THE JOURNAL OF AGRICULTURE
OF THE UNIVERSITY OF PUERTO RICO

Issued quarterly by the Agricultural Experiment Station of the University of Puerto Rico, Mayagüez Campus, for the publication of articles and research notes by staff members or others, dealing with scientific agriculture in Puerto Rico and elsewhere in the Caribbean Basin and Latin America.

VOL. 84 JULY AND OCTOBER 2000 No. 3-4

Establishment of rhizoma perennial peanut (*Arachis glabrata*) under irrigation at two semiarid sites in the Caribbean[1]

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J. Agric. Univ. P.R. 84(3-4):105-114 (2000)

ABSTRACT

Two experiments were conducted to determine time for full establishment of rhizoma perennial peanut (RPP) under irrigation. Experiment one (E1) and experiment two (E2) were conducted, respectively, at the Lajas and Fortuna Substations of the Agricultural Experiment Station of the University of Puerto Rico. At Lajas, rhizomes of accessions USDA-ARS no. 17033, 17050, 17052, 17097 (PI no. 276233, 262826, 262833, 262839, respectively) and cultivars Florigraze and Arbrook, planted at 0.76 and 1.5 m apart in rows, were compared for rate of establishment at 60, 120, 180 and 240 days postplanting. At Fortuna, rhizomes of accessions 17033 and 17097, and cv. Florigraze were compared at 80, 160, and 240 days postplanting. In E2, plots were subjected to the following weed control methods: (1) manual, (2) mowing, and (3) chemical. Time to full establishment in E1 increased from about six months to eight with an increase in planting distance from 0.76 to 1.5 m. Accessions 17033 and 17097 and cv. Florigraze showed a tendency for faster lateral spread prior to 120 days postplanting than the other RPPs. However, peanut genotypes achieved full cover at about the same time. The use of herbicide in E2 was the most effective method for promoting faster cover of RPP plants. Establishment of the stand was achieved prior to 240 days in plots receiving weed control treatments 1 and 3, whereas those re-

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ceiving treatment 2 achieved only 62.5% cover. Compared to a tropical grass, RPP exhibits a slower pattern of lateral spread and requires a longer time for full establishment when planted under similar conditions. However, *reducing planting distance and using herbicides to control weeds are management* strategies that can reduce time for full establishment of the RPP stand.

Key words: rhizoma perennial peanut, establishment, weed control

RESUMEN

Establecimiento bajo riego de maní rizoma perenne (*Arachis glabrata*) en dos localidades semiáridas en el Caribe

El establecimiento con irrigación del maní rizoma perenne se evaluó en experimentos en la subestación de Lajas (E1) y en la subestación de Fortuna (E2) de la Estación Experimental Agrícola de la Univiversidad de Puerto Rico. En Lajas, se sembraron rizomas de las accesiones 17033, 17050, 17052 y 17097 (Núm. PI 276233, 262826, 262833, 262839, respectivamente) y de los cultivares Arbrook y Florigraze en hileras a 0.76 y 1.5 m de distancia. Estos fueron comparados en términos de la tasa de establecimiento a los 60, 120, 180 y 240 días postsiembra. En Fortuna, las accesiones 17033 y 17097, y el cultivar Florigraze fueron comparados a los 80, 160 y 240 días postsiembra. Las parcelas en el E2 fueron sometidas a uno de los siguientes métodos para el control de malezas: (1) manual con azada, (2) talado y (3) químico. En E1 un aumento en la distancia de siembra de 0.76 a 1.5 m resultó en un retraso de dos meses en el establecimento de la parcela (de seis a ocho meses). A los 120 días postsiembra las accesiones 17033 y 17097 y Florigraze en E1 aparentaron tener una mayor cobertura que los otros maní perennes. Sin embargo, luego de los 120 días el porcentaje de cobertura y el tiempo hasta el establecimiento completo fueron similares para los seis genotipos. El uso de herbicidas en E2 resultó ser el método más efectivo para promover mayor tasa de cobertura del maní. El establecimiento completo del maní ocurrió previo a los 240 días en aquellas parcelas que recibieron los tratamientos 1 y 3, mientras que en las parcelas que recibieron el tratamiento 2 sólo se alcanzó 62.5% de cobertura a los 240 días. Comparado con las gramíneas, el maní rizoma es lento en su establecimiento; sin embargo, el reducir la distancia de siembra y el uso de herbicidas son estrategias que ayudan a reducir el tiempo de establecimiento.

INTRODUCTION

Rhizoma perennial peanut (RPP) is a primitive forage peanut that produces very few seeds. It is a warm-season tropical legume introduced into the United States originally from Brazil and Paraguay. Two RPP cultivars, Florigraze (Prine et al., 1981) and Arbrook (Prine et al., 1985), have been released for commercial use in Florida. There is now more than 10,000 ha in production of Florigraze in this state, and area planted has been increasing yearly.

Perennial peanut, as it is commonly known, has proven adaptable to periods of low rainfall and prefers well-drained soils. Most genotypes of RPP flower regularly. Their flowers can be pastel yellow or orange. It has wide ovate and lanceolate leaves usually with four leaflets. Accessions with forage potential are characterized by vigorous rhizome

growth and deep root systems. These characteristics enable the plant to mine a large volume of soil for both moisture and nutrients; thus, it tolerates dry periods and grows well in low-fertility soils (French and Prine, 1989). However, the vigorous dense rhizome growth contributes to a slow rate of establishment. In subtropical climates, where the growing season is only about six months, it often takes two to three years before full cover is achieved when no irrigation is provided. Newly planted rhizoma peanut is slow to exhibit lateral spread prior to the eighth week after planting (Valencia et al., 1997). Average percentage ground cover of 12 RPP accessions at Isabela was only about 70% at 24 weeks. Most of the accessions achieved full cover by 36 weeks postplanting. The length of time to full establishment of newly planted rhizomes is the principal limitation for commercial introduction of RPP. Therefore, the objective of this study was to determine the effect of distance between rows and method of weed control on the establishment of the most promising accessions of RPP under semiarid conditions.

MATERIALS AND METHODS

Rhizomes of RPP were evaluated for rate of establishment under irrigation during consecutive years at Lajas (E1) and Fortuna (E2) Substations of the Agricultural Experiment Station of the University of Puerto Rico. At both locations the RPPs were planted in a San Antón soil (fine-loamy, mixed, isohyperthermic Cumulic Haplustolls). Rhizomes were placed in rows, at a depth of 3 to 4 cm; soil was packed firmly on top of the rhizomes to enhance moisture retention.

Experiment 1:

Rhizomes of the cultivars Florigraze and Arbrook and four accessions (USDA-ARS no. 17033, 17050, 17052, and 17097; PI no. 276233, 262826, 262833, 262839, respectively) were planted 15 February 1995. The four accessions were selected from a group of RPPs previously evaluated at Isabela (Valencia, 1993), primarily for their superior dry matter yield. Experimental plots were 3.7×6.1 m, each containing two row pairs. Distance between parallel rows was 0.76 m, and between row pairs in the same plot 1.5 m. The RPPs were evaluated for lateral spread measured as percentage of ground cover (PGC) at 60, 120, 180, and 240 days postplanting. Area in weeds within the peanut stand was included in the PGC determination. All plots were treated with the broad spectrum preemergent herbicide metolachlor (1.0 kg ai/ha) after soil preparation was completed. In addition, plots were treated with paraquat (0.227 kg ai/ha) at 21 days postplanting and fluazifop-p-butyl (1.2 kg ai/ha) after each evaluation at 60, 120, 180, and 240 days. At

seven days postplanting, the equivalent of 136 kg/ha of fertilizer of the formula 0-10-20-10-10 (N-P-K-Mg-S) was applied to each plot.

Percentage ground cover of the stand was determined visually by using an eight-point scale; each point represented 12.5% of the area between rows covered by RPP plants. Within a plot, lateral spread was measured between rows (0.76 m) and row pairs (1.5 m). Weed density was estimated visually by using a 10-point scale (1 = 10%; 10 = 100%) and represented the percentage of the area between rows (0.76 m) covered by weeds. Peanut cultivars were assigned to whole plots arranged as a randomized complete block with four replications. Planting distances (0.76 and 1.5 m) were assigned to subplots. Evaluation time was used as a sub-sub plot. Thus, experimental data were analyzed according to a split-split-plot in time design of a Randomized Complete Block by using the Mixed procedure of SAS (Littell et al., 1991). Means were compared by Least Significant Difference (LSD) at the 0.05 probability level.

Experiment 2:

Rhizomes of accessions 17033 and 17097 and the cultivar Florigraze were planted on 25 February 1996, and subsequent plant growth was evaluated by using one of the following weed control methods: (1) manual control (hoeing), (2) mowing of the plot, and (3) chemical control. The three RPP genotypes by three control methods (nine treatment combinations) were replicated four times, and were randomly assigned to each of the nine plots within a block. Planting was as in E1 in plots measuring 6 × 5 m. Unlike in E1, in this experiment rows were all at the same distance (0.9 m) apart; and a 1.5-m alley separated plots. All plots were treated with preemergent herbicide (metolachlor, 1.0 kg ai/ha) followed by a second application of the same herbicide three weeks after planting. In this experiment, no fertilizer was applied prior to or after planting of the rhizomes. Manual control consisted of hoeing to remove weeds from each plot. This hoeing was done a few days after each application of herbicide in those plots receiving chemical weed control. In plots that were mowed for weed control, the mowing was done above the height of the peanut plant at 130, 170 and 210 d postplanting. Treatment 3 consisted of the application of the herbicides imazethapyr (0.043 kg ai/ha) and fluazifop-p-butyl (1.2 kg ai/ha) as needed (about 50, 130 and 170 d postplanting).

Plots were evaluated for area covered in peanut plants as a percentage of the sampling area at 80, 160 and 240 days postplanting by using methodology described by Toledo (1982). The evaluations were made in a one-meter square divided into 25 equal parts. Evaluations were made at one site, randomly selected, within each experimental plot. An eval-

uation of area covered by the peanut plants was made within each subdivision of the square. Experimental data were analyzed as split-plot in time (evaluation period) of a RCB design with four replications by least squares analysis of variance using the Mixed procedure of SAS (Littell et al., 1991).

RESULTS AND DISCUSSION

Experiment 1:

The time required for RPP to achieve full cover was influenced positively by planting distance (interaction between planting distance and time of evaluation, $P < 0.01$). At a distance of 0.76 m between rows, three-fourths cover was achieved prior to four months; and full plot cover was achieved six months after planting (Table 1). When rhizomes were planted 1.5 m apart, cover of three-fourths of the area was achieved at about six months postplanting, and it took 240 days to achieve full plot cover. The greatest cover between evaluations was achieved during the first 60 days postplanting (Table 2). At the 60-day evaluation, percentage ground cover was about a third (33.3%) of the area between rows (1.5 m). Subsequently ground covered by peanut plants increased by 24%, 16%, and 25% units from 60 to 120, 120 to 180 and 180 to 240 days postplanting, respectively.

The PGC of the plots increased ($P < 0.01$) with an increase in time postplanting. Percentage ground cover at 60, 120, 180 and 240 days postplanting, averaged for RPPs and planting distance, was 44, 68, 86, and 99%, respectively. Full establishment, across RPP and planting distance, was achieved at or near 240 days postplanting (Table 3). At 60 days postplanting, accessions 17050 and 17052 showed a tendency for a slower rate of establishment than accessions 17097, 17033, and cv

TABLE 1.—*Lateral spread of rhizoma perennial peanut stand, measured as percentage ground cover, when rows were planted 0.76 or 1.5 meters apart at 60-day intervals postplanting.*

	Days postplanting			
Planting distance (m)[1,2]	60	120	180	240
	---------- % ----------			
0.76	54[c]	79[b]	100[a]	100[a]
1.50	33[d]	57[c]	73[b]	97[a]

[1]Interaction between planting distance and days postplanting was significant, $P < 0.01$.

[2]Within the same row, means with different letters were significant, $P < 0.01$.

TABLE 2.—*Lateral spread of stand, measured as percentage ground cover, at 60, 120, 180 and 240 days postplanting of six rhizoma perennial peanut genotypes planted in rows 0.76 and 1.5 m apart.*

Days postplanting	Genotypes					
	17033	17050	17052	17097	Arbrook	Florigraze
	%					
0.76 m						
60	63	47	44	59	50	59
120	83	69	78	81	81	81
180	100	100	100	100	100	100
240	100	100	100	100	100	100
1.5 m						
60	41	28	28	34	31	38
120	63	44	56	59	59	59
180	78	66	69	72	75	78
240	100	94	100	100	100	91

Florigraze, even though the interaction between RPP genotype and time of evaluation was not significant ($P < 0.05$). The PGC among 17033, 17097 and Florigraze averaged 49% to only 37% cover for accessions 17050 and 17052 at 60 days postplanting.

At 120 days postplanting, PGC was similar among RPP genotypes and averaged 70% cover (Table 3). The slowest lateral spread was ob-

TABLE 3.—*Lateral spread of stand, measured as percentage ground cover (PGC), and percentage weed cover (PWC) of six rhizoma perennial peanut genotypes at 60-day intervals postplanting.*

Days postplanting	Genotypes					
	17033	17050	17052	17097	Arbrook	Florigraze
	%					
PGC						
60	52	38	36	47	41	48
120	72	56	67	70	70	70
180	89	83	84	86	88	89
240	100	97	100	100	100	95
PWC						
60	30	40	40	33	40	43
120	38	50	40	28	42	45
180	23	35	22	20	22	30
240	13	25	30	15	20	30

served for accession 17050, which covered only 56% of the plot. Accession 17050 appeared to have a slower initial rate of spread during establishment prior to 180 days postplanting. Nevertheless, time to full establishment was similar for all RPPs. For the short planting distance (0.76 m) full establishment was achieved at about 60 days earlier than for the longer distance (1.5 m). Furthermore, the interaction between planting distance and RPP genotype was not significantly different ($P < 0.05$).

Weed density in plots, averaged for the six RPPs, declined ($P < 0.01$) from 60 to 240 days postplanting. Mean weed cover at the 60- and 120-day evaluations was 38 and 40.5, respectively. It declined ($P < 0.01$) to 25 and 23% by the 180- and 240-day evaluations, respectively. No differences in percentage weed cover were observed among the six RPPs evaluated (Table 3). However, at the 240-day evaluation, plots with accessions 17033 and 17097 appeared to have less weed cover, averaging 11 and 13 fewer percentage units, respectively, than the average of the other four genotypes. Throughout the 240-day evaluation, plots of accessions 17033 and 17097 (averaged 27% weed cover) appeared to contain fewer weeds than those of 17050 and 17052 and Florigraze (averaged 36% weed cover). Accession 17033 had the tallest plants and accession 17097 had a denser growth and both had a tendency for rapid early growth. These characteristics are factors that could justify better competitiveness with weeds.

Experiment 2:

As expected, PGC of the plots (across weed control method and RPP genotype) increased ($P < 0.01$) with an increase in time postplanting. Percentage ground cover was 39, 60 and 86% at 80, 160 and 240 days postplanting, respectively. Application of herbicide was the most effective method of weed control during establishment ($P < 0.01$). It resulted in greater plot cover of the peanut plants. When averaged for RPPs and time of evaluation, herbicide use resulted in plots with 12% more cover than those receiving manual control of weeds (82 vs. 73% PGC). Both of the above mentioned methods were superior to periodic mowing of the plot, which had a mean of only 30% cover. Periodic mowing resulted in very slow cover of the plots at 80 and 160 days postplanting (Table 4).

The establishment of the peanut was affected ($P < 0.01$) by the interaction between method of weed control and time of evaluation. When the manual weed control method was used, PGC increased linearly as time of evaluation increased from 80 to 240 days postplanting (Table 4). Chemical control resulted in a faster establishment considering there were no significant differences in PGC between the 160- and 240-day evaluations. The use of mowing after an initial chemical treatment re-

TABLE 4.—*Percentage ground cover by rhizoma perennial peanut plants in plots under different weed control management, measured at three intervals postplanting.*

Days postplanting	Weed control method[1,2]		
	Mowing	Manual (hoe)	Chemical
	%		
80	12[a]	49[a]	56[b]
160	14[a]	75[b]	90[a]
240	63[b]	95[c]	99[a]

[1]Interaction between days postplanting and weed control method was significant, $P < 0.01$.

[2]Within the same column, means with different letters are significantly different at the 0.01 level.

sulted in very slow initial cover, being similar at 80 and 160 days postplanting and averaging only 13%. However, PGC increased rapidly (48% units) from 160 to 240 days. Over the same period, ground cover increased only by 20 and 9% units in plots receiving the manual and herbicide weed control treatments, respectively. Regardless of the slower rate of establishment and subsequent greater weed invasion observed in the plots receiving the periodic mowing treatment, full establishment of the peanut stand was achieved six to eight weeks after the last evaluation. This stand was accomplished by the application of herbicide (fluazifop-p-butyl) after 240 days postplanting. Periodic mowing of the plots is less labor intensive with lower use of resources and could be utilized to establish RPP in areas where extensive agriculture is practiced. Regardless of the treatment used to control weeds, an initial application of a preemergent herbicide, followed by a postemergence application two to four weeks postplanting, appears necessary for initial establishment.

Accessions and cultivars varied ($P < 0.05$) in the rate of establishment of the RPP stand. Plots in accession 17033 showed slower coverage averaging 52% cover compared to 67 and 65% for 17097 and Florigraze, respectively. The latter two had similar cover over the same time frame and method of weed control as seen in Table 5. No interaction between method of weed control and RPP genotype was observed. The slower rate of establishment of accession 17033 observed in this trial does not agree with results in E1. This disparity could be the result of the method of determining peanut cover used in this experiment. Accession 17033 grows taller and is less dense than the other two RPPs. This factor could have resulted in a lower estimation of cover by the evaluator for this accession than for accessions 17097 and cv. Florigraze, which have shorter and denser growth.

TABLE 5.—*Percentage ground cover by rhizoma peanut plants in plots of three rhizoma perennial peanut genotypes using herbicide for weed control, measured at three intervals postplanting.*

Days postplanting	Genotype[1]		
	17033	17097	Florigraze
	%		
80	40	58	68
160	90	90	91
240	98	100	100

[1]Interaction between days postplanting and RPP genotype was not significant, $P < 0.05$.

When only plots receiving the herbicide treatment (which proved to be the most efficient method of weed control) were evaluated (Table 5), differences among the RPPs seem to have been confined to those observed at the 80-day evaluation. At this stage, cover of the plots containing accession 17033 was considerably less than the cover of the other two. Ground cover at the 160- and 240-d evaluations was not different among them. By the 160-d evaluation, on average, 90% of the plots was covered by the rhizoma peanut plants, thus indicating that full establishment of the plots receiving chemical treatment was achieved closer to 160 than to 240 d postplanting.

The use of herbicides to control weeds was as effective as manual weeding in maintaining the growth and development of the RPP plants. Thus, since chemical control is less labor intensive, the use of herbicides is the recommended method of weed control during establishment of rhizoma peanut. Results confirm that the establishment of RPP is a slow process even under the best management conditions, particularly when compared to the establishment of a tropical grass. The time required to establish a tropical grass such as stargrass from stem cuttings in a well-prepared soil is only about four months (Vicente-Chandler et al., 1974). The longer establishment period can be a significant limitation to the rapid development of RPP farms necessary to support a hay production industry. Therefore, more research is needed in this area in order to devise management strategies effective in reducing time for full establishment of RPP stands relative to that of grass.

CONCLUSION

Increased distance between rows increased the time to full cover of the plots. At distances of 0.76 m (E1) and 0.91 m (E2), full cover of the

plots was achieved at about 180 days postplanting. Rapid establishment is important because it will increase farm income during the year of planting. This rapid cover could offset the additional seed and labor associated with closer planting distance. Increasing the distance between rows to 1.5 m increased the time to full establishment by about two months. Prior to 120 days postplanting, there was a tendency for accessions 17033 and 17097 to have faster lateral spread, which could be an advantage in reducing early weed interference as evidenced by the results of E1. All plant material achieved full cover at the same time. Early weed control management is essential for proper establishment of the stand. The use of herbicides regularly during establishment was the most effective method of establishing a RPP stand. Using two applications of herbicide, one at planting and another between six and eight months postplanting, and periodic mowing to prevent excessive shading of the peanut plants will result in slower establishment. However, full cover will be achieved with less use of herbicides and less use of manual labor. The implementation of such a system could be advantageous when the aim is to introduce RPP into an established grass stand under extensive grazing management.

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