5

BARD

United States - Israel Binational Agricultural Research and Development Fund

FINAL REPORT

PROJECT No. I-130-79

Development of Melons Suitable for Once-Over Mechanical Harvest

H.S. Paris, Z. Karchi, H. Nerson,
D.J. Cantliffe

1984

PAR

630.72

BAR

2nd copy

Standard BARD Cover Page for Technical Reports

December 5, 1983

BARD
P. O. Box 6
Bet Dagan, Israel

BARD No. of Proposal: I-130-79.

Title of Proposed Research: DEVELOPMENT OF MELONS SUITABLE FOR
ONCE-OVER MECHANICAL HARVEST.

Names of Investigators

Principal Investigator: Harry S. Paris (Israel)
Cooperating Investigators: Zvi Karchi (Israel)
Haim Nerson (Israel)
Daniel J. Cantliffe (U.S.A.)

Name and Address of Affiliated Institutions

Grantee Institution: Agricultural Research Organization
P. O. Box 6
Bet Dagan (50-250), Israel

Cooperating Institution: Institute of Food and Agricultural Sciences
University of Florida
Gainesville, FL 32611 U.S.A.

Project's starting date: June 1, 1980.Type of report: FINAL.

Signatures

Principal Investigator

Institution's Authorizing Official

Yehud Eshdat
Dr. YUVAL ESHDAT
Head, Div. for Research Projects and Budgets
Agricultural Research Organization

RECEIVED
DEC 12 1983
137-113

1) Melons - Harvesting

630.72 : 635.61 : 631.55
BAR

2nd copy

b. Table of contents.

Abstract.....	3
Body of report in form of a scientific paper.....	4
Introduction.....	4
Materials and Methods.....	6
Results and Discussion.....	8
Comparison of accessions.....	8
Breeding.....	9
Progeny testing.....	10
Germination, emergence, and development.....	11
Flowering and fruit set.....	12
Genetics.....	12
Effects of growth regulators.....	13
Origin and edaphic adaptation.....	14
Literature Cited.....	15
Tables.....	18
Figures.....	29
Evaluation of research achievement.....	34
Description and results of cooperation.....	35
Benefit to agriculture.....	35
Published reports.....	36

c. Abstract.

Production of melons (Cucumis melo L.) is mechanized up to but not including the harvest. The extended fruiting period results in lack of adaptation of this crop to once-over harvest. The "birdsnest" plant type, reported as having compact growth, placement of fruits close to the base of the plant, and concentrated fruit set and ripening, offered a promising approach of solving this problem. The objectives of this project were to identify and compare birdsnest sources, combine, through breeding, the birdsnest phenotype with good horticultural characteristics, and gain a better understanding of the development, genetics, and physiology of this plant type. Of the 5 birdsnest accessions identified, the 4 from Iran had the strongest birdsnest expression. However, all 4 had poor horticultural characteristics. Two of them were exploited for breeding purposes. Breeding was conducted through use of the backcross and pedigree selection method and advanced as far as the BC_3 and BC_4 generations for several Israeli and American cultivars. Results of progeny tests conducted in Israel and Florida indicated that considerable progress had been made in incorporating the concentrated yield characteristic into the leading Israeli cultivar. The Iranian birdsnest accessions germinated, emerged, and grew quickly at sub-optimal temperatures. Their compact appearance resulted from their short internodes and production of many side branches from the main stem. The short internodes were found to be conditioned by a major recessive gene plus one or more modifiers. Male to perfect flower ratio was normal but flower production nearly ceased upon fruit set and early stages of fruit growth. Fruit set and maturity were concentrated. Attempts to improve concentration of fruit maturity by applications of growth regulators were unsuccessful. The Iranian birdsnest accessions appear to have originated as a short life cycle ecotype adapted to desert or semi-desert conditions.

d. Body of report in form of a scientific paper.

DEVELOPMENT OF MELONS SUITABLE FOR ONCE-OVER MECHANICAL HARVEST.

INTRODUCTION

Melons (Cucumis melo L. var. reticulatus Naud. -- muskmelons and C. melo L. var. inodorous Naud. -- keeping melons) are an important vegetable crop in Israel and the U.S.A..

In Israel, melons are a major crop for export as well as the local market and a much-needed "hard" currency source. Export of fruits has increased from almost nil 25 years ago to 17,200 tons, a value of \$10,000,000, in fiscal 1980-81. Overall production is 45,600 tons (24).

The increase in export can be attributed to the high income afforded by the crop, improved agrotechniques, and the development of improved cultivars. The leading muskmelon for export is 'Galia', a powdery mildew resistant F_1 hybrid released in 1974 (6). This melon, which combines superb eating quality with an exterior easily recognized by consumers, created its own demand in foreign markets and has since become a trade name in Europe. The leading melon of the keeping group is 'Noy 'Amid', an early, long-keeping, powdery mildew resistant and downy mildew tolerant, yellow-rinded casaba type (7).

In the U.S.A., melons are grown commercially in most states. California and other southwestern states, followed by the southern tier of states, are the principal producers of melons for shipment to lucrative eastern markets. Annual income from this crop in California alone approximates \$100,000,000 (8).

Mechanization of most phases of melon production is well advanced. Machines for seedbed preparation, laying plastic mulch, punching holes in the mulch,

sowing seeds, placing plastic tunnels, irrigation scheduling, loading and packing of the fruits, have all been developed. However, much hand labor is required for harvesting of the fruits. This labor is costly and is a severe limiting factor in encouraging more farmers to grow this crop. The use of seasonal labor is a growing problem for both Israel and the U.S.A.. It is apparent that the production of this crop could be facilitated if its dependence on seasonal labor could be reduced or eliminated.

Attempts at developing mechanical harvesting of melons have met with limited success. Neither the multiple-harvest system, due to low recovery per harvest, nor the once-over system, due to yield reduction, has had large-scale commercial application (16). The chief obstacle has been the absence of a cultivar that has concentrated multiple fruit set and development.

Plant habits available in melons include vine, short-internode, and birdsnest. Commonly grown cultivars are of vine type. Plants of this type characteristically exhibit 2 or more cycles of fruit set and development. The first fruits have to grow for 10-14 days before their inhibition effect on subsequent fruit set diminishes (11,22). The time period from fruit set to fruit maturity is remarkably constant for a given cultivar (11,21). Thus, lack of concentrated fruit maturity and yield is a direct result of lack of concentrated fruit set.

The short-internode type, sometimes called the bush type (2,12,23), is conditioned by a major recessive gene plus one or more modifiers (2,23). Although taking less space than the vines, it also does not have a concentrated fruit set. The differences in internode length between short-internode and vine types are due mainly to cell number. Short-internode type plants have brittle, thin, twisted internodes and small fruit size (2).

The birdsnest plant type, first described by Slomnicki et al. (25) and Denna (3), is characterized by a compact appearance early in development, concentrated multiple fruit set, and uniform development and maturation of fruits. Plants of this type have short internodes, but do not suffer any of the deleterious effects exhibited by short-internode type plants.

The objectives of this project were to identify and compare birdsnest sources, combine, through breeding, the birdsnest phenotype with good horticultural characteristics, and gain a better understanding of the development, genetics, and physiology of this plant type.

MATERIALS AND METHODS

Persia 201, Persia 202, Persia 203, Persia 221 (25) and Russia 5062 (3) were compared for expression of birdsnest habit. Other various plant introductions were screened for birdsnest habit. Evaluation was conducted under field conditions at Newe Ya'ar, using standard cultural practices. These included direct field seeding on bare ground and drip irrigation. The field was prepared in the fall in the form of raised beds, 2 m between bed centers, with 600 kg/hectare superphosphate banded into the row and 600 kg/hectare ammonium sulfate broadcast. Seeds were sown 1 m apart, seedlings thinned to 1 per m shortly after emergence.

For breeding birdsnest accessions with improved horticultural characteristics, Persia 202 and Persia 221 were used as donor parents. A description of the cultivars and lines used as recurrent parents is given in Table 1. Breeding was conducted using the backcross and pedigree selection method (1). Selection was carried out from starting populations of 400-500 plants. The breeding was conducted during all 3 years of the project.

Progeny testing was conducted at both Newe Ya'ar and Gainesville using cultural practices typical for each area including direct seeding, drip irrigation, and no mulch at Newe Ya'ar and transplanting, overhead sprinkler irrigation, and black plastic mulch in Florida. The chief testing was conducted during the final year, using 'Galia' and birdsnest breeding line D48. D48 is an F_1 constructed from a BC_3F_2 accession (recurrent parent: 'Galia' female parent; donor parent: Persia 202) crossed with a BC_4F_2 accession (recurrent parent: 'Galia' male parent; donor parent: Persia 202), and thus a prototype for a concentrated-ripening 'Galia'. Statistical design was 4 randomized blocks. At Newe Ya'ar, plots were 10 x 2 m, with 50 cm spacing between single plants in the row. In Florida, plots were 5 x 2 m.

Investigation of the inheritance of internode length was conducted under field conditions at Newe Ya'ar during all 3 years of the project using Persia 202 (birdsnest) and 'Noy Yizre'el' (vine), and the F_1 , F_2 , and BC_1 progenies. Seeds were sown singly, 70 cm apart. Plants were taken after full expansion of the first 10 internodes on the main stem and the first three internodes of each of the first three side branches. 'Top Mark' and U. C. Top Mark Bush (26), and the F_1 of the latter with Persia 202, were included in the latter two years.

A study of inheritance of high-branching tendency was initiated during the final year, using Persia 202, 'Noy Yizre'el', and their F_1 . Number of branches originating from the main stem were counted in mature plants.

Comparisons of early development were conducted at Newe Ya'ar in spring 1980 using Persia 202 and 'Noy Yizre'el'. Further comparisons of birdsnest accessions with vine cultivars Noy Yizre'el, Top Mark, and Perlita and with short-internode lines U. C. Top Mark Bush, U. C. Perlita Bush (26) and

U. F. G509 (4) were conducted during the first 2 years in both Israel and Florida. Comparison of their responses to treatments with Ethrel (commercial ethephon) (to enhance femaleness) and Curbiset (commercial chlorflurenol) (to enhance fruit set) were conducted during the second and third years at both locations. Ethrel and Curbiset treatments were carried out in both greenhouse and field. Ethrel was applied at 250 ppm at the third and fifth leaf stages. Curbiset was applied at 100 ppm to individual flowers at anthesis in the greenhouse and at the beginning of fruit set in the field.

RESULTS AND DISCUSSION

Comparison and identification of birdsnest accessions.

The introductions reportedly having birdsnest habit were evaluated in replicated trials during the summers of 1979 and 1980. Particular attention was paid to compactness of growth and closeness of fruits to the base of the plant. Persia 203 exhibited a spreading, prostrate growth and distant placement of fruits, and thus could not be considered as being of the birdsnest type. Russia 5062 was not so compact as the remaining three accessions and its fruits were significantly farther from the center of the plant. Persia 201, Persia 202, and Persia 221 (Fig. 1) were equally desirable with regard to fruit position. Persia 201 appeared to be somewhat less compact than Persia 202 and Persia 221. Observations of Persia 201, Persia 202, and Persia 221 plants surviving to maturity supported the contention that fruits of individual plants ripen nearly simultaneously. Each was vigorous, with large light green leaves, large seeds, and andromonoecious. All 3 were highly susceptible to diseases. Fruits of Persia 201 and Persia 202 were round and had a heavy, coarse netting. Fruits of Persia 221 were usually flat in shape, had a fine netting, and a rind that

turned bright yellow-orange when ripe. Flesh of Persia 201 and Persia 221 was orange and that of Persia 202 segregated for orange and green. In all three accessions, fruit weight averaged slightly over one kg., the seed cavity was large and the flesh thin and low in sugar (3-4% soluble solids content by refractometer), and the fruits decayed quickly (18,20).

In a survey of plant introductions carried out in 1979, an accession represented by five plants, of which only one survived to maturity, appeared to have birdsnest habit. From its brief description, this accession was designated as Persia Hot Dry. Self-pollinated progeny of the surviving plant were grown out in 1980 alongside the replicated comparison of the other birdsnest accessions. Persia Hot Dry progeny had birdsnest habit, with an expressivity which appeared to be as high as that of the other Persia accessions and greater than that of Russia 5062. Plant characteristics closely resembled those of the other Persia accessions, fruit characteristics most resembling those of Persia 202. Its flesh color was green (19). No other birdsnest introductions were found out of hundreds of introductions observed.

Breeding

Work with 'Galia' and 'Noy Yizre'el' has reached advanced stages. Plants of the BC₄ generation in the female parent of 'Galia' and 'Noy Yizre'el' have been obtained having as high as 15% soluble solids content of fruit, firm, thick flesh, fruit weight 1-2 kg., medium to small seed cavity, moderate keeping quality, no unusually high susceptibility to diseases of the original birdsnest material, and powdery mildew resistance. In the male parent of 'Galia', BC₅ generation plants having soluble solids content of fruit as high as 14%, firm, very thick flesh, extremely small cavity, uniform fine netting, good keeping

quality, and no unusually high susceptibility to diseases have been isolated. In the summer of 1983, the BC₆ was conducted on the 'Galia' male parent, and the BC₅ on the female parent. Work on 'Noy 'Amid' and 'Tamdew' has reached the BC₃ generation, with that of 'PMR 45' and 'Golden Perfection' at the BC₂ and 'Ananas Yoqne'am' and 'Far North' at the BC₁. Each of the selections has horticultural characteristics that are much improved over the donor parent (Persia 202 or Persia 221) and is several days earlier than the recurrent parent.

Progeny testing

Some preliminary progeny testing was conducted for 'Galia' and 'PMR 45' lines at the Biq'at HaYarden Experiment Station (lower Jordan Valley, eastern Israel) and for a 'Galia' line at Gainesville during the second year of the grant. The results from both locations were encouraging. The results of the final progeny test, D48 vs. 'Galia', conducted in both Israel and Florida, are summarized in Table 2. In Florida, D48 outyielded 'Galia' by 20% and concentrated 81% of its yield in a 5-day harvest period, as compared to 58% for 'Galia'. During the most fruitful 3-day period, D48 yielded nearly twice as much as 'Galia'. In Israel, D48 concentrated 60% of its yield, as compared to 46% for 'Galia' during the most fruitful 5-day harvest period. During this period, D48 outyielded 'Galia' by 36%, and produced 62% more fruits. D48 fruits weighed 0.5 kg less than 'Galia' fruits. The 62% increase in number of fruits together with smaller size of fruits represents a significant increase in monetary value for the Israeli farmer growing melons for export; smaller fruits bring the highest prices, with 'Galia' fruits often being too big for export.

Peak yield of D48 was 4 days prior to that of 'Galia', at both locations.

However, D48 averaged 1.8% less soluble solids content and in addition, after a brief storage period, the flesh of D48 became soft and watery.

Thus, the concentrated yield of the birdsnest source material appears to have been effectively transferred thus far. Soluble solids content has been improved from the original 3-4% to 10-11%, an acceptable level but still about 2% lower than the superb 'Galia'. Flesh texture is also in need of improvement. The high disease susceptibility of the original material, thin flesh, and large seed cavity have all been eliminated. It is estimated that 2 more cycles of backcross and pedigree breeding will be enough to fully recover the characteristics of 'Galia'.

Germination, Emergence, and Development

Birdsnest accessions from Iran germinate quickly at sub-optimal temperatures (Table 3), emerge rapidly in early-season sowings (Table 4), and have a markedly faster rate of fresh weight accumulation from such sowings (Figs. 2 and 3) (14). They also possess light green plant color, large, unlobed leaves, and low chlorophyll content per unit leaf area, but the significance of these characteristics is difficult to assess at this time. Light color and large leaves, for example, are also possessed by some vine cultivars and plant introductions.

The birdsnest accessions have internodes which are shorter than those of vine-type plants but longer than those of short-internode type plants (17). However, the internodes of short-internode type plants are thin, brittle, and twisted (2), features which are not present in the birdsnest type.

Birdsnest accessions exhibit uniform development of the primary branches early in development (Table 5) (14) and tend to produce many branches from the main stem (Table 6). The overall compact appearance of these plants can be relegated to their relatively short internodes and their uniform, high-branching tendency (17).

Flowering and Fruit Set

Persia 202 (birdsnest) and 'Noy Yizre'el' (vine) had a similar ratio of staminate to perfect flowers and a similar number of perfect flowers early in the flowering period (Table 7, Fig. 4) but were quite different with regard to concentration of fruit set and yield (Fig. 5, Table 8) (14). This implies that a female tendency stronger than that already possessed by modern cultivars is not a prerequisite to achieving concentrated fruit set. This conclusion can also be reached from a study in which femaleness was increased by application of ethephon, but concentration of fruit set and yield were not increased over the control (9).

In Persia 202, complete cessation of perfect flower production coincided with fruit set and early stages of fruit growth (Figs. 4 and 5) (14). Persia 202 had a concentrated fruit set (Fig 5) and yield (Table 8). Length of the period from fruit set to fruit maturation in melons is more or less constant (11,21). Concentrated yield would, therefore, be the outcome of concentrated fruit set.

Genetics

Overall, inheritance of the birdsnest phenotype is complex as it appears to be made up of at least two component characteristics, short internodes and production of many side branches from the main stem.

The inheritance of short internodes was worked out for the cross of Persia 202 (birdsnest) and 'Noy Yizre'el' (vine), the results being summarized in Table 9. The data indicate that the short-internode character of the birdsnest accession is conditioned by a major recessive gene and that this gene is not allelic to the gene b for short internodes possessed by the short-internode

type. However, the distribution of the data (not presented, manuscript in preparation), indicated that one or more modifier genes are also involved in determining internode length, and these have a confounding influence on the data. Thus, breeding for the short-internode character of the birdsnest type is a difficult task. In addition, the environment plays an important role in determining internode length. Field observations and the isolation of lines having concentrated yield but not short internodes suggest that the short-internode gene possessed by the birdsnest type is not connected with the concentrated fruit maturity characteristic.

The inheritance of the uniform, high-branching tendency of the birdsnest accessions has not yet been worked out because of wide, non-genetic variations between plants, even in highly inbred lines of the parents. However, the F_1 has been observed to be intermediate of the parents for this characteristic (Table 6). Breeding results suggested that there is a strong connection between high-branching tendency and concentrated fruit set.

Effects of growth regulators

In both Israel and Florida, ethephon increased femaleness in all three plant types (Tables 10 and 11) but did not increase the number of fruit set or yield.

In Florida, Curbiset had little or no effect on mean number of fruit per plant and increased earliness only in U. C. Perlita Bush (short-internode) (Table 10) (10). In Israel, Curbiset increased the number of fruit set per plant in all three plant types but did not affect total yield (Table 11) (13). If anything, it had a negative effect on fruit set concentration. It had little or no effect on the yield concentration of the birdsnest accession but increased yield concentration in the vine and short-internode types.

Combined Ethrel and Curbiset treatment increased flowering concentration and number of fruit set in 'Noy Yizre'el' (vine) in Israel, but failed to increase its yield or yield concentration (Table 11) (13). The combined treatment also increased the number of fruit set in Persia 202 (birdsnest) and increased its yield and yield concentration.

Yield quality was negatively affected by Ethrel, as reported by Karchi (5), and to a lesser extent by Curbiset. Ethrel decreased soluble solids content by 1-3% and caused many elongated or misshapen fruits. Curbiset decreased total soluble solids by 0.5-1% and resulted in the production of many small, unmarketable fruits.

In summary, attempts to further improve concentration of fruit maturity with growth regulators has not had great success. Successful acclimation of the melon crop to once-over harvest is dependent upon exploitation of genetic resources and their mechanism of action rather than upon these chemical growth regulators.

Origin and Edaphic Adaptation

Based on the meager information available from the collection of seeds of birdsnest plant introductions, we suggested (19) that the Iranian birdsnest accessions represent a short life cycle ecotype that originated and is adapted to arid or semi-arid conditions. The ability of these accessions to germinate quickly at sub-optimal temperatures, their rapid emergence and early development from early-season sowings, brief period of perfect flower production, early and concentrated fruit maturity, and extreme susceptibility to diseases present in mild, humid climates reinforce this view.

LITERATURE CITED

- (1) Allard, R.W. 1960. Principles of plant breeding. John Wiley & Sons, New York, NY.
- (2) Denna, D.W. 1962. A study of the genetic, morphological and physiological basis of the bush and vine habit of several cucurbits. Ph.D. Thesis, Cornell Univ., Ithaca, NY.
- (3) Denna, D.W. 1973. Personal correspondence (to Z. Karchi). September 11.
- (4) Halsey, L.H. 1980. U. F. G508, G509, G510, G511, and G515 muskmelon breeding lines. HortScience 15: 538.
- (5) Karchi, Z. 1970. Effects of 2-chloroethanephosphonic acid on flower types and flowering sequences in muskmelon. J. Amer. Soc. Hort. Sci. 95: 515-518.
- (6) Karchi, Z. 1979. Development of F₁ hybrid muskmelons. Spec. Public. 129, Volcani Center, Bet Dagan, Israel. 12 pp. (in Hebrew with English abstract).
- (7) Karchi, Z. and A. Govers. 1971. Noy Zahov 'Amid -- zan melonim hadash leyizzu. ['Noy Zahov 'Amid' -- a new melon cultivar for export.] Hassadeh 51: 377-381 (in Hebrew).
- (8) Kasmire, R.F. (Comp.). 1981. Muskmelon production in California. Leaflet 2671, Div. Agric. Sci., Univ. Calif., Berkeley.
- (9) Lippert, L.F., M.O. Hall, O.D. McCoy, and H. Johnson, Jr. 1972. Muskmelon responses to preflowering treatments of ethephon. HortScience 7: 177-179.
- (10) McCollum, T.G. and D.J. Cantliffe. 1983. Alteration of plant habit, sex expression and fruit set in muskmelon with ethrel and curbiset. HortScience 18: 596 (Abstr.).
- (11) McGlasson, W.B. and H.K. Pratt. 1963. Fruit-set patterns and fruit growth in cantaloupe (Cucumis melo L. var. reticulatus Naud.). Proc. Amer. Soc. Hort. Sci. 83: 495-505.
- (12) Mohr, H.C. and D.E. Knavel. 1966. Progress in the development of short-internode (bush) cantaloupes. HortScience 1: 16.

- (13) Nerson, H., D.J. Cantliffe, H.S. Paris, and Z. Karchi. 1982. Low-temperature germination of birdsnest-type muskmelons. HortScience 17: 639-640.
- (14) Nerson, H., H.S. Paris, and Z. Karchi. 1983. Characteristics of birdsnest-type muskmelons. Scientia Hort. 21: (in press).
- (15) Nerson, H., H.S. Paris, Z. Karchi, and D.J. Cantliffe. 1982. Yield concentration in muskmelon as affected by the genotype and application of ethrel and chlorflurenol. HortScience 17: 506-507 (Abstr.).
- (16) O'Brien, M. and B.L. Harriott. 1975. A new melon pickup machine for reducing onerous labor.. Trans. Amer. Soc. Agric. Eng. 18: 803-805.
- (17) Paris, H.S., Z. Karchi, H. Nerson, and Y. Burger. 1982. On the compact appearance of birdsnest type muskmelons. HortScience 17: 476 (Abstr.).
- (18) Paris, H.S., Z. Karchi, H. Nerson, M. Edelstein, A. Govers, and D. Freudenberg. 1981. A new plant type in Cucumis melo L. Cucurbit Genet. Coop. Rep. 4: 24-26.
- (19) Paris, H.S., Z. Karchi, H. Nerson, M. Edelstein, A. Govers, and D. Freudenberg. 1982. Further observations on "birdsnest" muskmelons. Cucurbit Genet. Coop. Rep. 5: 28-29.
- (20) Paris, H.S., H. Nerson, Z. Karchi, Y. Burger, M. Edelstein, and A. Govers. 1982. On the possibility of mechanizing the melon harvest by introduction of the "birdsnest" plant type. Hassadeh 62: 802-804 (He./En.).
- (21) Pratt, H.K., J.D. Goeschl, and F. W. Martin. 1977. Fruit growth and development, ripening, and the role of ethylene in the 'Honey Dew' muskmelon. J. Amer. Soc. Hort. Sci. 102: 203-210.
- (22) Rosa, J.T. 1924. Fruiting habit and pollination of cantaloupe. Proc. Amer. Soc. Hort. Sci. 21: 51-57.

- (23) Rudich, J. 1969. Genetic and hormonal control of internode length in melons. M.S. Thesis, Hebrew Univ. of Jerusalem, Faculty of Agriculture, Rehovot, Israel (in Hebrew with English abstract).
- (24) Sicron, M. 1982. Statistical abstract of Israel. Central Bureau of Statistics. Hed Press, Jerusalem, p. 398 (in Hebrew and English).
- (25) Slomnicki, I., A. Stein, and J. Nothmann. 1968. Exploration, collection and screening of indigenous and local varieties of vegetable crops cultivated in Turkey and Iran. Final Report, Ford Foundation Project No. 5/A4.
- (26) Zink, F.W. 1978. U. C. SR-91 Bush, U. C. Top Mark Bush, and U. C. Perlita Bush muskmelon breeding lines. HortScience 13: 486.

Table 1. Cultivars and lines used as recurrent parents in breeding birdsnest muskmelons having improved horticultural characteristics.

Cultivar/Line	Melon type	Where Grown	Earliness	Flesh Color	Sweetness	Cavity size	Rind	Disease resistance*
¹ Galia (Male and Female Parents)	Muskmelon	Israel	Medium	Green	Very high	Small	Fine net	P
Noy Yizre'el ¹	Muskmelon	Israel	Late	Green	Very high	Mid-small	Smooth	P
Noy 'Amid ¹	Casaba	Israel	Mid-late	Cream	Very high	Mid-large	Wrinkled	P D
Tamdew ¹	Honey dew	U.S.A.	Late	Green	Very high	Mid-large	Smooth	P D
PMR 45 ²	Muskmelon	U.S.A.	Medium	Orange	High	Mid-small	Coarse net	P
Golden Perfection ²	Muskmelon	U.S.A.	Medium	Orange	High	Mid-small	Coarse net	P D A
Ananas Yoque'am ²	Muskmelon	Israel	Medium	Orange	Very high	Mid-large	Fine net	None
Far North ²	Muskmelon	U.S.A.	Early	Orange	Mid-high	Medium	Part net	None

¹Birdsnest donor parent: Persia 202

²Birdsnest donor parent: Persia 221

* P = powdery mildew, D = downy mildew, A = Alternaria leaf spot.

Table 2. Yield, yield concentration, and fruit concentration of 'Galia' and D48 ('Galia' concentrated-yield prototype) muskmelons at Gainesville, Florida and Newe Ya'ar, Israel. Spring, 1983.

Parameter	Place	D48	Galia	t*	P
Days to maturity of first fruit	Gainesville	59.5	62.5	4.23	0.01-0.001
	Newe Ya'ar	74.3	75.5	1.00	0.40-0.30
Days to most fruitful harvest	Gainesville	61.5	65.5	2.96	0.05-0.02
	Newe Ya'ar	79.0	83.0	4.88	0.02-0.01
Fruit weight (kg)	Gainesville	1.55	2.03	3.77	0.01-0.001
	Newe Ya'ar	1.44	1.78	11.33	0.01-0.001
Soluble solids contents (%)	Newe Ya'ar	10.6	12.4	6.73	0.01-0.001
Total yield (kg/m ²)	Gainesville	3.90	3.20	1.01	0.40-0.30
	Newe Ya'ar	6.00	5.85	0.67	>0.50
Number of fruits per m ²	Gainesville	2.58	1.61	1.79	0.20-0.10
	Newe Ya'ar	4.16	3.29	4.90	0.02-0.01
Yield on most fruitful harvest date	Gainesville	1.39	0.68	3.20	0.02-0.01
	Newe Ya'ar	1.85	1.14	5.52	0.02-0.01
Yield on 2 consec. most fruitful dates	Gainesville	2.50	1.28	2.21	0.10-0.05
	Newe Ya'ar	2.86	1.91	4.21	0.05-0.02
Yield on 3 consec. most fruitful dates	Gainesville	3.12	1.87	2.10	0.10-0.05
	Newe Ya'ar	3.65	2.69	5.66	0.02-0.01
Percent yield on most fruitful date	Gainesville	36.3	22.1	2.73	0.05-0.02
	Newe Ya'ar	30.6	19.4	6.45	0.01-0.001
Percent yield on 2 cons. fruitful dates	Gainesville	66.1	39.8	2.00	0.10-0.05
	Newe Ya'ar	47.3	35.4	1.95	0.20-0.10
Percent yield on 3 cons. fruitful dates	Gainesville	81.4	58.2	2.96	0.05-0.02
	Newe Ya'ar	60.4	46.1	3.81	0.05-0.02
Number of fruits/m ² on most fruit. date	Gainesville	0.97	0.32	3.28	0.02-0.01
	Newe Ya'ar	1.30	0.64	7.36	0.01-0.001
Number of fruits/m ² on 2 consec. dates	Gainesville	1.69	0.59	2.82	0.05-0.02
	Newe Ya'ar	2.00	1.19	3.59	0.05-0.02
Number of fruits/m ² on 3 consec. dates	Gainesville	2.04	0.86	2.72	0.05-0.02
	Newe Ya'ar	2.55	1.56	8.03	0.01-0.001
Percent fruits on most fruitful date	Gainesville	37.4	21.7	3.16	0.02-0.01
	Newe Ya'ar	31.0	19.3	6.00	0.01-0.001
Percent fruits on 2 consec. dates	Gainesville	66.4	37.1	2.98	0.05-0.02
	Newe Ya'ar	47.8	36.2	1.54	0.30-0.20
Percent fruits on 3 consec. dates	Gainesville	80.4	53.8	3.05	0.05-0.02
	Newe Ya'ar	60.9	47.6	2.41	0.10-0.05

*At Gainesville, unpaired t (df=6). At Newe Ya'ar, paired t (df=3).

**At Gainesville, from transplanting. At Newe Ya'ar, from direct seeding.

@kg/m²

Table 3. Germination at 15°C of vine (V), short-internode (SI), and birdsnest (B) muskmelons.

Accession	Germination (%)					
	2 days	7 days	12 days	17 days	25 days	
Persia 201 (B)	0	66	99	--	--	
Persia 202 (B)	0	31	91	92	--	
Persia 221 (B)	0	84	85	--	--	
Noy Yizre'el (V)	0	0	0	0	3	
Perlita (V)	0	0	0	0	0	
Top Mark (V)	0	0	0	0	1	
U. C. Perlita Bush (SI)	0	0	0	0	1	
U. C. Top Mark Bush (SI)	0	0	0	0	0	

Table 4. Emergence percent of vine (V), short-internode (SI) and birdsnest (B) muskmelons.

Accession	Days after sowing		
	4	7	13
<u>Field, Newe Ya'ar, sown 18 April 80</u>			
Noy Yizre'el (V)	--	43 b [*]	84 b
U. C. SR-91 Bush (SI)	--	1 a	61 a
Persia 202 (B)	--	78 c	89 b
<u>Greenhouse, Gainesville, sown 26 March 81</u>			
Noy Yizre'el (V)	15 a	85 bc	--
Top Mark (V)	8 a	80 bc	--
Perlita (V)	6 a	72 ab	--
U. C. Top Mark Bush (SI)	7 a	58 a	--
U. C. Perlita Bush (SI)	8 a	63 a	--
Persia 201 (B)	85 b	88 c	--
Persia 202 (B)	88 b	99 c	--
Persia 221 (B)	92 b	94 c	--

*Mean separation by Duncan's multiple range test, 0.01 significance level.

Table 5. Length of main stem and primary branches in Noy Yizre'el (vine)^{***} and Persia 202 (birdsnest). 54 days after emergence. Newe Ya'ar, Spring 1980.

Main stem or branch	Length (cm)	
	Noy Yizre'el	Persia 202
Main stem	75 c	49 ab
First branch	92 d	57 b
Second branch	88 d	59 bc
Third branch	71 c	54 b
Fourth branch	37 a	48 ab

Table 6. Number of side branches developing from the main stem in Persia 202 (birdsnest), 'Noy Yizre'el' (vine) and their F_1 . Newe Ya'ar, Summer, 1983.

Line	Number of side branches developing from the main stem	
	Range	Average
Persia 202	8-13	10.0 a
'Noy Yizre'el'	5-7	6.2 c
F_1 ('Noy Yizre'el' x Persia 202)	6-10	7.9 b
S.E. = 0.6		

Table 7. Male and perfect flower numbers and their ratio in 'Noy Yizre'el' (V), Persia 202 (B), and 2 short-internode lines at Gainesville, Florida.

Flower type	Autumn 1980 (38-56 days)				Spring 1981 (40-75 days)			
	Noy		Persia		U. F.		Noy	
	Yizre'el	(Vine)	202	(Birdsnest)	6509	(Short-internode)	Yizre'el	202
Male	94		73		66		258	109
Perfect	12.3		10.2		5.2		18.2	11.0
Male/Perfect Ratio	7.7 a		7.1 a		12.7 b		14.2 a	9.9 a
								35.6 b

Table 8. Yield per plant during the 5 most fruitful days in Noy Yizre'el (vine), Persia 202 (birdsnest), and U. C. Perlita Bush (short-internode). Gainesville, Spring 1981.

Accession	Days after emergence	Yield (kg)	Percent of total
Noy Yizre'el	91-95	1.5	25 a
Persia 202	76-80	2.7	56 b
U. C. Perlita Bush	86-90	0.8	32 a

Table 9. Summary of data on internode length.

Generation	Cultivar/Line/Cross	Long*	Short	Total	Expected Ratio	χ^2	P
P ₁	Persia 202	0	105	105			
P ₂	Noy Yizre'el	105	0	105			
F ₁	P ₁ x P ₂	78	0	78			
F ₁	P ₂ x P ₁	44	0	44			
F ₁	Total	122	0	122			
F ₂	(P ₁ x P ₂)	72	16	88	3:1	2.19	0.25-0.10
F ₂	(P ₂ x P ₁)	64	16	80	3:1	1.06	0.50-0.25
F ₂	Total	136	32	168	3:1	3.17	0.10-0.05
BC ₁	P ₁ x F ₁	51	54	105	1:1	0.09	0.90-0.75
BC ₁	P ₂ x F ₁	105	0	105			
P ₃	Top Mark	23	0	23			
P ₄	U. C. Top Mark Bush	0	15	15			
F ₁	P ₁ x P ₄	21	0	21			
F ₁	P ₄ x P ₁	25	0	25			
F ₁	Total	46	0	46			

Table 10. The effect of growth regulators on female flowering and fruit development in three muskmelon lines. Gainesville, Field, Spring 1981.

Line	Treatment	Number of Perfect+Female Flowers/plant	Number of Fruit per Plant	Earliness*
Perlita (vine)	Control	7.6	3.4	5.7
	E	18.9	3.6	5.2
	C	6.8	4.2	5.6
	E + C	20.9	4.0	5.6
U. C. Perlita Bush (short-internode)	Control	2.3	3.7	5.4
	E	21.2	2.3	4.4
	C	2.1	3.4	5.9
	E + C	16.1	2.4	4.8
Persia 202 (birdsnest)	Control	5.9	2.9	3.5
	E	16.7	3.4	3.4
	C	3.8	2.9	3.5
	E + C	17.2	4.1	3.4

* Earliness expressed as average number of weeks from anthesis to harvest.

'Noy Yizre'el' (vine) as affected by ethephon and chlorflurenol. Newe Ya'ar, Field, average 1981-1983.

Line or Cultivar	Treatment	Ratio of Male to Female + Perfect Flowers	Number of Female + Perfect Flowers	Female + Perfect of First 10 Days (Percent of Total)	Number of Fruit Set in First 10 Days (Percent of total)	Number of Fruit Set per Pistillate Flower	Yield (kg per Plant)	Yield in Most Fruitful Week (Percent of Total Yield)
Persia 202	Control	20.0	13.1	63	4.2	0.32	4.8	0.81
Persia 202	E	0.9	16.7	82	4.8	0.29	4.2	0.83
Persia 202	C	13.2	16.2	48	5.9	0.36	5.1	0.86
Persia 202	E + C	0.6	19.9	70	7.8	0.39	5.4	0.93
U.C. Perl.	Control	16.1	20.4	53	3.7	0.18	2.5	0.64
U.C. Perl.	E	1.4	25.1	74	2.4	0.10	1.9	0.42
U.C. Perl.	C	6.2	31.9	34	4.7	0.15	2.1	0.76
U.C. Perl.	E + C	0.3	24.3	68	3.0	0.12	1.3	0.58
Noy Yizr.	Control	20.2	16.5	46	4.7	0.28	6.1	0.41
Noy Yizr.	E	3.7	16.6	83	6.0	0.36	6.6	0.53
Noy Yizr.	C	12.2	23.2	48	7.8	0.34	6.0	0.62
Noy Yizr.	E + C	1.9	14.9	90	8.6	0.58	6.6	0.47

Figure 1. Concentrated fruit placement in a plant of *Persia* 221.

Figure 2. Mean fresh weight accumulation in birdsnest (B), vine (V) and short-internode (SI) plants under greenhouse conditions. Gainesville, Winter (Experiment A) and Spring (Experiment C) 1981.

Figure 3. Ratio of mean fresh weight of birdsnest (B) and short-internode (SI) plants to mean fresh weight of vine plants under field conditions.
Newe Ya'ar, Spring 1980.

1000

Figure 5. Number of developing fruits in 'Noy Yizre'el' (vine) and Persia 202 (birdsnest) at Newe Ya'ar (left) and 'Noy Yizre'el', Persia 202, and U. C. Perlita Bush (SI) at Gainesville (right).

e. Evaluation of the research achievement with respect to the original research proposal.

All of the objectives of the original proposal were achieved at least in part.

Comparison and identification of the birdsnest accessions has been completed. We possess 5 birdsnest accessions of which the 4 from Iran are similar and clearly superior to the one from Russia. Two of the Iranian accessions have been exploited for breeding purposes.

The breeding objective has been carried out right on schedule all along, and even has been expanded to include recurrent parents not mentioned in the original objective. A high-quality, birdsnest cultivar should be ready for release in 1986 or 1987. As seed stocks have become available, the genetic material has been constantly evaluated under both Israeli and U.S. environments. The lines thus far developed react similarly to both environments.

The development of the Iranian birdsnest accessions has been clarified and in some cases quantified. Short internodes and uniform high-branching tendency have been identified as the chief components of the birdsnest phenotype. The inheritance of short internodes has been worked out, and its lack of relationship to the major gene possessed by the short-internode plant type demonstrated. The inheritance of the high-branching tendency has, so far, not been worked out because of wide variations within parental lines. The difference in flowering pattern between birdsnest and vine types is now much better understood. Plant growth regulator treatments cannot be expected to substitute for the genetically-based concentrated yield possessed by the birdsnest accessions. The mechanism of uniform multiple fruit set is not clearly

understood and needs to be investigated in more detail. This would aid in developing techniques for maintaining the birdsnest character in lines already developed.

A hypothesis for the origin and edaphic adaptation of the birdsnest accessions has been presented along with supporting evidence.

f. Description and results of cooperation.

Cooperation has included (a) exchange of personnel: Dr. H. Nerson, Israeli cooperating investigator, spent a sabbatical year at the American cooperating institution with Dr. D. J. Cantliffe, American cooperating investigator; (b) exchange of germ plasm: advanced breeding lines developed in Israel were sent to Florida for field, greenhouse, and laboratory evaluation; (c) communication of experimental results; (d) cooperative publications (see list). The cooperation has led to fulfillment of objectives of the proposal, especially with regard to understanding the development, flowering pattern, and fruit set pattern of the plant material, as well as the evaluation of advanced breeding material with regard to yield concentration and horticultural qualities. The conducting of these studies jointly in 2 regions (Israel and Florida) differing widely in climatic and edaphic conditions affords much greater confidence in the usefulness of the plant material and the progress in breeding than would have been possible had this work been carried out in Israel or Florida alone.

g. Thesis.

None.

h. Benefit to agriculture.

The research has contributed to the rapid development of genetic material possessing birdsnest plant type together with fairly good horticultural characteristics. An additional one to 2 years of breeding is expected to

result in the first high-quality birdsnest cultivars, and shortly after that, several others.

Much hand labor is required for harvesting the present-day vine-type cultivars. This labor is costly and is a severe limiting factor in the growing of melons. The use of seasonal labor is a growing problem for both Israel and the U.S.A. It is apparent that the production of this crop could be facilitated if its dependence on seasonal labor could be reduced or eliminated.

In addition, growing consistently high-quality melons is difficult to achieve. This is because vine-type melon plants characteristically exhibit 2 or more cycles of fruit set and development. For example, a light N-P top dressing applied for the purpose of encouraging development of young, green melons will adversely affect the eating quality of a nearly mature fruits growing on the same plant.

Incorporation of the birdsnest character into high-quality cultivars is expected to make once-over mechanical harvest an economical alternative to multiple hand harvest as well as simplify the cultural management of this crop.

i. Inventions.

None.

j. Published reports.

- *1. Paris, H.S., Z. Karchi, H. Nerson, M. Edelstein, A. Govers, and D. Freudenberg. 1981. A new plant type in Cucumis melo L. Cucurbit Genet. Coop. Rep. 4: 24-26.
- *2. Paris, H.S., Z. Karchi, H. Nerson, M. Edelstein, A. Govers, and D. Freudenberg. 1982. Further observations on "birdsnest" muskmelons. Cucurbit Genet. Coop. Rep. 5: 28-29.

- *3. Paris, H.S., H. Nerson, Z. Karchi, Y. Burger, M. Edelstein, and A. Govers. 1982. On the possibility of mechanizing the melon harvest by introduction of the "birdsnest" plant type. Hassadeh 62: 802-804 (in Hebrew with English abstract.).
- *4. Nerson, H., D.J. Cantliffe, H.S. Paris, and Z. Karchi. 1982. Low-temperature germination of birdsnest-type muskmelons. HortScience 17: 639-640.
- +5. Paris, H.S., Z. Karchi, H. Nerson, and Y. Burger 1982. On the compact appearance of birdsnest type muskmelons. HortScience 17: 476 (Abstr.).
- +6. Nerson, H., H.S. Paris, Z. Karchi, and D.J. Cantliffe. 1982. Yield concentration in muskmelon as affected by the genotype and application of ethrel and chlorflurenol. HortScience 17: 506-507 (Abstr.).
- +7. McCollum, T.G. and D.J. Cantliffe. 1983. Alteration of plant habit, sex expression and fruit set in muskmelon with ethrel and curbiset. HortScience 18: 596 (Abstr.).
- **8. Nerson, H., H.S. Paris, and Z. Karchi. 1983. Characteristics of birdsnest-type muskmelons. Scientia Hort. 21: (in press).

*2 reprints already supplied to BARD.

+Abstracts of presentations, 2 photocopies enclosed herewith.

**In press, 2 photocopies of manuscript enclosed herewith.