PHENOTYPE INTERRELATIONS IN AUTUMN VETCH

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Abstract: *The autumn vetchs are fodder plants with multiple uses. They can be used as main, stubble or intermediate crops or can be successfully used as green manure on different soil types. The autumn vetch inclusion in the agricultural crop rotation is auspicious attributes as it can contribute to the improving of the soil properties (density, porosity, accumulation of humus in soil) primarily because legumes are able to fix the nitrogen atmosphere (CLARK et al, 2007; SCHULZ ET AL, 1999). The purpose of this paper is to determine correlations between the main morphological characters of autumn vetches in the phenophase 46 (according to the code BBCH- UWE MEYER, 2001) in order to evaluate their potential, when they are used as green manure. Thus there was shown a strong linear correlation between the internodes number and the number of roots, between the plant weight and the shrub height, between the root number and the nodule number, between the plant weight and the number of roots, respectively between the plant weight and the nodule number. Based on these correlations it was determined functional dependences between these well correlated morphological characters. In particular, it was determined the linear regression of the root number based on the internodes number, the linear regression of shrub height depending on the plant weight, and the linear regression of nodule number based on the number of roots. As biological material was used the autumn vetch, seeded in September, after a bearded ryegrass culture. The vetch will be incorporated into the soil, as green manure. In this situation, we are interested in both the morphological characters at the ground surface, as they represent the amount of biomass and the root characters because they influence the soil processes, and by their death they enrich the humus layer. It is not insignificant that the morphological characters development at the ground surface increases the characters and properties of root such as root weight, main root length, number of secondary roots and the root nodule number. There are positive linear correlations between the number of roots and the internodes number; the shrub height and the plant weight; the nodule number and the number of roots Based on these correlations there were determined functional dependencies between these well correlated morphological characters.*

Key words**:** *autumn vetch, morphological characters, linear correlation, linear regression.*

INTRODUCTION

Annual forage legumes, as autumn vetches, include a large group of Fabaceae family with high content of protein and minerals, which are well consumed by all species of animals, and improve the physical and chemical characteristics of soil providing high yields of green biomass (LUMINIȚA COJOCARIU and HORTENSIA RADULESCU, 2005).

Green manure crops play an important role in the ecological agriculture. JEON W.T. ET AL, (2009), studied in Korea the changes of green manure biomass and soil properties in different seeding methods, demonstrating that autumn vetch, used as green manure, contributes to improvement of the physical and chemical properties of the soil.

The green manure crops consisting of vetch play an important role in the field of ecological agriculture.

MATERIAL AND METHODS

The investigated area administratively belongs to the land territory of the Ciacova commune, situated in the Western Plains of Romania, the eastern section of the Pannonian

Plain. The soil where the experiments were placed is eutric cambisol, strongly gleyed.

The data recorded at the meteorological station from Timisoara were used to characterize the climate conditions. Changing climate conditions in 2010 highlights the oscillator nature of these, with significant deviations from yearly averages.

The sowing of the autumn vetches was performed on September 20, after an Italian ryegrass culture using a quantity of 60 kg/ha. As the experiment aims is the use of the autumn vetches as green manure biomass in different phenophase, in the present work we show only the manifestation of character in phenophase 46 in order to find positive linear correlations between characters studied.

The assessment of the biological material was performed by the biometric measurements of the main characters of the root and the aerial part.

The data were statistically analyzed by the STATISTICA 8 package (PETERSEN R.G., 1994; MEAD R. et al., 2002). In our statistical analysis, the plant weight, the shrub height, the numbers of plant shoots, the root length, the root number, the nodule number, the root weight, the internodes number were denoted by GrPl, HT, NrLaPl, LRad, NrRad, NrNod, GrRad and NrInt respectively. For every variable above mentioned, it was determined the minimum (the lowest value of the data), the maximum (the highest value of the data), the mean (arithmetic mean is the most commonly used method of describing central tendency of data), the variance (the spread of values around the central tendency), the standard deviation (that allows us to get some conclusions about specific scores in our distribution; assuming that the distribution of scores is close to "normal", the following conclusions can be reached: approximately 68% of the scores in the sample fall within one standard deviation of the mean, approximately 95% of the scores in the sample fall within two standard deviations of the mean, approximately 99% of the scores in the sample fall within three standard deviations of the mean), the skewness (a measure of the asymmetry of the probability distribution; a negative skew indicates that the *tail* on the left side of the probability density function is *longer* than the right side and the bulk of the values, including the median, lie to the right of the mean; a positive skew indicates that the *tail* on the right side is *longer* than the left side and the bulk of the values lie to the left of the mean; a zero value indicates that the values are relatively evenly distributed on both sides of the mean, typically but not necessarily implying a symmetric distribution.) and the kurtosis (a measure of the "peakedness" of the probability distribution; higher kurtosis means more of the variance is the result of infrequent extreme deviations, as opposed to frequent modestly sized deviations). Then there were calculated the linear correlation coefficients associated to every pairs of variables. For the well correlated variables above, were performed linear regression analyses. The linear regression try to model the relationship between two variables using a function of the form y=ax+b. The graph of such function is a straight line that will fit the analyzed data. In order to find the line that best fit the data, it was used the least squares approach. The regression coefficients were tested by the analysis of variance.

RESULTS AND DISCUSSIONS

The basic descriptive statistics for the plant weight, the shrub height, the numbers of plant shoots, the root length, the root number, the nodule number, the root weight, the internodes number are presented in Table 1.

The Box and Wisker diagram for the the plant weight, the shrub height, the numbers of plant shoots, the root length, the root number, the nodule number, the root weight, the internodes number is presented in Figure 1.

A graphical display of the linear correlations between the plant weight, the shrub height, the numbers of plant shoots, the root length, the root number, the nodule number, the root weight, the internodes number is shown in Figure 2.

Table 1

Descriptive statistics for the studied variables

Variable	Descriptive Statistics						
	Mean	Minimum	Maximum	Variance	Std.Dev.	Skewness	Kurtosis
GrPl	2,83091	1,350000	4,35000	1,1669	1,08022	-0,387236	-1,55827
HT	11,98182	7,500000	17,80000	17,2796	4,15688	0,175944	-2,13141
NrInt	7,45455	2,000000	15,00000	19,4727	4,41279	0,378959	-1,15031
NrLaPl	4,54545	2,000000	9,00000	4,8727	2,20743	0,778129	-0,03854
LRad	13,99091	9,500000	21,00000	9,6429	3,10530	0,827767	1,87544
NrRad	21,00000	8,000000	37,00000	74,2000	8,61394	0,238649	-0,23077
NrNod	22,00000	6,000000	45,00000	141,0000	11,87434	0,557572	-0,00010
GrRad	0,75636	0,350000	1,93000	0,2262	0,47563	1,854602	3,27706

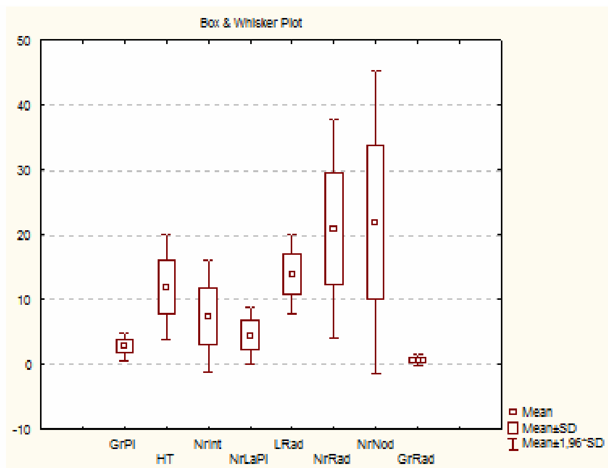

Figure 1: Box and Whisker diagram for the studied variables

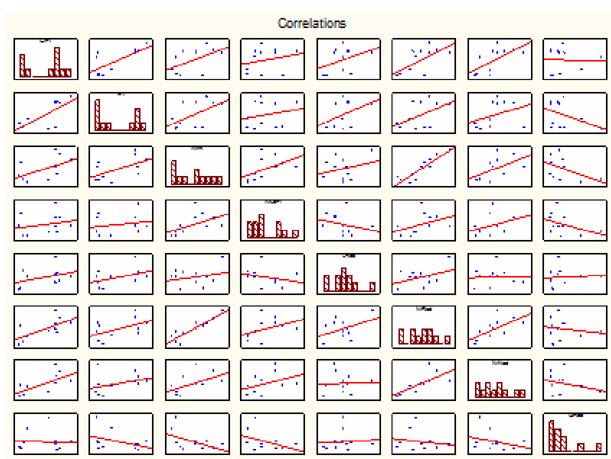

Figure 2: Graphical display of the linear correlations between variable

The matrix of the linear correlation coefficients between the plant weight, the shrub height, the numbers of plant shoots, the root length, the root number, the nodule number, the root weight, the internodes number is shown in Table 2.

Table 2

Matrix of linear correlations between variables

	GrPl	HT	NrInt	NrLaPl	LRad	NrRad	NrNod	GrRad
GrPl	1,00	0,73	0,53	0,23	0,39	0,65	0,64	-0,03
HT	0,73	1,00	0,56	0,19	0,44	0,49	0,34	-0,40
NrInt	0,53	0,56	1,00	0,50	0,27	0,91	0,53	-0,48
NrLaPl	0,23	0,19	0,50	1,00	-0,26	0,39	0,38	-0,40
LRad	0,39	0,44	0,27	-0,26	1,00	0,42	0,04	0,07
NrRad	0,65	0,49	0,91	0,39	0,42	1,00	0,66	-0,17
NrNod	0,64	0,34	0,53	0,38	0,04	0,66	1,00	-0,28
GrRad	-0,03	-0,40	-0,48	-0,40	0,07	-0,17	-0,28	1,00

It can be noticed the positive linear correlation between the number of roots and the internodes number; the shrub height and the plant weight; the nodule number and the number of roots. The interrelations between nodule number and the other characters reveal the existence of the significant positive correlations, therefore the plant weight, the root number, and the internodes number are directly influenced by the nodule number. The correlation between plant weight and all other characters is positive, excepting the root weight, where the correlation is insignificantly negative. Besides, the correlation between root weight and all other studied characters is negative, the increase of the root weight is followed by decrease of the values of the other characters.

A special attention was paid to the influence of the parameters from the soil surface (GrPl, Ht, NrLaPl and NrInt) on the parameters inside the soil. Thus, the increase of the plant growth positively influences the increase of root and nodule number in autumn vetch. Increase of the plant height and also the increase of the shoot number influence only in small measure the root parameters. Interesting is the fact that the nodule number influences the increase of the root number (r value is 0,66). The explanation consist of ramification of plant, which led to biomass increase and consequently the assimilation capacity is maximal.

Based on these correlations it was determined functional dependences between these well correlated morphological characters.

A linear regression analysis of the number of roots based on the internodes number was performed (see Table 3). It was determined that the proportion of variance in the number of roots per plant (159) was statistically significant (F=11, df=1) for p value under 0,05 (95% confidence interval), where the F ratio provided the test of statistically significance.

Table 3

Anova for the regression line coefficients of the number of roots based on the internodes number

	Univariate Tests of Significance for NrRad				
Effect	SS	Degr. of Freedom	MS	F	p
Intercept	159,8029	1	159,8029	11,30575	0,008357
NrInt	614,7880	1	614,7880	43,49507	0,000100
Error	127,2120	9	14,1347		

The regression equation $y=b_0+b_1x$ is the linear equation used to fit the best straight line to the data (see Figure 3). Thus the number of roots NrRad was expressed depending on the internodes number NrInt by the equation

$$NrRad = 7,7544 + 1,7768*NrInt.$$

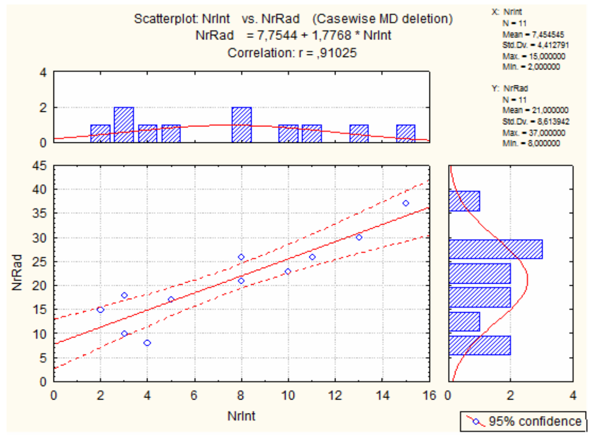

Figure 3: Linear functional dependence of the number of roots based on the internodes number

The 95% confidence interval for the slope of the regression line was (1,167374; 2,38631) which represents the lower and upper bounds for the unstandardized regression coefficient. It can be noted that the 95% confidence interval does not include 0 suggesting that the slope is significantly different than 0 which means there is a linear relationship between the number of roots and the internodes number.

A linear regression analysis of the shrub height based on the plant weight was performed (see Table 4). It was determined that the proportion of variance in the shrub height was 20 for F=2,3 (df=1) and for p = 0,16 (95% confidence interval), where the F ratio provided the test of statistically significance.

Table 4

Anova for the regression line coefficients of the shrub height based on the plant weight

Effect	Univariate Tests of Significance for HT SS	Degr. of Freedom	MS	F	p
Intercept	20,58570	1	20,58570	2,31411	0,162530
GrPl	92,73474	1	92,73474	10,42463	0,010344
Error	80,06163	9	8,89574		

The linear regression equation was used to fit the best straight line to the data (see Figure 4). Thus the shrub height HT was expressed depending on the plant weight GrPl by the equation

$$HT = 4,0012 + 2,8191*GrPl.$$

The 95% confidence interval for the slope of the regression line was (0,84394; 4,794260) which represents the lower and upper bounds for the unstandardized regression coefficient. It can be noted that the 95% confidence interval does not include 0 suggesting that the slope is significantly different than 0 which means there is a linear relationship between the shrub height and the plant weight.

A linear regression analysis of t the nodule number based on the number of roots was performed (see Table 5). It was determined that the proportion of variance in the nodule number was 11,76 for F=0,13 (df=1) and for p = 0,72 (95% confidence interval), where the F ratio provided the test of statistically significance.

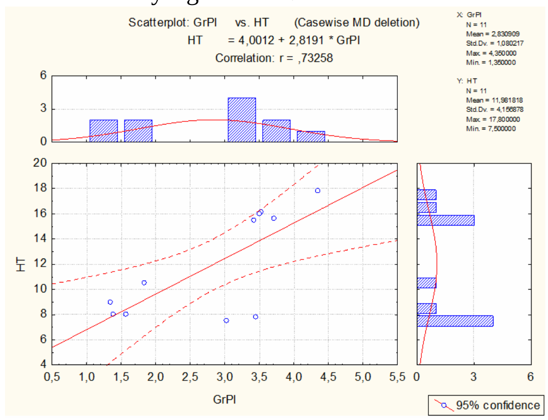

Figure 4: Linear functional dependence of the shrub height based on the plant weight

Table 5

Anova for the regression line coefficients of the nodule number
based on the number of roots

Effect	Univariate Tests of Significance for NrNod SS	Degr. of Freedom	MS	F	p
Intercept	11,7672	1	11,7672	0,133667	0,723106
NrRad	617,6941	1	617,6941	7,016540	0,026525
Error	792,3059	9	88,0340		

The linear regression equation was used again to fit the best straight line to the data (see Figure 5). Thus the nodule number NrNod was expressed depending on the root number NrRad by the equation

$$NrNod = 2,83 + 0,91*NrRad.$$

The 95% confidence interval for the slope of the regression line was (0,1332; 1,69159) which represents the lower and upper bounds for the unstandardized regression coefficient. It can be noted again that the 95% confidence interval does not include 0 suggesting that the slope is significantly different than 0 which means there is a linear relationship between the nodule number and number of roots.

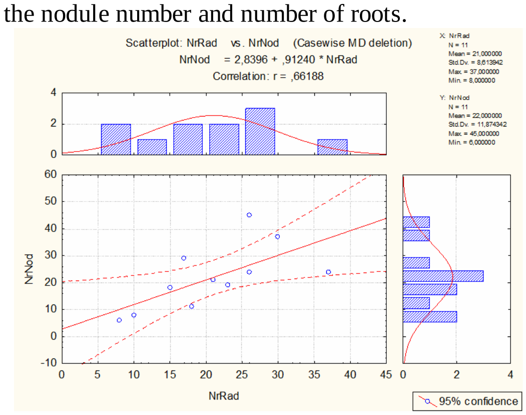

Figure 5: Linear functional dependence of the nodule number
based on the number of roots

CONCLUSIONS

The investigated characters are in a higher or lower dependence, each of them influences the plant biomass, respectively the quantity of organic matter that will be incorporated into the soil.

There are positive linear correlations between the number of roots and the internodes number; the shrub height and the plant weight; the nodule number and the number of roots Based on these correlations there were determined functional dependencies between these well correlated morphological characters.

The 95% confidence intervals and the statistical significance of the models were pointed out.

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