7-25-5M

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

BULLETIN NO. 326 April, 1925

DIVISION OF HORTICULTURE

BREEDING EXPERIMENTS WITH BLACKBERRIES AND RASPBERRIES

B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

STAFF (As of May 1, 1925)

ADMINISTRATION

B. YOUNGBLOOD, M. S., Ph. D., *Director*
A. B. CONNER, M. S., *Vice Director*
A. H. LEIDIGH, M. S., *Assistant Director*
CHAS. A. FELKER, *Chief Clerk*
A. S. WARE, *Secretary*
M. P. HOLLEMAN, JR., *Assistant Chief Clerk*
J. M. SCHAEDEL, *Executive Assistant*
C. B. NEBLETTE, *Technical Assistant*

VETERINARY SCIENCE

*M. FRANCIS, D. V. M., *Chief of Division*
H. SCHMIDT, D. V. M., *Acting for Chief of Division*
V. J. BRAUNER, D. V. M., *Veterinarian*

CHEMISTRY

G. S. FRAPS, Ph. D., *Chief of Division; State Chemist*
S. E. ASBURY, M. S., *Assistant Chemist*
WALDO H. WALKER, *Assistant Chemist*
J. K. BLUM, B. S., *Assistant Chemist*
J. E. TEAGUE, B. S., *Assistant Chemist*
VELMA GRAHAM, *Assistant Chemist*
K. KITSUTA, M. S., *Assistant Chemist*
ADAH E. PROCTOR, B. S., *Assistant Chemist*
N. J. VOLK, M. S., *Assistant Chemist*

HORTICULTURE

A. T. POTTS, M. S., M. S. C., *Chief of Division; Citriculturist*
H. NESS, M. S., *Berry Breeder*

RANGE ANIMAL HUSBANDRY

J. M. JONES, A. M., *Chief of Division; Sheep and Goats*
JAY L. LUSH, Ph. D., *Animal Breeder* (genetics)
FRANK GRAYSON, *Wool Grader*

ENTOMOLOGY

F. L. THOMAS, Ph. D., *Chief of Division; State Entomologist*
**H. J. REINHARD, B. S., *Entomologist*
E. HOBBS, B. S., *Assistant Entomologist*
C. S. RUDE, B. S., *Chief Foul Brood Inspector*
H. S. CAVITT, B. S., *Apiary Inspector*

AGRONOMY

E. B. REYNOLDS, M. S., *Chief of Division*
A. B. CONNER, M. S., *Agronomist, Grain Sorghum Research*
A. H. LEIDIGH, M. S., *Agronomist, Small Grain Research*
G. N. STROMAN, Ph. D., *Agronomist, Cotton Breeding*
C. H. MAHONEY, B. S., *Assistant in Cotton Breeding*
R. H. STANSEL, B. S., *Assistant in Crops*

PLANT PATHOLOGY AND PHYSIOLOGY

J. J. TAUBENHAUS, Ph. D., *Chief of Division*

FARM AND RANCH ECONOMICS

L. P. GABBARD, M. S., *Chief of Division*
B. YOUNGBLOOD, M. S., Ph. D., *Farm and Ranch Economist*
V. L. CORY, M. S., *Grazing Research Botanist* (Sonora)
***T. L. GASTON, JR., B. S., *Assistant, Farm Records and Accounts*
***A. S. BRIENT, B. S., *Assistant, Ranch Records and Accounts*
***B. P. HARRISON, B. S., *Collaborator*

SOIL SURVEY

***W. T. CARTER, B. S., *Chief of Division*
H. W. HAWKER, *Soil Surveyor*
E. H. TEMPLIN, B. S., *Soil Surveyor*

BOTANY:

H. NESS, M. S., *Chief of Division*

PUBLICATIONS:

A. D. JACKSON, *Chief of Division*

SWINE HUSBANDRY

FRED HALE, B. A., *Swine Husbandman*

DAIRY HUSBANDRY

G. R. WARREN, M. S., *Chief of Division*

POULTRY HUSBANDRY

R. M. SHERWOOD, M. S., *Chief of Division*

FEED CONTROL SERVICE

F. D. FULLER, M. S., *Chief of Division*
S. D. PEARCE, *Secretary*
J. H. ROGERS, *Feed Inspector*
W. H. WOOD, *Feed Inspector*
G. M. MORRIS, B. S., *Feed Inspector*
W. C. GAINEY, B. S., *Feed Inspector*
C. D. WHITMAN, B. S., *Feed Inspector*
K. L. KIRKLAND, B. S., *Feed Inspector*

SUBSTATIONS

No. 1, Beeville, Bee County
R. A. HALL, B. S., *Superintendent*

No. 2, Troup, Smith County
W. S. HOTCHKISS, *Superintendent*

No. 3, Angelton, Brazoria County
V. E. HAFNER, B. S., ***Superintendent***

No. 4, Beaumont, Jefferson County
R. H. WYCHE, B. S., *Superintendent*

No. 5, Temple, Bell County
A. B. CRON, B. S., *Superintendent*

No. 6, Denton, Denton County
P. B. DUNKLE, B. S., *Superintendent*

No. 7, Spur, Dickens County
R. E. DICKSON, B. S., *Superintendent*
D. H. BENNETT, D. V. M., *Veterinarian*
V. L. CORY, M. S., *Grazing Research Botanist*
***O. G. BABCOCK, B. S., *Collaborating Entomologist*
O. L. CARPENTER, *Shepherd*

No. 8, Lubbock, Lubbock Coounty
R. E. KARPER, B. S., *Superintendent*

No. 9, Balmorhea, Reeves County
J. J. BAYLES, B. S., ***Superintendent***

No. 10, College Station, Brazos County (Feeding and Breeding substation)
R. M. SHERWOOD, B. S., *Poultry Husbandman in Charge of Farm*
L. J. McCALL, *Farm Superintendent*

No. 11, Nacogdoches, Nacogdoches County
G. T. McNESS, *Superintendent*

***No. 12, Chillicothe, Hardeman County**
D. L. JONES, *Superintendent*

No. 14, Sonora, Sutton-Edwards Counties
E. M. PETERS, B. S., *Superintendent*

No. 15, Llano Grande, Hidalgo County
W. H. FRIEND, B. S., *Superintendent*
A. T. POTTS, M. S., M. S. C., *Citriculturist*

No. 16, Iowa Park, Wichita County
E. J. WILSON B. S., *Superintendent*

Members of Teaching Staff in the School of Agriculture Carrying Cooperative Projects:

G. W. ADRIANCE, M. S., *Associate Professor of Horticulture*
S. W. BILSING, Ph. D., *Professor of Entomology*
F. A. BUECHEL, Ph. D., *Professor of Agricultural Economics*
W. E. GARNETT, Ph. D., *Professor of Rural Sociology*
H. V. GEIB, B. S., *Assistant Professor of Agronomy*
G. P. GROUT, M. S., *Professor of Dairy Husbandry*
V. P. LEE, Ph. D., *Professor of Agricultural Economics*
E. O. POLLOCK, A. M., *Assistant Professor of Agronomy*
W. L. STANGEL, M. S., *Professor of Animal Husbandry* (Swine)
R. C. WHITE, M. A., *Associate Professor of Rural Sociology*

---

*Dean, School of Veterinary Medicine.
**On leave for one year.
***In cooperation with United States Department of Agriculture.

Bulletin No. 326 April, 1925

BREEDING EXPERIMENTS WITH BLACKBERRIES AND RASPBERRIES

H. Ness

Breeding experiments with blackberries and raspberries were begun in 1909. The object of this work was to study variation and hybridization in varieties and species that might offer economically desirable combinations of characters.

At an early stage of the hybridization work hereafter recorded, it seemed that the segregation of the parental characters and their regrouping in the subsequent generations of the cross did not occur in conformity with any simple Mendelean ratio. In fact, all attempts at the comparison of individual characters by counts or measurements resulted only in doubts and confusion. Variations that occurred in the hybrid progeny were either of a nature comparable to those that occur among individuals of what is taxonomically considered a true species, or the individuals fell into groups which either exhibited the features intact of one or the other of the parents, or appeared as various degrees of blendings. Fertility seemed in such cases to be associated with purity; sterility with a mixture of characters.

Another peculiar feature of this work was the similarity of the above behavior exhibited by the compound hybrids, that is hybrids in which one or both of the parents were themselves hybrids. Among the progeny of this origin, the features of one of the immediate parents would show up intact, that is, without visible traces of the other parent, or of its components crossed in the first instance. Intermediates showing all shades of blending would also occur, but in a manner too confused for classification, if sufficiently numerous. In such cases the fertility seemed, as above, to be correlated with the purity in which the features of one or the other of the parent forms would appear. Those exhibiting the most blended form would show the greatest sterility.

The available material at the beginning of the work consisted of plantings of about a dozen varieties of the blackberries and of the dewberries most generally cultivated in Texas. Among them were the Austin or Austin-Mayes dewberry, Dallas, Early Harvest, and McDonald blackberries.

SEEDLINGS

For a few years, seedlings were raised from several varieties in as large a number as could be handled with the very limited supply of labor. Variations were obtained in great numbers, but of no improvement in quality worthy of propagation and name. A few natural hybrids also appeared among the seedlings, as, for example, between the Rogers dewberry and a white-fruited dewberry. But, as these combinations gave no promise of special economic or scientific interest, they were not continued.

The seedlings that aroused most interest were those of the McDonald blackberry.

The seeds of this variety were sown in seedling trays (flat boxes) in November, 1909. In the following spring, two thousand of them were transplanted from pots into the field, where they fruited in the spring of 1911.

The Spineless Forms

They turned out to be a most valuable lot; yet, the variations were of such nature as to permit of their classification into a certain number of more or less definable groups. One of these groups was conspicuous by the uniformity of its smooth, glossy foliage consisting of oblong-elliptical, or oblong-lanceolate leaflets, which were so firm as to be classed as coriaceous in texture. Besides the glossy, unfurrowed surface, the narrow outline and the entire margins of the leaflets made this group conspicuous among all the others.

Upon closer inspection, two individuals were found which might be considered the type and the acme of this group. These two were entirely without spines or pubescence on any of their organs. Their shoots were long-jointed, straight, green in color, and almost herbaceous in texture. But in one individual, they were stouter, inclined to be fluted, and strictly erect; in the other, slender, terete, diffuse, or even prostrate. These plants differed also in the flowers and fruit. In the first, both the flowers and the fruit were larger, and the fruit was of fair quality; while in the second plant, the flowers were very small, of a greenish tinge, and the fruit small and worthless.

At first, both plants were permitted to flower exposed to insects, and set some fruit; but later, these fruits and all the open flowers were picked off, and the plants covered with cages of close mosquito netting, (Fig.

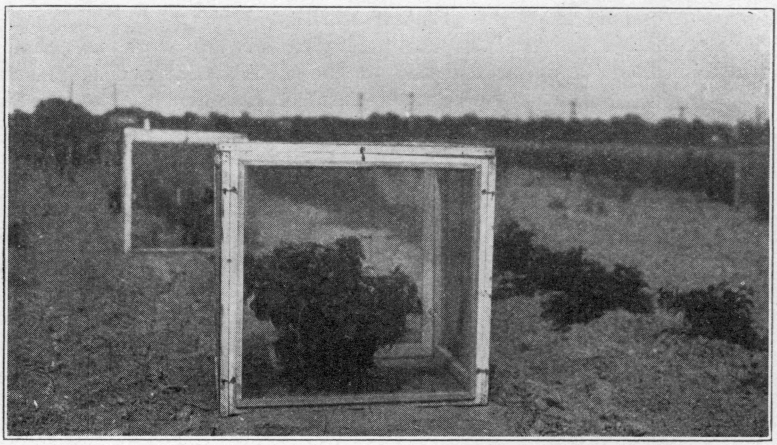


Figure 1. Cages for Excluding Insects.

1). The flowers of both forms proved to be self-fertile, as they continued to produce fruit as before covering.

The fruits were gathered and the seeds of each, which were much smaller than in the original MacDonald, were sown separately in flats, October 26, 1911. The germination was fair and gave rise to a considerable number of seedlings, especially from the erect form. But a weak-constitution and accidents due to a storm, which injured the roof of the propagation house, left very few plants to be transplanted into the field.

In the records, the spineless forms were designated the Spineless-erect and the Spineless-diffuse. Each gave rise to several generations which, especially in the case of the Spineless-erect, were very difficult to raise because of the great mortality during their nursery age. The plants of the Spineless-erect were, for that reason, lost in the third generation, while those of the Spineless-diffuse were continued. The descendants from each form were, however, not to be distinguished, as diffuse or erect growths arose indiscriminately among the descendants of each class. The same was also true for other characters which served as distinction between the two parents. About one-half the number of seedlings in each generation of both forms bore the Spineless characteristics, which were distinguished by the smooth, firm, lanceolate form of the first leaves, so similar in outline to the leaves of many violets that the plants might easily, at that stage, have been passed as violets. The other half of the seedlings returned, in all their features, to the original form of the spiney McDonald (Fig. 2). These spineless forms could, therefore, not be con-

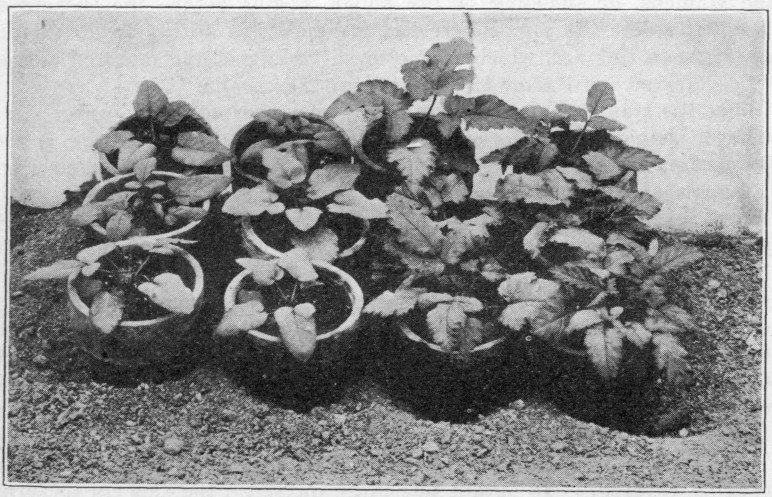


Figure 2. Left: Spineless and spiny seedlings. Right: Descendents of McDonald blackberry.

sidered mutations, although they varied from the original McDonald in every organ to such an extent that no taxonomist, ignorant of their origin, would have included them in the same species with McDonald. Their be-

havior may, however, be compared to what Dr. Vries has named Half-race.*

The seedlings of the spineless forms were subject to great mortality in the nursery stage, the most evident cause of which was that a great number, perhaps as many as thirty per cent of the seedlings, lacked every trace of chlorophyll, and therefore failed to live beyond the seed-leaf stage. The number of plants which, in each generation, reached maturity were on that account small, especially the Spineless-erect. Twenty-nine plants of the third generation of Spineless-diffuse, planted in 1915, reached bearing maturity. They had the characteristic violet form of leaves in the nursery stage, but at maturity they developed to be classified as follows: 10, no spines; 8, spines few or inconspicuous; 3, spines evident; 8, both spines and bristles conspicuously present.

These groups of variations, though obtained from a small generation, would most probably have been the same and of similar proportion in a much larger generation of plants having the violet-like type of leaves in their infant stage.

The variations in the size and quality of the fruit were very evident; so that, even among so small a number of plants, there were opportunities for the selection of individuals bearing fruit, scarcely inferior to that of McDonald.

METHODS OF CROSS POLLINATION USED IN HYBRIDIZATION

Emasculation of the flowers and cross-pollination are very easily performed in plants of the blackberry and raspberry genus. The dehiscence of the stamens, or shedding of the pollen, begins before the flowers are quite open; unless the atmosphere be very moist, as during foggy or rainy weather; when this act, which is due to shriveling of the matured anthers, may be deferred until after the opening of the corolla.

Since the stamens, and also the petals, are inserted on the upper rim of the saucer-shaped body of the calyx (hypanthium), emasculation is most easily performed by clipping off this upper rim, thereby removing both the stamens and the petals as well as the lobes of the calyx, but leaving the torus with its pistils untouched and uninjured. The time when this circumscision can be performed with the least injury to the pistils and without danger of leaving pollen on the stigmas, is just before the dehiscence has started in any of the anthers. During a foggy morning, it may be done after the tips of the petals have become disengaged in the opening of the corolla; in dry weather, it must be done before the tips of the petals are unfolded. Even then, it is a necessary precaution to examine every flower with a good lens that magnifies ten or twelve times, to see if there be any pollen on the stigmas after the emasculation.

It is well to employ large quantities of pollen, leaving all the stigmas thoroughly covered. To obtain this large quantity, the flowers to furnish it must be gathered the day before in the stage at which the anthers have just commenced bursting to shed their pollen. The flowers, having been gathered, may be left to wilt for 15 to 20 hours in a beaker or a wide-

*Species and Varieties, p. 358.

mouthed bottle, when the pollen will be greatly in evidence, adhering to the surface of the anthers. The act of pollination can then be easily performed by seizing the flower with a pair of tweezers and touching the stigmas of the emasculated flower with the pollen-laden anthers of the flower functioning as male.

Although insects are not liable to visit a flower made inconspicuous by the removal of its most showy parts, it is necessary to cover immediately after pollination, to prevent injury to the wounded parts from too great loss of moisture. An ordinary one-half-pound grocery dealer's paper sack tied over the shoot bearing the flowers operated on, will be sufficient. Without this precaution, the failure to set fruit will become general. This cover should be removed after five or six days.

HYBRIDS

Early Harvest X Austin: In selecting parents for hybrids, two objects were kept in view; namely, the improvement of the fruit and the combination of such characters as could be readily recognized in the component offspring and referred to their proper source.

Early Harvest, a blackberry, and the Austin, (or by some known as the Austin-Mays) a dewberry, were considered ideal for both purposes.

The Early Harvest has erect, fluted canes with leaves of a pinnate type; elongated, leafy flower clusters, of many rather short, lateral pedicels, and small flowers. The fruits are also small, but of fine flavor and pulpy, because of correspondingly small seed.

The Austin is opposite in all characters; its canes are prostrate, slender and terete, with a few straight, almost bristle-like spines. The leaves are more of the pedate type with five to seven leaflets. The flower clusters are open, flat-topped, with short rachis and long, slender, bractless pedicels. The flowers are very large, as are also the fruits and seeds, but the drupelets are comparatively few and loose.

The cross-pollination which produced Early Harvest X Austin* was made March 29, 1909, resulting in an F_1, or first generation, of which 28 plants reached maturity and fruited in May 1912. All of them appeared uniformly Austin in their vegetative organs. They fruited abundantly but the berries were imperfect, many drupelets failing to develop; and those that did were of two kinds; large and small, this being the most visible mark of their hybrid nature.

Second Generation F_2: One plant of the first generation was selected to be the mother of a second generation, because it was estimated to possess more traces characteristic of the Early Harvest than any of the others. It was, therefore, covered with a cage of mosquito netting during the flowering. From the seed obtained from this plant, an F_2 generation of 465 plants was raised. These plants reached fruiting maturity in the spring of 1915. The majority, namely 376 individuals, had the appearance of pure Austin. The characters of both parents were recog-

*In the nomenclature of the hybrids given in this Bulletin, the name of the male will always precede that of the female parent.

nized in 37, and 21 had the appearance of pure Early Harvest; while the remainder, 31 plants, seemed to possess characters not referable to either of the original parents.

No one organ of any plant in these groups seemed to vary to a greater extent than any other, or independently of the others, but all appeared to vary in the same proportions; that is, in correlation with each other. The assignment of a certain plant to a certain group was, therefore, purely a result of estimation, since the differences in characters were not such as could be tabulated, or represented by the exactness of graphs.

One individual, which in no organs seemed to differ from those of the Early Harvest, was screened to produce seed for a third generation; but, although flowering very profusely, it failed to set a single fruit. This was so much more unexpected because the true Early Harvest had proved perfectly self-fertile.

Early Harvest X Austin F_2:—Seed for the generation were gathered from two mother plants, not screened during the flowering. One of these was of the Austin, the other of the Early Harvest type.

A very small number of plants was obtained. Only 36 individuals of the Austin type grew strong enough to be planted into the field in April 1915. All of these retained their Austin characteristics, but were inferior in both vigor and quality of fruit, which was small and of irregular form, because of the presence of large and small drupelets in the same fruit.

The parallel lot, descending from the Early Harvest type, was equally few in number and showed no positive traces of either Austin or Early Harvest, but unmistakable resemblance to *Rubus rubrisetus*, of which there was a plat in the neighborhood. For these reasons, both lots were accounted useless for further study, abandoned, and destroyed in 1917.

[Spineless-erect X (Early Harvest X Austin) F_2] F_1: Pollination of a mother plant in which the Early Harvest predominated was made April 1st, 1914, and resulted in four plants which grew to be planted in the field a year later.

Note taken May 18, 1917: "Three plants are characteristic of the Early Harvest, but the fourth shows only the spineless form in both the canes and the foliage."

The fruit of this individual was perfect, abundant, of fair size, and of decidedly sweet flavor. The drupelets were uniformly small, as were also the seeds. This individual was screened as soon as the nature of its fruit became evident. It continued to produce perfect fruit under the screen, and the seeds were gathered for a second generation.

[Spineless-erect X (Early Harvest X Austin) F_2] F_2:—The seed were sown September 10th, 1917. Germination commenced in December and by Christmas each box had 20 to 30 plants. Many of the seedlings lacked every trace of chlorophyll, and therefore, died in the seed-leaf stage. Those surviving developed into two distinct groups, one with the violet form of leaves, the other with rugose and laciniate margined leaves. (similar to types in Fig. 2). The first were characteristic of the true spineless, while the second simulated the Early Harvest. No individual arose

that positively could be referred to Austin. This was so much more remarkable because that form was persistently dominant in every generation of Early Harvest X Austin. Nor was there any individual which could be referred to the McDonald, parent of the Spineless. Both these forms seemed, therefore, according to the language of the geneticists, to have been eliminated in the successive recombinations of the genes.

On April 19, 1918, seventy-seven plants most typical of the first group and one hundred and thirty most typical of the second were transplanted into the field. Here the Early Harvest forms retained their characteristics; but the canes in some of the Spineless assumed more the form of the Spineless-diffuse. In others, they developed a spiny and sulcate form of stem, thus approaching the Early Harvest as they grew into maturity. The form and texture of the leaves characteristic of the spineless group were retained, however. Among these last mentioned, several individuals occurred that produced fruit of good size and fine quality. They were marked as elites, preparatory to multiplication and introduction into cultivation, but as other combinations had arisen that were of more striking interest, both in a genetic and economic sense, these newer forms engrossed all the attention that could be spared for the work.

In the first group, or those showing the Early Harvest characteristics from the start, there arose no individual worthy of cultivation or of special interest, all being uniformly inferior from an economic standpoint.

Mammoth X Dallas F_1: Mammoth* is reported to be a hybrid between *Rubus vitifolius*, a dewberry of the Pacific coast, and a blackberry called the Texas Early.

The Mammoth is a strong, diffuse, nearly prostrate, spiny growth, easily distinguished from the Dallas and other varieties by a dark green color and a texture of foliage quite peculiar to itself. The shoots, as well as their spines, are also easily distinguished by more intense colors.

Dallas is assigned to *Rubus nigrobaccus*, or the same species as Texas Early; but there is nothing in the appearance of the Mammoth to lead anyone to suspect any specific relationship to the Dallas blackberry.

The only thing of interest that the cross of these two forms produced, was the strange metamorphosis which took place in the flowers of some of the progeny.

Cross-pollination of the Dallas was made with pollen from Mammoth, April 16th and 17th, 1909. The resulting fruit was gathered May the 24th, and the seed sown June 19th. On February 28th, thirty-one plants were potted. Of these, thirteen plants lived to be transplanted into the field February 8, 1911. Note taken May 14, 1912: "Eleven plants alive; vigorous, and in general appearance intermediates of the parents. Shoots as erect as in Dallas with color and spines of Mammoth; leaflets large with color, texture, and marginal serrations plainly showing Mammoth; the flowers large; filaments very short, in some individuals shorter than the anthers, and the inner whorls of stamens suppressed, but replaced with a circle of papilloid accessory receptacles, bearing pistils."

*Bush-Fruits by Card, p. 249.

The stamens in these flowers produced at least some potent pollen, as fruiting took place under screen.

Two individuals of the above type were screened off to produce fruit for a second generation.

Mammoth X Dallas F_2 and F_3: The seed were sown October 14, 1913. An F_2 generation of several hundred individuals grew to be potted off, but only ninety-three reached bearing age in the field.

The notes taken during May and June of 1916 described the plants of this generation as falling into three groups: namely, fifty-one individuals, in which the characteristics of Mammoth were predominating; twelve, which simulated Dallas; and the remaining thirty, which could not be referred to either.

The reduction of the number of stamens as well as the lengths of their filaments was evident in a varying degree in all those in which the characteristics of Mammoth prevailed. The development of the accessory pistils replacing the stamens varied with the reduction of the stamens. In the group characteristic of Dallas no accessory pistils were noted, but the stamens varied from having almost normal filaments to where the anthers appeared sessile.

Out of the ninety-three plants, three were marked as elites, because of the fine quality of the fruit. Any one of these would have been worthy of cultivation, except for sterility of stamens. Two of them carried the characters of Mammoth, while the third was more decidedly of the Dallas type with only traces of the Mammoth. Seed, for a third generation, was gathered from all three and sown separately, according to the types of the three mother plants.

This F_3 generation consisted of only four descendants reaching maturity from the Mammoth type, while one hundred and twenty from the Dallas type reached maturity. Among the last, there were several individuals of good fruiting quality, but their mongrel nature showed strong interference of foreign pollen; the characters of *Rubus rubrisetus* were especially evident. Further work with them was, therefore, abandoned.

[Logan X (Mammoth X Dallas) F_1] F_1: Flowers on several individuals of Mammoth X Dallas F_1 were pollinated with the Logan berry April 11, 1913. This resulted in twenty-five plants which were transplanted into the field, one year later.

All these were very similar in appearance, showing the Mammoth form in all their parts. The canes were prostrate, and the basal leaflets were more inclined to produce lateral lobes than in the Mammoth and Dallas. The suppression of the stamens and their replacement with pistils were carried even further than in the immediate mother form, so that in several individuals there was no vestige left of the stamens; but the accessory pistils, as well as the disk of their insertion, were correspondingly developed.

A few flowers on a plant of this kind gave rise to perfect fruits, when pollinated with pollen of the Phenomenal. (Fig. 3).

The seeds obtained from two fruits of this unique origin were sown

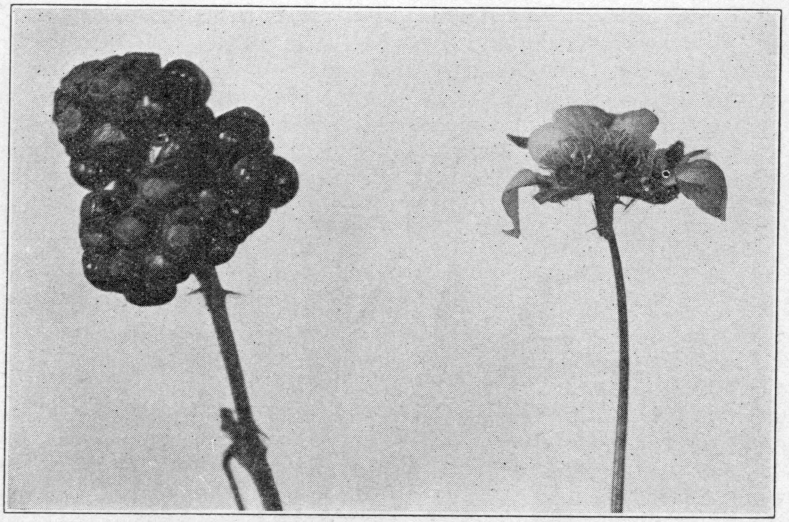


Figure 3. Right: Flower of Logan X Mammoth-Dallas. Unisexual through substitution of stamens by pistils. Left: Fruit of same through pollination with Phenomenal.

October 7, 1915, and gave rise to a single plant, which, however, proved short-lived.

Two plants in which the stamens were fairly well developed were screened during flowering but set no fruit. A few fruits were, however, obtained from plants exposed to foreign pollen. The seed from these were sown October 7, 1915, but no germination was recorded.

RUBUS RUBRISETUS Rydb

Rubus rubrisetus differs obviously from *R. trivialis*, the Southern dewberry, in producing two forms of shoots; namely, low, spreading, slender, profusely branching shoots; and erect, stout shoots, 4 to 6 feet high with very few or no branches, and more densely covered with long, red bristles than the low shoots (Fig. 4).

Two quarts of the fruit of this species were presented in the spring of 1910 for this breeding work by Mr. W. Newell, at that time, Entomologist of the Texas Experiment Station. The fruit was obtained by him from a plantation in Southern Louisiana, for which reason the plants raised from the seed of that fruit are hereafter to be known in this Bulletin as the Louisiana berry, or abbreviated, as La.

The seeds were sown October 4 of the same year and by November, germination was evident in all boxes. In April 1911, about 200 plants were transplanted from pots into the field. These plants proved to be very uniform in vigor as well as in structural characters. The greatest variation occurred in the size and abundance of fruit—horticultural rather than botanical differences.—Fig. 4.

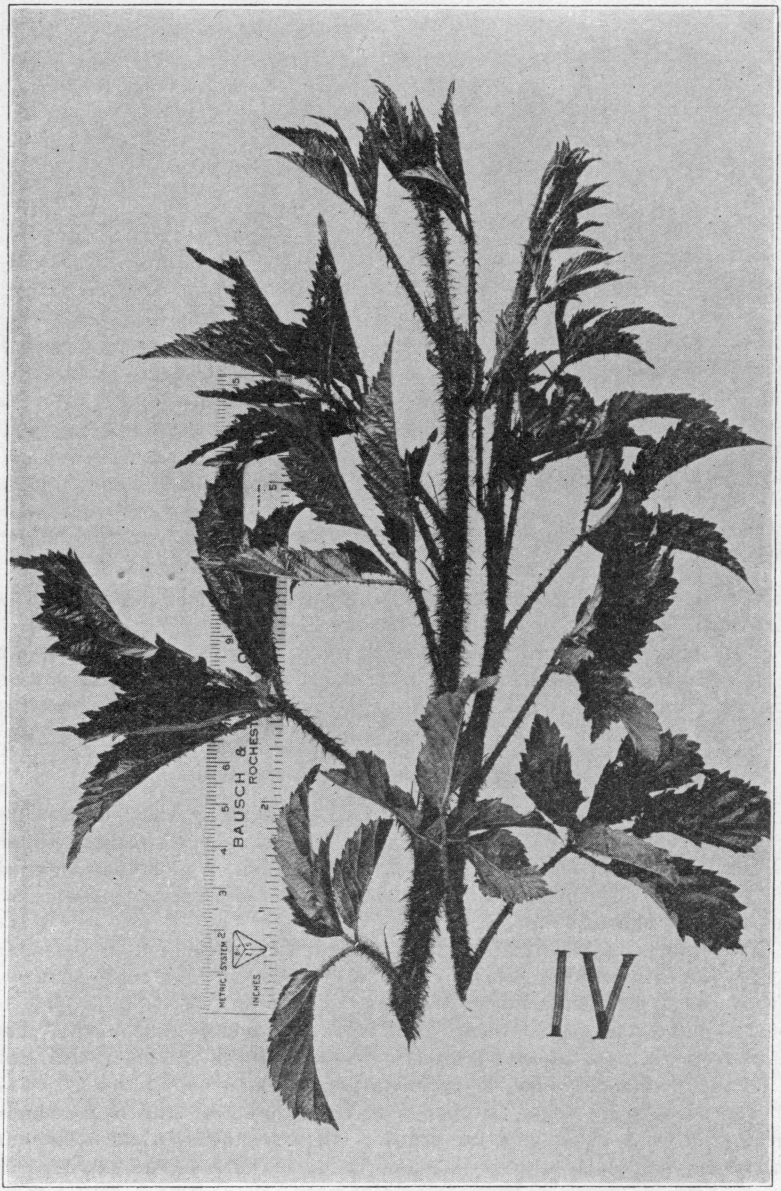


Figure 4. Shoots of *Rubus rubrisetus*.

Brilliant X Louisiana F_1: On April 22, 1912, flowers of several individuals producing the finest fruits were pollinated with pollen from Brilliant, a red raspberry, variety of *R. Strigosus.* A number of more or less perfect fruits was the result. The seeds of these were sown on October 15, and by the last of November, 24 vigorous young plants were growing. Later several more germinated, but only 21 plants grew strong enough to survive the transplanting into the field, March 13, 1913. There they developed into a uniform raspberry type, showing only such differences in the vegetative organs as might be attributed to differences in vigor. In the size and abundance of the flowers, the differences were somewhat greater.

Notes taken May 26, 1915 give the following description:

"Raspberry type very dominant; no visible traces of the mother form; canes ascending stouter than in the raspberry, closely set with bristly prickles; foliage dark green, the leaves in most of the individuals larger than in the raspberry (Fig. 5); flowers on pedicels 2 to 5 c. m. in length, forming open carymbose clusters of the mother type; the size of the flowers intermediate between that of the parent types; stamens well developed, exceeding the pistils in height, and pollen apparently abundant. Only seven plants have flowers to date, but the others appear to be of sufficient maturity; fruit very imperfect, consisting of a few scattered drupelets of glossy, dark-red, cherry color, and mild acid, raspberry flavor."

Three plants covered with cages of mosquito netting produced the same kind of fruit and equally abundant.

The drupelets were gathered and the seed sown two years in succession, but only a few plants of a second generation were obtained each year, and these gave no progress, because of their sterility. Finally, in 1915, the crop of fruit was a little more abundant and the drupelets were gathered from all plants, only two of which were covered during flowering. The seeds were sown separately for each group October 7, 1915. No plants were obtained from the lot raised under cover, but the others germinated fairly well, so that by February 15, 1916, 53 plants had been potted off and others were coming on.

On May 5, 1916, 280 plants were transplanted from pots to the open field. On June 14, 1917, 125 were alive, vigorous, and of fruiting maturity. They were estimated to fall into the following characteristic groups: 41 per cent Louisiana berry dominant; 28 per cent raspberry dominant; 22 per cent intermediate, and 3 per cent indefinable.

This grouping has, of course, but little significance, because the parents flowered exposed to the visits of insects.

The group in which the raspberry characters predominated, could again be divided into three groups; namely, one of plants having very strong growth, or giants; another of those of medium growth; and the third of positive dwarfs. In all these groups, flowering was general, very few failing; but all were more or less sterile, except in the most vigorous raspberry—dominant group, where five plants were found to set perfect

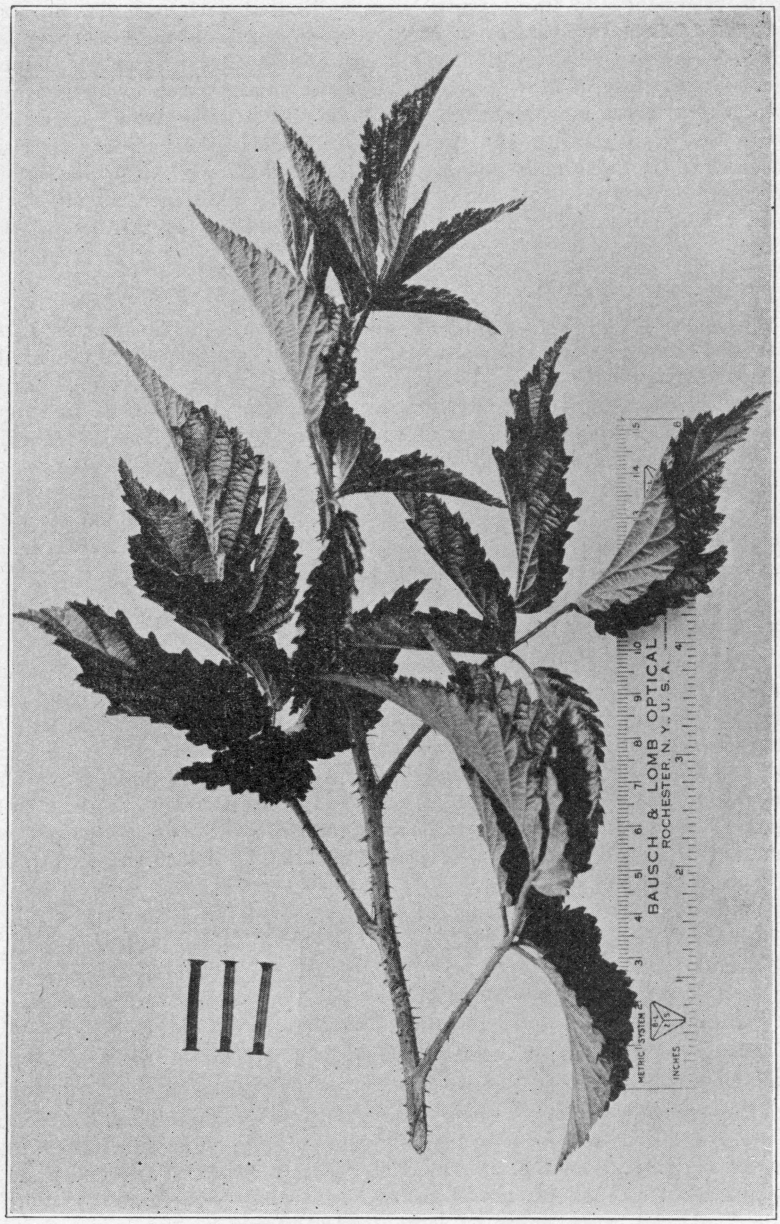


Figure 5. Shoot of Brilliant X *R. rubrisetus* F^1.

fruits and appeared to differ from each other in no character, except that one was of more vigorous growth and bore a larger crop of fruit than the others. (Figs. 6-7) To this, the preliminary name, "First Choice," was

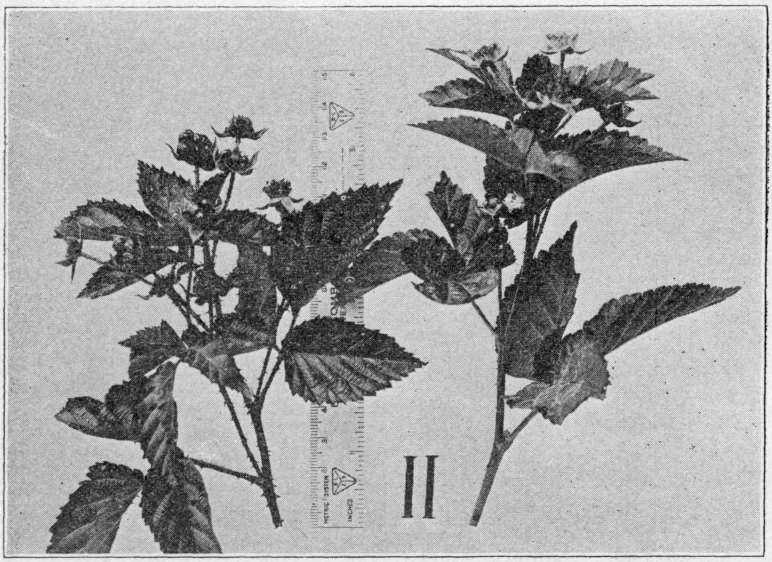


Figure 6. Shoots from an infertile plant of Brilliant X *R.—rubrisetus* F_2x.

given in order to distinguish it from the others. All five were coarse raspberry forms with heavy ascending, or prostrate canes, covered with numerous weak, short prickles. The leaves were very large, of raspberry texture with three to five ovate, or rotund leaflets. The flowers were intermediate in size between those of the parents of the F_1 generation, and were borne on elongated pedicels, similar to those of the Louisiana berry. The fruit was dark cherry-red, becoming brown, or nearly black when overripe. Its size was much larger than that of either parent of the F_1 generation,—in fact, larger than any fruit produced by the Logan berry on our grounds. The flavor was mildly acid with a strong reminder of the raspberry (Fig. 8).

As soon as the perfect fertility of these plants was evident, they were covered with cages, under which the fruiting continued uninterrupted. Their pollen, when used in cross-pollination of other forms, proved to possess normal potency.

The fruit was gathered from the three plants proving most prolific and gave an abundant supply of seed for a third generation.

Brilliant X Louisiana F_3: The seed from each of the three plants were sown separately September 10, 1917. The germination and vigor of the plants were good; so that on April 9, 1918, 859 plants were transplanted

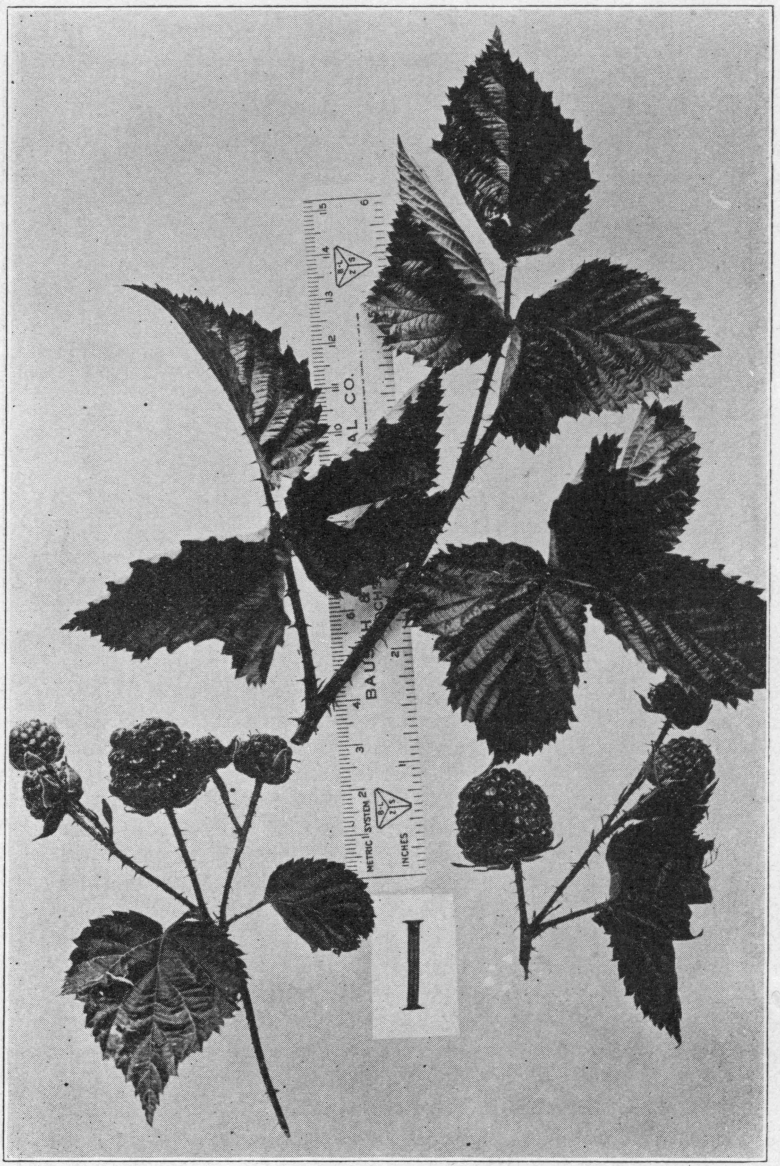


Figure 7. Shoot of a fertile plant of Brilliant X *R. rubrisetus* F_2x.

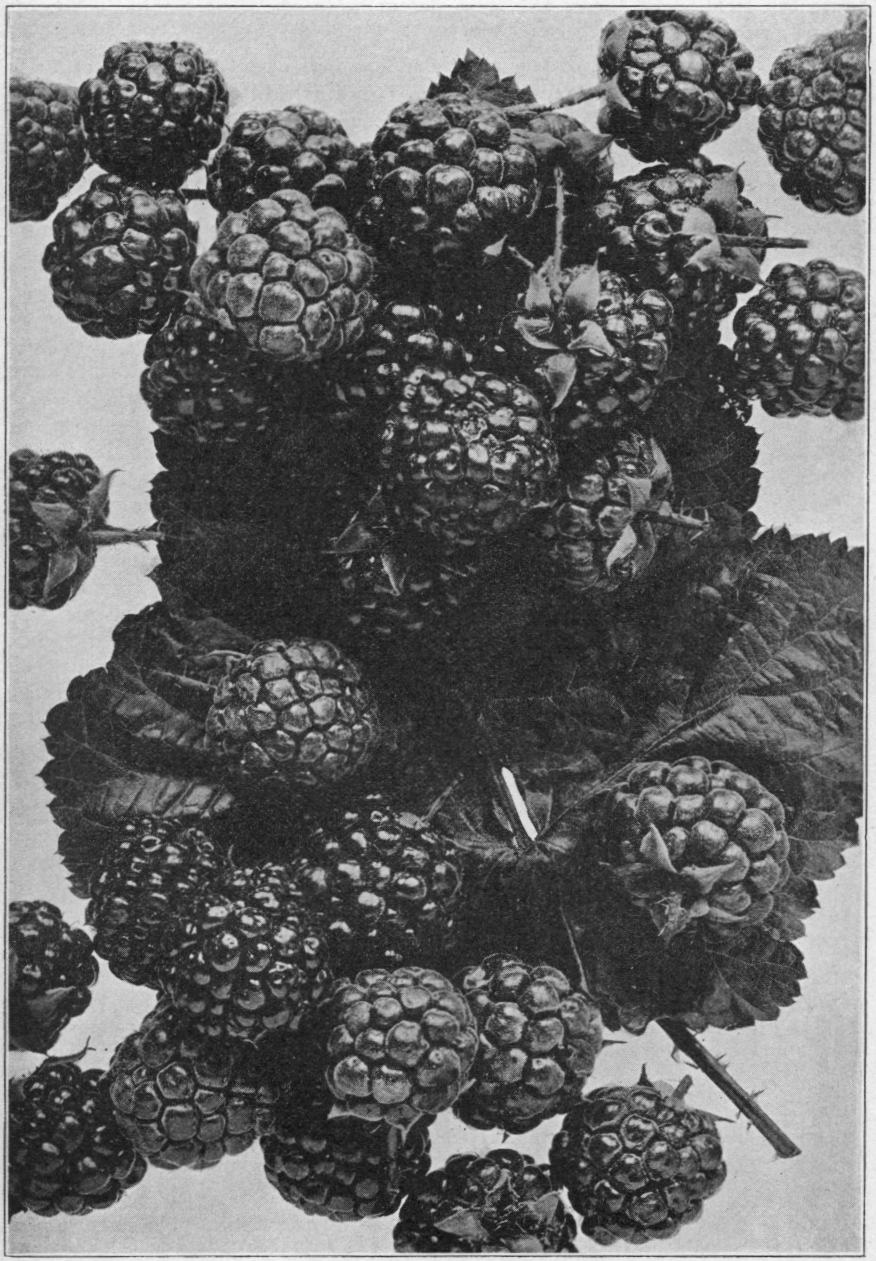


Figure 8. Fruit and leaf of First Choice; natural size.

into the field. Of these, 581 were descendants of "First Choice;" 254, of No. 2; and 24, of No. 3.

With the exception of the month of April, the growing season of 1918 was one of the driest experienced in Texas within the memory of the present generation. The drought was especially destructive, because it was cumulative, the precipitation having been decreasing for several seasons preceding. The lack of moisture in the soil was evident in the forests of this vicinity, where many trees died during the summer of 1918, even along many water courses, which had dried completely up. But, in spite of the drought and a shallow soil deficient in humus, these plants made a good growth, and the mortality among them was negligible.

The growth was resumed in early part of April 1919 after a winter of abundant rains. Some of the more advanced plants began flowering by the first of May and flowering became general three weeks later. Very few, mostly of abnormal types, failed to flower and to set perfect fruit. By June nearly all the plants were sufficiently advanced to show their individual characters in all parts. It was surprising to find that the variations in the characters were no greater than what would be expected from individuals of a homogeneous species. In fact, the variations were only such as had been met with in the seedlings of *Rubus rubrisetus*, their mother species. The various individuals differed only in the vigor of growth, time of flowering, size and abundance of fruit. A few abnormalities were found, chief among which were excessive dwarfness and excessive laciniation of the leaves, but the extreme forms of these, amounting to no more than two per cent., failed to flower and proved short-lived. The description given of the mother plants is also applicable to the progeny (Fig. 9).

As in the mother plants of the F_2 generation, the drupelets adhered to the core, after the manner of the blackberry; but unlike the blackberry, the fruit did not disjoint within the calyx, leaving this attached to the pedicel when matured. The picking of the fruit is, therefore, slightly embarrassed, since the calyx adheres to the fruit as in the strawberry and no special joint for the separation of the fruit from the pedicel is formed. The picking can, however, be made easy: simply seize the fruit with the thumb firmly against the calyx and, in pulling, bend it to one side, when the pedicel will readily break immediately underneath the calyx.

A diligent watch upon the development of each plant and a search for individuals that might be classed as elites were kept up until August, when fruiting ceased. From time to time, certain plants were marked and their development critically noted. Twenty-five such elite plants were marked, but only about half of them were retained to the end of the season. After the trial of another season, 1920, this number was reduced to eight (Fig. 10).

All of these elites were descendants of "First Choice." Though a few from the other two lots were marked, they were dropped, because they were judged inferior to those retained. The eight elites were retained,

Figure 9. Field of Brilliant X *R. rubrisetus* F_3, the generation that gave the Nessberry.

because it was not possible to give any one the preference over the others. They were each given a number and propagated from the tips of the shoots. The new plants, thus obtained, were transplanted into an increase plat where each lot, as a separate strain, bore the number of its mother plant. This increase plat contained nine such strains, but the ninth was obtained in 1921 from a second sowing of seed from one of the five fertile plants of the F_2 generation, a sister plant of "First Choice."

This new fruit has been named the Nessberry by the authorities of the College, and 5653 plants from the nine strains have been distributed among the public under that name.

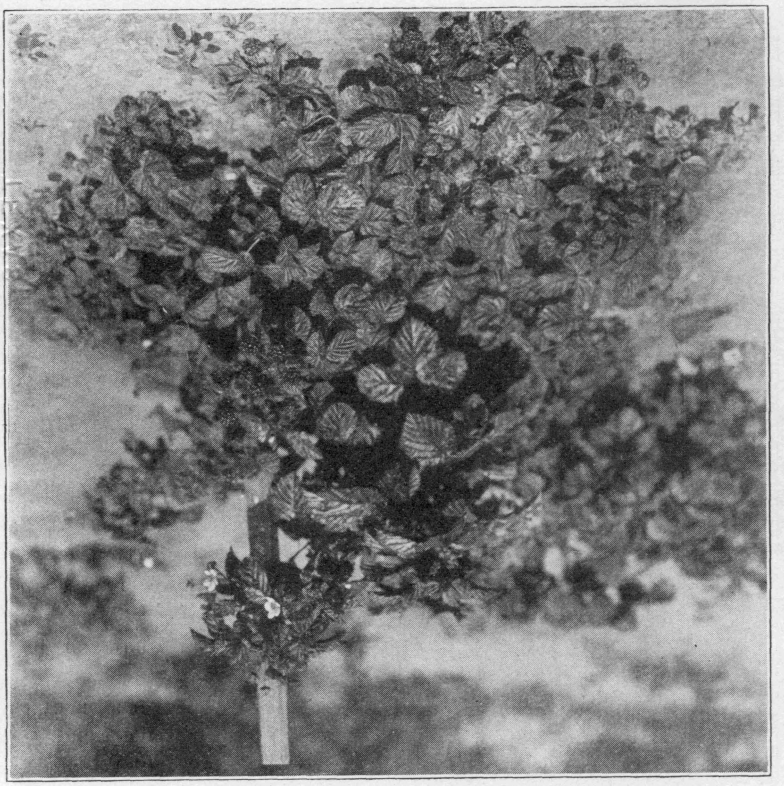


Figure 10. Elite plant of Brilliant X *R. rubrisetus* F_3x.

THE NESSBERRY FORM HYBRIDIZES EASILY WITH OTHER FORMS

One of the most noticeable qualities of this new form is the ease with which it lends itself to further hybridization with other forms, whether used as pollen or pistil parent. In every instance where its pollen has been applied to the stigmas of another form of Rubus, the result has been viable seed in good quantities. The following are some of the hybrids to which it has contributed:

[(Brilliant X La) F_2 X (Haymaker X La) F_1] F_1
[Spineless-diffuse X (Brilliant X La) F_2] F_1
[Early Harvest X (Brilliant X La) F_3] F_1
[(Mammoth X Dallas) F_3 X (Brilliant X La) F_3] F_1
[Himalaya X (Brilliant X La) F_3] F_1
[La X (Brilliant X La) F_3] F_1
[Brighton X (Brilliant X La) F_3] F_1
[Hailsham X (Brilliant X La) F_3] F_1

[Cumberland X (Brilliant X La) F_3] F_1

[Van Fleet X (Brilliant X La) F_2] F_1

These combinations are at the present writing, September 1924, represented in our cultures by one generation or another either in the field or in the nursery. The history of the more important is as follows:

Haymaker X La F_1: Cross-pollination of the Louisiana berry with the Haymaker *(R. neglectus)* was made May 1, 1915, resulting in 25 plants planted in the field in May of the next year. The characteristics of the male parent predominated in all organs, so that no trace of the mother was discoverable. The shoots were of very rank growth, the principal ones being 10 to 15 feet long, decidedly glaucous, and covered with weak prickles. The leaflets were large, with laciniately serrate margins. The flowers were scarcely larger than in the Haymaker and quite sterile, less than half of them producing fruits, each of which was composed of one or only a few scattered drupelets. No fruit was produced under cover.

An F_2 generation of 19 strong plants was obtained in 1919. They were transplanted into the field in 1920, and proved to be very uniform in appearance, closely similar to the F_1 generation, with the exception that the flowers were larger; and on the five plants which flowered, the fruits were perfect. Two of the best plants were covered and continued to produce perfect fruit, not dissimilar in size and other characters to the fruits of the Nessberry. The rankness of growth was, however, too great for the amount of fruit.

An F_3 generation was planted in 1921, but consisted only of eight individuals, which appeared to differ in no essentials from F_2.

[**(Brilliant X La) F_2 X (Haymaker X La) F_1] F_1:**—The very sterile **Haymaker X La. F_1** was pollinated at different times in April and May 1918 with pollen from "First Choice." About 60 seeds were obtained and sown September 10, 1918. The result was seven vigorous plants, which were transplanted into the field May 3, 1920. Note May 13, 1921:

"Shoots stout, terete, and of somewhat ranker growth than those of First Choice. Leaves large, 3 to 7 foliate, leaflets in all respects similar to those of the mother plant. (Haymaker X La F_1). The features of Haymaker are more visible in the color and prickles of the canes, as well as in the inflorescence; but no traces of those of the Louisiana berry can be detected in any of the seven individuals. Four plants fruiting; fruit perfect, as large as in Brilliant-La descendants and of similar form; size and adherence to the core as in "First Choice."

One plant fruited under screen, but the seeds were also gathered from the other three and sown separately October 13, 1921.

[*(Brilliant X La) F_2 X (Haymaker X La) F_1] F_2*:—The seeds from the uncovered plants gave 203 individuals for planting into the field on June 5, 1921, and the covered gave 76. Owing to the late season of planting and accidents incident to that cause, the plants that succeeded in reaching maturity were reduced in number to about half of those planted from each lot. The following note of June 13, 1922 describes their characterisics:

"No difference between plants from covered and uncovered parents; very course and uniform growth of raspberry type; canes purplish, glaucous, covered with purplish, straight, weak prickles; characteristics very similar to F_1—no segregation; all plants fertile; fruit perfect, similar to that of the Nessberry in size and form, but of a more dull color and more tart flavor."

After observations made during 1923 and continued in 1924, five plants were marked as elites worthy of name and propagation. These plants were so similar that no preference could be assigned to any one. But as the soil in which they grew was of unequal quality, the differences may be latent and come into view on better and more uniform soil.

As far as observed, the fruit is as large and abundant as in the strains of the Nessberry, but it is a little more tart in flavor and of easier picking. Both of these qualities are advantages over the Nessberry, especially the tartness, or sharper taste, because the jelly of Nessberry is somewhat lacking in tartness.

[Himalaya X (Brilliant X La) F_3] F_1:— The Himalaya berry is of an Asiatic origin and referred to *Rubus thyrsoideus*, Wimmer. It is a blackberry with perennial, very rank growing, spiny shoots, capable of attaining a length of thirty feet or more in a single season. It is a climber, and is therefore grown on high trellises or as arbors. The flowers are pale purple and borne in large terminal, thyrsoid panicles.

The Nessberry was pollinated with this form, first in June 1921, and again in May of the following year. It was done more to test the feasibility of the operation than with any hope of economic results. In both years, fruit, due to this pollen, was obtained from the Nessberry; and the result is eight plants, four from each season, growing in the field. Two of the first planting (1922) bore fairly perfect fruits and gave some seed this season (1924). The plants are uniformly Himalaya in characteristics, even to the form, color, and size of the flowers, excepting that the season of fruiting seems to be earlier than in the Himalaya and the plants of much dwarfer and more erect growth, corresponding in that respect to the Nessberry. The greatest surprise was the perfectness of the fruit from a combination so heterogeneous.

[La X (Brilliant X La) F_3] F_1:—The cross-pollination giving rise to this, as well as the reciprocal of it, was performed in May 1921. Seeds were obtained in both cases, but those from the reciprocal failed to give any plants.

The cross was made with the hope of obtaining a fruit of better picking qualities than the Nessberry, and still retain some of the good features of that form.

The generation consists of 27 plants, planted in the field in June 1922. The notes taken in May and June of 1924 describe their characters as follows:

"Plants intermediate of the parents, except three individuals which show only the Nessberry in all parts and bear a heavy crop of perfect fruits; all the others are more or less sterile, with canes showing traces

of both parents, being glaucescent and covered with numerous purplish-brown, bristly prickles. The leaves have the form and size of the Nessberry, but their texture and surface are characteristic of the blackberries. The flowering is abundant, but each resulting fruit consists only of a few scattered drupelets."

It was exepected that this combination would prove fertile in the first generation, since Haymaker-Louisiana, when crossed with the Nessberry form, produces a fertile first generation.

The seeds were gathered from both classes of variants for a second generation, which presumably will give fertile plants.

[Spineless-Diffuse X (Brilliant X La) F_2] F_2:—This hybrid is now represented by only 16 individuals on our ground. They can be referred to the four following types:

6, McDonald.
6, Louisiana (Shoots red-bristly)
2, Spineless-diffuse.
2, Nessberry.

The most peculiar phenomenon is the purity in which the Spineless-diffuse and the Nessberry occur, as they show no traces of McDonald or the Louisiana.(Fig. 11). The Nessberry types were dwarfs and have not flowered, although this is the third season since planting.

The Spineless-diffuse type bore a good crop of handsome, fine flavored fruits. In the others the fruit was more or less scant and imperfect.

[(Mammoth X Dallas) F_2 X (Brilliant X La) F_2] F_2:—This, the second generation of this combination, has been growing in our test field for two years. It is represented by 223 individuals, too variable for classification. However, the Mammoth type,—more or less pure, may be pointed out in several individuals. In eight individuals the Nessberry is evident, but as dwarfs or semi-dwarfs. The fertility is low for the entire generation; more than half failed to flower. Those that set some fruit were invariably individuals of a purer type, showing Dallas, Mammoth, or the Nessberry more distinctly than the sterile forms. Many are constitutional weaklings, apparently too backward in growth to set flowers.

[Brighton X (Brilliant X La) F_2] F_1:—This, the first generation, consisting of about 230 individuals, was planted in the test field along with 40 individuals of [Hailsham X (Brilliant X La) F_2] F_1 on May 1, 1923.

Brighton and Hailsham are varieties of *Rubus Idaeus*, the European red raspberry. Plants of these varieties were kindly presented for this work by Mr. Darrow, Pomologist of the Bureau of Plant Industry, Washington, D. C.

The object sought by this cross is the combination of the qualities peculiar to *R. Idaeus*, among which is a very fine aroma, with the qualities of the Nessberry, the pistil parent in this case.

In this generation the two combinations show no character by which one may be distinguished from the other. The individuals are also more similar to each other than the first generation of any of the hybrids described above. They differ from the Nessberry in having more decidedly glaucous canes, and in the color of the leaves, which are of a very dark

Figure 11. Three shoots of the spineless-diffuse type and one of the Nessberry type in (spineless-diffuse X (Brilliant X *R. rubrisetus*) F_2) F_2.

green on the upper surface and silvery, or canescent underneath; hence, distinctly bicolored. The leaves while young and the tips of the growing shoots are also more purple colored than in the Nessberry; and the plants are larger and of a more even growth, at the end of the first season than those of (Brilliant X La) F_3 which gave rise to the Nessberry (Fig. 12).

All of the plants set a profusion of flowers, but not a single flower produced perfect fruit. Each fruit consisted, as in other cases of partial sterility, of only a few drupelets. By gathering nearly every drupelet, an ample amount for seed of a second generation was secured.

RESUME' AND CONCLUSIONS

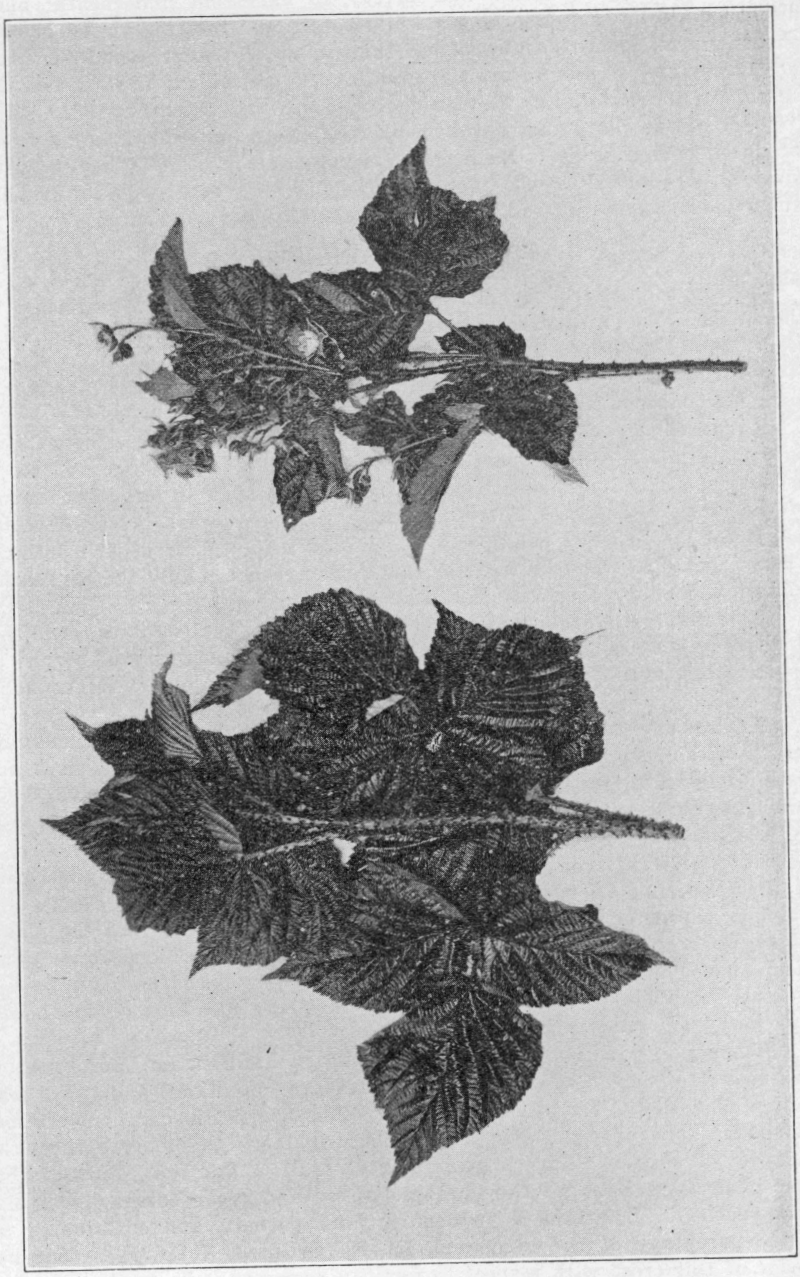
It has been extremely difficult on our soil to maintain materials for the work. The raspberries, for example, are very short-lived and liable to die before fruiting; therefore, they cannot be relied on as seed parents. It is for this reason that reciprocal crosses, with a raspberry as mother, were not obtained, although several starts were made.

Crosses between various forms of blackberries or dewberries gave poor materials for study, partly because of persistent sterility, and partly because of difficulty in identifying parental characters in later generations of the cross. Progress, therefore, dates from the employment of *Rubus rubrisetus* as mother, which can be crossed easily with other species.—These concluding remarks will, for that reason, cencern only the forms that contain *R. rubrisetus*, or the Louisiana berry.

The first generation was more or less sterile in all crosses, except in Brilliant—La X Haymaker—La., where perfect fertility as well as, to all appearances, specific stability in all other characters observed ensued at once.

Haymaker—La., though very sterile in the first generation, became fertile in the second. Two second generations were raised, the first consisting only of a few plants, the other of a somewhat larger number. In neither generation was I able to discover splitting of characters, and both were apparently perfectly fertile. The performance was, therefore, a repetition of what took place in a large third and small fourth generation of Brilliant—La., in which the individuals remained perfectly fertile and stable in character. This stability was not such, however, that the plants might be suspected of having parthenogenic origin, which would place them on a par with plants raised from cuttings, since there was about the same individual variation as found among the seedlings of the Louisiana berry *(R. rubrisetus)*.

Keeping in mind the fertile F_1 generation of Brilliant-La. X Haymaker-La., it was expected that when the Nessberry (Brilliant X La F_3) was pollinated with the Louisiana, it would result in a fertile first generation, which, if large enough, would leave nothing more to be done than the choosing of elites, to have a new form of fruit. But the plants of this first generation have all the characteristics of a cross between two distinct species. Louisiana is present in both parents, and contributes ¾ of the parentage of the compound, La. X (Brilliant X La. F_3). The behavior of this cross with respect to fertility seems to indicate that the im-



mediate parents were genetically further apart than Brilliant-La. is from the Haymaker-La., in which La. contributes one-half, and two different species of raspberry, the other half. As already stated, La. X Nessberry F_1 consists of 24 plants apparently intermediate between the immediate parents and affected with sterility, and 3 plants with the characters of the Nessberry and fertile.

The next cross of interest is the Spineless-diffuse X Nessberry. The first generation of this consisted only of 3 plants, in which all the characters appeared to be intermediate of the parents. The fruits were imperfect, each made up of only a few scattered, dark-brown drupelets, a color similar to that of an over-ripe Nessberry. The remarkable part of this combination is the purity in which the Spineless-diffuse reappeared in two individuals of the second generation. It had already been noted that whenever this form was used in crossing with other forms, it would always reappear with conspicuous purity in some of the progeny. It is also certain that a much larger number of the seedlings than those developed belonged to this type, since a large number of them died through lack of chlorophyll in every culture.

The outstanding features of this breeding work as indicated by the results may be stated in the following sentences:

1. The seedlings of the three forms, Nessberry, Haymaker-La., and Nessberry X Haymaker-La., act to all appearances as the progeny of a true species.

2. Wherever segregation could be positively distinguished, the most common form resembled one or the other of the parental types. The number of plants showing recombinations of several characters from each parent, or combinations of characteristics which could not be readily attributed to either parent, was relatively small.

HORTICULTURAL CHARACTERS OF THE NESSBERRY

As already stated, the Nessberry is of an excessively strong growth, some of its branches attaining a length of 10 to 15 feet in a single season. Their position is, therefore, prostrate. Without pruning, the cultivation would be made cumbersome; and, as in the case of an unpruned grapevine, they would fail to develop fruit of proper quantity and quality. But the plants may be readily forced by pruning to assume a bush form, similar to that of a rose bush, which will permit of easy cultivation both by plow and hoe. This form is easily attained, since the canes do not rise from the roots, but as branches on a main trunk. By removing the lowest of these branches and keeping the others cut back to a convenient height, whenever they threaten to fall in the way of cultivation, a bush form may be obtained that is not only easily cultivated, but is also a producer of an abundance of fruit, uniform in size and of high quality.

The space needed for the plants trained in this manner is 6 to 7 feet between the rows and 4 to 4½ feet between the plants in the row. Since no sprouts arise from the roots this space is not liable to be encroached upon. Another advantage secured from this habit of growth is the facility of clearing the ground of the plants, whenever it may be desired to

do so. Cutting off of the plants a few inches below the surface with a hoe or a breaking plough, will accomplish their destruction.

Propagation:—This is accomplished by rooting the tips of the growing shoots. When a shoot of the current season is bent to the ground and its tip buried two or three inches into the soil, this tip will commence to thicken and form a callous growth. It will soon send out roots and form a new bud, which will give rise to a new shoot with its buds pointing in reverse direction to those of the layered branch. This new shoot may, as soon as long enough, be layered in turn, and this process continued as long as the season and conditions permit. In this way one single plant of the Nessberry gave rise to over 300 new plants in 1922, and would have given more, if the opportunities had been more closely utilized, and the ground more carefully cultivated.

It must be remembered, in making the layers, that the more perpendicularly the tip meets the ground, the quicker the rooting will take place, and that no other part of the shoot covered will give rise to a new rooted shoot.

Planting:—Rooted tips, separated from the mother plant, and transplanted before the buds have developed into shoots, are somewhat difficult to grow, especially, if the bud be deeply covered with soil. If planted at that stage, the bud should be left touching the surface and slightly exposed to the light; and the loss of moisture from the soil should be guarded against until a shoot is made.

The Fruit:—The size, flavor, and picking quality of the fruit have already been described. Its color, as has also been stated, is deep red, or blood red, but becomes dark brown when over-ripe. The fruit should be picked while the color is most vividly red, as the flavor deteriorates perceptibly after the color has begun to turn dark. If picked before that stage it may be kept in cold storage for considerable time, and the flavor will be perceptibly improved. Its keeping quality in the temperature of an ordinary kitchen refrigerator seems to be remarkably good, and for that reason, its shipping quality is expected to be good.

It is hoped that this fruit, when its qualities become known, will be for the South what the famous Logan Berry is for the states on the Pacific Coast.

PUBLICATIONS AVAILABLE

Order by NUMBER

BULLETINS

No.
128 Cottonseed Meal as a Human Food (Technical)—1910.
159 Steer Feeding—1913.
162 Composition and Digestibility of the Chloroform Extract of Texas Hays and Fodders (Technical)—1913.
163 Digestion Experimets on men with Cottonseed Meal—1913.
165 Ammonia-Soluble Inorganic Soil Colloids—1914.
166 Digestion Experiments with Texas Feeding Stuffs—1914.
167 Commercial Fertilizers and Their Use—1914.
169 The Total Fatty Acids and Other Ether-Soluble Constituents of Feedstuffs—1914.
170 Texas Feeding Stuffs; Their Composition and Utilization—1914.
171 Losses of Moisture and Plant Food by Percolation—1914.
172 Sudan Grass—1915.
173 The Composition of the Soils of the Texas Panhandle—1915.
174 The effect of Organic Compounds in Pot Experiments—1915.
175 Distribution and Digestibility of the Pentosans of Feeds—1915.
178 The effect of the Additions on Availability of Soil Phosphates—1915.
181 Oxidation of Organic Compounds in the Soil—1915.
182 Steer Feeding—1912.
183 Moisture Relations of Some Texas Soils—1915.
184 Cooperative Fertilizer Experiments with Corn—1908-14.
185 The Production Co-Efficients of Feeds (Technical)—1916.
186 Fattening Lambs—1916.
187 Sprays and Spraying—1916.
188 Tile Drainage—1916.
189 The Composition of Cottonseed Meal and Cottonseed—1916.
190 The Effects of Additions on the Availability of Soil Potash and the Preparation of Sugar Humus—1916.
191 The Composition of Rice and Its By-Products—1916.
192 Soils of Grayson, Lee, McLennan, Titus and Tyler Counties—1916,
195 Japanese Sugar Cane as a Forage Crop—1916.
196 Digestibility of Sugar, Starches, and Pentosans of Roughages—1916.
197 Progress Report, Substation No. 3, Angleton, Texas—1909-14.
200 Progress Report, Substation No. 4, Beaumont, Texas, 1909-14.
201 Peanut Meal and Ground Whole Pressed Peanuts for Hogs—1916.
203 The Productive Values of Some Texas Feeding Stuffs—1916.
204 The Recurving of Milo and some Factors Influencing It. (Technical)—1917.
207 Poultry Houses and Poultry Equipment for Texas—1917.
208 The Fig in Texas—1917.
209 Progress Report, Substation No. 2, Troup, Texas, 1909-14.
210 Barns for Work Animals—1917.
211 Field Experiments with Crown Gall—1913-17.
212 The Availability of Phosphoric Acid in Rock Phosphate—1917.
213 The Composition of the Soils of South Central Texas—1917.
214 Progress Report, Substation No. 1, Beeville, Texas—1910-14.
215 Progress Report, Substation No. 5, Temple, Texas—1910-14.
218 Progress Report, Substation No. 7, Spur, Texas—1909-14.
219 Progress Report, Substation No. 8, Lubbock, Texas—1910-14.
221 Progress Report Substation No. 9, Pecos, Texas—1910-14.
222 The Composition of Peanuts and Peanut By-Products—1917.
224 The Influence of Peanuts and Rice Bran on the Quality of Pork—1918.
226 Cooperative Soft Pork Investigations—1918.
227 Studies of the Harlequin Bug—1918.
228 The Influence of Peanut Meal on the Quality of Pork—1918.
229 Experiments at Substation No. 3, Angleton, Texas—1909-16.
231 The Beemoth or Waxworm—1918.
232 Mineral Requirements of Sheep—1918.
236 Grain Sorghum Improvement—1918.
240 The Utilization of Yucca for the Maintenance of Cattle—1918.
243 The Need of Texas Soils for Lime—1919.
244 Composition of the Soils of Archer, Franklin and Harrison Counties—1919.
245 Feeding Values of Certain Feeding Stuffs—1919.
247 The Chemical Composition of the Cotton Plant—1919.
255 Beekeeping for Beginners.
258 Report of Experiments at Substation No. 4, Beaumont, Texas—1915-18.
259 Nitrification in Texas Soils (Technical)—1920.
262 The Searing Iron vs. the Knife for Docking or Detailing Lambs—1920.
263 Rations for Fattening Steers—1920.
269 Grain Sorghum vs. Corn for Fattening Lambs—1920.
270 A Study of the Black and Yellow Molds of Ear Corn—1920.
275 Spur Feterita—1921.
277 Sweet Potato Fertilizer Experiments at Substation No. 2—1921.
279 Type and Variability in Kafir (Technical)—1921.
282 Composition and Feeding Value of Wheat By-Products—1921.
286 Rice Bran for Fattening Hogs—1922.
292 The Blueweed and Its Eradication.

295 Correlation between External Body Characters and Annual Egg Production in White Leghorn Fowls.
296 Grain Sorghum vs. Corn for Fattening Baby Beeves—1922.
305 Swine Feeding Experiments—1923.
306 Grain Sorghum vs. Corn for Fattening Lambs—1923.
307 Texas Root Rot of Cotton and Methods of its Control—1923.
308 The Sweet Potato Weevil—1923.
309 I. Fattening Steers on Cottonseed Hulls With and Without Corn.—II. The Influence of Age on Fattening Steers—1923.
310 The Interpretation of Correlation Data—1923.
311 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by range Sheep—1923.
312 Commercial Fertilizers in 1922-23.
313 Rice Bran and Rice Polish for Growing and Fattening Pigs—1923.
314 Commercial Feeding Stuffs, Sept, 1, 1922 to Aug. 31, 1923.
315 Digestion Experiments with Oat By-Products and other Feeds, Report No. 7—1924.
316 The Soils of Brazos, Camp, Ellis and Washington Counties—1924.
317 Comparative Influences of Various Protein Feeds on Laying Hens—1914.
318 The Relation between Rents and Agricultural Land Values in Theory and in Practice—1924.
319 Field and Laboratory Notes on a fatal Disease of Cattle Occurring on the Costal Plains of Texas (Loin Disease)—1914.
320 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by Angora Goats under Range Conditions—1924.
321 Cotton Variety Experiments at the Main Station—1912 to 1922.
322 Commercial Fertilizers in 1923 and 1924.
323 The Price of Feed Utilities.
324 Commercial Feeding Stuffs.
325 Effect of Cropping upon the Active Potash of the Soil.
326 Breeding Experiments with Blackberries and Raspberries.

CIRCULARS

1 Strawberries Under Irrigation in South Texas—1914.
7 Insect Enemies of Sudan Grass—1915.
10 Housing Farm Implements—1015.
22 The Malvaceous Plants of Texas—1920.
26 Cost of Production; Its Relation to Price—1920.
30 The Practicability of the Milking Machine—1923.
31 Standard Fertilizers and their Use (Reprint)—1923.
32 Cotton Boll Weevil Control in Texas—1924.
33 Texas Agricultural Experiment Station System—1924.
34 The Lower Rio Grande Valley of Texas.
35 Suggestions on Queen Rearing.
36 Foulbrood Control and Diseases of Bees—Foulbrood Law and Revised Regulations.

ANNUAL REPORTS

25th for 1912; 26th for 1913; 27th for 1914; 28th for 1915; 29th for 1916; 32nd for 1919; 35th for 1922, and 36th for 1923.

Address all communications to

B. YOUNGBLOOD, Director,

Agricultural Experiment Station,
Agricultural and Mechanical College of Texas,
College Station, Texas.