EFFECTS OF MINERAL NUTRITION ON INTER- AND INTRASPECIFIC INTERFERENCE OF PEANUT (*Arachis hypogaea* L.) AND HAIRY BEGGARTICKS (*Bidens pilosa* L.)

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SUMMARY

*The present work was carried out to study the effects of mineral nutrition on peanut (*Arachis hypogaea *L) cv. IAC Runner-886 and hairy beggarticks (*Bidens pilosa *L.) growth, when submitted to inter- and intraspecific competition. The treatments consisted of two peanut plants per pot, two hairy beggarticks per pot and one plant of each species per pot. The plants were nourished with Hoagland and Arnon (1950) complete solution, or without potassium, or without phosphorus or without nitrogen. Sixty days after planting, no inter- or intraspecific competition effect on growth characteristics of peanut was verified and nutrition was not a limiting factor to the culture. No interaction between competition and nutrition effects was observed for both species. The weed suffered more negative effects from intraspecific competition and nutrition. The absence of N had a pronounced effect compared to the other elements, resulting in a reduction in all the evaluated characteristics. The deficiency of nutrients and competition affected the weed more than the crop, showing that peanut was more competitive than hairy beggarticks.*

Introduction

The interference of weeds represents the sum of interactions between plants, including competition and alellopathy (Rizzardi *et al*., 2001). It is necessary to understand the effects of each individual component of interference in order to evaluate the best strategy for weed management (Bozsa and Oliver, 1993). In the case of peanut, cv. Runner IAC 886, weed interference can reduce yield by more than 80% (Nepomuceno *et al*., 2007; Dias *et al*., 2009).

The level of interference can be ascertained when plants of the same species (intraspecific) or from different species (interspecific) suffer morphological and/or physiological modifications, beneficial or malefic, originating from mutual coexistence. The level of this interference can depend on planting density, spacing, specific composition and distribution of plants that cohabit the same environment, among other factors (Pitelli *et al*., 1981; Dias *et al*., 2009). Clark (1971) reasoned that the more physiologically similar two species are, the more similar their need for resources and the more intense will be the interspecific competition.

Among the factors that increase the level of interference between crop and weed, nutrients, principally nitrogen, phosphorus and potassium, are among the most important. However, the lack of studies related to mineral nutrition on weeds present in Brazilian crops hinders the understanding of nutritional interference factors between culture and weeds (Procópio *et al*., 2004). According to Marschner (1995), mineral nutrition can influence the growth and the yield of crops, causing secondary modifications on growth, morphology, anatomy and chemical composition.

The importance of weed species on the level of interference is relevant because different species present a great variation on their capacity for recruitment of environmental resources, varying in form and intensity of interference on the peanut culture (Pitelli *et al*., 1981). Hairy beggarticks (*Bidens pilosa* L.) is one of the most damaging weeds found in annual and perennial crops grown in South Central Brazil (Lorenzi, 2000), including peanut and crops that succeed sugarcane and no-till soybean in the State of Minas Gerais. Hairy beggarticks can produce high levels of nutrient extraction from the soil and therefore could reduce crop yield (Catunda *et al*., 2006). Knowledge of the biological aspects is fundamental, specially growth, nutritional requirements and responses to environmental changes, among others (Bianco *et al*., 2005).

Research addressing the nutritional requirements of crops and weeds under interference conditions is needed in order to develop strategies of the soil nutritional state and fertilizer management aimed at increasing the competitive advantage of the crop with the weeds. The present work was carried out to study the effects of mineral nutrition on peanut (*Arachis hypogaea* L) 'IAC Runner-886' and hairy beggarticks (*Bidens pilosa* L.) growth, when submitted to inter- and intraspecific competition.

Materials and Methods

The experiment was conducted from December 2007 to February 2008, in a green-

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EFECTOS DE LA NUTRICIÓN MINERAL EN LA COMPETENCIA INTER- E INTRAESPECÍFICA DE MANÍ (*Arachis hypogaea* L.) Y AMOR SECO (*Bidens pilosa* L.)

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RESUMEN

*El presente trabajo se llevó a cabo para investigar los efectos de la nutrición mineral en el crecimiento de maní (*Arachis hypogaea *L.) cv. 'Runner IAC-886' y amor seco (*Bidens pilosa *L.) cuando se somete a la competencia inter- e intraespecífica. Los tratamientos consistieron en dos plantas de maní por maceta, dos de amor seco por maceta y una planta de cada especie por maceta. Las plantas fueron regadas con solución completa de Hoagland y Arnon (1950), o sin potasio, o sin fósforo o sin nitrógeno. Sesenta días después de la siembra, el crecimiento del maní no mostró efectos a los tratamientos de competencia inter- e intraespecífica ni a los de los de nutrición. Por el contrario, el crecimiento de la maleza mostró una respuesta negativa a la competencia intraespecífica y a las deficiencias nutricionales. No se observaron interacciones entre los tratamientos. La ausencia de N en la solución fue la que tuvo el efecto más pronunciado en comparación con los otros elementos, resultando en la reducción en todas las características evaluadas. El maní fue más competitivo que amor seco en condiciones de deficiencias nutricionales.*

EFEITOS DA NUTRIÇÃO MINERAL NA COMPETIÇÃO INTER- E INTRAESPECÍFICA DE AMENDOIM (*Arachis hypogaea* L.) E PICÃO PRETO (*Bidens pilosa* L.)

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RESUMO

*O presente trabalho foi realizado para investigar os efeitos da nutrição mineral no crescimento de amendoim (*Arachis hypogaea *L.) cv. 'Runner IAC-886' e picão preto (*Bidens pilosa *L.) quando se submete à competição inter- e intraespecífica. Os tratamentos consistiram em duas plantas de amendoim por vaso, duas de picão preto por vaso e uma planta de cada espécie por vaso. As plantas foram regadas com solução completa de Hoagland & Arnon (1950), ou sem potássio, ou sem fósforo ou sem nitrogênio. Sessenta dias depois de plantado, o crescimento do amendoim não mostrou efeitos aos tratamentos de competição inter- e intraespecífica nem aos dos de nutrição. Pelo contrario, o crescimento do mato mostrou uma resposta negativa à competição intraespecífica e as deficiências nutricionais. Não se observaram interações entre os tratamentos. A ausência de N na solução foi a que teve o efeito mais pronunciado em comparação com os outros elementos, resultando na redução em todas as características avaliadas. O amendoim foi mais competitivo que picão preto em condições de deficiências nutricionais.*

house of the Department of Agriculture Applied Biology, School of Agricultural and Veterinary Sciences, São Paulo State University (UNESP), Jaboticabal, SP, Brazil, utilizing 15 liter plastic pots containing washed and sieved sand as substrate.

Hairy beggarticks seeds (achenes) were collected in infested areas in Jaboticabal, in the proximity of the University, and stored until utilized. The seeds were allowed to germinate in trays containing 126 cells, using Plantmax® as substrate. The resulting seedlings were transplanted to 15 liter pots with the substrate when they presented two pairs of expanded leaves. The peanut cultivar utilized was Runner IAC-886. Peanut was sowed directly in the 15 liter pots. At the occasion of the hairy beggarticks seedling transplant, the peanut presented two pairs of expanded leaves.

Plants were arranged as follows: two plants of peanut/pot (intraspecific interference), two plants of hairy beggarticks/pot (intraspecific interference) and one plant of peanut to one of hairy beggarticks/pot (interspecific interference).

The establishment phase was 10 days, during which time the seedlings were irrigated daily with deionized water. At the end of this period, nutrient applications were initiated: pots were irrigated with modified Hoagland and Arnon (1950) solution according with treatments, receiving 25% of the original concentration in the first seven days, and 50% of the original concentration in the following week. After this period and until the end of experimental period the plants were irrigated with a 100% solution (original concentration). The nutrient solution was applied in the morning, and during the day moisture was maintained by irrigation with deionized water, avoiding excess water.

The experimental treatments consisted of the interference conditions (intra- and interspecific) with the following four mineral nutrition schemes: complete solution (C), no nitrogen (-N), no phosphorus (-P) and no potassium (-K), totalizing 8 treatments for each plant species. These treatments were established in a 2×4 factorial scheme, with four replications in a completely randomized design.

At the end of 60 days of experiment management, which is a critical period for weed interference in peanut (Nepomuceno *et al.*, 2007; Dias *et al.*, 2009), the hairy beggarticks and peanut plants were collected and separated in roots, stems and leaves. These plant parts were washed according to procedure described by Sarruge and Haag (1974), dried at 60-70°C for 96h, and the dry mass of the different plant parts and the total dry mass were determined. The plant material was ground and the macronutrient concentration was determined for the different plant parts except for the roots of hairy beggarticks, due to insufficient material. Height, leaf area (LI 3000A) and number of leaves were evaluated for each species.

The total nitrogen (Nt) and phosphorus (P) were determined by semimicroKjedahl and colorimetric methods utilizing phosphovanadate-molybdic acid, respectively, according to Sarruge and Haag

(1974). Potassium (K), calcium (Ca) and magnesium (Mg) were determined by atomic absorption spectrophotometry according to the method described by Jorgensen (1977). Sulfur (S) was determined by the turbidimetric method, as described by Vitti (1989). The nutrient uptake of each species was obtained by multiplying the concentration of the nutrient in the different parts of the plant by its dry mass. Nutrient uptake has been more frequently used than concentration in studies of competition between plants. This is the preferential method since some plant species can present greater nutrient concentration but, due to low biomass production, they display low concentration (Pitelli, 1985).

The statistical analysis was carried out in two parts. In the first part, the analysis included the intraspecific competition of peanut and the interspecific competition with hairy beggarticks. In the second part, the analysis included the intraspecific interaction of hairy beggarticks and interspecific competition with peanut. The data were submitted to variance analysis utilizing the F test and, when pertinent, the Tukey test at a 5% level of probability to average comparison.

Results and Discussion

Observations on the intraspecific interaction of peanut and interspecific interaction with hairy beggarticks showed no interaction among factors at different levels of nutrition (Table I).

TABLE I
EFFECTS OF INTRA- AND INTERSPECIFIC INTERFERENCE AND MINERAL NUTRITION CONDITIONS ON SOME CHARACTERISTICS OF GROWTH OF *Arachis hypogaea* L. AFTER 60 DAYS OF COEXISTENCE

Variable	Height (cm)	Number of leaves	Leaf area (cm^2)	Dry mass (g)			Total dry mass (g)
				Leaves	Stems	Roots	
Interference (I)							
Inter	4.37	7.44	27.00	2.09	1.69	1.40 b	3.03
Intra	4.58	7.73	29.08	2.21	1.83	1.68 a	3.34
Nutrition (N)							
Complete	4.59 a	7.47 a	28.66 ab	2.14 a	1.81 a	1.54 a	3.20 a
- N	4.37 a	7.96 a	30.75 a	2.24 a	1.83 a	1.57 a	3.30 a
- P	4.31 a	7.23 a	24.24 b	2.02 a	1.65 a	1.45 a	2.99 a
- K	4.67 a	7.68 a	28.51 ab	2.20 a	1.74 a	1.63 a	3.25 a
F_I	1.74 ns	0.68 ns	2.45 ns	1.43 ns	1.99 ns	9.96 **	4.39 ns
F_N	0.98 ns	0.74 ns	4.27 *	0.82 ns	0.61 ns	0.70 ns	0.84 ns
IxN	1.90 ns	0.09 ns	2.24 ns	0.69 ns	0.14 ns	0.48 ns	0.46 ns
CV %	8.92	11.65	11.56	11.94	14.23	13.96	11.12

All data transformed to √x; equal letters in a given column indicate statistically similar values; ns: not significant; *, **: significant at 5% and 1% probability level, respectively.

TABLE II
EFFECTS OF INTRA- AND INTERSPECIFIC INTERFERENCE AND MINERAL NUTRITION CONDITIONS ON SOME GROWTH CHARACTERISTICS OF *Bidens pilosa* L. AFTER 60 DAYS OF COEXISTENCE

Variable	Height (cm)	Number of leaves	Leaf area (cm^2)	Dry mass (g)			Total dry mass (g)
				Leaves	Stems	Roots	
Interference (I)							
Inter	9.23 a	4.70 a	28.32 a	1.94 a	2.57 a	1.80 a	3.71 a
Intra	7.78 b	4.01 b	21.93 b	1.50 b	1.85 b	1.35 b	2.75 b
Nutrition (N)							
Complete	11.14 a	4.78 a	35.86 a	2.47 a	3.70 a	2.28 a	5.01 a
- N	4.39 c	3.34 b	9.09 c	0.56 c	0.66 c	0.63 c	1.07 c
- P	10.04 ab	4.61 a	27.77 b	1.94 b	2.35 b	1.69 b	3.49 b
- K	8.45 b	4.70 a	27.78 b	1.92 b	2.12 b	1.69 b	3.33 b
F_I	8.63**	9.15**	11.18**	13.01**	8.50**	10.31**	10.87**
F_N	36.24**	8.96**	35.24**	44.76**	25.68**	23.23**	31.38**
IxN	0.63 ns	0.48 ns	0.96 ns	2.36 ns	0.60 ns	1.38 ns	1.15 ns
CV %	14.15	12.84	18.64	17.38	27.22	22.25	21.95

All data transformed to √x; equal letters in a given column indicate statistically similar values; ns: not significant; *, **: significant at 5% and 1% probability level, respectively.

TABLE III
EFFECTS OF INTRA- AND INTERSPECIFIC INTERFERENCE AND MINERAL NUTRITION CONDITIONS ON THE CONCENTRATION OF NUTRIENTS IN *A. hypogaea* L. AT 60 DAYS OF COEXISTENCE

Nutrient	N	P	K	Ca	Mg	S
	mg/plant					
Interference (I)						
Inter	270.61 a	16.19 b	84.99 b	139.22 a	58.45 a	13.27 b
Intra	307.28 a	20.94 a	108.94 a	171.35 a	69.57 a	20.44 a
Nutrition (N)						
Complete	267.42 a	19.09 ab	167.91 a	159.97 a	54.17 b	22.66 a
- N	322.43 a	22.07 a	94.79 b	149.09 a	54.25 b	19.85 ab
- P	258.89 a	14.43 b	68.81 b	136.10 a	67.23 ab	11.58 c
- K	307.04 a	18.65 ab	56.34 b	175.97 a	80.39 a	13.33 bc
F_I	2.02 ns	7.11 *	5.25 *	3.62 ns	2.99 ns	17.42 **
F_N	1.41 ns	3.12 ns	22.84 **	1.00 ns	3.79 *	9.34 **
IxN	0.33 ns	1.72 ns	4.10 *	0.32 ns	0.51 ns	2.84 ns
CV %	21.89	23.49	26.39	26.64	24.6	24.99

Equal letters in a given column indicate statistically similar values; ns: not significant; *, **: significant at 5% and 1% probability level, respectively.

After 60 days of coexistence, no inter- and intraspecific interference on peanut growth characteristics was observed, with the exception of root dry mass, that was low under interspecific interference, independent of nutrition (Table I). Nutrition was not a limiting factor to the crop, except for leaf area that was smaller in the absence of P than in the absence of N, independent of the interference condition. This result differed from Rodrigues Filho *et al.* (1988) for cv. Tatu, in which the height and the dry mass were reduced in the absence of macronutrients. This was explained as being a result of the upright characteristic of this cultivar that can result in a different response and the absence of weed interference.

No meaningful intraspecific interaction for hairy beggarticks interactions or interspecific interaction with peanut was observed between the factors studied after applying different nutritional solutions for 60 days (Table II). The hairy beggarticks suffered more negative effects from interference and nutrition. The intraspecific interference decreased in all characteristics analyzed, independent of the nutrition condition. Absence of N had a greater effect than

that of other elements, resulting in the reduction of all the evaluated characteristics (Table II). According to Shafiq *et al*. (1994), among the nutrients, greater competition between weeds and crops occurs with N. The vital importance of N is related to amino acids buildup, protein and enzymatic activity related to chlorophyll synthesis (Malavolta *et al*., 1989; Marschner, 1990). Procópio *et al*. (2004) verified that *B. pilosa* presents high efficiency in the utilization of absorbed N, converting it into biomass, therefore, the absence of this element can accentuate the negative effects on the weed.

Nutrition deficiency and interference affected the weed more than the crop, indicating that peanut is more competitive for nutrients than hairy beggarticks (Table II). Plants that utilize resources quickly or are capable of continuing growth at low nutrient levels are 'good competitors' (Radosevich *et al*., 1996). Cralle *et al*. (2003) also observed that wheat growth was less inhibited in deficient soil (in this case, P) than Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) cultivated in the same soil.

The interference altered the concentration of P, K and S in peanut plants, which was smaller with interspecific interference (Table III). Ronchi *et al*. (2003) observed the potential of hairy beggarticks in the reduction of the availability of nutrients to coffee trees.

There was no difference related to nutrition in the concentration of N and Ca in peanut plants. The concentration of P, K and S was lower in the absence of N, P and K. The absence of K increased the concentration of Mg (Table III).

TABLE IV
CONCENTRATION OF POTASSIUM IN PEANUT AS A FUNCTION OF NUTRITIONAL CONDITIONS AND INTRA- AND INTERSPECIFIC CONDITION (INTERACTION I×N)

Nutrient	K, mg/plant	
	Inter	Intra
Complete	b 131.37 A	a 204.45 A
- N	a 107.82 AB	a 81.77 B
- P	a 49.05 B	a 88.57 B
- K	a 51.74 B	a 60.94 B
DMS to N in I	59.84	
DMS to I in N	44.32	

Lower-case letter within each row compare the interference under each nutritional condition; upper-case letter within each column compare the nutritional conditions under each interference.

Interaction was observed between the type of interference and the nutrition only for K, in which greater amounts of macronutrients were found in plants that received complete solution, with intra- and interspecific interference. Comparison of the interference effects under each nutritional condition indicated interspecific interference differences only at low concentrations of complete nutrition (Table IV).

Hairy beggarticks were more affected by intraspecific interference with decreases in all macronutrient concentrations. The absence of N resulted in reduction in the concentration of all macronutrients (Table V). Procópio *et al*. (2004) observed that the supply of N can be more beneficial to weeds that do not belong to the Fabaceae family than to crops, therefore, the absence of N can have a greater effect on the weed than on peanut.

In the interaction of interference with nutrition related to Ca and Mg, both concentrations were low in the absence of N under either inter- or intraspecific interference. The absence of K caused lower concentrations of these two macronutrients under intraspecific interference (Table VI).

Hairy beggarticks accumulated greater amounts of macronutrients if compared to the peanut receiving complete solution (Tables III and V). Other research with five hairy beggartick plants per pot found relative concentrations 4, 14, 6, 7 and 9 times greater for N, P, K, Ca and Mg, respectively, in the aerial part of coffee plants cultivated without weed interference (Ronchi *et al*., 2003). Procópio *et al*. (2005) reports that fertilizer application is more beneficial to weeds than to crops.

TABLE V
EFFECTS OF INTRA- AND INTERSPECIFIC INTERFERENCE AND MINERAL NUTRITION CONDITIONS ON THE CONCENTRATION OF NUTRIENTS IN HAIRY BEGGARTICKS 60 DAYS AFTER COEXISTENCE

Nutrient	N	P	K	Ca	Mg	S
	mg/plant					
Interference (I)						
Inter	278.865 a	20.51 a	177.91 a	190.77 a	95.45 a	12.42 a
Intra	156.93 b	11.21 b	123.77 b	106.79 b	56.80 b	7.47 b
Nutrition (N)						
Complete	345.64 a	29.38 a	383.59 a	211.24 a	94.00 a	24.90 a
- N	19.46 b	2.40 c	12.71 c	13.81 b	5.38 b	0.80 c
- P	247.77 a	15.50 b	132.49 b	177.24 a	98.58 a	7.11 b
- K	248.71 a	16.17 b	74.56 bc	192.81 a	106.55 a	6.95 b
F_I	16.08 **	12.83 **	10.19 **	18.85 **	13.73 **	12.85 **
F_N	20.99 **	18.02 **	92.04 **	22.15 **	20.69 **	56.56 **
IxN	2.24 ns	2.04 ns	2.91 ns	3.80 *	3.63 *	3.01 ns
CV %	34.18	40.07	27.53	31.8	33.56	34.04

Equal letters in a given column indicate statistically similar values; ns: not significant; *, **: significant at 5% and 1% probability level, respectively.

TABLE VI
CONCENTRATION OF Ca AND Mg IN HAIRY BEGGARTICKS AS A FUNCTION OF NUTRITIONAL CONDITIONS AND INTRA- AND INTERSPECIFIC INTERFERENCE (INTERACTION I×N)

Nutrients	Ca, mg/plant		Mg, mg/plant	
	Inter	Intra	Inter	Intra
Complete	a 249.18 A	a 173.30 A	a 110.92 A	a 77.08 A
- N	a 15.89 B	a 11.73 B	a 6.85 B	a 3.91 B
- P	a 212.09 A	a 142.39 A	a 109.93 A	a 87.23 A
- K	a 285.90 A	b 99.72 AB	a 154.12 A	b 58.99 AB
DMS for N within I	110.79		59.75	
DMS for I within N	82.06		44.25	

Lower-case letter within each row compare the interference under each nutritional condition; upper-case letter within each column compare the nutritional conditions under each interference.

Conclusions

The weed suffered more negative effects from intraspecific interference and nutrition. The absence of nitrogen promoted more effect than other elements, resulting in decreases in all evaluated characteristics. The absence of nutrients and the interference affected the weed more than the crop, demonstrating that the crop was more competitive than hairy beggarticks.

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