SARE Project LS92-46

EFFECTS OF PARTRIDGE PEA-PEANUT ROTATIONS ON POPULATIONS OF *MELOIDOGYNE ARENARIA*, INCIDENCE OF *SCLEROTIUM ROLFSII*, AND YIELD OF PEANUT†

R. Rodríguez-Kábana, N. Kokalis-Burelle, D. G. Robertson, C. F. Weaver, and L. Wells

Professor, Postdoctoral Fellow, Senior Research Associate, Senior Research Associate, and Assistant Superintendent, Wiregrass Substation, respectively, Department of Plant Pathology, Auburn University, Alabama Agricultural Experiment Station, Auburn, AL 36849-5409, U.S.A.

ABSTRACT

Rodríguez-Kábana, R., N. Kokalis-Burelle, D. G. Robertson, C. F. Weaver, and L. Wells. 1995. Effects of partridge pea-peanut rotations on populations of *Meloidogyne arenaria*, incidence of *Sclerotium rolfsii*, and yield of peanut. Nematropica 25:27-34.

The value of partridge pea (*Cassia fasciculata*) as a rotation crop for the management of root-knot nematode (*Meloidogyne arenaria*) and southern blight (*Sclerotium rolfsii*) in 'Florunner' peanut (*Arachis hypogaea*) was assessed in a 6-year field experiment. Partridge pea did not support significant numbers of *M. arenaria* juveniles in soil. When peanut followed partridge pea, the numbers of juveniles were always lower than in plots with continuous peanut. Aldicarb applied to peanut following 2 years of partridge pea resulted in increased yields over continuous peanut without nematicide. When the nematicide was applied to peanut following 1 year of partridge pea, yields were improved in 2 out of the three years when peanuts were planted in this cropping system. Peanut without nematicide following 1 year of partridge pea yielded more than peanut monoculture in only 1 out of the 3 years when peanuts were planted in this system. Yields of peanut without nematicide following 2 years of partridge pea were higher than those obtained with continuous peanut with or without nematicide in 1 out of the 2 possible years when plots with this rotation were in peanut. Application of aldicarb to continuous peanut failed to increase yields in all but two years of the study. Partridge pea had no effect on the incidence of southern blight in peanut.

Key words: aldicarb, *Arachis hypogaea*, *Cassia fasciculata*, crop rotation, *Meloidogyne arenaria*, nematode control, peanut, root-knot nematode, *Sclerotium rolfsii*, southern blight.

RESUMEN

Rodríguez-Kábana, R., N. Kokalis-Burelle, D. G. Robertson, C. F. Weaver y L. Wells. 1995. Efectos de rotaciones mani-arvejilla americana sobre poblaciones de *Meloidogyne arenaria*, incidencia de *Sclerotium rolfsii*, y rendimiento en maní. Nematrópica 25:27-34.

El uso de la arvejilla americana (*Cassia fasciculata*) como cultivo de rotación para el manejo del nematodo agallador (*Meloidogyne arenaria*) y el tizón sureño (*Sclerotium rolfsii*) en el maní (*Arachis hypogaea*) variedad Florunner, fue evaluado en un experimento de campo por 6 años. La arvejilla americana no presentó un número significativo de larvas juveniles de *M. arenaria* en el suelo. Cuando se plantó maní seguido de arvejilla americana, el número de larvas juveniles fue siempre menor en comparación a parcelas con maní contínuo. La aplicación de aldicarb a parcelas con maní, seguido de 2 años de arvejilla americana, resultó en un aumento en rendimiento mayor que las parcelas con maní contínuo sin nematicida. Cuando aldicarb se aplicó a maní seguido por un año de arvejilla americana, los rendimientos mejoraron en dos de los tres años cuando maní se plantó en este sistema de cultivo. Maní sin nematicida seguido de un año de arvejilla americana rindió más que parcelas con maní en monocultivo en sólo uno de los tres años con maní. Rendimentos de maní sin nematicida

†Alabama Agricultural Experiment Station Journal Series Number 18-944784.

seguido de dos años de arvejilla americana fueron mayores que aquellos obtenidos con maní contínuo con o sin nematicida en uno de los dos posibles años, cuando parcelas con esta rotación estaban sembradas con maní. La aplicación de aldicarb a maní contínuo fracasó en aumentar rendimientos en todos los ensayos de dos años. Arvejilla americana no tuvo efecto sobre la incidencia del tizón sureño (*Sclerotium rolfsii*) en maní.

Palabras clave: aldicarb, *Arachis hypogaea*, *Cassia fasciculata*, control de nematodos, *Meloidogyne arenaria*, maní, nematodo nodulador, rotación de cultivos, *Sclerotium rolfsii*, tizón sureño.

INTRODUCTION

Root-knot disease, caused by *Meloidogyne arenaria*, and southern blight, caused by *Sclerotium rolfsii*, are the principal yield-limiting diseases of peanut (*Arachis hypogaea*) in the southeastern United States (5,6,9). Damage from root-knot nematode and southern blight can be so severe that continuous production of peanut is impossible in fields with high infestations of these pathogens. Currently, there are no commercially available peanut cultivars resistant to *M. arenaria* or *Sclerotium rolfsii* (5). Control of root-knot nematodes has been based on the use of chemicals. Due to increasing environmental awareness and regulation of agricultural chemicals, the number of nematicides available for use by producers is very limited and costs of these pesticides are high (1,12). Crop rotation to control pathogen populations is a viable alternative to the use of chemicals. Rotations of peanut with bahiagrass (*Paspalum notatum*), cotton (*Gossypium hirsutum*), and several other crops are effective for the management of *M. arenaria* (3,14,16). Summer legumes can also be effective as rotation crops for the management of nematode problems in peanut. Some legumes of tropical origin such as velvetbean (*Mucuna deeringiana*) and hairy indigo (*Indigofera hirsuta*) can suppress *M. arenaria* and increase peanut yields when used as rotation crops in fields with severe infestations of the nematode (17). There are also legume species indigenous to the southeastern region of the United States that are non-hosts for *M. arenaria* and offer the possibility of being used as rotation crops (4). One of these, partridge pea (*Cassia fasciculata*), can be grown throughout the peanut producing areas of the United States (8). Preliminary studies showed that partridge pea is not a host to *M. arenaria* and other phytonematodes and offers good potential as a rotation crop with peanut (15). This paper presents additional studies on the use of partridge pea for the management of root-knot nematode and southern blight in peanut.

MATERIALS AND METHODS

An experiment was established in 1988 in southeastern Alabama to assess the value of partridge pea as a rotation crop for the management of root-knot nematodes and southern blight in peanut. The experiment was conducted in an irrigated field at the Wiregrass Substation near Headland, Alabama, U.S.A., that had been in continuous peanut production for a decade. The field was heavily infested with both *Sclerotium rolfsii* and *M. arenaria* (> 100 juveniles/100 cm^3 soil at peanut harvest). Cropping systems (treatments) included in the experiment were: 1) continuous peanut without nematicide; 2) continuous peanut with application of nematicide (aldicarb); 3) partridge pea for one year followed by peanut without nematicide; 4) same as system 3 but with nematicide applied to peanut; 5) partridge pea for two

Table 1. Effect of rotation with peanut and partridge pea on juvenile densities of *Meloidogyne arenaria* in a 6-year field study at the Wiregrass Substation near Headland, Alabama, U.S.A.

Crop and year[y]						*M. arenaria* juveniles/100 cm³ soil[z]					
1988	1989	1990	1991	1992	1993	1988	1989	1990	1991	1992	1993
P(-)	P(-)	P(-)	P(-)	P(-)	P(-)	590	311	164	221	269	245
P(+)	P(+)	P(+)	P(+)	P(+)	P(+)	196	237	50	69	104	115
PP	P(-)	PP	P(-)	PP	P(-)	9	102	13	100	1	109
PP	P(+)	PP	P(+)	PP	P(+)	9	29	5	65	0	72
PP	PP	P(-)	PP	PP	P(-)	9	6	0	6	0	82
PP	PP	P(+)	PP	PP	P(+)	1	7	3	3	0	20
					FLSD ($P \leq 0.05$):	280	141	62	105	97	141

[y]P = Peanut; PP = Partridge Pea; (-) = No nematicide; (+) = With at-plant application of aldicarb at 3.0 g a.i./10 m row.
[z]Determined 2-3 weeks before peanut harvest using the "salad bowl" incubation technique.

years followed by peanut without nematicide; and 6) same as system 5 but with nematicide applied to peanut (Table 1). Plots were maintained fallow during the winter. The nematicide, aldicarb, was applied at-plant with ground driven boxes attached to a John Deere® 7100 planter in a 20-cm-wide band at 3.0 g a.i. per 10 m row (3.3 kgs a.i./ha), with light (2-4 cm) incorporation into the soil. Plots in the experiment were eight rows wide (11 m) and 10 m long. The experiment was arranged in a randomized complete block with 8 replications per cropping system. Cultural practices, fertilization, and control of insects, weeds, and foliar diseases for peanut were according to recommendations for the area (2). Partridge pea seed was broadcast at 17 kg/ha.

Soil samples for nematode analyses were collected each year from every plot 2-3 weeks before peanut harvest to coincide with the period of maximal *M. arenaria* juvenile population development in soil (13). Samples from peanut plots consisted of 18-20, 2.5-cm-diam soil cores taken with a soil probe from the root zone to a depth of 20-25 cm at approximately 0.5 m intervals along the two center rows of each plot. The cores from each plot were composited, and a 100 cm³ soil subsample was used for nematode analysis by the "salad bowl" incubation method (10). Soil cores from plots with partridge pea were collected from the center 1.5 m of each plot at 0.5 m intervals and were processed as described for peanut soil samples.

Incidence of southern blight in peanut was determined by counting the number of disease loci or "hits" in the two center rows of each plot after digging and inversion of the crop. A disease locus is a length of row ≤ 30 cm affected by the disease (9).

Peanut yields were obtained by harvesting the two center rows of each plot at crop maturity. Plots with partridge pea were not harvested in 1988. In 1989-1992, partridge pea seed yield was from a 20 m² area in the center of each plot.

All data were analyzed following standard procedures for analysis of variance (18). Fisher's least significant differences were calculated when F values were significant for determining differences among treatment means. Regression analyses also were determined according to standard procedures (18). All differences referred to in the text were significant at the 5% or lower level of probability.

RESULTS AND DISCUSSION

Partridge pea did not support significant juvenile populations of *M. arenaria* in soil (Table 1). When peanut followed partridge pea, the numbers of juveniles were always lower than in plots with continuous peanut with no nematicide. The application of nematicide to peanut following partridge pea had no significant effect on juvenile populations. No significant differences in numbers of juveniles were found in peanut following either 1 or 2 years of partridge pea. Application of aldicarb to monoculture peanut reduced juvenile populations in all but in 1989 and 1993. Numbers of *M. arenaria* juveniles in soil were inversely related to peanut yields in 1993, when partridge pea - peanut cropping systems were in peanut (Fig. 1).

Southern blight in peanut was very severe (>50 loci per 100 m row) in all years of the study (Table 2). Application of aldicarb to continuous peanut had no effect on southern blight. With one exception, (peanut + nematicide after 2 years of partridge pea), partridge pea had no effect on the incidence of southern blight in peanut. Peanut yields were inversely related to the incidence of southern blight in 1989,

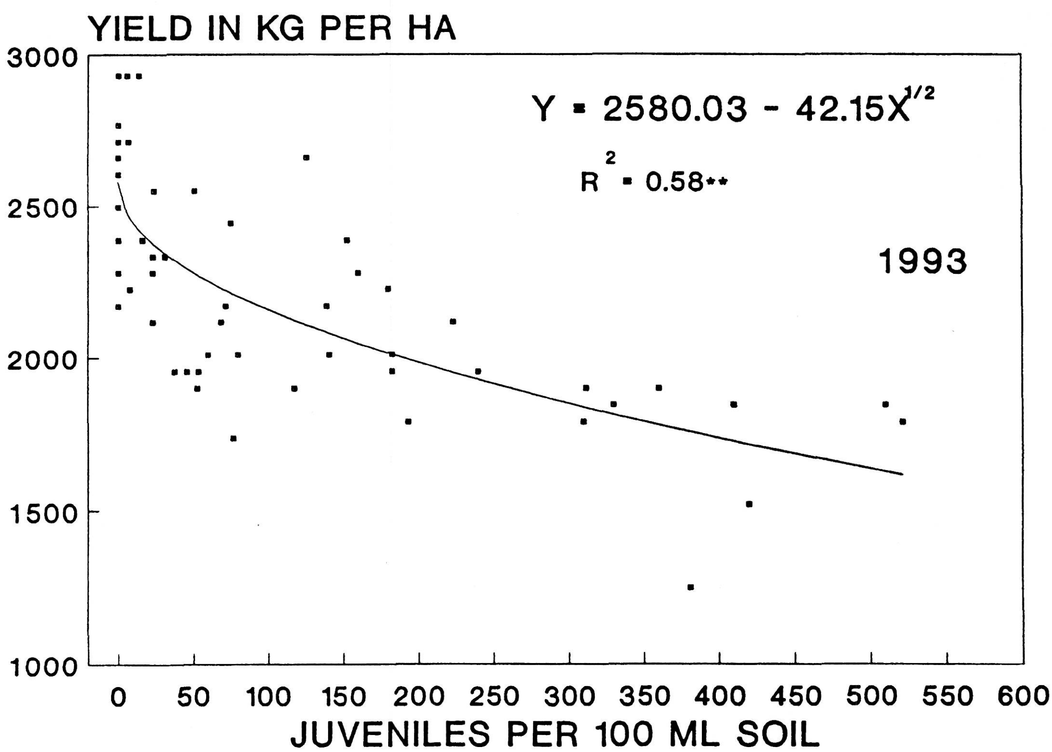

Fig. 1. Relationship between peanut yield per ha and populations of *Meloidogyne arenaria* juveniles in soil, represented by data from 1993.

Table 2. Effect of rotation with peanut and partridge pea on southern blight (*Sclerotium rolfsii*) and peanut yield in a 6-year field study at the Wiregrass Substation near Headland, Alabama, U.S.A.

Crop and year[y]						Southern blight loci/100 m Row[z]						Yield in kg/ha					
1988	1989	1990	1991	1992	1993	1988	1989	1990	1991	1992	1993	1988	1989	1990	1991	1992	1993
P(-)	P(-)	P(-)	P(-)	P(-)	P(-)	92	106	104	84	52	68	1 953	1 844	1 736	3 011	3 146	1 980
P(+)	P(+)	P(+)	P(+)	P(+)	P(+)	82	79	97	101	121	83	1 790	2 305	2 143	3 445	3 634	2 007
PP	P(-)	PP	P(-)	PP	P(-)	—	81	—	112	—	71	—	2 585	—	3 092	—	2 170
PP	P(+)	PP	P(+)	PP	P(+)	—	90	—	110	—	84	—	2 666	—	3 662	—	2 170
PP	PP	P(-)	PP	PP	P(-)	—	—	91	—	—	67	—	—	2 212	—	—	2 495
PP	PP	P(+)	PP	PP	P(+)	—	—	71	—	—	58	—	—	2 794	—	—	2 522
					FLSD ($P \leq 0.05$):	N.S.	N.S.	26	N.S.	52	N.S.	N.S.	403	488	610	374	363

[y]P = Peanut; PP = Partridge Pea; (-) = No nematicide; (+) = With at-plant application of aldicarb at 3.0 g a.i./10 m row in a 20-cm-wide band.
[z]A disease locus is a length of row ≤ 30 cm affected by the disease.

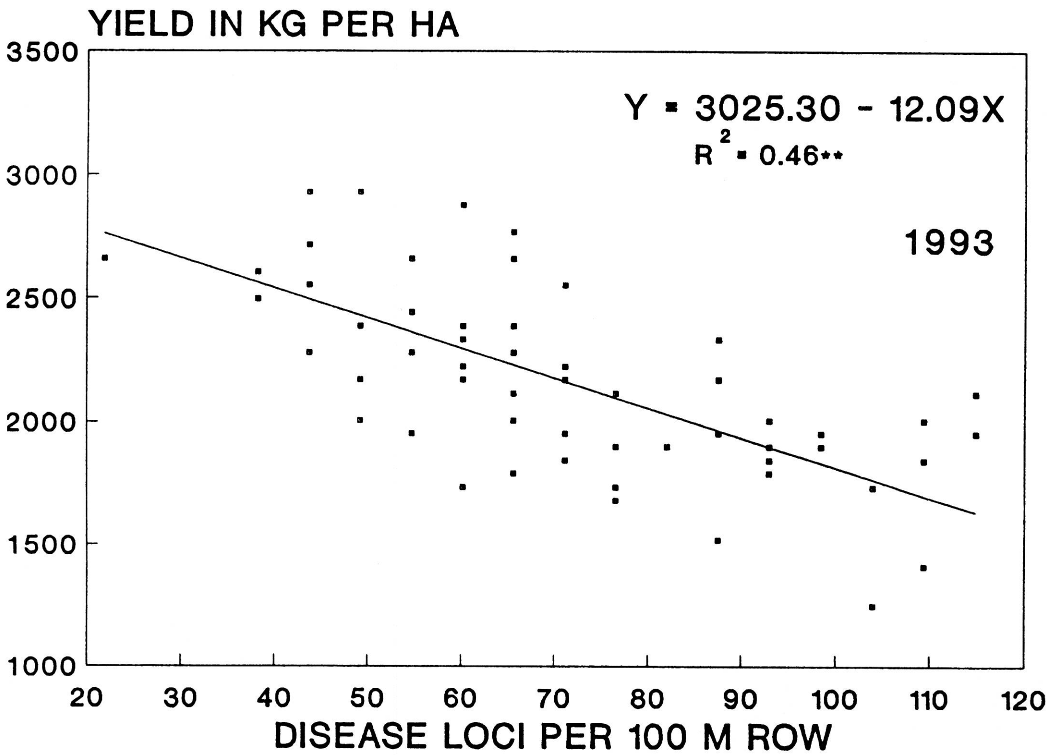

Fig. 2. Relationship between peanut yield per ha and incidence of southern blight, represented by data from 1993.

1991, and 1993 (Fig. 2). Yield losses per disease locus ranged from 8.71 in 1989 to 14.91 kg/ha in 1991.

Application of aldicarb to continuous peanut failed to increase peanut yields in all but two years (1989,1992) (Table 2). Aldicarb applied to peanut following 2 years of partridge pea resulted in increased yields over continuous peanut without nematicide. When the nematicide was applied to peanut following one year of partridge pea, yields were improved over those of continuous peanut without nematicide in 2 (1989,1991) out of the 3 possible years. Peanut without aldicarb following 1 year of partridge pea yielded more than peanut monoculture without nematicide in 1989 but not in 1991 nor in 1993, although the trend was the same. Yield of peanut without nematicide following 2 years of partridge pea were higher than those obtained with continuous peanut (with or without aldicarb) in 1993 but not in 1990. Partridge pea seed yield averaged 379 kg/ha in 1989, 235 in 1990, and 325 in 1991 and 1992.

These data show that partridge pea can be an effective rotation crop for the management of the root-knot nematode in peanut. This confirms earlier preliminary work with this crop (15). Plots with peanut following partridge pea had lower *M. arenaria* juvenile densities than those in monoculture. This suggests a suppressive effect of partridge pea on population development of the nematode which contrasts with effects following other nonhost crops (16).

Reductions in juvenile numbers in response to the partridge pea rotations were not always accompanied by significant increases in peanut yields. This lack of response was probably due to destruction from other pathogens. In addition to the injury caused by southern blight, we observed significant incidence of Rhizoctonia limb rot caused by *Rhizoctonia solani.* While damage from *S. rolfsii* was assessed, we were unable to determine yield losses from Rhizoctonia limb rot, which appeared to uniformly affect the field.

Partridge pea had essentially no effect on the incidence of southern blight in peanut. Partridge pea was susceptible to *S. rolfsii* although damage from this pathogen was not serious. However, partridge pea could have served to perpetuate this pathogen during years without peanut. These data contrast with other rotation crops which suppress not only *M. arenaria* but also southern blight (17). Results thus indicate that rotations of partridge pea with peanut require management of southern blight and Rhizoctonia limb rot in peanut through use of appropriate fungicides (1) or other means.

The relation between peanut yield (Y) and *M. arenaria* juvenile densities in soil (X) was not linear. We chose to describe the relationship with the function:

$$Y = a - bX^{1/2} \qquad \text{I.}$$

where a and b are constants. The model implies that the loss in yield in relation to juvenile density dY/dX is greatest in the range 0 - 200 juveniles per 100 cm^3 soil. This fits well with previous field observations (11). Also, our analyses indicated that there is a strong seasonal influence on parameter values of the model. This was also in agreement with previous reports (11).

Incidence of southern blight in peanut was linearly and inversely related to peanut yield. Yield loss estimates agreed with previous reports (9). This relationship was also subject to seasonal influences varying from 8.71 kg per locus in 1989 to 14.91 kg per locus in 1991. Analysis of the 1993 data indicated a strong relationship between the incidence of southern blight (Ys) and *M. arenaria* juvenile densities (X). The relationship was described by:

$$Ys = -0.29 + 1.08\sqrt{X} \qquad \text{II.}$$

Sclerotium rolfsii is a pathogen with a strong saprophytic phase and typically invades diseased or injured plant host tissue (6,7). Equation II suggests that damage from *M. arenaria* could make peanut more susceptible to southern blight.

Peanut soils in the southeastern United States are sandy, low in organic matter (<2.0%) and have limited cation exchange capacity (< 10 meq per 100 g soil). In addition to reducing nematode populations without the use of chemicals, partridge pea could be planted as a green manure crop to improve soil fertility through N fixation. Partridge pea seed is also valuable for its use in wildlife management. It is necessary that both researchers and peanut producers more seriously consider leguminous green manures and cover crops to both reduce nematode populations and increase soil organic matter and fertility.

LITERATURE CITED

1. ALABAMA COOPERATIVE EXTENSION SERVICE. 1993. Alabama pesticide handbook. Circular ANR 500, Auburn University, Auburn, Alabama, U.S.A.
2. COPE, J. T. Jr., C. E. EVANS, and H. C. WILLIAMS. 1981. Soil test fertilizer recommendations for Alabama soils. Circular 252. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama, U.S.A.
3. DICKSON, D. W., and T. E. HEWLETT. 1989. Effects of bahiagrass and nematicides on *Meloidogyne arenaria* on peanut. Supplement to Journal of Nematology 21:671-676.
4. GRAINGE, M., and S. AHMED. 1988. Handbook of plants with pest-control properties. John Wiley & Sons, New York, New York, U.S.A., 470 pp.

5. MINTON, N. A., and P. BAUJARD. 1990. *in* Plant parasitic nematodes in subtropical and tropical agriculture, Pp. 285-320. M. Luc, R. A. Sikora and J. Bridge, eds. CAB International Institute of Parasitology, U.K.
6. PORTER, D. M., D. H. SMITH, and R. RODRIGUEZ-KABANA. 1984. Compendium of peanut diseases. American Phytopathological Society Press, St. Paul, Minnesota, U.S.A.
7. PUNJA, Z. K. 1985. The biology, ecology and control of *Sclerotium rolfsii*. Annual Review of Phytopathology 23:97-127.
8. RADFORD, A. E., H. E. AHLES, and C. RITCHIE BELL. 1968. Manual of the Vascular Flora of the Carolinas. The University of North Carolina Press, Chapel Hill, North Carolina, U.S.A., 1183 pp.
9. RODRIGUEZ-KABANA, R., P. A. BACKMAN, and J. C. WILLIAMS. 1975. Determination of yield losses to *Sclerotium rolfsii* in peanut fields. Plant Disease Reporter 59:855-858.
10. RODRIGUEZ-KABANA, R., and M. H. POPE. 1981. A simple incubation method for the extraction of nematodes from soil. Nematropica 11:175-186.
11. RODRIGUES-KABANA, R., J. C. WILLIAMS, and R. A. SHELBY. 1982. Assessment of peanut yield losses caused by *Meloidogyne arenaria*. Nematropica 12:278-287.
12. RODRIGUEZ-KABANA, R., and P. S. KING. 1985. Evaluation of selected nematicides for the management of *Meloidogyne arenaria* in peanut: A multi-year study. Nematropica 15:155-164.
13. RODRIGUEZ-KABANA, R., C. F. WEAVER, D. G. ROBERTSON, and E. L. SNODDY. 1986. Population dynamics of *Meloidogyne arenaria* in peanut. Nematropica 16:53-63.
14. RODRIGUEZ-KABANA, R., D. G. ROBERTSON, L. WELLS, P. S. KING, and C. F. WEAVER. 1989. Crops uncommon to Alabama for the management of *Meloidogyne arenaria* in peanut. Supplement to the Journal of Nematology 21:712-716.
15. RODRIGUEZ-KABANA, R., D. G. ROBERTSON, P. S. KING, and L. WELLS. 1991. American jointvetch and partridge pea for the management of Meloidogyne arenaria in peanut. Nematropica 21:97-103.
16. RODRIGUEZ-KABANA, R., and G. H. CANULLO. 1992. Cropping systems for the management of phytonematodes. Phytoparasitica 20:211-224.
17. RODRIGUEZ-KABANA, R., J. W. KLOEPPER, D. G. ROBERTSON, and L. WELLS. 1992. Velvetbean for the management of root-knot and southern blight in peanut. Nematropica 22:75-80.
18. STEEL, R. G. D., and J. H. TORRIE. 1980. Principles and Procedures of Statistics. McGraw-Hill, New York, New York, U.S.A., 631 pp.

Received: *3.IX.1995*
Recibido:

Accepted for publication: *2.II.1995*
Aceptado para publicación: