

THE INHERITANCE OF PUBESCENT NODES IN A CROSS BETWEEN TWO VARIETIES OF WHEAT¹

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Nearly all varieties of wheat have glabrous nodes, but there are some which have pubescent (velvet) nodes. One of these was furnished to the authors by J. A. Clark, of the Office of Cereal Investigations. It was a bearded variety with glabrous glumes, which had been found by Ball and Clark as a rather common admixture in a plot of mixed Pacific Bluestem and Baart (Early Baart) wheat on the Adams County Branch Station at Lind, Washington. It was given Cereal Investigations accession number 5877 and, tentatively, the name "Velvetnode." As it does not occur as a commercial variety, it does not appear in the published classification of American wheats. Its most peculiar character was the possession of hairy nodes.

To study the inheritance of the hairy node the Velvetnode variety was crossed with a strain of unknown origin in the plant-breeding nursery. It was being carried under the name "New Columbia" but is not related to the variety grown commercially under that name, which is the same as Fultzo-Mediterranean. The Cornell strain is beardless, has pubescent glumes, and glabrous nodes. This strain has been given Cereal Investigations No. 5946. It is most closely related to Mealy but has very purple stems.

The first generation of this cross resulted in plants that were beardless, with pubescent glumes and nodes. The plants seemed to be perfectly fertile and the heads were well filled with seed.

The seeds from these F₁ plants were sown in the field in the fall of 1921, and the resulting plants were studied during the following summer. Although it had been thought that the Velvetnode was a spring variety, all of the plants seemed to survive the winter and produced fairly thrifty plants.

At harvest time the plants were pulled and sorted first for pubescent nodes only. While there was some variation in the length and number of hairs on the nodes there was no attempt to distinguish between the different types, and all individuals that had any hairs on the node were classed as pubescent. The segregation seemed to indicate a 3:1 ratio with pubescent node dominant. On observing the two lots of plants, however, it was noted that all of the bearded plants were in the group with hairy nodes. No bearded plants were found in the glabrous-noded class. The plants were then reclassified according to the characters of nodes and beards. The results of this segregation are shown in Table I.

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TABLE I.—Showing the segregation in F_2 for beards and pubescent nodes

	Pubescent node		Glabrous node	
	Beardless	Bearded	Beardless	Bearded
Observed.....	468	202	237	0
Calculated 2 : 1 : 1.....	453.5	226.75	226.75	0
Deviation.....	14.5	24.75	10.25	0

These results show that there were no bearded plants with glabrous nodes. The presence of beards usually is due to one factor for beards and the ratio obtained usually is 3 beardless to 1 bearded, and the pubescent-node character occurs in the simple 3 : 1 ratio with pubescence dominant, as described above. Therefore, when the grouping is made according to the two characters one would expect to obtain some plants that were bearded with glabrous nodes unless linkage occurs. In this case the data seem to indicate that there may be a linkage between beards and pubescent nodes. These two characters come in together and out of 907 plants there is not a single case of a crossover type. This also may suggest that beards and hairy nodes result from one factor and that the difference between the parent forms is due to one factor pair. For the present such an assumption will be made.

In respect to the node character the Velvetnode variety may be designated by VV and the beardless strain with glabrous nodes by vv . The F_1 gametes may then be represented by Vv . In F_2 there will be the following types and in the ratio indicated:—1 VV : 2 Vv : 1 vv . The numbers obtained deviated somewhat from the calculated numbers and the value of P is 0.168, which does not indicate a very good fit. When the different plants are tested in F_3 , however, it seems that the facts support this 1 : 2 : 1 assumption. There are certain exceptions that will be mentioned later.

According to this assumption, the bearded plants with pubescent nodes (VV) all will breed true; the same is true also for the beardless plants with glabrous nodes (vv). The beardless hairy-noded plants (Vv) all should segregate again into the three types.

Of the F_2 plants, 238 were chosen for testing in the F_3 . The numbers from the different classes were as follows: 123 beardless with pubescent nodes, 68 bearded with pubescent nodes, 47 beardless with glabrous nodes.

From the F_2 generation, 123 plants that were beardless with pubescent nodes were tested in F_3 . According to the above assumption these would be expected to segregate into beardless glabrous, beardless pubescent, and bearded pubescent, in the ratio of 1 : 2 : 1. Of these plants, 117 segregated in this manner, and, while the number of individuals is not large in some of the families, yet the total number of plants is rather large. The total number is 1,295 beardless glabrous, 2,524 beardless pubescent, and 1,158 bearded pubescent. The calculated numbers for the three classes are 1,244.25 : 2,488.50 : 1,244.25.

There is considerable difference between the calculated and observed numbers. Part of this may be due to the fact that some plants became very ripe in the field before they were harvested (all the notes were taken in the field), and owing to the shattering of some of the awns or beards it was difficult at times to be sure a plant was bearded. The value of P in this case is only about 0.014, which shows a poor fit for a case of this sort. If it were not for the breeding behavior, one would conclude that the deviation from expectancy was too great to substantiate the hypothesis assumed.

In addition to these 117 plants there were certain ones that showed a different behavior. For example, there were four F_2 beardless plants with pubescent nodes whose progeny did not segregate into the three groups as did those of the 117 plants noted above. Two of these plants produced plants with hairy nodes only, but segregated for beards. These produced 76 plants that were beardless with pubescent nodes and 20 plants that were bearded with pubescent nodes. While these numbers are not large, nevertheless in other cases with smaller numbers the expected 1:2:1 ratio was obtained or approached. The other two F_2 plants produced only beardless plants in F_3 , but segregated for pubescent and glabrous nodes.

Thus, out of 123 plants of the F_2 , 117 reproduced the three types in the expected ratio, 1:2:1, that would follow providing the difference between the parent forms is due to one pair of factors. The occurrence of these six plants that did not give the expected ratio suggests that there may be more than one pair of factors concerned.

From the F_2 generation 68 plants that were bearded and had pubescent nodes were selected to test in F_3 . All of the 68 plants bred true to the type selected; that is, all plants produced were bearded with hairy nodes.

There also were 47 beardless plants with glabrous nodes selected from the F_2 generation to test in F_3 . All but two of these plants produced beardless plants with glabrous nodes.

The possibility that more than one pair of factors is concerned is further emphasized by the fact that there were two F_2 plants classed as beardless with glabrous nodes that did not breed true to this character, as would be expected, but segregated for beards. These produced 38 beardless plants with glabrous nodes and 19 bearded plants with glabrous nodes. While in the F_2 no bearded plants with glabrous nodes were obtained, yet in F_3 it is seen that some plants of this class do occur occasionally.

In addition to the plants whose behavior in F_3 is cited above, there were five that produced some bearded plants with glabrous nodes, but the numbers were so small that it may be questioned whether they may not be accidental crosses or mixtures of some kind. These plants are being tested further.

The six F_2 plants that have been mentioned as giving ratios differing from the expected ratios may be crossovers; and, if so, the genetic constitution assumed would have to be modified. A very close linkage would be indicated and the difference between the parent forms would be considered as due to two pairs of factors rather than one. It may be possible that these six aberrant plants result from natural hybridization in the field. This, however, is rather unlikely as no simple cross will explain certain of the results. For example, take the case of the two plants that produced all beardless plants in F_3 , but segregated for pubescent and glabrous nodes. As a 3:1 ratio for node type was obtained, it is difficult to see how this could arise from hybridization. If true-breeding pubescent-noded beardless types existed, this could be explained by a cross with a beardless glabrous-noded type, but so far no such constant type has been found.

It does not seem wise to conclude that natural crossing may be the cause of these few plants which produce different ratios from the majority of plants found in the same F_2 classes.

It is possible that they may be explained by mutations occurring in the germ cells, but at present no attempt will be made to assign a definite cause. After further breeding tests, now under way, are finished, a definite explanation can be given.

The plants of F_2 and F_3 also were classified for pubescent glume to determine whether this character segregated independently. The distribution of the F_2

plants for the three characters concerned is shown in Table II, together with the data for 55 F_2 plants tested in F_3 . From the results of both F_2 and F_3 it is evident that the pubescent-glume character segregates independently and is not linked in any way so far as this material is concerned. Considering pubescent glume alone, it segregates in a simple 3:1 ratio with pubescence dominant.

TABLE II.—Showing the distribution of the F_2 and F_3 plants according to beards, pubescent nodes, and pubescent glumes

	Beardless				Bearded			
	Pubescent glume		Glabrous glume		Pubescent glume		Glabrous glume	
	Pubescent node	Glabrous node	Pubescent node	Glabrous node	Pubescent node	Glabrous node	Pubescent node	Glabrous node
Results from F_2	344	184	124	53	153	0	49	0
Results from 55 F_2 plants in F_3	963	475	355	192	448	0	139	0

CONCLUSION

The results presented indicate that the character pubescent node as found in the Velvetnode variety is very closely linked with the bearded condition. Whether the few aberrant cases are really crossovers or may be explained in another way can not be definitely established at this time. The breeding tests that are now under way will shed more light on this question.