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CHAMPAIGN, NOVEMBER, 1888.

BULLETIN NO. 3.

FIELD EXPERIMENTS IN OATS, 1888.

Experiment No. 12. Oats: Quantity of Seed Per Acre.*

Seven contiguous plats, each two by four rods, were sown broadcast April 5th, at the rate of from one to four bushels per acre. The seed was sown on fall-plowed land, covered by use of a disk harrow and twice harrowing. The field notes show that the oats came up evenly and well; that they headed evenly June 18th to 21st; that they were blown flat by a storm July 10th. July 18th and 19th they were mowed and bound. At this time the straw, leaves, and glumes were mostly yellow and dry. Those on plats 1 and 2, on which the least quantities of seed were sown, were slightly greener than the others. These plats also, especially plat 1, contained more weeds. The crop was threshed July 26th and 27th, that from plats 5, 6, and 7 after a slight shower and when somewhat damp.

The following table gives yield of grain and straw per plat, and calculated yield per acre:

TABLE SHOWING SEED SOWN: YIELD OF GRAIN AND OF STRAW.

Plat.	Quantity sown per acre, bu.	Grain, per plat, lb.	Grain per acre, bu.	Straw per plat, lb.	Straw per acre, lb.
1	1	84	52.5	191	3820
2	1.5	95	59.4	220	4400
3	2	98	61.3	227	4540
4	2.5	102	63.8	243	4860
5	3	99	61.9	261	5220
6	3.5	100	62.5	220	4400
7	4	97	60.6	213	4260

*The numbers given to these experiments are those which they bear in the records of the Station. (See pp. 11 and 12, Bulletin No. 1.)

Experiment No. 13. Oats: Compact or Loose Seed Bed.

Three plats, each two by four rods, were sown broadcast, April 6th, at the rate of two and one-half bushels per acre.

In plat 1, the oats were sown on fall-plowed land, and lightly covered with a disk harrow. The land was then rolled with a heavy garden roller and afterwards harrowed.

Plat 2 was cultivated with a disk harrow before sowing; the oats were covered by disking once and once harrowing.

Plat 3 was disked three times before sowing, once afterward, and then harrowed.

The oats came up evenly and ripened at the same time. They were harvested July 19th and threshed July 27th to 28th.

The following table gives the yield of grain per plat in pounds, and calculated yield per acre in bushels, with yield of straw per plat and per acre in pounds:

TABLE SHOWING CONDITION OF SEED BED; YIELD OF GRAIN AND OF STRAW.

Plat.	Seed bed.	Grain per plat, lb.	Grain per acre, bu.	Straw per plat, lb.	Straw, per acre, lb.
8	Compact	96	60	209	4180
9	Medium loose	106	66.3	269	5380
10	Very loose	97	60.6	223	4460

Experiment No. 14. Oats: Time of Sowing.

Four adjacent plats, each two by four rods, were sown broadcast, at the rate of two and one-half bushels per acre, at intervals of one week, from April 6th to April 27. In each case the oats were sown on fall-plowed land, and were covered by use of a disk harrow and the common tooth harrow.

The plants fairly covered the ground on plat 1 in nineteen days after sowing; on plat 2 in fourteen days; plat 3 in ten to twelve days; and on plat 4 in ten days.

The oats on plat 1 headed three days earlier than those on plat 2, and eleven days earlier than those on plats 3 and 4. The oats on plats 1 and 2 ripened nearly at the same time. They were mowed and bound July 20th, plat 1 being a little the riper. Plats 3 and 4 were harvested three days later, when at about the same stage of ripeness as plat 1 was when cut.

The following table gives the yield of grain per plat in pounds, the calculated yield per acre in bushels, and the yield of straw per plat and per acre in pounds:

TABLE SHOWING DATE OF SOWING AND YIELD OF GRAIN AND STRAW.

Plat.	Date of Sowing.	Grain per plat, lb.	Grain, per acre, bu.	Straw, per plat, lb.	Straw, per acre, lb.
11	April 6, 1888	106	66.3	254	5080
12	April 13, 1888	91	56.9	251	5020
13	April 20, 1888	78	48.8	252	5040
14	April 27, 1888	79	49.4	251	5020

Experiment No. 15. Oats: Depth of Sowing.

Sixty selected kernels were sown in each of twelve rows, ten feet long. The first two rows were covered one inch deep; and each succeeding two rows one inch deeper, rows 11 and 12 being covered with six inches of earth.

The number of plants growing in each row at various dates is shown by the following table:

TABLE SHOWING NUMBER OF PLANTS GROWING AT GIVEN DATES.

Row.	1	2	3	4	5	6	7	8	9	10	11	12
May 2	12	0	1	0	0	0	0	0	0	0	0	0
May 5	20	4	25	0	25	33	27	17	0	0	0	0
May 7	34	25	39	15	43	45	52	48	18	18	6	5
May 9	52	52	53	55	55	55	56	52	42	37	26	22
May 11	50	58	55	57	53	54	56	53	42	36	30	23
June 1	45	58	56	58	54	55	52	51	39	33	31	26
Aug. 4	41	51	46	53	46	48	46	46	38	31	30	20

The size and the apparent vigor of the plants in the rows was in the following order: First, rows 5 and 6; second, rows 3, 4, 7, and 8; third, rows 1 and 2; fourth, rows 9 and 10; fifth, rows 11 and 12.

The oats in rows 1 to 8 inclusive were fully headed July 6th; those in rows 9 and 10, less fully; and those in rows 11 and 12, still less.

The following table gives the yield of grain and of grain and straw in ounces, the number of plants and heads per row, and the number of heads per plant or stool in each row:

TABLE SHOWING YIELD OF GRAIN AND OF STRAW; NUMBER OF STOOLS AND OF HEADS.

Row.	Ounces of grain.	Ounces of straw and grain.	No. of stools.	No. of heads.	Heads per stool.
1	5.	35.	41	341	8.3
2	4.	22.	51	225	4.4
3	4.5	26.	46	265	5.8
4	3.5	20.	53	230	4.3
5	4.5	22.	46	217	4.7
6	5.5	26.	48	248	5.2
7	4.5	24.	46	239	5.2
8	5.	24.	46	230	5.
9	4.5	22.	38	222	5.8
10	3.5	23 5	31	259	8.4
11	2.5	21.	30	240	8.
12	3.	20.	20	205	10.3

OBSERVATIONS UPON GERMINATION AND STOOLING.

The fourteen plats used in these experiments were adjacent to each other. On each of these the number of plants growing on a given area, the proportion of seeds capable of germinating estimated to be sown, the number of plants growing under the different conditions of the plats, and the number of culms per plat or stool was ascertained.

The number of kernels in an ounce of the variety of oats sown was found to be 1,044. From this basis, the rate of seeding of each plat being known, the average number of kernels sown on 1-10,000 of an acre was computed.

The percentage of seeds capable of germinating under favorable conditions was found to be 87. The average number capable of germinating on 1-10,000 of an acre was computed for each plat.

The average number of plants growing May 11th on 1-10,000 of an acre in each plat was approximately determined by counting the number of plants found within a frame enclosing this area, the frame being placed at four equidistant points along the middle line of each plat. In a similar manner the number of stubs was ascertained after harvest. The average number of straws harvested, for each plant growing on May 11th, was thus ascertained.

The following table summarizes the results:

TABLE SHOWING FOR 1-10,000 ACRE, AVERAGE NUMBER OF SEEDS SOWN; AVERAGE NUMBER CAPABLE OF GERMINATING; AVERAGE NUMBER OF PLANTS; AVERAGE NUMBER OF STUBS. ALSO PER CENT. OF SEEDS CAPABLE OF GERMINATING FROM WHICH PLANTS GREW, AND AVERAGE NUMBER OF STRAWS FOR EACH STOOL.

Plat.	Average No. of seeds sown on 1-10,000 acre.	Average No. capable of germinating on 1-10,000 acre.	Average No. plants or stools on 1 10,000 acre.	Average No. stubs on 1-10,000 acre.	Per cent. of seeds capable of germinating from which plants grew.	Average No. of straws or culms per plant or stool germinating.
1	53	46	28	85	61	3.3
2	80	70	45	105	64	2.3
3	107	93	52	117	56	2.2
4	133	116	67	102	58	1.5
5	160	139	86	135	62	1.6
6	187	163	85	123	52	1.5
7	214	186	93	135	50	1.5
8	133	116	62	116	54	1.6
9	133	116	60	95	52	1.6
10	133	116	61	122	53	2.
11	133	116	58	114	50	2.
12	133	116	57	111	49	2.
13	133	116	54	88	47	1.6
14	133	116	55	111	47	2.

This table shows that when the oats were sown at varying rates, of from one to four bushels per acre, there should have been from 53 to 214

seeds sown on 1-10,000 of an acre (about 4.4 sq. ft.). Since 87 per cent. of similar seed germinated under favorable conditions, from 46 to 186 of these seeds were capable of germinating. Four weeks after sowing, from 28 to 93 plants were found growing in 1-10,000 of an acre in these plats; that is, from 50 to 64 per cent. of the seeds capable of germinating produced plants. In general, the larger proportion grew where the seeding was thinnest, although there were marked exceptions.

On eight plats, each sown at the rate of two and one-half bushels per acre, 51 per cent. of the seeds capable of germinating gave plants, or 44 per cent. of the seeds sown.

The average number of plants at harvest on 1-10,000 of an acre, on plats sown with different quantities of seed, varied from 85 to 135, or from about 20 to 30 per square foot.

At harvest the number of stalks was from 1.5 to 3.3 times the number of plants growing May 11th, on the plats sown at the rate of two and one-half bushels per acre; the average number of stalks was a little less than two from each plant or stool. Not all the plants counted May 11th came to maturity.

SUMMARY.

The trial was made in 1888, a season favorable for the oat crop in central Illinois, except for injury by a violent storm July 10th. The soil was a prairie loam of good quality, and the land had been manured and plowed the autumn previous. The plats were small, generally one-fortieth of an acre.

Welcome oats, a white variety of good reputation, were used in each experiment.

The rate of yield per acre of oats sown broadcast, at rates varying from one to four bushels per acre, varied from 52.5 bushels from sowing one bushel, to nearly 64 bushels from sowing two and one-half bushels per acre. There was but little variation in the plats sown at rates varying from two to three and one-half bushels per acre. The largest yield in any trial was at the rate of 66.3 bushels per acre, when two and one-half bushels had been sown per acre. The largest yield of straw was at the rate of 5,220 lb. per acre, when three bushels had been sown.

With plats sown at intervals of one week from April 6th to April 27th, with other conditions as nearly similar as possible, the earliest sowing gave a yield at the rate of 66.3 bushels per acre; about nine bushels more than from sowing one week later, and about seventeen bushels more than from either of the still later sowings. The yield of straw in each case was at the rate of about 5,000 lb. per acre. The later sowings came up more quickly and were but three days later in ripening.

Of selected kernels planted in rows and covered at depths varying from one to six inches, the more shallow plantings came up first, headed first, and ripened a little the earliest. The largest yield was from seed covered three inches; the next, from that covered four inches; the next from that covered one inch.

Oats sown on a moderately loose seed bed yielded at the rate of 66.3 bushels per acre, about six bushels more than when the seed bed was either more compact or very loose. The difference in yield of straw was still more directly in favor of the moderately loose seed bed.

Thirteen per cent. of the kernels of oats apparently of good quality and vitality failed to germinate under favorable conditions. In broadcast seeding in field plats, little more than 55 per cent. grew in any case, and an average of only 44 per cent. grew on eight plats.

The average number of stalks in each stool was less than two in the broadcast seeding.

Testing the vitality of oats designed for seed should be a common practice. With ordinary methods of field culture, probably less than one-half the kernels sown produce mature plants.

GERMINATION OF GRASS AND CLOVER SEEDS.

TESTS AND OBSERVATIONS IN CONNECTION WITH EXPERIMENTS NOS. 16-24.

There are four things which may affect the stand which may be obtained from seed sown in ordinary farm practice: (1) the quality and quantity of the seed; (2) the condition of the seed bed; (3) the depth to which seed is sown; (4) the character of the season. This inquiry relates to the first of these conditions.

The germinating power of grass and clover seeds is manifestly as important as that of corn; but while an insufficient stand of corn is usually attributed to poor seed, a like trouble with grasses and clovers is commonly charged to the character of the season.

The Station obtained from a reputable seedsman seeds of nineteen varieties of grasses and clovers. These, together with timothy and medium clover seed of home growth, were sown for purposes of experiment, such as comparison of varieties on small areas; growing on large areas for making feeding tests of varieties and mixtures; and sowing varieties with and without grain.

In this case it was not practicable to test the germinating power of varieties before sowing them; but samples were preserved and a test made, beginning June 20th, with the Geneva germinating apparatus invented at the New York Agricultural Experiment Station, Geneva, to the officers of which this Station is indebted for a model of the apparatus.

It consists of a pan made of tinned copper, 9x14 inches, and 3 inches deep, in which are folded two pieces of cotton flannel so as to make 50 pockets. The pockets are held in place by an equal number of copper rods resting on a shoulder around the inside of the pan, a little below the top. Care is taken to have all the pockets of the same depth, so that the water may be so put into the pan as just to touch the bottom of each. The pan is covered with a plate of glass and a place is made for the reception of a thermometer. This makes it possible to keep the seeds under

Of the twenty-one varieties of seed tested, an average of less than forty-two per cent. germinated during the first week. During the twelve following weeks about seven per cent. more germinated. The seeds of seven varieties, yellow oat grass, sweet vernal grass, Kentucky blue grass, rough-stalked meadow grass, meadow foxtail, and crimson trefoil, almost failed to germinate; not more than five per cent. in any case during the first week, and not more than eleven per cent. during the thirteen weeks, germinated. Of the seeds of six varieties, orchard grass, Italian rye grass, sheep's fescue, wood fescue, alfalfa, and red-top, about forty per cent. germinated, on an average, during the first week, and nearly fourteen per cent. more in the succeeding twelve weeks. Of eight varieties, timothy, perennial rye grass, tall meadow oat grass, meadow fescue, medium red clover, mammoth red clover, alsike clover, and white clover, a little more than seventy-seven per cent. germinated, on an average, during the first week, and about five per cent. more during the succeeding twelve weeks. The seeds of the first group were manifestly worthless; of the second, evidently of poor quality and impaired vitality; of the third, first class. The impaired vitality in the second was not only shown by the small percentage germinating, but by the slowness, fourteen per cent. germinating after the first week, while only five per cent. germinated after the first week in the third group. Grass seeds are necessarily lightly covered, and, therefore, easily injured by changes in the weather; hence it is of the greatest importance that they germinate quickly and vigorously.

It is hardly necessary to point out the obvious importance of testing the germinating power of seeds, illustrated by this simple experiment. Failure to obtain a stand not only involves present loss from direct outlay in seed and labor, but future loss from partial non-use of land as well as the disorganization of any system of cropping. No one factor in western farming so effectively prevents a careful and systematic rotation of crops as does the failure to obtain a stand of grass or clover.

It is an easy matter to test the vitality of grass and clover seeds, by placing a given number, say one hundred, of the variety to be tested, between woolen cloths moistened with water. Care should be taken to boil the cloths before using, to scald the plate or pan in which the cloths are laid, and to use only recently boiled water with which to moisten the cloths, in order to retard the growth of fungi, or moulding. Two or more cloths may first be laid upon the plate or pan, the seeds distributed upon the upper one and another cloth laid upon the seeds. Sufficient water should be applied to keep the cloths moist. A plate of glass laid over the plates or pans would add to the efficiency of the device by retarding evaporation and protecting the interior from floating germs of fungi. At a temperature of 70 to 80 degrees Fahrenheit, good seed should germinate in from a week to ten days. That seeds will germinate after being under such influence several weeks is plainly shown by the test herein reported; but seeds that do not respond in from seven to ten days under such fav-

orable influences can be of little value when subjected to the vicissitudes of an ordinary seed bed.

Having ascertained what percentage of the seeds in a given sample will germinate, we have yet to determine at what rate such seed must be sown in order to insure the desired stand of plants.

As the next step, a gram of the seed of each variety of grass and clover, such as was sown, was taken and the number of seeds in it counted. Some weed seeds were found, and they were counted separately. The number of seeds in one pound of each variety of seed was then computed.

The following table gives the number of seeds per gram and per pound thus found. The table gives also the number of seeds per pound (taken from Flint's Grasses and Forage Plants, p. 271), as ascertained by Lawson, of Edinburgh; the rate at which seed was sown here per acre in pounds; the computed number of seeds sown per square foot; and the computed number of these capable of germinating under favorable conditions:

TABLE SHOWING NUMBER OF GRASS AND CLOVER SEEDS PER GRAM AND PER POUND; RATE OF SOWING; SEEDS SOWN PER SQUARE FOOT; GERMINABLE SEEDS PER SQUARE FOOT.

Plat.	Name.	No. seeds per gram.		Computed No. of grass or clover seeds per pound.	Computed No. of grass or clover seeds per pound. — Lawson.	Pounds of seed sown per acre.	Computed No. seeds per sq. foot sown.	Computed No. seeds per sq. ft. capable of germinating under favorable circumstances.
		Grass or clover seeds.	Weed seeds.					
1	Orchard grass.....	1006	0	457,272	640,000	35	368	169
2	Timothy.....	3127	7	1,421,363	1,184,000	15	490	314
3	Perennial rye grass.....	539	0	245,000	250,000	60	337	226
4	Italian rye grass.....	607	0	275,909	432,000	60	380	118
5	Tall meadow oat grass.....	342	0	155,454	336,000	40	143	86
6	Yellow oat grass.....	2430	0	1,104,545	1,188,000	30	761	0
7	Meadow fescue.....	613	1	278,637	416,000	30	192	154
8	Sweet vernal grass.....	1406	10	639,091	1,136,000	30	440	22
9	Kentucky blue grass.....	4807	12	2,185,000	3,888,000	40	2006	0
10	Rough-stalked meadow grass.....	5982	0	2,719,091	3,472,000	30	1873	56
11	Wood meadow grass.....	4763	5	2,165,000	2,768,000	30	1491	45
12	Sheep's fescue.....	1719	0	781,364	1,024,000	30	539	210
13	Wood fescue.....	1908	1	867,272	0	30	597	203
14	Meadow foxtail.....	2190	5	995,454	1,216,000	40	914	18
15	Medium red clover.....	801	2	364,091	256,000	10	84	71
16	Mammoth red clover.....	732	6	332,727	256,000	10	76	72
17	Alsike clover.....	1490	2	677,272	0	75	117	103
18	Crimson trefoil.....	335	6	152,272	0	10	35	2
19	White clover.....	1899	4	863,181	512,000	10	198	154
20	Alfalfa.....	535	0	243,181	201,600	10	56	29
	Red-top.....	9099	1	4,135,909	7,800,000	30	2849	1168

It must be borne in mind that the number of seeds will vary somewhat, often considerably, in samples from different lots of the same seed,

and even in different samples from the same lot. Results, therefore, can be taken, at best, as approximations only. As computed, the average number of seeds per pound for the fifteen varieties of grasses was, in round numbers, 1,228,000. The variety containing the largest number of seeds per pound, 4,136,000, was red-top; the variety containing the least number, 155,000, was tall meadow oat grass. Kentucky blue grass contained 2,185,000; timothy, 1,421,000; and orchard grass, 457,000 seeds per pound.

The average number of seeds per pound of the six varieties of leguminous plants (clovers and alfalfa), was 439,000; white clover contained the largest number, 863,000; crimson trefoil the least number, 152,000; mammoth clover contained 364,000; medium clover, 333,000; alsike, 677,000; and alfalfa, 243,000 seeds per pound.

Such large numbers convey but little meaning to the mind, except comparatively. When the numbers sown on a small area, as a square foot, are considered, they are more easily comprehended. In the table, the rate of seeding is given in pounds per acre, and is the rate employed in the experiments above mentioned. From this, the average number of seeds per square foot may be computed.

The average number of seeds sown per square foot, thus computed, was 892 for the fifteen varieties of grasses. The largest number was 2,849 for red-top; the smallest number, 143, for tall meadow oat grass. The number of seeds of timothy was 490; of orchard grass, 368; and of Kentucky blue grass, 2,006. The average number of seeds sown per square foot for the six leguminous varieties was 94; the largest number, 198, for white clover; the least number, 35, for crimson trefoil.

Assuming that the percentage germinating within a week in the test is the percentage capable of germinating under favorable conditions, the number per square foot capable of germinating under favorable conditions may be computed. Returning to the former grouping, the average number germinating in the first group would be 20; in the second, 317; in the third, 152. In the third, the average germinating power is nearly double that of the second, while there would be but half the number capable of germinating under favorable conditions on account of the smaller number of seeds sown.

Notwithstanding the long-time discussion of the relative merits of thin and thick seeding, there are few exact data as to the proper amount of seed to be sown; the proportion between the amount capable of germinating under favorable conditions and the amount germinating in an ordinary seed bed; or the number of plants per square foot necessary to constitute a good stand in meadows, in American farm practice.

Probably from eight to twelve pounds per acre of timothy is usually sown, or from 250 to 400 seeds per square foot; and eight pounds per acre of medium clover, or about 70 seeds per square foot. In sowing a given variety, the number of seeds to be sown will depend largely upon the habits of growth of the plant and somewhat on the size of the seed;

for the larger the seed the greater the percentage of seeds that will be capable of resisting unfavorable conditions.

Taking present practice as a guide, it is probable that with those grasses whose habits of growth are somewhat like timothy, such as orchard grass, the rye grasses, and the fescues, from 250 to 400 seeds should be sown. With grasses like red-top and Kentucky blue grass, more is desirable. With the clovers and alfalfa, from 50 to 100 seeds per square foot seems sufficient.

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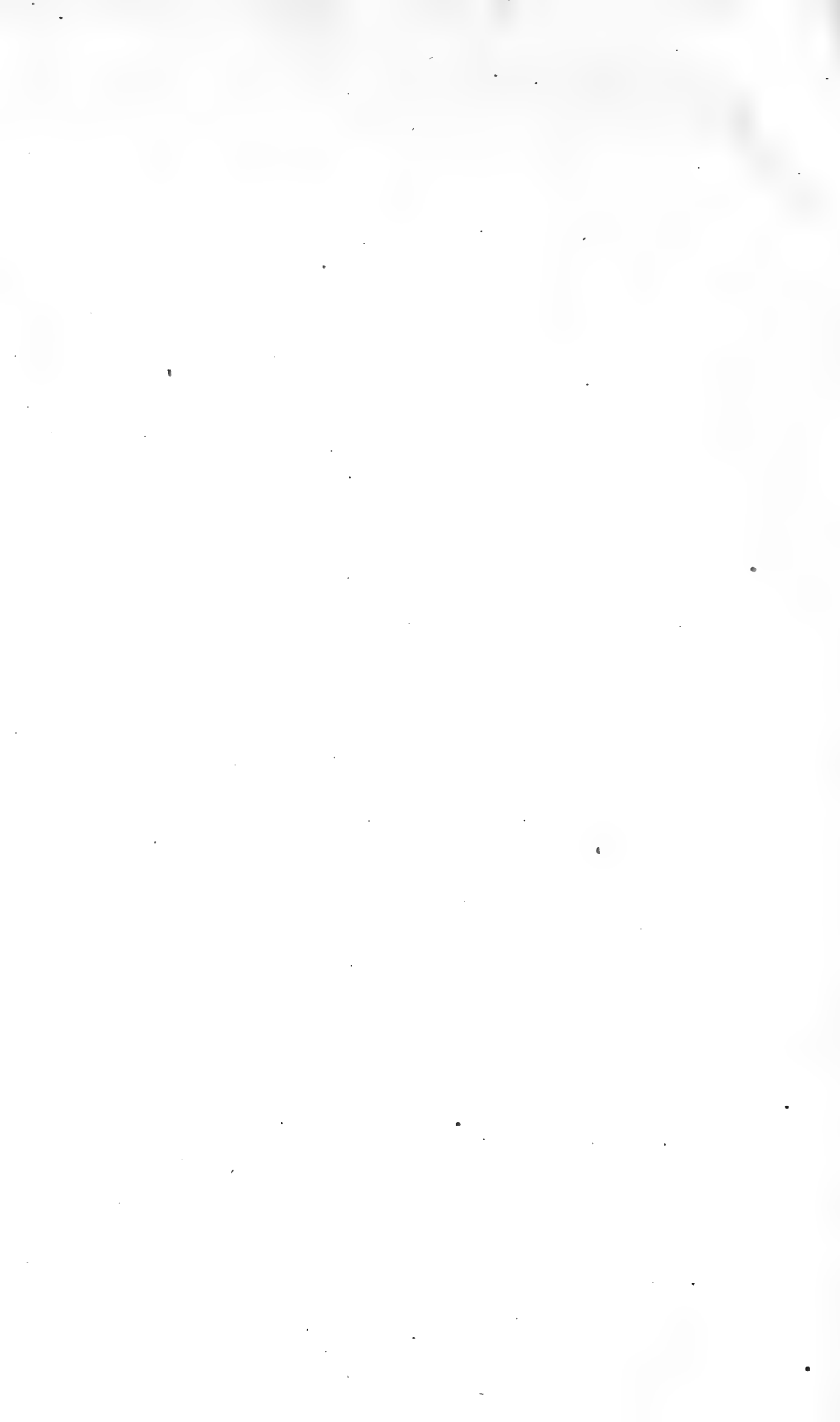
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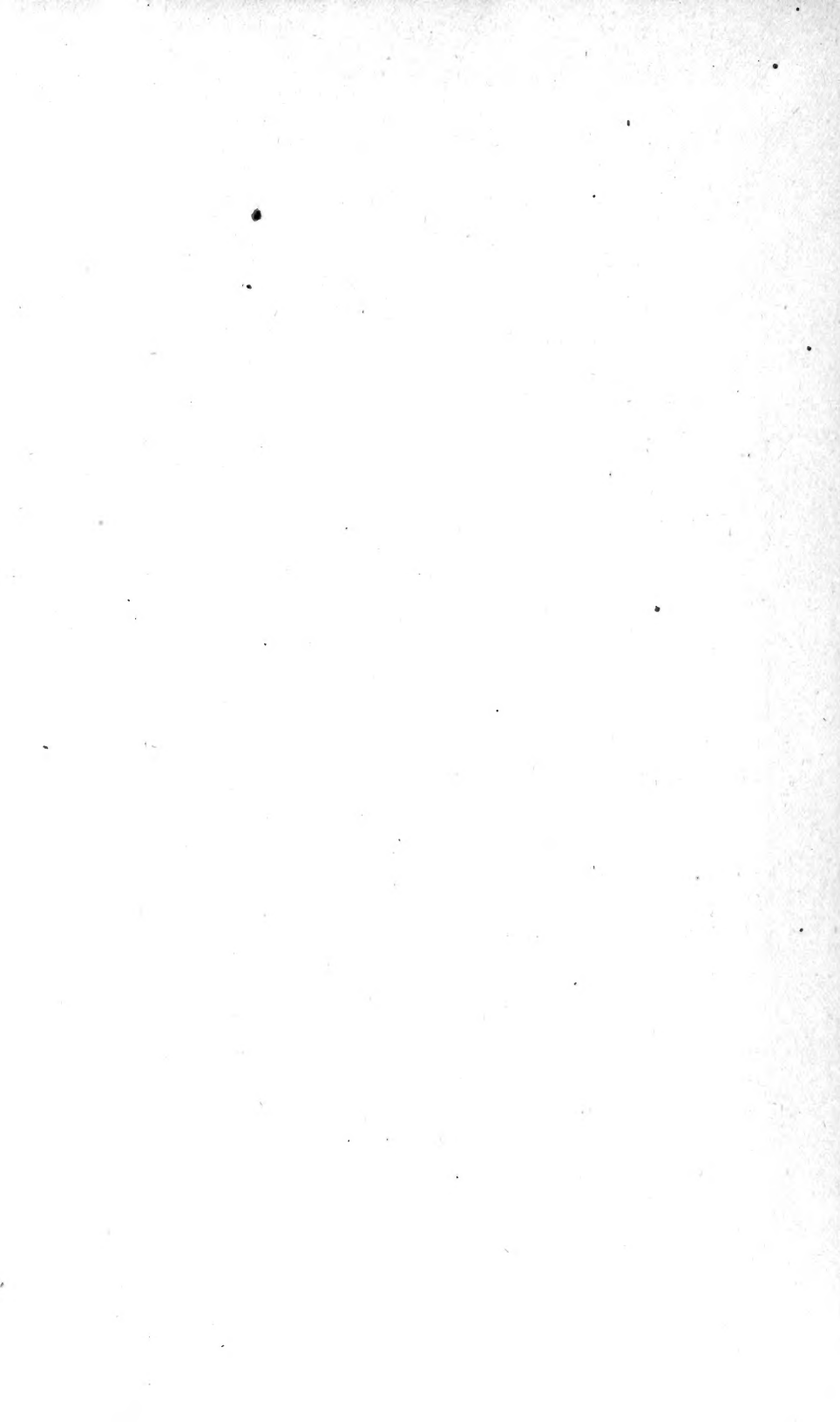
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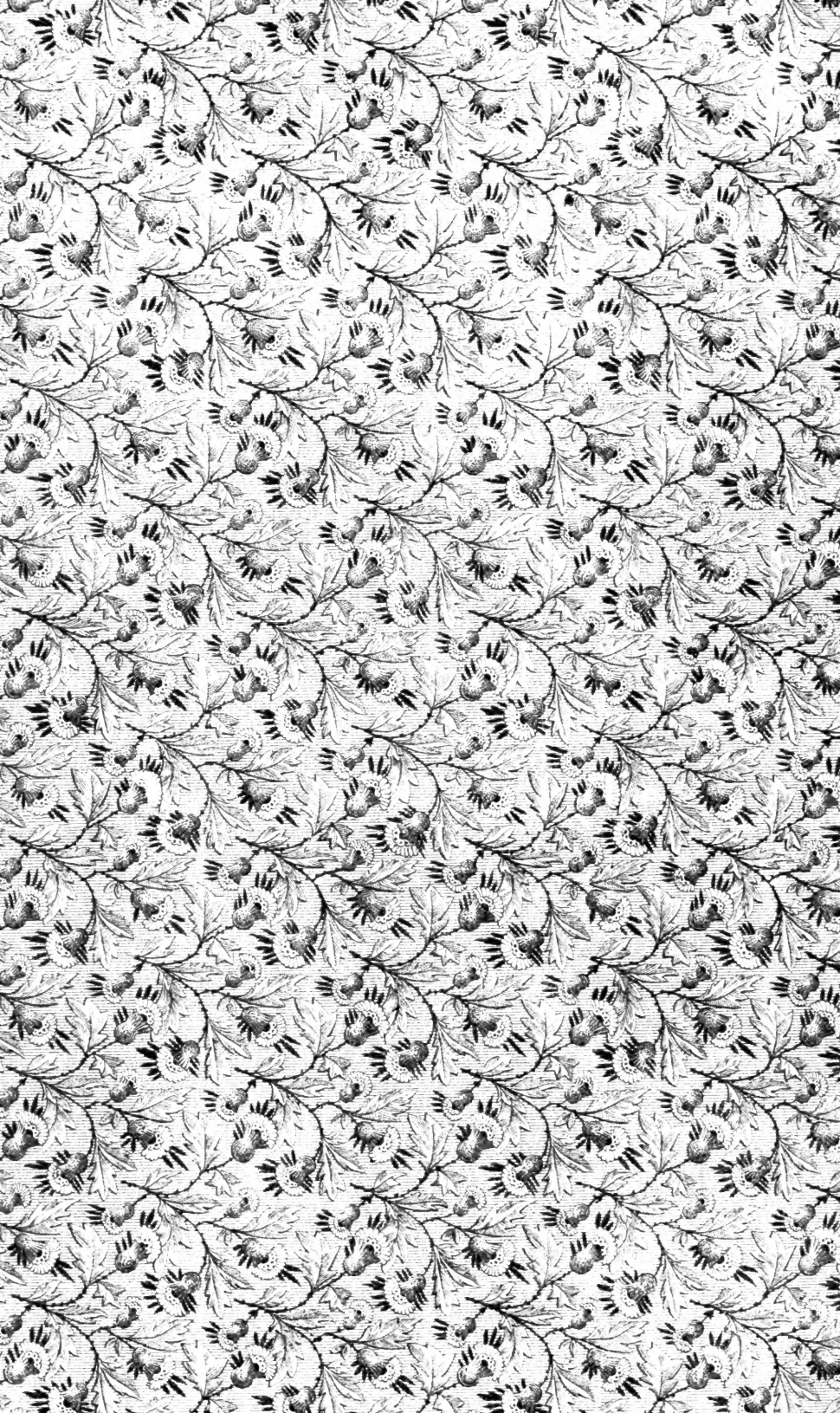
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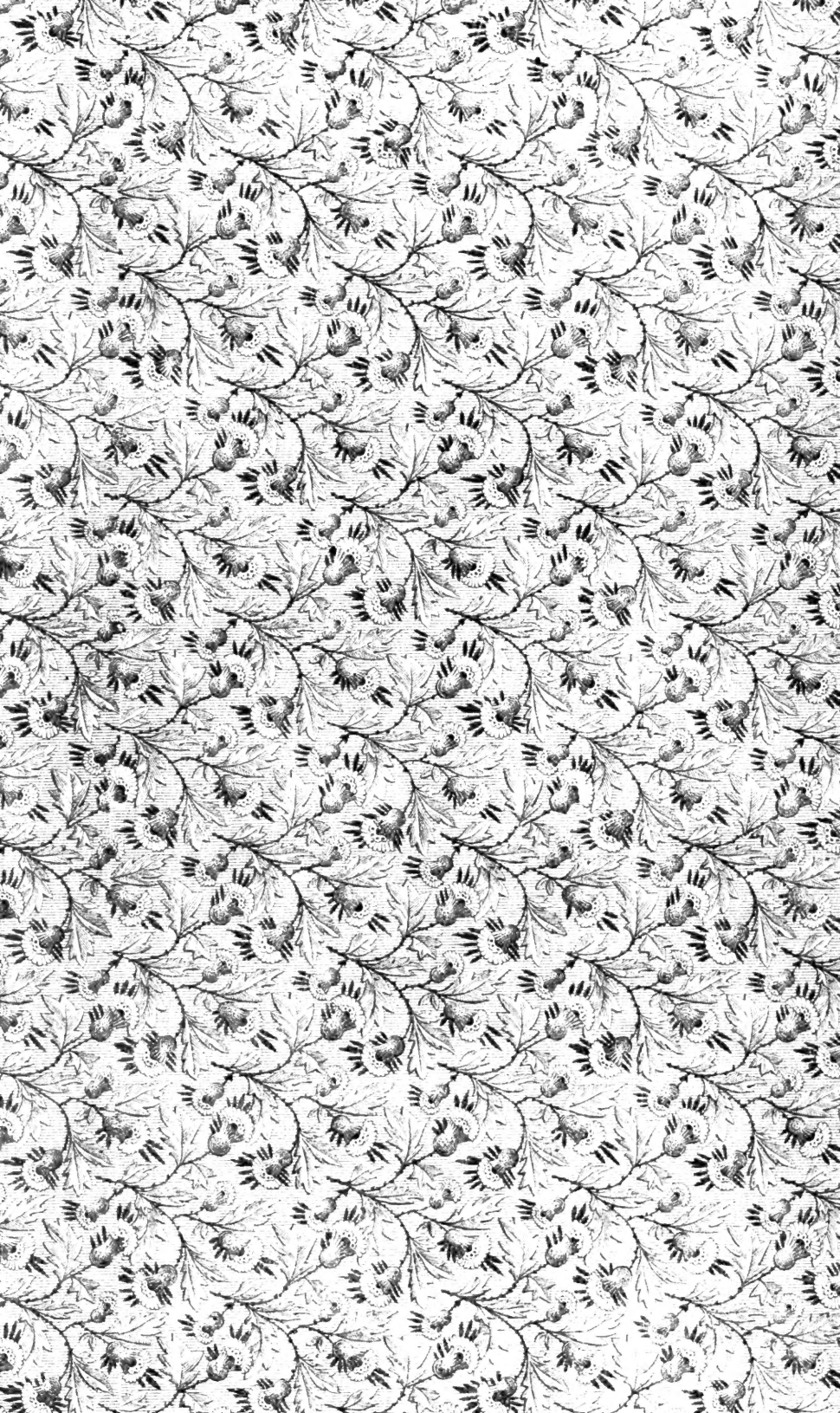
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