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Associations between morpho-agronomic traits in Conilon (*Coffea canephora*) 8142 with different green manure management

Associações entre caracteres morfo-agronômicos em Conilon (*Coffea canephora*) 8142 com diferentes manejos de adubação verde

Asociaciones entre rasgos morfoagronómicos en Conilon (*Coffea canephora*) 8142 con diferentes manejos de abono verde

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Abstract

The work consisted of the morpho agronomic evaluation of coffee crop under the influence of intercropping with different types of green manures. The experiment was carried out in the Southern Region of the State of Espírito Santo, Brazil. The experimental plot consisted of five plants per experimental unit, using the clone "Incaper 8142" ConilonVitória, intercropping with different types of green manure plants, which were: guandu beans (*Cajanus cajan*), pig bean (*Canavalia ensiformis*), mucuna preta (*Mucuna Pruriens*) and Mexican margaridão (*Tithonia diversifolia*) in addition to a control treatment without green manure. The planting

consisted of rows adjacent and located in the “upper interline” meaning is not clear of the coffee crop. The morpho agronomic characteristics evaluated were: plant height, orthotropic branch diameter, plagiotropic branch diameter, number of leaves, number of nodes, number of orthotropic branches, number of plagiotropic branches and productive nodes e productivity green coffee kg/ha, besides the main dependent: The characteristics of greatest direct contribution were number of nodes and number of productive nodes. The species of green fertilizer Mexican Margaridão (*Tithonia diversifolia*) provided a negative effect on the main variables related to production, and is not recommended for interplanting with robusta coffee.
Keywords: *Coffea Canephora*; Robusta; Conilon; Consortium; Correlations; Track analysis.

Resumo

O trabalho consistiu na avaliação morfoagronômica da cultura do café sob a influência do consórcio com diferentes tipos de adubos verdes. O experimento foi realizado na Região Sul do Estado do Espírito Santo, Brasil. A parcela experimental constou de cinco plantas por unidade experimental, utilizando o clone "Incaper 8142" Conilon Vitória, consorciadas com diferentes tipos de adubos verdes, quais sejam: feijão guandu (*Cajanus cajan*), feijão suíno (*Canavalia ensiformis*), mucuna preta (*Mucuna pruries*) e mexicano margaridão (*Tithonia diversifolia*) além de um tratamento controle sem adubo verde. O plantio consistia em fileiras adjacentes e localizadas na “interlinha superior”, o que não é claro para a cultura do café. As características morfoagronômicas avaliadas foram: altura da planta, diâmetro do ramo ortotrópico, diâmetro do ramo plagiotrópico, número de folhas, número de nós, número de ramos ortotrópicos, número de ramos plagiotrópicos e nós produtivos e produtividade café verde kg/ha, além do principal dependente: As características de maior contribuição direta foram número de nós e número de nós produtivos. A espécie de fertilizante verde Mexican Margaridão (*Tithonia diversifolia*) apresentou efeito negativo nas principais variáveis relacionadas à produção, não sendo recomendada para o intercalamento com café robusto.
Palavras-chave: *Coffea Canephora*; Robusta; Conilon; Consórcio; Correlações; Análise de faixas.

Resumen

El trabajo consistióen la evaluación morfoagronómica del cultivo del café bajo la influencia del consorcio con diferentes tipos de fertilizantes verdes. El experimento se llevó a cabo en la Región Sur del Estado de Espírito Santo, Brasil. La parcela experimental consistió en cinco plantas por unidad experimental, utilizando el clon "Incaper 8142" Conilon Vitória, intercalado con diferentes tipos de abonos verdes, a saber: guandú (*Cajanus cajan*), frijol porcino (*Canavalia ensiformis*), mucuna negra (*Mucuna pruriens*) y margarita mexicana (*Tithonia diversifolia*) además de un tratamiento control sin abono verde. La siembra consistió en hileras adyacentes y ubicadas en la "hilera superior", lo que no es claro para el cultivo del café. Las características morfo agronómicas evaluadas fueron: altura de planta, diámetro de la rama ortotrópica, diámetro de la rama plagiotrópica, número de hojas, número de nudos, número de ramas ortotrópicas, número de ramas plagiotrópicas y nodos productivos y productividad de café verde kg/ha, además de la dependiente principal: Las características de mayor contribución directa fueron el número de nodos y el número de nodos productivos. La especie de fertilizante verde mexicano Margaridão (*Tithoniadiversifolia*) tuvo un efecto negativo en las principales variables relacionadas con la producción, y no se recomienda su intercalación con café robusto.

Palabras clave: *Coffea Canephora*; Robusta; Conilon; Consorcio; Correlaciones; Análisis de pista.

1. Introduction

Coffee is a highly prized beverage in various parts of the world, production estimates for 2019-2020 are 167.4 million bags of green coffee, and 42.8% of this total corresponds to the species *Coffea Canephora Known* as conilon or robusta (International Coffee Organization - ICO, 2019). This percentage represents 71.72 million bags, 1.5% more than the previous harvest.

Although the *Coffea arabica* species is the most cultivated in Brazil, the *Coffea canephora* species has potential for increased national production. According to the National Supply Company - CONAB (2020), Coffea canephora occupies an average planted area of 400 thousand hectares and corresponds to approximately 25% of national production.

Espírito Santo concentrates its agriculture on the production of coffee, especially *Coffea canephora*, which contributes approximately 76% of Brazilian conilon production. However, it is the largest conilon producer in the country (Capixaba Institute for Technical Assistance and Research in Rural Extension - INCAPER, 2019). Despite the high productivity, the production cost of this crop remains high, with the need to prioritize techniques that aim to reduce these costs.

The use of legumes capable of symbiotic bacteria fixing atmospheric nitrogen can act as a nitrogen source for coffee trees (Coelho et al., 2006; Ricci et al., 2002). Green manure plants of the Fabaceae family concentrate other nutrients in the superficial layer of the soil due to the mineralization of the organic matter, and, in addition, it promotes improvements in the root environment of the coffee trees due to nitrogen mineralization, making them less subject to attack *Cercospora Sp*. and more resistant to losses of productive branches (Chaves, 2001).

Productivity is the main characteristic used in the selection of new varieties and strains of coffee (Carvalho et al., 2010). Research involving perennial plants such as coffee, requires a long research time to confirm unequivocal results. Thus requiring improvement programs with large volumes of physical, financial and human resources, being advantageous to practice the selection of superior genotypes (Rodrigues et al., 2015).

Productivity is the main characteristic used in the selection of new varieties and strains of coffee (Carvalho et al., 2010).

The correlation allows to identify among the characteristics evaluated, those with the greatest direct effect in favor of selection, in such a way that the correlated response through indirect selection is efficient (Galarça et al., 2010). Despite the usefulness of correlations in understanding a complex character such as production, it only informs about the association between characters (Sobreira et al., 2009), not determining the importance of the direct and indirect effects of the characters that compose it (Teixeira et al., 2012).

Furthermore, the fact that the direct interpretation of the magnitudes of the correlations can result in mistakes in the selection strategy, since a high correlation between two characters may be the result of the effect of a third character, or of a group of characters, about them (Wright, 1921).

To improve the understanding of the association between characters, Wright (1921) proposed a methodology that allows, through the standardization of variables and regression equations, to unfold the genotypic correlations in direct and indirect effects of the explanatory variables on a main characteristic, providing a measure of the influence of each cause and its effect. This methodology is called trail analysis.

Therefore, the objective of this work was to evaluate the relationship between morphological and agronomic traits with the direct and indirect effects of the coffee trail coefficients in intercropped plant in gand managed with different green manur especies.

2. Materials and Methods

The experiment was carried out in the municipality of Alegre-ES, Oeste and an altitude of approximately 134 m. The Climate is characterized as a dry season in winter and hot and rainy summer - with an average e annual temperature of 22.2ºC, ranging from 17° to 29°C.

The experiment was a randomized block design with a 4x2+1 factorial, totaling 9 treatments and 4 replications. Four green manure plants -pigeon peas, pork beans, black mucuna, Mexican daisy –intercropped in two levels both sides or one side above the coffee rowand one factor of conventional fertilization. The crop has an average age of seven years, with a plant population of approximately 1.672 plants per hectare and installed in soil with a slope of 11%.

The experimental unit consisted of five coffee plants, clonal variety “Incaper 8142” ConilonVitória variety 12V (precocious), with a spacing of 2.30 x 2.60 meters. At leastone coffee rowisused between the experimental units.

Green manure plants evaluated were: guandu beans, black mucuna, pig bean and Mexican margarida, in both adjacent lines (100%) and only in the line located in the upper line (50%), in addition to a control treatment, without green manure, with conventional fertilization.

Before the installation of the experiment, soil samples were collected from the 0–20 cm deep layer and analyzed according to the methodology recommended by (Embrapa, 1999). For each treatment, 15 simple samples were collected and placed in a laboratory wash container for analysis. The physical and chemical attributes of the soil before planting green manures are shown in Table 1.

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Table 1. Chemical analysis of the areas studied prior to setting up the coffee experiment intercropped with green fertilizers (pork beans, pigeon peas, black mucuna, Mexican daisy) and the control. Performed an average of 15 samples.

Determinations	I	II	III	IV	V
M.O dag/dm^3	1.2	1.0	1.2	1.3	1.4
pH	5.5	5.4	5.4	5.4	5.5
P mg/dm^3	3.4	3.7	3.2	3.4	4.2
K mg/dm^3	78	60	98	41	72
Cacmol/dm^3	2.2	2.6	2.6	2.6	2.6
Mg $cmol/dm^3$	0.7	0.8	0.9	0.9	0.8
Al $cmol/dm^3$	0.35	0.24	0.26	0.21	0.18
H+Alcmol/dm^3	5.80	5.30	5.30	5.10	5.30
SB $cmol/dm^3$	3.10	3.55	3.75	3.60	3.58
CTC $cmol/dm^3$	8.90	8.85	9.05	8.70	8.88
V %	35	40	41	41	40
% K CTC	2	2	3	1	2
% Ca CTC	25	29	29	30	29
% Mg CTC	8	9	10	10	9
% Al CTC	3.9	2.7	2.9	2.4	2.0
% H+Al CTC	65	60	59	59	60
P-rem mg/L	28.6	31.6	32.9	28.1	32.7
S. monóico mg/dm^3	28	30	20	26	20
B mg/dm^3	0.40	0.50	0.60	0.50	0.60
Zn mg/dm^3	0.5	0.6	0.7	0.6	1.2
Mn mg/dm^3	15.2	12.5	17.4	13.0	16.1
Cu mg/dm^3	0.3	0.2	0.3	0.2	0.3
Fe mg/dm^3	32	37	36	28	34

I – Pigeon Peas; II - Black Mucuna; III - Pork Beans; IV - Mexican Margarida; V – control. NOTE: M.O = Organic matter; SB = Sum by base; CTC= Cation Exchange Capacity; P-rem = Remaining phosphorus; V = Base saturation. Source: authors.

Legumes were sown or planted approximately 1.30 m from the stem of coffee trees in a single row, in a furrow arranged between the lines of the coffee trees. The sowing densities indicated in the technical recommendations of Embrapa (2000) were used for pigeon pea, black mucuna and pork bean please indicate the average distance between seed or established plants for each species. Mexican daisy was planted using cuttings about 20 cm long, spaced 50 cm apart.

Green manure was cut or pruned, in full bloom. The black mucuna and the porkbean were cut with a portable brush cutter and left on the soil surface. Subsequently, it became a sowing of these species again in each treatment. Pork bean cutting occurred up to 75 days after sowing, when the plants were in full bloom soon after replanting was carried out. Black mucuna wascut 90 days after sowing, plants were in the vegetative stage. Pigeon pea waspruned1.2 m when the plants reached 1.70 m, 90 days after planting, a period in which the species was found in vegetative growth (Calegari, 1995). In the absence of bibliographic references for handling Mexican daisy, it was pruned similar to pigeon pea as it presents similar vegetative growth.

The control treatment (conventional fertilization) was fertilized three times: at the stage of grain pellets not clear, fruit about 5 mm diameter, at the beginning of the stage of parchment hardening and after harvest during vegetative rest, in October, November and February, respectively. The mineral fertilization per plant was composed of 45 g of urea, 27.5 g of potassium chloride and 35 g of simple superphosphate, in each season, according to the recommendations of the soil analysis of the area follow ing the recommendations of Prezotti and Muner (2008).

The morpho-agronomic characteristic se valuated in coffee trees were:

I. Length of the largest orthotropic branch, the largest orthotropic branch was selected and measured from 2 cm from the soil surface to its summit (m). This characteristic was named as plant height (ALT);

II. Diameter of the orthotropic branches (DRO), with standardized measurement in the central region of the second internode of each of the two branches (mm);

III. Diameter of the plagiotropic branch productive (DRP) measured in the second internode from the center of the plant to the tip of the selected branch;

IV. Number of leaves on the plagiotropic branches (NF), obtained by counting these leaves in the plagiotropic branches;

V. Number of productive and non-productive nodes (NO) in the plagiotropic branches obtained by direct counting in the plagiotropic branches;

VI. Number of orthotropic branches (NRO) obtained by direct counting of plants;

VII. Number of plagiotropic branches per orthotropic (NRP), obtained by direct counting two orthotropic branches per plant;

VIII. Number of productive nodes in the plagiotropic branches (NP), obtained by directly counting the nodes in the selected branches;

IX. Kilograms of coffee produced per plant (kg) obtained by weighing the coffee after harvest, on a digital scale.

X. The height of the coffee fruit was extracted from pendulum to crown (AFRUT) measured by the harvest of each experimental unit.

XI. Diameter of coffee fruit(DFRUT) measured by harvesting each experimental unit.

Measure were per formed with digital tweezers and manual measuring tape. Allvariables were collected during the experimental period.

In the next stage, the computational application R Core Team (2017) the correlation matrix between the morpho agronomic characteristics evaluated was constructed. Given the presence of collinearity between characteristics (high degree of interrelation), a multicollinearity analysis was performed, with correlation matrix eigenvalues analysis, to identify the nature of the linear dependence between the characters and to detect which ones contributed to the emergence of multicollinearity. When necessary, some of the characteristics were discarded, choosing among those considered redundant, by maintaining the one that offered the greatest contribution to explaining productivity. In the sequence, a path analysis was performed, having as main dependent variable.

3. Results and Discussion

Phenotypic correlations were selected to be used since the phenotype is usually used as the basis for selection. The variables that correlate phenotypically have practical selection value since they have a high genetic component in their phenotypic expressions, resulting in gains via visual selection (Andrade et al., 2010; Ferreira et al., 2007).

Positive and relevant correlations observed between the two maneuvers studied 50 and 100%. Among them are the number of node (NO) on diameter of plagiotropic branches (PRD) with (0.60 and 0.64 one and two rows of green manure), number of plagiotropic branch (NRP) in the management 50% (one row) and diameter of the plagiotropic branch (DRP) (0.66), in the same variable correlated with number of leaves for both one and two rows of green manure of 0.88 and 0.86 respectively, in the correlations of productive node (NP) and stem diameter (DRO) in the management 50% values of positive magnitudes (0.64) were provided, which does not occur in the 100% management in which a negative magnitude correlation of (-0.67) was obtained, evaluating the 50% management on the NP variable, positive correlation was identified on NF and NRP with 0.74 and 0.84 (Table 2).

For the variable Kg, positive correlations were obtained over NF and NRP with magnitudes of 0.67 and 0.66 and fruit height (AFRUT) correlated positively with NF and NRP with 0.77 and 0.73 in 100% management in the correlation with Kg, it was observed that both managements excelled with a correlation of positive magnitudes of 0.71 and 0.74.

Table2. Correlations between morpho-agronomic traits with different types of management and green fertilizers in coffee.

Variáveis	Manejo	DRO	DRP	NF	NO	NRO	NRP	NP	KG	AFRUT	DFRUT
ALT	50%	0.1979	0.1373	-0.1309	-0.0635	0.1370	-0.1986	0.0151	-0.0680	0.0829	0.2217
	100%	0.4945	0.0738	0.3032	0.3129	-0.3968	0.3231	-0.3169	0.4408	0.4897	0.0704
DRO	50%		0.4269	0.5011	0.1417	0.3174	0.5610	0.6433	0.3493	0.4099	0.3815
	100%		-0.0293	0.4383	0.3562	0.0260	0.5545	-0.6759	0.4833	0.5283	0.4436
DRP	50%			0.5236	0.6022	0.2379	0.6667	0.5190	-0.0248	-0.0836	0.3846
	100%			-0.1807	0.6466	-0.1008	0.1214	-0.1956	-0.0010	-0.1264	0.1336
NF	50%				0.0187	0.1913	0.8819	0.7405	0.4084	0.5120	0.4260
	100%				0.0250	-0.1147	0.8633	-0.2541	0.6727	0.7732	0.3182
NO	50%					0.2614	0.1641	0.1713	-0.4967	-0.5347	0.0042
	100%					-0.0579	0.3470	-0.4823	0.0305	0.0070	0.1445
NRO	50%						0.1741	0.3294	-0.0338	0.0705	-0.2054
	100%						-0.0685	0.0401	-0.0856	-0.0784	-0.0289
NRP	50%							0.8460	0.4011	0.4204	0.3741
	100%							-0.5063	0.6603	0.7350	0.2650
NP	50%								0.4317	0.4666	0.2488
	100%								-0.3292	-0.3233	-0.0870
KG	50%									0.7149	0.3872
	100%									0.7447	0.0701
AFRUT	50%										0.2153
	100%										-0.0157

Length of the largest orthotropic branch (ALT), Diameter of the orthotropic branches (DRO), .Diameter of the plagiotropic branch productive (DRP), Number of leaves on the plagiotropic branches (NF), Number of productive and non-productive nodes (NO), Number of orthotropic branches (NRO), Number of plagiotropic branches per orthotropic (NRP), Number of productive nodes in the plagiotropic branches (NP), Kilograms of coffee produced per plant (kg), The height of the coffee fruit was extracted from pendulum to crown (AFRUT), Diameter of coffee fruit (DFRUT). Green manure plants evaluated were: guandu beans, black mucuna, pig bean and Mexican margaridão, in both adjacent lines (100%) and only in the line located in the upper line (50%), in addition to a control treatment, with conventional fertilization. Source: Authors.

According to Nogueira et al., (2012), in the interpretation of correlations, three aspects should be taken into account: magnitude, direction and significance. The positive correlation coefficient estimate indicates the tendency of one variable to increase when the other also increases, and negative correlations indicate a tendency for one variable to increase while the other decreases.

According to Cruz and Carneiro (2012), when a character correlates positively with some and negatively with others, there is an indication of additional care, because, when selecting a certain character, undesirable changes can be provoked in others.

Productivity is a primary component that should be taken into account in the selection process, whether in the management in the choice of genotype or even of the treatment applied, however, when the explanatory variables are correlated with each other, the research should be focused on the unfolding of existing correlations, their direct and indirect effects, to evaluate the degree of importance of each of the explanatory variables with the main one (Oliveira et al., 2010).

In the evaluation of the coefficients of determination (R2) effects of high magnitudes were observed for the evaluated treatments being 0.98 and 0.99. These results found (Table 3) corroborate those of Dalcolmo (2012), who obtained a determination coefficient equal to 1.00 by means of trial analysis in genotypes of conilon coffee. The coefficients of the R^2 determinations, considered high, show that the variations occurring in the basic variable were explained by the measured variables.

The direct effects of the primary components on production per plant in kg were of low magnitudes for ALT, DRO, DRP, NF and NO not exceeding (0.60) in the two managements adopted (Table 3). The same does not occur in the characteristics NRO, NRP, NP, obtained high magnitudes through direct effect the production in Kg values were above (0.88) in both managements studied. For the Characteristics AFRUT and DFRUT, the magnitudes were high with values above 0.90, respectively, for 50% management.

The influence of these variables is directly related to the productivity of the coffee plants studied in the mediated that one character increases the other also providing better performance in the final production.

According to Carvalho et al. (2010) and Teixeira et al. (2012) and few studies involving the species *Coffea canephora*, conilon variety. In addition, no studies of this nature were found, obtained in situations where conilon coffee crops received different ty peso green fertilization.

Evaluating the 50% management, indirect effects of NRO via NRP was of high magnitude with a value of (0.92), for the NRP character indirect effects were observed via NRO and NP with values of 0.91 and 0.99 respectively (Table 3). The NP character via indirect effect on NRO and NRP in both managements were of high magnitudes with 0.85 to 0.92 respectively (Table 3).

This is due to the source-drain relationship existing in the plant. Because the higher the number of fruits per plant, the greater the competition for photoassimilates, resulting in lower fruit mass.

These results were similar to those presented by (Dalcolmo, 2012) and Costa Jaeggi et al. (2019), in the coffee crop, in which the decrease in fruit number sallowed thein crease of mass (size).

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Table 3. Direct and indirect effects of morphoagronomic coffee variables in response to types of green manure and management.

Variable	Effect	Via	Single row green manure	Two row green manure
ALT	Direct	Kg	-0.2723	0.1927
	Indirect	DRO	0.0030	0.2407
		DRP	0.0251	0.0326
		NF	0.0404	0.1766
		NO	0.0346	-0.1385
		NRO	0.0094	-0.0212
		NRP	0.0252	0.0325
		NP	0.0075	-0.0267
		AFRUT	-0.0248	-0.0227
		DFRUT	0.0835	-0.0252
	Total		-0.0679	0.4407
DRO	Direct	Kg	0.0154	0.4868
	Indirect	ALT	-0.0539	0.0953
		DRP	0.0780	-0.0129
		NF	-0.1549	0.2552
		NO	-0.0772	-0.1577
		NRO	0.0219	0.0013
		NRP	-0.0714	0.0558
		NP	0.3244	-0.057
		AFRUT	0.1230	-0.0244
		DFRUT	0.1438	-0.1589
	Total		0.3492	0.4833
DRP	Direct	Kg	0.1829	0.4424
	Indirect	ALT	-0.0373	0.0142
		DRO	0.0066	-0.0142
		NF	-0.1619	-0.1052
		NO	-0.3283	-0.2863
		NRO	0.0164	-0.0053
		NRP	-0.0848	0.0122
		NP	0.2617	-0.0165
		AFRUT	-0.0250	0.0058
		DFRUT	0.1450	-0.0478
	Total		-0.0248	-0.0009
NF	Direct	Kg	-0.3093	0.5824
	Indirect	ALT	0.0356	0.0584
		DRO	0.0077	0.2133
		DRP	0.0957	-0.0799
		NO	-0.0102	-0.0110
		NRO	0.0132	-0.0061
		NRP	-0.1122	0.0870
		NP	0.3734	-0.0214
		AFRUT	0.1536	-0.0358
		DFRUT	0.16060	-0.1140

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	Total		0.4084	0.6727
NO	Direct	Kg	-0.5452	-0.4428
	Indirect	ALT	0.0173	0.0602
		DRO	0.0021	0.1733
		DRP	0.1101	0.2860
		NF	-0.0057	0.0145
		NRO	0.0180	-0.0030
		NRP	-0.0208	0.03496
		NP	0.0864	-0.0407
		AFRUT	-0.1604	-0.0003
		DFRUT	0.0015	-0.0517
	Total		-0.4967	0.0305
NRO	Direct	Kg	0.9012	0.8970
	Indirect	ALT	-0.0373	-0.0764
		DRO	0.0049	0.0126
		DRP	0.0435	-0.0446
		NF	-0.0591	-0.0667
		NO	-0.1425	0.0256
		NRP	0.9221	-0.0069
		NP	0.1661	0.0033
		AFRUT	0.0211	0.0036
		DFRUT	-0.0774	0.0103
	Total		-0.0338	-0.0856
NRP	Direct	Kg	0.9072	0.8807
	Indirect	ALT	0.0540	0.0622
		DRO	0.0086	0.2699
		DRP	0.1219	0.0537
		NF	-0.2727	0.5027
		NO	-0.0894	-0.1536
		NRO	0.9120	-0.0036
		NP	0.99266	-0.2427
		AFRUT	0.1261	-0.0340
		DFRUT	0.1410	-0.0949
	Total		0.4011	0.6602
NP	Direct	Kg	0.9043	0.8840
	Indirect	ALT	-0.0040	-0.0610
		DRO	0.0099	-0.3290
		DRP	0.0949	-0.0865
		NF	-0.2290	-0.1479
		NO	-0.0934	0.2136
		NRO	0.9227	0.9021
		NRP	0.9076	0.8510
		AFRUT	0.1400	0.0149
		DFRUT	0.0937	0.0311
	Total		0.4316	-0.3292
AFRUT	Direct	Kg	0.9201	-0.0463
	Indirect	ALT	0.0225	0.0943
		DRO	0.9063	0.2571

		DRP	-0.0152	-0.0559
		NF	-0.1583	0.4503
		NO	0.2915	-0.0031
		NRO	0.0048	-0.0041
		NRP	-0.0535	0.0740
		NP	0.8353	-0.0273
		DFRUT	0.9811	0.2056
	Total		0.7148	0.7447
DFRUT	Direct	Kg	0.9770	-0.3584
	Indirect	ALT	-0.0603	0.0135
		DRO	0.9059	0.9159
		DRP	0.0703	0.0591
		NF	-0.1317	0.1853
		NO	-0.0022	-0.0639
		NRO	-0.0141	-0.0015
		NRP	-0.0476	0.0267
		NP	0.9254	-0.0073
		AFRUT	0.9646	0.9007
	Total		0.3871	0.0700
Coefficient of determination			0.9887	0.9725
Effect of residual variable			0,1080	0,1256

Length of the largest orthotropic branch (ALT), Diameter of the orthotropic branches (DRO), .Diameter of the plagiotropic branch productive (DRP), Number of leaves on the plagiotropic branches (NF), Number of productive and non-productive nodes (NO), Number of orthotropic branches (NRO), Number of plagiotropic branches per orthotropic (NRP), Number of productive nodes in the plagiotropic branches (NP), Kilograms of coffee produced per plant (kg), The height of the coffee fruit was extracted from pendulum to crown (AFRUT), Diameter of coffee fruit (DFRUT). Green manure plants evaluated were: guandu beans, black mucuna, pig bean and Mexican margaridão, in both adjacent lines (100%) and only in the line located in the upper line (50%), in addition to a control treatment, with conventional fertilization. Source: Authors.

Through the path analysis, with a causal diagram, it was found that the primary components (AFRUT and DFRUT) resulted in high magnitudes of direct effects with values of 0.92 and 0.97 in management 50% respectively. In the evaluation of the indirect effects of AFRUT via DRO, NP and DFRUT on productivity (Kg) the values were of high magnitudes, above 0.90, 0.83 and 0.98 respectively. The same occurred with DFRUT character via indirect effect DRO, NP and AFRUT with values of 0.90, 0.92 and 096 respectively.

In situations similar to this, the use of indirect causal factors is considered simultaneously in the selection process. In this context, indirect selection can be performed via NP, AFRUT, DRUT and DRO since, of the secondary morphological variables, it was the one with the greatest direct and indirect effect on the basic variable.

These results corroborate Dalcolmo (2012) in which the secondary variable with the greatest contribution were diameters of the orthotropic branches (OD), because it has shorter internode lengths accumulating more carbohydrate possibly used later for plant maintenance and production.

When comparing the results of the estimates of correlations and trail coefficients, it is perceived that it is possible to identify, after the unfolding of the correlation in direct and indirect effects, which are the variables that exert the greatest influence on coffee productivity, concentrating efforts on the variables that will provide greater gains with the selection of character indirect tly whentested phytotechnical managements (Dalcolmo, 2012).

4. Conclusions

The trail analysis was efficient in identifying the characteristics that exerted the greatest influence on the productivity of *Coffea canephora* clone 12V submitted to different fertilization and management.

The characteristics such as productive node (NP), fruit height (AFRUT) and fruit diameter (DFRUT), were those that exerted direct effect and number of plagiotropic branches (NRP) indirectly influenced the productivity of *Coffea canephora* clone 12V after green fertilization and management 50%.

In view of the presupposed work of morpho-agronomic evaluation in a green fertilization system, it may later become a source for future researchers who will use it in the choice of the best alternative fertilization for the management of coffee plantations.

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