Comparison of Virginia and Runner Market-Type Peanut (*Arachis hypogaea*) Grown in the Virginia-Carolina Production Region

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ABSTRACT

Research was conducted in North Carolina and Virginia from 1997 through 1999 to compare runner and virginia market-type peanuts as influenced by cultivar selection, fertility practices, and pest management strategies. The runner market-type cultivar Georgia Green yielded and provided gross market value equivalent to the virginia market-type cultivar NC-V11 under a wide range of edaphic and environmental conditions. Calcium (as gypsum) applied at initial pegging increased the percentage of extra large kernels, the percentage of total sound mature kernels, and market value (¢/kg) of the virginia market-type cultivar Gregory. The runner market-type cultivars Georgia Green and GK-7 were less responsive to calcium. Response of both market types was dependant upon environmental conditions. Pest management strategy affected pod yield, gross value, and economic return of peanut similarly for both virginia and runner market types. Results from these studies suggest that runner market-type peanut can provide pod yield, gross value, and economic returns similar to commonly grown virginia market-type peanut when grown in the Virginia-Carolina region. However, the peanut industry in the Virginia-Carolina region is designed for virginia market-type peanut used for the in-shell market, and popularity of growing runner market-type peanut in this region will most likely depend upon market pressures rather than agronomic potential.

Key Words: Calcium, economic return, integrated pest management, production system, soil fertility.

Historically, virginia market-type peanut (referred to as virginia peanut) in the U.S. has been grown almost exclusively in North Carolina and Virginia, a production region often referred to as the Virginia-Carolina (V-C) region (Smith and Simpson, 1995). However, significant plantings of virginia market-type peanut occur in west Texas (R. Lemon, Texas Agric. Ext. Ser., pers. commun.). Although runner market-type peanut (referred to as runner peanut) has been grown in this area periodically, production has encompassed only a small fraction of plantings. Runner peanut is grown in the southeastern and southwestern production areas of the U.S.

Changes in farm legislation in 1996 resulted in reductions of quota and price support and removal of the escalator provision (Brown, 1998). These changes caused growers to closely evaluate production costs and consider possible alternatives to traditional production systems. Some growers in the V-C area have expressed interest in growing runner peanut. Production costs associated with seeding and supplemental calcium applications during pegging are lower for runner than for virginia peanut. Higher seeding rates (kg/ha) for virginia peanut are required to establish the same plant population as runner peanut because seed for runner market-type peanut is smaller. Large-seeded virginia peanut has a greater calcium requirement than small-seeded runner peanut resulting in a greater need for supplemental calcium (Cox and Sholar, 1995).

Information regarding production of runner peanut in the V-C region is limited, and few studies have addressed newly released cultivars. The growing season in the V-C region is relatively short compared with southeastern states, and early maturity is critical when trying to avoid freeze damage. Evaluating yield potential of more recently released runner peanuts is important when determining the feasibility of growing these cultivars in the V-C region.

Management of diseases, insects, and weeds are three major costs associated with peanut production (Lynch and Mack, 1995; Sherwood *et al.*, 1995; Wilcut *et al.*, 1995). Cost of managing these pests is approximately 33% of total annual operating costs in North Carolina (Brown, 1998). The three major insect pests of peanut in the V-C area are tobacco thrips (*Frankliniella fusca* Hinds), southern corn rootworm (*Diabrotica undecimpunctata* Howardi), and twospotted spider mite (*Tetranycyhus urticae* Koch). Peanut growers in North Carolina spend approximately 9% of total operating costs on insect management (Brown, 1998).

Major diseases of peanut grown in North Carolina are early leaf spot (caused by *Cercospora arachidicola* Hori), Cylindrocladium black rot (CBR) [caused by *Cylindrocladium crotalarie* (Loos) Bell and Sobers], Sclerotinia blight (caused by *Sclerotinia minor* Jagger), rhizoctonia limb and pod rot (caused by *Rhizoctonia solani* Kuhn), and southern stem rot (caused by *Sclerotium rolfsii* Sacc.) (Bailey, 2000). Peanut growers in North Carolina spend approximately 14% of total operating costs on fumigants and fungicides to manage diseases (Brown, 1998). Expenditures vary considerably from year to year depending on fluctuations in weather. Weather-based advisories are used to schedule fungicide sprays for early and late leaf spots and Sclerotinia blight (Bailey, 2000). Long-term rotation with non-host crops also reduces disease severity; however, pesticide use is critical in maintaining yield in most fields. Fungicides

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are relatively effective in controlling most diseases except Sclerotinia blight (Bailey, 2000). Fumigation with metam sodium controls CBR in most situations but must be applied as a preventive treatment. Improved host-plant resistance is being developed for Sclerotinia blight, CBR, nematodes, and leaf spots (Sherwood *et al.*, 1995). However, the level of resistance found in commercially acceptable cultivars generally is not sufficient to prevent economic loss from these pests.

Digging requirement and relatively poor competition of peanut with weeds require effective season-long weed control to prevent yield loss (Wilcut *et al.*, 1995). A range of herbicides are available to control weeds found in North Carolina peanut fields, although herbicide programs can be expensive (Jordan and York, 2000). Economic threshold data for specific weed populations can be used in computer models to determine when herbicide use is economically justified (White and Coble, 1997). Peanut HERB has been successful in using the density of each weed species, projected yield loss, control cost, yield, and economic value to rank herbicide options (MacDonald *et al.*, 1998; Wilcut *et al.*, 1999). However, few cooperative extension personnel, consultants, or growers are currently using Peanut HERB in the V-C region.

Integrated pest management (IPM) strategies can reduce pest management costs for peanut production in the V-C region by $50 to $125/ha (Mueller and Linker, 1999). A better understanding of the complexities and interactions among pests, pest control tactics, and production systems comparing runner and virginia peanut is important in determining utility of runner peanut in the V-C region.

Because of changes in federal legislation reducing farmer stock value of peanut, there is an increased need to develop and implement pest management strategies that are less expensive while maintaining yield and quality. Uncertainty of future farm legislation and concern about long-term profitability of peanut production in the V-C region has increased the need to explore alternatives to traditional production systems. Since production of runner peanut requires less input costs, research was conducted in North Carolina and Virginia to evaluate pod yield and gross economic value of the runner peanut cultivars Georgia Green and GK-7 compared with virginia peanut. In these studies, peanut response to supplemental calcium and pest management strategies were evaluated.

Materials and Methods

Comparison of Peanut Cultivars. Experiments were conducted in North Carolina at four locations in 1997, five locations in 1998, and four locations in 1999. The experiment was conducted also at three locations in Virginia during 1997 and 1998. Peanut was planted on sandy loam and loamy sand soils in early to mid-May in conventionally prepared seedbeds at 90 kg/ha for the runner peanut cultivars Georgia Green and GK-7 and 130 kg/ha for the virginia peanut cultivars NC-V 11 and VA-C 92R. These cultivars are among the most commonly grown cultivars in the Southeastern U.S. and the V-C region, respectively (J. Beasley, Georgia Coop. Ext. Ser., pers. commun.; Spears, 2000). Cultural and pest management practices were based on Cooperative Extension Service recommendations for the region. Plot size was two rows (0.9 m spacing) by 10 to 15 m in length.

Cultivars were dug on the same day at each location. A composite sample for each cultivar was combined from each replication and used to determine the percentage of extra large kernels (% ELK) (virginia peanut), the percentage of sound mature kernels (% SMK), the percentage of total SMK (% TSMK), and the percentage of other kernels (% OK). Economic value per kg farmer stock peanut and gross economic value per hectare (referred to as gross value) were determined based on market grade factors and pod yield.

The design for each experiment was a randomized complete block with four replications. Means from each experiment for pod yield and gross value were considered as replications and used in the pooled analysis. Percentages of both maximum yield and maximum gross value relative to the cultivar with the highest yield or gross value in each experiment were determined. Means for pod yield, gross value, percentage of maximum yield, and percentage of maximum gross value were separated using Fisher's Protected LSD test at $P = 0.05$.

Cultivar Response to Calcium. Experiments were conducted from 1997 through 1999 at the Peanut Belt Research Station located near Lewiston, NC and in 1998 and 1999 at the Upper Coastal Plain Research Station located near Rocky Mount, NC. Soil at Lewiston was a Norfolk sandy loam (fine-loamy, siliceous, thermic Aquic Paleudalts) and soil at Rocky Mount was a Goldsboro sandy loam soil (fine-loamy, siliceous, thermic Aquic Paleudalts). The virginia peanut cultivar Gregory was seeded at 130 kg/ha and the runner peanut cultivars Georgia Green and GK-7 were seeded at 90 kg/ha in conventionally prepared seedbeds.

Calcium (85% calcium sulfate, USG Ben Franklin, U.S. Gypsum Company, Chicago, IL) was applied in late June during flowering and initial pegging on a 30-cm band over peanut rows (spacing of 0.9 m). The calcium sulfate rates were 340 and 680 kg/ha. A no-calcium control was included also for each cultivar. Pod yield, % ELK, % SMK, % TSMK, % OK, market value (¢/kg), and gross value were determined for each treatment and replication. Soil cores at a depth of 7 cm were collected from each plot 2 wk after calcium was applied and were analyzed for potassium, calcium, magnesium, base saturation, pH, cation exchange capacity, and organic matter content using North Carolina Dept. of Agric. and Consumer Serv. guidelines (Tucker *et al.*, 1997).

The experimental design was a randomized complete block with four replications. Data were subjected to analyses of variance with basic partitioning for a three (cultivar) by three (calcium rate) factorial treatment arrangement. Means of significant main affects and interactions were separated using Fisher's Protected LSD Test at $P = 0.05$.

Pest and Fertility Management. Experiments were conducted during 1997 and 1998 at the Upper Coastal Plain Research Station located near Rocky Mount, NC, in 1997 on a private farm located near Oak City, NC, and in 1998 at the Peanut Belt Research Station located near Lewiston, NC. Soils were a Norfolk sandy loam at Lewiston and Oak City and a Goldsboro sandy loam at Rocky Mount. Peanut was planted in conventionally tilled fields on beds. Plot size was four rows (0.9 m spacing) by 15 m long.

The cultivars NC 7 (virginia peanut) and GK-7 were planted at Oak City. The cultivars NC 10C (virginia peanut) and GK-7 were planted during both years at Rocky Mount while the cultivars NC 12C (virginia peanut) and Georgia Green were planted at Lewiston. Virginia peanut cultivars were seeded at 130 kg/ha and runner peanut cultivars were seeded at 90 kg/ha during the first 2 wk of May.

Treatments were arranged factorially with two levels of pest and fertility management (maximum input approach and conservative input approach) for management of disease, insects, and weeds and application of supplemental calcium and two levels of peanut market-type (virginia and runner peanut). Supplemental calcium (USG Ben Franklin) at 680 kg/ha was applied to the virginia market types regardless of the input approach. Supplemental calcium at 340 kg/ha was applied to runner peanut when the input approach was defined as maximum. Supplemental calcium at this rate was not applied to runner peanut in the conservative input approach. Soil test recommendations for supplemental calcium for runner peanut, based on soil pH, soil calcium level, and ratio of calcium to potassium, indicated that additional calcium was not needed (Jordan, 2000).

The maximum input approach was composed of aldicarb [2-methyl-2-(methylthio)propionaldehyde] applied in-furrow at 1.2 kg ai/ha for tobacco thrips control and chlorpyrifos [*o,o*-diethyl*o*-(3,5,6-trichloro-2-pyridinyl) phyosphorothioate] at 2.5 kg ai/ha applied at pegging for southern corn rootworm control (Table 1). Fungicides were applied to control foliar and soil-borne diseases beginning in late June followed with biweekly applications thereafter in this approach. Chlorothalonil (tetrachloroisophtalonitrile) was applied at 1.1 kg ai/ha from late June through mid-July. From mid-July through late August in 1997, 1.1 kg/ha chlorothalonil + 0.31 kg ai/ha flutolanil {*N*-[3-(1-methylethoxy)-phenyl]-2-(trifluoroethyl)-benzamide} were applied. In 1998, 0.23 kg ai/ha tebuconazole {μ-[2-[(4-chlorophenyl)-ethyl]-μ-(1,1-dimethylethyl)} was used for these sprays. A final spray of chlorothalonil at 1.1 kg/ha was applied in September. When field histories suggested that Sclerotinia blight was present, iprodione [3-(3,5-dichlorophenyl)-*N*-(1-methylethyl)-2,4-dioxo-1-imidazolidinecarboxamide] at 1.1 kg ai/ha was applied in late July. Metam sodium at 38 L/ha was applied 2 wk before planting in the maximum input approach at Lewiston and Oak City. Greater emphasis was placed on prophylactic preemergence and ground cracking herbicide applications in the maximum input approach (Wilcut *et al.*, 1995). Additional postemergence herbicides were applied when target species were observed, but not based on economic thresholds. All plots received the same herbicide treatment regardless of weed population.

The conservative input approach involved scouting for insects, weeds, and diseases or the damage caused by these pests using available information on economic thresholds, field histories, or available weather-based advisories (Johnson *et al.*, 1985; Linker *et al.*, 1991; Herbert, 1999; Bailey, 2000). The Peanut HERB model was used to target postemergence herbicide applications for individual plots (White and Coble, 1997; Jordan and York, 2000). Weed densities were determined in early June and mid-July during both years, and in early August during 1997. Economic thresholds were used to target postemergence application of acephate (*O,S*-dimethylacetylphosphoramidothioate) at 1.1 kg ai/ha to control tobacco thrips based on a threshold of 25% leaflet damage during the first month after planting in the conservative input approach (Herbert, 1999). Fall armyworm, *Spodoptera frugipera* (J.E. Smith) and corn earworm [*Helicoverpa zea* (Boddie)] populations did not reach thresholds of 13 larvae/m row (Herbert, 1999). The decision to apply chlorpyrifos (2.5 kg/ha) at pegging to control southern corn rootworm in the conservative input approach was based on the Southern Corn Rootworm Index (Herbert *et al.*, 1997). This index ranks fields into categories of low, moderate, and high risk of damage from southern corn rootworm based on planting date, cultivar selection, soil drainage characteristics, soil texture, field history relative to presence of southern corn rootworm, and irrigation. Field history at Rocky Mount suggested that no CBR was present while field history at Lewiston and Oak City suggested 10% or less CBR damage during the previous peanut crop in those fields. Therefore, fumigation was not included in the conservative approach. Weather-based advisories were used to schedule fungicide sprays to control foliar diseases, southern stem rot, rhizoctonia limb and pod rot, and Sclerotinia blight in the conservative input approach (Bailey, 2000).

Table 1. Pest management inputs for four experiments conducted in North Carolina peanut fields in 1997 and 1998 evaluating pest management strategies in virginia and runner market types.

Pest and fertility	Rocky Mount		Oak City	Lewiston
management	1997	1998	1997	1998
Maximum	ALD	ALD	MET	MET/RVAR
	CHLOR	CHLOR	CHLOR	CHLOR
	CAL	CAL	CAL	CAL
	IPR	SCVA	IPR	IPR
	SCVA	SCRU	SCVA	SCVA
	SCRU	PROP	PROP	PROP
	PROP			
Conservative	ACE	ACE	ACE	RVAR
	CHLOR	CHLOR	CHLOR	ACE
	WBA	WBA	WBA	WBA
	HERB	HERB	HERB	HERB
	SCVA	SCVA	SCVA	SCVA

[a]Abbreviations: ALD, aldicarb applied in-furrow; ACE, acephate applied postemergence; CAL, fungicides applied biweekly; CHLOR, chlorpyrifos applied for southern corn rootworm; HERB, Peanut HERB for weed management based on economic thresholds; IPR, iprodione applied for Sclerotinia blight suppression; MET, fumigated with metam sodium; PROP, prophylactic herbicide applications; RVAR, resistant variety; SCVA, supplemental calcium at 680 kg/ha applied to virginia market types; SCRU, supplemental calcium at 340 kg/ha applied to runner market types; WBA, weather-based advisories to schedule fungicide sprays.

The percentage of leaflets damaged by tobacco thrips was recorded 1 and 3 wk after peanut emergence in the center two rows of each plot. With respect to early and late leaf spot, the percentage of leaflets with one or more spots was recorded in early September. Infection and damage by southern stem rot or rhizoctonia was not documented in these experiments. Damage caused by Sclerotinia blight was determined in mid-July and at harvest by counting the number of 0.3-m spaces with disease present in the center two rows of each plot. Damage caused by CBR was determined in mid-September based on the procedure used for

Sclerotinia blight. In both instances, the percentage of diseased plants was calculated based on actual counts. Twenty-five pods per plot in 1997 or 100 pods per plot in 1998 were randomly removed in early September to determine the percentage of pods damaged by southern corn rootworm and used to calculate the percentage of damaged pods. The percentage of plants showing damage from the twospotted spider mite was recorded in late August on a scale of 0 to 100% where 0 = no foliage damage to 100 = all foliage expressing damage from this pest.

Peanut was harvested using conventional harvesting equipment in early to mid-October. Five hundred g of pods were collected at harvest from each plot to determine % ELK, % SMK, % TSMK, % OK, and market value as described previously. Economic value per kg farmer stock peanut was determined based on market grade characteristics. Gross value ($/ha) was determined based on the combination of market grade factors and pod yield. Gross returns reflect the current quota price of $0.75/kg (Brown, 1998). Estimated economic return (referred to as economic return) was calculated as the difference between gross economic value and total operating, interest, ownership, and labor costs using a budget developed by Brown (1998). Cost of all production practices other than those used for disease, insect, and weed management and seed and supplemental calcium were held constant at $1235/ha (Table 2). Average costs of fungicides, fumigant, insecticides, herbicides, seed,

Table 2. Variable costs associated with pest and fertility management in peanut.

Market type	Pest and fertility management	Rocky Mount 1997	Rocky Mount 1998	Oak City 1997	Lewiston 1998
		---- $/ha ----		$/ha	$/ha
Runner	Conservative	403	410	422	395
Runner	Maximum	788	580	699	642
Virginia	Conservative	514	543	605	509
Virginia	Maximum	902	679	798	744

and supplemental calcium were based on prices quoted by two major agribusiness organizations in northeastern North Carolina.

The experimental design was a split plot with four replications. Conservative and maximum input approaches served as whole plots and cultivars (virginia and runner peanut) served as subplots. Data for peanut foliage and pod damage, pod yield, market grade factors, gross value, and economic returns were subjected to analyses of variance appropriate for the factorial treatment arrangement. Means for appropriate main effects and interactions were separated using Fisher's Protected LSD Test at P = 0.05.

Results and Discussion

Comparison of Peanut Cultivars. No differences in actual pod yield or gross value were noted among virginia and runner peanut (Table 3). However, when calculated as the percentage of maximum yield, the cultivars NC-V11 and Georgia Green averaged 93 and 95%, respectively, when pooled over the 16 experiments (Table 3). These respective cultivars averaged 91 and 96% of maximum gross value. Although percentages of maximum pod yield and gross value for VA-C 92R did not differ from that of NC-V11, these parameters were lower for VA-C 92R than for Georgia Green. GK-7 had lower percentages of maximum yield and gross value than Georgia Green. These data suggest that the runner peanut cultivar Georgia Green provides pod yield and gross economic returns equal to or greater than two of the most popular virginia peanut cultivars grown in the V-C area.

Table 3. Pod yield and gross value of runner and virginia market-type peanuts[a].

Cultivar	Pod yield	Gross value	Maximum yield: Pod yield	Maximum yield: Gross value
	kg/ha	$/ha	---------%	--------
Georgia Green	4090 a	2944 a	95 a	96 a
GK-7	3720 a	2580 a	86 c	85 b
NC-V11	4030 a	2790 a	93 ab	91 ab
VA-C 92R	3830 a	2612 a	88 bc	85 b

[a]Means within a parameter followed by the same letter are not significantly different according to Fisher's Protected LSD test at P = 0.05. Data are pooled over 16 experiments where individual experiments were considered as replications.

Cultivar Response to Calcium. The interaction of experiment by cultivar by calcium rate was not significant for pod yield or gross value. However, interactions of experiment by calcium rate and experiment by cultivar were significant for these parameters. Additionally, the interaction of cultivar by calcium rate was significant for gross value, but not for pod yield. The interaction of experiment by cultivar by calcium rate was significant for the % TSMK and market value (¢/kg).

Variation in pod yield and gross value were noted for the cultivars in each experiment (Table 4). In four of five experiments, Georgia Green provided yield and gross value equal to or greater than the other cultivars. Lower yield and gross value of the cultivar Gregory at Lewiston in 1997 can be attributed to dry conditions during pegging and pod fill. Gregory is a large-seeded virginia peanut which requires a higher level of moisture for pod fill and development when compared to smaller-seeded runner peanut cultivars. Differences in yield and gross value noted among cultivars in the remaining experiments is more difficult to explain. Cultivars were dug on the same day, and this may have favored one cultivar over another, given that differences in maturity exist among these cultivars. The cultivars NC-V11 and VA-C 92R are among the latest maturing virginia market-type cultivars. Although not substantiated in these studies, optimum maturity of Georgia Green and GK-7 most likely occurred several days to a week after optimum maturity of the virginia market types. In 1998 at Lewiston, soil moisture and temperatures were adequate throughout the season for normal maturation, and this may have allowed the runner peanut cultivars, which are considered later maturing than most virginia peanut cultivars, to reach maturity by the digging date. While heat unit accumulation was adequate at Rocky Mount in 1998 (data not shown), soil moisture was limiting during pod fill. This may have resulted in lower yield for the cultivar Gregory due to limited pod fill. Also, lower yield by the cultivar GK-7 at this location during 1998 may have been associated with later maturity than the cultivar Georgia Green. Preliminary studies evaluating pod mesocarp color determination of maturity suggests that Georgia Green may reach optimum maturity more quickly than GK-7 (Jordan, 1998). At Lewiston in 1999, rainfall was excessive throughout late summer and fall, and this experiment was planted on the lower end of the field.

Table 4. Influence of environment and cultivar on pod yield and gross value of peanut[a].

Cultivar	Lewiston 1997	Lewiston 1998	Lewiston 1999	Rocky Mount 1998	Rocky Mount 1999
Pod yield		kg/ha		kg/ha	
Gregory	3130 b	6070 a	5470 a	4850 b	4910 b
Georgia Green	3470 a	5860 a	5100 b	5300 a	5450 a
GK-7	3570 a	5930 a	4530 c	4950 b	4940 b
Gross value		$/ha		$/ha	
Gregory	1884 b	4664 a	3607 a	3232 c	3092 b
Georgia Green	2317 a	4415 b	3313 b	3922 a	3582 a
GK-7	2274 a	4372 b	2895 c	3665 b	3100 b

[a]Data are pooled over calcium rates. Means within a year and location followed by the same letter are not significantly different according to Fisher's Protected LSD test at P = 0.05.

Maturation of peanut was slowed during this prolonged wet period which may have resulted in lower yields for the later maturing GK-7.

Supplemental calcium affected pod yield in two of five experiments (Table 5). At Lewiston in both 1997 and 1999, applying calcium at 680 kg/ha increased yield over peanut grown without calcium. Pod yield was similar when calcium was applied at 340 or 680 kg/ha. In contrast, there was no yield response to calcium rate at Lewiston in 1998 or at Rocky Mount during either year. Calcium rate affected market value at Rocky Mount in 1999 and at Lewiston in 1997 and 1999. At Lewiston during these years, there was no difference between the 340 kg/ha rate and the 680 kg/ha rate, whereas the higher rate was needed for maximum gross value at Rocky Mount. No difference in gross value was noted in 1998 at either location. In 1998, soil moisture was adequate for normal plant growth throughout the season at both locations, and this may partially explain lack of response to calcium. However, rainfall at Lewiston in 1997 during July and August was less than 2 cm (data not shown), and this may explain the positive response to calcium. Virginia peanut often respond to calcium, especially under dry soil conditions (Gascho and Davis, 1995). Although rainfall was not limiting in 1999 at Lewiston or Rocky Mount in July and early August, both locations received above-average rainfall from late August through September (data not shown). Excessive rainfall may have leached calcium from the pegging zone resulting in differential response to calcium (Gascho and Davis, 1995).

In the experiments where calcium increased gross value of peanut (Lewiston and Rocky Mount in 1999), applying calcium increased the concentration of calcium in the soil 2 wk after application (Table 5). Although one would expect the level of calcium to increase after application, this was not the case when soil was sampled 2 wk after application at the other locations. Peanut response to calcium is rather complex. Soil moisture affects the amount of calcium in soil solution which in turn moves by mass flow into developing pegs. More intensive soil

Table 5. Influence of environment and supplemental calcium on pod yield and gross value of peanut[a].

Calcium rate[b]	Lewiston 1997	Lewiston 1998	Lewiston 1999	Rocky Mount 1998	Rocky Mount 1999
Pod yield		kg/ha		kg/ha	
0	3020 b	6000 a	4800 b	5100 a	5040 a
340	3480 ab	5870 a	5140 ab	4980 a	4970 a
680	3670 a	5980 a	5510 a	5050 a	5290 a
Gross value		kg/ha		kg/ha	
0	1819 b	4472 a	3045 b	3637 a	3103 b
340	2268 a	4453 a	3404 a	3592 a	3167 b
680	2390 a	4506 a	3365 a	3660 a	3504 a
Soil calcium[c]		ppm		ppm	
0	---	908 a	1116 b	697 a	656 b
340	---	907 a	1159 b	699 a	711 a
680	---	920 a	1208 a	704 a	733 a

[a]Data are pooled over cultivars. Means within a year and location followed by the same letter are not significantly different according to Fisher's Protected LSD test at P = 0.05.

[b]Applied as USG Ben Franklin landplaster at initial pegging.

[c]Soil samples taken 2 wk after calcium application. Soil samples were not taken at Lewiston in 1997.

sampling at greater depths may have increased our understanding of the response noted in these studies.

While the interaction of experiment by calcium rate suggests that virginia and runner market types respond to supplemental calcium, the significant interaction of cultivar by calcium rate suggests that virginia market types are more responsive than runner market types with respect to gross value (Table 6). When pooled over experiments, gross value of the large-seeded virginia cultivar Gregory was affected by calcium rate while the runner peanut cultivars Georgia Green and GK-7 were not. Increasing the rate of calcium increased market value of Gregory but did not affect runner peanut. These results are consistent with the recommended production practices for these cultivars. Calcium application at initial pegging is recommended for all virginia market types while runner market types are often grown without supplemental calcium (Cox and Sholar, 1995). Exceptions to this recommendation for runner market types are when cultivars are grown for seed or when soil levels of calcium and pH are low and/or the potassium concentration is relatively high when compared with the calcium concentration. In our study, the ratio of calcium to potassium was at least 6 to 1 when comparing meq element/100 cm^3, pH ranged from 5.9 to 6.1, and soil calcium ranged from 656 to 1116 ppm in the no-calcium control (Table 7). These data suggest that supplemental calcium is needed for virginia peanut even though soil calcium levels were as high as 1116 ppm.

Table 6. Influence of cultivar and supplemental calcium on pod yield of peanut[a].

Cultivar	Calcium rate[b]	Gross value
	kg/ha	$/ha
Gregory	0	2970 e
Gregory	340	3180 d
Gregory	680	3360 a
Georgia Green	0	3470 bc
Georgia Green	340	3531 ab
Georgia Green	680	3431 bc
GK-7	0	3190 d
GK-7	340	3292 cd
GK-7	680	3283 cd

[a]Data are pooled over experiments. Means followed by the same letter are not significantly different according to Fisher's Protected LSD test at P = 0.05.

[b]Applied as USG Ben Franklin landplaster at initial pegging.

Table 7. Nutrient levels, pH, base saturation, and cation exchange capacity taken from the no-calcium control[a].

Year	K	Ca	Mg	Ca/K ratio	Ca	pH	CEC	BS	OMC
	-- meq/100 cm^3 --				ppm		cmol$_c$/kg	%	g/100 cm^3
				Lewiston					
1998	0.30	3.89	0.92	13:1	908	5.9	6.13	84.2	1.15
1999	0.24	4.90	0.65	20:1	1116	5.9	6.72	86.3	1.58
				Rocky Mount					
1998	0.49	3.09	0.92	6:1	696	5.9	5.19	87.0	1.07
1999	0.35	2.79	0.67	7:1	656	6.1	4.33	86.1	0.48

[a]Abbreviations: K, potassium; Ca, calcium; Mg, magnesium; CEC, cation exchange capacity; BS, base saturation; OMC, organic matter content. Samples taken from no-calcium control. Samples were not taken at Lewiston in 1997.

Differences in the % ELK and % TSMK most likely contributed to differences in gross value among cultivars and calcium rates. Applying calcium at 340 or 680 kg/ha increased the % ELK from 40% when calcium was not applied to 46 and 51%, respectively (data not presented). Variation in the % TSMK was noted among experiments. Supplemental calcium increased the % TSMK in all experiments for the cultivar Gregory (Table 8). As mentioned previously, Gregory is large seeded and requires supplemental calcium for normal pod fill and maturation (Jordan, 2000). In contrast, the % TSMK was similar regardless of calcium rate in all experiments for Georgia Green and in all but one experiment for GK-7 (Rocky Mount in 1999) (Table 8). Differences in market value (¢/kg) for the cultivar/calcium rate combinations closely resembled differences in % TSMK (data not presented).

Pest and Fertility Management. There was no difference among pest infestation, pod yield, gross value, or economic return at Oak City in 1997 or at Rocky Mount in 1998 (data not presented). In contrast, pest and fertility management approaches did influence these parameters at Rocky Mount in 1997 and Lewiston in 1998. When pooled over market types, economic return at Rocky Mount in 1997 in the maximum input approach decreased compared with the conservative approach by 825 $/ha (data not shown). The decrease in economic return most likely was associated with twospotted spider mite damage resulting from the intensive disease management program in the maximum input approach. Twospotted spider mite damage was 61% when fungicides were sprayed biweekly compared to only 16% when applied based on weather-based advisories (data not shown). Other research has shown elevated levels of spider mite populations when fungicides are applied routinely under dry conditions (Brandenburg, 2000). Six fungicide applications were made in the maximum input approach compared with only two applications when based on the weather-based advisory in the conservative approach (data not presented). The decrease in yield coupled with the added expense of three additional sprays for leaf spot and one spray for Sclerotinia blight control resulted in the loss of 825 $/ha compared with the less pesticide intensive, conservative approach.

Table 8. Influence of cultivar and calcium on percentage of sound mature kernels[a].

Cultivar	Calcium rate[b]	Lewiston 1997	Lewiston 1998	Lewiston 1999	Rocky Mount 1998	Rocky Mount 1999
	kg/ha	%			%	
Gregory	0	45 d	73 c	63 c	64 c	58 d
Gregory	340	61 c	78 a	67 ab	68 b	62 c
Gregory	680	64 b	78 a	68 a	68 b	66 b
Georgia Green	0	68 a	78 a	64 bc	76 a	68 a
Georgia Green	340	69 a	78 a	66 ab	76 a	67 ab
Georgia Green	680	67 ab	76 ab	66 ab	76 a	69 a
GK-7	0	64 b	76 ab	67 ab	75 a	62 c
GK-7	340	65 b	76 ab	65 bc	76 a	66 b
GK-7	680	64 b	74 bc	65 bc	76 a	66 b

[a]Data are pooled over experiments. Means followed by the same letter are not significantly different according to Fisher's Protected LSD test at P = 0.05.

[b]Applied as USG Ben Franklin landplaster at initial pegging.

In contrast to results at Rocky Mount in 1997, estimated economic return was greater in the maximum input approach rather than conservative approach by 1,284 $/ha (data not presented). No differences in tobacco thrips, weed, leaf spot, CBR, or tomato spotted wilt virus control were noted among production/pest management approaches (data not presented). However, pod damage from southern corn rootworm was 39% when chlorpyrifos was not applied (conservative approach) compared with 2% when chlorpyrifos was applied in the maximum input approach (data not presented). Although the Southern Corn Rootworm Index suggested that chlorpyrifos was not needed, these data suggest that considerable pod damage occurred and that the resulting loss in yield and economic value most likely was associated with damage from this pest. Because conditions were relatively dry at this location, peanut was irrigated late in the season (August and September) while the decision to apply chlorpyrifos was made much earlier in the season. Irrigation most likely created an environment favorable for development and survival of southern corn rootworm. These results suggest that irrigation must be considered when utilizing the index regardless of other factors. Although southern stem rot incidence was not documented in these studies, it is possible that chlorpyrifos reduced yield loss associated with southern stem rot (Melouk and Backman, 1995).

Collectively, results from these studies suggest that the runner peanut cultivar Georgia Green performed as well as the virginia peanut cultivars NC-V11 and VA-C 92R, and that response to pest management was similar for both market types. Although savings were noted for cost of seed and supplemental calcium for runner market types, these inputs did not appear to have a major impact on yield or economic returns when comparing among market types. As expected, the large-seeded virginia market type cultivar Gregory was more responsive to supplemental calcium than smaller seeded runner market types. Acceptance of runner peanut in the V-C region most likely will be driven by market forces even though these data suggest that runner peanut present a successful alternative to current production systems.

Acknowledgments

Funding for these studies was provided through the North Carolina Peanut Growers Assoc. Inc., the Rural Advancement Foundation Int.-USA through the Peanut Project, and the Peanut CRSP, USAID grant no. LAG-G-00-96-90013-00. Appreciation is expressed to Ray Gardner, Donald Madre, H and S Farms, Gillam Farming, Ed Nixon, Wilbur Ward, Jimmy Worsley, Chowan Farms, the Upper Coastal Plain Res. Sta., the Peanut Belt Res. Sta., and the Tidewater Agric. Res. and Ext. Center for assistance with these studies. Dewayne Johnson, Carl Murphy, Brenda Penny, Virginia Curtis, Bryan Royals, David Horton, Gail White, Michael Williams, Lewis Smith, Billy Griffin, Michael Shaw, Arthur Whitehead, Wayne Nixon, Scott Marlow, Wayne Nixon, and Charlie Tyson provided technical support. Runner market types were provided by FF&M, Golden Peanut Co., and Georgia Coop. Ext. Serv. Keel Peanut Co. provided seed for the cultivars VA-C 92R, NC-V11, and Gregory.

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