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TUBER RUSSET PHENOCOPIES IN POTATO (*SOLANUM TUBEROSUM* L.) INDUCED BY MEFLUIDIDE

by

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Paul M. Bessey — May 3, 1982

PAUL M. BESSEY — Date

Associate Professor of Plant Sciences

Dedicated to

Basil A. Mankono Bidja

Rachel Oyono Ebogo

who have always given me their best in understanding, counsel, and friendship

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ABSTRACT

Greenhouse studies were conducted to determine the effects of mefluidide (N-2[2,4-dimethyl-5[[trichloromethyl)sulfolyl]amino]phenyl]acetamide) on potato (Solanum tuberosum L.) tuber skin color. 'White Burbank' (white-skinned) and 'Russet Burbank' (netted russet-skinned) were used.

Foliar applications of mefluidide (0 and 1000 ppm) were made when potato plants were actively setting tubers. Cv. 'White Burbank' was affected by the treatment. It produced quite a few russet-skinned tubers. Meanwhile, cv. 'Russet Burbank' did not respond to mefluidide.

Cv. 'White Burbank', when reared under normal conditions (absence of mefluidide), produced the normal color, white. The acquired russet pattern was maintained only when mefluidide was reapplied. Thus, the change in appearance of 'White Burbank' cv. was produced as a noninherited phenocopy.

CHAPTER I

INTRODUCTION

The cultivated potato, Solanum tuberosum L., is an annual, dicotyledonous plant belonging to the Solanaceae family. Sometimes it is regarded as a probable perennial because of its ability to reproduce vegetatively by means of tubers.

Potatoes vary in tuber colors: white, red, pink, russet, purple, blue and yellow. Tuber russeting ranges from light to heavy. Although potato varieties can be distinguished by the color of their tubers, tuber color is of little or no nutritional importance. In a survey, Tronstad et al. (1975) found that flavor was the most important single characteristic governing the choice of a potato cultivar by consumers. However, according to Howard (1970), skin and flesh color are among the characteristics looked for in potatoes.

Russet potatoes are in great demand in the United States. In an old study, Garey (1937) concluded that 47.5 percent of all potatoes handled in urban centers of the United States were russets. Furthermore, De Joung (1981) found that russet skin was a much sought-after trait in

potatoes in North America. Of 28 new cultivars which were described in the American Potato Journal during the decade January 1971 to December 1980, 25 percent have russet tubers.

Russet in potatoes is under genetic control; that characteristic can be enhanced or lessened by environmental conditions (Ruf, 1963).

The purpose of this study is (1) to determine how MBR 12325 2-S affects potato tubers' skin color in terms of russeting, and (2) to find out whether the above chemical induces a somatic mutation in the tubers.

MBR 12325 2-S, a plant growth regulator/herbicide, is N-[2,4-dimethyl-5-[[trifluoromethyl)sulfonyl]amino] phenyl]acetamide. Its common name is mefluidide and its trade name is "Embark."

CHAPTER 2

LITERATURE REVIEW

Potato performance is influenced by the environment and the genotype. Only genetics per se of skin pigmentation is discussed.

Environmental Effects on Potatoes

The environment is defined here as all the parameters (except genotype) that influence development of potato plants. Those parameters are divided into two groups: exogenous growth substances and environmental effects on gene expression.

Some Effects of Exogenous Growth Substances on Potatoes

Growth substances are very important to plants. Bidwell (1979) stated that the common thread, which runs through every phase of plant development and behavior, is control by growth substances.

Potatoes are not exempted from the above principle; they are prone to be influenced by growth substances and other chemicals as well.

Auxins, kinetins, gibberellins and ethylene when applied to potato plants enhance or inhibit (directly or

indirectly) certain plant features. Tuber formation, even though it is under the control of internal stimulus, is influenced by exogenous applications of growth substances. Thus, auxins such as indoleactic acid (IAA), 2,4-dichlorophenoxyacetic acid (2,4-D), and naphthalene acetic acid (NAA) may increase the size and the earliness of tubers (Harmey et al., 1966, Radwan et al., 1976). However, Kumar and Wareing (1974) found that at certain concentrations, IAA is inhibitory. Furthermore the same authors found that gibberellin acid (GA) delayed tuber formation; however, Radwan et al. (1976) obtained high tuber yield with low concentrations of GA.

Using Solanum andigena (cv. 'Ulter Premier'), El-Antably et al. (1976) were able to promote tuber formation by spraying the plants with absiscic acid (ABA). However, Smith and Rappaport (1969) failed to obtain a similar response with S. tuberosum L. (cv. 'White Rose').

In culture medium, kinetin was found to be stimulatory of tuber induction (Forsline and Langille, 1976).

There is some evidence that ethylene may play a promoting role in tuber formation. In cultured stem segments, ethrel, a substance which releases ethylene, promoted tuber formation (Garcia-Torres and Gomez-Campo, 1973). Ethylene does have some adverse effects on potato plants. Under field conditions, high ethylene

concentrations and low oxygen levels in the soil were associated with reduced top growth, leaf injury, lower tuber quality and 20 percent decrease in potato yield (Campbell and Moreau, 1979).

Sometimes a combination of growth substances has to be used in order to have a useful effect. A mixture of NAA and BA induced increases in growth rates of treated potato tubers. With the same combination, in the field, substantial increases in tuber number and final tuber volume per plant were recorded (Ahmed and Sagar, 1981).

Flowering is a significant problem for potato breeders. Most varieties do not flower profusely; when they do flower, abscission usually occurs shortly (Bukasov, 1936, Stevenson, 1948, Buck, 1966).

Foliar applications of auxin analogs can be useful in preventing bud and flower abscission (Wieksema, referenced by Harris, 1978). Other potato characters such as chip color, yield and quality are also influenced by applications of chemicals.

According to Murphy and Goven (1966), chip color is influenced by chemicals that stimulate or reduce physiological activities of potato tubers. Chip color is also influenced by herbicides that are used for the destruction of potato vines (Akeley, 1955, Cunnigham et al., 1959, Murphy, 1961).

Weiss et al. (1980) showed that foliar applications of maleic hydrazide (MH) to 'Russet Burbank' potatoes resulted in a greater number of U.S. No. 1 tubers. However, O'Keefe (1974) attributed serial tubers, tuber formation, tuber cracking and suppression of yield to maleic hydrazide.

Gene Expression in Potatoes and Environmental Effects

The relationship between genes and their phenotypic effects is not always a linear one. The presence of a particular allele does not always guarantee a subsequent effect.

In the potato, the environment can modify the effect of particular genes. Potato characters such as chip color, yield, specific gravity, tuber skin color, just to name a few, are influenced by the environment and the genotype.

Stevenson et al. (1954) stated that even when the most desirable combination of genes is present, the development of potatoes' characteristics is influenced by the environment.

Potato tuber greening, even though under genetic control, is also controlled by the environment, namely light. In the field, tuber greening is observed when the potato tubers are not well covered. In the market, the

extent and the intensity of potato tuber greening are related to method of display and the amount of light that is incident upon the potatoes (Brown and Riley, 1976).

Some anatomical characteristics of potatoes are affected by the environment in which plants are grown. Usually, the thickness of potato tuber periderm is a varietal feature (Artschwager, 1924); however, it is influenced by cultural conditions. For instance, high levels of nitrogen fertilizer and deep planting produce a thin periderm but high phosphate and irrigation produce a thick one. Furthermore, high soil temperatures can induce the formation of rough and scaled skin (Yamaguchi et al., 1964). Tuber deformity (second growth) and "buckskin" in red potatoes seem to be associated with periods of stress occurring during the period of tuber growth. Although the occurrence of external cracks in tubers is mainly associated with particular varieties, they can develop in tubers when associated with periods of rapid growth (Harris, 1978).

Chemical composition of potatoes is related to the environment. For instance, seasonal and other environmental conditions and cooking are among the parameters that influenced the amount of ascorbic acid in the finished cooked product.

The environment, in terms of season, affects some potato characters. Hereditability estimates and expected genetic advances show appreciable variation under different environments. In India, Sawant (1974) found that the estimates of the genetic coefficient of variation, hereditability and genetic advances were lower under late sowing (December) than under normal sowing (October). According to Johansen et al. (1967), potato cultivars grown in the northern United States generally are of higher specific gravity than the same cultivars grown in the South.

Many potato varieties differ in plant maturity and vigor when grown in different environments. Miller and McGoldrich (1941) found that potato cultivars matured earlier and produced less vegetative growth under the short day conditions of the southern United States than under long day conditions of the northern areas.

Genetics of Pigmentation in Potatoes

The basis of skin pigmentation in potatoes is the presence of anthocyanins dissolved in the cell sap of the periderm (Burton, 1966).

In wild species, only one anthocyanin which gives purple color is found, whereas in the cultivated species there is a much wider range of anthocyanins (Harbone, 1960, Dodds and Paxman, 1962).

Five basic anthocyanidins are found in potatoes. They are: pelargondin, peonidin, petanidin, delphinidin and cyanidin (Howard, 1970).

In cultivated diploid species, anthocyanin formation is controlled by three independent loci, P, R and Ac. The gene P, which is epistatic to R, controls the production of delphinidin in flowers and tubers. The production of cyanidin in flowers and pelargonidin in tubers are controlled by the gene R (Dodds and Paxman, 1962).

Clark (1933) found that potato skin russeting was due to a complementary action by three independently segregating dominant genes (A, B and C). Moreover, he showed that mutations from russet to nonrusset and vice versa can occur as a result of a change at only one of the three loci. For instance, a change from A-B-Cd to A-B-cc changes russet to nonrusset. The Clark study was confirmed by Pavek and Corsini (1981) who found that russet skin in diploid potatoes is controlled by three independently inherited complementary genes. Heavy russeting appeared to result from homozygosity at one or more of the three loci.

In cultivated diploid species, the distribution of anthocyanin in the various parts of the plant is determined by at least three loci, B, I and F, which are closely linked (Howard, 1970).

Even though light has a significant influence on potato tuber greening, that characteristic is under genetic control. Akeley and coworkers (1962) showed that tuber greening was incompletely dominant and quantitatively inherited. But Parfit and Peloquin (1981) found no evidence for the qualitative inheritance of tuber greening; they did find that tuber greening is quantitatively inherited. In the field, the major cause of greening is insufficient cover over the tubers during planting (Lewis and Rowberry, 1973); that effect can be aggravated by varieties whose tubers form near the surface (Bleasdale and Thompson, 1965).

Compared to cultivated diploids, little work has been done on the genetics of pigmentation in cultivated tetraploid potatoes. A good view of what was done was summarized by Howard (1970). At least six major genes control anthocyanin in the tetraploid cultivated potatoes; they are:

D - a basic gene, controls brownish red color in stems and inflorescences.

R - controls red color in sprouts; R-D- plants have tubers with a deep red color in the periderm; R-dddd plants have more or less white tubers.

E - controls red color in sprouts, stems and inflorescences; E-D- plants have tubers with a deep red color in the periderm; E-dddd plants have white tubers.

P - converts red of both E and R to purple.

F - a gene for flower color. D-F- plants have violet red flowers; ddddF- and D-ffff plants have white flowers.

M - restricts ED and PED tuber periderm pigmentation to areas around the eyes.

Effects of Mefluidide on Other Plants[1]

Mefluidide can be used either as a plant growth regulator or as a herbicide.

Plant Growth Regulation

Grasses and broadleaf plants have responded to applications of mefluidide on established turf. Some of those plants are:

Alfalfa, common	Medicago sativa
Barley, common	Hordeum vulgare
Bermudagrass	Cynodon dactylon
Johnsongrass	Sorghum halepense

[1] 3M Company, 1977. MBR 12325 Experimental Plant Growth Regulator/Herbicide. Technical Bulletin.

Wild oat Avina fatua

Mefluidide has exhibited excellent growth suppression of woody plants. Applications of mefluidide 2 to 4 weeks after early bloom stimulated spur development and suppressed terminal growth. Peach (Prunus persica), pear (Pyrus communis), plum (Prunus domestica) and prune (Prunus spp.) are among trees that responded to foliar applications of mefluidide.

Some agronomic crops responded positively to mefluidide applications. Sugar cane (Saccharum officinarum), when treated 8 to 12 weeks before harvest, responded with increased sugar content.

Wheat (Triticum destivum) and barley (Hordeum vulgare) showed lodging resistance when treated at early stem elongation.

Applications of mefluidide on tall fescue (Festuca arundinacen) resulted in improved forage quality.

Weed Control

Mefluidide, when applied post-emergence to certain weeds, has suppressed growth and inhibited seedhead formation of grasses and broadleaf weeds.

Mefluidide herbicide was used successfully against volunteer corn (Zea mays) and volunteer grain sorghum (Sorghum bicolor).

Classification of Crops and Weeds in Terms of Their Response to Mefluidide Herbicide

Tolerant Crops

Alfalfa	*Medicago sativa*
Flax	*Linum usitatissimum*
Potato	*Solanum tuberosum*
Soybean	*Glycine max*
Sugarbeet	*Beta vulgaris*
Sugarcane, mature	*Saccharum officinarum*
Sweet potato	*Ipomea batata*
Watermelon	*Citrillus lanatus*

High Susceptibility

Johnsongrass	*Sorghum halepense*
Shattercane	*Sorghum bicolor*
Sunflower	*Helianthus annuus*
Wild oat	*Avina fatua*

Moderate Susceptibility

Fall panicum	*Panicum dichotomiflorum*
Mustard	*Brassica kaber*

Low Susceptibility

Jimsonweed	*Datura stamonium*

Morning glory	Ipomea tricolor
Redroot pigweed	Amaranthus retroflexus

CHAPTER 3

MATERIALS AND METHODS

This study was conducted in two sets of experiments

Experiment 1

This experiment was designed to determine whether foliar applications of mefluidide affect potato skin color.

Potato tubers (4089 'White Burbank' and 4030 'Russet Burbank' varieties) were obtained from Beltsville Agricultural Research Center, Beltsville, Maryland, U.S.A. (courtesy of Dr. R. E. Webb). True seeds of a population that had segregated 147 white and 220 russet skin were also obtained.

A total of 40 tuber pieces (after being dusted with maneb as a Fusarium spp preventative) were grown in a greenhouse on February 13, 1981. These seed pieces were planted 10 cm deep in a light mixture of soil contained in one-gallon cans. The soil mixture was composed of sand, vermiculite, soil and bark in a 2:2:1:1 ratio. No fertilizer was added to the soil as potato periderm structure is affected by fertilizers (see Chapter 2).

A completely randomized design was used.

True seeds were sown on January 15 and 16, 1981, in two 200-hole trays containing a mixture of vermiculite, white perlite and peat moss in a 1:1:1 ratio. The trays were covered with a black plastic until emergence of the seedlings.

Trays as well as cans were watered once every three days; in early April the watering pattern was changed to once every day.

A foliar application of mefluidide was applied on April 25, 1981, on potato plants (those in cans) when they were approximately 25 cm tall and were actively setting tubers. The plants (randomly chosen) were individually sprayed with a stainless steel two-gallon knapsack sprayer. The application rates were: 0 ppm (control) and 1,000 ppm. In a previous field study, Bessey[2] found that high rates of mefluidide affected more potato tubers than low rates; 1,000 ppm was one of the high rates that he used. The potato plants were not watered during the three days that followed the treatment, hence mefluidide was not washed down.

The plants were divided into four groups:

--9 plants from white tubers: treated
(White Treated)

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[2]Bessey, P. M., Personal communication.

--9 plants from white tubers: untreated
(White Untreated)

--6 plants from russet tubers: treated
(Russet Treated)

--6 plants from russet tubers: untreated
(Russet Untreated)

On April 29 and 30, 1981, seedlings from true seeds were transplanted in the field; the delay was caused by the low growth rate of the seedlings. The seedlings were planted in single-row beds that were 3.7 m long and 45 cm wide. Drip irrigation was used and the seedlings were watered once every day. As fertilizer, we used ammonium phosphate at a rate of 454 kg/ha and phorate (0.9 kg/ha) as a systemic insecticide.

Experiment 2

This second experiment was designed to determine whether the color acquired in the first experiment was inheritable. In the second phase of the investigation, the same type of soil as in Experiment 1 was used. No fertilizer was added to the soil.

On November 6, 1981, almost all the tubers harvested in Experiment 1 were grown in 5-gallon plastic containers. As in Experiment 1, a completely randomized design was used.

The containers were watered once every three days; this watering pattern was maintained until the investigation ended.

Two weeks after germination, artificial light was used in order to prolong the day length. Four flourescent lamps, controlled by an automatic switch, were located 76 cm above the containers' level. The day length was extended from 10 hours to 15 hours.

Only the White Treated that changed color (White Treated #1 and White Treated #2, see Table 4) were treated with a foliar application of mefluidide on January 6, 1982, when plants were actively setting tubers. Application rates were 0 ppm (control) and 1,000 ppm.

Data Analysis

Since there are no definite expected values for this experiment, the test for independence (contingency chi-square) was used as the statistical tool.

If N is the total number of observations--a, b, c and d, the individual numerical contributions to N--then the calculations are as follows:

	Categories of observations		
	1	2	
A	a	b	
B	c	d	$N = a + b + c + d$

$$\text{chi-square} = \chi^2 = \frac{[\,|ad - bc| - (1/2)N]^2 \cdot N}{(a + b)(a + c)(c + d)(b + d)}$$

CHAPTER 4

RESULTS AND DISCUSSION

Experiment 1

Since mefluidide is known to affect the development of certain plants,[3] a study was conducted to determine the effects of that growth regulator/herbicide on potatoes ('White Burbank' and 'Russet Burbank' cvs). The results of the experiment are shown in Table 1.

Previous study[4] has shown that mefluidide does not influence potato characters such as plant vigor, chip quality, specific gravity and marketable yield; only tuber skin color was affected. This study will exclusively deal with tuber skin color.

Even though a visual ranking system is subject to error because of differences in human perception, such a system was adopted to rank potato tubers according to their degree of russeting (see figure 1).

Tubers fell into four classes:

0: white skin

1: light russet skin

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[3] 3M Company, op. cit.

[4] Bessey, op. cit.

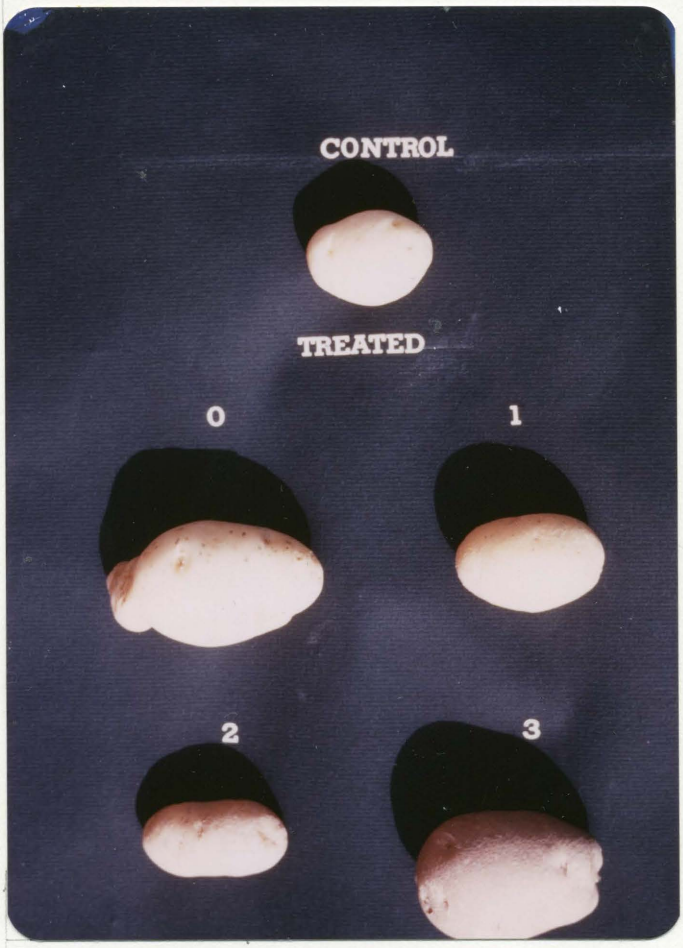

Figure 1. Degree of Skin Russeting Occurring on var 'White Burbank' Tubers.

Table 1. Effects of Mefluidide on Tuber Color (Experiment I)

Original tuber color	Treated				Untreated			
	Tuber ranking[5]							
	0	1	2	3	0	1	2	3
White	7	13	28	0	26	22	0	0
Russet	0	0	10	21	0	0	26	16

[5] 0 being white, 3 heavy russet, and 1 and 2 intermediate.

2: moderate russet skin

3: heavy russet skin

For statistical analysis purposes, classes 1, 2 and 3 were considered as one class, russet (see Tables 2 and 3).

Potatoes were harvested on July 7, 1981.

Effects of Mefluidide on var. 'White Burbank'

From Table 1 it can be seen that treated plants of var. 'White Burbank' produced white and russet tubers. The question is whether the change in appearance is independent or dependent on the conditions under which it was observed (mefluidide applications).

The computed chi-square from Table 2 is 19.63. It is a highly significant value ($P_{.05}$). Therefore, the change in color is not independent of the experimental conditions; foliar applications of the growth regulator/herbicide induced changes in the skin color of var 'White Burbank.' Such color changes were also observed in 'Kennebec' (a white thin-skinned variety) and in cv. 'Denali' (considered as a white-skinned potato) when treated with mefluidide.[6]

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[6] Ibid.

Table 2. Categories of Observations of Var. 'White Burbank' in Terms of Number of Tubers (Experiment I)

	categories of observations	
Treatment	White	Russet
Treated	7	41
Untreated	26	22

Table 3. Categories of Observations of Var. 'White Burbank' in Terms of Number of Tubers (Experiment I)

	categories of observations	
Treatment	White	Russet
Treated	0	31
Untreated	0	42

The question is whether that color acquisition is inheritable. In other words, did mefluidide induce a somatic mutation in cv. 'White Burbank'?

Somatic mutations occur in potatoes with a frequency of about one plant per 200,000 to 500,000 (Heiken, referenced by Harris, 1978). Although somatic mutations in potatoes are most frequently deleterious, they can give rise to new varieties (Miller, 1954, Heiken, 1961, Simmonds, 1965a and 1965b, Janhar, 1969, Howard, 1970). For instance, var. 'Gladstone Red' is a well known somatic mutant (Howard, 1961).

Potato apical meristems consist of

1. a tunica with two layers of cells (L_1 and L_2), and
2. a corpus (L_3) (Sussex, 1955).

Potato tuber color is due to anthocyanin produced from layers L_1 and/or L_2. A mutation in one of the two layers can affect tuber color; a mutation, started in a single cell (of L_1 or L_2), after numerous divisions, can cover a whole layer in the developing meristem with mutant cells. Plants which experienced such a mutation will be composed of tissues of two genetically distinct types; they are called chimeras (Asseyeva, 1927, Tilney-Basset, 1963).

Mefluidide applications on cv. 'White Burbank' were made when plants were actively setting tubers; thus

some underground stolons were still meristematic. All such subsequent tubers are potential chimeras. The change in color favors the following hypothesis: the treatment with mefluidide did induce mutations in certain tubers; then they became chimeras and changed tuber color.

Effects of Mefluidide on var. 'Russet Burbank'

Results in Table 3 and the chi-square ($P_{.05}$) value (zero) calculated from the same table indicate that cv. 'Russet Burbank' was not affected by the treatment. Therefore, the growth regulator/herbicide has a one-way action: it converts to russet, but not vice versa.

Differences in tuber appearance were observed after a month in storage. Some tubers have shrunken. That happened to 50 percent of cv. 'White Burbank' tubers which changed color. Tubers from cv. 'Russet Burbank' (treated and untreated) and those from cv. 'White Burbank' (untreated and treated that did not change color) were not affected. This matter will be discussed later.

In the field, despite the adequate irrigation system used, the transplanted seedlings failed to grow. The failure was attributed to excessive high temperatures. Average temperature was about 33° C, significantly different from the recommended 5 to 10°C (McCollum, 1975).

Experiment 2

Experiment 2 was designed to determine whether the change of color was due to a mutation. In other words, this second experiment will determine whether the acquired color is inheritable.

Since vegetative propagation (tubers) was used, it was expected to find the characters (including the new color) of a mother plant in its progeny.

The results are shown in Table 4.

Potatoes were harvested on March 3, 1982. Cultivar 'Russet Burbank' failed to form tuber. Tuber initiation had just begun when the potatoes were harvested; tubers were so tiny that they were discarded.

Contingency chi-square ($P_{.05}$) calculated from Table 5 is 59.03. It is a highly significant value. This suggests, once again, that cv. 'White Burbank' tuber color is affected by foliar applications of mefluidide.

Of the russet tubers, 81.81 percent were produced by White Treated #1 and White Treated #2 when treated, while only 18.18 percent were produced by those two classes when untreated. Hence, the new color is maintained in the population only if the treatment is reapplied. This indicates that the growth regulator/herbicide did not induce any mutation in cv. 'White Burbank'.

Table 4. Effects of Mefluidide on Tuber Color (Experiment 2)

Original tuber color	Treated				Untreated			
	Tuber ranking[7]							
	0	1	2	3	0	1	2	3
White Treated #0	-	-	-	-	53	3	0	0
White Treated #1	0	0	11	27	20	7	0	0
White Treated #2	2	3	13	0	21	5	0	0
White Untreated #0	-	-	-	-	21	5	0	0
White Untreated	-	-	-	-	9	19	0	0

[7] Ibid.

Table 5. Categories of Observations of var. 'White Burbank' in Terms of Number of Tubers (Experiment 2)

	categories of observations	
Treatment	White	Russet
treated	2	54
untreated	41	12

This change in color that imitates mutant effects is solely due to the environment; that is mefluidide. The growth regulator/herbicide has induced phenocopies in cv. 'White Burbank'. Phenocopies are defined as environmentally induced, nonhereditary phenotypic imitations of the effects of certain genes (Goldschmidt, 1938, Begg, 1959, Merrel, 1975).

Possible Mechanism of Mefluidide Action

In Chapter 2 it was shown that potato anthocyanins are controlled by three independent loci in diploids and six loci in tetraploids. In both tetraploids and diploids, white color is expressed when one of the loci is homozygous recessive. Let's illustrate the phenomenon with an example.

D - controls brownish color in stems and inflourescences.

E - controls red color in sprouts, stems and inflourescences.

E - D - plants have red tubers

E - dddd plants have white tubers (see Chapter 2).

This suggests that the homozygous recessive is sufficient to hide whatever colors occur in the E locus.

In developmental terms, the appearance of color (in this case) arises from two processes, the first being controlled by D and the second by E (see figure 2).

If the genotype of the hypothetical organism is D- E-, the end product (red color) is produced. This fact indicates that both D- and E- are functional. On the other hand, if the genotype is ddddE-, no pigments are produced; therefore the dddd is a nonfunctional locus (no enzyme is produced). This is true for the eeee locus also.

Although in the case of cv. 'White Burbank,' the genotype (for the control of authocynin production) is not known, it is assumed to have a homozygous recessive locus as its color is white (see Chapter 2).

The growth regulator/herbicide (or substance synthesized from mefluidide) may have just activated the process that was deficient without changing the structure of gene(s) involved. This is, therefore, a temporary modification of gene action in cv. 'White Burbank' plants (tubers) caused by applications of mefluidide.

Shrinkage of Treated Tubers (see figure 3)

Eighty-five percent of the tubers which changed color shrank after two weeks in storage (see Experiment 1 also). This tuber shrinkage was attributed to excessive water loss.

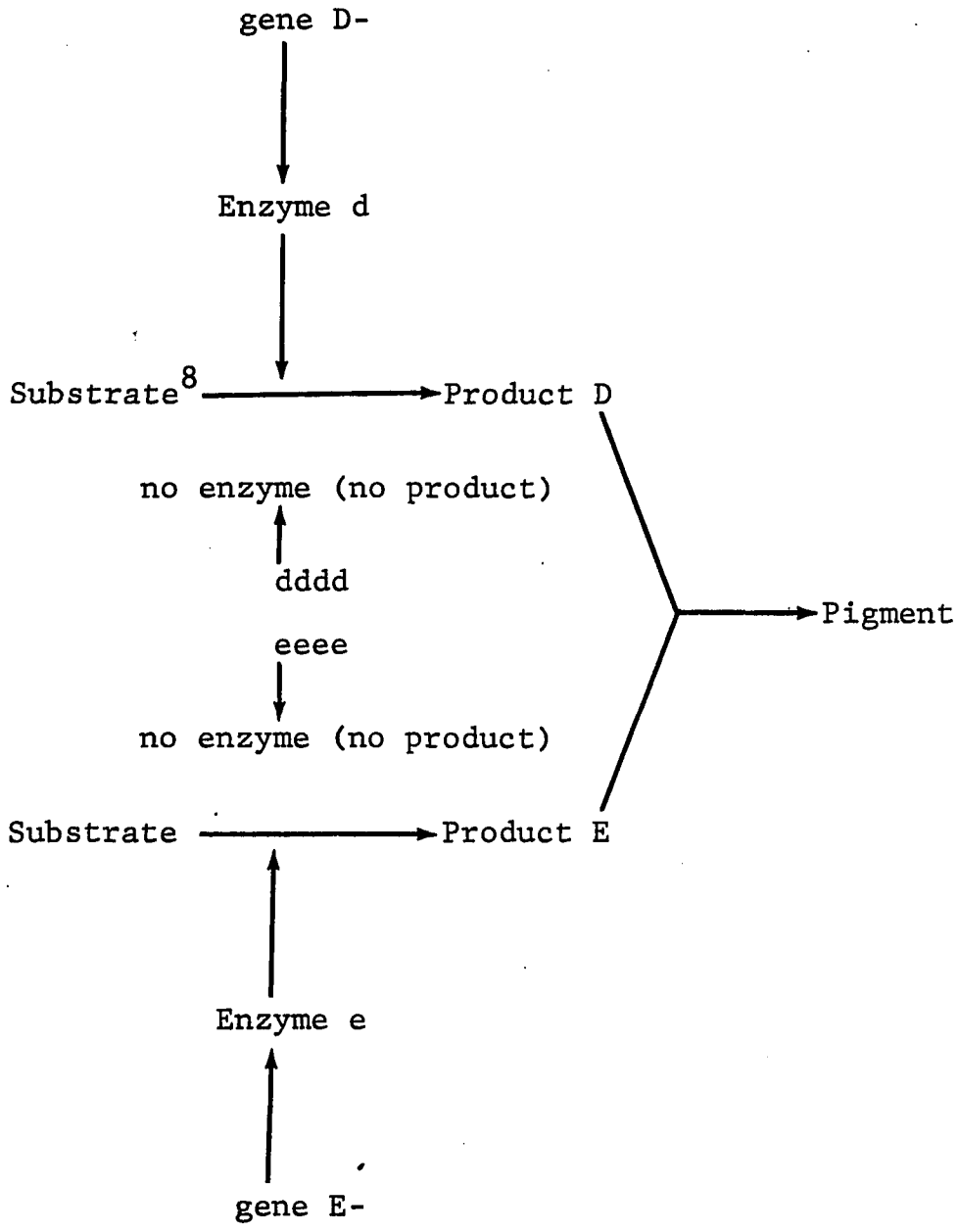

Figure 2. Diagrammatic representation of metabolic sequence producing pigment from a substrate in which two steps controlled by two enzymes are necessary. Each enzyme is, in turn, controlled by an individual locus.

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[8]Adapted from Strickberger, 1976.

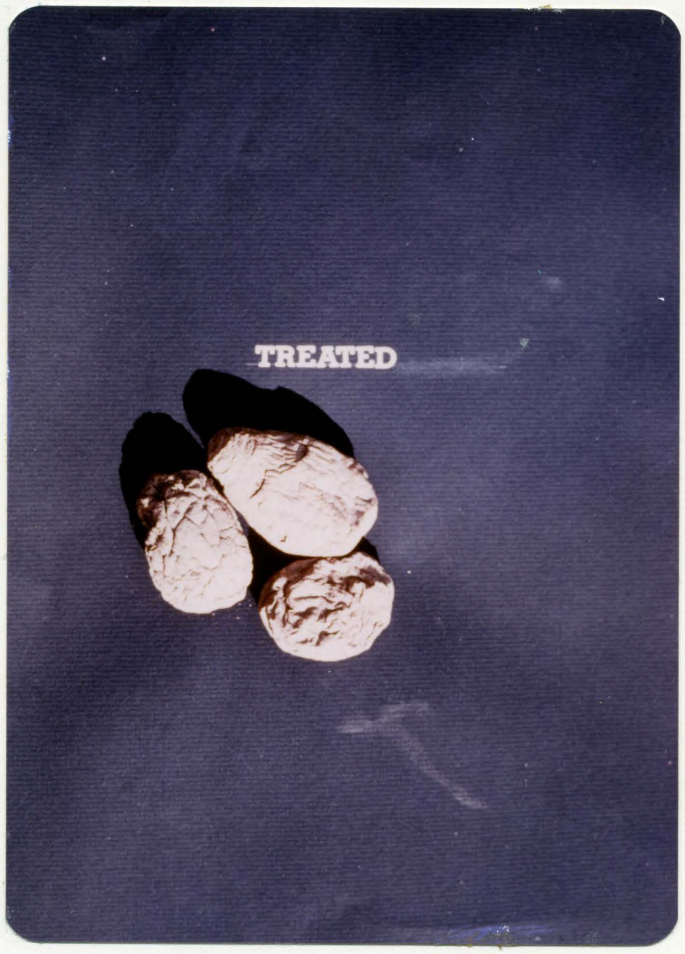

Figure 3. Var. 'White Burbank' Tuber Shrinkage.

Differences in skin surface appearance were noticed between shrunken and normal tubers observed with a binocular lens. The netting of the shrunken tubers was deep splitted into the cortex, while the netting of normal tubers was splitted superficially in the periderm.

Temperature and relative humidity are very important in preventing tuber shrinkage from occurring. According to Smith (1969), immediately after harvest and for 15 days, temperatures of 10 to 15° C and 90 to 95 percent relative humidity are best for healing cuts and preventing shrinkage.

After harvest, tubers were stored at room temperature (about 25° C) in paper bags. Therefore, high temperatures, low relative humidity and most of all deep splittings helped the occurrence of the shrinkage process.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Foliar applications of mefluidide on potato plants at the time of tuber initiation induced color changes in cv. 'White Burbank'. Such changes in color were not transmitted to the next generation.

The expression of the new noninheritable character (new color) proves that in some instances the strength of the environment (mefluidide) can modify the development of an organism so that its phenotype mimics the effects of a particular gene, although this effect is not inherited. Such organisms are called phenocopies.

Mefluidide should not be used in potatoes (at least white cvs.) because in this experiment it failed to induce useful results.

The growth regulator/herbicide only incided negative results:

1. Lack of uniformity. Treated plants produced both white and russet tubers.
2. Bad storage ability of treated tubers. Treated tubers which changed color shrank shortly after harvest.

3. Mefluidide is not mutagenic. The color acquired was not transmitted to the following generation.

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