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The Agricultural Experiment Station.

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TOBACCO.

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The Agricultural Experiment Station.

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INTRODUCTION.

The question of raising tobacco in Colorado was first discussed in a conversation between the Director and the late Horticulturist and Botanist of the Agricultural College—James Cassidy—some time during the year 1883, and, in the following year, a few plants were raised, but were not properly ripened or cured. The experience of that year was so encouraging that each year following some tobacco was raised. Leaf tobacco was raised that was pronounced by experts to be excellent, and samples, which were sent to various places to be examined, bore out the previous testimony as to its good quality.

Tobacco was not grown in quantity until 1888 and 1889, after the organization of the Experiment Station, under an act of Congress. The results of the two years work are recorded briefly in this bulletin. The chemical analysis of the several varieties raised is also tabulated for comparison and reference, and shows a quality that is good from the chemical standpoint. Cigars have been made from the crop of 1888, which have been tested by many persons. One box was manufactured and presented to the Denver Manufacturers' Exchange, for use at their annual banquet, January, 1890, where only Colorado products, so far as was possible, were used.

The people of the State will be pleased to know that the work has been carried to a successful conclusion. One

more money-making crop has been added to the varied crops heretofore produced; one which will bring to the producer, if well cared for and well cured, as much cash return per acre as many acres of wheat, and as every new article produced within our State adds to its wealth producing power, so this crop will put money in the hands of the farmers, either from that retained within the State by means of a home production, or from exported surplus.

It is a pleasure for me to state that the work, from first to last, was in the hands of Prof. James Cassidy, who closed his life and his labors November 21, 1889, just as he was closing his labors for the year. The value of this work cannot be estimated to-day; in the next half century some approximation may be attempted.

With the issue of this bulletin the State Experiment Station closes its work with tobacco, for the present at least, hoping that its other lines of work, when completed, may lead to as valuable results as this has done.

Respectfully,

C. L. INGERSOLL,

Director.

TOBACCO.

The cultivation of tobacco was continued the past season. Only three varieties were grown—Havana, White Burley and Golden Pryor. The area devoted to the main crop was one-half acre, which was set out exclusively to Havana. The White Burley and Golden Pryor were planted in single rows 100 feet in length, merely at the request of New York parties, with a view to test the quality of the same. Tests were also made with tobacco grown on poor soil and rich soil, to determine the quality by chemical analysis. The results appear in the report of Dr. O'Brine, the Chemist of the Station. The cultivation of the plant was nearly the same as in the previous year, with these exceptions (see Annual Report, 1888). The raising of plants in hot-beds is expensive, and a rather difficult matter for anyone but a gardener, for it takes great care and experience to keep the small plants while they are in the seed leaf from damping off. To overcome this we started a cold frame, covered with cloth. Seed was sown April 9, ten days later than those sown in the hot-bed. The plants raised were set out about a week later than the others, but the tobacco ripened about the same time. Our soil is a clay loam that was heavily manured with well-rotted stable manure and coarse spoiled hay and rubbish. The latter were burned off, so

as to give the soil the potash, so essential to the raising of a good tobacco. The planting was done May 28 and 29, in rows three feet apart, plants one foot apart in the row. Our aim this year was to grow a finer leaf, more suitable for wrappers. In this we succeeded, by crowding the plants closer together, 8,000 being needed to set a half acre. The weight of stalk and leaves, when harvested, was 5,842 pounds.

CURING.

This season we did not place the tobacco in layers on the floor, when it came from the field. The tobacco was hung up at once, and the room closed. In this way we succeeded in obtaining a leaf of firmer texture and more uniform color. We also saved considerable labor. Care must be taken to keep the tobacco house closed and the air moist until the leaf has attained a deep yellow color, when a little ventilation will be necessary. This is to be increased as the curing process advances.

BULKING.

After the leaves were stripped and tied in bundles, called hands, the tobacco was piled in a conical heap, butts out, to go through a sweat or process of fermentation. A year ago we deferred this fermentation until the following spring by breaking up these heaps as soon as they became warm, but found that we were unable to bring the tobacco to a sweat without artificial means. The heat soon rises (in from two to three days), and it is of the most importance to watch this fermentation closely. If the heat rises above 130° F., the heaps must be opened up. It is advisable to break up the bulks after the first fourteen days, and again a month later. Change the hands by bringing the center on the outside, and the

outside ones in the center. The tobacco may now remain in bulk until there is a chance for sale, when it is packed in boxes. The tobacco grown from our own seed, raised here a year ago, proved to be much inferior to that grown from imported seed, and it would not pay to raise such tobacco. The experiences of this year show that nothing but Havana seed leaf should be grown in this region. A fine Havana leaf will always command a ready sale at a good price. The expense of raising the crop was somewhat greater than a year ago, and we think it would be of interest to compare the crop of 1888 with that of 1889:

	Green Tob., lbs.	Cured Tob., lbs.	Expense.	Relative Expense Per Acre.
1888----	4,858	850	\$52.34 $\frac{2}{3}$ a.	\$69.79
1889-----	5,842	732	39.25 $\frac{1}{2}$ a.	78.50

The price offered for the crop of 1888 was 17 cents per lb., which would make the following showing:

850 lbs. tobacco at 17 cts. ----	\$144.50
Expense of raising -----	52.34
	<hr/>
Net profit, two-thirds acre, \$	92.16

Or the rate of \$138.24 net per acre.

A computation for the crop of 1889 would show the following result:

732 lbs. at 17 cts-----	\$124.44
Deduct expense of raising----	39.25
	<hr/>
Net profit, one-half acre--\$	85.19

This would make a net profit at the rate of \$170.38 per acre for the crop of 1889, although the cost of raising the one-half acre in 1889 was more than that of raising

the two-thirds acre in 1888, yet the net results are relatively greater in 1889.

It will also be seen that this year's crop has a much lighter leaf than the tobacco raised in 1888, as it weighed 1,000 pounds more green, but over 100 pounds less when cured.

[Extract from report of 1889, Section of Botany and Horticulture.]

Chemical Section.

In 1888 and 1889, there was undertaken by this Section of the Experiment Station, a study of the tobaccos grown by the Section of Horticulture. This was to comprise an analysis of the ash of each variety, for purposes of comparison; and, also, analyses of the same variety when grown upon rich (fertilized) soil and poor (unfertilized) soil.

Before giving the results of such work, a few words as to the work heretofore performed, and results attained, may not be out of place, as showing how this crop is affected by various circumstances.

In general, it has been found that the plant varies in texture and quality with the climate, the soil, the fertilizer used, and, perhaps, from other circumstances attending its growth and cultivation.

CLIMATE.

The climate has more influence on the quality of tobacco than soil or manner of cultivation. The proper degree of heat, of moisture, and the influence of sunlight have much to do with the development of the aromatic principle for which certain brands of tobacco are so highly esteemed. Colorado has excellent conditions for producing tobacco of fine quality. The summer climate is superb, giving that heat and dryness so essential, and with

water of irrigation to produce the proper moisture, while the greater number of hours of sunlight in connection with the foregoing, gives peculiar and advantageous conditions of growth.

THE SOIL.

The soil here is formed from the disintegrated rocks of the adjacent foothills and mountains. The College garden has a soil quite similar to a majority of this region, and was that upon which the varieties of tobacco were grown. Its analysis shows the following constituents present, and the per cent. in which each was found:

Moisture -----	2.78
Insoluble silica -----	72.71
Hydrated silica -----	7.07
Soluble silica -----	.04
Iron, $\text{Fe}_2 \text{O}_3$ -----	3.37
Alumina, $\text{Al}_2 \text{O}_3$ -----	4.29
Phosphoric acid, $\text{P}_2 \text{O}_5$ -----	.21
Calcium, CaO -----	.70
Magnesia, MgO -----	.85
Potash, $\text{K}_2 \text{O}$ -----	.41
Soda, $\text{Na}_2 \text{O}$ -----	.71
Sulphuric acid, SO_3 -----	.08
Chlorine, Cl -----	.12
Carbonic acid, CO_2 -----	2.79
Volatile and organic matter ---	4.53
	100.66

of which .02 is nitrogen.

Coarse gravel -----	34.72
Fine material -----	65.28

FERTILIZERS.

We have already noticed the fact that fertilizers affect the tobacco plant. Heavy manuring increases the quantity per acre, but the tobacco is generally of an

inferior quality. We are indebted to Schloesing and Nessler for the action of manures upon tobacco ground. Their experiments show that potash salts, sulphates and carbonates act beneficially upon the quality, while the chloride injures it. Nessler shows that gypsum has an excellent effect upon the burning quality of tobacco, possibly by liberating potash. Farm-yard manures, when well rotted, are excellent; wood ashes also. It is for this reason that lands recently cleared of heavy timber are excellently suited for the crop.

BURNING QUALITIES.

The burning qualities of tobacco determine its relative value. Schloesing found that a soil with but little potash produced a tobacco with poor burning qualities, and that this was improved by using potassium carbonate, sulphate or nitrate. A soil rich in nitrogenous matter also produces a strong tobacco, which burns poorly. Nessler's experiments prove that potassium carbonate, as manure, produced the best tobacco; with the sulphates one of poorer quality, and the chloride, the worst of all. The Connecticut Experiment Station (see Report, 1884) says that the most potash and the least lime were found in the tobacco which burned badly. In comparing the burning quality of the upper with the lower leaves of the same plant, Nessler found that the former were the better. In studying the burning of tobacco and the composition of the ash, several difficulties arise. Many organic acids, when burned, yield carbonates. Salts that fuse at the temperature of burning must hinder the process, while if there be present a large amount of cellulose (woody tissue) this fact must give a good burning quality.

VARIETIES AND ANALYSES.

The following varieties were cultivated in 1888 and 1889:

1—Landreth. 2—Veulte Abajo. 3—Spandona (imported from Italy). 4—Wilson's Prolific. 5—Dele de Sumatra (imported seed). 6—Havana Seedling. 7—Spagnola. 8—Cienfuegos. 9—Fiji Orinoco. 10—Spanish Hybrid. 11—Persian Rose Muscatella. 12—Isabella. 13—Benta (imported, Italy). 14—Dele de Sumatra (Missouri seed). 15—Golden Pryor. 16—Havana (rich soil). 17—Havana (poor soil). 18—White Burley.

The analyses were made from the stripped leaves; the dry and ground tobacco was burned at a low red heat in a platinum dish to obtain the crude ash. The amount of pure ash is obtained by subtracting the water, carbonic acid, silica and carbon from the crude ash. The silica present might be called an accidental impurity, as most of it consists of fine sand which has blown upon and adhered to the plant. There is nothing in the method of analysis worthy of especial mention, except that the method of soda lime for nitrogen determination gives results below that of Kjeldahls' method. The nicotine in No. 5 was determined after the method of Schloesing, and 2.85 per cent. was found present. Following is the table of results found in analysis of the eighteen varieties of tobacco grown upon the College farm, at the State Experiment Station:

ANALYSES OF TOBACCO ASH.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number	8.27	8.40	8.80	7.80	6.50	8.00	7.50	7.04	6.49	7.68	8.70	7.64	7.25	8.60	6.08	13.60	14.00	9.35
Moisture, 100° C.	23.63	25.01	27.00	24.00	22.60	27.00	28.00	25.00	25.80	27.05	26.40	26.00	23.10	25.90	17.90	24.90	26.07	25.85
Silica, SiO ₂	13.79	18.70	12.22	12.06	19.80	22.23	16.88	18.80	18.60	18.50	16.40	18.60	18.80	18.60	19.80	8.56	17.30	20.42
Carbon, C47	4.19	6.01	2.05	1.00	2.00	.65	1.01	3.59	.57	2.01	1.47	3.50	2.29	3.78	5.38	6.08	6.04
Iron and Alumina, Fe ₂ O ₃ -I- Al ₂ O ₃	5.46	3.55	4.08	.16	.94	2.02	5.42	.81	4.74	4.01	4.15	3.41	4.42	2.60	4.60	4.58	6.83	7.17
Lime, Ca O	18.03	20.27	20.83	17.38	16.56	24.34	20.09	21.21	19.06	18.43	21.17	18.83	18.00	18.80	15.56	21.03	19.05	16.54
Magnesia, Mg O	7.81	4.68	4.74	9.20	11.71	.59	Lost	.17	1.43	7.13	4.16	4.07	7.65	10.75	7.86	4.38	1.73	.84
Potash, K ₂ O	21.70	16.46	19.15	25.50	18.46	19.00	17.50	26.30	18.70	16.99	16.03	17.46	15.20	17.70	15.30	19.96	12.67	15.45
Soda, Na ₂ O29	.40	.65	.54	.37	.61	.75	.58	.49	.76	.79	.49	.39	.81	.52	3.73	5.77	4.08
Phosphoric Acid, P ₂ O ₅	2.84	2.81	2.68	3.12	1.46	1.42	2.33	1.66	2.31	2.79	3.26	2.55	1.86	1.44	2.79	2.64	3.88	2.86
Sulphuric Acid, SO ₃	5.65	4.15	7.34	2.64	4.89	3.90	5.93	2.29	4.67	7.09	7.63	6.64	4.77	5.28	6.70	5.29	8.18	4.90
Carbonic Acid, CO ₂	20.50	20.85	19.14	23.80	22.25	22.10	24.31	24.87	22.85	21.20	22.72	21.30	22.70	18.50	21.24	24.51	17.85	21.23
Chlorine, Cl	4.48	5.17	4.06	4.65	3.34	2.45	6.87	2.87	4.30	2.06	2.17	6.49	3.53	4.30	3.64	1.12	.64	.98
Oxygen equivalent to Chlorine	101.02	101.23	100.90	101.10	100.78	100.69	101.28	100.57	100.94	100.43	100.49	101.41	100.82	101.07	101.79	100.98	100.03	100.51
	1.01	1.16	.90	1.05	.75	.55	1.55	.65	.97	.46	.49	1.46	.79	.97	.82	.25	.14	.22
	100.01	100.07	100.00	100.05	100.03	100.14	99.72	99.92	99.97	99.97	100.00	99.95	100.03	100.10	99.97	100.73	99.89	100.29

Lithium was found in the ash of all the samples by the spectroscope. It possibly came from the lepidolite of the neighboring foothills.

The reader will please note the difference in composition of tobaccos grown on rich and poor soils respectively. But one analysis was made of the acids present in tobacco. By qualitative test there were found acetic, pectic, citric, malic and oxalic acids. Resinous and fatty substances were found in considerable quantities. Of their nature little is known. The active principle of tobacco is a volatile, highly poisonous liquid alkaloid, known as nicotine ($C_{10}H_{14}N_2$). Nessler says that this substance increases as the plants ripen, but again decreases when the plants are allowed to become overripe. When the tobacco is smoked the nicotine is partly decomposed, and the resulting products, together with those of the other constituents of the leaf, unite with the nicotine, which is unaltered, to produce the physiological effects which occur while smoking. If the tobacco burns well, a greater amount of nicotine is decomposed; but when it burns poorly, even though the sample may contain less nicotine, a less quantity is decomposed, and a greater narcotic effect is produced on the human system. The amount of nicotine present in the plant depends upon several considerations. The climate, the soil, the treatment during growth and curing, have each an influence. The finer tobaccos usually contain the smaller percentages.

CONCLUSIONS.

1. For conclusions, with reference to particulars in growth and after-treatment, see Bulletin No. 4 and First Annual Report, 1888.

2. Cigars manufactured from the crop of 1888 have been tested by many persons. The uniform testimony is that Colorado-grown tobacco makes a cigar of fine flavor with excellent burning qualities.

3. The chemical examination of the samples grown shows, by comparison with Connecticut grown tobaccos,

and those reported upon by Moore, Special Census on Tobacco, that, chemically, these tobaccos were good and fully up to the average of tobaccos produced elsewhere.

4. That tobacco is a profitable crop for the farmers of Colorado to raise; one which, if well grown and cured, will add much to the productive wealth of the State.

DAVID O'BRINE,

Chemist.

