Multi-State Field Trials of ARS Russian Honey Bees

2. Honey Production 1999, 2000

by T. E. RINDERER[1], L. I. DE GUZMAN[1], G. T. DELATTE[1], J. A. STELZER[1], V. A. LANCASTER[2], J. L. WILLIAMS[1], L. D. BEAMAN[1], V. KUZNETSOV[3], M. BIGALK[4], S. J. BERNARD[5] and H. TUBBS[6]

SUMMARY

Field trials of Russian honey bees (ARS Primorsky stock) propagated as queen lines from queens imported from the far-eastern province of Primorsky were conducted in 1999 and 2000 in Iowa, Louisiana, and Mississippi. While honey production varied between apiaries and states, the honey production of the majority of Primorsky queen lines met or exceeded commercial standards. For example, the best production came from Mississippi in 2000. There, the overall average production was 125 pounds, not including fall production. Selected breeder queens from Mississippi in 2000 averaged 185 pounds and ranged from 149 to 238 pounds. Overall, given favorable nectar flows and beekeeping, ARS Primorsky stock, selected for retention in the breeding program and released to the beekeeping industry, will not sacrifice honey production.

INTRODUCTION

The human-assisted host range expansion of *Varroa destructor* (Anderson and Trueman, 2000) to include *Apis mellifera* has resulted in an unprecedented threat to *A. mellifera* apiculture. Without acaricide treatments repeated up to three times a year, colonies die.

However helpful they are, acaricides present several difficulties. The chemicals are costly, require additional time and costs to apply, must be applied during periods when bees are not producing honey, which will be harvested for human consumption, may contaminate honey or wax, and mites have an ability to become genetically resistant to them.

One possible solution to the problems caused by *V. destructor* is the identification and use of stocks of honey bees that are resistant to the mite. However, the breeding and selection of mite-resistant honey bees must also include breeding and selection to assure adequate honey production ability since most beekeepers rely on honey production to supply most of their income.

A. mellifera of the far-eastern Russian territory of Primorsky have been used to found the ARS Primorsky stock (Danka, 1995, Rinderer, *et al.* 1997, 1999), which has substantial resistance to *V. destructor* (Rinderer, *et al.* 2000, 2001). We conducted field trials in order to evaluate the resistance of ARS Primorsky honey bees to *V. destructor* in a general way and to conduct specific progeny tests of queen lines that were previously identified as being among the best that were imported from Primorsky. Honey production was an essential component of these evaluations. This report focuses on the honey production results of ARS Primorsky queen line evaluations in 1999 and 2000.

METHODS

Daughter queens of each ARS Primorsky queen selected for progeny testing were produced using standard queen rearing procedures and mated to drones from the general pool of selected Primorsky colonies, according to a "round robin" inter-block design (Rinderer *et al.* 1999). Natural matings were facilitated on a Louisiana coastal island to assure that only drones from selected colonies mated with the queens. Daughters of six and ten queen lines were tested in 1999 and 2000, respectively.

The trials were conducted in apiaries in Iowa, Louisiana, and Mississippi. In 1999, three apiaries were established near Cresco, Iowa, two apiaries were established near Henderson, Louisiana, and two were established near Webb, Mississippi. Forty-two Primorsky colonies and forty-two domestic colonies were studied in each state, with the colonies divided equally among the apiaries. Seven sister Primorsky queens from six Primorsky queen lines were evaluated in each state. Domestic colonies were of the commercial stock that has been traditionally used in each location. Their purpose was to supply a commercial standard for the selection of Primorsky queen lines to be included into a long-term breeding program. In Iowa and Louisiana, colonies were in hives on individual bottom boards. In Mississippi, colonies were in hives on "4- way" pallets. In Mississippi, both hives facing one direction on each pallet were of the same stock to reduce effects of drift between side-by-side units. Otherwise, colony or pallet position in the apiaries was randomized.

In 2000, each state was represented by three apiaries. Prior studies provided ample evidence of the general comparative resistance to *V. destructor* by Primorsky honey bees and the general acceptability of their honey production. Selections of queen lines with above average honey production for inclusion into the breeding program could be made with confidence that they were within the range of acceptability. Also, the tested "Yellow 99" Primorsky line with a known response to *V. destructor* and honey production history was included as a control and to provide the line with an additional year of selection to improve its resistance to *V. destructor*. Further, each state location had apiaries stocked with domestic colonies which gauged the area's general honey production potential during the trial periods. Hence, in order to accommodate desires to conduct progeny tests on more lines, each represented by more sister queens, only Primorsky queens were established in the test apiaries. Each of 9 untested queen lines and the "Yellow 99" control line was represented by 36 daughters, equally divided among states and apiaries. In Louisiana and Iowa, where colonies were on individual bottom boards, the arrangement of queen lines within apiaries was random. In Mississippi, where colonies were on 4-way pallets, each queen line was randomly assigned to one pallet in each apiary, in order to reduce the drift between colonies of different queen lines.

In both years, Iowa colonies were established as queen-right 5-frame nucleus colonies (standard deep frames) in

1 USDA-ARS Honey-Bee Breeding, Genetics & Physiology Laboratory, 1157 Ben Hur Road, Baton Rouge, LA 70820-5502
2 Neptune & Company, Inc. 1505 15th Street, Suite B, Los Alamos, NM 87544
3 Institute of Biology and Pedology, Far East Branch of the Russian Academy of Sciences Vladivostok 690022, Russia
4 Golden Ridge Honey Farms, 23226 20th Street, Cresco, IA 52136
5 Bernard's Apiaries, Inc., P. O. Box 615, Beaux Bridge, LA 70517-0615
6 Tubbs' Apiaries, P.O. Box 3, Webb, MS 38966

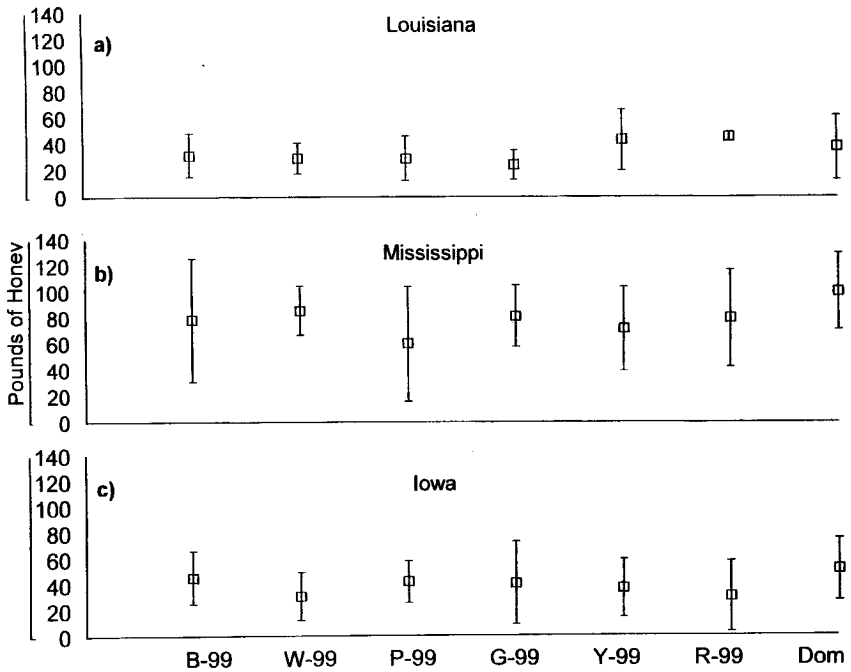

Figure 1. Honey yields obtained in 1999 in tests of ARS Primorsky honey bees in Louisiana (A), Mississippi (B) and Iowa (C) , B = blue, W = white, P = purple, G = green, Y = yellow, R = red, Dom = domestic controls.

Louisiana and transported to Iowa. Louisiana colonies were established on site as queen-right five-frame nucleus colonies on site. In 1999, Mississippi colonies were established as queen-right five-frame nucleus colonies on site. In 2000, the Mississippi colonies were established as five-frame nucleus colonies and transported to Mississippi. In 1999, domestic colonies were divided to produce nucleus colonies for all locations. In 2000, Primorsky colonies were divided to produce nucleus colonies for Iowa and Mississippi, while domestic colonies were used for producing the Louisiana colonies. Subsequent management procedures differed between states, except that treatments to control parasitic mites were not used. Otherwise, management procedures followed the practices normally employed by the three cooperating beekeepers. However, both Primorsky and domestic colonies were given the same management in each state.

Honey production in each year and location was determined in the field using a portable electronic scale. Data were collected at the end of the spring (Louisiana) or summer flow (Iowa and Mississippi). (Fall honey production was not measured, but general observations were made of it in 2000). Bees were removed from honey supers and a total gross weight was determined for each colony by weighing the honey supers. Net weights were calculated by subtracting the average weight of the equipment containing honey from the total gross weight. These data were used in analyses of variance for general comparisons of Primorsky and domestic colonies of honey bees and for comparisons among specific queen lines of Primorsky honey bees.

While analysis of variance is useful in comparing average honey production of groups of colonies classified as Primorsky, domestic or according to a specific queen-line, it lacks the ability to identify the best colony. A direct comparison of honey production is unsuitable since a poorer colony in a better apiary location might be chosen as a breeder over a better colony in a poorer apiary location. Z-score transformations were used to overcome many of the effects of varied apiary conditions (Rinderer 1986). Z-scores standardize individual colony scores to a common scale of "normal distribution units" with each colony assigned a score by comparison to the average production in it's own apiary.

RESULTS AND DISCUSSION

In 1999, several trends were apparent (Fig. 1). Differences in honey production occurred between both states and apiaries. Differences in nectar flow strengths and durations and differences in the timing of nectar flows, respective to colony development, probably account for differences in the amount of honey produced in different apiaries and states. Hence, these data cannot be used to support any conclusion regarding the comparative honey production potential of the different beekeeping areas.

Production of the Primorsky colonies compared favorably with that of the domestic control colonies. The Primorsky colonies represented 6 candidate queen lines that were being evaluated for inclusion into a breeding program designed to select for a stock having decreased mites

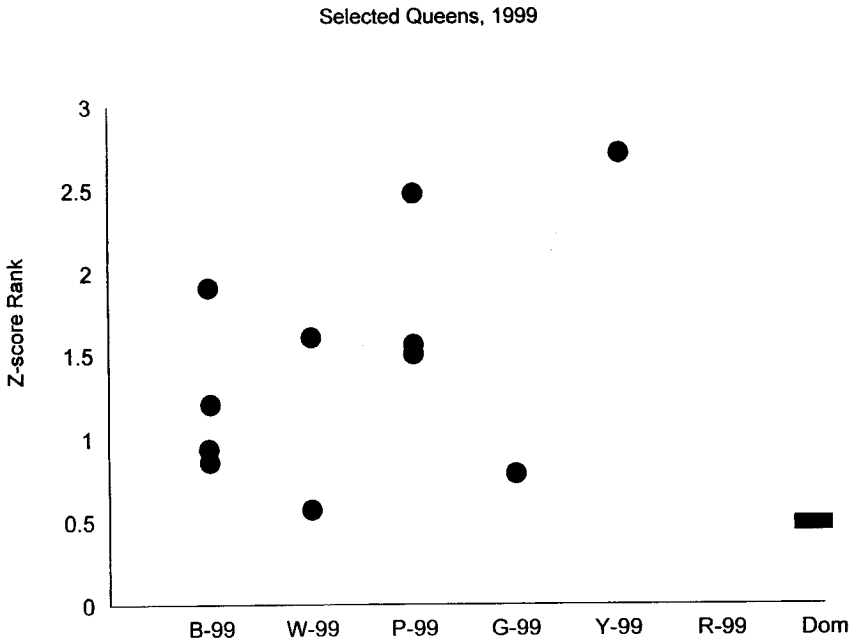

Figure 2. Relative honey yield of individual ARS Primorsky honey bees selected as breeder queens in 1999 to produce daughters for stock propagation or release and the average honey yield of domestic control colonies. The Z -score or relative rank in comparison to group average for Primorsky and domestic colonies in apiaries was used rather than absolute honey production. This permits the comparison of colonies or groups of colonies in different states and apiaries. ● =selected colony for breeding based on both honey production and resistance to *V. destructor*, ■ =average for domestic control colonies. Queen lines with no indicated breeder queen have been culled from the program.

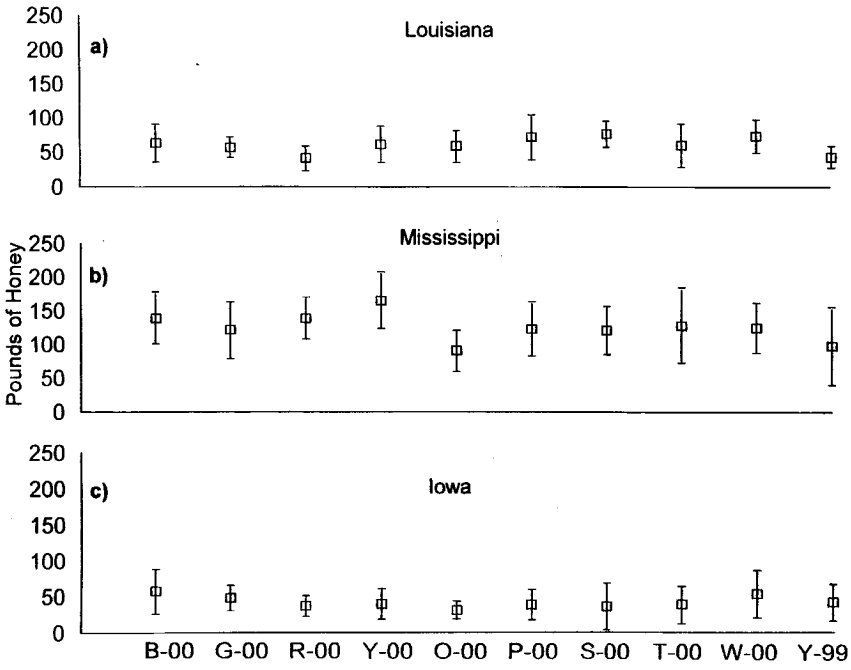

Figure 3. Honey yields obtained in 2000 in tests of ARS Primorsky honey bees in Louisiana (A), Mississippi (B) and Iowa (C), B = blue, W = white, P = purple, G = green, Y = yellow, R = red.

and increased honey production. Most of these Primorsky queen lines had honey productions which were within the commercial range established by the control colonies (Fig. 1). However, as a result of the evaluation, the "Red 99" queen line was dropped from the program, partly as a result of its comparatively lower honey production in Iowa (P =0.02). The "Green 99" and "Yellow 99" queen lines were retained in the program with the goal of further improvement, but not selected for release to the beekeeping industry, partly because of their variation in honey production. The released queen lines, Blue 99, White 99 and Purple 99, had honey productions similar to those of the commercial standards. Also, the breeder queens selected to propagate these lines had honey productions that generally exceeded that of the average for domestic honey bee colonies (Fig. 2).

In 2000, there was again substantial variation in honey production between states and apiaries. Once again, differences in nectar flow strengths and durations and differences in the timing of nectar flows, respective to colony development, probably account for differences in the amount of honey produced in different apiaries and states. Also, once again, these data cannot be used to support any conclusion regarding the comparative honey production potential of the different beekeeping areas.

In 2000, honey production for most untested queen lines compared favorably to very favorably with the production of the control line (Fig. 3) and beekeeping expectations based on the production of nearby apiaries of domestic honey bees. Despite averages lowered by the production of colonies in queen lines destined to be culled because of comparatively low honey production, the average overall honey production of the ARS Primorsky colonies was quite acceptable. The best production came from Mississippi (Fig. 3). There, the overall average production was 125 pounds. Selected breeder queens from Mississippi averaged 185 pounds and ranged from 149 to 238 pounds. These colonies also stored at least an additional 30 pounds in the Autumn after the data were collected and the trial was concluded. In Louisiana, at least an additional 50 pounds of honey was stored by each of the colonies during Autumn in addition to the 63 pound average presented here. Overall, the Louisiana colonies averaged about 113 pounds of net honey production. Iowa colonies had the lowest production where poor nectar-flow conditions resulted in a 41 pound average.

Although the overall honey production was good to excellent, some queen lines were less productive. The Orange 2000, Tan 2000, and White 2000 queen lines were culled from the project. The Yellow 1999 and the Silver and Red 2000 queen lines were retained for further selection, but not for immediate release. The Blue, Green, and Yellow 2000 queen lines were identified for release to the industry in 2001. The Purple 2000 queen line was identified for release to the industry in 2002. The breeder queens selected to propagate the lines selected for retention and release had honey productions that generally exceeded the group averages. (Fig. 4).

The honey production by the ARS Primorsky queen lines tested in 1999 and 2000 ranged from more than to less than the honey production of commercial control stocks. Since every ARS Primorsky

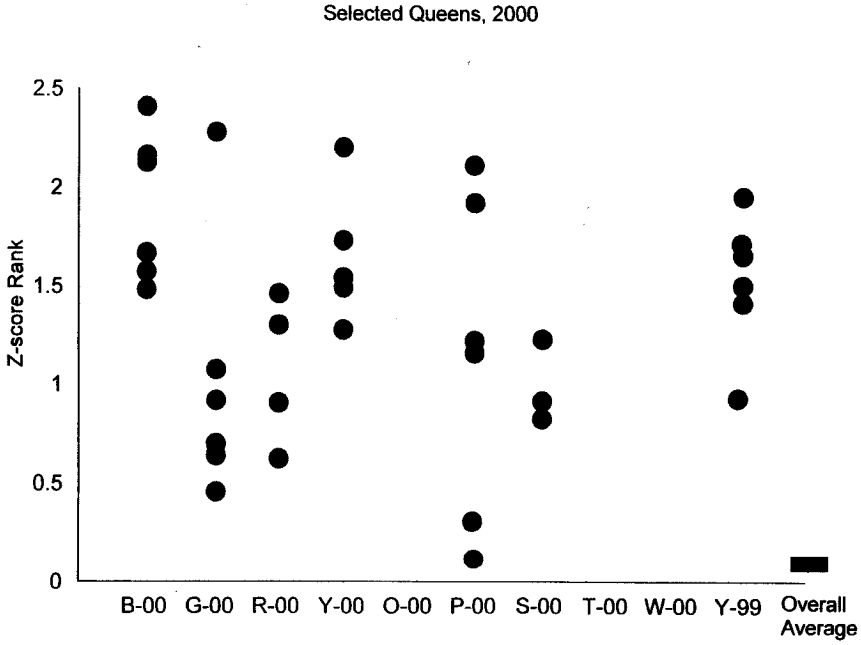

Figure 4. Relative honey yield of individual ARS Primorsky honey bees selected as breeder queens in 2000 to produce daughters for stock propagation or release and the average honey yield of all colonies. The Z-score or relative rank in comparison to group average for Primorsky and domestic colonies in apiaries was used rather than absolute honey production. This permits the comparison of colonies or groups of colonies in different states and apiaries. ● =selected colony for breeding based on both honey production and resistance to *V. destructor*, ▬ =average for all colonies. Queen lines with no indicated breeder queen have been culled from the program.

queen line was more resistant to *V. destructor* than the commercial control stocks, many of them have both acceptable to excellent honey production and excellent comparative resistance to *V. destructor*. Hence, the progeny of the selected breeders for these lines, which will produce daughters for the 2001 release to the beekeeping industry, can be expected to contribute to successful beekeeping. Given favorable environmental conditions and management, their honey production should meet or exceed industry standards and provide an opportunity for beekeepers to explore reducing the frequency of treatments for mite control.

The queen lines that have been retained in the program exhibit variation in honey production, both within and between lines. Hence, there is still more opportunity for breeding and selection techniques to improve the already good honey production of ARS Primorsky stock.

CONCLUSIONS

Given favorable nectar flows and beekeeping, ARS Primorsky stock will produce large crops of honey. In general, their honey production potential meets or exceeds industry standards displayed by domestic commercial stocks.

Honey production of ARS Primorsky queen lines retained in the program and selected for industry release met or exceeded industry standards.

Honey production of ARS Primorsky queen lines retained in the program for further selection prior to release to industry ranged from nearly achieving industry standards to exceeding them.

Overall, the variation in honey production between the ARS Primorsky queen lines retained for a breeding and selection program suggests that future selective breeding will further improve the honey production in the overall ARS Primorsky stock.

ACKNOWLEDGMENTS

We thank Rusty Babineaux, Jason Hebert, Warren Kelly and Chris Tubbs for their able and cheerful beekeeping advice and assistance and Janice Bernard, Linda Bigalk, and Karen Tubbs for their gracious hospitality and tolerance of muddy boots in their kitchens and honey houses.

REFERENCES

Anderson, D. L., & Trueman, J. W. H., 2000. *Varroa jacobsoni* (Acari: Varroidae) is more than one species. *Exp.. & Applied Acarol.* 24: 165-189.

Danka, R.G., Rinderer, T.E., Kuznetsov, V.N., & Delatte, G. T. 1995. A USDA-ARS project to evaluate resistance to *Varroa jacobsoni* by honey bees of Far-Eastern Russia. *Am. Bee J.* 135: 746-748.

Rinderer, T. E. 1986. Selection. *In*: Bee Genetics and Breeding. Rinderer, T. E. *ed.* Academic Press, New York, pp. 305-321.

Rinderer, T.E., Kuznetsov, V.N., Danka, R.G., & Delatte, G.T., 1997. An importation of potentially Varroa-resistant honey bees from Far-Eastern Russia. *Am. Bee J.* 137: 787-789.

Rinderer, T.E., Delatte, G.T., de Guzman, L.I., Williams, J., Stelzer, J.A., & Kuznetsov, V.N., 1999. Evaluations of the varroa-resistance of honey bees imported from Far-Eastern Russia. *Am. Bee J.* 139: 287-290.

Rinderer, T. E., deGuzman, L. I., Delatte, G. T., Stelzer, J. A., Lancaster, V. A., Kuznetsov, V., Beaman, L., Watts, R., & Harris, J. W., 2001. Resistance to the parasitic mite *Varroa jacobsoni* in honey bees from far-eastern Russia. *Apidologie. In Press.*

Rinderer, T. E., deGuzman, L. I., Delatte, G. T., Stelzer, J. A., Williams, J. L., Beaman L. D., Kuznetsov, V., Bigalk, M., Bernard S. J. and H. Tubbs. 2000. Multi-state field trials of Russian honey bees 1. Responses to *Varroa destructor* 1999, 2000. *Am. Bee J.* 141:658-661.

U.S. POSTAL SERVICE
STATEMENT OF OWNERSHIP MANAGEMENT AND CIRCULATION

1. Title of publication-American Bee Journal, USPS 017—520.
2. Date of filing—8/23/01.
3. Frequency of issue—Monthly.
4. No. of issues published annually—12.
5. Annual subscription price—$19.95.
6. Location of known office of publication-51 South 2nd Street, Hamilton, Illinois 62341.
7. Location of the headquarters of general business offices of the publishers—51 South 2nd Street, Hamilton, Illinois 62341.
8. Names and addresses of publisher, editor and managing editor—
   Publisher—Dadant & Sons, Inc, 51 South 2nd Street, Hamilton, Illinois 62341
   Editor—Joe Graham, Dadant & Sons Inc., 51 South 2nd Street, Hamiltion, Illinois 62341.
9. Owner (if owned by a corporation, its name and addresses must be stated and also immediately thereafter the names and addresses of stockholders owning or holding I percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated)—T.C. Dadant, #4 Belmont Drive, Hamilton, IL 62341; T.G. Ross, 302 Hillcrest, Hamilton, IL 62341; N.J. Dadant, #6 Belmont Drive, Hamilton, IL 62341; Marta C. Menn, 236 Jamar Ct., Hamilton, IL 62341; Mary V. Marting, 19 Riverview, Nauvoo, IL 62354; Nicole Jones, 3401 Brenwick Dr., Peoria, IL 61614 (Trust); Jennifer M. Blum, 7400 North Villa Lake Drive, Bldg. B, Unit 4, Peoria, IL 61614 (Trust); Gabriel C. Dadant, #6 Belmont Drive, Hamilton, IL 62341 (Trust); Ashley L. Marting, 19 Riverview, Nauvoo, IL 62354 (Trust); Sarah A. Marting, 19 Riverview, Nauvoo, IL 62354 (Trust); Christopher C. Dadant, #6 Belmont Drive, Hamilton, IL 62341 (Trust); Arlene T. Dadant, #5 Belmont Drive, Hamilton, IL 62341(Trust); Lucas D. Menn, 236 Jamar Ct., Hamilton, IL 62341 (Trust); Jacob D. Menn, 236 Jamar Ct., Hamilton, IL 62341 (Trust); Dorothy D. Irish, 212 S. Williams, Colchester, IL 62326; Dadant & Sons, Inc., 51 South 2nd Street, Hamilton, IL 62341.
10. Known bondholders, mortagagees, and other security holders owning or holding I percent or more of total amount of bonds, mortgages or other securities—None.
11. Extent and nature of circulation—Average No. copies each issue during preceding 12 months, Oct. '00-Sept. '01; Actual number of copies of single issue published nearest to filing date, Sept. '01.
    A. Total No. copies printed—14,841; 15,630.
    B. Paid and/or requested circulation—
       1. Sales through dealers and carriers, street vendors and counter sales—334; 334.
       2. Mail subscriptions—13,572; 13,951.
    C. Total paid and/or requested circulation—13,906;14,285.
    D. Free distribution by mail—(samples, complimentary, and other free copies); 89; 95.
    E. Free distribution outside the mail (carriers or other means)—375; 350.
    F. Total free distribution (some of 11D and 11E)—464; 445.
    G. Total distribution—14,370; 14,730.
    H. Copies not distributed—
       1. Office use, left-over, unaccounted, spoiled after printing—471; 900.
       2. Returns from news agents—0; 0.
    I. Total—14,841; 15,630.
12. Percent paid and/or requested circulation (11C/11G X 100)—94%; 97%.
13. This statement of ownership will be printed in the October 2001 issue of this publication.
14. I certify that these statements made by me above are correct and complete.
    JOE GRAHAM-Editor, date 8/23/01