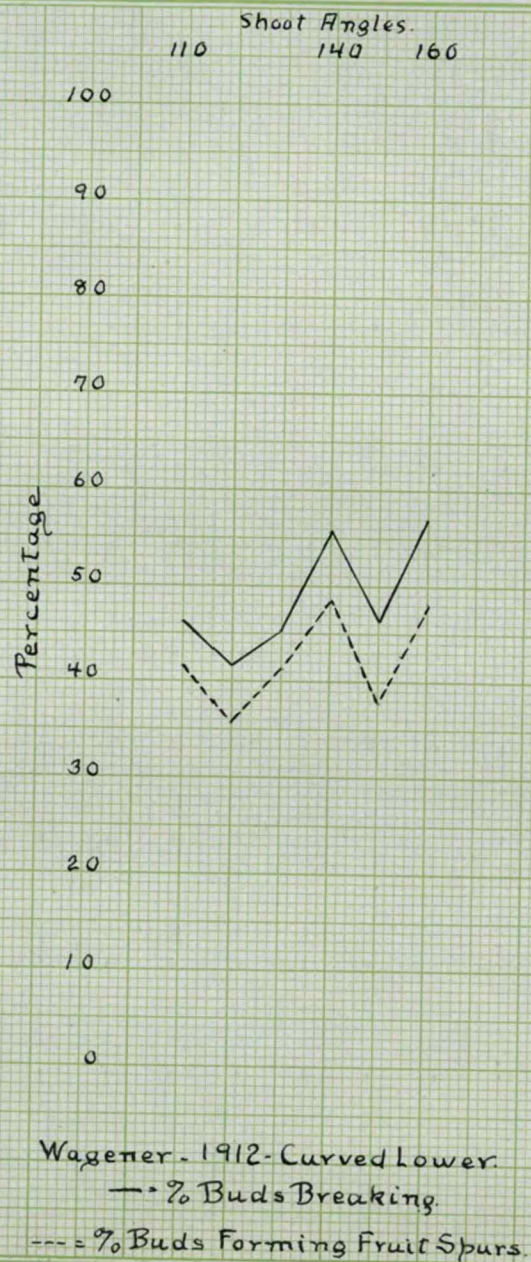


Figure 29.

TABLE LIX.

 CORRELATION TABLE FOR PER CENT OF BUDS
 BREAKING AND ANGLE OF SHOOTS IN WAGENER,
 1912 GROWTH. LOWER PORTIONS OF CURVED
 SHOOTS.

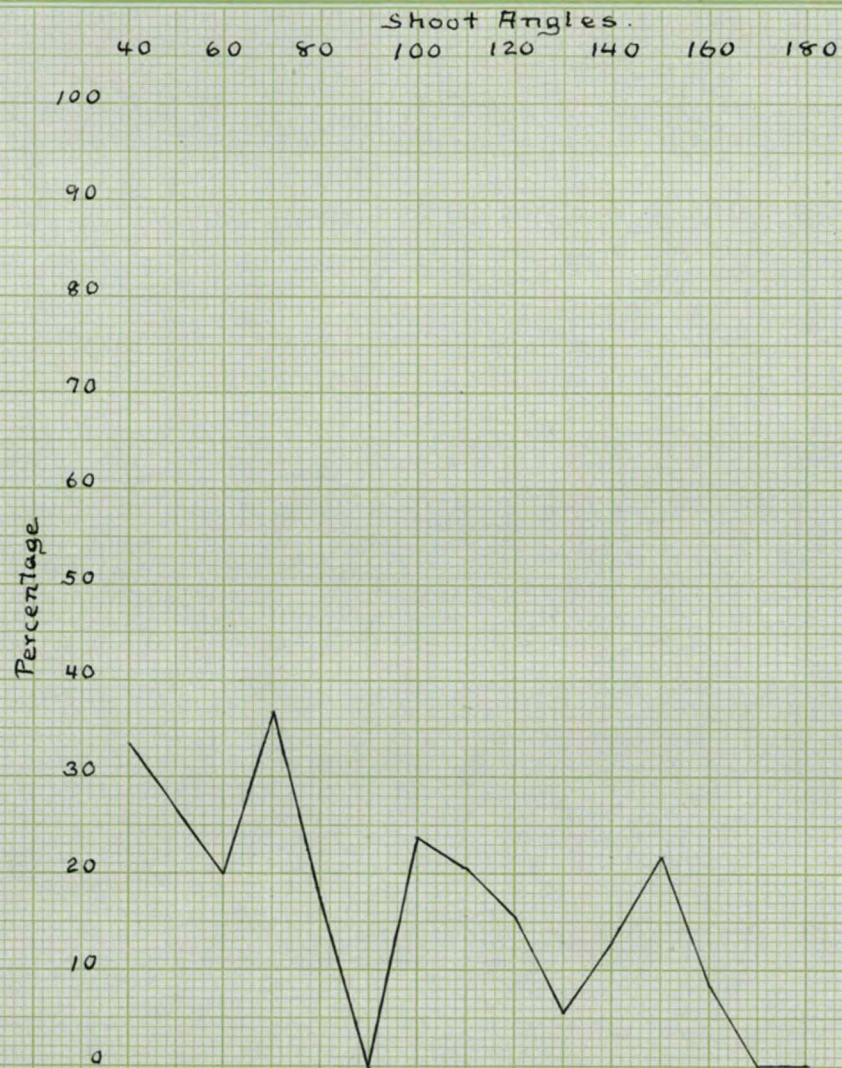
	Shoot Angles.						Frequency.
	110	120	130	140	150	160	
0	1	1		1	1		4
5							
10							
15	1			1	2		4
20		2	3	2		1	8
25		1	1	1	1		4
30		1	1	1	1		4
35	1	1	1	1	1		5
40			1	2	2		5
45		1	2	1	2		6
50	6	1	6	3	2	1	19
55							
60	2		3	1	1	1	8
65	1			3	1		5
70			1	2		1	4
75		2		1			3
80		1	1	1	2		5
85							
90				1			1
95							
100		1		1	1		3
Fre- quency	12	12	20	23	17	4	88

TABLE LX

TABLE SHOWING AVERAGE BRANCHES FOR THE
GIVEN ANGLES IN WAGENER,--1912 GROWTH.
LOWER PORTIONS OF CURVED SHOOTS.

For key to columns see page 11.

1	2	3	4	5	6	7	8	9	10
110	12	6.09	23.8	5.4	2.9	.25	2.3	46.2	41.5
120	12	6.65	21.9	5.6	3.3	.33	2.0	41.8	35.8
130	20	7.06	24.6	6.3	3.5	.25	2.6	45.2	41.3
140	23	7.79	25.0	6.5	2.9	.48	3.1	55.7	48.3
150	17	7.10	26.5	6.4	3.4	.53	2.4	46.3	37.9
160	4	7.69	27.8	6.3	3.0	.25	3.0	52.0	48.0



Shiawassee 1913
 Curved Branches. Lower Portion.
 — % Buds Breaking
 ---- % Buds Forming Fruit Spurs.

Figure 30.

TABLE LXI.

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOTS IN SHIAWASSEE,--1913 GROWTH.
 LOWER PORTIONS OF CURVED SHOOTS.

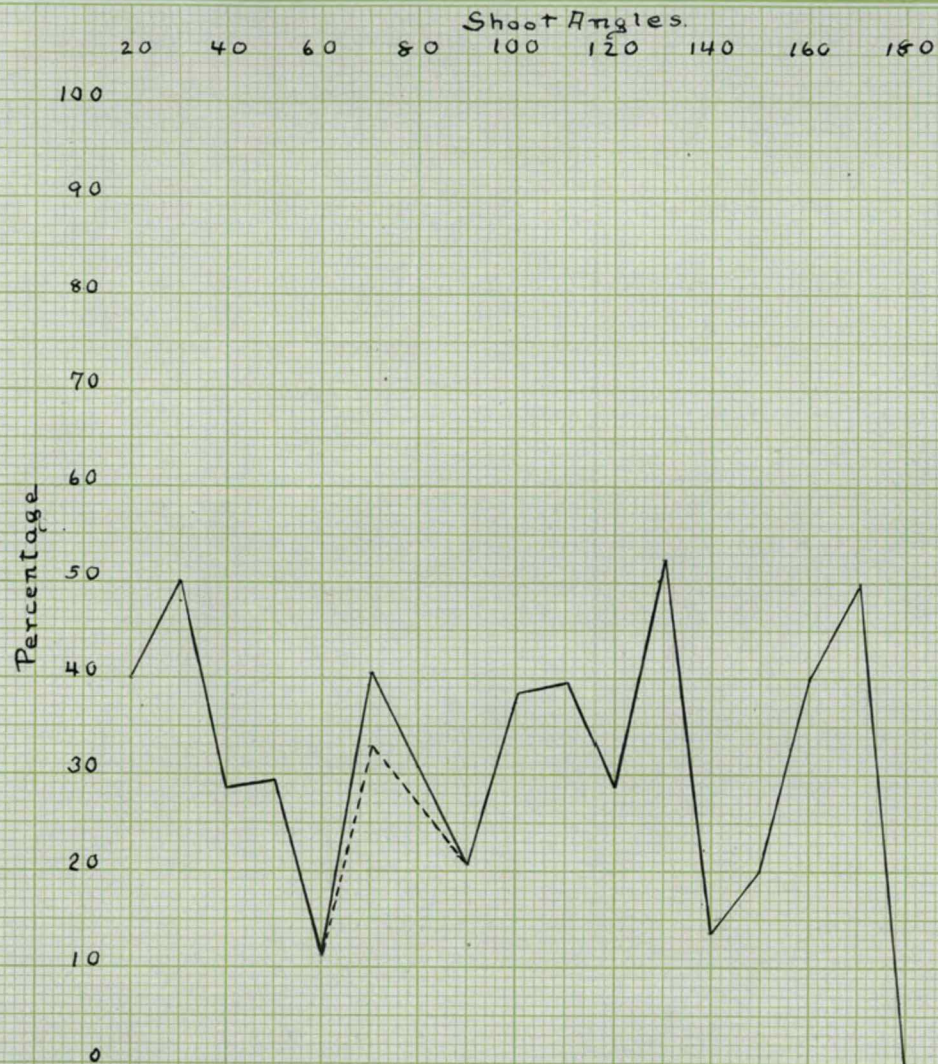
Shoot Angles.																	
	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	Fre- quency	
0				1	2	3	3		6	5	3	6	2	1	1	2	35
5																	
10																	
15								1	1	1							3
20			1				1						1	1			4
25					1			1	1				1				4
30																	
35	1				1				1		2						5
40							2										2
45													1				1
50				2				1	1								4
55																	
60																	
65								1									1
70																	
75							1										1
80																	
85																	
90																	
95																	
100																	
Fre- quency	1	1	3	4	3	7	10	9	4	8	5	2	1	2	60		

TABLE LXII

 TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN SHIAWASSEE,--1913 GROWTH. LOWER PORTIONS
 OF CURVED SHOOTS.

For key to columns see page 11.

1	2	3	4	5	6	7	8	9	10
40	1	2.00	4.9	3.0	2.0	0	1.0	33.3	33.3
60	1	3.87	5.3	5.0	4.0	0	1.0	20.0	20.0
70	3	2.66	5.1	3.6	2.3	0	1.3	36.7	36.7
80	4	3.41	4.2	4.3	3.5	0	.8	17.6	17.6
90	3	3.33	5.0	6.3	6.3	0	0	0	0
100	7	4.77	5.9	6.6	5.0	0	1.6	23.9	23.9
110	10	4.25	4.7	4.9	3.9	0	1.0	20.4	20.4
120	9	4.32	5.6	5.0	4.2	0	.89	15.6	15.6
130	4	4.69	5.3	4.5	4.3	0	.2	5.6	5.6
140	8	4.70	6.1	5.8	5.0	0	.8	13.0	13.0
150	5	6.07	5.2	6.4	5.0	0	1.4	21.9	21.9
160	2	4.81	5.3	6.0	5.5	0	.5	8.3	8.3
170	1	1.75	4.0	2.0	2.0	0	0	0	0
180	2	4.31	5.0	3.0	3.0	0	0	0	0



Fameuse - 1913
 Curved Branches-Lower Portion.
 — = % Buds Breaking.
 --- = % Buds Forming Fruit Spurs.

Figure 31.

TABLE LXIII

 CORRELATION TABLE FOR PER CENT OF BUDS BREAKING
 AND ANGLE OF SHOOT IN FAMEUSE,--1913. GROWTH.
 LOWER PORTIONS OF CURVED SHOOT.

	Shoot Angles																	Frequency
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
0				3	1	2	2	3	5	3	1		4	1			2	27
5																		
10							1						1					2
15						2	2	1	1	2		1	1					10
20					1			2			2							5
25			1			1		1	1		1							5
30										1								1
35			1				1											2
40	1									3					1	2		7
45								1			1							2
50		2		1			2	1	4				2	1				13
55											1					1		2
60									1			1				1		3
65							1		2	1		1	1					6
70												1						
75									1									1
80							1			1								2
85																		
90																		
95																		
100						2				1								3
Fre- quency	1	2	2	4	2	7	10	9	15	12	6	4	9	2	1	4	2	92

TABLE LXIV

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
ANGLES IN FAMEUSE,-- 1913 GROWTH. LOWER POR-
TIONS OF CURVED SHOOTS.

For key to columns see page 11.

1	2	3	4	5	6	7	8	9	10
20	1	3.75	4.5	5.0	3.0	0	2.0	40.0	40.0
30	2	2.87	5.9	4.0	2.0	0	2.0	50.0	50.0
40	2	2.31	5.3	3.5	2.5	0	1.0	28.6	28.6
50	4	5.09	5.4	6.0	4.2	0	1.8	29.3	29.3
60	2	3.80	6.6	4.5	4.0	0	.5	11.1	11.1
70	7	4.55	6.4	5.3	3.1	.5	1.7	40.5	32.9
80	10	3.84	5.7	4.6	3.2	0	1.4	30.9	30.9
90	9	4.59	5.6	6.0	4.8	0	1.2	20.8	20.8
100	15	4.70	5.2	5.3	3.3	0	2.0	37.5	37.5
110	12	5.82	6.8	6.8	4.1	0	2.7	39.5	39.5
120	6	7.64	5.8	7.5	5.3	0	2.2	28.9	28.9
130	4	4.94	6.8	5.2	2.5	0	2.7	52.4	52.4
140	9	6.11	5.9	7.2	6.2	0	1.0	13.8	13.8
150	2	7.12	5.2	7.5	6.0	0	1.5	20.0	20.0
160	1	6.75	6.6	5.0	3.0	0	2.0	40.0	40.0
170	4	5.62	6.4	6.5	3.25	0	3.25	50.0	50.0
180	2	3.44	4.3	5.0	5.0	0	0	0	0



Figure 32.

TABLE LXV.

 CORRELATION TABLE FOR PER CENT OF BUDS
 BREAKING AND ANGLE OF SHOOTS IN FAMEUSE,
 1912 GROWTH. LOWER PORTIONS OF CURVED
 SHOOTS.

		Shoot Angles.															Frequency
		50	60	70	80	90	100	110	120	130	140	150	160	170			
Per cent of buds breaking	0	1					2	2	2	1	1			1	10		
	5																
	10									1					1		
	15						1	1			1		1		4		
	20																
	25								1						1		
	30																
	35							1		1					2		
	40																
	45			1	1										2		
	50							1	1						2		
	55							1							1		
	60			1											1		
	65				1										1		
	70																
	75																
	80																
	85						1								1		
	90																
	95																
	100						1								1		
Fre- quency		1			2	2	5	6	4	3	2		1	1	27		

TABLE LXVI

TABLE SHOWING AVERAGE BRANCHES FOR THE GIVEN
 ANGLES IN FAMEUSE,--1912 GROWTH. LOWER POR-
 TIONS OF CURVED SHOOTS.

For key to columns see page 11.

1	2	3	4	5	6	7	8	9	10
50	1	7.25	5.9	7.0	7.0	0	0	0	0
80	2	5.5	6.4	6.0	3.0	0	3.0	50.0	50.0
90	2	5.87	7.8	7.5	3.5	0	4.0	53.3	53.3
100	5	3.25	5.3	5.0	3.4	.2	1.4	32.0	28.0
110	6	6.27	7.0	8.1	5.3	0	2.8	34.7	34.7
120	4	4.88	7.3	5.8	4.8	.2	.8	17.4	13.0
130	3	6.12	7.9	6.6	5.62	0	1.0	15.0	15.0
140	2	4.12	5.2	5.5	5.0	0	.5	9.1	9.1
160	1	5.5	3.7	7.0	6.0	0	1.0	14.3	14.3
170	1	7.5	5.0	7.0	7.0	0	0	0	0

DISCUSSION OF DATA PRESENTED.

From the data that have been presented it is evident that there is a relationship existing between the angle of the shoot and the character of the buds it produces, or at least between the angle of the shoot and the type of growth resulting from these buds. In the varieties which naturally exhibit an upright form this is especially marked, while in the varieties of spreading habit there seems to be a point very close to the mean angle of the shoots where the greatest number of fruit buds is to be found. In no case, where there was a large enough frequency to largely avoid experimental error, was there any evidence showing the superiority as future fruiting branches of shoots growing at an angle below the horizontal.

This is contrary to the ideas of some of the early horticulturists cited in the introduction. It will be noticed, however, that in the experiment and experiences upon which former opinions were based, the shoots were bent or inclined artificially to a more horizontal or downward direction. Herein lies the difference perhaps. Bailey⁸ in his Pruning Book says:-

"Bending the shoot to a horizontal or deflexed position tends to lessen growth, perhaps because of its position, but chiefly because of the kinking or modification of the tissues at the bend." This "kinking" which takes place at the bend is bound to restrict the flow of sap in the shoot and instead of being conducted to other portions of the tree, will be used in the shoot itself in the formation of fruit buds. It would have an effect

similar to that of ringing, but not to so marked a degree. A limb growing naturally on a tree at a depressed angle would not have any action upon it similar to this to cause fruiting. It would seem that the sap would be as free to flow in it as in any other portion of the tree. Furthermore, branches at these lower angles have characteristics which, as will be shown later, are not conducive to maximum fruit spur formation.

RELATION OF ANGLE OF SHOOT TO LENGTH OF SHOOT.

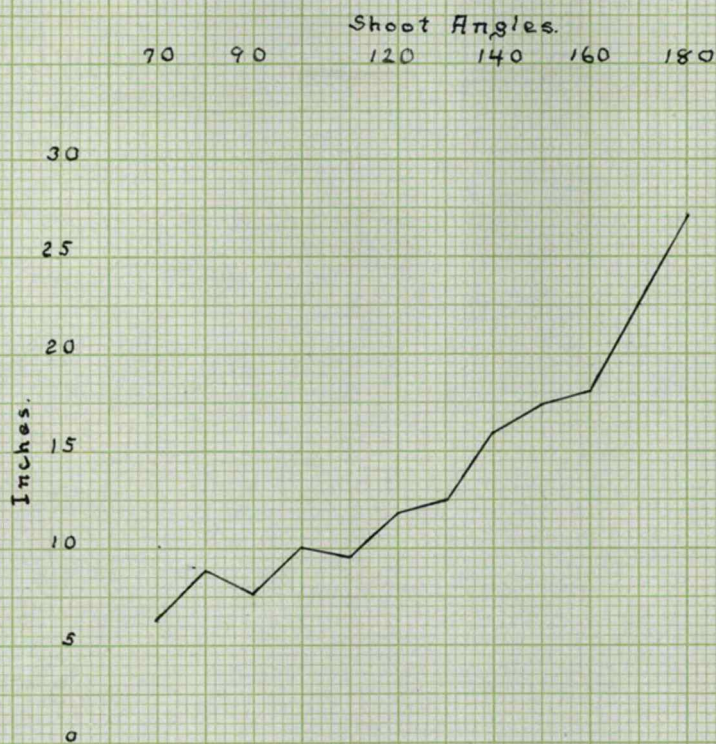
The effect of the angle upon the length of shoots in plants has frequently been mentioned in botanic and horticultural literature. Dr. Ludwig Jost⁹ writes: "Growth in length is in general markedly influenced by gravity. Thus it has been clearly established that "Chars" and "Phycomyces" (Elving 1880; Richter, 1894) grow more slowly when inverted than when in a normal position, and other plants behave in a similar manner."

Another interesting reference is found in Hovey's "Magazine of Horticulture" for 1862. In speaking of cordon training fruit trees the Rev. T.C. Brehant¹⁰ writes: "Another method of strengthening a weak branch is to untie it from the wall, and allow it to swing loosely in the free play of sun and air. Of course, then to tie down a branch has a contrary effect, and the more we approach the horizontal position, not so speak of the extreme method of bending it downwards altogether, the more the branch is checked in its development outwards. So, if it is desired, to lengthen a branch, it must be directed upwards, and a branch tied, for a season, vertically, and exposed at the same time, in wall trees,

to the free action of light and air, will grow much more rapidly than another tied to the wall, and carried into a horizontal line."

In this work similar results were obtained. On the average, the more vertical the shoot, the greater is its length. The foregoing tables present data showing the average length of the shoots for each angle in all of the varieties, and Figures 33, 34, 35, 36, and 37 represent in plotted forms these values for the 1913 and 1912 growth of all the different varieties studied. Yellow Newtown and Wagener showed the greatest increase in length as the angle increased. This would naturally be expected as the growth ranged from a few inches to over three feet in the young trees, allowing a curve to be constructed that would demonstrate the relationship very strikingly. While there is an increase as well in the older trees, the difference in the lengths is so small that it is not brought out so strikingly unless the tables are read in conjunction with the graphs.

Figure 33.



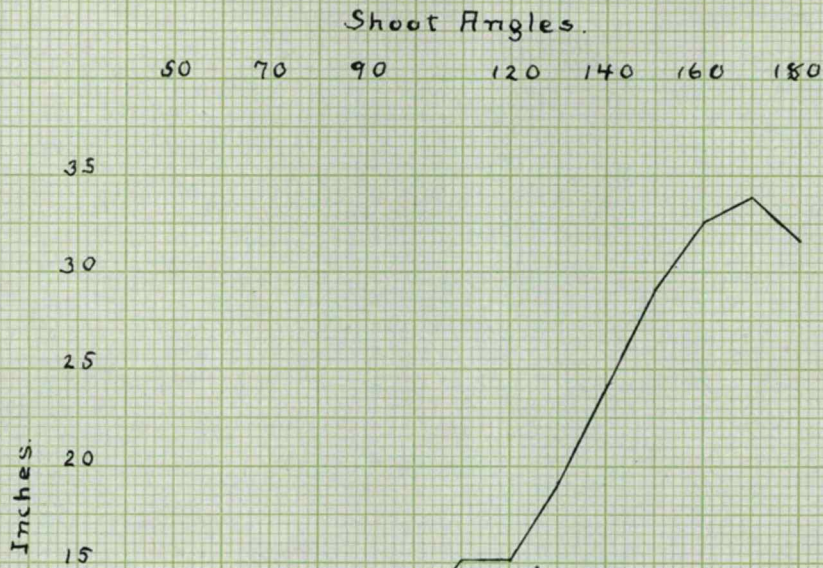
Wagener 1913 Cut Back



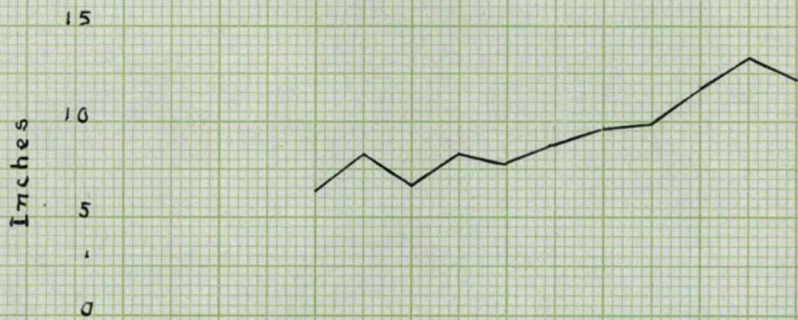
Wagener 1912 Cut Back

Average Lengths Per Angle.

Figure 34.



Yellow Newtown-1913-Young Trees.



Yellow Newtown-1912-Young Trees-Headed Back.

Average Lengths Per Angle.

Figure 35.

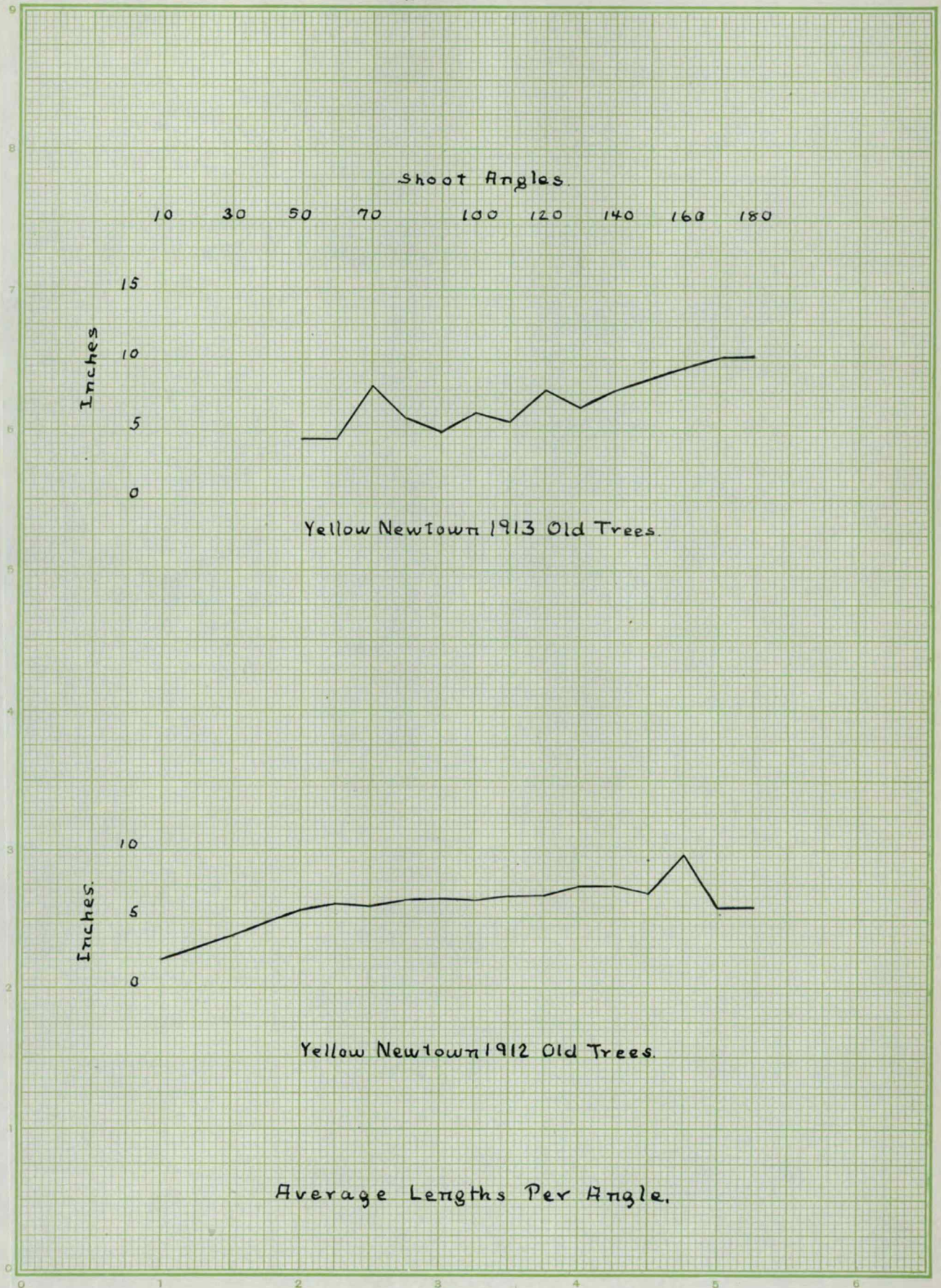
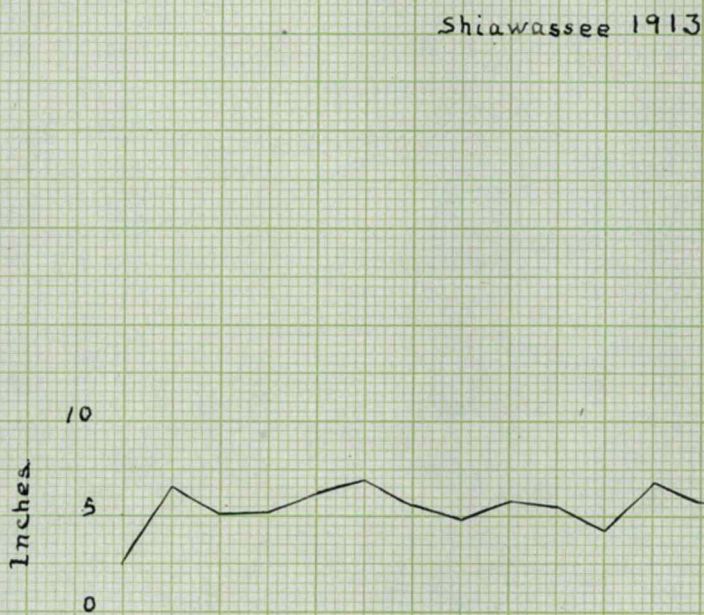
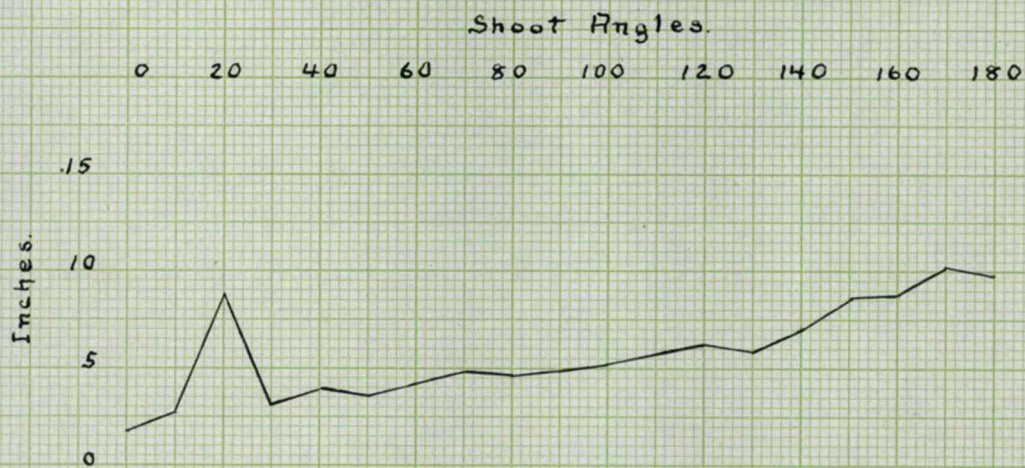


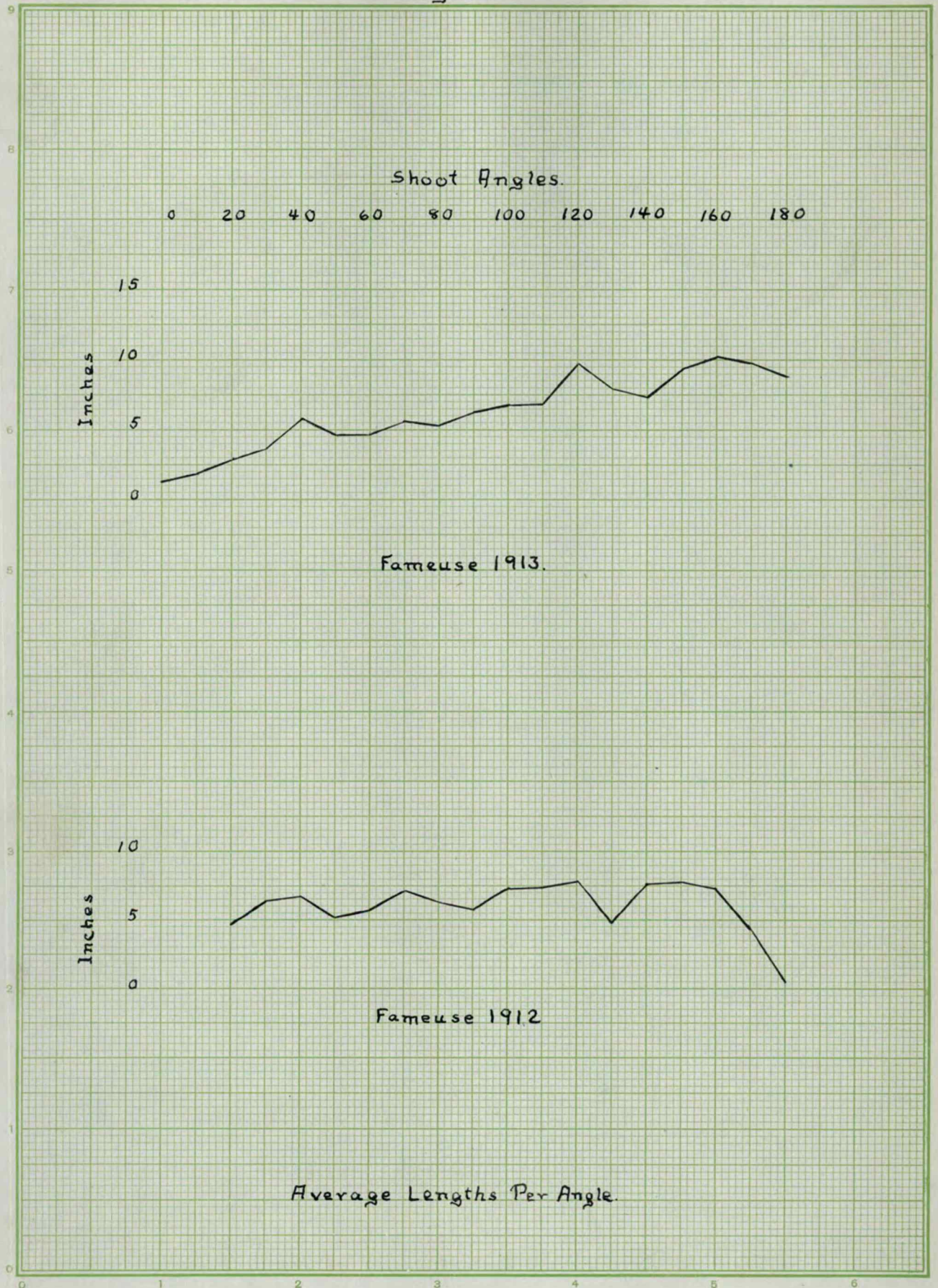
Figure 36



Shiawassee 1912

Average Lengths Per Angle.

Figure 37.



RELATION OF ANGLES OF SHOOTS TO THEIR DIAMETERS

Diameters of branches show a strong correlation with the angles at which they are found. Especially is this the case with the young Yellow Newtowns and the Wageners. Here, as the diameter increases the more upright the branches become. While the same principle holds in the case of the old Yellow Newtowns, Shiawasse, and Fameuse, the curves on the same scale (Figs. 38, 39, 40, 41, 42, and 43) do not bring it out so clearly, due to the fact that the increase is less in actual millimeters and is not comparatively as great as in the former. This can be explained by the fact that the increase in length is small per degree of angle and the accompanying increase in diameter is also small. It is evident from the tables that an increase in length means an increase in diameter, or in other words, the two go hand in hand.

Figure 38

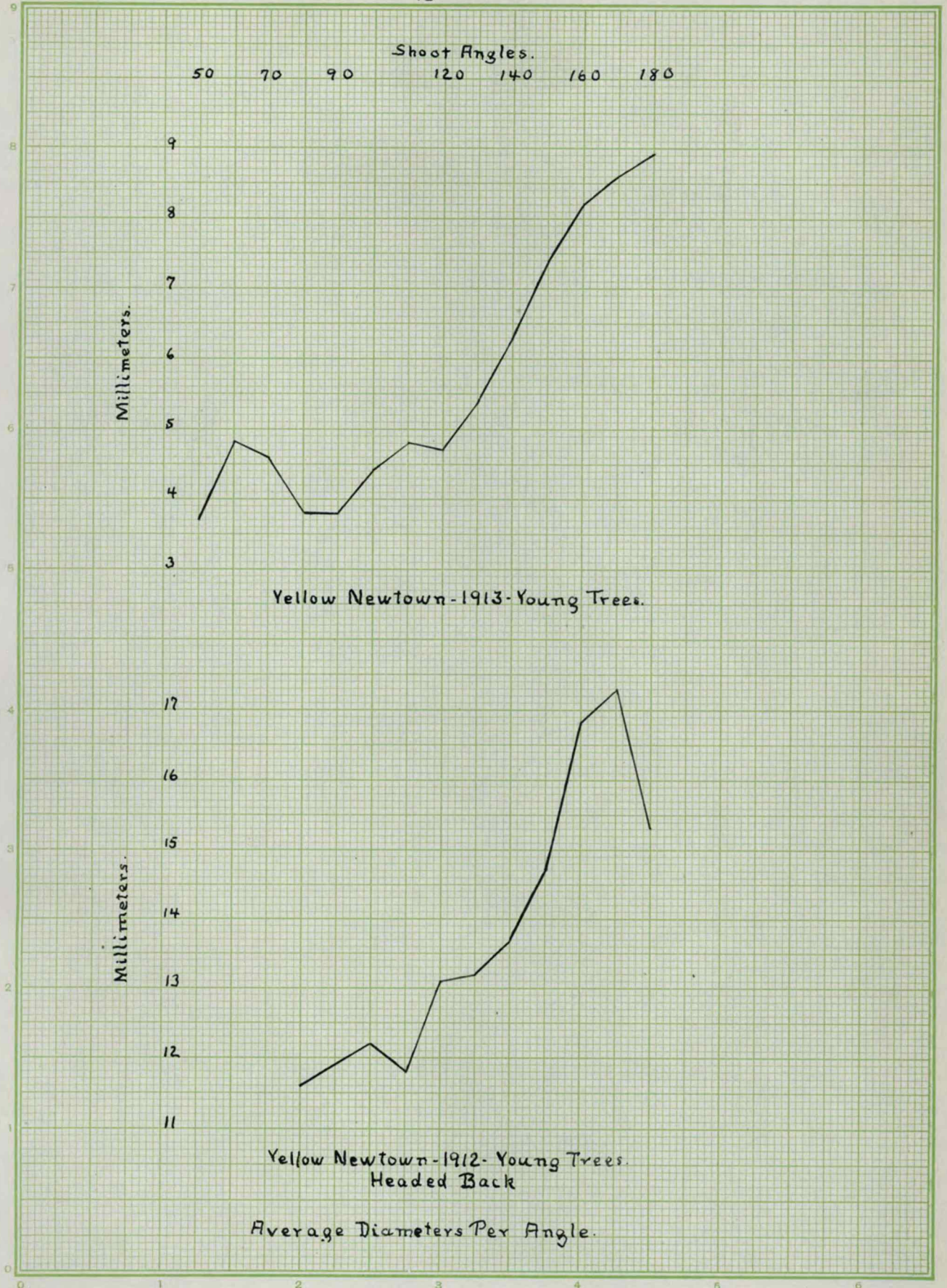


Figure 39

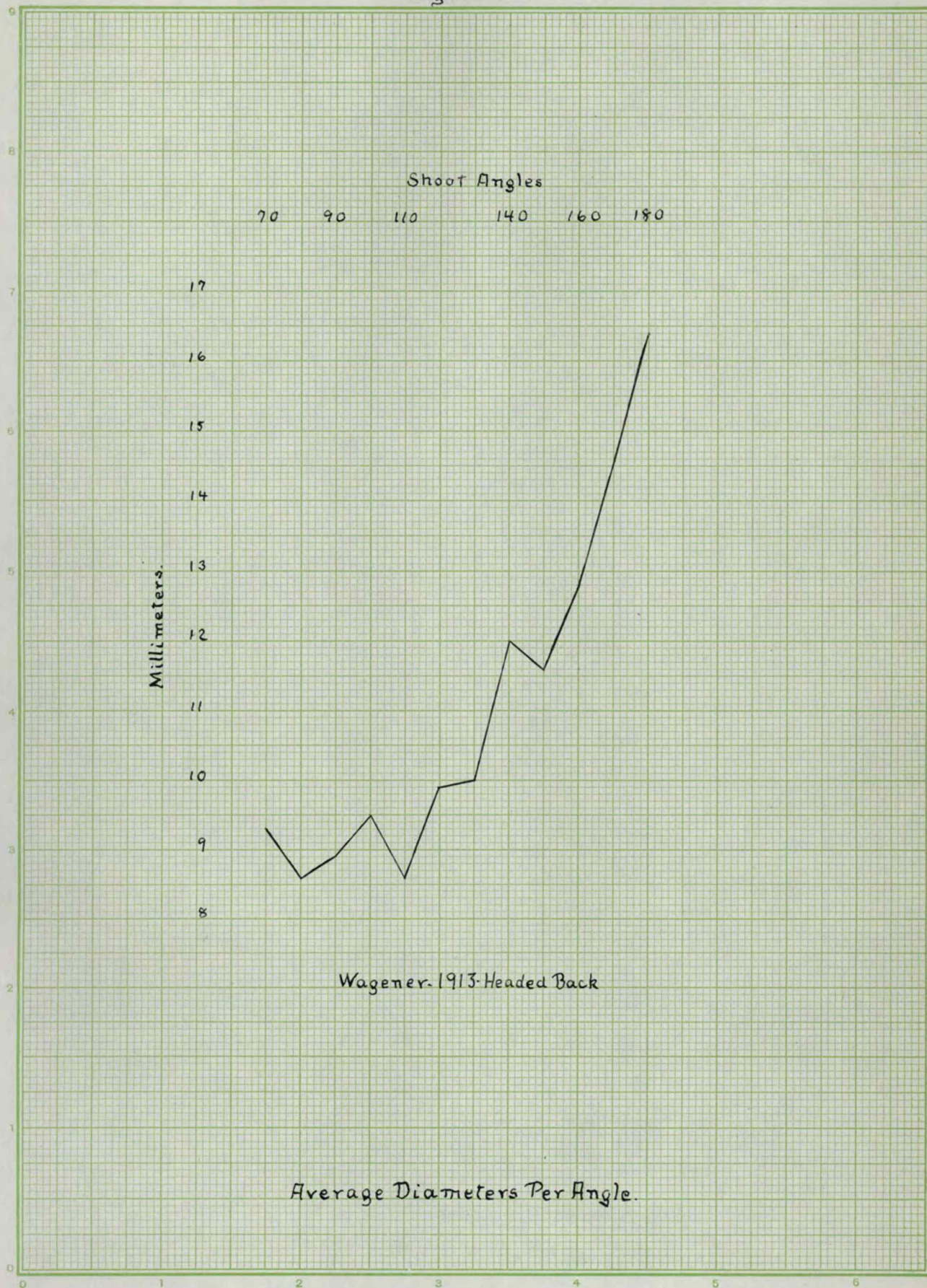


Figure 40.

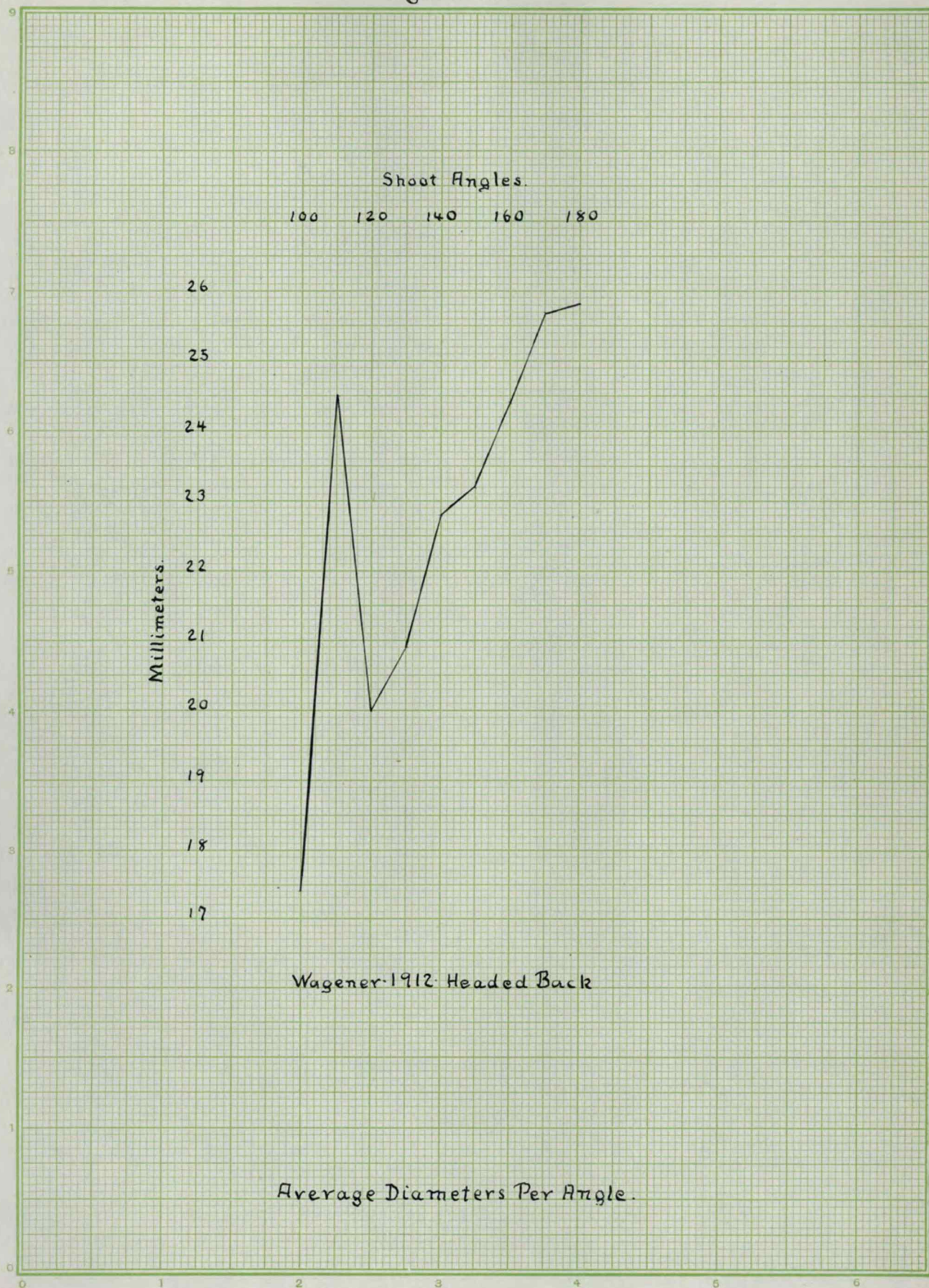


Figure 41.

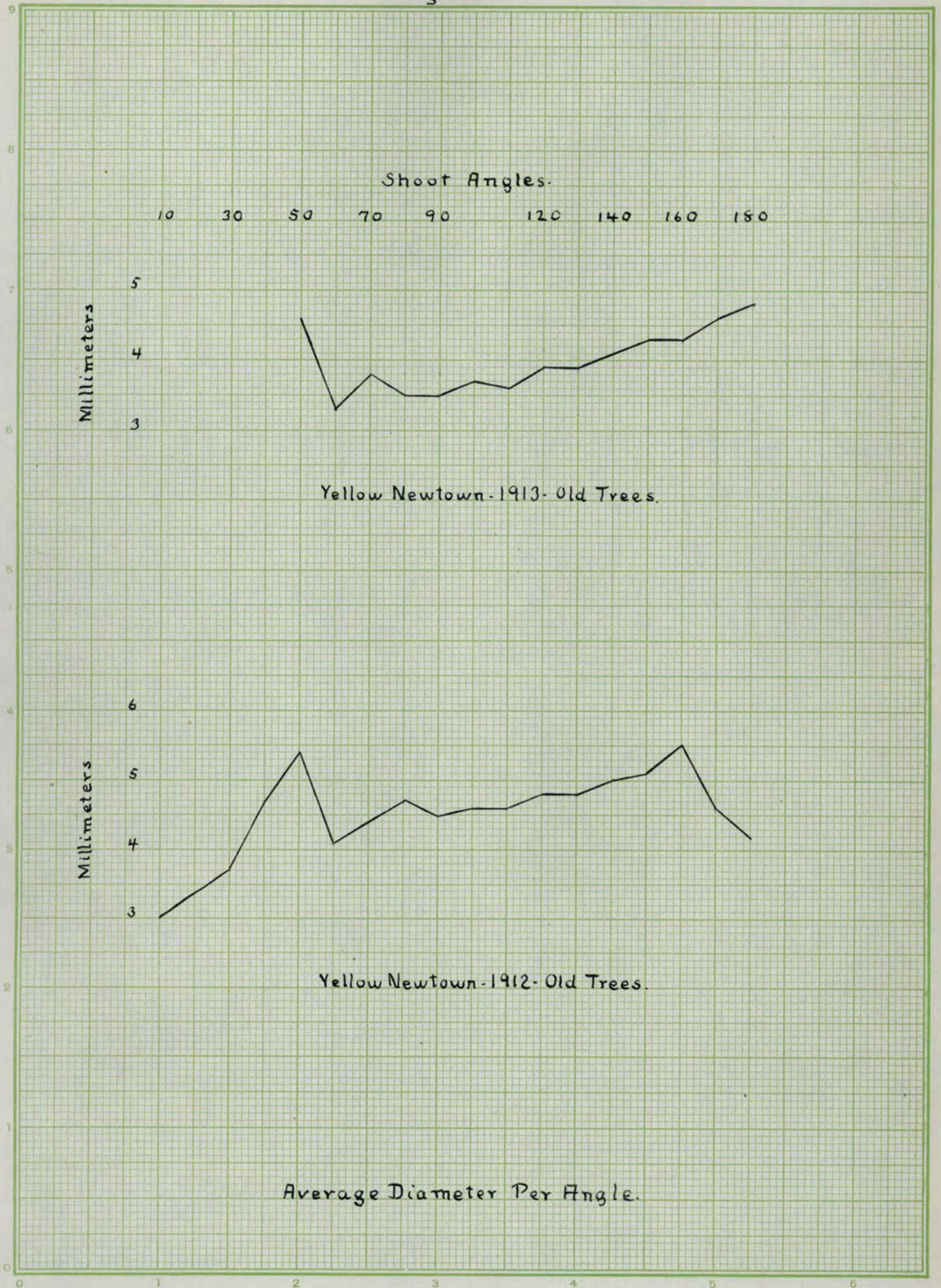


Figure 42.

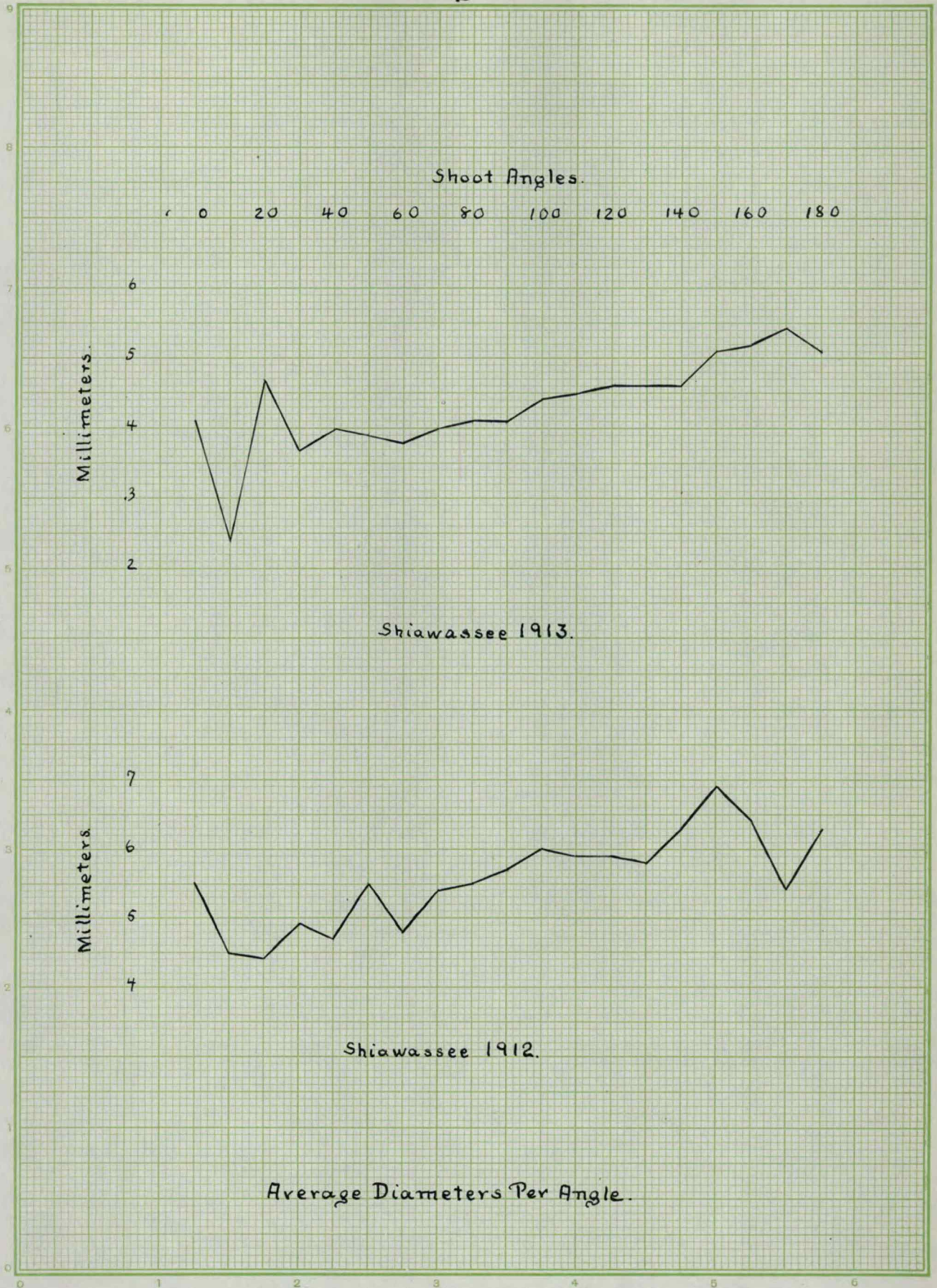
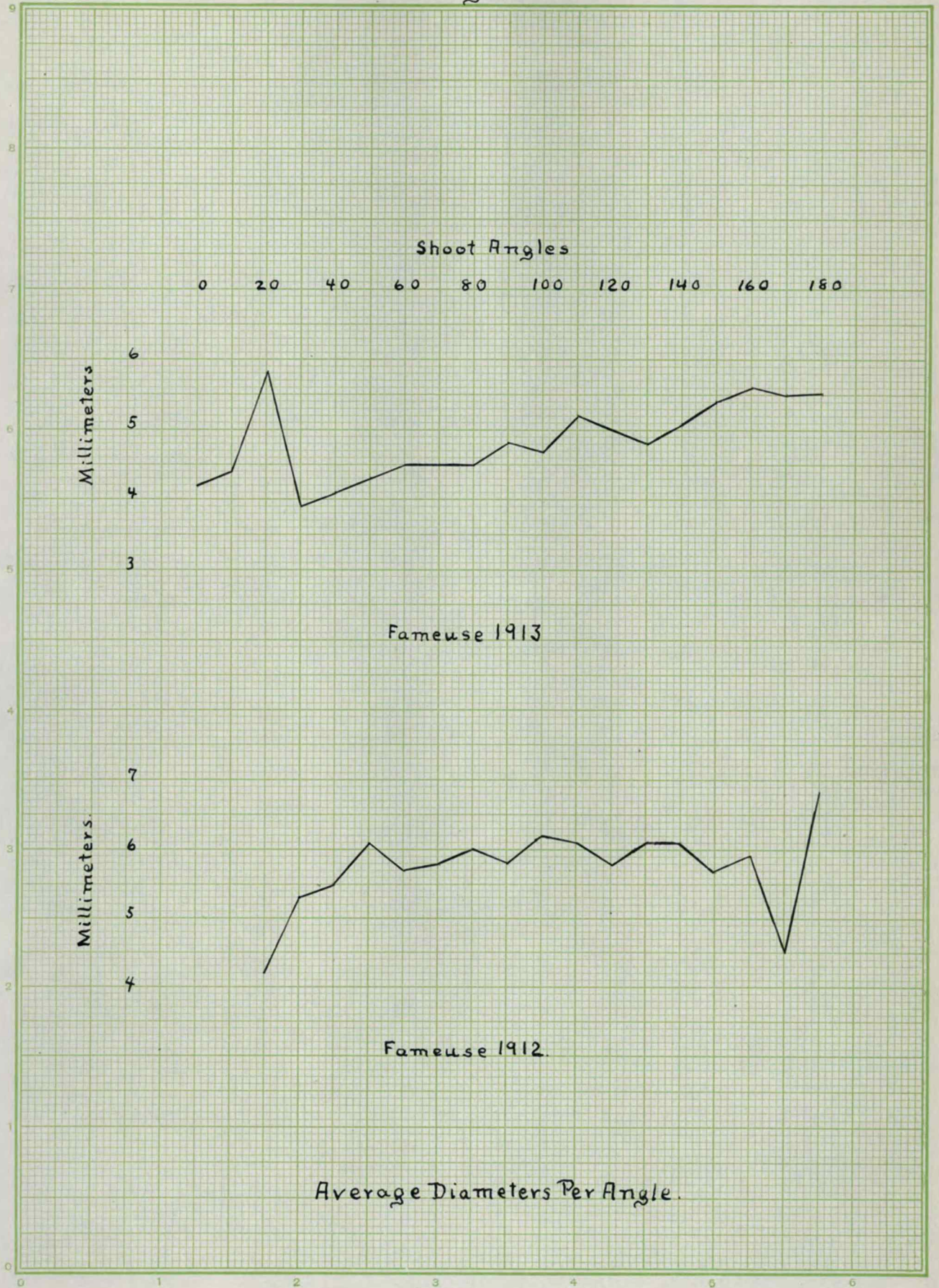


Figure 43.



RELATION OF LENGTH OF SHOOT TO BUD DEVELOPMENT.

In order to determine whether the length of a shoot has any influence upon the development of the buds upon it, four varieties were studied. Realizing that the angle of any particular shoot has an effect upon the development of the buds it bears, each angle was treated separately to avoid the error due to a consideration in the same group of shoots of varying angles. In order to have as large a frequency as possible and yet secure a number of different lengths that can be compared, the shoots of each angle were divided into a number of groups according to length, averages determined for each group, and likewise the average percentages of buds breaking and of fruit spurs forming in each group. For the Wagener and Young Yellow Newtown, where the growth had been very great, groups were made to include all the shoots from 0-8", 8-16", 16-24", etc; while for the Fameuse and Shawanese, varieties in which the lengths were not great, the groups were made from 0-4", 4-8", 8-12", etc. Generally, there were four or five groups for each angle, allowing a good opportunity for comparison. See tables LXVII, LXVIII, LXIX and LXX.

The results obtained from such a comparison are very convincing. They show without any doubt that with an increase in length of shoots the percentage of buds breaking, as well as those forming fruit spurs increases. Of course there are a few exceptions where the percentage of buds breaking is greater for short than for long shoots, but these exceptions are few in number and are to be expected.

In a number of instances, especially in Fameuse, the percentages for the longest group are just a few points lower than those for the preceding group, suggesting that perhaps there is some optimum length for the development of spurs. This is easily conceivable in the case of shoots that have made an unusually long, spindling growth, and that, as a consequence, have not developed such large, strong buds. However, the figures are hardly sufficient to warrant definite conclusions.

COLUMNS IN
KEY TO TABLES LXVII--LXXIV.

1. Angle of shoots.
2. Groups into which shoots are divided.
3. Average length of shoots in inches.
4. Average diameter of shoots in millimeters.
5. Total number of buds per average shoots.
6. Number of dormant buds per average shoots.
7. Number of vegetative shoots or branches per average shoot.
8. Number of fruit spurs per average shoot.
9. Per cent of buds breaking.
10. Per cent of buds forming fruit spurs.
11. Number of shoots included in group.

TABLE LXVII

TABLE SHOWING INCREASE IN THE PER
CENT OF BUDS BREAKING AND OF BUDS
FORMING FRUIT SPURS, WITH AN IN-
CREASE IN THE LENGTH OF SHOOTS.
YOUNG YELLOW NEWTOWN,--1913 GROWTH.

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11	-
<u>80°</u>											
0-8 "	3.84	3.5	6.0	5.5	0	.5	8.3	8.3	4		
8-16"	12.65	4.1	15.8	11.5	.5	3.8	27.0	23.8	4		
<u>90°</u>											
0-8 "	5.43	3.4	6.9	5.3	.1	1.5	23.4	22.8	23		
8-16"	10.31	4.0	11.2	6.4	.1	4.7	42.5	41.8	12		
16-24"	18.19	5.4	21.8	13.0	0	8.8	40.2	40.2	4		
<u>100°</u>											
0-8 "	4.81	3.3	6.5	4.9	0	1.6	24.0	24.0	20		
8-16"	11.75	4.2	12.3	6.1	.1	6.1	50.7	49.5	28		
16-24"	19.15	5.6	20.0	9.6	0	10.4	51.9	51.9	13		
24-32"	26.96	8.0	26.7	11.7	.7	14.3	56.2	53.8	3		
<u>110°</u>											
0-8 "	5.83	3.3	7.2	5.3	0	1.9	25.5	25.5	19		
8-16"	11.68	4.0	12.8	6.3	.1	6.4	50.6	49.7	28		
16-24"	20.20	5.6	20.6	9.3	.1	11.2	55.0	54.2	31		
24-32"	27.05	6.9	26.3	8.4	1.1	16.8	68.1	63.9	10		
<u>120°</u>											
0-8 "	5.57	3.2	7.0	5.1	0	1.9	26.1	26.1	22		
8-16"	10.82	3.7	11.1	5.1	.2	5.8	53.8	52.4	32		
16-24"	19.61	5.4	20.0	10.0	.1	9.9	49.8	49.1	34		
24-32"	27.0	6.7	25.3	9.5	.2	15.5	62.6	61.1	13		
32-40"	33.27	7.2	31	10	0	21	67.7	67.7	1		
<u>130°</u>											
0-8 "	5.93	3.2	7.3	4.8	0	2.5	34.5	34.5	16		
8-16"	12.77	4.2	12.9	4.8	.2	7.9	62.8	60.9	32		
16-24"	20.6	5.6	21.0	8.5	.3	12.2	59.6	58.1	43		
24-32"	26.95	6.9	25.3	9.1	.5	15.7	64.2	62.2	34		
32-40"	33.29	7.3		8.0	1.5	17	68.6	63.5	6		
<u>140°</u>											
0-8 "	5.08	2.9	6.9	4.6	0	2.3	32.8	32.8	8		
8-16"	10.43	3.7	10.7	4.9	.1	5.7	53.9	53.4	18		
16-24"	20.51	5.5	21.0	9.2	.3	11.5	56.2	54.7	28		
24-32"	28.08	7.2	26.8	8.9	5.5	17.3	66.8	64.7	74		
32-40"	34.16	7.8	30.8	9.0	1.7	20.1	70.7	65.2	23		
40-up"	40.88	9.3	36.5	8.5	3.0	25.0	76.7	68.5	2		

TABLE LXVII--- page 2

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
<u>150°</u>										
0-8"	4.75	3.6	6.0	2.0	0	4.0	66.7	66.7	3	
8-16"	12.31	4.5	12.4	5.1	.3	7.0	59.1	56.4	12	
16-24"	23.58	6.2	22.2	6.1	.5	14.6	68.9	66.4	11	
24-32"	28.80	7.3	27.4	7.9	.7	18.8	71.2	68.5	68	
32-40"	34.77	8.5	31.7	8.2	1.3	22.2	74.2	70.2	56	
40-up"	43.66	9.7	38.0	10.0	2.7	25.3	73.7	66.7	3	
<u>160°</u>										
0-8 "	6.0	3.0	6	4	0	2	33.3	33.3	1	
8-16"	10.31	3.3	10.1	5.1	.1	4.9	49.4	48.2	8	
16-24"	20.31	6.6	20.2	8.5	.3	11.4	57.7	56.3	11	
24-32"	28.44	7.1	27.3	8.4	1.0	17.9	69.1	65.6	32	
32-40"	35.67	8.9	32.9	8.0	2.4	22.5	77.2	68.0	91	
40-up"	41.46	10.6	37.4	7.1	5.3	25.0	81.2	67.0	15	
<u>170°</u>										
0-8 "	7.0	2.7	7.0	4.5	0	2.5	35.7	35.7	2	
8-16"	11.67	3.6	10.3	3.7	0	6.6	64.5	64.5	3	
16-24"	20.69	5.6	20.0	7.0	.5	12.5	65.0	62.5	2	
24-32"	29.86	7.4	29.4	6.8	1.5	21.0	76.8	71.6	17	
32-40"	36.60	9.4	34.1	6.5	3.4	24.2	80.8	71.0	39	
40-up"	43.15	11.0	40.3	7.5	6.5	26.3	81.4	65.3	12	

TABLE LXVIII

TABLE SHOWING INCREASE IN THE PER CENT OF BUDS
BREAKING AND OF BUDS FORMING FRUIT SPURS, WITH
AN INCREASE IN THE LENGTH OF SHOOTS. WAGENER,
1913 GROW TH.

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
80°										
	0-8"	4.41	7.6	5.3	3.3	.7	1.3	37.5	25.0	3
	8-16"	11.21	9.1	10.3	4.6	1.8	3.9	55.8	37.2	6
90°										
	0-8 "	5.18	8.1	6.2	2.6	.6	3.0	57.5	53.1	17
	8-16"	10.33	9.9	9.6	3.9	1.8	3.9	59.4	40.6	11
100°										
	0-8 "	5.89	7.4	7.9	2.5	1.1	3.3	63.9	48.2	12
	8-16"	11.48	10.3	10.5	4.3	2.2	4.0	58.7	37.4	17
	16-24"	18.58	12.5	15.3	6.3	2.7	6.3	58.7	41.3	3
110°										
	0-8 "	5.93	6.32	5.6	2.3	.7	2.6	58.9	47.8	16
	8-16"	11.88	10.4	10.3	3.9	2.2	4.2	60.	40.2	39
	16-24"	16.37	11.9	12.3	4.0	3.3	5.0	67.6	40.6	3
120°										
	0-8 "	5.95	7.5	5.3	2.1	.7	2.5	60.8	47.3	14
	8-16"	11.80	10.0	10.1	3.5	2.2	4.4	62.2	43.6	52
	16-24"	18.74	11.9	14.9	5.4	2.7	6.8	64.	45.7	11
130°										
	0-8"	6.09	6.8	6.0	2.2	.6	3.2	63.9	54.2	12
	8-16"	12.19	10.3	10.2	4.0	2.0	4.2	60.9	41.7	30
	16-24"	18.88	12.2	15.5	4.8	2.7	8.0	68.8	51.6	12
	24-32"	26.0	11.9	17.0	3.0	2.0	12.0	82.3	70.6	1
140°										
	0-8"	7.38	8.4	6.3	2.0	1.3	3.0	68.0	48.0	4
	8-16"	12.36	10.5	10.5	3.3	1.9	5.3	68.3	50.2	28
	16-24"	19.92	11.4	16.1	5.0	2.7	8.4	69.2	52.2	23
	24-32"	25.67	11.27	17.7	5.7	3.7	8.3	67.9	47.2	3
150°										
	0-8 "	7.25	6	7	4	1	2	42.9	28.6	1
	8-16"	12.82	10.7	10.6	3.4	2.3	4.9	67.7	48.3	25
	16-24"	19.76	12.1	15.6	3.5	3.0	9.1	77.9	58.5	29
	24-32"	27.44	13.4	21.5	4.3	4.9	12.3	79.9	57.3	6

TABLE LXVIII--page 2.

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
160°										
0-8 "	6.62	11.8	5.3	1.0	2.0	2.0	81.3	37.5		3
8-16"	12.54	11.3	10.7	3.0	2.1	5.6	72.0	52.1		31
16-24"	19.60	12.8	15.9	4.2	3.1	8.6	73.3	53.9		56
24-32"	25.96	13.5	20.6	5.4	3.6	11.6	73.7	56.3		14
170°										
0-8 "	6.87	12.0	8.0	1.0	2.0	5.0	87.5	62.5		1
8-16"	14.05	13.1	11.5	2.3	3.0	6.2	80.2	53.7		21
16-24"	20.33	14.3	16.3	3.7	3.3	9.3	77.5	57.1		117
24-32"	27.18	15.0	21.7	4.3	4.4	13.0	79.9	59.6		59
180°										
8-16"	14.23	14.8	12.0	5.1	2.4	4.5	57.5	37.5		10
16-24"	20.18	14.9	16.6	3.7	3.4	9.5	77.7	57.3		48
24-32"	28.42	16.3	23.4	5.1	4.3	14.0	78.4	60.1		83
32-40"	35.08	16.7	28.6	6.3	5.8	16.5	77.9	58.0		24

TABLE LXIX

 TABLE SHOWING INCREASE IN THE PER
 CENT OF BUDS BREAKING AND OF BUDS
 FORMING FRUIT SPURS, WITH AN INCREASE
 IN THE LENGTH OF SHOOTS.
 SHIAWASSEE, 1913 GROWTH.

 For key to columns see page. 25-a

1	2	3	4	5	6	7	8	9	10	11
<u>30°</u>										
	0-4 "	1.95	3.5	3.0	2.4	0	.6	20.0	20.0	5
	4-8 "	6.0	4.2	7.5	3.5	0	4.0	53.3	53.3	2
<u>40°</u>										
	0-4 "	2.39	4.1	3.3	2.5	0	.8	25.0	25.0	6
	4-8 "	5.06	3.7	6.0	5.3	0	.7	12.5	12.5	4
	8-12"	8.25	4.9	10	4	0	6	60.0	60.0	1
<u>50°</u>										
	0-4 "	2.73	3.9	4.2	3.4	0	.8	19.6	19.6	12
	4-8 "	5.39	3.8	6.3	3.8	0	2.5	39.5	39.5	6
<u>60°</u>										
	0-4 "	2.68	3.6	3.9	3.3	0	.6	15.5	15.5	15
	4-8 "	6.07	4.1	7.0	3.6	0	3.4	49.0	49.0	7
	8-12"	9.25	4.5	8.5	4.5	0	4	47.1	47.1	2
<u>70°</u>										
	0-4 "	2.95	3.9	4.3	3.3	0	1.0	22.4	22.4	19
	4-8 "	6.46	4.0	6.8	4.9	.8	1.9	29.4	28.3	26
	8-12"	9.81	4.8	10	7.5	0	2.5	25.0	25.0	2
<u>80°</u>										
	0-4 "	2.42	3.8	4.0	2.8	0	1.2	29.6	29.6	34
	4-8 "	5.25	4.1	6.4	3.6	0	2.8	43.2	43.2	30
	8-12"	9.38	4.8	10.5	4.1	0	6.4	60.9	60.9	10
	12-16"	13.5	5.2	15	3	0	12	80.0	80.0	1
<u>90°</u>										
	0-4 "	4.94	3.8	4.2	3.2	0	1.0	22.8	22.8	30
	4-8 "	5.68	4.3	6.8	4.4	.2	2.3	35.0	34.6	42
	8-12"	9.25	4.7	10.4	4.0	0	6.4	61.5	61.5	8
<u>100°</u>										
	0-4 "	2.64	3.9	4.4	3.3	0	1.1	24.9	24.9	48
	4-8 "	5.76	4.3	7.3	4.7	0	2.6	36.1	36.1	36
	8-12"	9.44	5.2	10.9	5.6	.2	5.1	48.6	46.4	13
	12-16"	13.42	6.3	15.2	8.0	0	7.2	47.4	47.4	5

TABLE LXIX-- page 2

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
<u>110°</u>										
0-4 "	4.01	3.9	4.4	3.2	0	1.2	27.9	27.9	55	
4-8 "	6.09	4.5	7.9	4.6	.1	3.2	41.8	41.4	49	
8-12"	9.42	5.3	11.5	5.7	.1	5.7	50.4	50.0	25	
12-16"	13.06	5.5	15.0	8.5	0	6.5	43.4	43.4	4	
16-up"	16.56	5.8	17.5	14.0	0	3.5	20.0	20.0	2	
<u>120°</u>										
0-4 "	2.66	4.1	4.2	3.2	0	1.0	24.4	24.4	31	
4-8 "	5.86	4.5	7.6	4.5	.1	3.0	40.7	39.9	56	
8-12"	9.69	5.3	10.9	5.9	0	5.0	48.1	48.1	21	
12-16"	13.85	5.7	14.2	7.2	0	7.0	49.3	49.3	5	
16-up"	16.44	6.8	22.0	14.5	0	7.5	34.1	34.1	2	
<u>130°</u>										
0-4 "	2.87	4.0	4.1	2.9	0	1.2	29.5	29.5	41	
4-8 "	5.94	4.7	7.6	4.7	0	2.9	38.5	38.0	57	
8-12"	9.49	5.1	7.3	6.5	.1	4.7	41.9	41.5	26	
12-16"	12.78	6.1	14.0	7.5	0	6.5	46.4	46.4	4	
<u>140°</u>										
0-4 "	2.65	4.0	4.1	3.5	0	.6	14.3	14.3	22	
4-8 "	5.81	4.7	7.4	5.0	0	2.4	32.0	32.0	50	
8-12"	9.59	5.3	11.8	6.5	0	5.3	44.8	44.8	26	
12-16	13.49	5.6	14.0	7.8	0	6.2	44.3	44.3	10	
16up	18.75	6.5	19.0	11.7	0	7.3	38.6	38.6	8	
<u>150°</u>										
0-4 "	2.35	3.9	3.4	2.7	0	.7	20.6	20.6	10	
4-8 "	6.02	4.6	8.1	5.6	0	2.5	30.7	30.7	50	
8-12"	9.62	5.4	10.9	6.8	0	4.1	38.0	38.0	18	
12-16"	13.50	5.7	16.3	10.5	0	5.8	35.6	35.6	10	
16-up"	18.87	7.0	19.6	9.1	.1	10.4	53.6	53.1	10	
<u>160°</u>										
0-4 "	2.35	4.0	3.8	3.0	0	.8	20.6	20.6	18	
4-8 "	6.12	4.7	7.8	5.1	0	2.7	34.2	34.2	17	
8-12"	10.11	5.4	12.8	9.3	0	3.5	27.7	27.7	25	
12-16"	14.13	6.7	17.2	9.6	0	7.6	43.9	43.9	11	
16-up"	19.46	6.8	21.4	11.3	.1	10.0	47.3	46.7	7	

For key to columns see page 25-a

	1	2	3	4	5	6	7	8	9	10	11
<u>170°</u>											
0-4 "			2.62	3.5	3.7	3.2	0	.5	13.5	13.5	10
4-8 "			5.62	4.4	7.3	4.9	0	2.4	32.5	32.5	16
8-12"			10.09	5.8	12.3	6.8	0	5.5	44.9	44.9	8
12-16"			14.07	6.2	16.0	7.4	0	8.6	53.7	53.7	5
16-up"			19.95	7.1	20.6	10.4	.2	10.0	49.4	48.4	14

TABLE LXX

TABLE SHOWING INCREASE IN THE PER
CENT OF BUDS BREAKING AND OF BUDS
FORMING FRUIT SPURS, WITH AN INCREASE
IN THE LENGTH OF SHOOTS. FAMEUSE,
1913 GROWTH.

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
<u>40°</u>										
1-4 "	2.41	4.23	4.3	3.7	-	.6	15.4	15.4	3	
4-8 "	5.71	3.8	7	4.6	.1	2.3	34.7	32.7	7	
<u>50°</u>										
0-4 "	2.62	4.05	4.2	2.6	.1	1.5	39.4	36.8	9	
4-8 "	5.71	4.22	6.7	4.5	-	2.2	33.3	33.3	16	
<u>60°</u>										
0-4 "	2.62	4.05	4.2	2.9	.1	1.2	30.7	27.3	21	
4-8 "	5.88	4.42	7.1	4.6	-	2.5	35.6	35.6	17	
8-12 "	8.99	5.16	11.0	4.8	-	6.2	56.4	56.4	5	
<u>70°</u>										
0-4 "	2.64	4.17	4.3	2.5	.1	1.7	41.1	39.3	25	
4-8 "	6.02	4.42	7.5	3.3	.1	4.1	55.9	54.8	25	
8-12 "	9.49	5.31	9.9	1.9	.2	7.8	80.7	78.7	10	
12-22 "	17.83	4.43	16.3	9.6	0	6.7	40.8	40.8	3	
<u>80°</u>										
0-4 "	2.65	4.18	4.4	2.9	.1	1.4	34.3	33.5	35	
4-8 "	5.73	4.52	7.	3.1	.1	3.8	55.4	54.2	36	
8-12 "	10.03	4.80	11.0	4.5	.1	6.4	59.1	58.5	14	
12-16 "	13.41	5.33	13.8	5.8	-	8.0	58.2	58.2	4	
<u>90°</u>										
0-4 "	2.58	4.33	4.4	2.9	.2	1.3	33.1	28.0	27	
4-8 "	5.90	4.46	7.5	4.0	.1	3.4	45.5	43.9	33	
8-12 "	9.62	5.15	11.1	4.9	.2	6.0	55.9	53.8	25	
12-17 "	14.02	5.30	14	9.1	-	4.9	34.5	34.5	6	
<u>100°</u>										
0-4 "	2.84	4.24	4.3	3.1	0	1.2	36.2	36.2	28	
4-8 "	5.91	4.71	7.6	3.8	.1	3.7	50.3	49.0	41	
8-12 "	9.79	5.05	11.2	4.9	.1	6.2	44.9	54.3	26	
12-16 "	13.87	5.17	13.6	6.7	0	6.9	50.5	50.5	8	

TABLE LXX-- page 2

For key to columns see page 25-a

1	2	3	4	5	6	7	8	9	10	11
<u>110°</u>										
0-4 "	2.69	4.34	4.3	3.0	.1	1.2	29.1	27.7	33	
4-8 "	5.76	4.71	7.0	4.4	0	2.6	45.0	45.0	34	
10-12"	9.43	5.59	11.7	4.3	.2	7.2	64.8	63.0	29	
12-16"	14.53	6.18	15.7	6.3	.2	9.2	60.8	58.5	10	
<u>120°</u>										
0-4 "	2.87	4.22	4.3	2.6	.1	1.6	40.0	39.1	27	
4-8 "	5.57	4.67	7.4	3.7	.2	3.5	49.4	47.2	44	
8-12"	10.09	5.23	11.7	5.3	.1	6.3	54.3	53.5	35	
12-16"	13.91	6.05	15.2	6.7	.1	8.4	55.9	55.0	14	
16-24"	18.90	6.13	19.25	9.7	.1	9.5	49.8	49.4	12	
<u>130°</u>										
0-4 "	2.58	4.14	4.0	2.8	.1	1.1	30.5	29.7	32	
4-8 "	6.11	4.41	7.8	4.3	.1	3.4	44.5	44.2	40	
8-12"	9.98	5.43	11.3	4.1	.1	7.1	64.5	63.5	14	
12-16"	14.64	6.11	16.6	6.3	.2	10.1	62.1	60.9	10	
16-35"	21.44	6.8	21.0	10.6	.2	10.2	49.4	48.1	8	
<u>140°</u>										
0-4 "	2.77	4.14	4.4	2.9	.1	1.4	34.3	31.3	23	
4-8 "	5.89	4.58	7.5	3.9	.1	3.5	47.7	45.8	29	
8-12"	9.98	5.48	11.8	6.4	.1	5.3	45.7	45.2	16	
12-16"	14.19	5.98	15.2	7.9	0	7.3	48.6	48.6	14	
16-26"	20.34	6.63	21	9.1	.1	11.8	56.4	55.8	7	
<u>150°</u>										
0-4 "	2.66	4.30	4.3	2.3	0	2	46.2	46.2	18	
4-8 "	6.35	4.37	8.0	4.9	.1	3.0	39.4	37.4	20	
8-12"	10.24	6.12	12.4	5.4	.4	6.6	56.5	53.2	15	
12-16"	14.87	6.55	15.2	6.2	.3	8.7	59.2	57.2	10	
16-26"	20.83	6.70	22.4	8.0	.1	14.3	64.4	64.0	9	
<u>160°</u>										
0-4 "	2.68	4.73	4.3	2.9	.1	1.3	33.3	31.4	12	
4-8 "	5.94	4.86	7.1	3.8	.2	3.1	46.5	43.5	14	
8-12"	9.93	5.49	10.8	4.4	-	6.4	59.4	59.4	8	
12-16"	13.93	6.47	16.2	7.5	1.0	7.7	53.7	47.4	6	
16-26"	21.29	6.83	22.6	9.3	-	13.3	59.2	59.2	8	

TABLE LXX-- page 3

For key to columns see page 25-a

170°

0-4 "	2.50	4.74	4.1	2.9	0	1.2	30.2	30.2	13
4-8 "	5.75	4.45	6.5	2.5	1	3	61.6	46.2	2
8-12"	9.33	6.22	5.2	2.5	.2	2.5	51.6	47.4	3
12-20"	15.81	6.05	15.3	7.6	.2	7.4	50.0	48.3	8

180°

0-4 "	2.0	4.57	3.6	2.6	0	1.0	27.5	27.5	3
4-8 "	5.46	5.28	7.2	3.8	0	3.4	46.5	46.5	6
8-14"	10.41	5.71	15	7.5	.5	7.0	50.0	48.3	4

RELATION OF DIAMETER OF SHOOT TO BUD DEVELOPMENT

It was the general impression among early horticulturists that thick branches are mainly useful for further wood production, and that it is the small ones that are mainly useful in the production of fruit. A few quotations from De la Quintinye¹¹ will bring out some of these early ideas:-

"In vigorous trees the weaker branches are the fruit bearers; in weak trees, the stronger chiefly."

"Fruit buds that are nearest the ends of branches are commonly thicker, and so better fed than others."

"It is very material to preserve the good, weak ones for fruit."

"The farther a weak branch is distant from the trunk, the less nourishment it receives; thick branches the more distant from the heart, receive the more, and are therefore to be removed."

To determine approximately what the relationship is between diameter and the percentage of buds breaking, and of those forming fruit spurs, the same groups were considered that were used in determining the inter-relationship of shoot length and development of buds. The average diameter for each group in the preceding tables was determined, and this was used to divide the whole group into two equal parts, the one part above the mean and the other below. The average diameter for each sub-group was then calculated.

In by far the majority of cases a comparison of these two groups shows the superiority of the branches with the larger diameters. There was a higher percentage, both of buds breaking

and in the number of fruit spurs formed. Wagener was the only variety not showing a clear cut tendency in this direction. In the case of fruit spurs it showed rather the opposite tendency. This can be partially explained by the fact that the larger branches were more prone to develop shoots than the small ones, and that their number cut down the percentage of fruit buds enough to bring it just below the percentage of fruit buds on the smaller branches. A careful study of the tables will reveal the fact, not only in the Wagener but in the other varieties, that when the slender branches exceed the thicker in per cent of buds breaking it is by a very small margin, while when the reverse is the case the margin averages considerably larger.

The following table indicates the percentage of groups in which the thick shoots show a greater tendency than the thin shoots to have their buds break and to form fruit spurs. Only 1913 growth was considered.

Variety	Break	Fruit Buds.
Yellow Newtown--young.	74.4	66.7
Wagener	55.9	26.5
Shiawassee	74.1	74.1
Fameuse	71.7	70.0

Two reasons may be offered to explain this increase. The twig with a large diameter naturally has a larger amount of food conducting tissue than has the one with a small diameter, and is thus more capable of nourishing its buds.

There may have been a difference in the light supply available to the shoots.

The Rhode Island Experiment Station¹² has shown that when apple limbs are exposed to a strong light a greater number of fruit buds are formed, than when in partial shade. In order to ascertain this they went into an orchard and cut two limbs about one inch in diameter from each of ten trees in different parts of the orchard, one being taken that was in strong sunlight, and the other in partial shade. The number of fruit buds was then counted with the following results:-

Tree Variety	Limbs in Sunlight Clusters flower buds	Limbs in partial shade. Clusters flower buds.
1 Rhode Island Greening	194	120
2 Rhode Island Greening	295	226
3 Variety not known	112	82
4 Early Harvest	202	149
5 Variety not known	163	157
6 Baldwin	213	91
7 Baldwin	140	74
8 Variety not known	148	104

9 Roxbury Russet	238	232
10 Pear Sweeting	115	128
Average	182	136

It is a known fact that in bright sunlight growth in volume is impeded by certain portions of the sun's rays¹³, although the actual division of the cells is not influenced to any great extent. Thus when we get growth impeded and cell division still proceeding, it seems very probable that a greater thickness in the shoot will be secured. The fact that it is in the presence of strong light results in a larger number of fruit buds, than would be the case of the twig of same length produced in partial shade and having a smaller diameter.

The data presented in the last two sets of tables offer an explanation of the increase in per cent of buds breaking and in fruit spurs formed with an increase in the angle approaching the vertical. It will be remembered that curves were plotted showing greater lengths and greater diameters when the angles were nearer the vertical. Now it naturally follows that if the longer shoots, and those with the largest diameters, are more productive of fruit spurs, that the greatest breaking of buds and greatest number of fruit spurs are to be found in the more upright shoot angles which, because of their direction, are comparatively long and thick. The shoots that are horizontal or dropping are exceedingly short and small in diameter and are not to be expected to be any more productive than the tables have shown.

TABLE LXXI

TABLE SHOWING INCREASE IN THE PER CENT
OF BUDS BREAKING AND OF BUDS FORMING FRUIT
SPURS, WITH AN INCREASE IN THE DIAMETER OF
SHOOTS OF APPROXIMATELY THE SAME LENGTH.
YOUNG YELLOW NEWTOWN, 1913 GROWTH.

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11	
<u>80°</u>										
	0-8 "	3.3	6.0	5.3	0	.7	11.1	11.1	3	
		3.9	6	6	0	0	0	0	1	
	8-16"	3.5	11.0	7.5	0	3.5	31.8	31.8	2	
		4.9	20.5	15.5	1.	4.0	24.8	19.5	2	
<u>90°</u>										
	0-8 "	2.9	7.0	5.6	0	1.0	19.2	19.2	15	
				4.6	.1	2.0	31.5	29.7	8	
	8-16"	3.8	11.6	6.5	.1	5.0	44.1	43.0	8	
		4.6	10.2	6.2	0	4.0	39.0	39.0	4	
	16-24"	5.1	24.5	16.5	0	8.0	32.7	32.7	2	
		5.8	19	9.5	0	9.5	50.0	50.0	2	
<u>100°</u>										
	0-8 "	3.0	6.1	5.0	0	1.1	17.7	17.7	13	
		3.9	16.7	11.0	0	5.7	34.0	34.0	7	
	8-16"	3.6	11.2	5.3	.1	5.8	52.5	51.4	16	
		4.9	13.8	7.1	.1	6.6	48.1	47.6	12	
	16-24"	4.9	19.0	10.7	0	8.3	43.8	43.8	6	
		6.2	20.9	8.7	0	12.1	58.2	58.2	7	
	24-32"	7.7	26.5	10.5	.5	15.5	60.4	58.5	2	
		8.6	27	14	1.	12	48.2	44.5	1	
<u>110°</u>										
	0-8 "	3.0	6.9	5.1	0	1.8	26.7	26.7	13	
		4.1	7.8	6.0	0	1.8	23.4	23.4	6	
	8-16"	3.5	12.2	6.3	0	5.9	48.7	48.7	16	
		4.6	13.8	6.5	.3	7.0	52.7	50.9	12	
	16-24"	5.0	19.6	10.0	.1	9.5	49.2	48.6	17	
		6.4	21.8	8.4	.2	13.1	61.3	60.3	14	
	24-32"	6.6	25.8	9.3	.5	16.0	63.9	61.9	6	
		7.3	27.0	7.0	2.0	18.0	74.1	66.7	4	
<u>120°</u>										
	0-8 "	2.8	6.6	5.1	-	1.5	22.5	22.5	12	
		3.8	7.3	5.1	0	2.2	30.3	30.3	10	
	8-16"	3.2	10.0	5.0	.1	4.9	49.5	49.1	21	
		4.6	13.2	5.3	.4	7.5	60.0	57.2	11	
	16-24"	4.8	19.6	10.6	.1	8.9	46.1	45.8	17	
		6.1	20.5	9.5	.2	10.8	53.9	52.8	17	
	24-32"	6.2	24.4	10.1	0	18.3	58.5	58.5	8	
		7.5	26.8	8.4	1.	17.4	68.7	64.9	5	

TABLE LXXI--page 2.

For key to columns see page. 25-a

1	2	4	5	6	7	8	9	10	11	
<u>130°</u>										
	0-8 "	3.0	7.2	4.7	0	2.5	34.4	34.4	11	
		3.6	7.4	4.8	0	2.6	35.3	35.3	5	
	8-16"	3.6	11.8	4.3	.2	7.3	63.6	62.3	21	
		5.5	15.2	5.8	.5	8.9	61.7	58.7	11	
	16-24"	4.8	19.5	8.0	.2	11.3	59.3	58.1	21	
		6.4	22.4	9.0	.4	13.0	59.8	58.2	22	
	24-32"	6.1	24.7	8.5	.3	15.8	65.2	64.1	18	
		8.0	26.0	9.6	.8	15.6	63.1	60.2	16	
	32-40"	6.6	29.3	8.5	1.3	19.5	70.9	66.6	4	
		7.9	30.5	11.0	2.0	17.5	64.0	57.4	2	
<u>140°</u>										
	0-8 "	2.7	7.0	4.8	0	2.2	31.0	31.0	6	
		3.7	6.5	4.0	0	2.5	38.5	38.5	2	
	8-16"	3.4	10.8	5.5	0	5.3	48.6	48.6	13	
		4.6	10.2	3.2	.2	6.8	68.6	66.7	5	
	16-24"	4.5	20.3	5.7	.1	10.6	53.3	52.6	15	
		6.2	21.9	8.9	.5	12.5	59.3	56.8	13	
	24-32"	6.5	25.8	9.2	.3	16.3	64.5	63.4	37	
		7.8	27.7	8.6	.8	18.3	69.1	66.2	37	
	32-40"	7.1	30.4	10.2	1.0	19.2	66.4	64.2	11	
		8.4	31.3	8.0	2.3	21.0	74.5	67.0	12	
<u>150°</u>										
	0-8 "	3.1	7.0	2.5	0	4.5	64.3	64.3	2	
		4.8	4.0	1.0	0	3.0	75.0	75.0	1	
	8-16"	3.7	11.0	4.5	.1	6.4	59.1	58.0	8	
		5.7	15.3	6.3	.8	8.2	59.1	54.1	4	
	16-24"	5.6	21.2	6.8	.5	13.8	67.7	65.4	6	
		6.9	23.4	7.0	.6	15.8	70.1	67.5	5	
	24-32"	6.4	25.6	7.5	.7	17.4	70.6	68.1	28	
		8.0	28.7	8.1	.9	19.7	71.7	68.7	40	
	32-40"	7.7	31.3	8.9	.4	22.0	71.4	70.1	27	
		9.3	32.2	7.5	2.1	22.6	76.0	70.2	29	
<u>160°</u>										
	8-16"	2.8	9.0	4.7	0	4.3	48.1	48.1	3	
		3.7	10.8	5.4	.2	5.2	50.0	48.1	5	
	16-24"	5.8	19.0	9.4	0	9.6	50.5	50.5	5	
		7.4	21.2	7.8	.5	12.9	63.0	60.6	6	
	24-32"	4.9	26.5	8.4	.5	17.6	68.2	66.4	19	
		8.2	24.4	8.4	1.7	18.3	70.5	64.6	13	
	32-40"	8.2	31.8	8.3	1.6	21.9	73.8	68.8	49	
		9.8	33.6	7.6	3.4	22.6	77.3	67.1	42	

For key to columns see page 25-a

	1	2	4	5	6	7	8	9	10	11
<u>160°</u>										
40-up"			10.1	35.7	6.3	4.6	24.8	82.3	69.5	9
			11.4	40.0	8.2	6.3	25.5	79.6	63.7	6
<u>170°</u>										
24-32"			6.4	28.6	7.4	.5	19.5	69.8	68.1	8
			8.3	30.0	6.3	2.4	22.3	82.6	74.5	9
32-40"			8.5	33.6	6.6	1.4	25.6	80.4	76.4	20
			10.2	34.5	6.5	5.4	22.6	81.2	77.2	19
40-up"			10.3	39.0	8.7	5.7	24.6	77.8	63.3	6
			11.7	41.7	6.3	7.4	28.0	84.8	67.2	6

TABLE LXXII

TABLE SHOWING INCREASE IN THE PER CENT OF BUDS
BREAKING AND OF BUDS FORMING FRUIT SPURS, WITH
AN INCREASE IN THE DIAMETER OF SHOOTS OF
APPROXIMATELY THE SAME LENGTH. WAGENER, 1913
GROWTH.

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11	
80°										
	1-8 "	(6.5	3.5	2.5	0	1.0	28.6	28.6	2	
		10.0	9.0	5.0	2.0	2.0	44.5	22.2	2	
	8-16"	(8.0	10.3	3.7	1.3	5.3	64.5	51.6	3	
		(10.1	10.3	5.7	2.3	2.3	45.2	22.6	3	
90°										
	0-8 "	(6.3	6.5	3.5	.8	2.2	46.1	34.6	8	
		(9.7	6.0	1.9	.4	3.7	68.6	61.9	9	
	8-16"	(8.9	9.8	4.2	1.5	4.1	57.6	42.4	6	
		(11.1	9.4	3.6	2.2	3.6	61.7	39.2	5	
100°										
	0-8 "	(5.6	6.4	2.1	.7	3.6	66.7	55.6	7	
		(9.9	7.6	3.0	1.6	3.0	60.5	39.5	5	
	8-16"	(8.6	10.3	3.9	1.7	4.7	62.5	45.8	7	
		(11.7	10.7	4.7	2.6	3.4	56.1	31.8	10	
	16-24"	(11.2	15.0	6.0	1.0	8.0	60.0	53.3	1	
		(13.1	15.5	6.5	3.5	5.5	58.1	35.5	2	
110°										
	0-8 "	(4.9	5.3	2.2	.3	2.8	58.3	52.1	9	
		(8.3	6.0	2.4	1.0	2.6	59.5	42.8	7	
	8-16"	(7.7	8.9	4.1	1.2	3.6	54.5	41.2	16	
		(12.2	11.4	3.8	2.7	4.5	63.0	39.7	23	
	16-24"	(10.6	11.0	4.0	3.0	4.0	63.6	36.7	1	
		(12.6	13.0	4.0	3.5	5.5	69.3	42.3	2	
120°										
	0-8 "	(6.30	5.2	2.1	.5	2.6	59.6	50.0	10	
		(10.4	5.8	2.2	1.3	2.3	60.9	39.1	4	
	8-16"	(7.5	8.8	3.2	1.2	4.4	64.1	49.7	19	
		(11.5	10.9	3.7	2.7	4.5	65.9	40.8	33	
	16-24"	(10.6	14.4	4.4	2.2	7.8	69.4	54.2	5	
		(12.9	15.3	6.2	3.1	6.0	59.8	39.2	6	

TABLE LXXII- page 2

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11	
130°										
	0-8 "	(5.7	5.5	2.2	.3	3.0	60.6	54.5	6	
		(7.7	6.5	2.2	.8	3.5	66.7	53.9	6	
	8-16"	(8.1	9.9	4.7	1.5	3.7	52.3	37.5	13	
		(12.0	10.5	3.5	2.3	4.7	67.1	44.7	17	
	16-24"	(11.3	15.2	6.2	2.4	6.6	59.2	43.4	5	
		(12.8	15.7	3.9	2.8	9.0	75.5	57.2	7	
140°										
	0-8"	(6.6	6.0	2.0	1.0	3.0	67.7	50.0	2	
		(10.2	6.5	2.0	1.5	3.0	69.2	46.2	2	
	8-16"	(8.5	9.9	3.8	.9	5.2	61.2	52.7	13	
		(12.3	10.9	2.9	2.8	5.2	73.8	48.8	15	
	16-24"	(10.1	16.1	4.9	2.7	8.5	69.4	52.9	12	
		(12.6	16.1	5.0	2.8	8.3	68.9	51.4	11	
	24-32"	(10.1	17.5	7.0	2.5	8.0	60.0	45.7	2	
		(14.8	18.0	3.0	6.0	9.0	83.4	50.0	1	
150°										
	8-16"	(8.5	9.6	3.0	1.4	5.2	68.9	53.7	11	
		(12.3	11.4	3.8	2.9	4.7	66.9	41.2	14	
	16-24"	(10.4	16.0	3.6	2.7	9.7	77.4	60.4	15	
		(14.0	15.2	3.3	3.4	8.5	78.4	56.4	14	
	24-32"	(12.4	22.3	3.0	3.7	15.6	86.6	70.1	3	
		(14.3	20.7	5.7	6.0	9.0	72.6	43.5	3	
160°										
	0-8 "	(8.7	4.0	2.0	1.0	1.0	50.0	25.0	1.	
		(13.3	6.0	.5	3.0	2.5	91.7	41.6	2	
	8-16"	(8.4	9.6	2.6	1.3	5.7	73.0	55.6	12	
		(13.2	11.4	3.3	2.7	5.4	71.4	47.9	19	
	16-24"	(11.3	15.7	4.4	2.9	8.4	72.0	53.6	25	
		(14.1	15.8	4.1	3.3	8.4	75.7	54.9	31	
	24-32"	(12.5	20.0	5.0	3.2	11.8	75.0	59.1	6	
		(14.23	21.0	5.8	3.9	11.3	72.6	54.2	8	
170°										
	8-16"	(11.2	10.7	1.9	2.9	5.9	82.3	55.2	9	
		(14.6	12.2	2.6	3.2	6.4	78.8	52.7	12	
	16-24"	(12.9	15.8	3.4	3.2	9.2	78.2	57.9	58	
		(15.8	14.9	3.9	3.4	9.3	76.8	56.1	59	
	24-32"	(13.5	19.0	3.8	3.7	11.5	80.4	60.6	28	
		(16.3	22.0	4.4	4.6	13.4	80.2	58.9	31	

TABLE LXXII-- page 3
For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11
0									0

180°

8-16"	(13.5	11.2	4.8	2.4	4.0	57.1	35.7	5
	(16.2	12.8	5.4	2.4	5.0	57.8	39.1	5
16-24"	(13.3	16.3	4.0	3.4	8.9	75.5	54.5	21
16	(16.1	16.8	3.5	3.4	9.9	79.2	59.2	27
24-32"	(14.9	23.0	4.5	4.2	14.3	80.4	62.2	44
	(17.9	23.9	5.7	4.4	13.8	76.1	57.9	39
32-40"	(15.2	28.7	5.6	5.9	17.2	80.5	59.8	15
	(18.8	28.4	7.6	5.4	15.4	73.5	54.3	9

TABLE LXXIII

TABLE SHOWING INCREASE IN THE PER CENT OF BUDS
BREAKING AND OF BUDS FORMING FRUIT SPURS, WITH
AN INCREASE IN THE DIAMETER OF SHOOTS OF
APPROXIMATELY THE SAME LENGTH. SHIAWASSEE, 1913
GROWTH.

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11	
30°										
	0-4 "	(3.2	3.0	2.3	0	.7	22.4	22.4	3	
		(4.0	3.0	2.5	0	.5	16.7	16.7	2	
	4-8 "	(3.8	6.0	3.0	0	3.0	50.0	50.0	1	
		(4.5	9.0	4.0	0	5.0	55.6	55.6	1	
40°										
	0-4 "	(4.0	2.8	2.3	0	.5	18.2	18.2	4	
		(4.4	4.5	3.0	0	1.5	33.3	33.3	2	
	4-8 "	(3.3	5.0	4.5	0	.5	10.0	10.0	2	
		(4.2	7.0	6.0	0	1.0	14.3	14.3	2	
50°										
	0-4 "	(3.6	4.3	3.7	0	.6	15.4	15.4	9	
		(4.9	4.0	2.7	0	1.3	33.3	33.3	3	
	4-8 "	(3.4	6.3	4.3	0	2.0	32.0	32.0	4	
		(4.7	6.5	3.0	0	3.0	53.8	53.8	2	
60°										
	0-4 "	(3.2	3.6	3.0	0	.6	17.3	17.3	8	
		(4.1	4.2	3.6	0	.6	15.8	13.8	7	
	4-8 "	(3.6	6.6	2.8	0	3.8	57.6	57.6	5	
		(5.2	8.0	5.5	0	2.5	31.3	31.3	2	
	8-12"	(4.4	11.0	3.0	0	8.0	72.8	72.8	1	
		(4.5	6.0	6.0	0	0	0	0	1	
70°										
	0-4 "	(3.6	4.3	3.6	0	.7	14.9	14.9	11	
		(4.4	4.3	2.9	0	1.4	32.7	32.7	8	
	4-8 "	(3.6	6.5	4.9	1	1.5	26.7	24.4	14	
		(4.7	7.1	4.7	0	2.4	32.6	32.6	12	
	8-12"	(4.5	9.0	7.0	0	2.0	22.4	22.4	1	
		(5.1	11.0	8.0	0	3.0	27.5	27.5	1	

For key to columns see page 25-a.

1	2	4	5	6	7	8	9	10	11
80°	1-4 "	3.5	3.8	2.8	0	1.0	25.0	25.0	19
		4.4	4.2	2.7	0	1.5	34.9	34.9	15
	4-8 "	3.7	5.6	3.7	0	1.9	33.3	33.3	15
		4.4	7.2	3.5	0	3.7	50.9	50.9	15
	8-12"	4.4	9.8	5.3	0	4.5	46.2	46.2	4
		5.2	11.0	3.3	0	7.7	69.7	60.7	6
90°	1-4 "	3.4	3.9	3.3	0	.6	15.3	15.3	15
		4.2	4.5	3.2	0	1.3	29.4	29.4	15
	4-8 "	3.8	6.4	4.4	0	2.0	31.7	31.7	24
		4.9	7.8	4.5	1.1	2.8	39.1	38.3	18
	8-12"	4.3	10.0	5.2	0	4.8	48.0	48.0	5
		5.3	11.0	2.0	0	9.0	81.8	81.8	3
100°	1-4 "	3.4	4.3	3.2	0	1.1	25.0	25.0	24
		4.5	4.3	3.2	0	1.1	24.0	24.0	24
	4-8 "	3.9	6.9	5.1	0	1.8	26.4	26.4	23
		4.9	8.0	3.9	0	4.1	50.9	50.9	13
	8-12"	4.5	10.1	6.6	0	3.5	35.7	35.7	7
		6.0	11.8	4.5	.5	6.8	62.0	57.7	6
	12-16"	5.6	14.0	9.0	.0	5.0	35.8	35.7	2
		6.9	16.0	7.3	0	8.7	54.2	54.2	3
110°	1-4 "	3.4	4.1	3.0	0	1.0	27.4	27.4	30
		4.5	4.8	3.4	0	1.4	28.6	28.6	25
	4-8 "	4.1	7.4	3.9	.1	3.4	48	47	27
		5.0	8.5	5.5	0	3.9	35.6	35.6	22
	8-12"	4.6	10.4	5.6	0	4.8	46.6	46.6	14
		6.2	12.9	5.9	.1	6.9	54.2	53.5	11
	12-16"	5.3	13.7	7.0	0	6.7	48.8	48.8	3
		6.2	19.0	13.0	0	6.0	31.6	31.6	1
120°	1-4 "	3.6	4.1	3.3	0	.8	20.0	20.0	16
		4.7	4.4	3.1	0	1.3	28.8	28.8	15
	4-8 "	3.9	6.9	4.5	0	2.4	34.4	34.4	25
		5.1	8.1	4.5	.1	3.5	45.0	43.8	31
	8-12"	4.8	9.7	5.2	0	4.5	46.4	46.4	10
		5.8	12.0	6.5	0	5.5	45.4	45.4	11
	12-16"	5.5	13.8	6.0	0	7.8	56.4	56.4	4
		6.6	16.0	12.0	0	4.0	25.0	25.0	1

TABLE LXXIII- page 3

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11	

130°										
	0-4 "	(3.4	4.0	2.9	0	1.1	28.2	28.2	22	
		(4.7	4.0	2.8	0	1.2	31.2	31.2	19	
	4-8 "	(4.0	7.0	4.3	0	2.7	39.2	39.2	31	
		(5.5	8.4	5.2	.1	3.1	37.3	36.9	26	
	8-12"	(4.6	10.2	6.4	0	3.8	37.6	37.6	13	
		(5.7	12.0	6.5	.1	5.4	47.0	46.4	13	
	12-16"	(5.7	13.5	7.5	0	6.0	44.4	44.4	2	
		(6.5	14.5	7.5	0	7.0	48.3	48.3	2	

140°										
	0-4"	(3.3	4.0	3.4	0	.6	15.4	15.4	13	
		(5.0	4.3	3.9	0	.5	12.8	12.8	9	
	4-8 "	(4.0	6.4	4.6	0	1.8	27.7	27.7	28	
		(6.5	8.6	5.5	0	3.1	36.5	36.5	23	
	8-12"	(4.9	11.4	6.8	0	4.6	41.0	41.0	16	
		(6.0	12.3	6.1	0	6.2	50.4	50.4	10	
	12-16"	(4.8	12.5	7.5	0	5.0	40.0	40.0	4	
		(6.3	15.0	8.0	0	7.0	46.7	46.7	6	
	16-up	(5.5	19.0	18.0	0	1.0	5.3	5.3	1	
		(7.0	19.0	8.5	0	10.5	55.2	55.2	1/2	

150°										
	0-4 "	(3.4	3.2	3.0	0	.2	6.3	6.3	5	
		(4.6	3.6	2.4	0	1.2	33.3	33.3	5	
	4-8 "	(3.8	6.6	4.4	0	2.2	34.1	34.1	27	
		(5.5	9.7	7.0	0	2.7	38.1	28.1	23	
	8-12 "	(4.8	10.3	6.4	0	3.9	37.6	37.6	9	
		(5.9	11.5	7.1	0	4.4	38.5	38.5	9	
	12-16"	(5.5	15.6	11.8	0	3.8	24.7	24.7	5	
		(5.9	17.0	9.2	0	7.8	45.9	45.9	5	
	16-up	(6.1	17.0	9.6	0	7.5	43.5	43.5	5	
		(7.8	22.0	8.6	.2	13.4	61.2	60.4	5	

160°										
	0-4 "	(3.6	3.6	2.9	0	.7	18.6	18.6	12	
		(4.7	4.3	3.3	0	1.0	23.9	23.1	6	
	4-8	(3.9	6.6	4.1	0	2.5	37.7	37.7	8	
		(5.4	8.8	6.0	0	2.8	31.7	31.7	9	
	8-12"	(4.4	10.0	6.7	0	3.3	33.3	33.3	9	
		(6.0	14.4	10.7	0	3.7	25.5	25.5	16	
	12-16"	(6.1	15.8	9.2	0	6.6	41.8	41.8	5	
		(7.3	18.3	10.0	0	8.3	44.4	45.5	6	
	16-up	(6.2	20.0	12.0	.2	7.8	40.0	39.0	5	
		(8.3	25.0	9.5	0	15.5	62.0	62.0	2	

TABLE LXXIII --page 4

For key to columns see page 25-a

1	2	4	5	6	7	8	9	10	11
170°									
0-4 "	(3.6	3.3	3.3	0	0	0	0	7	
	(5.0	4.7	3.0	0	1.7	55.6	55.6	3	
4-8 "	(3.9	6.1	4.7	0	1.4	28.4	28.4	8	
	(5.0	8.5	5.1	0	3.4	39.7	39.7	8	
8-12"	(4.5	10.3	7.3	0	3.0	29.0	29.0	3	
	(6.6	13.4	6.4	0	7.0	52.2	52.2	5	
12-16"	(5.2	17.0	12.0	0	5.0	29.4	29.4	1	
	(6.4	15.8	6.3	0	9.5	60.3	60.3	4	
16-up	(6.6	19.1	11.9	0	7.2	37.9	37.9	8	
	(7.9	22.7	8.5	.5	13.7	62.5	60.3	6	

TABLE LXXIV

TABLE SHOWING INCREASE IN THE PER CENT OF BUDS BREAKING
AND OF BUDS FORMING FRUIT SPURS, WITH AN INCREASE IN
THE DIAMETER OF SHOOTS OF APPROXIMATELY THE SAME
LENGTH. FAMEUSE, 1913 GROWTH.

For key to columns see page 25-a

1	2	4	9	10	11
40°	1-4 "	(5.30 (3.70	0 22.2	0 22.2	1) 2)
	4-8 "	(4.30 (3.60	46.7 29.4	46.7 26.5	2) 6)
50°	1-4 "	(4.28 (3.82	40.0 38.9	40.0 33.3	5) 4)
	4-8 "	(4.96 (3.88	44.7 27.3	44.7 27.3	5) 11)
60°	1-4 "	(4.62 (3.53	31.3 30.0	27.1 27.5	10) 11)
	4-8 "	(4.93 (3.97	42.0 28.8	42.0 28.8	8) 9)
	8-12"	(5.70 (4.80	63.6 51.4	63.6 51.4	2) 3)
70°	1-4 "	(4.73 (3.66	42.9 39.7	42.9 36.4	12) 13)
	4-8 "	(4.96 (4.06	61.2 51.4	60.0 50.5	10) 15)
	8-12"	(5.90 (4.75	79.5 81.6	74.4 81.6	4) 6)
	12-22"	(5.0 (3.7	52.9 7.7	52.9 7.7	2) 1)
80°	1-4 "	(4.72 (3.58	35.5 31.6	34.7 31.6	19) 16)
	4-8 "	(5.08 (4.02	63.7 47.2	62.1 46.4	17) 19)
	8-12"	(5.12 (4.0	69.5 36.5	68.5 36.5	10) 4)
	12-16 "	(5.73 (4.1	65.1 33.3	65.1 33.3	3) 1)
90°	1-4 "	(5.17 (3.88	49.0 22.1	38.8 20.6	10) 17)
	4-8 "	(5.05 (3.74	51.0 37.6	48.3 37.6	18) 15)
	8-12"	(5.86 (4.59	59.8 50.6	56.8 49.3	11) 14)
	12-17"	(6.03 (4.56	50.0 19.	50.0 19.	3) 3)

TABLE XXIV--page 2.

For key to columns see page 25-a

1	2	4	9	10	11
100°	1-4 "	(5.21 3.61	33.3 38.3	33.3 38.3	11) 17)
	4-8 "	(5.37 4.12	63.2 36.2	62.6 34.9	20) 21)
	8-12"	(5.53 4.59	60.9 50.8	59.5 50.8	14) 12)
	12-16"	(5.80 4.80	41.5 58.7	41.5 58.7	3) 5)
110°	1-4 "	(5.30 3.81	33.3 25.6	33.3 23.1	14) 19)
	4-8 "	(5.60 4.16	52.8 40.0	52.8 40.0	13) 21)
	8-12"	(6.44 4.82	63.5 65.9	59.6 65.9	13) 16)
	12-16"	(6.72 5.62	67.5 51.4	66.3 50.0	5) 5)
120°	1-4 "	(4.97 3.62	49.0 32.8	47.1 32.8	12) 15)
	4-8 "	(5.42 3.98	51.2 47.4	48.8 45.5	21) 23)
	8-12"	(6.21 4.71	66.4 47.1	64.5 47.1	12) 23)
	12-16"	(6.85 5.45	66.7 46.7	66.7 44.7	6) 8)
	16-24"	(6.91 5.04	65.9 24.5	65.2 24.5	7) 5)
130°	1-4 "	(5.38 3.48	41.3 24.4	39.1 24.4	11) 21)
	4-8 "	(4.99 3.76	50.3 36.6	50.3 35.9	21) 19)
	8-12"	(5.97 5.03	62.0 62.2	60.7 62.2	6) 8)
	12-16"	(6.70 5.52	65.9 57.7	63.6 57.7	5) 5)
	16-25"	(7.28 5.47	53.6 41.4	51.8 41.4	5) 3)
140°	1-4 "	(4.86 3.60	32.0 36.5	32.0 36.5	10) 13)
	4-8 "	(5.30 3.99	47.1 48.2	44.1 47.3	13) 16)
	8-12"	(6.56	60.2	59.1	7)

TABLE LXXIV- page 3

For key to columns see page 25-a

		2	4	9	10	11
			(4.65	27.0	27.0	9)
12-16"			(6.59	71.8	71.8	8)
			(5.19	26.8	26.8	6)
16-26"			(7.47	73.8	72.7	4)
			(5.5	27.5	27.5	3)
150° 1-4 "			(6.25	51.6	51.6	6)
			(3.67	42.2	42.2	12)
4-8 "			(5.42	41.2	37.8	9)
			(3.51	37.1	37.1	11)
8-12"			(7.37	72.0	69.4	6)
			(5.29	45.9	42.3	9)
12-16"			(7.48	56.2	48.9	5)
			(5.63	68.7	68.2	5)
16-26"			(7.01	66.4	65.7	6)
			(6.06	59.3	59.3	3)
160° 1-4 "			(5.85	23.6	17.4	4)
			(4.16	38.3	38.3	8)
4-8 "			(5.66	44.0	44.0	6)
			(4.25	54.6	47.7	8)
8-12"			(6.08	56.3	56.3	4)
			(4.90	63.2	63.2	4)
12 -16"			(7.13	81.0	71.4	3)
			(5.80	32.7	29.1	3)
16-26"			(7.23	58.5	58.5	5)
			(6.07	60.3	60.3	3)
170° 1-4 "			(5.72	33.3	33.3	6)
			(3.90	29.6	29.6	7)
4-8 "			(5.4	71.5	42.8	1)
			(3.5	50.0	50.0	1)
8-12"			(6.8	25.0	20.0	2)
			(5.7	90.8	90.8	1)
12-20"			(6.62	54.9	52.1	4)
			(5.48	39.2	39.2	4)
180° 1-4 "			(5.0	0	0	1)
			(4.25	57.3	57.3	2)
4-8 "			(5.70	37.9	37.9	4)
			(4.45	85.7	85.7	2)
8-14"			(7.8	67.5	65.0	2)
			(3.6	15.	15.	2)

The question arises: "Of what value is all this to the fruit grower?" Several lessons may be drawn. It is evident that trees do better in their natural form, that is, a naturally upright variety produces relatively more fruit spurs on its upright branches than on its horizontal ones, and therefore this tendency should be fostered in the tree. In the case of the more spreading varieties, the most upright shoots are not the most productive, but rather those growing at an angle slightly above the horizontal. It is thus evident that a spreading variety should not be trained to an upright habit, but it should be allowed to spread, with as many as possible of its shoots approaching the mean angle.

The advantages of having long and thick shoots has been clearly brought out, and conditions should be made such that an abundance of these will be produced. Light undoubtedly plays an important part in fruit bud production, and proper thinning should be practiced to secure its beneficial action.

SUMMARY

Opinions of early horticulturists, and experiments consisting in actually bending down twigs, have led to the idea that twigs found at an angle lower than the horizontal are more productive of fruit spurs than those growing more upright. A study of nine thousand shoots has led to the conclusion that such is not the case, and that in upright varieties the greatest production of fruit spurs occurs on the more vertical shoots; and in spreading

varieties on shoots growing at approximately the mean angle for the shoots of the variety. Even in the case of spreading varieties the most downward shoots are still comparatively unproductive.

Correlation coefficients showing the relationship between percentage of buds breaking and angle of shoots were determined as follows:-

1913 growth:	Young Yellow Newtown,--	.574.
	Wagener,	-- .429.
	Old Yellow Newtown ,--	.124.
	Shiawassee,	-- .079.
	Fameuse,	-- .047.
1912 growth:	Young Yellow Newtown,--	.357.
	Wagener,	-- .181.
	Old Yellow Newtown ,--	.119.
	Shiawassee,	,-- .004.
	Fameuse,	-- .058.
1911 growth	Old Yellow Newtown ,--	.1003.
	Shiawassee,	--- .036
	Fameuse,	-- .058

In general in the case of shoots that have been headed back the percentage of fruit spurs forming is no greater, and in the case of Wagener is not so great as in the unheaded shoots. The percentage of buds breaking is considerably greater, however, due to the larger number of shoots that are formed.

The length and diameter of shoots was found to increase with the increase in angle of the shoot.

There appears to be a relationship between the length of the shoot and the percentage of buds breaking and of those forming fruit spurs, the longer shoots showing the higher percentage.

A certain relationship also exists between the diameter of the shoots and the per cent of buds breaking, and buds forming fruit spurs. In three of the four varieties studied over 70% of the groups compared showed that the thicker branches were more productive of fruit spurs.

The last two statements undoubtedly account for the increase in percentage of buds breaking and of fruit spur production in the more upright shoots.

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PLATE A.

Fig. 1. Showing large number of fruit spurs on vertical shoots in Wagener, 1913 growth. Shoots headed back. The measurements of the shoots are as follows:-

No. of shoot	Angle	Length in inches	Diameter in mm.	Total no. buds	Dormant buds	Vegetative shoots	Buds forming fruit spurs
1	(180°	13.0)	17.5	(10	0	3	7
	(150°	10.5)		(8	4	0	4
2	160°	25.25	14.1	20	4	3	13
3	170°	39.5	18.7	30	5	4	21
4	180°	29.5	18.8	23	3	4	16
5	180°	24.75	17.4	20	4	3	13
6	180°	30.0	18.2	24	6	3	15
7	160°	21.25	14.2	16	2	3	11
8	110°	12.0	14.4	9	2	4	3

Fig 2. Showing the large number of vegetative shoots formed in Wagener, 1913 growth. Shoots headed back.

1	170°	39.5	17.0	32	3	11	18
2	160	33.7	15.4	26	2	7	17

Fig. 3. Showing large number of fruit spurs on vertical shoots in Wagener, 1913 growth. Shoot headed back.

1	170	22.75	17.0	17	1	5	11
2	170	24.0	16.1	19	1	5	13
3	(170	16.0)	13.7	(11	0	4	7
	(150	11.25)		(10	5	0	5

PLATE A.



FIG. 1

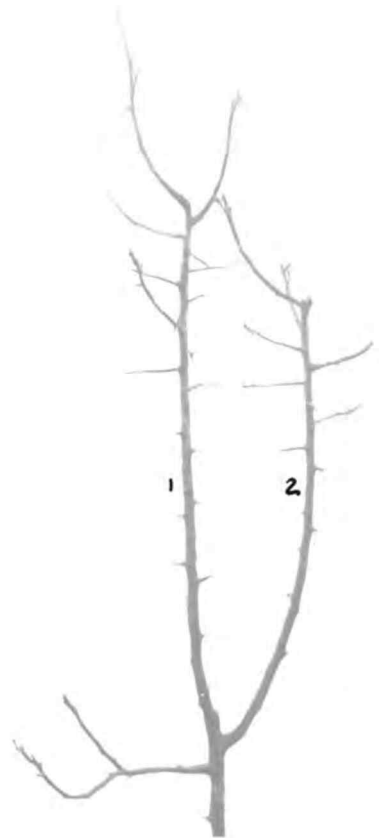


FIG. 2

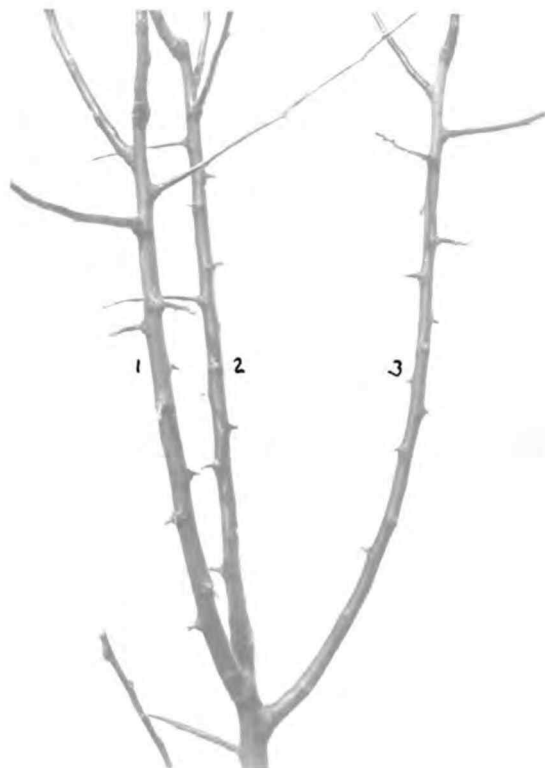


FIG. 3

PLATE B

Showing the shorter growth, and lack of bud development
in the more horizontal shoots of Wagener, 1913 growth.
Shoots headed back.

Fig. 1

No. of shoot	Angle	Length in inches	Diameter in mm.	Total no. buds	Dormant buds	Vegetative shoots	Buds forming fruit spurs
1	100°	11.0	11.4	11	4	2	5
2	110°	16.25	12.8	12	5	3	4

Fig. 2

1	120°	13.5	9.3	12	5	1	6
2	130°	25.0	11.8	19	7	3	9

PLATE B



FIG. 1



FIG. 2

PLATE C.

Group of shoots of Fameuse that grew in a downward position at angle of less than 30° , showing the short growth and the small development of buds.

PLATE C



PLATE D

Showing the greater number of fruit
spurs developed in thick shoots com-
pared with thin shoots.

Fig. 1. Fameuse, 1913 growth.

No. of Shoot	Diameter in millimeters.
1	5.2
2	4.9
3	5.0
4	2.9
5	2.8
6	2.6

Fig. 2. Fameuse, 1912 growth.

1	2.4
2	3.6
3	3.8
4	4.4
5	5.2
6	5.3

PLATE D



FIG. 1



FIG. 2

PLATE E.

Showing the greater number of fruit
spurs developed in thick shoots com-
pared with thin shoots.

Fig. 1 Shiawassee, 1913 growth.

No. of shoot	Diameter in millimeters
1	4.4
2	4.8
3	2.8
4	3.6

Fig. 2 Shiawassee, 1912 growth.

1	7.2
2	3.7

PLATE E

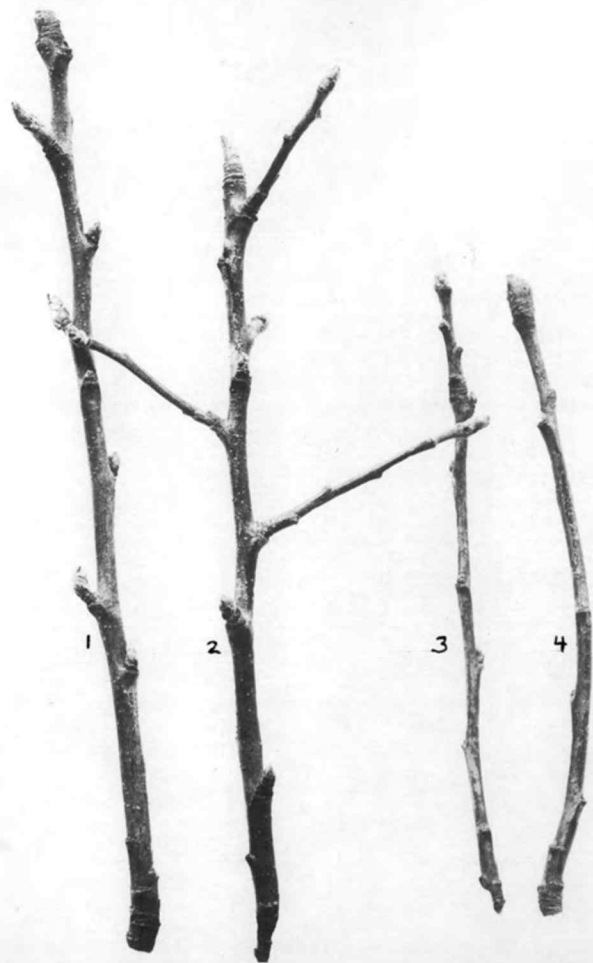


FIG. 1



FIG. 2