such as thin planting on rich land when it was expected that the crop grown from this seed would be planted thick on soil of average fertility. Severe selective processes for the purpose of adapting the plant to its environment must always be active. For this reason it would seem that good ears from rather thick planting would be much more valuable for seed purposes than good ears from thin plantings. In the ordinary field of corn, planted in hills, if you find a hill with but one plant, it usually bears a good ear, while the ears on plants, 4 in a hill are generally much smaller. However, even in thick planting, now and then a stalk will produce a good ear. This ear should be valuable for seed, since the plant has demonstrated its ability to produce well even in thick plantings. This seems to be an important point to give attention to in seed selection, and one of the principal arguments in favor of selecting seed in the field, where it will be possible to see whether the good ear has grown under unusually favorable conditions or under merely average conditions.

SOME CORRELATED CHARACTERS IN WHEAT AND THEIR TRANSMISSION.

By T. L. Lyon, *University of Nebraska, Lincoln, Nebr.*

I shall spend no time in discussing the reasons why a study of the correlated characters in wheat is of importance to the breeder of that crop. The fact that Dr. Webber's name appears upon the program for a paper on "The Importance of Correlated Characters in Plant Breeding" makes any further discussion of the subject superfluous.

The results that I present herewith were obtained in the course of a coöperative experiment now being carried on between the Plant Breeding Laboratory of the Federal Department of Agriculture and the Nebraska experiment station, in which the attempt is being made to improve the quality as well as the yield of wheat. The work has necessitated making a large number of determinations of total proteids, gliadin, glutenin, etc., in the kernels of wheat from individual plants, and the relation of these chemical constituents to certain physical characters has led to conclusions somewhat at variance with the commonly accepted beliefs. Owing to insufficient time for preparation the results cover a period of only two years instead of four years, as it was intended they should do.

PROTEID NITROGEN CONTENT IN RELATION TO NUMBER, WEIGHT AND SIZE OF KERNELS.

In the summer of 1902, eight hundred spikes of wheat of the Turkish Red variety were selected in the field, care being taken that they were fully ripe and that they were composed of healthy, well-formed kernels. Of these spikes, 257 were sampled by removing one row of spikelets from each spike and the kernels so removed were tested for moisture, proteid nitrogen, specific gravity and weight of kernel, and from the last two was calculated the relative volume of the average kernel. It had previously been demonstrated that a sample taken in the manner described above, permits of an accurate estimation of the average composition of the kernels on the spike.

In Table 1 the average for all spikes having a proteid nitrogen content of from 2 to 2.5 per cent are arranged in one group, and on the same line with these are placed the number of kernels on one row of spikelets, weight of these kernels, weight of average kernel, relative volume of average kernel, specific gravity of kernel, grams of proteid nitrogen in one row of spikelets, and grams of proteid nitrogen in average kernel. Spikes having a proteid nitrogen content of from 2.5 to 3 per cent are similarly arranged, and so with all spikes up to 4 per cent.

TABLE 1.—*Summary of analyses of wheat, arranged according to nitrogen content of kernels—crop of* 1902.

Range of percentage of proteid nitrogen	Percentage of proteid nitrogen in kernels.	Number of—		Weight of—		Volume of average kernel.	Specific gravity.	Proteid nitrogen in—	
		Analyses	Kernels on row of spikelets.	Kernels.	Average kernel.			Kernels.	Average kernel.
Per cent	*P. ct.*			*Gram.*	*Gram.*	*cc.*		*Gram.*	*Gram.*
2 to 2.5	2.32	18	17	0.4759	0.0266	0.0209	1.374	0.01141	0.000643
2.5 to 3	2.76	82	17.1	.4791	.0279	.0207	1.368	.01332	.000776
3 to 3.5	3.23	107	17.4	.4724	.0270	.0199	1.367	.01520	.000874
3.5 to 4	3.70	49	17.3	.4715	.0257	.0199	1.349	.01672	.000982

From this table it will be seen that with an increase in the percentage of proteid nitrogen, the number of kernels on a row of spikelets remains about constant; that in general there was a decrease in the weight of the kernels on a row of spikelets and a slight decrease in the weight of the average kernel; and that the volume of the average kernel decreased, as did the specific gravity.

It may safely be stated that a high percentage of proteid nitrogen was in these spikes associated with a kernel of low specific gravity, light weight, and small relative volume, and, as the spikes were selected for their ripeness and healthy appearance, this relation can not be attributed to immaturity or disease.

The table last referred to shows a decrease in the weight of the kernels on the spike as the percentage of proteid nitrogen increases; but it also shows that in spite of the decrease in the weight of the kernels there is an increase in the actual amount of proteid nitrogen they contain, and that the same is true of the average kernel.

Table 2 gives a summary of the same analyses, arranged according to the specific gravities of the kernels. All spikes whose kernels had a specific gravity below 1.30 are grouped in one class, those having a specific gravity of 1.30 to 1.33 in another class, and so on until finally all spikes having a specific gravity of more than 1.42 form the last class.

TABLE 2.—*Summary of analyses of spikes of wheat, arranged according to specific gravities of kernels—crop of* 1902.

Range of specific gravity.	Specific gravity of kernels.	Number of—		Weight of kernels.	Percentage of proteid nitrogen in kernels.	Weight of average kernel.	Proteid nitrogen in—	
		Analyses.	Kernels.				Kernels.	Average kernel.
Per cent.				*Gram.*	*P. ct.*	*Gram.*	*Gram.*	*Gram.*
Below 1.30	1.255	8	16.7	0.3887	3.29	0.02331	0.01280	0.0007662
1.30 to 1.33	1.315	17	16.5	.4315	3.35	.02617	.01446	.0008762
1.33 to 1.36	1.347	50	17.3	.4008	2.91	.02366	.01508	.0008756
1.36 to 1.39	1.375	71	17.2	.4794	3.06	.02786	.01462	.0008559
1.39 to 1.42	1.399	40	16.7	.4848	3.03	.02899	.01459	.0008729
1.42 and over	1.463	8	19.1	.5287	3.07	.02773	.01605	.0008371

This table shows no constant relation between the specific gravity and the number of kernels on the spike. With an increase in the specific gravity there is an increase in the weight of the kernels on the spike, and with some exceptions an increase in the weight of the average kernel. As the specific gravity increases, the percentages of proteid nitrogen decreases, which agrees with the previous table. The grams of proteid nitrogen in the kernels on the spikes and in the average kernel increase with the specific gravity.

Table 3 shows the summary of the same analyses, arranged according to the weight of the average kernel. Spikes whose kernels have an average weight of less than 0.024 gram form the first class, and each succeeding class increases by 0.002 gram.

TABLE 3.—*Summary of analyses of spikes of wheat, arranged according to weight of average kernel—crop of* 1902.

Range of weight of average kernel.	Weight of average kernel.	Number of—		Weight of kernels.	Specific gravity of kernels.	Percentage of proteid nitrogen in kernels.	Proteid nitrogen in—	
		Analyses.	Kernels				Average kernel.	Kernels.
Gram.	*Gram.*			*Gram.*		P. ct.	*Gram.*	*Gram.*
Below 0.024	0.02214	27	16.9	0.3812	1.341	3.197	0.0007184	0.01215
0.024 to 0.026	.02528	38	17.5	.4425	1.361	3.28	.0008294	.01438
0.026 to 0.028	.02705	48	17.0	.4609	1.360	3.22	.0008711	.01475
0.028 to 0.030	.02896	40	17.0	.4916	1.372	3.11	.0009090	.01546
0.030 to 0.032	.03089	26	17.0	.5274	1.388	2.86	.0008787	.01506
0.032 and over	.03324	19	16.8	.5588	1.373	2.88	.0009594	.01617

There seems to be no relation between the weight of the average kernel and the number of kernels on the spike. The weight of all the kernels on the spike naturally increases with the weight of the average kernel. The specific gravity of the kernels increases with the weight of the average kernel. The percentage of proteid nitrogen decreases with an increase in the weight of the average kernel, in which respect it agrees with the two previous tables. The grams of proteid nitrogen in the average kernel and the total proteid nitrogen in the spike increase with the weight of the average kernel.

Samples from each of the spikes of wheat from which these data were derived were planted, together with samples from other spikes all of which have been analyzed, aggregating 800 in all. Each kernel was planted separately at a distance of 6 inches each way from every other kernel. The kernels from each spike were marked by a stake bearing the record number of the spike.

During the winter a considerable number of plants were killed, so that the stand was irregular in the spring. In some cases all of the plants resulting from a spike of the previous year were killed, and in other cases only a portion of such plants. The result was a somewhat uneven stand, which doubtless gave certain plants an advantage over others in growth and yield.

When the crop was ripe in 1903, each plant was harvested separately and all of those resulting from spikes which the previous year had shown a proteid nitrogen content of more than 4 per cent or less than 2 per cent were analyzed, as were also a certain number resulting from spikes of intermediate values.

The good kernels on each plant were counted and weighed, thus giving a record of the yield of each plant. From these data the average weight of the kernels per plant was calculated. The specific gravity was not determined and consequently the average volume of the kernels on each plant was not calculated, as was done the previous year.

In Table 4, the plants harvested in 1903 are arranged in classes of 1 to 2 per cent proteid nitrogen, 2 to 2.5 per cent, 2.5 to 3 per cent, 3 to 3.5 per cent, 3.5 to 4 per cent, 4 to 4.5 per cent, and over 4.5 per cent. The number and weight of the kernels on each plant are stated, as is also the average weight of each kernel. The number of grams of proteid nitrogen in all the kernels of the plant is shown, and also the number of grams of proteid nitrogen in the average kernel on each plant.

TABLE 4.—*Summary of anlayses of plants, arranged according to percentage of proteid nitrogen.—crop of* 1903.

Range of percentage of proteid nitrogen	Pecentage of proteid nitrogen in kernels.	Number of—		Weight of—		Proteid nitrogen in—	
		Analyses	Kernels.	Kernels.	Average kernel.	All kernels.	Average kernel.
Per cent.	*P. ct.*			*Grams.*	*Gram.*	*Gram.*	*Gram.*
1 to 2	1.749	28	320.3	6.2382	0.01871	0.10655	0.0003291
2 to 2.5	2.32	65	396	8.2502	.02011	.19032	.0004660
2.5 to 3	2.73	145	370	7.1755	.01935	.19442	.0005271
3 to 3.5	3.18	66	235	4.3856	.01837	.13966	.0005816
3.5 to 4	3.69	22	190	3.6895	.01867	.13698	.0006872
4 to 4.5	4.27	11	292	5.0340	.01769	.21674	.0007559
4.5 and over	5.07	14	208	4.1573	.01859	.20897	.0009487

These results, so far as they cover the same ground as those of the previous year, have the same significance. They show quite a uniform although slight decrease in the weight of the average kernel accompanying an increase in the percentage of proteid nitrogen, and a very marked increase in the number of grams of proteid nitrogen in the average kernel. Especially marked is the increase in the amount of proteid nitrogen in the average kernel, amounting to 28 per cent of the weight of the kernel for every 1 per cent increase in the content of proteid nitrogen.

One column of this table, not contained in that compiled from results of the previous year, shows the number of grams of proteid nitrogen contained in all of the kernels on the plant; or, in other words, the proteid nitrogen production of the plant. This appears, on the whole, to increase with the percentage of proteid nitrogen, although the results are not sufficiently consistent to permit of an unqualified statement to that effect. The uneven stand of the plants, before referred to, doubtless accounts for these inconsistent results.

Two other columns contain data not obtained in 1902. The first of these shows the number of kernels per plant, which apparently decreases slightly as the percentage of proteid nitrogen increases, but this cannot be stated unqualifiedly. The next column shows the weight of kernels per plant or the yield per plant, which likewise seems to decrease slightly with an increase in the percentage of proteid nitrogen.

When the results obtained in 1903 are tabulated according to weight of average kernel and range of proteid nitrogen in average kernel they confirm the results of 1902.

Condensing the results of the two years it may be said that the kernels of high nitrogen content are smaller and lighter, both by actual weight and by specific gravity, than are kernels of low nitrogen content. It may also be said that the plants having kernels of high nitrogen content do not produce as large an amount of grain as do those having kernels low in nitrogen. This is an important consideration for the wheat breeder, because it shows that there will be a difficulty to meet in attempting to improve both the productiveness and the milling quality of wheat.

Another fact brought out by these results is that, while selection of large heavy kernels for seed would result in discarding the immature and unsound kernels, there would also he discarded many sound kernels which, although of low specific gravity, would contain a high percentage of proteids and would come from plats that would reproduce these qualities.

RELATION OF QUANTITY AND QUALITY OF GLUTEN IN WHEAT.

On the supposition that the ratio of gliadin to glutenin in wheat determines the quality of the gluten it is of interest to ascertain the relation of the gluten content to the ratio of these two constituents in wheats having high and low percentages of gluten.

In Table 5 analyses of the crop of 1903 are arranged in groups according to their content of gliadin plus glutenin. The first group comprises all plants having less than 1 per cent; the second those plants having from 1 to 1.25 per cent; the third those having from 1.25 to 1.50; etc.

TABLE 5.—*Summary of analyses, showing the ratio of gliadin to glutenin as the content of the sum increases.*

Range of percentage of gliadin-plus-glutenin nitrogen.	Percentage of gliadin-plus-glutenin nitrogen.	Number of analyses.	Percentage of— Gliadin nitrogen	Percentage of— Glutenin nitrogen	Proportion of— Gliadin.	Proportion of— Glutenin.	Percentage of— Proteid nitrogen	Percentage of— Other proteid nitrogen.
Per cent.	*Per cent.*		*Per ct.*	*Per ct.*			*Per ct.*	*Per cent.*
Below 1	0.484	11	0.276	0.208	0.562	0.438	2.93	2.448
1 to 1.25	1.166	3	.914	.252	.793	.207	2.89	1.721
1.25 to 1.50	1.385	10	.741	.645	.536	.463	2.90	1.518
1.50 to 1.75	1.619	18	.852	.767	.523	.477	2.65	1.037
1.75 to 2	1.889	37	1.044	.845	.552	.448	2.82	.929
2 to 2.25	2.130	39	1.187	.943	.557	.443	3.05	.921
2.25 to 2.50	2.374	12	1.268	1.105	.535	.465	3.16	.791
2.50 and over	2.947	7	1.588	1.358	.534	.466	3.98	1.029

It will be seen from Table 5 that the ratio of gliadin to glutenin remains practically the same as the percentage of their sum increases.

It would therefore be safe to assume that an increase in the gluten content of a given variety of wheat raised in the same region would carry with it a corresponding improvement in its value for bread-making, although there might be fluctuations from year to year in quality of gluten, as there is in the quantity.

TRANSMISSION OF SOME CORRELATED CHARACTERS.

Selected plants have been grown on a large scale for two years. From these results it is very apparent that a high percentage of nitrogen and the qualities that go with it are transmissible from one generation to another.

TABLE 6.—*Summary of analyses, showing transmission of nitrogen from one generation to another.*

Range of percentage of proteid nitrogen.	1902 Percentage of proteid nitrogen in kernels.	1902 Number of analyses.	1902 Proteid nitrogen in average kernel.	1902 Weight of average kernel.	1903 Percentage of proteid nitrogen in kernels.	1903 Number of analyses.	1903 Proteid nitrogen in average kernel.	1903 Weight of average kernel.
Per cent.	*Per ct.*		*Gram.*	*Gram.*	*Per ct.*		*Gram.*	*Gram.*
1 to 2	1.66	15	....	....	2.59	46	0.0004960	0.01991
2 to 2.5	2.35	3	0.000601	0.02585	2.68	13	.0005172	.01915
2.5 to 3	2.61	2	....	....	2.49	11	.0005147	.02032
3 to 3.5	3.24	84	.000875	.02700	2.93	199	.0005604	.01919
3.5 to 4	3.68	31	.000990	.02650	2.91	79	.0005508	.01920
4 to 4.5	4.12	3	.000988	.02472	2.81	8	.0005496	.01959
4.5 and over	4.95	1	.001074	.02171	3.43	2	.0004496	.01000

In Table 6 are analyses of the plants of the crop of 1902, grouped according to their proteid nitrogen content into classes of from 1 to 2 per cent, 2 to 2.5 per cent, 2.5 to 3 per cent, etc. Opposite the plant number of each plant of the crop of 1902 are given its percentage of proteid nitrogen and weight of proteid nitrogen in kernels. On the same line are the plant numbers for the entire progeny in 1903, and following these are the percentage of proteid nitrogen, weight of proteid nitrogen per average kernel, and average weight of kernel for all of these progeny.

This table is designed to show whether there has been a tendency for plants of a certain class to reproduce the qualities pertaining to that class, or whether these are lost in the offspring.

It is unfortunate that there are not a greater number of analyses of plants of medium and of low nitrogen content. The plants selected for reproduction in 1903 were largely those of high nitrogen content, and consequently, comparatively few analyses of the low nitrogen and medium nitrogen plants of 1903 are at hand.

Table 6 shows that in the main there is a tendency for each class of plants to reproduce in the same relation to the other classes, but that there is less difference between the extreme classes in the offspring than in the parent plants. In other words, while all plants tend to reproduce their own qualities, those plants varying widely from the average, produce, in general, offspring varying from the average less widely than did the parents. Although this is a rule, its application to the individual is not universal. Certain plants may be found whose tendency to variation extends through both generations. There is also wide variation between certain plants of the same parent. For instance, the plants numbered from 21205 to 21212, all of which come from the same parent, vary from 2.16 to 5.23 per cent in proteid nitrogen content, while plants 69805 and 69806 vary from 5.82 to 1.66 per cent in this constituent.*

It would seem, therefore, entirely reasonable to believe that a very considerable increase in the proteid nitrogen content of wheat may be effected by careful and continuous reproduction from plants of high proteid content.

TABLE 7.—*Analyses showing transmission of proteid nitrogen in average kernel.*

Range of proteid nitrogen in average kernel.	1902				1903			
	Proteid nitrogen in average kernel.	Number of analyses.	Percentage of proteid nitrogen in kernels.	Weight of average kernel.	Proteid nitrogen in average kernel.	Number of analyses.	Percentage of proteid nitrogen in kernels.	Weight of average kernel.
Gram.	*Gram.*		*Per ct.*	*Gram.*	*Gram.*		*Per ct.*	*Gram.*
0.000600 to 0.000700..	0.000659	3	3.03	0.02220	0.000496	8	2.59	0.01895
0.000700 to 0.000800..	.000776	9	3.29	.02405	.000444	15	2.68	.01673
0.000800 to 0.000900..	.000850	18	3.33	.02576	.000544	38	2.91	.01875
0.000900 to 0.001000..	.000938	18	3.37	.02796	.000514	35	2.89	.01784
0.001000 and over....	.001077	15	3.71	.02880	.000593	28	3.06	.01905

*Table 6 represents the properties of each plant grown in 1903 arranged according to immediate families. For instance, plants numbered 17305-17308 are all offspring of the same plan grown in 1902. The parent bears the number 17301. This is the system of records devised by Prof. W. M. Hays, Asst. Sec., U. S. Department of Agriculture.

Table 7 contains the analyses of plants raised in 1902 and their progeny raised in 1903, arranged according to the number of grams of proteid nitrogen contained in the average kernel of the former.

TABLE 8.—*Analyses showing transmission of kernel weight.*

Range of weight of average kernel.	1902 Weight of average kernel.	1902 Number of analyses.	1902 Percentage of proteid nitrogen in kernels.	1902 Proteid nitrogen in average kernel.	1903 Weight of average kernel.	1903 Number of analyses.	1903 Percentage of proteid nitrogen in kernels.	1903 Proteid nitrogen in average kernel.
Gram.	*Gram.*		*Per ct.*	*Gram.*	*Gram.*		*Per ct.*	*Gram.*
Below 0.024	0.02253	12	3.61	0.000811	0.01684	19	2.69	0.000450
0.024 to 0.026 ..	.02515	12	3.28	.000813	.01740	28	2.88	.000503
0.026 to 0.028 ..	.02709	18	3.43	.000927	.01947	38	2.91	.000562
0.028 to 0.030 ..	.02878	16	3.41	.000993	.01875	31	2.98	.000573
0.030 and over ..	.03152	6	3.31	.001044	.01869	12	2.96	.000548

Table 8 shows the analyses of plants raised in 1902 and their progeny raised in 1903, arranged according to weight of average kernel. There is more variation in this table than in the preceding one, but the tendency toward transmission of proteid nitrogen in the average kernel may be noted. The averages for 1902 are much higher than for 1903, owing partly to the higher percentage and partly to greater kernel weight.

The weight of the average kernel shows some tendency toward transmission, although there are some variations. It will be noticed that the kernels average much heavier in 1902 than in 1903, and that in spite of this the percentage of proteid nitrogen is higher in 1902. The relation of light kernel and high percentage of nitrogen does not therefore appear to hold as between crops of different years.

All of the qualities of which determinations have been made in both years appear to be transmitted. It may be safely assumed that certain plants will have greater power to transmit these qualities than will the average plant. Such plants will assert themselves in the course of three or four generations. From these plants individuals may be selected that have a combination of the desired qualities.

RELATION OF LENGTH OF GROWING PERIOD TO YIELD AND NITROGEN CONTENT OF GRAIN.

Each wheat plant on the breeding plats was harvested separately in 1903, and a record was kept of the date of harvesting of each of these plants. These data have been tabulated for the purpose of showing the relation between the length of the growing season and the yield of grain from individual plants of the same variety.

Table 9 contains these data, tabulated according to the date of ripening. Plants ripening between the 7th and 11th of July, 1903, form the first class, those ripening between July 11 and 15 the second class, and so on by periods of four days until July 27, all ripening after that date constituting the last class. The dates of ripening thus extend over a period of three weeks.

TABLE 9.—*Summary of yield and nitrogen content of grain, tabulated according to length of growing period.*

Plants grouped according to date of ripening.	Number of analyses.	Average date of ripening.	Yield.	Percentage of proteid nitrogen.	Weight of average kernel.	Proteid Nitrogen in—	
						Kernels.	Average kernel.
			Grams.	*Per ct.*	*Gram.*	*Gram.*	*Gram.*
July 7 to 11	49	July 8.9 ..	9.9067	2.69	0.02024	0.26475	0.0005356
July 11 to 15	65	July 13 ...	7.6611	2.81	.01887	.20820	.0005290
July 15 to 19	50	July 16.2 .	5.1354	2.87	.01869	.14452	.0005222
July 19 to 23	56	July 20.1 .	6.5399	2.93	.01886	.18064	.0005482
July 23 to 27	52	July 23.2 .	4.9015	2.93	.01878	.13654	.0005544
July 27, or later ...	83	July 27.2 .	4.6636	2.94	.01992	.12854	.0005800

It is very evident from this table that the early-maturing plants are the most prolific. The weight of the average kernel remains very uniform; the later-maturing plants do not appear to have produced shrunken kernels. Evidently the plants ripening during the first four days produced the largest amounts of grain, and their kernels were as heavy as those produced later. The smaller productiveness of the later maturing plants in the season of 1903 does not appear to have been due to shrunken or light kernels.

The percentage of proteid nitrogen appears to be somewhat less in the grain of the early-maturing plants. The number of grams of proteid nitrogen in the average kernel is likewise less in the early-maturing plants.

The relation of length of growing season to both yield and composition of grain is contrary to what might have been supposed. A long growing period without excessively hot or dry weather might naturally be thought to increase the yield and increase the percentage of carbohydrates in the grain.

RELATION OF SIZE OF HEAD TO YIELD, HEIGHT, AND TILLERING OF PLANT.

The size of the head has always been considered to be closely connected with the productiveness of wheat. The well-known work of Hallet in increasing the yielding qualities of wheat is perhaps the best example of wheat improvement by the selection of plants having large heads. Whether large heads or a large number of medium-sized heads on a plant are more desirable is still a question.

Table 10 gives the yields, etc., of between 300 and 400 plants, tabulated according to the number of kernels on the head. Table 36 is a summary of these, while tables 11 and 12 consist of the same data tabulated according to the yield per plant and yield per head, respectively.

TABLE 10.—*Summary of relation to size of head to yield, height and tillering of plant.*

Classification according to number of kernels on head.	Number of plants.	Average number of kernels on spike.	Yield per plant.	Yield per head.	Weight of average kernel.	Height.	Tillering.
			Grams.	*Gram.*	*Gram.*	*Cm.*	
Below 16	18	13.3	1.3169	0.2654	0.02059	55.2	6.9
16 to 20	36	18.4	3.7758	.3383	.01862	64.1	13.7
20 to 24	80	22.2	6.8466	.4355	.01953	73.8	21.4
24 to 28	84	25.9	7.5207	.4848	.01874	73.8	21.2
28 to 32	73	30.1	7.4992	.5598	.01958	74.5	19.4
32 to 36	38	34.1	7.2530	.6868	.02023	73.9	15.4
More than 36	25	42.1	3.3723	.7148	.01710	71.0	10.2

It will be seen from Table 10 that the heads of slightly more than medium size produced the largest yields of grain; that the weight of the average kernel did not increase with the size of the head, nor did it decrease except on the very largest heads; that the plants with somewhat more than average sized heads were the tallest, and that the plants with medium-sized heads or slightly less tillered most largely.

TABLE 11.—*Relation of yield of plant to height and tillering, and to the yield per head.*

Classification according to yield per plant.	Number of plants.	Yield per plant.	Height.	Tillering.	Yield per head.
Grams.		*Grams.*	*Cm.*		*Grams.*
Below 1	31	0.6050	56.5	3.7	0.3553
1 to 2.5	67	1.7673	62.2	7.0	.4740
2.5 to 5	87	3.5526	69.1	11.6	.4917
5 to 10	93	7.6485	75.4	22.1	.5320
10 to 15	51	12.2862	84.4	32.3	.5592
15 to 20	20	17.1908	84.6	42.9	.5310
More than 20	5	23.2829	85.2	43.2	.686

Table 11 shows that, with an increased yield per plant, there is a constant increase in the height and tillering of the plant.

TABLE 12.—*Relation of yield per head to yield, height, and tillering of plant, and to weight of average kernel.*

Classification according to yield per head.	Number of plants.	Yield per head.	Yield per plant.	Height.	Tillering.	Weight of average kernel.
Grams.		*Gram.*	*Grams.*	*Cm.*		*Gram.*
Below 0.300	30	0.2484	1.6939	60.8	11.4	0.01586
0.300 to 0.400	62	.3567	3.7365	65.6	15.5	.01737
0.400 to 0.500	98	.4524	6.7326	72.8	19.9	.01847
0.500 to 0.600	78	.5477	9.5646	76.6	21.8	.02073
0.600 to 0.700	50	.6372	7.6214	74.3	17.3	.02056
0.700 to 0.800	25	.7456	4.4523	75.2	18.6	.02179
More than 0.800	12	.9229	5.7687	73.7	10.3	.02151

Table 12 indicates that the yield per head and yield per plant do not increase together, but that the largest yielding plants are those of medium yield per head. The same would seem to be true of the height and tillering of the plant. The weight of the average kernel increases quite uniformly with the yield per head.

It is quite evident from these tables that the number of heads on a plant is more important in determining its productiveness than is the size of the heads, and that, although the kernels are larger on plants having large heads, they are not necessarily so on plants producing the greatest weight of grain.

PLANT ADAPTATION.

By A. M. TEN EYCK, *Professor of Agriculture, State Agricultural College, Manhattan, Kansas.*

That the varieties of domesticated plants under cultivation vary in productiveness, quality and hardiness in different soils and climates is a fact well authenticated but not fully understood. In the annual convention of the American Agricultural Colleges and Experiment Stations, in 1890, Prof. W. J. Green, of the Ohio experiment station in discussing the subject of variety testing, stated that as a general rule it is true that varieties of fruit which proved best in one State proved best in all other States having the same latitude and similar climatic conditions. He did not consider the difference in location or soil to be prominent factors in determining the value of a variety for any particular locality. Apparently the adaptation of plants is more influenced by climatic conditions than by soil conditions, although doubtless both have their effect on the plants in determining the adaptation of a certain variety for a certain locality. However, I have observed, in studying variety testing of several crops at different experiment stations, that the best producing varieties of corn and other grains at one station are often found to be among the best producers at other stations, although often the climate and soil conditions are not entirely similar. Evidently there is a great deal in breeding, and in the hereditary power of a well-bred plant to transmit its qualities to its descendants under varying conditions. However, we learn from the origin and development of plant varieties that a variety of fruit or any other plant should not do equally well everywhere and why it should not.

Out of 270 species of cultivated plants, M. De Candolle has succeeded in finding the wild forms of 193 species. Of the remainder, 27 he considers doubtful as half-wild, and the rest he has not yet been able to find in the wild state. Darwin holds that in such cases the cultivated plant has either changed so much that its wild prototype can no longer be recognized, or that its original form has ceased to exist. From a single comparatively valueless, primitive, wild form have originated in the course of time thousands of valuable varieties of plants, all differing from the original, and some to such an extent that they cannot be recognized.