Progressive
Agriculture
in Arizona

Volume XXIV, No. 2, March-April, 1972

College of Agriculture, University of Arizona, Tucson 85721

3rd Printing of Plant Disease Book

On occasion I take pleasure in directing your attention to the excellent works of one of our devoted faculty. This time it is Dr. Rubert B. Streets, Sr., Professor Emeritus at the University of Arizona.

"Doc Streets" as he is affectionately called by students and faculty alike has received many state and national awards for his excellent contributions to the study of plant diseases.

One such recognition Doc Streets received is the highest award obtainable from the Men's Garden Clubs of America. It is called the Johnny Appleseed Award and it was awarded to Doc in 1967.

Other equally honored awards bestowed upon Doc Streets include: Silver Beaver Award from the Boy Scouts of America; Medallion of Merit from the University of Arizona; Faculty Recognition Award of the Tucson Trade Bureau; and Citation for Services to Horticulture of the Ameri[illegible] Horticulture Society.

As many have said before, Dr. R. B. Streets has made many practical contributions by research and study of plant diseases in the southwest. And, it is fitting that the University of Arizona Press has published some of his knowledge and experiences in a book.

It is called, "The Diagnoses of Plant Diseases. A field and Laboratory Manual Emphasizing the Most Practical Methods for Rapid Identification" and is in its third printing.

Doc Streets is internationally known for his excellent research on root rot problems peculiar to the Southwest.

And, his studies since the early 1920's have greatly enhanced our understanding of root rot and more importantly, what to do about it.

In this book he covers diagnostic equipment, supplies and procedur[illegible] He describes the ways in which [illegible] make diagnosis, including special methods.

He describes many non-parasitic diseases, bacterial diseases and those caused by nematodes, viruses and fungi.

And, the more common, or more prevalent of the diseases are pictured by either photographs, or by artists' drawings. This book is available from the University of Arizona Press.

Although Doc Streets is retired he continues to provide good service for the farmers, ranchers, and gardeners of our state.

Harold E. Myers

Dean,

College of Agriculture, &

School of Home Econom[illegible]

In this Issue . . .

Progressive Agriculture in Arizona

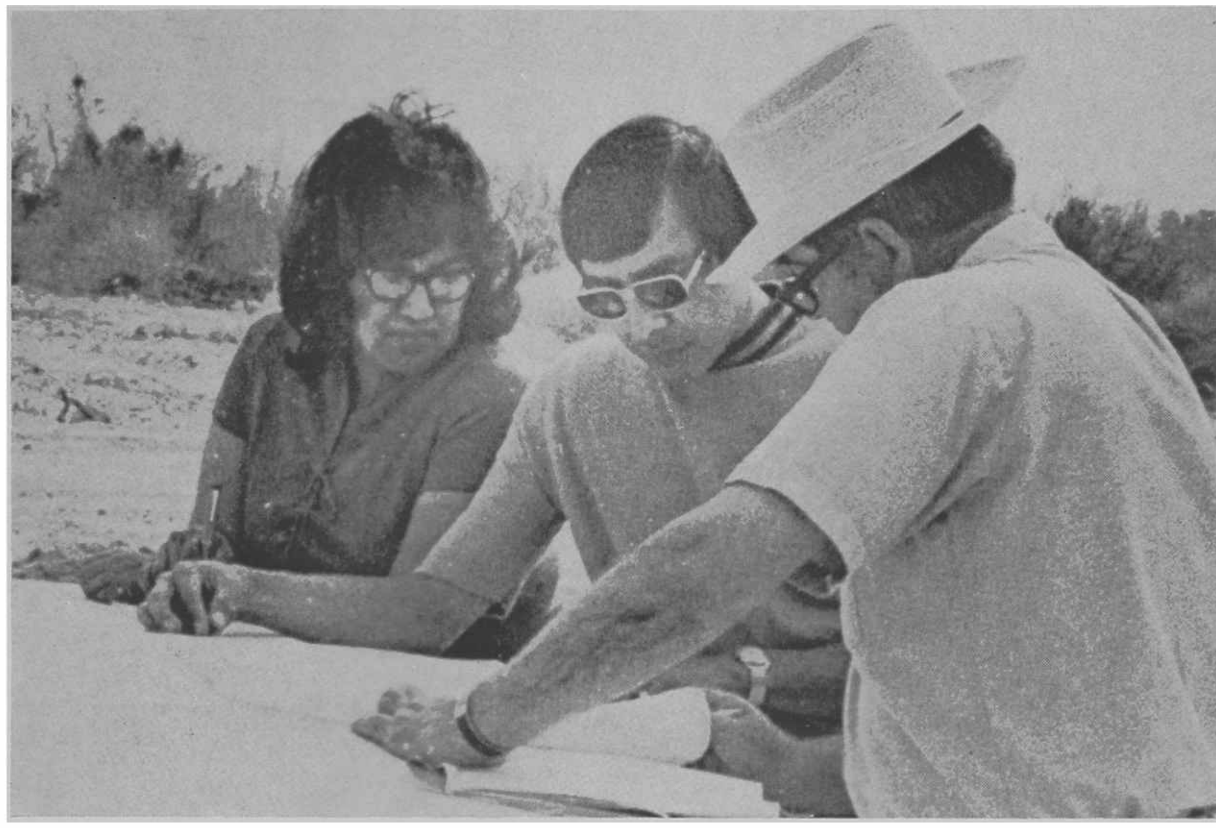
March - April, 1972, Vol. XXIV, No. 2

Published Bi-Monthly by the College of Agriculture, including Agricultural Experiment Station, Cooperative Extension Service and Resident Instruction in the College of Agriculture and the School of Home Economics at the University of Arizona, Tucson, Arizona 85721. Harold E. Myers, Dean.

Second Class postage paid at Tucson, Arizona.

Articles and illustrations in this publication are provided by the faculty and staff of the College of Agriculture. Editorial use of information contained herein is encouraged. Photos or other illustrations will be furnished on request.

MR. AND MRS. MURDOCK (VERONICA, LEFT, AND MYRON, MIDDLE) LAYOUT PLANS WITH AGRICULTURE AGENT G. L. LOVELESS, JR. FOR ECONOMICAL UTILIZATION OF THEIR LAND.



Partners in Progress Along the Colorado

*by G. L. Loveless, Jr.**

With first observation it is not too apparent that you would find an industrial complex on the Colorado River Reservation, but it's there!

Naturally, a great deal depends on how you define an industrial complex, but in stretching a point slightly we might look upon the agricultural developments along the Colorado as being comparable to an industrial complex.

Both industry and agriculture turn out salable products . . . both turn out products which are marketed with value . . . both bring income and commerce to the area.

Whether the salable products come from a building, from a mine or from lush green fields is not as important in this context as the fact that the area has developed capability to generate income. This income is generated through the production and marketing of lettuce, alfalfa, cotton, wheat, barley and sorghum . . .to name just a few of the twenty to twenty-five products produced in the area.

These crops with the large investments made by lease holders for land and water improvements and developments, machinery and buildings, bring in millions of dollars to the people of the area of whom hundreds now have gainful employment throughout the year.

The general belief is that when lease holders, large and small, do well . . . then, the Tribe which controls the land of the Colorado River Reservation will similarly do well. And, when agricultural enterprises do well in the area there appears to be an attraction for other enterprises to come to the area to do equally well.

The Arizona Cooperative Extension Service plays an integral part in the educational phase of the agricultural development of this area and helps to encourage the utilization of practices to improve crop yields, adaptations of new and usually better varieties, use of safe and effective pest controls and improve overall water management and cultural practices. The Arizona Cooperative Extension Service brings into play the resources of the University of Arizona College of Agriculture, the U.S. Department of Agriculture and the Bureau of Indian Affairs.

Whenever new areas are developed all members of the agricultural team-enterprise pool their knowledge and experience to supplement the many informational meetings and problem-solving on-the-farm visits.

One example is the research being conducted to determine profitability of a planned-for cattle operation to be operated by the Tribe, as well as by individual Indian families. Another would indicate a need for feasibility study concerning the production of citrus on near-by mesas.

And, sometimes finding out that proposals would be uneconomical saves the expense of trial-and-error failures. For a time it was felt that an alfalfa dehydration plant might benefit the area until it was shown that it would in all probability be unprofitable. Similarly, a catfish production operation on, or adjacent to, the Colorado River while looking promising would have suffered the problem of too high production costs in relation to marketing prospects.

It is a collection of examples as this when people from various parts of the state get together, work together to develop growth in an area that we have a true demonstration of Partners in Progress. This time we're along the Colorado. Come see us.

Agricultural Agent in Northern Yuma County, Cooperative Extension Service, University of Arizona.

Effects of Method of Planting Rate of Planting and Row Position on Beds on the Growth and Grain Yield of Barley

*by A. D. Day, Fred Turner, Jr., & R. M. Kirkpatrick**

Experiments were conducted over a 2-year period (1969-1970) at Safford, Arizona to determine some effects of method of planting, rate of planting, and row position on beds on growth and grain yield of spring barley planted on beds in saline soil. The soil was an Anthony silty clay loam (sand, silt, clay = 16, 50, 34%, respectively) which was saline-sodium (4) in nature. Two sources of water were available for irrigation: (a) well water, which had a high total soluble salt content (2,000 ppm) and a high sodium absorption ratio (9.3) and (b) water from the Gila River, which had a lower concentration of soluble salts (864 ppm) and a more favorable sodium absorption ratio (5.0). An average of 28 acre-inches of water was applied per acre during the growing season (75% river water and 25% well water, applied separately). Rainfall during this period was 0.95 inch.

Elevated beds were prepared by listing on 40-inch centers and then shaping to 8 inches high and 18 inches across the top. Beds were oriented North to South in one experiment and East and West in the second experiment. Two methods of planting on beds were studied: (a) seven drilled rows, 6 inches apart, over the entire bed and furrow and (b) two rows, 12 inches apart on top of each bed. A regular grain drill, with disk openers, was used for the drilled method of planting and John Deere Model 70 Flexi-planters, with disk openers, were used for the two-row method of planting.

Two planting rates were compared: (a) 25 lb./acre and (b) 50 lb./acre. Each year, seed of 'Arivat' barley was planted in November, in dry soil, and irrigated-up. The grain was harvested with a hand sickle in June of the following year. Irrigation, fertilization, and other cultural practices were those suggested for barley in Arizona (1, 2, 3). The experimental design was a split, split plot with four replication of methods of planting on beds as main plots, planting rates as subplots, and row positions on beds as sub-subplots. Each sub-subplot was 4 square feet. At harvest, plant height, number of heads, number of seeds per head, weight of 1,000 seeds, and grain yield were recorded. All data were analyzed using the standard analysis of variance.

Row Position on East-West Beds

When beds were constructed in an East to West direction, barley plants in rows on the warmer, south side of the beds were taller, had more heads per unit area, had more seeds per head, had heavier seeds, and produced more grain than plants in rows on the North side (Table 1). The combined effect of these growth and production factors was more lodging on the South side of the beds than on the North side.

Rate of Planting on East-West Beds

The 25 pounds per acre rate of planting on East-West beds resulted in plants that had more seeds per head, heavier seeds and higher grain yields than did the 50 pounds per acre rate (Table 1). Rate of planting had no significant effect on plant height or number of heads per unit area.

Method of Planting on East-West Beds

The drilled method of planting on East-West beds resulted in plants that had more heads per unit area and fewer seed per head than did the two-row method (Table 1). Method of planting had no significant effect on plant height, seed weight or grain yield.

Row Position on North-South Beds

When beds were oriented North to South, plants in rows on the East side of the beds were taller, had more heads per unit area, and had heavier seeds than plants in rows on the West side (Table 2). Row position had no significant effect on seeds per head or grain yield.

Rate of Planting on North-South Beds

The 25 pounds per acre rate

*Agronomist, Superintendent of Safford Branch Agricultural Experiment Station, and former Research Assistant in the Department of Agronomy and Plant Genetics, respectively.

**Trade names used in this article are for identification purposes only and do not imply endorsement of products named or criticism of similar products not mentioned.

Table 1. Average plant height, number of heads, number of seeds per head, weight of 1,000 seeds, and grain yield of Arivat barley as affected by method of planting on beds, rate of planting, and row position on beds, with beds running East and West, at Safford, Arizona.

Method of planting on beds	*Rate of planting (lb./acre)*	*Row position on beds*	*Plant height (in.)*	*Heads in 4 ft.² (no.)*	*Seeds per head (no.)*	*Weight of 1,000 seeds (g)*	*Grain yield in 4 ft.² (g)*
Drilled	**25**	**North**	**37**	**92**	**32**	**48.9**	**135**
		South	**40**	**194**	**34**	**52.1**	**339**
	50	**North**	**38**	**110**	**25**	**48.6**	**153**
		South	**41**	**179**	**34**	**49.6**	**262**
Two-row	**25**	**North**	**36**	**74**	**38**	**46.6**	**130**
		South	**38**	**160**	**41**	**51.9**	**339**
	50	**North**	**35**	**83**	**33**	**45.0**	**123**
		South	**37**	**175**	**38**	**48.2**	**318**
C.V. (%)			**2.4**	**14.2**	**8.5**	**2.6**	**24.4**
Significance of differences:							
1. Between row positions on beds			**	**	**	**	**
2. Between rates of planting			ns	ns	*	*	*
3. Between methods of planting			ns	**	*	ns	ns

*Legend: ns = not significant at 5%, * = significant at 5%, ** = significant at 1%.*

planting on North-South beds resulted in plants that had more heads per unit area and more seeds per head than did the 50 pounds per acre rate (Table 2). Rate of planting had no significant effect on plant height, seed weight or grain yield.

Method of Planting on North-South Beds

The drilled method of planting on North-South beds resulted in plants that had more heads per unit area and less seeds per head than did the two-row method (Table 2). Method of planting had no significant effect on plant height, seed weight or grain yield.

Potential Weed Problem

When only two rows were planted on top of the bed, more weeds were observed than when seven rows were drilled over the entire bed and furrow on both North-South and East-West beds. There were no barley plants between beds to compete with weeds, when only two rows were planted on top of the bed. The two-row per bed method of growing barley in saline soil may require additional cultivation or other means of weed control.

References

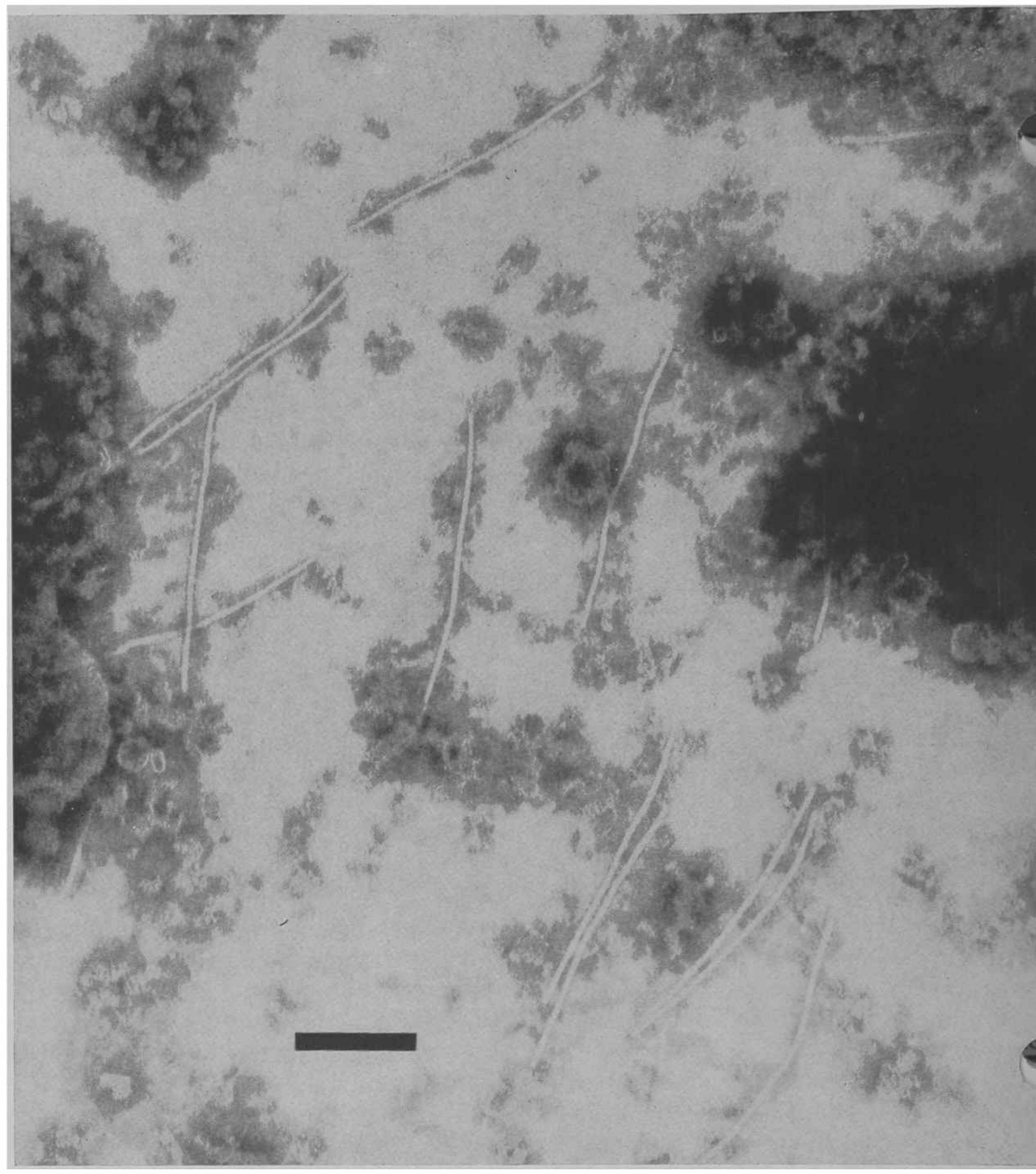
1. *Amburgey, L.A. 1964. Fertilizer recommendations for Arizona. Arizona Coop Ext. Ser. 107.*
2. *Day, A. D., and R. E. Dennis. 1965. Barley in Arizona. Arizona Coop. Ext. Ser. and Agr. Exp. Sta. Bull. A-15. 20 p.*
3. *Erie, L. J., O. F. French, and K. Harris. 1968. Consumptive use of water by crops in Arizona. Arizona Agr. Exp. Sta. Tech. Bull. 169. 46 p.*
4. *U. S. Salinity Laboratory Staff. 1954. Diagnosis and improvement of saline and alkali soils. U. S. Dept. Agr. Handbook 60. 160 p.*

Table 2. Average plant height, number of heads, number of seeds per head, weight of 1,000 seeds, and grain yield of Arivat barley as affected by method of planting on beds, rate of planting, and row position on beds, with beds running North and South, at Safford, Arizona.

Method of planting on beds	*Rate of planting (lb./acre)*	*Row position on beds*	*Plant height (in.)*	*Heads in 4 ft.² (no.)*	*Seeds per head (no.)*	*Weight of 1,000 seeds (g)*	*Grain yield in 4 ft.² (g)*
Drilled	**25**	**East**	**37**	**136**	**31**	**47.6**	**200**
		West	**36**	**125**	**33**	**46.3**	**191**
	50	**East**	**36**	**147**	**30**	**47.3**	**193**
		West	**35**	**141**	**30**	**45.3**	**201**
Two-row	**25**	**East**	**36**	**110**	**33**	**49.1**	**212**
		West	**35**	**100**	**39**	**49.0**	**184**
	50	**East**	**36**	**151**	**32**	**48.6**	**238**
		West	**35**	**113**	**31**	**46.7**	**184**
C.V. (%)			**1.7**	**14.3**	**11.0**	**2.9**	**20.4**
Significance of differences:							
1. Between row positions on beds			*	**	ns	*	ns
2. Between rates of planting			ns	*	*	ns	ns
3. Between methods of planting			ns	*	**	ns	ns

*Legend: ns = not significant at 5%, * = significant at 5%, ** = significant at 1%.*

Figure 1. An electron micrograph of sap from a diseased pepper plant. The rod-shaped structures are the particles of the Arizona pepper virus. They are not present in the sap of healthy plant. Bar = 0.3 micron.



Pepper Mosaic in Southeast Arizona

*by Merritt R. Nelson & Raymond E. Wheeler**

Severe distortion of leaves and fruit of chili peppers has announced the presence of a virus disease new in Arizona. This disease was most likely present for several years earlier but the first serious outbreak occurred in 1969 near Elfrida. Losses as high as $30,000.00 for a single grower have been reported to us.

The disease was thought first to be caused by herbicide damage but after successful transmission by sap to greenhouse-grown peppers, there was little doubt that a virus was the cause. The electron microscope enabled us to promptly confirm the presence of a virus and narrowed the field considerably, in our attempt to identify the specific virus involved. Examina-

**Professor of Plant Pathology and Assistant in Research in Plant Pathology.*

tion of diseased, crude pepper sap revealed the presence of flexuous, rodlike particles not found in healthy sap (Figure 1). These particles are the size and shape of virus particles of a well-known group of plant viruses called the potato virus Y group, consisting of at least twenty members. This group is composed of viruses that infect one or sometimes several of the following plants: potatoes, tomatoes, watermelons, turnips, tobacco, peppers and others. There are, however, only three members of the group known to infect peppers, and each was eliminated in the diagnoses of the Arizona isolate because of several differing characteristics. Having, therefore, properties distinct from any other member of the PVY-group, it is suggested that the Arizona pepper virus (AzPV) either has never been reported or is not usually known to infect peppers.

We are now engaged in a research program aimed at controlling the disease caused by this virus. Our two principal objectives are to find or aid in the development of tolerant varieties and to determine the plant or plants that serve as overwintering hosts of AzPV in the Elfrida area.

Of 24 commercial varieties of pepper tested in the greenhouse, all but one were severely affected by AzPV. The one that showed some degree of tolerance (Large Cherry) is of no economic importance in Arizona. We have been fortunate, however, in acquiring some commercially useful breeding lines from Dr. Paul G. Smith of the University of California which show some tolerance to AzPV (Figure 2). We are in the process of selecting chili pepper types with such tolerance and will conduct field tests in 1972.

Work toward the second objective has also yielded results. We have demonstrated that a native plant in the area, *Datura* spp. (Jimson weed), is an alternate host of the virus. This plant does not occur in the valley near Elfrida but is relatively abundant in the foothills to the East and West. We have found infected *Datura* both East and West of the valley. Depending on the location, from 5 to 20% of the *Datura* plants observed had symptoms of AzPV. From our and growers observations it appears that the pepper fields most severely damaged by AzPV were near the periphery of the valley, within a mile or two of infected *Datura*.

Datura is an ideal alternate host for AzPV because it is perennial (living more than one year) and therefore maintains a supply of virus for transmission to peppers. The only other factor required is an insect vector to transmit the virus from plant to plant. Several grain aphids in the area apparently do this job. Although they do not colonize and reproduce on the pepper plant, we suspect that they fly sporadically into fields of pepper to transmit the virus. Another plant, *Atriplex canescens* (the four-winged salt-bush), is suspect as an additional alternate host, but final proof is lacking.

Because of the wide distribution of the *Datura* in nonagricultural areas, eradication as a means of control is not feasible. Similarly, chemical control of insect vectors of plant viruses is usually unsuccessful as a virus control measure. The only practical solution to the problem is in the development and introduction of new varieties tolerant or immune to infection by the Arizona pepper virus.

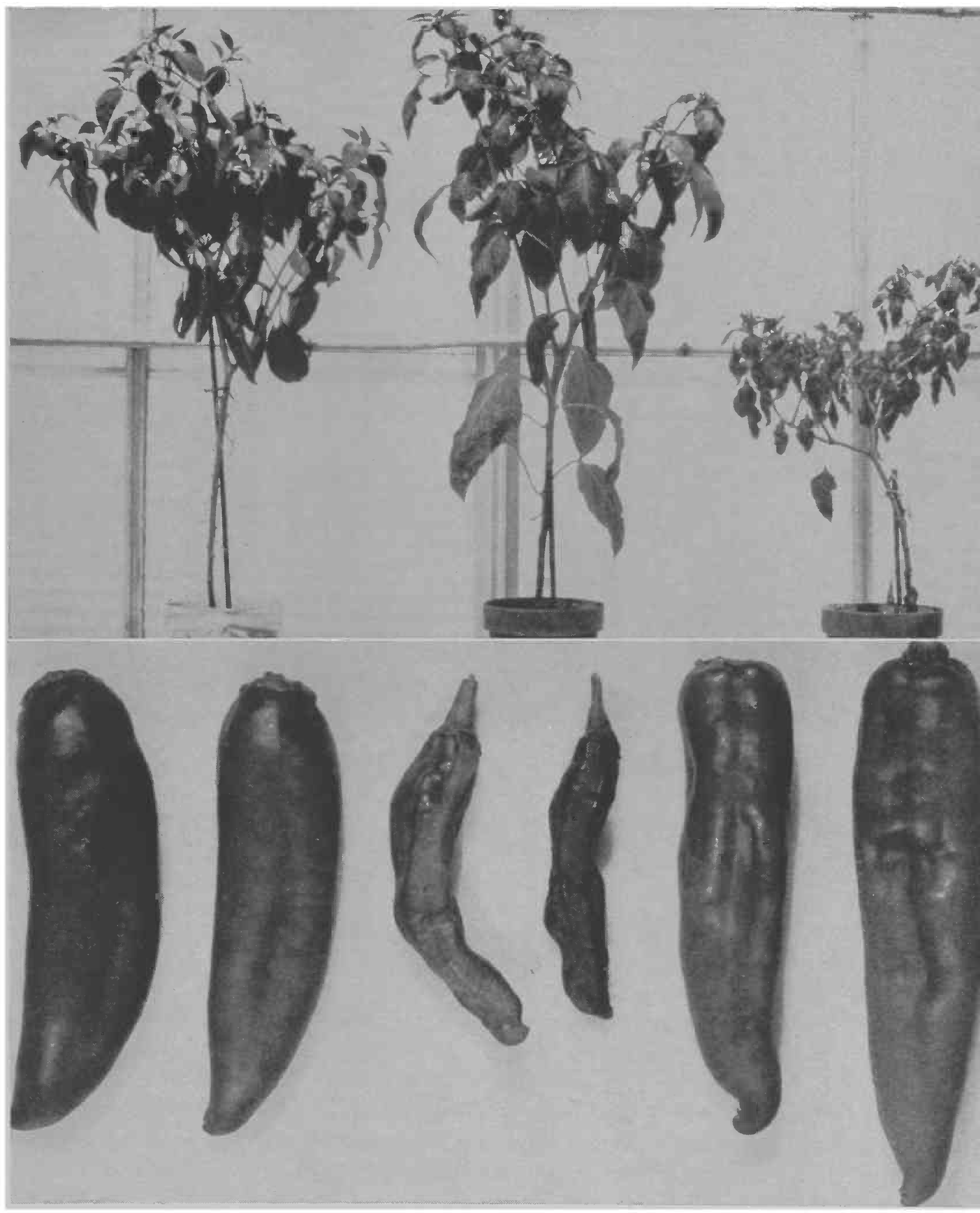
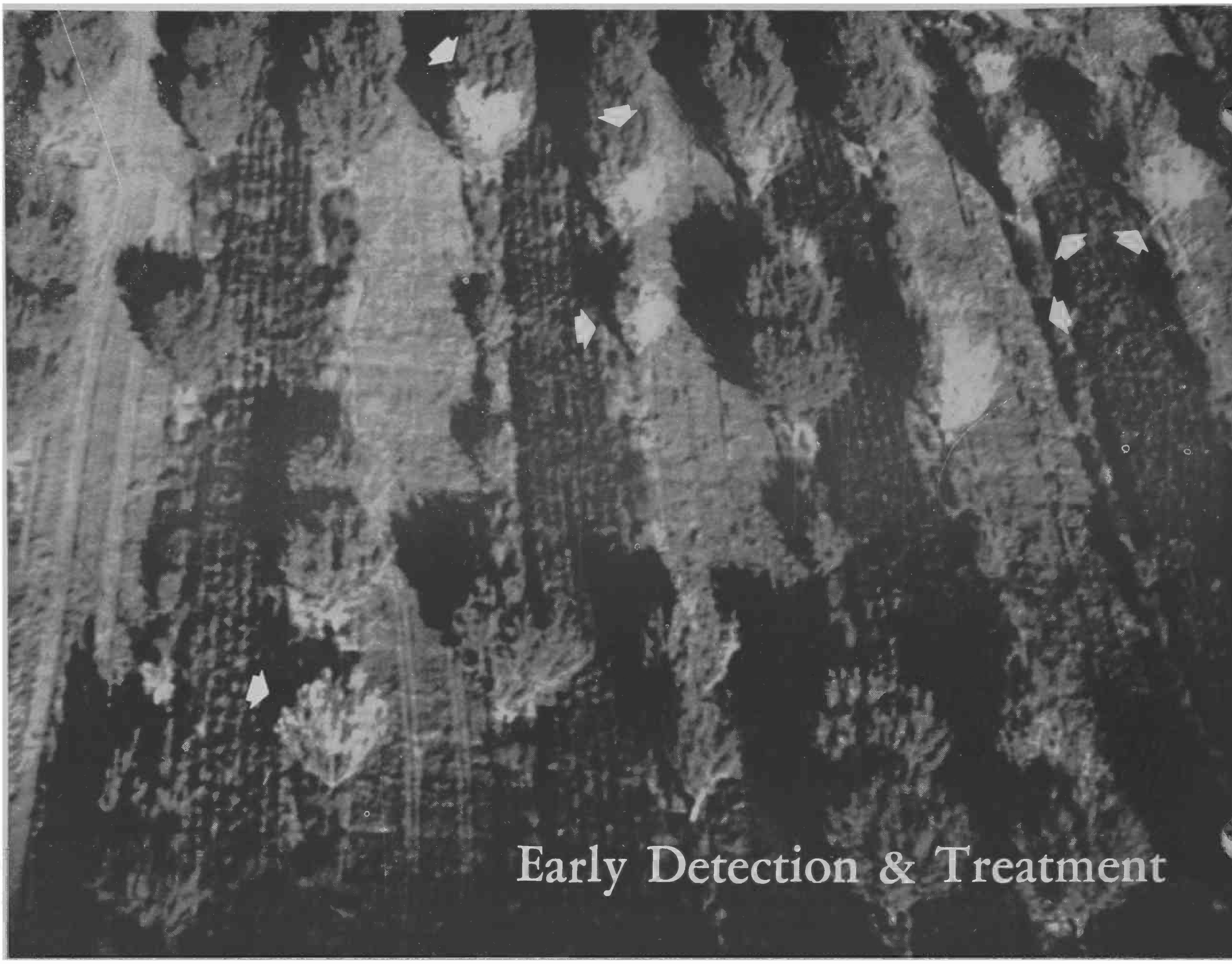


Figure 2. Comparison of the effect of AzPV on Anaheim chili (a variety quite similar to that grown in the agricultural area of Elfrida) and on one of the breeding lines (AzPV-tolerant) received from the University of California. In the photo of plants at the top are from left: a healthy Anaheim chili plant; Az-PV-infected tolerant selection; and right is an AzPV-infected Anaheim chili plant. In the bottom photo from left are: fruit from healthy Anaheim Chili plant; fruit from AzPV-infected Anaheim chili plant; and right is fruit from AzPV-infected tolerant selection.



of *Phymatotrichum* Root Rot in Fruit Trees

by H. E. Bloss & R. B. Streets, Sr.[*]

Figure 1. This is a black and white illustration of an aerial infra-red photograph of infected almond trees. Light colored trees at arrows indicate symptom of wilting caused by infection of their roots by *Phymatotrichum omnivorum.*

The photo on the cover of this issue of P.A. shows young almond trees replanted in fumigated soil following loss of two-year-old trees to *Phymatotrichum* root rot. Infra-red aerial photography aids in detecting symptoms and losses in orchards to the disease. The black and white photo also demonstrates which trees are infected.

Phymatotrichum omnivorum, the soil-borne fungus widely distributed in soils of southern Arizona, New Mexico, Texas and much of northern Mexico, has been a serious pathogen of vines and fruit- and nut-bearing trees for many decades. The disease is quick-acting, usually fatal to the infected plant and extremely difficult to control. Some current approaches to control of the disease in orchards and vineyards are discussed in this brief progress report.

Nature of the Fungus and Disease

Phymatotrichum root rot, first discovered in Texas in 1888 on cotton plants, causes an estimated $50,000,000 in losses of ornamental trees and shrubs as well as fruit-

* *Associate Professor and Professor, Respectively, of Plant Pathology Department.*

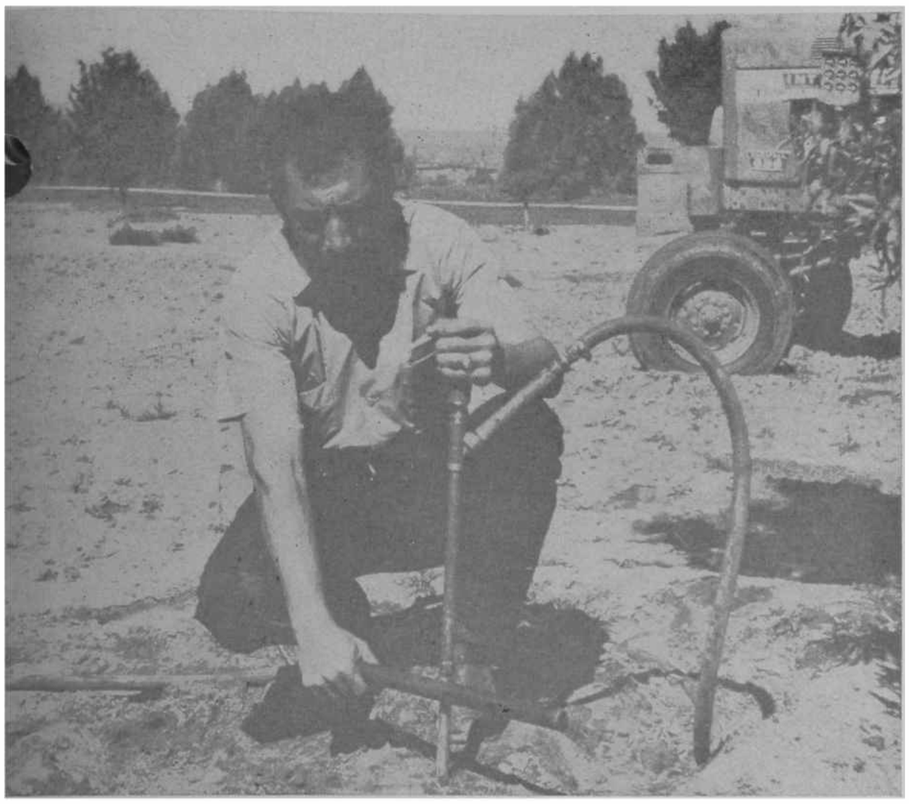


Figure 2. Apparatus for injecting fungicide into soil infested with the fungus, *Phymatotrichum omnivorum*, the cause of root rot among many susceptible fruit trees. Fungicide can be injected into the soil as deep as 36 inches under 200 p.s.i. pressure for control of the fungus.

Figure 3. Injection of benzimidazole fungicide to almond tree at the right resulted in excellent recovery from *Phymatotrichum* root rot. Tree at left rear is untreated control which died of Texas root rot following severe infection of its root system.

and nut-bearing trees each year. Roots of trees penetrated by the fungus below the surface of the soil, soon loose their cortical tissue by sloughing. The result may be sudden wilting of the tree and sometimes death within a few weeks. The fungus thrives in alkaline soils of the southwestern deserts. It produces sporemats on the surface of the soil during the summer rainy season. The fungus survives for one year or more as hard-seed-like bodies called sclerotia or as strands of plaited hypae on roots of cultivated plants and weeds. Strands may follow roots to depths of 10 to 12 feet on large trees. Eradication of strands and sclerotia formed at these depths is difficult and expensive.

Detection and Early Diagnosis

Control of the disease in trees is possible when symptoms are detected in time to allow proper treatment. The temperature of leaves rises on trees whose roots are extensively penetrated by the fungus. Wilting is apparent after a few days. Remote sensing by aerial photography using color infra-red film has provided a method to detect symptoms early in the summer when the fungus begins to attack the roots. Healthy trees appear deep red on infra-red film, whereas trees showing incipient wilt appear pale yellow. Physiologic changes in the foliage, especially temperature, are responsible for the change in color recorded on the film. These differences, when detected as early in infection as possible, may permit the application of effective measures for controlling further invasion by the fungus.

Treatment Following Diagnosis

Significant advances in control of *Phymatotrichum omnivorum* were made following the realization that immediate applications of manure, ammonium sulfate, and sulfur reduce growth and infection by the fungus. In addition, the tree benefits from these chemicals as nutrients and recovers from the infection more rapidly.

Barriers of sulfur poured into narrow trenches have proved effective in preventing the fungus from growing through soil between rows of trees. However, sulfur alone has not proved an effective treatment for trees already infected. Winter cover crops such as sorghum, barley and other cereals, incorporated as green manure in young orchards, are helpful in reducing amounts of the fungus in the soil. Treatments directly remedial for infected trees, however, have been scarce.

Recently, several new fungicides, particularly the benzimidazoles, have proven highly effective in reducing the growth of *P. omnivorum*. Benomyl, (l-butyl-carbamoyl-2-benzimidazole carbamic acid, methyl ester) is showing encouraging results in experimental plots of almonds, pecans, apricots, peaches and cherries for control of Phymatotrichum root rot. Benomyl, 50% wettable powder, at a concentration of 1 gram per liter of water is injected under 200 pounds pressure. The fungicide is applied by means of a 36-inch tube, 3/8″ in diameter, with 4, 1/16″ holes drilled at the tip. The application of two grams of Benomyl in each of 12 injection sites is followed by deep, flood irrigation. Trees showing incipient wilt and typical symptoms of Phymatotrichum root rot have recovered within one month following this treatment and regained normal color and vigor.

Early Diagnosis, Rapid Treatment Essential

Although this treatment is new and not fully evaluated, the combination of early detection and immediate treatment offers promise for remedial action in confining local infestations of *P. omnivorum* in orchards and reducing losses of trees. When combined with chemical barriers or manure-sulfur-ammonium sulfate treatments, new fungicides with some systemic activity and residual properties may provide control in 3- to 4-year old plantings where fumigation and replant requirements have been more costly.

Virus Yellows Control in Sugarbeets

Sanitation and Resistant Varieties

*by J. M. Nelson and M. E. Stanghellini**

Sugarbeet production in central Arizona has generally been hampered by diseases commonly known as virus yellows. The most serious outbreak occurred in the 1969-70 growing season when a high incidence of the virus yellows greatly depressed yields. In that season, root yields were nearly 30 percent lower than those of previous years.

There are two diseases involved: beet yellows and beet western yellows, each of which is caused by a different virus. Both viruses are transmitted primarily by the green peach aphid. Symptoms of the two diseases are similar and consist of yellowish, thickened, and somewhat brittle leaves. Older leaves tend to develop an interveinal bright yellow to orange yellow chlorosis. Eventually these leaves develop necrotic spots and die prematurely. Visual distinction in the field between sugarbeets infected with beet yellows virus (BYV) and beet western yellows virus (BWYV) is difficult.

Beet yellows, the more serious of the two diseases, may reduce yields 20 to 40 percent. Loses from beet western yellows disease are somewhat less, ranging from 10 to 20 percent. When beets are infected with both BYV and BWYV, the losses are additive. Damage is greatest when plants are infected when young.

Disease surveys and transmission tests conducted between 1965 and 1968 by research personnel of the U. S. Department of Agriculture revealed that BWYV was more prevalent than BYV in the Salt River Valley. BWYV was consistently detected as early as November; while BYV was not detected until April or May or late in the growing season.

In the 1969-70 season, when virus yellows were very damaging, disease symptoms were observed in early November. Although it is not known if BYV was present in November, it is probable that infection by this virus also occurred early in the season. It is likely, then, that the heavy losses can be attributed to the additive effects of both viruses infecting beets early in the season.

In California, virus yellows epidemics have generally occurred after one or more years of large acreages, especially when growing seasons have overlapped. This is much the same situation that occurred in Arizona prior to the poor crop in 1970. A combination of large acreage and high yields prolonged the harvest in 1969 and did not allow sufficient time between sugarbeet crops for proper cleanup of beets remaining in fields after harvest (keeper beets). Unless destroyed, keeper beets may serve as a primary source of BYV inoculum for infection of the succeeding beet crop.

Primary spread of the yellows viruses from reservoir host plants (sugarbeets and certain weeds) to beet fields, and secondary spread within fields are dependent upon the occurrence and abundance of the aphid vector. In the Salt River Valley, green peach aphids first appear in September or October. The aphids increase in numbers during the winter months, reaching peak production in the spring. In the 1969-70 season, aphids moved into beet fields early in the fall and persisted in large numbers until late spring, making possible early initial infection and rapid secondary spread of the yellows viruses.

Control of the virus yellows through the destruction of the aphid vector has not proven feasible, even though many insecticides are effective against the aphid. Programs to obtain green peach aphid control may reduce secondary spread of the viruses within fields, but these are expensive and generally ineffective due to the ability of the aphid to persist and reinfest fields throughout a large portion of the growing season.

Cultural practices that prevent carryover of the yellows viruses, particularly BYV, can help greatly in reducing disease losses. A beet-free period (time between harvest and succeeding crop) of approximately one month is essential in an effective control program. This break between sugarbeet crops allows the grower time to carry

* *Assistant Agronomist in Department of Agronomy and Plant Genetics and Assistant Professor in Department of Plant Patholog*

Table 1. Comparison of the yield, sucrose content and bolting of sugarbeet varieties grown at Mesa, Arizona, 1968-69, under moderate virus yellows conditions.

Variety	Sugar Yield (Tons/A)	Root Yield (Tons/A)	Sucrose Content (%)	Bolting (%)
US H9A	4.4a**	32.3a	13.7a	8
US H9B	4.4a	31.7a	13.9a	13
S301 H8	3.8b	28.9b	13.2a	1

** *Means followed by the same letter are not significantly different at the 5 percent level.*

out a sanitation program to destroy beets that have escaped harvest before the next crop is planted. The control of keeper beets is of utmost importance, since, as mentioned earlier, the sugarbeet itself can serve as a main reservoir host of BYV. Besides keeper beets, weed beets (beets from seed produced by bolters) and weeds such as saltbush should also be eliminated.

The most promising means of control of the virus yellows diseases would appear to be through the use of resistant varieties, since control by other measures is difficult. Although a high degree of resistance to virus yellows is presently not available in a commercial variety, there are two varieties available with moderate resistance. These varieties, designated US H9A and US H9B, were developed by research personnel at the U. S. Agricultural Research Station at Salinas, California. Both varieties were found to be adapted to a wide range of growing conditions, indicating the possibility of their use in Arizona.

The yellows resistant varieties were subsequently tested at the University of Arizona Agricultural Experiment Station at Mesa over a three year period. In these tests, they were compared with S301 H8, the standard commercial variety. This variety has been well adapted to central Arizona climatic conditions, particularly because of its outstanding resistance to bolting (production of seed stalks). The sugarbeet varieties were planted in replicated plots in September and were harvested in mid-June in the field tests reported here.

Table 2. Comparison of the yield, sucrose content and bolting of sugarbeet varieties grown at Mesa, Arizona, 1969-70, under severe virus yellows conditions.

Variety	Sugar Yield (Tons/A)	Root Yield (Tons/A)	Sucrose Content (%)	Bolting (%)
US H9A	3.9a**	24.8a	15.9a	3
US H9B	4.2a	26.4a	15.9a	2
S301 H8	3.0b	19.1b	15.8a	0

** *Means followed by the same letter are not significantly different at the 5 percent level.*

In the 1968-69 season, virus yellows damage was moderate. Under those conditions, the yellows resistant varieties produced about three tons more roots per acre and 1200 pounds more sugar per acre than S301 H8 (Table 1). However, bolting was much greater for the yellows resistant varieties. There were no differences among varieties in sugar content in any of the three seasons the tests were conducted.

Root yields and sugar production were greatly reduced in the 1969-70 season as the result of the early and high incidence of virus yellows (Table 2). Under this severe disease situation, the varieties with resistance produced an average of over six tons more roots and one ton more sugar per acre than S301 H8. Bolting was not a factor in this season.

In 1970-71, the incidence of virus yellows was very low until late in the season and consequently yields were outstanding (Table 3). Even under these conditions, the resistant varieties showed some yield advantage over the commercial variety, but they again showed a lack of bolting resistance.

Although US H9A and US H9B out produced S301 H8 each year, they also produced substantially more bolters than is desirable. Bolting is objectionable for a number of reasons: roots of plants that have bolted generally contain less sugar, seed from bolters can produce weed beets, pollen produced may be carried to seed fields, and roots of bolted plants are sometimes more woody than normal, making slicing at the factory more difficult. If a high percentage of bolting does occur in a commercial field, it may be necessary to remove the seed stalks to prevent the production of pollen and seed.

Research directed toward developing varieties with improved resistance to virus yellows is currently being conducted at the U.S. Agricultural Research Station at Salinas. Spreckels Sugar Company breeders are also involved in developing varieties with both virus yellows and bolting resistance. At this time, however, the most effective means of control of virus yellows diseases includes the use of the moderately resistant varieties coupled with a beet-free period and careful sanitation after harvest to reduce the sources of the viruses for the next sugarbeet crop.

Table 3. Comparison of the yield, sucrose content and bolting of sugarbeet varieties grown at Mesa, Arizona, 1970-71, under mild virus yellows conditions.

Variety	Sugar Yield (Tons/A)	Root Yield (Tons/A)	Sucrose Content (%)	Bolting (%)
US H9A	6.0a**	40.5a	14.8a	16
US H9B	5.5ab	36.7ab	15.0a	14
S301 H8	5.0b	34.1b	14.7a	4

** *Means followed by the same letter are not significantly different at the 5 percent level.*

Blend Production & Use Factors

in Livestock Production

for Maximum Profit

*by Robert E. Dennis & Albert M. Lane**

The principal factors limiting yield of forage crops in Arizona are usually water and nitrogen for grasses and for legumes, water and phosphorus. Management skill is also essential, especially for production and grazing of irrigated pastures. Maximum profit can only be realized by carefully blending all production and utilization factors.

Carrying capacities for planning purposes can be determined by using projected yields of dry matter forage and estimates concerning feed requirements. The discussion that follows assumes that feed consumption for an animal unit (1000 pound animal or its equivalent) would be the equivalent of 22 pounds of air dry feed (10% moisture) per day.

The feed requirement for other size animals would be as follows:

450 lb. calves	— 11 lbs.
600 lb. cattle	— 15 lbs.
850 lb. cattle	— 18 lbs.
165 lb. ewes	— 4 lbs.

The amount of forage used by immature animals is slightly higher proportionally, as reflected in the 600 lb. figure for cattle. These estimates do not equate with feedlot consumption figures. The estimates should be considered as guides for determining carrying capacities somewhat above maintenance. To achieve maximum gains, animals will need supplementary feed, usually extra energy such as grain.

**Agronomist and Livestock Specialist, respectively, Cooperative Extension Service.*

Perhaps the most important variable for projecting carrying capacities is forage yield. In the tables that follow three different yield levels have been assumed. Select the yield level most nearly correct for the situation under consideration. Estimates for water are given in each of the tables as consumptive use.

Permanent Pasture

Warm season grasses such as bermudagrass and Blue panicgrass are suggested for most of the irrigated land at the lower elevations. At the higher elevations, cool season grasses such as Tall fescuegrass and orchardgrass are better adapted. (See Bulletin A-49, "Establishment and Management of Irrigated Pastures in Arizona.")

Table 1. Estimates Concerning Use of Warm and Cool Season Grasses for Permanent Pasture

Annual Yield[1] *(lbs./acre)*	*Animal Units*[2] *Per Acre (220 days)*	*Water (Acre Feet Per Acre)*
8,000	1.7	4.5
10,000	2.1	5.5
12,000	2.5	6.5

[1] *Air dry forage actually consumed by animals. Green forage contains 70 or more percent moisture depending upon stage of maturity, time of year and other factors.*

[2] *4/10 to 11/15.*

Winter Pasture

Ryegrass, barley, oats, wheat and rye may be used to provide winter pasture.

Table 2. Estimates Concerning the Use of Winter Pasture

Yield[1] *(lbs./acre)*	*Animal Units/A.*[2]	*Water (Acre Feet Per Acre)*
4,000	1.3	2.5
5,000	1.7	3.0
6,000	2.0	3.5

[1] *Air dry forage actually consumed by animals.*

[2] *11/15 to 4/10.*

Silage

Forage sorghum, corn or other crops may be used to provide silage, unusually for winter feeding.

Table 3. Estimates Concerning Use of Sorghum or Corn for Silage Feed

Yield[1] *(Tons/Acre)*	*Animal Units/Acre*[2]	*Water (Acre Feet Per Acre)*
18	3.2	4.0
24	4.3	4.5
30	5.4	5.0

[1] *Yield of 30% dry-matter silage.*

[2] *Ration of 22 pounds of air dry feed per day for 4½ months. Also assumes a 15% loss of dry-matter in storage.*

Hay

Table 4. Estimates Concerning the Use of Alfalfa for Hay

Annual Yield[1] *(Tons/Acre)*	*Animal Units Per Acre*	*Water (Acre Feet Per Acre)*
4	This alfalfa will be used to supplement pasture and silage	3.5
6		5.0
8		6.5

[1] *Air dry forage harvested as hay. After storage for 60 days it will probably contain about 8% moisture. Many factors affect the rate of drying and the final equilibrium moisture.*

Solving a Practical Problem Concerning the Number of Animal Units that May be Supported

Assumptions

1. 1,400 acre feet of water available annually
2. 70% delivery efficiency of irrigation water
3. Intermediate level of production and use efficiency.

Animal Units

1. Livestock Feed Crop	Acres	(About 7½ Months) Water Use (Acre feet)	Animal Units
Permanent pasture	110	550	230
Alfalfa	40	200	100
			330

2. Livestock feed Crop	Acres	(About 4½ Months) Water Use (Acre feet)	Animal Units
Alfalfa	40	200	150
Ryegrass, barley, oats, wheat or rye[1]	30	90	50
Silage[2]	30	135	130
			330

[1] *The intermediate level of carrying capacity is assumed to be 2½ animal units per acre for 220 days.*

[2] *Double crop. An alternative is to plant a dual purpose sorghum about March 15. Use first crop for grain and second crop for forage.*

In this illustration 220 acres supported 330 animal units for 12 months. Thus carrying capacity was 1½ animal units per acre.

Increasing Animal Units

The number of animal units could be increased by:
1. Producing higher crop yields.
2. More efficient use of water than estimated. Per larger area could be irrigated.)
3. Use of supplementary feed.
4. Improving pasture use efficiency.
5. Improving Livestock handling practices for more efficiency. Carrying capacity could also be less than that estimated.

Managing Barley For Maximum Profit

by James F. Armstrong*

Objective

The objective of the tests reported here was to evaluate the profitabliity of barley using restricted inputs.

Introduction

For several years barley has been considered a "marginal" or "break-even" crop. It was grown, primarily, because it fit into a rotation where other crops did not. It seemed logical that methods to improve the profitability of this crop needed further exploration. Improved, higher yielding varieties had not appreciably changed the profit picture up to this point.

The approach used in this testing program was that of limiting inputs, thereby reducing costs. The limits were determined by careful consideration of knowledge already generated in its various forms.

A new system of growing barley (rows on beds) had recently been introduced, which showed much promise of fitting the input control system. Optimum planting date, rate of seeding and method of planting were products of previous work. Reduction in amount of water used to grow barley became a primary consideration. It was concluded that amount of water supplied would be keyed closely to plant need.

The following tables present results of three years testing under this restricted input system.

Summary

The following discussion deals with the results of all the testing generally and does not consider each test separately in any detail.

The results of one or more tests supports the conclusions which are listed below and generally support the limited input system as an economic approach to barley production.

Suggestions for planting under this system are:

- Plant two rows on top of the bed 10-14 inches apart.
- Use 20-25 pounds of seed per acre.

1968-69

Table 1. Yields in Response to Amount of Nitrogen and Planting Method

Pounds of Nitrogen	*Solid Drill*[1] *pounds per acre*	*Rows on Bed*[1] *pounds per acre*
0	**3584 c**	**3007 b**
100	**5056 a**	**4776 a**
200	**4351 b**	**4816 a**

[1] *Yields followed by same letter do not differ significantly at 5% level.*

Planted: December 1, 1968
Harvested: May 22, 1969
Soil Type: Silty Loam
Previous Crop: Sorghum
Seeding Rate: Rows on bed — 25 lbs.; Solid drill — 90 lbs.
Total Water: Rows on bed — 18.8 inches; Solid drill — 25.1 inches
Variety: Arimar

Table 2. Yields by Variety (2 Rows on Bed)

Variety	*Yields per Acre*[1] *pounds*	*Field Loss pounds per acre*	*Potential Yield pounds per acre*
Arivat	**4185 a**	**293**	**4478**
Hembar	**3730 a**	**1036**	**4766**
Arimar	**3695 a**	**293**	**3988**
Az 6251	**2880 b**	**126**	**3006**

[1] *Yields followed by same letter do not differ significantly at 5% level.*

Planted: December 1, 1968
Harvested: May 22, 1969
Soil Type: Silty Loam
Previous Crop: Sorghum
Total Water: 18.8 inches
Fertilizer: 100 lbs. N, 95 lbs. P_2O_5
Seeding Rate: 25 lbs. per Acre
Planting Method: 2 rows on bed 12" apart with 40 inch centers

[1] *Pima County Agricultral Agent, Cooperative Extension Service. The work reported in this article was spearheaded by the author, who served as project leader. This research was conducted on the University of Arizona Marana Branch Experimental Farm, Marana, Arizona. A team approach was used to accomplish the project objectives. The team consisted of Allan D. Halderman, Extension Irrigation Specialist; Walter W. Hinz, Extension Machinery Specialist; Dr. Robert E. Dennis, Extension Agronomist; Dr. Martin D. Openshaw, Extension Soils Specialist; Dr. Arden D. Day, Agronomist, and Rex Thompson, Research Associate in Agronomy, all of the University of Arizona.*

1969-70

Table 3. Yields by Variety (3 Rows on Bed)

Variety	Average Yield pounds/Acre[1]	Field Loss pounds/Acre	Potential Yield pounds/Acre
Briggs	**5525 a**	**315**	**5840**
Arivat	**5085 ab**	**305**	**5390**
Arimar	**4790 b**	**425**	**5215**

[1] *Yields followed by same letter do not differ significantly at 5% level.*

Planted:	*December 12, 1969*	*Total Water:*	*18.5 inches*
Harvested:	*May 23, 1970*	*Fertilizer:*	*112 lbs. N. and 115 lbs.* P_2O_5/A
Soil Type:	*Silty Loam*	*Seeding Rate:*	*22 lbs. per acre*
Previous Crop:	*Sorghum*	*Planting Method:*	*2 rows on bed 12" apart with 40 inch centers*

Table 4. Yields by Variety (Solid Planting)

Variety	Average Yield[1] pounds/Acre	Field Loss pounds/Acre	Potential Yield pounds/Acre
Briggs	**6570 a**	**95**	**6665**
Arimar	**6175 ab**	**195**	**6370**
Arivat	**5960 b**	**395**	**6355**

[1] *Yields followed by same letter do not differ significantly at 5% level.*

Planted:	*December 13, 1969*	*Total Water:*	*27.2 inches*
Harvested:	*May 23, 1970*	*Fertilizer:*	*124 lbs. N and 115 lbs.* P_2O_5/A
Soil Type:	*Silty Loam*	*Seeding Rate:*	*90 lbs. per Acre*
Previous Crop:	*Sorghum*	*Planting Method:*	*Solid drill over beds*

Briggs variety has consistently produced more than the other varieties tested and has been the most lodge resistant.

- Plant dry and irrigate up, December 1-15.
- Use 250 pounds of 16-20-0 fertilizer preplant (or other material which will supply approximately 40 pounds Nitrogen and 50 pounds P^2O^5).
- Add approximately 40 pounds of nitrogen in the water at two different times (usually early to mid-March and mid-April).
- Irrigate only as needed by the plants.
- Eliminate January and February irrigation and fertilization.

Two rows on the bed — This practice has several advantages. First, it permits better water control. Secondly, it allows growers to take advantage of the profuse tillering ability of some barley varieties. Thirdly, it allows for a reduction in seeding rate by some 4 or 5 times. A fourth advantage is that harvesting is easier by this practice even when lodging occurs. Another advantage is that if weed control becomes necessary it can be accomplished by cultivation. In general, two rows on the bed contributes greatly towards improving efficiency.

Twenty to 25 pounds of seed — This rate allows for the reduction of seed cost appreciably and results in yields of 4000 to 6000 pounds per acre.

Plant dry and irrigate up — It is easier to establish a good seedbed in dry soil and compaction is minimized. This practice is where water control really begins. Usually a satisfactory job of thoroughly wetting the beds can be done with less than 8 inches of water (where good water control is possible). This is considerably less water than is normally applied for preirrigation. A planting date of December 1-15 is optimum. It allows plants to become established and attain a stage of growth which is least affected by cold weather (thru mid-March). It is also a time when weed competition with stand establishment is minimal.

Fertilizer — Excellent results have been obtained from applying 250 pounds of 16-20-0 preplant and then supplying 40 pounds of nitrogen in two equal split applications in the water. These applications usually come in early to mid-March and in mid-April. They are keyed directly to irrigation based on plant needs and stage of plant growth. Phosphate is not mobile in water, so it must be applied preplant and incorporated in the soil to the desired depth to be effective. The use of Uran 32 or similar material in the water is more desirable than NH_3.

Irrigation — After irrigating up, water should only be applied as needed by the plant. A soil probe and observing plant appearance are the tools used in determining when water should be applied. It has never been necessary to apply water in January and February when planting was made in early December. Prevailing weather conditions should also be considered in deciding when to irrigate. Don't irrigate if rainfall is predicted.

Rows on beds require about 25% less water than solid planting. Total applied water for rows on beds has averaged 16.3 inches per acre per season, including the irrigating-up. When rainfall is added to applied water the total has never exceeded 21 inches of water per season.

Eliminate January and February irrigations — By eliminating this practice and any accompanying fertilization lodging is minimized and frost damage is greatly reduced. Freeze damage has never been identified in the test fields, but considerable damage has been observed in nearby fields that were irrigated (in most cases also fretilized) in January and February.

The savings accrued by this system when compared to conventional planting are listed below.

- Normally about 3½ acre feet of water per acre are used to pro-

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Manage Barley

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duce barley — thus approximately 1½ acre feet are saved, plus the labor necessary for its application. Under local conditions this amounts to over $15 per acre.

- The usual seeding rate varies from 90-125 pounds per acre. A savings of 75% in seed cost is possible. Certified seed costs about $8 cwt. (depending on type & variety) thus about $6 is saved (75% x $8).
- Common practice is to apply at least 200 pounds of nitrogen per acre per season. This system utilizes only 120 pounds. This savings amounts to about $4 per acre (depending on form of nitrogen and method of application).
- In many cases field loss has been reduced some 350-500 pounds. At $50/ton this could increase returns by $8.75 to $12.50 per acre.

The yields of solid plantings have exceeded the yields of rows on bed by up to 1000 pounds per acre. Assuming a $50 per ton value of barley, rows on bed will return more net profit per acre ($10-$20) than conventional planting.

There are other considerations worthy of mention. Under the restricted input system the rate of return on investment is much higher. Thus, a grower would not only realize higher profit per acre but also a much greater rate of return on his investment.

Should this approach, or similar ones, to production become universally accepted it could greatly influence the price and profitability picture.

CAUTION

This system of production is only recommended for the production of barley varieties. It is not recommended for the production of hybrid barley or Mexican wheat. All the work reported in this article was done in Marana and may or may not apply to other production areas.

1970-71

Table 5. Barley Yields Per Acre — Field D-4 (2 Rows on Bed)

	With Winter irrigation and fertilization			*Without Winter irrigation and fertilization*		
Variety	*Yield*[2]	**Field Loss*	**Potential Yield*	*Yield*[2]	**Field Loss*	*Potential Yield*
Briggs	**5550 a**	**580**	**6130**	**5273 a**	**160**	**5433**
Az 6260	**4479 b**	**1010**	**5489**	**5067 a**	**640**	**5707**
Amy	**3275 c**	**1470**	**4745**	**3091 b**	**800**	**3891**
Arivat	**3236 c**	**720**	**3956**	**5217 a**	**700**	**5917**

[1] *Consisted of 2.7 inches water and 23 pounds N/A applied January 25, 1971.*
[2] *Yields followed by same letter are not significantly different at 5% level.*

Planted: December 2, 1970
Harvested: June 1, 1971
Soil Type: Silty Loam
Previous Crop: Sorghum
Planting Method: 2 rows on bed 12" apart with 40 inch centers

Total Water: with Jan. application 23.36" without Jan. application 20.66"
Fertilizer: with Jan. application 137#N and 50#P_2O_5/A without Jan. application 114# N and 50# P_2O_5/A
Seeding Rate: Amy — 35 lbs./A, all others — 30#/A

Table 6. Barley Yields Per Acre — Field A-4 (2 Rows on Bed)

Variety	*Average Yield*[1] *pounds/Acre*	*Field Loss pounds/Acre*	*Potential Yield pounds/Acre*
Briggs	**5281 a**	**100**	**5381**
Arivat	**4960 a**	**158**	**5118**
Az 6210	**4590 a**	**192**	**4782**
CM 67	**4382 a**	**339**	**4721**
Amy	**4293 a**	**1580**	**5873**

[1] *Yields followed by same letter do not differ significantly at 5% level.*

Planted: December 1, 1970
Harvested: June 1, 1971
Soil Type: Silty Loam
Previous Crop: Fallow

Total Water: 20.21 inches
Fertilizer: 117# N and 50# P_2O_5/A
Planting Method: 2 rows on bed 12" apart with 40" centers
Seeding Rate: Amy-35#, CM67-30#, all others 25#/A

PROGRESSIVE AGRICULTURE IN ARIZONA

Official Publication of the College of Agriculture and School of Home Economics The University of Arizona

Harold E. Myers Dean

to: