horticultura brasileira

Research

VIEIRA FILHO, JSM; GUERRA, JGM; GOULART, JM; ARAÚJO, ES; ESPINDOLA, JAA; ROUWS, JRC. Management of green manure and organic fertilization with fermented compost fertilizer in agroecological cultivation of American broccoli. *Horticultura Brasileira* v.41, 2023, elocation e2599. DOI: http://dx.doi.org/10.1590/s0102-0536-2023-e2599

Management of green manure and organic fertilization with fermented compost fertilizer in agroecological cultivation of American broccoli

José Sávio M Vieira Filho [1]; José Guilherme M Guerra [2]; Jhonatan M Goulart [1]; Ednaldo da S Araújo [2]; José Antonio A Espindola [2]; Janaína RC Rouws [2]

[1]Universidade Federal Rural do Rio de Janeiro (UFRRJ), Seropédica-RJ, Brasil; jsmurucifilho@gmail.com; marinsgoulart@ymail.com. [2]Embrapa Agrobiologia, Seropédica-RJ, Brasil; guilherme.guerra@embrapa.br; ednaldo.araujo@embrapa.br; jose.espindola@embrapa.br; janaina.rouws@embrapa.br

ABSTRACT

This work aimed to evaluate the phytotechnical performance of the succession involving pre-croppings of maize and *Mucuna pruriens* (velvet bean) or the intercropping of these species in the agroecological cultivation of broccoli in the presence and absence of fermented compost fertilization. The experimental design was in randomized blocks in a factorial scheme 2 (maize monoculture or intercropped with velvet bean) x 2 (absence and presence of fermented compost fertilization) + 1 (velvet bean monoculture and without fertilization). After cutting the maize and velvet bean biomass, the broccoli seedlings were transplanted. In this stage, the design was in randomized blocks in a 3-factorial scheme (maize monoculture; maize intercropped with velvet bean; velvet bean monoculture) x 2 (presence and absence of fermented compost fertilization). The authors concluded that when the velvet bean was introduced into maize cultivation system no negatively interference was noticed concerning to phytotechnical components of baby corn, and it even allows an additional of 3.46 and 7.75 t/ha of fabaceous phytomass, respectively, in the first and second year. In the absence of fertilization, phytomasses of the intercroppings provided broccoli productivity of 12.87 t/ha, which represents an increase of 43.73% when compared to maize monoculture in the second year. An effect of fertilization with the fermented compost on broccoli cultivation under these study conditions was verified, providing a greater accumulation of N in the inflorescences in the first year and maximum productivity of 12.19 and 14.32 t/ha, respectively, first and second years.

Keywords: *Brassica oleracea var. italica,* organic agriculture, horticulture, bokashi.

RESUMO

Manejo da adubação verde e orgânica com composto fermentado no cultivo agroecológico de brócolis americano

Objetivou-se avaliar o desempenho fitotécnico da sucessão envolvendo pré-cultivos de milho e *Mucuna pruriens* ou o consórcio dessas espécies no cultivo agroecológico de brócolis na presença e ausência da fertilização com um composto fermentado. O delineamento experimental foi em blocos casualizados em esquema fatorial 2 (milho em monocultivo ou consorciado à mucuna) x 2 (ausência e presença de fertilização) + 1 (mucuna em monocultivo e sem fertilização). Após o corte da biomassa do milho e da mucuna, procedeu-se com o transplantio das mudas de brócolis. Nesta etapa, o delineamento foi em blocos casualizados em esquema fatorial 3 (milho em monocultivo; milho consorciado à mucuna; mucuna em monocultivo) x 2 (presença e ausência da fertilização). Constatou-se que a inserção da mucuna no sistema de cultivo de milho não interfere negativamente nos componentes fitotécnicos do minimilho e possibilita um adicional de 3,46 e 7,75 t/ha de fitomassa da fabácea, respectivamente, primeiro e segundo ano. Na ausência da fertilização, as fitomassas do consórcio proporcionaram produtividade de brócolis na ordem de 12,87 t/ha que representa um acréscimo de 43,73% quando comparado ao monocultivo de milho no segundo ano. Houve efeito da fertilização com o composto fermentado no cultivo de brócolis nas condições de estudo, proporcionando maiores acúmulos de N nas inflorescências no primeiro ano e produtividades máximas de 12,19 e 14,32 t/ha, respectivamente, primeiro e segundo ano.

Palavras-chave: *Brassica oleracea* var. *italica*, agricultura orgânica, olericultura, bokashi.

Received on January 12, 2023; accepted on May 2, 2023

Green manure is a multifunctional agricultural practice which contributes to a sustainable management of the agroecosystems. The benefits are associated with high biomass production *in situ*, which provides an increase in organic matter contents, soil decompression, nematode control (Rosa *et al*., 2015) and nutrient cycling. Moreover, when the species belonging to *Fabaceae* family is used in this fertilization, it can also contribute to the ingress of atmospheric nitrogen via biological nitrogen fixation, through mutualistic associations with nitrogen-fixing bacteria (Mercante *et al*., 2014).

Even considering the "multifunctionality" of the green manure, many farmers do not use the technique, as they are for areas destined for the cultivation of crops of economic interest, since the occupation with green manures, specifically in limited areas, can compromise the farmer's income.

One strategy which aims to deal with this limitation and contributes to use the green manure in production units is the intercropping using crops of economic interest (Goulart *et al*., 2021a).

In this sense, maize crop can be considered an element to facilitate farmers to insert green manures, as in addition to being widely cultivated at different technological levels, this crop allows the intercropping with crops of economic interest (Matoso *et al*., 2013; Viegas Neto *et al*., 2012) or biomass producers (Chieza *et al*., 2017; Paz *et al*., 2017). Furthermore, maize shows a high potential to produce biomass and can also produce baby corn, "corn hair", green ears and grains.

Another management which can complement the green manure is fertilizing with fermented plant composts, such as bokashi. These composts are rich in nutrients and can be prepared using a mixture of agricultural or agroindustrial residues (Siqueira & Siqueira, 2013). During preparation, the residues are inoculated with microorganisms and submitted to an incubation process. Adding this fermented compost into soil contributes to nutrient supply and soil revitalization.

Considering the above, studies on strategies of the insertion of green manure into vegetable production systems associated with fermented compost fertilizer, in special into the organic American broccoli farming, which is extensively cultivated and widely consumed, is able to contribute to soil fertility improvement and agroecosystem sustainability. This study aimed to evaluate the phytotechnical performance of the succession involving pre-croppings of maize and *Mucuna pruriens* or the intercropping of these species in the agroecological cultivation of broccoli in the presence or absence of fermented compost fertilization.

MATERIAL AND METHODS

The experiments were carried out at SIPA (Sistema Integrado de Produção Agroecológica) (Fazendinha Agroecológica, km 47), located in the municipality of Seropédica-RJ (22°46'S, 43°41'W, 33 m altitude), in two consecutive years, 2014 and 2015. The first step of the experiment consisted of the sowing of maize and velvet bean pre-croppings. The experimental design used was randomized blocks, in a factorial scheme 2 (maize monoculture or intercropped with velvet bean) x 2 (absence and presence of fermented compost fertilization in maize) + 1 (velvet beans monoculture and without fertilization). The experimental plots consisted of an area of 15 m^2 (5 x 3 m). The soil in the experimental area is classified as Red Yellow Latosol (Santos *et al*., 2018a), with a history of constant fertilizations with fermented composts and green manure, showing the following chemical properties in the 0-20 cm layer: pH = 6.5; Al^{+++}= 0.0 $cmol_c/dm^3$; Ca^{++}= 4.0 $cmol_c/dm^3$; Mg^{++}= 2.0 $cmol_c/dm^3$; K^+= 56 mg/dm^3; available P= 143 mg/dm^3. The exchangeable elements Al^{+++}, Ca^{++} and Mg^{++} were extracted using an extraction solution containing 1 M KCl, determining Al^{+++} by titration Ca^{++} and Mg^{++} by atomic absorption spectrometry. P and K^+ were extracted using the Mehlich 1 method, K^+ was determined using flame photometry and available P using spectrophotometry. The analyses were performed using the methodologies proposed by Nogueira & Souza (2005).

The soil was plowed and harrowed for sowing maize (var. Caatingueiro) and velvet beans, and this procedure was carried out in the two agricultural years. In this stage, the authors fertilized the maize crop only, a dose of 80 kg/ha of N was used on day 7 before sowing. This dose corresponded to a dry-based application of 1.55 t/ha of fermented compost/ha. The fermented compost was prepared by mixing 40% castor bean meal and 60% wheat meal (% m/m). The meals were weighed, mixed and inoculated with an activated solution of the commercial product Embiotic®, containing 10^4 UFC/mL of *Lactobacillus plantarum* and 10^3 UFC/mL *Saccharomyces cerevisiae*, respectively. Before using the bioaccelarator, the authors activated and diluted it. To prepare the active solution, we used 50 mL of the commercial product, 50 g brown sugar and 400 mL water, packaged in a plastic bottle for seven days. The activated solution was diluted in water (1% v/v) during preparation of the compost. The solution was added into the mixtures in order to reach moisture contents ranging from 35 to 40%, verified by manual compression of a portion of the mixture until obtaining a stable clod without crumbling or liquid runoff. The mixtures were compacted and packaged in airtight plastic buckets, for a minimum period of 21 days. The total macronutrient contents (g/kg) of the fermented composts determined using the methodology proposed by Nogueira & Souza (2005) in 2015 were: N (51.4); P (8.61); K (12.25); Ca (3.35); Mg (3.58). In 2016: N (37.7); P (10.26); K (13.0); Ca (2.45); Mg (8.8).

The maize and velvet bean sowing, in their respective monocultures, were carried out simultaneously in the two agricultural years, whereas the sowing of the intercropped velvet bean was performed 35 days after maize sowing, respectively. This procedure was adopted to minimize the competitive effect of velvet bean in relation to maize, since fabaceous growth is more pronounced. The maize crop aiming to produce baby corn was sown in simple rows, spacing 1.0 m between rows and in a population of 120,000 plants/ha which corresponds to 12 plants/linear meter, whereas the velvet bean was kept in a population of 20,000 plants/ha. Cultural practices were done during the experiment: manual weeding in the experimental area and the use of *Bacillus thuringiensis*-based biological inseticides at 0.05% to control fall armyworm (*Spodoptera frugiperda*) on maize crop.

The evaluated variables of the maize crop, considering the useful area of 2 m^2 were total and commercial productivity of baby corn ears. The authors also quantified the dry phytomass productivity and N accumulation in the shoot phytomass. To evaluate the ears of baby corn, we harvested baby corns every other day, totalizing seven harvests in different agricultural years. The methodology used to characterize these spikelets was described by Pereira

Filho & Cruz (2001), and those, which presented diameter from 0.8 to 1.8 cm and length from 4.0 to 12.0 cm, cylindrical shape and without deformations, were classified as commercial.

After cutting the phytomass produced by maize and velvet beans, four months after sowing, the American broccoli seedlings (cv. Grandíssimo) were transplanted, in spacing of 1.0 m between lines x 0.5 m between plants. In this stage, the experimental design used was randomized blocks, in a factorial scheme 3 (maize monoculture; maize intercropped with velvet beans; velvet bean monoculture) x 2 (presence or absence of topdressing fertilization in broccoli). A dose of 80 kg/ha of N which corresponded to an application of 2.12 tons of fermented compost/ha, 50% organic fertilizer applied at 30 days and 50% at 50 days after transplant.

Cultural practices were done, such as weeding, sprinkler irrigation and applications of a commercial product based on neem extract at 1% p/v to control aphids and caterpillars. We also performed preventive control of seedling damping-off by using a commercial product based on the antagonistic fungus *Trichoderma sp.* (3% v/v).

Broccoli inflorescences were harvested at 70 days after transplant, when these inflorescences reached the maximum height, showing a compact and 'closed' appearance. In inflorescences, the authors evaluated the diameter and the productivity. Moreover, subsamples were taken to be dried in a forced ventilation oven at 65°C, crushed in a Willey mill and evaluated in order to determine N contents using Kjedahl method.

Data were submitted to the variance analysis by F test. When significant differences between the factors were noticed, the averages were compared using Scott-Knott test ($p \leq 0.05$). The data were evaluated with the aid of the R software (R Core Team, 2021).

RESULTS AND DISCUSSION

For total and commercial productivity of baby corn, in the two agricultural years, no significant interaction was noticed between the cultivation system and organic fertilization (Table 1). The total productivity ranged from 1.21 to 1.34 t/ha in the first cultivation year, whereas in the second year, the productivity ranged from 459.68 to 934.25 kg/ha. In relation to the commercial productivity, the authors observed ranges from 969.40 to 1086.74 and 457.12 to 907.62 kg/ha, respectively, in the first and second cultivation year. Baby corn productivities found in this study are similar to the ones reported by Lana *et al.* (2012) who evaluated different maize varieties under similar climatic conditions.

The authors observed that including velvet bean in the maize production system aiming to produce "baby corn" do not interfere in total and commercial productivities of the crop of economic interest. This fact shows that the viability of this intercropping allows to harvest baby corn ears, generating income and enriching the soil with the phytomass of both species. In special, fabaceae, with high nitrogen contents, shall contribute with the crop grown in succession. For the benefits of maize intercropped with fabaceae, Corrêa *et al.* (2014) reported that this intercropping benefits the baby corn harvest and that the management adopted allows the permanence of most of the nitrogen supplied in the systems. Similarly, Paz *et al.* (2017) reported that maize intercropped with fabaceae is viable, resulting in a greater productivity when compared with poaceous monoculture.

Other authors also highlighted that including herbaceous Fabaceae (Chieza, *et al.*, 2017; Goulart *et al.*, 2021a) or shrub (Queiroz *et al.*, 2008; Goulart *et al.*, 2021b), in maize cultivation systems, do not interfere negatively in phytotechnical characteristics of this species, contributing with phytomass and nitrogen, especially the derivative of biological fixation that in the composition of velvet bean can correspond to 61% of the total N in the plant (Sant'anna *et al.*, 2018).

Regarding maize fertilization, in the first year, no significant difference was noticed when the crop was fertilized or not fertilized for baby corn variables, whereas, in the second year, the authors observed that the fertilization with the fermented compost provided an increase of 103.23% and 98.55% in the total and commercial production of baby corn ears, respectively. The leveling of productivities in the first year of cultivation may be associated with soil fertility, since the chemical analysis showed high nutrient contents according to the fertilization manual of Rio de Janeiro state (Freire *et al.*, 2013). The early harvest of baby corn ears was before the period of greater crop nutrional demand, which can minimize fertilizer demand (Santos *et al.*, 2014b).

For maize dry phytomass production and the amounts of N accumulation, no significant interactions between cultivation system and organic fertilization were also observed (Table 2). Maize dry phytomass production was not reduced in the presence of velvet bean, regardless of whether to fertilize

Table 1. Total and commercial productivity of baby corn monoculture or intercropped with velvet bean, in the absence and presence of fermented compost fertilizer. Seropédica, Fazendinha Agroecológica km 47, 2014-2015.

Cultivation system	Baby corn productivity (kg/ha)			
	1st year		2nd year	
	Total	Commercial	Total	Commercial
Maize monoculture	1208.50 A	969.40 A	628.75 A	619.06 A
Maize intercropped	1279.21 A	1086.74 A	765.18 A	745.68 A
Organic fertilization				
Absence	1144.97 A	1004.26 A	459.68 B	457.12 B
Presence	1342.74 A	1051.88 A	934.25 A	907.62 A
CV (%)	36.0	26.0	50.0	48.0

Averages followed by the same letter in the column do not differ from each other, respectively, by F test and Scott-Knott test, at 5% probability.

or not, in the two agricultural years. The leveling of maize dry phytomass production under the studied conditions, as described for baby corn ears production may be associated with the fertility of the soil in the experimental area, due to constant fertilizations with fermented compost and green manure. For nitrogen accumulation in maize phytomass in the first cultivation year, the authors observed ranges from 78.63 and 86.11 kg/ha. In the second year the accumulation ranged from 75.92 and 102.24 kg/ha of N, representing an increase in accumulation in the presence of organic fertilization, 34.66% nutrient accumulation.

In relation to productivity of shoot dry phytomass of the velvet bean, the nitrogen contents and the amount accumulated, regardless of cultivation system, no significant differences were observed for these variables, in the two agricultural years (Table 3). Phytomass production in monoculture was 2.90 and 6.50 t/ha, first and second year, respectively. For the intercropping cultivation, the productivities were 3.46 t/ha in the first year and 7.75 t/ha in the second cultivation year. Nitrogen content and accumulation in monoculture were 38.55 g/kg and 112.23 kg/ha, respectively, in the first year, whereas in the second year the content was 33.33 g/kg and accumulation was 213.82 kg/ha. Considering the intercropping cultivation, the content and accumulation of the nutrient in monoculture, respectively, were 39.99 g/kg and 140.10 kg/ha in the first year, whereas, in the second year, the content was 35.09 g/kg and the accumulation was 270.36 kg/ha.

We highlight that the accumulated amount of nitrogen is directly related to dry phytomass production. We observed that the accumulated amount of this nutrient in the first cultivation year was lower compared to the productivities found in the second year, due to hydric deficit during the experiment in the first year which resulted in a reduction of the productivity of dry shoot phytomass. Ambrosano *et al*. (2013) reported dry phytomass production of the velvet bean similar to the ones found in this study, 4.3 and 7.1 t/ha, in different regions. Including this fabacea in maize cultivation system contributed to an additional nitrogen supply of up to 270 kg/ha. Moreover, the velvet bean shows potential to promote the cycling of expressive amounts of P, K, Ca and Mg, respectively, 21.58; 149.52; 59.88 and 19.25 kg/ha contributing to nutrition of the crop grown in succession (Ambrosano *et al*., 2016).

In broccoli cultivation, the interaction between the factors related to cultivation system and organic fertilization for inflorescence diameter was significant in the two agricultural years (Table 4). In the first year, the velvet bean pre-cropping provided greater performance of this variable reaching 17.71 cm when compared with the other treatments without fertilization. This fact is related to higher supply of N of the shoot phytomass of fabaceae. In the presence of fertilization, the treatments did not differ between each other. However, a greater inflorencence diameter was verified, ranging from 19.30 to 20.09 cm. In the second year, in the absence of fertilization, the authors noticed that maize pre-cropping intercropped with velvet bean provided the greatest diameter of the inflorescence, 19.78 cm. In the presence of fertilization, regarding pre-cropping, the results were similar, ranging from 19.81 to 20.42 cm.

In literature, the benefits of green manure in growing brassicas are reported in different cultivation systems. Cordeiro *et al*. (2018) reported that the green manure using green velvet bean provided an increase in cabbage productivity when submitted to organic management when compared with maize pre-cropping and, it is able to substitute the organic top-dressing fertilization. In another study, Souza *et al*. (2014) also reported positive results of green manure for maize and velvet bean in intercropping system, benefiting the cabbage crop cultivated in succession.

Table 2. Dry phytomass productivity and N accumulation in the shoot phytomass of maize monocropped or intercropped with velvet bean, in the absence and presence of fermented compost fertilizer. Seropédica, Fazendinha Agroecológica km 47, 2014-2015.

Cultivation system	Phytotechnical characteristics of maize (kg/ha)			
	1st year		2nd year	
	Dry phytomass	N accumulation	Dry phytomass	N accumulation
Maize monoculture	8765.7 A	82.60 A	7319.8 A	92.46 A
Maize intercropped	8905.9 A	82.14 A	7576.3 A	85.70 A
Organic fertilization				
Absence	9235.8 A	78.63 A	6857.1 A	75.92 B
Presence	8433.5 A	86.11 A	8039.0 A	102.24 A
CV (%)	26.0	26.0	20.0	18.0

Averages followed by the same letter in the column do not differ from each other, respectively, by F test and Scott-Knott test, at 5% probability.

Table 3. Shoot dry biomass productivity of velvet bean, contents and accumulation of N in monoculture and intercropped with maize. Seropédica, Fazendinha Agroecológica km 47, 2014-2015.

Velvet bean	Phytotechnical characteristics of the velvet bean					
	Dry phytomass (kg/ha)		N content (g/kg)		N accumulation (kg/ha)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
Monoculture	2.90 A	6.50 A	38.55 A	33.33 A	112.23 A	213.82 A
Intercropped	3.46 A	7.75 A	39.99 A	35.09 A	140.10 A	270.36 A
CV (%)	32.0	24.0	12.0	10.0	25.0	23.0

Averages followed by the same letter in the column do not differ from each other, respectively, by F test and Scott-Knott test, at 5% probability.

For inflorescence productivity, we noticed interactive effects between cultivation system and organic fertilization in the two agricultural years (Table 4). When the crop was fertilized, no difference in relation to inflorescence productivity was noticed, regardless the cultivation system, with productivities ranging from 10.35 to 12.19 t/ha in the first year and 13.06 to 14.32 t/ha in the second year. However, in the absence of organic fertilization, in the first cultivation year, the remaining phytomass of the velvet bean provided greater inflorescence productivity, 7.41 t/ha, being possible to detect higher inflorescence productivities associated with an exclusive velvet bean cultivation (11.37 t/ha) or intercropped with maize (12.87 t/ha).

Comparing the effects of the species intercropped with maize monoculture, in the absence of fertilization, the authors observed that the use of Fabaceae as green manure increases the productivity of broccoli 43.73%, in the second year. We noticed that the velvet bean contributed to an increase of productivity, mainly in the intercropping with maize, providing N inflow, nutrient cycling and contributing to the nutrition of vegetables grown in succession. In relation to fertilization, except for maize intercropped with velvet bean in the second cultivation year, the authors noticed an increase in broccoli inflorescence productivity. The use of fermented compost, at the recommended dose, contributed to the ingress of expressive amounts of N, P, K, Ca and Mg enabling greater performance of broccoli, even in soil conditions with good fertility.

The results described in this study are similar to the ones reported by Geisenhoff *et al*. (2015), who reached productivities of broccoli ranging from 9.6 to 12.30 t/ha using synthetic fertilizers. Similarly, Oliveira *et al*. (2016) using 200 kg/ha of N, considering urea as source, reached a maximum productivity of 11.91 t/ha. In Rio de Janeiro, which is a mild climate region, the productivity of broccoli submitted to organic fertilization may range from 15 to 30 t/ha, according to liming and fertilization manual of the state of Rio de Janeiro (Freire *et al*., 2013).

In relation to N contents in inflorescences, the authors observed a significant interaction between cultivation system and fertilization (Table 5). In the first cultivation year, phytomass remaining in velvet bean provided higher N contents in inflorescences, regardless of whether fertilized or not, when compared with maize pre-croppings and the species intercropping. We also noticed that the phytomass remaining from the intercropping, when fertilized, provided higher N contents compared with the respective treatment in the absence of fertilization. In relation to the second year, the remaining phytomass of the velvet bean, in the absence of fertilization, provided higher N contents in broccoli inflorescences when compared with the other treatments. In the presence of fertilization, the biomass remaining in maize provided higher N contents in inflorescences when compared with the respective treatment without fertilization, showing no difference in fertilizing or not for the other treatments.

For the amounts of N accumulated in inflorescences in the first cultivation year, we observed greater accumulated amounts in the presence of organic fertilization ranging from 44.34 to 60.31 kg/ha. In relation to cultivation system, the remaining phytomass of velvet bean, in the absence of fertilization, provided greater N accumulation, reaching 40.03 kg/ha, considering that, in the presence of fertilization, monoculture and intercropping between velvet bean and maize, respectively, provided greater accumulated amounts of this nutrient 60.41 and 55.01 kg/ha. In the second cultivation year, concerning fertilization, the remaining phytomass of maize in the presence of fertilization

Table 4. Average diameter and productivity of broccoli inflorescences in succession to corn and velvet bean monocultures, and the intercropping with these species, in the absence and presence of fermented compost fertilizer. Seropédica, Fazendinha Agroecológica km 47, 2014-2015.

Organic fertilization	Broccoli inflorescence diameter (cm)		
	1st year		
	Maize monoculture	**Maize + velvet bean**	**Velvet bean monoculture**
Absence	8.78 Bc	13.11 Bb	15.71 Ba
Presence	19.30 Aa	20.09 Aa	19.49 Aa
CV (%)	10.25		
Fertilization	**2nd year**		
Absence	17.61 Bb	19.78 Aa	18.62 Ab
Presence	19.93 Aa	20.42 Aa	19.81 Aa
CV (%)	5.0		
Organic fertilization	**Broccoli inflorescence productivity (t/ha)**		
	1st year		
Absence	1.91 Bb	4.35 Bb	7.41 Ba
Presence	10.35 Aa	12.19 Aa	11.71 Aa
CV (%)	20.30		
Fertilization	**2nd year**		
	Maize monoculture	**Maize + velvet bean**	**Velvet bean monoculture**
Absence	8.95 Bb	12.87 Aa	11.37 Ba
Presence	13.05 Aa	14.32 Aa	13.57 Aa
CV (%)	11.03		

Averages followed by the same capital letter in the column and lower case letter in the line do not differ from each other, respectively, by F test and Scott-Knott test, at 5% probability.

Table 5. Contents and accumulation of N in broccoli inflorescences in succession to corn and velvet bean monocultures, and the intercropping with these species, in the absence and presence of fermented compost fertilizer. Seropédica, Fazendinha Agroecológica km 47, 2014-2015.

Organic fertilization	N contents in broccoli inflorescence (g/kg)		
	1st year		
	Maize monoculture	Maize + velvet bean	Velvet bean monoculture
Absence	42.46 Ab	40.14 Bb	48.93 Aa
Presence	40.80 Ac	45.48 Ab	50.80 Aa
CV (%)		6.70	
Fertilization	**2nd year**		
Absence	38.02 Bb	41.07 Ab	43.10 Aa
Presence	42.95 Aa	43.25 Aa	44.72 Aa
CV (%)		5.99	
Fertilization	**N accumulation in broccoli inflorescence (kg/ha)**		
	1st year		
Absence	9.46 Bb	19.17 Bb	40.03 Ba
Presence	44.34 Ab	55.01 Aa	60.41 Aa
CV (%)		5.29	
Fertilization	**2nd year**		
Absence	38.80 Bb	54.70 Aa	56.70 Aa
Presence	54.90 Aa	56.12 Aa	50.52 Aa
CV (%)		15.52	

Averages followed by the same capital letter in the column and lower case letter in the line do not differ from each other, respectively, by F test and Scott-Knott test, at 5% probability.

provided greater accumulated amount, 54.90 kg/ha, when compared with the respective treatment in the absence of fertilization 38.80 kg/ha. In relation to cultivation system, monoculture and intercropped velvet bean, in the absence of fertilization, provided greater accumulated amounts, respectively, 56.70 and 54.70 kg/ha, whereas in the presence of fertilization, no difference between the treatments was noticed.

The authors concluded that inserting velvet bean in maize cultivation system does not negatively influence phytotechnical components of baby corn and allows an additional of 3.46 and 7.75 t/ha of Fabaceae phytomass, respectively, first and second year. In the absence of fertilization, the phytomasses of the intercropping system provided a broccoli productivity of 12.87 t/ha which represents an increase of 43.73% when compared with maize monoculture in the second year. We observed a fertilization effect using the fermented compost on broccoli cultivation under the conditions of this study, providing greater N accumulation in the inflorescence in the first year and maximum productivities of 12.19 and 14.32 t/ha, respectively, first and second years.

REFERENCES

AMBROSANO, EJ; FOLTRAN, DE; CAMARGO, MS; ROSSI, F; SCHAMMASS, EA; SILVA, EC; AMBROSANO, GMB; DIAS, FLF. 2013. Acúmulo de biomassa e nutrientes por adubos verdes e produtividade da cana planta cultivada em sucessão, em duas localidades de São Paulo, Brasil. *Revista Brasileira de Agroecologia*, 8: 199-209.

AMBROSANO, EJ; WUTKE, EB, SALGADO, GC; ROSSI, F; DIAS, FLF; TAVARES, S; OTSUK, IP. 2016. Caracterização de cultivares de mucuna quanto a produtividade de fitomassa, extração de nutrientes e seus efeitos nos atributos do solo. *Cadernos de Agroecologia* 11: 2.

CHIEZA, ED; GUERRA, JGM.; ARAÚJO, ES; ESPINDOLA, JAA; FERNANDES, RC. 2017. Produção e aspectos econômicos de milho consorciado com *Crotalaria juncea* L. em diferentes intervalos de semeadura, sob manejo orgânico. *Revista Ceres* 64: 189-196.

CORDEIRO, AAS; RODRIGUES, MB; GONÇALVES JÚNIOR, M; ESPINDOLA, JAA; ARAÚJO, ES; GUERRA, JGM. 2018. Organic cabbage growth using green manure in pre-cultivation and organic top dressing fertilization. *Horticultura Brasileira* 36: 515-520.

CORRÊA, AL; ABBOUD, ACS; GUERRA, JGM; AGUIAR, LA; RIBEIRO, RLD. 2014. Adubação verde com crotalária consorciada ao minimilho antecedendo a couve-folha sob manejo orgânico. *Revista Ceres* 61: 956-963.

FREIRE, LR; CAMPOS, DVB; LIMA, E; ZONTA, E; BALIEIRO, FC; GUERRA, JGM; POLIDORO, JC; ANJOS, LHC; LEAL, MAA; PEREIRA, MG; FERREIRA, MBC. 2013. *Manual de calagem e adubação do Estado do Rio de Janeiro*. Seropédica: Editora Universidade Rural, 430p.

GEISENHOFF, LO; OLIVEIRA, FC; BISCARO, GA; ALMEIDA, ACS; SCHWERZ, F.2015. Produtividade do brócolis-de-cabeça sob diferentes sistemas de irrigação. *Engenharia Agrícola* 35: 863-874.

GOULART, JM; GUERRA, JGM; ESPINDOLA, JAA; ARAÚJO, ES; ROUWS, JRC. 2021b. Shrub legume green manure intercropped with maize preceding organic snap bean cultivation. *Horticultura Brasileira* 39: 319-323.

GOULART, JM; ROCHA, AA; ESPINDOLA, JAA; ARAÚJO, ES; GUERRA, JGM. 2021a. Agronomic performance of sweet potato crop in succession to leguminous plants in monocropping and intercropped with corn. *Horticultura Brasileira* 39: 186-191.

LANA, LO; GUERRA, JGM; ESPINDOLA, JAA; ARAÚJO, ES. 2012. Avaliação de genótipos de milho com dupla aptidão para produção de minimilho e biomassa para adubação verde. Seropédica, RJ: Embrapa Agrobiologia, 20p. (Boletim de pesquisa e desenvolvimento, 85).

MATOSO, ADO.; SORATTO, RP; CECCON, G; FIGUEIREDO, PG; LUIZ NETO, A. 2013. Desempenho agronômico de feijão-caupi e milho semeados em faixas na safrinha. *Pesquisa Agropecuária Brasileira* 48: 722-730.

MERCANTE, FM; HUNGRIA, M; MENDES, IC; REIS JÚNIOR, FB; ANDRADE, DS. Fixação biológica de nitrogênio em adubos verdes. 2014. In: LIMA FILHO, OF; AMBROSANO, EJ; ROSSI, F; DONIZETI, JA (org). Adubação verde e plantas de cobertura no Brasil - Fundamentos e Prática. 1ed. Brasília: Embrapa Informação Tecnológica, 2: 241-267.

NOGUEIRA, ARA; SOUZA, GB. 2005. Manual de laboratórios: solo, água, nutrição vegetal, nutrição animal e alimentos. São Carlos: Embrapa Pecuária Sudeste. 313 p.

OLIVEIRA, FC; GEISENHOFF, LO; ALMEIDA, ACSA; LIMA JÙNIOR, JA; NIZ, AIS; BARBIERO, DF. 2016. Produtividade do brócolis de cabeça sob diferentes doses de adubação nitrogenada. *Revista Agrarian* 9: 326-333.

PAZ, LB; GALLO, ADS; SOUZA, RDL; OLIVEIRA, LVN; CUNHA, C; SILVA, RF.

2017. Desempenho e produtividade do milho safrinha em consórcio com leguminosas em sistema orgânico. *Revista de Ciências Agrárias* 40: 788-794.

PEREIRA FILHO, IA; CRUZ, JC. 2001. Manejo cultural de minimilho. Embrapa Milho e Sorgo. EMBRAPA. CNPMS, 4p. (Circular Técnica 7).

QUEIROZ, LR; COELHO, FC; BARROSO, DG; GALVÃO, JCC. 2008. Cultivo de milho consorciado com leguminosas arbustivas perenes no sistema de aleias com suprimento de fósforo. *Revista Ceres* 55: 409-415.

R Core Team. 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

ROSA, JMO; WESTERICH, JN; WILCKEN, SRS. 2015. Reprodução de *Meloidogyne enterolobii* em olerícolas e plantas utilizadas na adubação verde. *Ciência Agronômica* 46: 826-835.

SANT'ANNA, SAC.; MARTINS, M; GOULART, JM; ARAÚJO, SN; ARAÚJO, ES; ZAMANC, M; JANTALIA, CP; ALVES, BJR; BODDEY, RM; URQUIAGA, S. 2018. Biological nitrogen fixation and soil N_2O emissions from legume residues in an Acrisol in SE Brazil. *Geoderma Regional* 15: e00196.

SANTOS, HG; JACOMINE, PKT; ANJOS, LHC; OLIVEIRA, VA; LUMBRERAS, JF; COELHO, MR; ALMEIDA, JA; ARAUJOFILHO, JC; OLIVEIRA, JB; CUNHA, TJF. 2018a. Sistema Brasileiro de Classificação de Solos. 5.ed., Brasília, DF: Embrapa. 353p.

SANTOS, RF; INOUE, TT; SCAPIM, CA; CLOVIS, LR; MOTERLE, LM; SARAIVA, FCS. 2014b. Effect of nitrogen and potassium fertilization on baby corn yield. *Revista Ceres* 61: 121-129.

SIQUEIRA, APP; SIQUEIRA, MFB. 2013. Bokashi: adubo orgânico fermentado. Niterói: *Programa Rio Rural*, 16p. (Programa Rio Rural Manual Técnico, 40).

SOUZA, RFD; FIGUEIREDO, CCD; MADEIRA, NR; ALCÂNTARA, FAD. 2014. Influência de sistemas de manejo e cobertura vegetal na dinâmica da matéria orgânica de solo cultivado com hortaliças. *Revista Brasileira de Ciência do Solo* 38: 923-933.

VIEGAS NETO, AL; HEINZ, R; GONÇALVES, MC; CORREIA, AMP; MOTA, LHDS; ARAÚJO, WD. 2012. Milho pipoca consorciado com feijão em diferentes arranjos de plantas. *Pesquisa Agropecuária Tropical* 42: 28-33.