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DEGENERATION IN COLORADO POTATOES

By
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and
C. MILTON TOMPKINS

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DEGENERATION IN COLORADO POTATOES

By E. P. Sandsten and C. Milton Tompkins.

In the spring of 1918, the horticultural section of the Colorado Agricultural Experiment Station decided to conduct an experiment on degeneration in Colorado potatoes, to find out some of the determining factors in the so-called "running-out" of potatoes. This experiment was carried on mainly to find out whether or not degeneration is of a permanent nature, whether it is influenced largely by soil and climatic conditions, and whether or not degeneration will disappear if the degenerate tubers are planted in good soil and given the best kind of environment. At the same time, efforts were made to discover the influence of small and ill-shaped seed tubers on stand and yield as compared with normal seed tubers, and also to determine whether diseased tubers affect the yield by reason of low vitality or by disease.

In Colorado, it is a common practice among certain farmers to save their screenings or small-sized, unmarketable potatoes for seed for the new crop. Screenings are small potatoes which go thru a two-inch screen on the grading machine. This method is followed year after year, with the result that only small tubers are planted, mostly from unproductive or poor yielding hills, and consequently the succeeding crops show run-out tendencies because of the bad seed selection.

Aside from a bad seed selection, or none at all, the cultural methods used by many farmers may be questioned. The potato is a plant which responds readily to thorough, careful cultivation, while on the other hand it shows marked signs of poor or neglectful cultural methods, and cultivation must be given whenever needed. This operation cannot be postponed for the sake of attending to some other crop, if the maximum production is to be secured.

Another fault is the lack of proper rotation of crops. It is only logical to suppose that if potatoes are planted on the same piece of ground for three or more years, yields decrease, fertility decreases, and diseases become prevalent. The improper use of irrigation water is generally more or less detrimental.

The following discussion attempts to explain some of the causes of degeneration in Colorado potatoes from the standpoint of environment rather than from the disease point of view.

REVIEW OF LITERATURE

Considerable attention has been given in the past to the "running-out of varieties," or degeneration, mostly from the non-parasitic side. Some general observations have been made, and, in order to conform to the ideas expressed in this bulletin, the brief reviews are given.

In Bulletin No. 225 of the University of Wisconsin Agricultural Experiment Station by J. G. Milward, the author makes the statement:

"A large amount of evidence shows that careful growers are able to maintain both type and quality over apparently an indeterminate period by attention to rotation, manuring, selection, and other careful cultural practices. However, arising largely from the lack of stability of standards, two important conditions have resulted: Substitution of coarse or intermediate types for standard varieties, and lack of attention to sorting and grading on the field and at loading stations. Coarse types have spread rapidly over some of the older potato sections. Where standard varieties have failed, growers have naturally changed to types which apparently are adapted to depleted soil conditions."

The authors recommend giving special attention to seed plots and storage conditions as a means of prevention.

"Observations on some degenerate strains of potatoes," by F. C. Stewart of the New York Agricultural Experiment Station at Geneva, Bulletin No. 422, is a publication of merit. The "running-out" of so many strains of potatoes was laid largely to the non-parasitic forms of diseases: Leaf-roll, curly-dwarf, mosaic and spindling-sprout. The statement is made to the effect that no evidence has been found to show that any one of the four forms of degeneration named is communicable from one plant to another except thru the medium of the seed tubers.

In Bulletin No. 243 of the Colorado Agricultural Experiment Station, the senior author says that contrary to the general opinion, varieties do not "run-out," but that the so-called "running-out" is due to lack of seed selection, lack of proper cutural methods, unfavorable soil and climatic conditions.

O. B. Whipple, of the Montana Agricultural Experiment Station, has published Bulletin No. 130, entitled: "Degeneration in Potatoes." Some important statements made are:

"Degeneration, as we have observed it, appears to be what we might call a tuber characteristic. In other words, the plants from a single tuber are all much alike.

"Foliage characteristics are the most reliable indicators of degenerate tendencies. The first symptom is a slight crinkling of the foliage and, as degeneration progresses, there is a general reduction in vigor.

"Where seed is selected upon tuber characteristics entirely, very shallow-eyed types, especially in medium and small sizes, should be looked upon with suspicion.

"In our experience, all types of degeneration appear much more

frequently in plots growing under unfavorable environmental conditions. We question the advisability of attempting to grow seed potatoes under conditions which do not provide sufficient moisture for maximum vine growth."

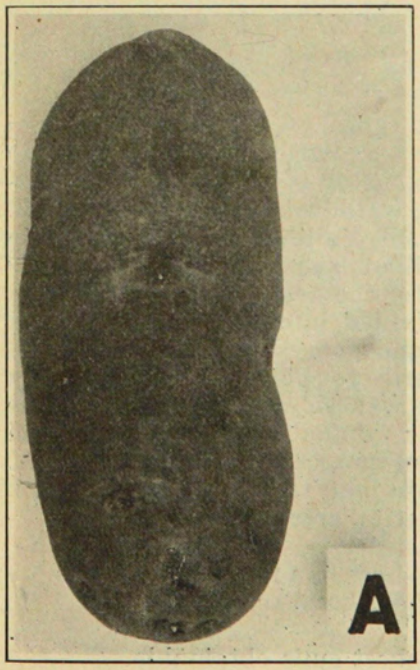
George Stewart, in Circular No. 40 of the Utah Agricultural Experimental Station, states:

"Some varieties deteriorate or run out. This need not happen if proper selection is practiced. There is a tendency to use or sell all the marketable potatoes, thus leaving the small ones for seed. Potato hills vary widely, not only in the number of potatoes they produce, but also in the kind. Since both very large and very small potatoes are undesirable for market purposes, hills with a fair number of medium-sized tubers are most desirable.

"It is bad practice to use small potatoes from the cellar or from the grading machine because most of them are from undesirable hills."

METHODS OF EXPERIMENTATION

The experimental plots where the degeneration work was carried on were located in the San Luis Valley, one-quarter of a mile east of Del Norte, at an elevation of eight thousand feet. The San Luis Valley is the bed of an old inland lake which existed hundred of years ago, located between the spurs of the Continental Divide. The Valley is approximately fifty miles wide and one hundred miles long and is entirely surrounded by lofty mountain ranges. The slope of the land in the Valley is from the North to the South, the southern end extending into New Mexico. Del Norte is located close to the northern foothills and is one of the large potato-producing centers in the Valley.



A. Russet Burbank—Typical tuber (average field type), from hand selected seed.

Since the San Luis Valley represents one of the largest producing sections in the State, is was selected as the place for carrying on the work. The two varieties grown most extensively are the Brown Beauty and Russet Burbank, and consequently these two varieties were used.

B. Brown Beauty—Typical tuber (average field type), from hand selected seed.

C. Russet Burbank—Typical tuber (average field type), from best culls obtainable.

There are many different types of soil to be found in this potato belt, varying from an extremely sandy type to heavy clays and black gumbo. However, the greater percentage of potatoes is grown on well-drained, sandy loam soil.

The climate of the San Luis Valley is ideal for potato production. Long days of brilliant sunshine and cool nights are in a large part responsible for the heavy yields.

The two varieties were divided into three series: Best hand-selected seed, best culls, and poorest culls obtainable.

The original seed for the series for both the Brown Beauty and Russet Burbank varieties was selected from the same field by the senior author. The foundation stock from which the selections were made was grown on the ranch of Mr. R. A. Chisholm at Del Norte, on whose land the experimental work was done. Following is the series arrangement:

Series I.

A. Russet Burbank—best hand-selected seed.
B. Brown Beauty—best hand-selected seed.

Series II.

C. Russet Burbank—best culls obtainable.
D. Brown Beauty—best culls obtainable.

Series III.

E. Russet Burbank—poorest culls obtainable.
F. Brown Beauty—poorest culls obtainable.

In the spring of 1918, the soil was well prepared and placed in excellent condition, outside of being somewhat dry, for the planting of seed, which operation occurred on May 15 of that year. Forty-nine pounds of cut seed were used for each member of the three series. The seed was cut longitudinally, excepting in the case of the large-sized tubers, which were cut into three or more pieces. An Aspinwall, or picker-type, planter was used. The plots were cultivated three times during the season. Three irrigations were applied by the furrow method.

D. Brown Beauty—Typical tuber (average field type), from best culls obtainable.

At digging time in the fall of 1918, it was noticed that the best hand-selected seed of both varieties had produced a better type of tuber than either of the two classes of culls. They were more uniform as to size and shape. The culls of both varieties were inclined to be pointed at the blossom ends, and the Russet Burbank potatoes showed considerable "knobbiness."

The yield for 1918, as recorded, was:

TABLE OF YIELDS—1918

	Variety	Total Yield in Pounds
A.	Russet Burbank	1193.5
B.	Brown Beauty	1021.0
C.	Russet Burbank	1115.0
D.	Brown Beauty	734.0
E.	Russet Burbank	1094.0
F.	Brown Beauty	——*

*No Brown Beauty "poor culls" were planted in 1918.

From the table, it can be seen that both variety series yielded in the same order—best hand-selected seed, highest; best culls, second highest; poorest culls, lowest. In other words, the season's work showed that the hand-selected seed had produced the greatest yield and that this method proved the best from the general farming standpoint.

Experiments at Paonia. In the spring of 1919, the work was transferred to Paonia, Colorado, to see what effects were

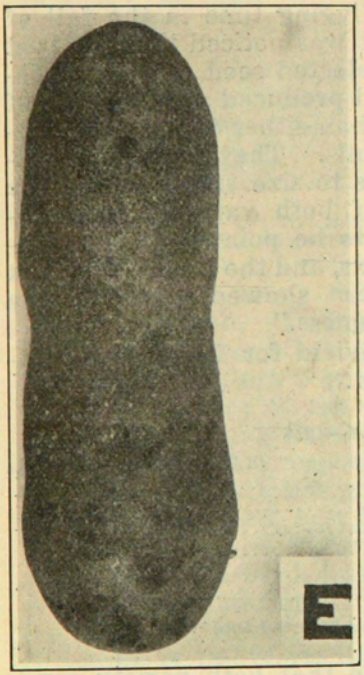
produced by a change in environment. Paonia is located on the western slope of the Rocky Mountains, in the eastern end of the valley of the North fork of the Gunnison River. The soil in that section of the State is not very well adapted to potato production on account of heavy, clay soil and too high temperature.

The work in this location was carried on by Mr. H. D. Locklin on Grove Brothers' ranch.

The results for 1919 were:

TABLE OF YIELDS—1919

	Variety	Total Yield in Pounds
A.	Russet Burbank	376.0
B.	Brown Beauty	356.0
C.	Russet Burbank	336.5
D.	Brown Beauty	424.5
E.	Russet Burbank	234.0
F.	Brown Beauty	385.0



E. Russet Burbank—Typical tuber (average field type), from poorest culls obtainable.

In 1919, it can be seen, the same results obtained in the case of the Russet Burbanks, the hand-selected seed leading the way in the matter of production. The 1918 results of the Brown Beauty were altered radically. The good culls yielded best, the poor culls ranked second in yield, and the best hand-selected stock produced the least. This variation, however, was not the result of a disease outbreak.

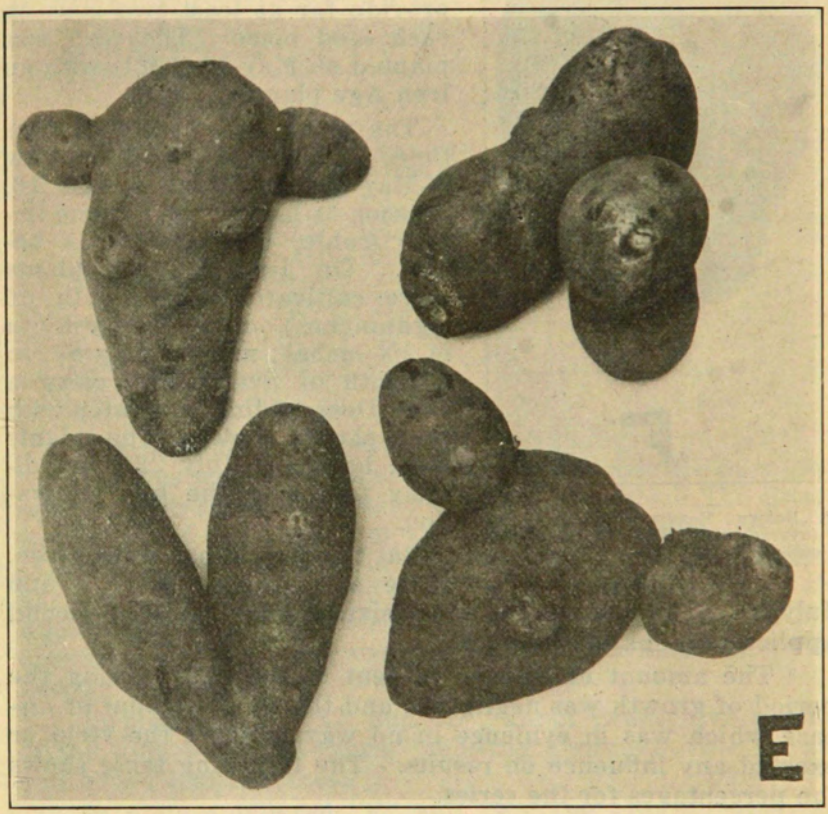
In 1920, the plots were located again at Del Norte. The same cultural methods were employed as previously reported. The yields follow:

TABLE OF YIELDS—1920

	Variety	Total Yield in Pounds
A.	Russet Burbank	135.5
B.	Brown Beauty	190.0
C.	Russet Burbank	187.5
D.	Brown Beauty	188.0
E.	Russet Burbank	276.0
F.	Brown Beauty	289.5

For 1920, the Russet Burbank yielding order was changed entirely. The poorest culls ranked first; the good culls second; and the hand-selected seed, third. This crop was noticeably free from disease. While true to type, the tubers

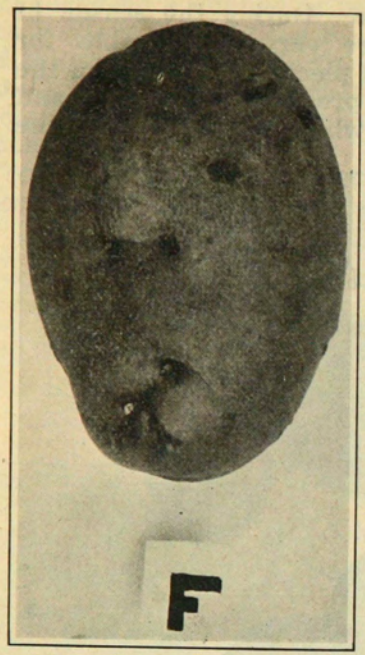
were very much under normal size. During the season of 1920, the weather conditions were very unfavorable for growth, and it appears that the seed pieces or cuttings of the poor culls of the Russet Burbanks produced a stronger and more vigorous vegetative growth, while the growth of the



E. Russet Burbank—Typical tubers showing extreme cases of degeneracy; from poorest culls obtainable.

good culls and hand-selected seed both showed inferior growth habits. The poor culls of the Brown Beauty also out-yielded the good culls and the hand-selected seed.

Experiments at Eagle. In the spring of 1921, the experimental field work was transferred to the Eagle River valley, Colorado, close to the town of Eagle. This valley has an elevation of 6,600 feet and is located on the western slope of the Continental Divide. The soil and climatic conditions in this valley are ideal for potatoes and the effect of these factors on the experimental plots could be studied under most favorable conditions.



F. Brown Beauty—Typical tuber (average field type), from poorest culls obtainable.

All of the seed used was treated in the usual manner, with corrosive sublimate. The seed was cut by hand, with an ordinary paring knife, care being taken to provide for at least two eyes on each seed piece. The seed was planted on May 19, 1921, with an Iron Age planter.

The plots were harrowed four times with a spike tooth harrow —May 20, 28, June 4 and 16. As soon as harrowing became impracticable, cultivation was begun. On June 23, the plants were cultivated to a depth of eight inches; on July 9, to a depth of six inches; and on July 21, to a depth of five inches, using a John Deere riding cultivator with four shovel plows. The plants were hilled on July 22, immediately following the last cultivation.

But two irrigations were given, these occurring on July 1 and July 28. The first one lasted for sixteen hours, and the second application took ten hours.

The amount of disease present in the plots during the period of growth was negligible, and the small amount of disease which was in evidence in no way affected the yield or exerted any influence on results. The following table shows the percentages for the series.

TABLE SHOWING PERCENTAGE OF DISEASE FOUND IN THE DIFFERENT SERIES—1921

Variety	Total Number of Plants	Total Number of Diseased Plants	Percentage of Disease
A. Russet Burbank.....	733	3	0.41
B. Brown Beauty.....	597	1	0.17
C. Russet Burbank.....	771	6	0.78
D. Brown Beauty.....	644	3	0.47
E. Russet Burbank.....	836	8	0.95
F. Brown Beauty.....	565	3	0.53

TABLE SHOWING YIELDS FOR THE DIFFERENT SERIES—1921

Variety	Total Number of Hills	Total Yield in Pounds	Average Yield per Hill in Pounds
A. Russet Burbank.....	733	913	1.24
B. Brown Beauty.....	597	733	1.23
C. Russet Burbank.....	771	884	1.14
D. Brown Beauty.....	644	686	1.06
E. Russet Burbank.....	836	847	1.01
F. Brown Beauty.....	565	631	1.11

TABLE SHOWING YIELDS IN SACKS PER ACRE, WEIGHT OF SEED PRODUCED BASED ON WEIGHT OF SEED PLANTED

Variety	Length of row in Feet	Pounds of Seed Planted	Yield in Pounds	Pounds of Seed Produced	No. of Sacks per Acre
A. Russet Burbank.	622	48.1	913	18.98	228.25
B. Brown Beauty...	598	49.1	733	14.93	183.25
C. Russet Burbank.	759	47.9	884	18.45	176.80
D. Brown Beauty...	635	47.9	686	14.32	171.50
E. Russet Burbank.	815	48.9	847	17.32	157.75
F. Brown Beauty...	568	48.6	631	12.98	141.17

Considerable variation among both varieties was noted as far as leaves were concerned. The plants from the best hand selected seed showed normal leaf characteristics. The Russet Burbank leaf has a medium width and is somewhat lighter in color of foliage than most other varieties. The Brown Beauty has a very narrow leaf and is darker in color than that of the Russett Burbank. The vine itself does not grow as erect as does that of the former variety, but it has a more spreading and trailing habit.

In plots labeled "C" and "D", about twenty-five percent of the hills were "off-types," showing enormous vine growth and broad leaf surfaces.

In plots numbered "E" and "F", the greatest variation occurred. Fully seventy-five percent of the Russet Burbank hills showed extremely wide leaf-surfaces, sometimes measuring twice the distance across the blade surface as the ordinary, normal leaf.

In the Brown Beauty plot, the degenerating characteristics were quite apparent. The leaves were very wide and long and possessed a roughened epidermis, quite a contrast to the normal leaf which is long and narrow, with a smooth, shiny, partially silver-green surface.

From the table showing yields in sacks per acre, it will be seen that Series I ranked first; Series II, second; and Series III, third.

TABLE SHOWING DIFFERENCES IN YIELDS ON RUSSET BURBANK PLOTS

Plot	Yield in Sacks per Acre	Difference in Sacks per Acre	Percentage Difference
Plot "A"	228.25	.....	.....
Plot "C"	176.80	51.45	22.37
Plot "E"	141.17	87.08	38.15

TABLE SHOWING DIFFERENCES IN YIELDS ON BROWN BEAUTY PLOTS

Plot	Yield in Sacks per Acre	Difference in Sacks per Acre	Percentage Difference
Plot "B"	183.25	.....	.....
Plot "D"	171.50	11.75	6.01
Plot "F"	157.75	25.50	15.92

CONCLUSIONS

Comparing all four seasons for climatic conditions, environment, soil, cultural methods, and irrigation, the writer believes that the season of 1921 was the most favorable for the normal functioning of the potato plants. In the results of yields, tabulated for 1921, it appears that the greatest fluctuations existed in the Russet Burbanks as compared with the Brown Beauties.

By having given all the plots like care and attention, results indicate that **the safest plan, so far as the average farmer is concerned, is to hand-select the seed for the following year.** Results are quite conclusive on this point, considering the Russet Burbank, inasmuch as the hand-selected seed produced more, after each season's work, with the exception of the summer of 1920 when the poorest culls produced the maximum yield at Del Norte, than did the best culls or the poorest culls.

With the Brown Beauty, hand-selected seed triumphed over the cull seed in 1918. In 1919, both plots of culls produced more than the hand-selected stock, evidently due to a more vigorous and luxuriant growth of vines in the cull hills. In 1920, the poorest culls led, followed by the hand-selected seed, and finally the best culls. In 1921, the hand-selected seed won the honors.

It is apparent from the foregoing work that the disease question was eliminated and did not enter into this discussion, inasmuch as less than one percent of disease was found in any of the plots in any one variety for any particular season. Also, the so-called parasitic diseases, such as leaf-roll, curly-dwarf, mosaic, and spindling-sprout did not enter into the problem. Thus, with the disease proposition eliminated, it became necessary to follow another line of pursuit, and this was done from a vegetative standpoint.

While hand-selection of seed tubers seems to be the best plan of procedure for general farming conditions, as found in this presentation, it is not recommended very strongly as the best or most practical method from the financial end. Rather it is urged that each farmer who grows potatoes should have his own seed plot from which the high-yielding and disease-resistant tubers are dug before the main crop each season and saved for the next year's seed plot, while the balance or major portion of the seed harvested each year from the seed plot is used for general planting purposes.

If rigorous seed selection is practiced in Colorado, there is no reason why potatoes should show any signs of the so-called "running-out" or degeneration. This work has shown conclusively that most of the causes can be laid directly to the farmer and the methods he pursues and that a high yield cannot be maintained season after season when no attention is given to seed selection.

SUMMARY

1. Degeneration, or the so-called "running-out" of varieties in Colorado potatoes is caused primarily by lack of proper seed selection, or none at all.

2. Degeneration is largely influenced, under Colorado conditions, by environmental relations. The different types of soil and climate exert a tremendous influence on vegetative parts of the plants during the growing season.

3. Disease, under ordinary field conditions, does cause to a marked degree, a decrease in vigor and yield in potatoes, but this consideration does not enter into the present problem, as the percentage of disease each year was found to be less than one percent.

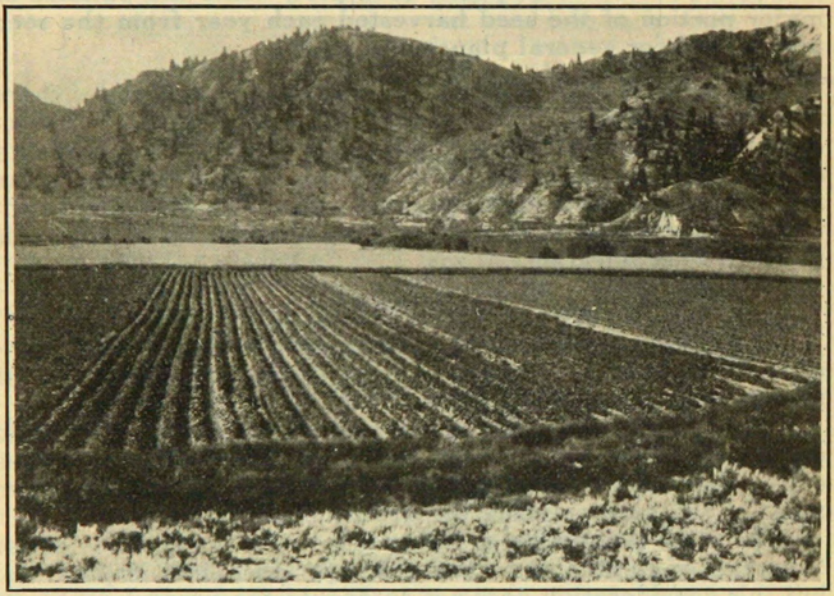
4. From results obtained, the conclusion is drawn that degeneration is not of a permanent nature. It is fluctuating depending to a considerable degree upon the environmental factors which surround the plants in the field.

5. Degenerate tubers, if planted in fertile soils, in a favorable climate, and given proper cultural care, will produce a crop of potatoes which is better than the seed planted, both from point of yield and vigor.

6. Under favorable conditions, there is every reason to believe that the planting of ill-shaped, knotty tubers derived from good stock, will result in a normal tuber development and yield, indicating that deformed tubers caused by unfavorable soil conditions and irrigation should not be classed with so-called degenerate or "run-out" stock.

7. With degenerate stock, the improvement, providing proper environmental conditions obtain, will be in direct ratio

to the amount of care given to seed selection by the grower. In other words, the tuber seed stock will deteriorate from year to year with little or no selection, while the crop will improve in quality, vigor, and yield with proper selection. Results obtained largely depend upon the grower in this problem of degeneration.



General View of the Experimental Field at Eagle, Colorado, Altitude 6,600 Feet.

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