INTERRELATIONS OF CLIMATOLOGICAL AND PHYSIOLOGICAL ATTRIBUTES AND COMPONENTS OF SOYBEAN SEEDS YIELD

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ABSTRACT – The objective of this work was to evaluate the interrelations between the climatic attributes, the physiological quality of seeds and the components of soybean yield from different levels of vigor. The experimental design used was the one of blocks at random, where the treatments were composed by DM 5958RSF IPRO®, belonging to the maturation group 5.8 and indeterminate growth habit was used. Before sowing, the seeds were stratified in batches with different levels of vigor. The obtained data were submitted to analysis of variance, later they were submitted to canonical correlation analysis. For the establishment of canonical groups the characters were separated into physiological (group I) and morphological and yield components (Group II). The group of morphological characters: thousand seed mass, germination, accelerated aging, electrical conductivity, viability and vigor, shoot and root length, shoot and root dry mass, field emergence are strongly associated with the yield components of soybean, regardless of the vigor level used. Depending on the level of vigor used, the maximum temperature, minimum temperature, average temperature, relative humidity, soil temperature at five centimeters, soil temperature at ten centimeters, radiation and precipitation influence the soybean yield components differently. From the climatic variables: maximum temperature, minimum temperature, average temperature, relative humidity, soil temperature at five centimeters, soil temperature at ten centimeters, radiation and precipitation, it is possible to predict morphological characters and yield components of soybean.

Keywords: environments effects, Glicine max L., production of seeds.

INTRODUCTION

Brazil is the second largest soybean producer in the world, with a production of 119.2 million tons in the 2017/2018 crop. Among the states, Rio Grande do Sul is the third largest soybean producer nationwide, only behind the states of Mato Grosso and Paraná. The state in the 2017/2018 harvest showed a production of 17.1 million tons, with an average yield of 3013 kg ha^{-1}, 11% lower than the National average (Conab, 2018).

The oscillation in the crop yield, mainly stems from factors that are beyond the control of the farmer. Climatic events such as photoperiod, air temperature, solar radiation, relative air humidity and precipitation that have strong action in the period of the crop development (Motta et al., 2000), as well as being distributed from the germination to the seed filling.

The germination process can be defined as the development of the essential structures of the embryo, manifesting the capacity to give rise to a normal seedling, under favorable environmental conditions (Marcos Filho, 2015). In contrast, vigor refers to properties that determine the potential for rapid, uniform emergence as well as the development of normal seedlings under adverse environmental conditions (Krzyzanowski et al., 1999; Oliveira et al., 2009). It can also be inferred that the vigor reflects in the competitive ability of the plant in inter and intraspecific scope.

The understanding of the relationships arising from climatological processes, as well as their inferences

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about what comprises the quality of seed, becomes essential. Through the oscillations resulting from these processes, scientists and farmers can seek the best solution to increase and sustain production chains.

In this way, identification analyzes and predictions can be used in order to carry out the selection of determinant attributes related to seed quality and yield. In this sense, the objective of this work was to evaluate the interrelations between the climatic attributes, the physiological quality of seeds and the components of soybean yield from different levels of vigor.

MATERIAL AND METHODS

The experiment was conducted in Passo Fundo - RS, located at coordinates 28º15'46 ''S and 52º24'24''W, with an altitude of 687 meters. The soil was classified as Typic Dystrophic Red Latosol (Oxisol) (Streck et al., 2008) and subtropical humid climate, type Cfa, as proposed by Köppen.

For this study the cultivar DM 5958RSF IPRO®, belonging to the maturation group 5.8 and indeterminate growth habit was used. Before sowing, the seeds were stratified in batches with different levels of vigor. For this procedure, the accelerated aging method was used, so that the seeds were distributed in single layers of approximately 250 grams and arranged on an aluminum screen fixed in the interior of a plastic container. In the container, 240 ml of distilled water were added and placed in an aging chamber set at 41°C for 48, 84 and 96 hours (Aosa, 1983). Then, the seeds were submitted to the germination test (BRASIL, 2009), this criterion was established to define the levels of vigor in 90% (high), 70% (medium) and 60% (low).

Correction of soil fertility and acidity was performed based on the previous analysis following the instructions of the manual of fertilization and liming (CQFS, 2016). 300 kg ha^{-1} of fertilizer N.P.K in the formulation 02-20-20 at the sowing base was used in the first half of November 2016. Seed density of 30 m^{-2} seeds was used. The experimental units were composed of five sowing rows with five meters in length, spaced 0.45 meters, totaling 11.25 m^2. Control of weeds, pest insects and diseases were carried out preventively to minimize the biotic effects on the result of the experiment.

For the evaluation of the yield components, 10 plants were collected from the experimental area, individually evaluated in the Laboratory of Seed Analysis (LDAS), in the Phytotechnology Department of the Faculty of Agronomy Eliseu Maciel, UFPel, in Pelotas, RS. Data were obtained from first pod insertion (FI), plant height (PH), number of pods in the main stem count (NPMS), contribution of the number of pods in the branches (NPB), number of branches in the main stem count (NBMS), contribution of the number of pods with one seed (N1), two seeds (N2) three seeds (N3) and four seeds (N4). Seed yield (SY), according to methodology (Szareski et al., 2015).

For the quality tests of the seeds, the useful area of each experimental unit was collected. The seeds presented around 18% at the time of harvest, and were then dried in a greenhouse with forced ventilation until reaching 12% moisture. The characters were measured by the homogenization of seeds from the plants of the useful area of each experimental unit, these being: Thousand seed mass (TSM), Germination (G) and Field Emergence (FE) according to Brazil methodology (2009). Accelerated aging (AA): based on AOSA (1983) and Marcos Filho (1999) methodologies. Electrical conductivity (EC), viability (VI) and vigor (VG) according to AOSA methodology (1983). Shoot (SL) and root (RL) lengths, shoot (SDM) and root (RDM) dry mass, according to Nakagawan methodology (1999).

The meteorological data were acquired with Embrapa - National Research Center for Wheat, Station: 83914 Passo Fundo. The meteorological variables: MAXT (maximum temperature), MINT (minimum temperature), AVET (average temperature), RH (relative air humidity), TS5 (soil temperature at five centimeters), TS10 (soil temperature at ten centimeters), RAD (solar radiation) and PRE (rainfall precipitation), comprise the period in which the soybean was in the field (from 11/02/2016 to 03/20/2017). After verifying the graph with the daily data, the mean of each variable was calculated.

The obtained data were submitted to analysis of variance, later they were submitted to canonical correlation analysis. For the establishment of canonical groups the characters were separated into physiological (group I) and morphological and yield components (Group II). Group I consists of morphological characters, field emergence (E), germination (G), accelerated aging (AA), tetrazolium test (VIG) and shoot dry mass (SDM). Group II is composed of yield components, ie, first pod insertion (FI); plant height (PH); number of pods in the main stem (NPMS); number of pods in the branches (NPB); number of branches on the main stem (NBMS); number of pods with one seed (N1); number of pods with two seeds (N2); number of pods with three seeds (N3); number of pods with four seeds (N4); thousand seed mass (TSM) and seed yield (SY). According to the procedures described by Cruz et al. (2012).

In order to understand the linear associations between the characters and to make a causal diagram, we determined the linear correlations, where the level of significance of the coefficients was obtained by the t test at 5% probability (Ramalho, 2012). Subsequently, a predictive model based on Stepwise multiple regression was developed, considering the statistical model:

$$yi = \beta0 + \beta1Xi1 + \beta2Xi2 + \cdots + \beta pXip + ei$$

Where:

i : 1, … , n

$Xi1, Xi2, \ldots, Xip$: are values of the constant variables.

$\beta0, \beta1, \beta2, \ldots, \beta p$: regression coefficients.

ei : errors, random and independent.

RESULTS AND DISCUSSION

Estimates of the canonical pair correlation coefficients between the physiological characters (Group I) and the characters linked to the morphology and yield components of the soybean (Group II) show significance through three canonical pairs (high vigor, medium vigor and low vigor). The significance is at the 1% probability level ($p < 0.01$) through the chi-square test, where the high magnitudes of the correlation coefficients show the dependence between the groups of characters (Table 1).

The first canonical pair (high vigor) had a correlation coefficient of r = 0.94 between groups (Table 1), revealing that the higher the values of the thousand-seed mass, number of pods with one, two and three seeds, and number of pods on the main stem (Group II), field emergence, accelerated aging, viability and shoot dry matter (Group I) are potentiated.

The second canonical pair (mean vigor) showed correlation coefficient r = 0.96 between groups (Table 1), showing that the higher the number of pods in the main stem, number of branches in the main stem, number of pods with one, two and three seeds and thousand seed mass (group II), field emergence, viability and shoot dry mass (group I) are potentiated. In this sense it is possible to understand that the higher the values of the yield characters, the stronger the data referring to the vigor and that these are directly related.

The third canonical pair (low vigor) presented correlation coefficient r = 0.90 between groups (Table 1), revealing that the higher the values of first pod insertion, plant height, number of pods in the branches, number of pods with four seeds and seed yield (group II), germination is potentiated (group I).

Table 1 - Canonical charges for the morphological characters (group I) and yield characters (group II) in the canonical correlations (r) between groups, for the three levels of vigor (high, medium and low)

Characters	Canonical pairs		
	High Vigor	Medium Vigor	Low Vigor
Group I			
E[1]	0,1222	0,50	-0,13
G	-0,8501	-0,75	0,82
EA	0,25	-0,04	-0,21
Vi	0,3157	0,86	-0,43
SDM	0,5758	0,82	-0,35
Group II			
FI[2]	-0,2047	-0,48	0,51
PH	-0,0994	-0,33	0,25
NPMS	0,7783	0,23	-0,36
NPB	-0,7783	-0,23	0,36
NBMS	-0,179	0,08	-0,12
N1	0,4551	0,42	-0,40
N2	0,5342	0,66	-0,52
N3	0,2461	0,35	-0,44
N4	-0,0054	-0,25	0,08
TSM	0,7914	0,82	-0,49
SY	-0,4361	-0,33	0,35
r*	0,94	0,96	0,90
p**	<0.0003	<0.003	<0,02

r *: canonical correlation.

p **: probability.

[1] (group I) Field emergence (E); Germination (G); Viability (Via) and shoot dry mass (SDM).

[2] (group II) first pod insertion (FI); plant height (PH); number of pods in the main stem (NPMS); number of pods in the branches (NPB); number of branches in the main stem (NBMS); number of pods with one seed (N1); number of pods with two seeds (N2); number of pods with three seeds (N3); number of pods with four seeds (N4); Thousand seed mass (TSM) and seed yield (SY).

The observed real climatological averages were: Maximum temperature 27.60°C, minimum temperature 16.70°C, average temperature 21.50°C, relative humidity 73.50%, soil temperature at 5 cm 25.17°C, soil temperature at 10 cm 24.88°C, radiation 6.80 MJ m^{-2} day^{-1} and precipitation 5.61 mm (Table 2).

Table 2 - Multiple regression with the contrast between climatological and morphological variables of the seeds grown at different vigor levels

Character	Vigor	α	Climatological data								Predicted value	Real average	CV
			MAXT	MINT	AVET	RH	TS5	TS10	RAD	PRE			
			27,6	16,7	21,5	73,5	25,176	24,885	6,8	5,6122			
	High	44,965	.	.	.	-0,149	-0,694	1,1674	.	0,0597	55,05	46,6	22,2
EC	Medium	93,741	-1,951	1,3365	.	-0,505	.	1,0575	-0,662	.	46,95	47,19	0,54
	Low	32,156	.	-1,346	0,9213	.	0,3879	.	0,1489	0,2823	41,86	43,04	3,9
	High	10,196	.	0,105	.	.	.	.	.	0,0174	12,05	11,95	1,12
SL	Medium	7,9693	0,2448	-0,183	.	.	.	.	-0,07	.	11,19	11,34	1,45
	Low	13,221	-0,045	.	-0,135	0,0589	0,3186	-0,418	0,148	.	12,03	11,91	1,06
	High	14,762	-0,557	.	0,7937	.	-0,119	.	0,1682	.	14,58	14,52	0,45
RL	Medium	14,93	.	.	.	-0,083	-0,044	0,3437	-0,322	.	14,07	14,05	0,17
	Low	16,572	-0,178	.	.	.	0,1376	.	.	.	15,12	15,02	0,7
	High	100	-1,251	-0,615	3,9531	-0,142	0,7378	-2,399	.	0,1309	89,36	89,51	0,24
AA	Medium	101,16	0,6827	0,5396	-1,363	-0,128	0,1073	.	-0,279	0,0306	91,26	91,33	0,11
	Low	103,94	0,2968	.	.	.	0,977	-1,747	-0,236	-0,054	91,36	91,15	0,33
	High	17,395	.	.	.	.	.	.	.	.	.	.	.
E	Medium	27,296	0,9892	.	-1,448	0,0909	.	.	.	0,057	61,02	61,11	0,22
	Low	7,0254	0,9892	.	-1,448	0,091	-1,044	1,925	.	0,0571	57,62	58,38	1,85
	High	85,576	.	.	.	.	.	.	-0,477	.	82,33	81,99	0,44
G	Medium	73,346	.	.	.	-0,138	0,7368	.	.	.	81,79	82,17	0,49
	Low	88,614	.	.	.	.	.	.	-0,871	.	82,69	82,11	0,74
	High	1,1585	.	.	.	-8E-04	.	.	.	-5E-04	1,1	1,09	0,47
SDM	Medium	.	.	.	.	.	.	.	.	.	.	.	.
	Low	1,0037	.	0,0023	.	.	.	.	0,0031	.	1,06	1,07	0,24
	High	-0,048	0,0077	0,0039	-0,016	.	.	0,009	-0,002	.	0,1	0,11	1,97
RDM	Medium	0,3857	-0,004	0,0192	-0,024	-0,003	-0,006	0,015	0,0041	.	0,09	0,12	28,28
	Low	0,2438	0,0056	.	.	.	0,0051	-0,017	.	.	0,11	0,11	0,66
	High	16,248	0,0822	.	.	.	.	-0,075	.	.	166,5	166,6	0,03
TSM	Medium	20,616	.	.	.	-0,032	.	-0,058	-0,059	-0,013	163,5	164,2	0,61
	Low	15,223	-0,271	-0,134	0,2932	0,0129	.	0,1514	0,0273	-0,008	166,8	167,9	0,95
	High	29,695	.	-2,879	.	0,4693	.	2,1077	.	.	68,56	69,63	1,63
VIGOR	Medium	81,42	.	.	.	-0,242	.	.	.	0,3662	65,7	68,1	5
	Low	78,346	.	.	.	.	.	.	-1,069	-0,22	69	69,88	1,79
	High	58,813	1,2479	-1,25	-0,926	0,3694	0,3625	.	.	-0,168	87,82	87,79	0,04
VIAB.	Medium	75,498	-2,463	-1,627	.	.	-1,626	5,6844	.	0,3485	82,83	85,89	5,05
	Low	94,404	.	.	.	.	.	.	-0,831	-0,098	88,21	87,8	0,66

Character: EC (electrical conductivity); SL (shoot length); RL (root length); AA (accelerated aging, E (field emergence), G (germination), SDM (dry shoot mass), RDM (root dry mass), TSM (thousand seed mass), VIGOR, VIAB (viability). α (Intercept); MAXT (maximum temperature); MINT (minimum temperature); AVET (average temperature); RH (relative humidity); TS5 (soil temperature at 5 cm); TS10 (soil temperature at 10 cm); RAD (radiation); PRE (precipitation). CV (coefficient of variation).

When using high-strength seeds, it was found that the maximum air temperature positively influenced PH, N4 (Figure 1), VIA and RDM (Figure 2), negatively the N3 (Figure 1), the AA and RL (Figure 2). The minimum air temperature positively influenced SY, N4 (figure 1), SL, RDM and VIA (Figure 2), and negatively PH (figure 1), AA and VIG (figure 2). The mean air temperature positively influenced NPB, SY, FI (figure 1), FE, RL and AA (figure 2), and negatively the N4, N2, NPMS, PH (figure 1), RDM and VIA (figure 2).

Relative humidity positively influenced PH, N1, FI (figure 1) and VIG (figure 2), and negatively SY (figure 1), AA, EC, SDM and VIA (figure 2). The soil temperature at five centimeters positively influenced N2, N3, N4 (figure 1), AA and VIA (figure 2), and negatively PH, SY, N1, FI (figure 1), RL and EC (figure 2). The soil temperature at 10 centimeters positively influenced the PH, N1, N3, NB (figure 1), EC and VIG (figure 2), and negatively the N4 (figure 1), AA and the RDM (figure 2). According to Silva (2002), soil temperature is one of the most important factors for seed germination and soybean development, where after the study the author found that the optimal temperature for germination lies in the range from 25 to 30ºC.

Radiation positively influenced NB, N3, N4 (figure 1) and RL (figure 2), and negatively the SY (figure 1), RDM and G (figure 2). Precipitation positively influenced NPB (Figure 1), VIA, FE, SL, AA and EC (Figure 2), and negatively NPMS, FI (figure 1) and SDM (Figure 2).

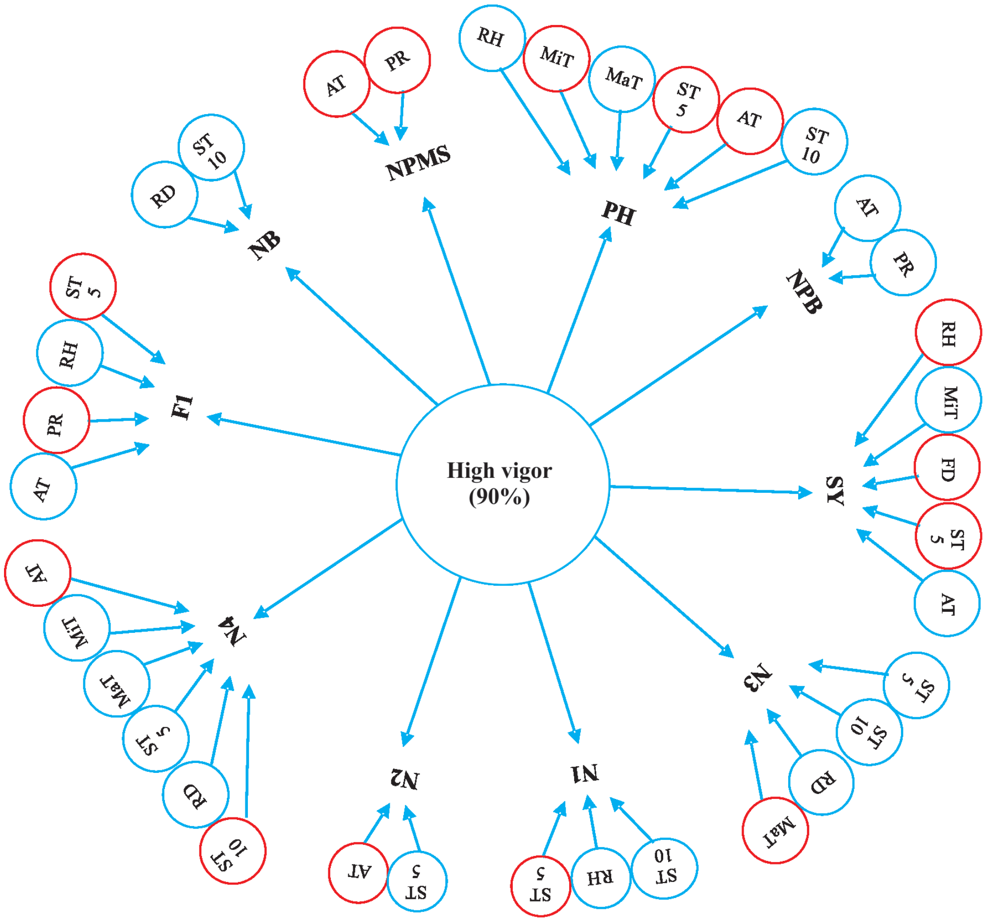

Figure 1 - Causal diagram drawn through the linear associations between the evaluated characters, N1 (number of pods with one seed), N2 (number of pods with two seeds), N3 (number of pods with three seeds), N4 (number of pods with four seeds), FI (first pod insertion), NB (number of branches), NPMS (number of pods in the main stem), PH (plant height), NPB (number of pods in the branches) and SY (seed yield) using high vigor seeds (High vigor 90%).

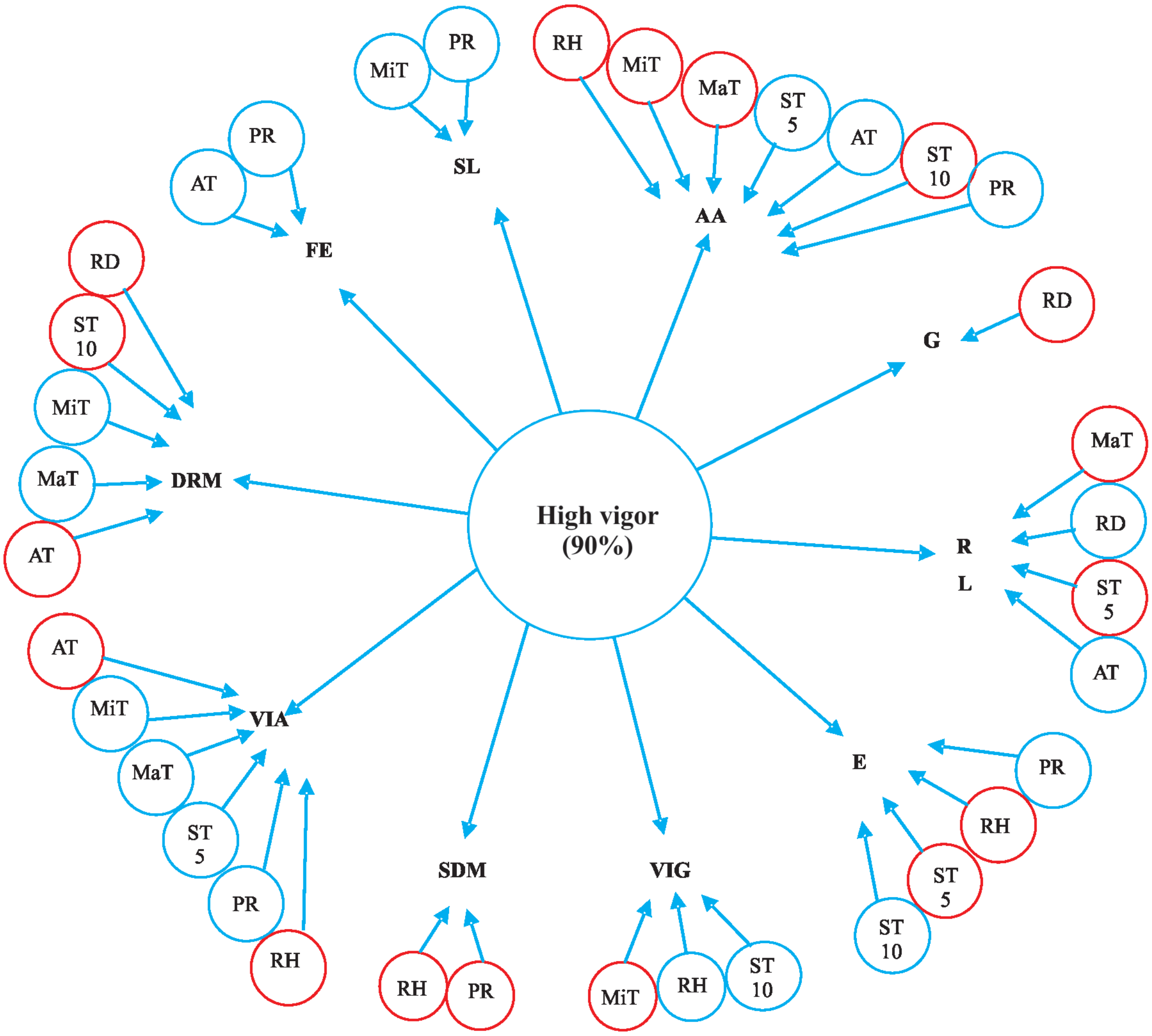

Figure 2 - Causal diagram developed through the linear associations between the evaluated traits, SDM (shoot dry mass), VIA (viability), RDM (root dry mass), FE (field emergence), SL (shoot length), AA (accelerated aging), G (germination), RL (root length), EC (electrical conductivity) and VIG (vigor) using high vigor seeds (High vigor 90%).

When using seeds of medium vigor, it was observed that the maximum air temperature positively influenced the N3, N4, NB (figure 3), AA, FE and SL (figure 4), negatively influenced the SY, FI (figure 3), VIA, RDM and EC (figure 4). The minimum air temperature did not influence the yield components (figure 3), but positively influenced the AA, RDM and EC, and negatively VIA and SL (figure 4). The mean air temperature positively influenced N3 (figure 3), and negatively N1 (figure 3), AA, FE and RDM (figure 4). The relative humidity positively influenced only the FE (figure 3), and negatively the TSM, SY, FI, N2 (figure 3), AA, RL, VIG, RDM, G and EC (figure 4). The soil temperature at five centimeters positively influenced the SY (figure 3), AA and G (figure 4), and negatively the VIA, RDM and RL. Soil temperature at 10 centimeters positively influenced PH, FI, NPMS (figure 3), RL, VIA, RDM and EC (figure 4), and negatively TSM (figure 3). Radiation positively affected FI (figure 3) and RDM (figure 4), and negatively TSM (figure 3), AA, RL, SL and EC (figure 4). Precipitation positively influenced NPMS (figure 3), AA, VIA, FE, VIG (figure 4), and negatively TSM and NPB (figure 3).

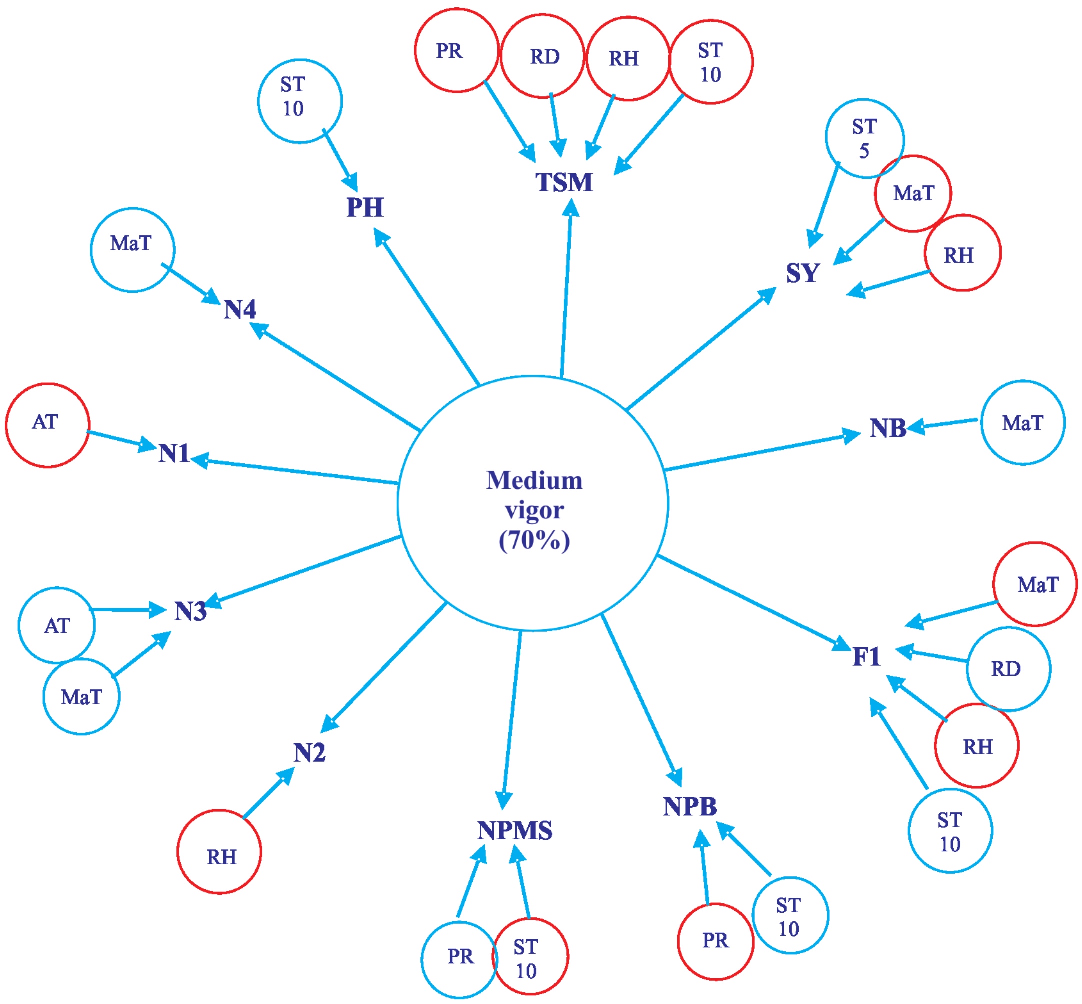

Figure 3 - Causal diagram drawn through the linear associations between the evaluated characters, N1 (number of pods with one seed), N2 (number of pods with two seeds), N3 (number of pods with three seeds), N4 (number of pods with four seeds), FI (first pod insertion), NB (number of branches), NPMS (number of pods in the main stem), PH (plant height), NPB (number of pods in the branches) and SY (seed yield) using medium vigor seeds (Medium vigor 70%).

When using seeds with low vigor, it was observed that the maximum air temperature positively influenced PH, N2 (figure 5), AA and RDM (figure 6), and negatively SY, N1, TSM (figure 5), RL and SL (Figure 6). The minimum temperature positively influenced the PH, NPMS (figure 5) and the ADM (figure 6), and negatively the N1, N2, NPB, NB, TSM (figure 5) and the EC (figure 6). The mean temperature positively influenced the PH, TSM (figure 5) and the EC (figure 6), and negatively only the SL (figure 5). Relative air humidity positively influenced PH, NPMS, TSM (figure 5) and SL (figure 6), and negatively only NPB (figure 5). The soil temperature at five centimeters positively influenced PH, NPB (figure 5), RL, AA, RDM, SL and EC (figure 6), and negatively N1, NPMS (figure 5) and FE (figure 6). The soil temperature at 10 centimeters positively influenced the N1, PH, NB, TSM (figure 5) and the FE (figure 6), and negatively the AA, SL and RDM (figure 6). Radiation positively influenced PH, N3, N4, SL, TSM (figure 5), ADM and EC (figure 6), and negatively VIA, G, AA and VIG (figure 6). Precipitation positively influenced PH, N2 (figure 5) and EC (figure 6), and negatively TSM, FI (figure 5), VIA, AA and VIG (figure 6).

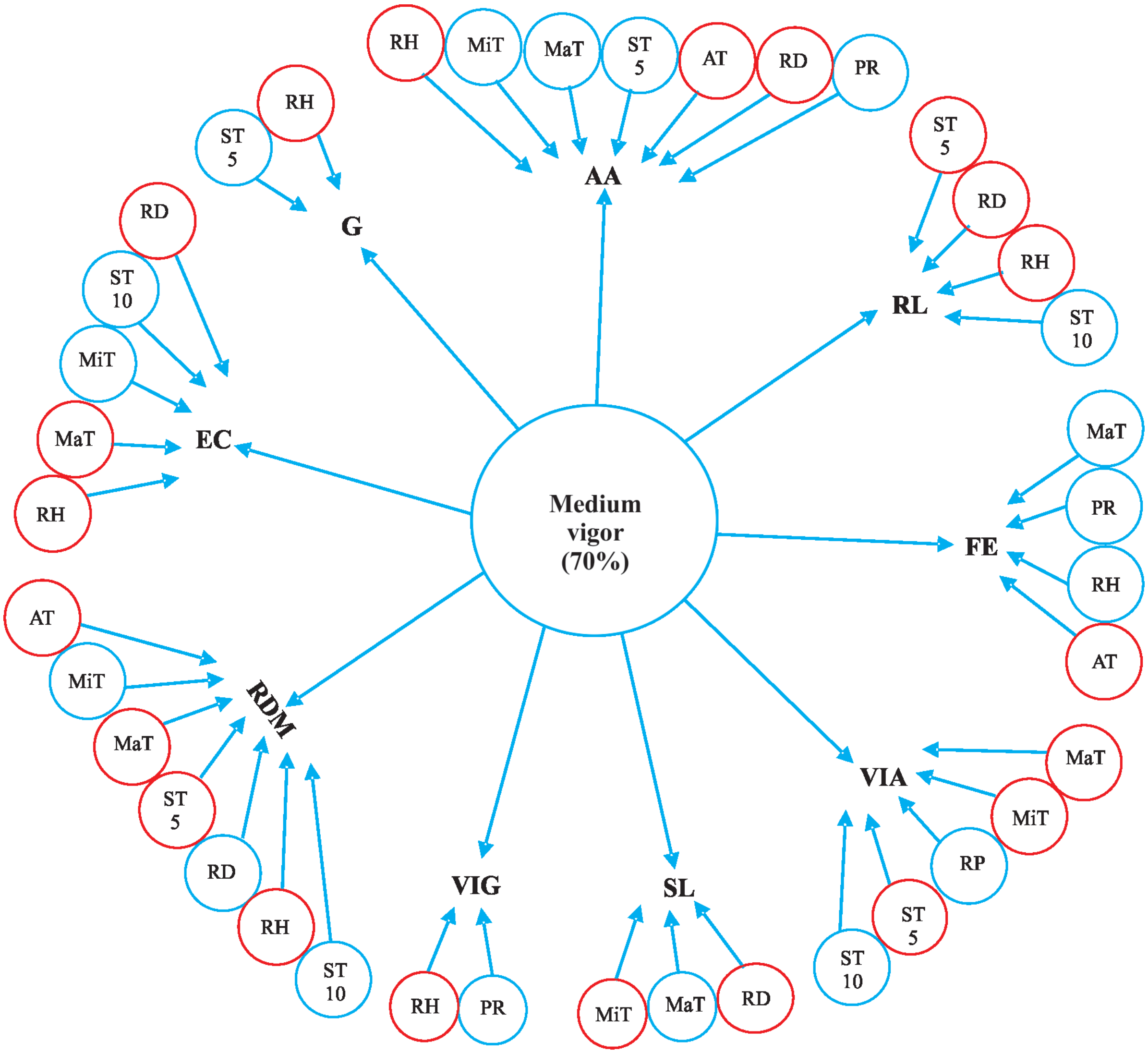

Figure 4 - Causal diagram developed through the linear associations between the evaluated traits, SDM (shoot dry mass), VIA (viability), RDM (root dry mass), FE (field emergence), SL (shoot length), AA (accelerated aging), G (germination), RL (root length), EC (electrical conductivity) and VIG (vigor) using medium vigor seeds (Medium vigor 70%).

According to Bellaloui (2011), temperature is an element of interference in the growth of soybean plants, presenting significant results in the development, production and composition of the grains, in this way, the increase of the temperature can have negative or positive effects, what will determine is the amplitude where she is. The ideal temperature range for soybean cultivation is 20 to 30 ºC, and below 10 ºC the plant stops growing. Flowering only occurs at temperatures above 13 ºC.

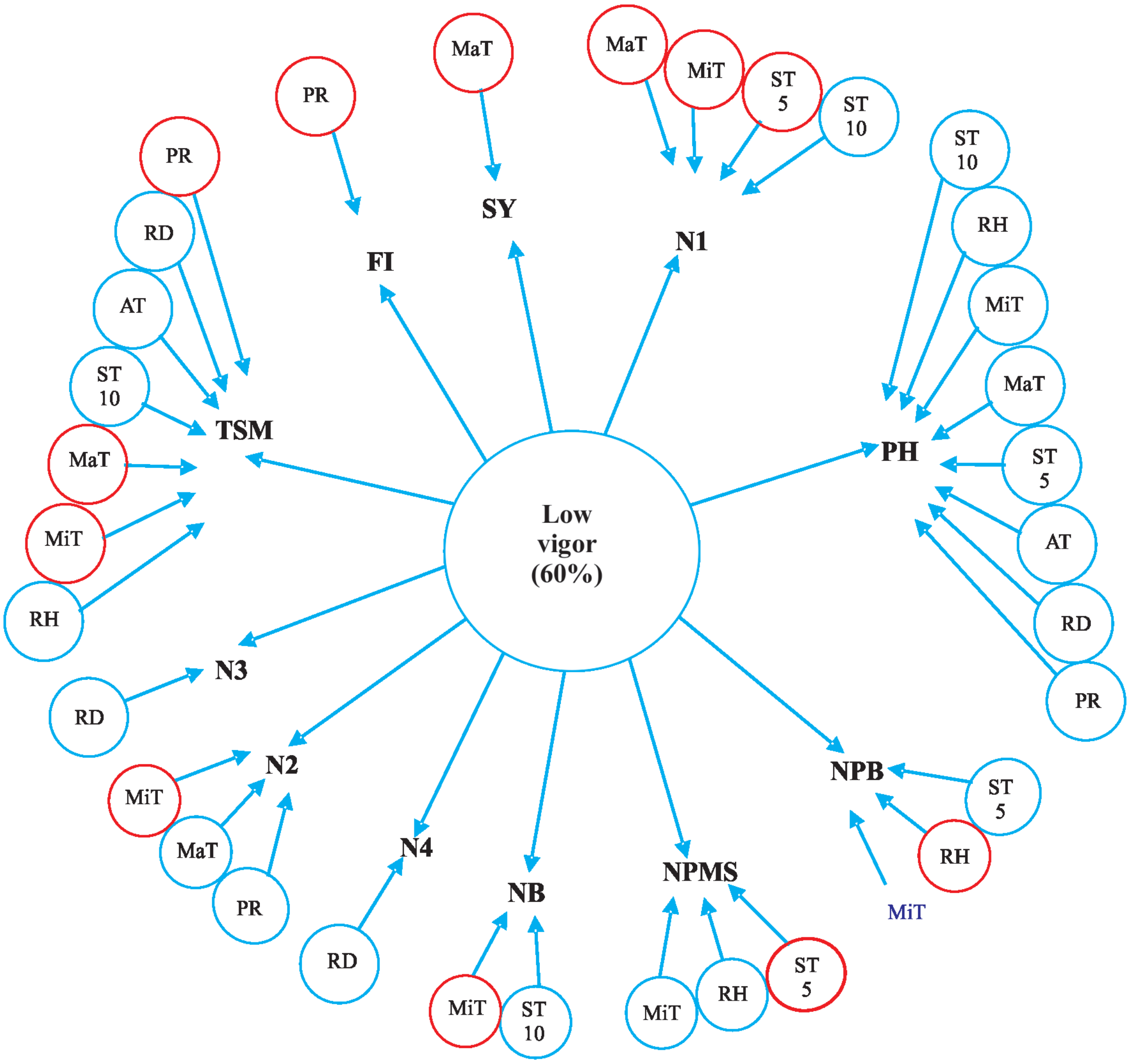

Figure 5 - Causal diagram drawn through the linear associations between the evaluated characters, N1 (number of pods with one seed), N2 (number of pods with two seeds), N3 (number of pods with three seeds), N4 (number of pods with four seeds), FI (first pod insertion), NB (number of branches), NPMS (number of pods in the main stem), PH (plant height), NPB (number of pods in the branches) and SY (seed yield) using low vigor seeds (Low vigor 60%).

When mild temperatures, lower relative humidity, soil temperature at 5 cm and at 10 cm between 24 and 25°C and average rainfall above 5.6 mm per day occur, sowing high vigor seeds, it can be predicted through accelerated aging test, that the harvested seeds would have 89.36% vigor (table 2).

Relative air humidity below 73%, soil temperature at 10 cm lower than 24°C, lower solar radiation and rainfall, when sowing seeds of medium vigor, it can be predicted, using the test of a thousand seed mass, that the weight of the harvested seeds would be 163.5g (table 2).

With the occurrence of lower minimum temperatures, high relative humidity and high soil temperature at 10 cm, sowing high vigor seeds, it can be predicted by the tetrazolium test that the vigor of the harvested seeds would be approximately 70%. By the same vigor test, occurring high maximum temperatures, lower minimum and average temperatures, higher relative humidity and soil temperature at 5 cm and lower rainfall, it is predicted that the harvested seeds would have 87,82% viability (table 2).

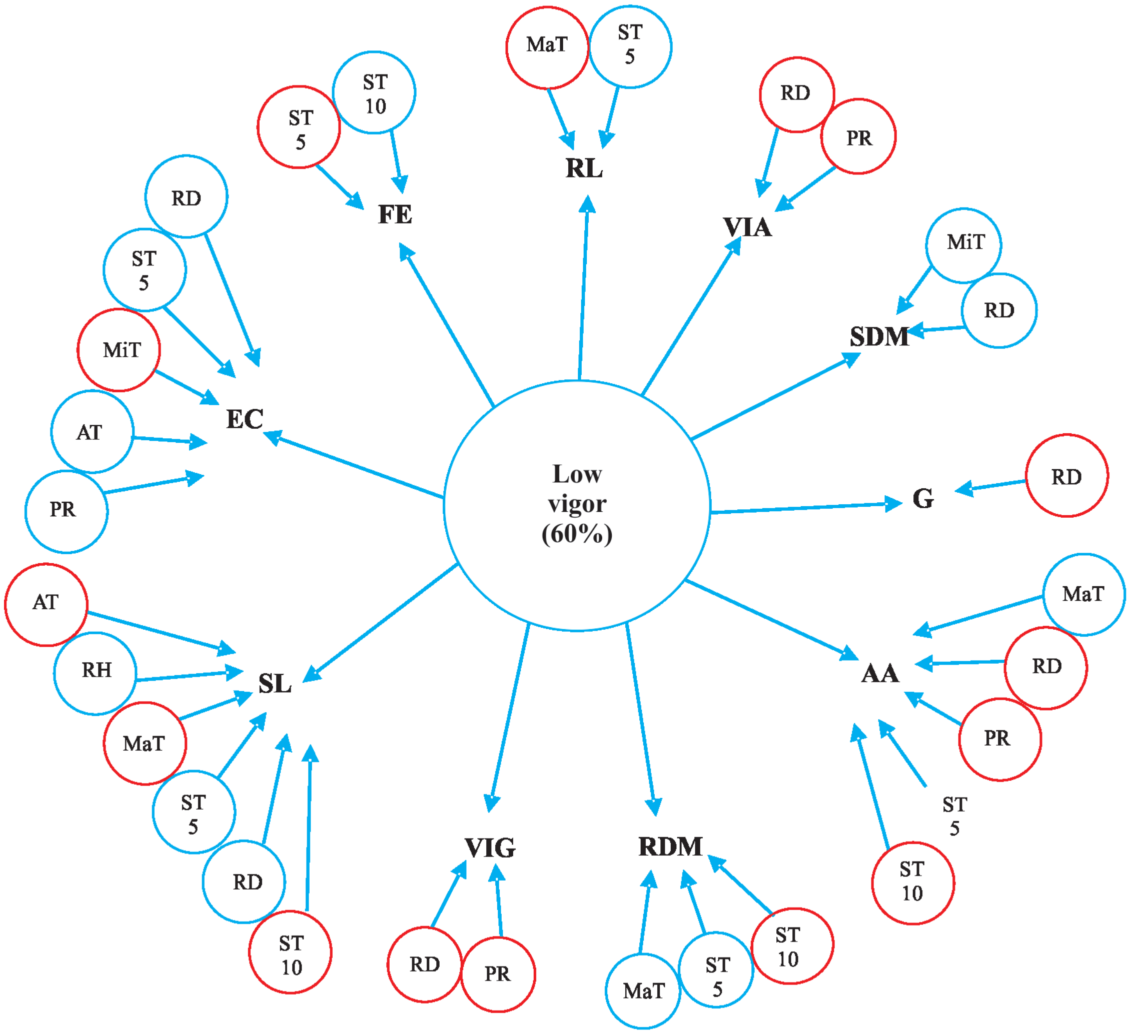

Figure 6 - Causal diagram developed through the linear associations between the evaluated traits, SDM (shoot dry mass), VIA (viability), RDM (root dry mass), FE (field emergence), SL (shoot length), AA (accelerated aging), G (germination), RL (root length), EC (electrical conductivity) and VIG (vigor) using low vigor seeds (Low vigor 60%).

When a mean temperature above 21.5°C, relative air humidity above 73.5%, soil temperature at 5 cm lower than 25°C and rainfall less than 5.6 mm occur, it can be predicted, when sowing seeds of high vigor, that the first pod insertion will be 19.01 cm (table 3).

With a lower maximum temperature, soil temperature at 5 and 10 cm higher than 25°C and solar radiation above 6.8 when sowing high vigor seeds, it can be predicted that the number of pods with three seeds per plant would be 38,32% (Table 3).

The occurrence of higher temperatures, higher relative humidity and soil temperature at 5 and 10 cm around 25°C, when sowing high vigor seeds, plants were predicted to have height of approximately 88.41 cm (table 3).

When high temperature, relative air humidity less than 73%, soil temperature at 5 cm lower than 25°C and solar radiation lower than 6.8 occur, sowing high vigor seeds, it can be predicted that the seed yield would be 70.39 sc ha^{-1} (table 3). Research by França Neto (1984), revealed increases of 20 to 35% in grain yield when using high vigor seeds. Kolchinski et al. (2005), determined that the use of high vigor seeds increases soybean yield by 35%, while, for Rossi et al. (2018), high vigor seed lots are closely related to high yields in this same crop.

Table 3 - Multiple regression with contrast between climatological variables and yield components of seeds grown at different levels of vigor

			Climatological data										
Character	Vigor	α	MAXT	MINT	AVET	RH	TS5	TS10	RAD	PRE	Predicted value	Real average	CV
			27,6	16,7	21,5	73,5	25,176	24,885	6,8	5,6122			
FI	High	19,35	.	.	0,1389	0,041	-0,248	.	.	-0,015	19,01	18,98	0,22
	Medium	15,739	-0,147	.	.	-0,017	.	0,2525	0,0373	.	16,99	16,88	0,73
	Low	16,68	.	.	.	.	.	.	.	-0,017	16,58	16,55	0,3
N1	High	0,549	.	.	.	0,0451	-0,392	0,6419	.	.	9,98	9,93	0,49
	Medium	12,55	.	.	-0,123	.	.	.	.	.	9,91	10,06	1,61
	Low	10,451	-0,244	-0,188	.	.	-0,313	0,6923	.	.	9,92	9,98	0,65
N2	High	29,053	.	.	-0,444	.	0,4787	.	.	.	31,56	31,63	0,22
	Medium	34,624	.	.	.	-0,05	.	.	.	.	30,92	31,34	1,43
	Low	24,04	0,4117	-0,234	.	.	.	.	.	0,04	31,73	31,97	1,07
N3	High	28,362	-0,365	.	.	.	0,2394	0,5101	0,1944	.	38,32	38,34	0,05
	Medium	34,636	0,4885	.	-0,342	.	.	.	.	.	40,77	41,14	0,97
	Low	41,092	.	.	.	.	.	.	-0,135	.	40,18	40,27	0,24
N4	High	0,2264	0,0877	0,0555	-0,098	.	0,0729	-0,114	0,0196	.	0,61	0,62	1,43
	Medium	-0,263	0,0362	.	.	.	.	.	.	.	0,74	0,73	0,24
	Low	0,6536	.	.	.	.	.	.	0,0207	.	0,79	0,8	0,23
NPB	High	28,378	0,6243	.	.	.	.	.	.	0,073	46,02	45,94	0,22
	Medium	46,293	.	.	.	.	.	0,478	.	-0,056	57,88	57,8	0,18
	Low	53,922	.	-0,384	.	-0,074	0,5975	.	.	.	57,1	56,98	0,22
NBMS	High	-0,476	.	.	.	.	.	0,157	0,0323	.	3,65	3,63	0,52
	Medium	1,4985	0,1303	.	.	.	.	.	.	.	5,09	5,15	1,07
	Low	3,9458	.	-0,14	.	.	.	0,1409	.	.	5,12	5,14	0,29
PH	High	79,69	0,4403	-0,116	-0,371	0,0988	-0,343	0,3153	.	.	88,41	88,37	0,05
	Medium	73,539	.	.	.	.	.	0,475	.	.	85,36	85,28	0,09
	Low	.	.	.	.	.	.	.	.	.	.	.	.
NPMS	High	71,622	-0,624	.	.	.	.	.	.	-0,073	53,98	54,06	0,19
	Medium	53,707	.	.	.	.	.	-0,478	.	0,0557	42,13	42,2	0,25
	Low	46,078	.	0,3838	.	0,0742	-0,598	.	.	.	42,9	43,02	0,3
SY	High	86,284	1,3671	0,8201	.	-0,474	-0,977	.	-1,156	.	70,39	70,5	0,16
	Medium	88,592	-1,232	.	.	-0,252	1,4286	.	.	.	72,07	73,04	1,41
	Low	90,967	-0,573	.	.	.	.	.	.	.	75,15	75,09	0

Characters: FI (first pod insertion), N1, N2, N3 and N4 (number of pods with one two, three and four seeds), NPB (number of pods in the branches), NBMS (number of branches in the main stem), PH (plant height), NPMS (number of pods in the main stem) and SY (seed yield).

CONCLUSIONS

The group of morphological characters: thousand seed mass, germination, accelerated aging, electrical conductivity, viability and vigor, shoot and root length, shoot and root dry mass, field emergence are strongly associated with the yield components of soybean, regardless of the vigor level used.

Depending on the level of vigor used, the maximum temperature, minimum temperature, average temperature, relative humidity, soil temperature at five centimeters, soil temperature at ten centimeters, radiation and precipitation influences the soybean yield components differently.

From the climatic variables: maximum temperature, minimum temperature, average temperature, relative humidity, soil temperature at five centimeters, soil temperature at ten centimeters, radiation and precipitation, it is possible to predict morphological characters and yield components of soybean.

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