CORRELATION BETWEEN THE STRUCTURAL ELEMENTS OF SOYBEAN YIELD GROWN IN THE CONDITIONS OF DIFFERENT HUMIDITY

Alexander Matev, Velika Kuneva, Radost Kalaydjieva, Hristopher Kirchev
Agricultural University – Plovdiv
E-mail: sa6_m@abv.bg, kuneva@au-plovdiv.bg

ABSTRACT

The purpose of the development is to analyze, by the application of correlation analysis, the dependencies between biometric parameters characterizing plant soybeans, which are changed to a different extent under the influence of irrigation regime applications. Data for the extraction and its structural elements in soybeans is used, derived from field experiments to study the irrigation regime, held in the period 2004 - 2006 in experimental field of Agricultural University - Plovdiv. The variants of the experiment are the following: 1) free irrigation; 2) optimum irrigation at 75% of the FC (field capacity) for the layer of 0 - 80cm; Variants 3, 4, 5, and 6 are with reduced irrigation rates, respectively 25, 50 and 75%. Variant 6 is irrigated in the groove (50% reduction in the rate per unit area). A very high statistical proven correlation is established (r> 0.9) between the yield and the number of nodes per plant, number of pods per plant, number of pods per node and plant height. Statistically, correlation between extraction and height of the first follicle is not proven, as well as the number of plant`s taps.

Key words: *soybean, irrigation regime, correlation analysis*

INTRODUCTION

Several studies show that the yield in soybeans and its structural elements are more or less interrelated. The study of these relationships would help for a more precisely control and timely implementation of agricultural projects, which, in its turn, leads to a yield increase within the capabilities of the particular variety.

According to R. Hutchinson (1983), L. G Heatherly & Elmore CD (1986) and G. Cucci, et. al. (1989) irrigation regime influences the height of the soybean plants, which is bound with the increased number of seeds per plant, and this gives a direct effect on the quality and quantity of yield. E. Ramseur (1984), G. Pritoni, et. al. (1989), C.F. Goreti et. al. (1992) and G. Restuccia, et. al. (1992) found a significant effect of irrigation on the distribution of the production elements. According to the authors, optimizing soil moisture leads to increased number of nodes, bean, seed weight, yield, number of seeds in a bean of the main stem and branches. In this respect, based on a study conducted in Kansas (Z. Yonova, 1989) it should not be allowed drought in flowering and pods forming when the daily average ET is 7.5 to 8.0 mm., since there is a risk of blossom falling, drying of most of already formed beans and eventually - a reduction in yield, and in addition, the plants remain short.After a precise vascular experiment, this view was confirmed by R.D 'Andria et. al. (1991), and by Pritoni G. et. al. (1992) and E. Scopel et. al.(1992). According to V. Shreyder (1990), 90-100% of ET must be compensated for obtaining the maximum yield and the weight of 1000 seeds at the time of flowering. Pritoni G. et. al. (1990) gives essential significance of the period of grain filling. According to the authors, the admission of water deficit in the first part of the vegetation period of the soy leads to a reduction in yield of grains, the number of pods per plant, the number of grains in a bean plant height, the number, and length of internode and taps. A. Klik et. al. (1991) found that with improving the water availability of plants, the number of pods per plant can grow with over 45%, which will certainly affect significantly the yield size. The negative impact on reduced irrigation rates of plant height, number of branches, leaf area and net assimilation is established. As a result, there are significant changes in the rate of yield (AE Moftah, 1997).

The main objective of the study is to assess the relationship between biometric parameters characterizing plant soybeans using correlation analysis, which are changed to a different extent under the influence of irrigation regime applications.

MATERIALS AND METHODS

For the development`s purpose it is used data from a field experiment, related to studying the influence of irrigation regime on the productivity of soybeans in the region of Plovdiv. The experiment was conducted during the period 2004 - 2006 at the experimental station of Agricultural University on alluvial-meadow soil of "Mira" variety. The experiment was set according to the block method in four replications (V.Barov, 1982). The following options were tested: 1) no irrigation; 2) the optimum irrigation at pre-irrigated humidity 75% of the FC (field capacity) valid for the soil layer 0-80 cm; 3) irrigation with 75% of optimum irrigation rate (75% m); 4) irrigation with 50% m; 5) irrigation with 25% m; 6) 50% m by irrigation in the groove._The data for the elements of the yield were based on measurements made on 10 plants of recurrence in all variants of the experiment. The biometric indicators used in this work with their values "Xi" (average for the three years of experiment) are presented in Table 1. The relationship between them) is analyzed and evaluated using correlation analysis (Genchev, G. et.al., 1975), expressed by the correlation coefficient "r". Mathematical treatment of the data was performed using the statistical program SPSS.

RESULTS AND DISCUSSION

The soybean is a crop which reacts specifically to water stress, depending on the phase in which it is allowed or, depending on its duration. Plant response is more expressed in a drier and more extreme weather during the whole year. In this sense, the three experimental years are relatively favorable; regarding the security of precipitation, 2004 and 2006 are average, and 2005 - moist.

Table 1. Provision of meteorological factors in the region of Plovdiv during V – IX

factor		experienced years			
		rate	2004	2005	2006
ΣT°	°C	3181 °C	3135	3141	3239
	P %	(for 93 years)	60.6	57.5	36.2
ΣD	HPa	1430 HPa	1675	1137	1590
	P %	(for 74 years)	13.3	90.7	21.3
N	mm	241,9 mm	233.5	455.5	228.0
	P %	(for 97 years)	44.9	3.1	50.0
ΣT° – temperature sum; ΣD – vapor pressure deficit; N – rainfall; P% – empirical probability of meteorological factors					

The value of the data for the probability of three major meteorological factors (rainfall, temperature and vapor pressure deficit) are presented in Table 1. Concerning the temperature sum, the vegetation period of the experimental years is not significantly different from the norm of Plovdiv region. It was slightly warmer was in 2006 with probability of 36.2%, i.e. it occupies an intermediate position between medium and medium hot. The first two years were around the norm. The greatest diversity is with regard to the vapor pressure deficit, as the driest year (2004) is with a probability of 13.3%, and the most humid is 2005 - with a probability of 90.7%. The third experimental year is dry on the average. Under these meteorological conditions, that are relatively favorable for soybeans, in 2004 and 2006 were made two irrigations (during flowering and bean formation, and during pod filling), and in 2005 - one watering after flowering. The small number of irrigations compared to the relatively favorable weather conditions is a prerequisite for a lower positive effect from irrigation and a lower negative effect from the induced water stress with variants, irrigated with reduced irrigation rates (Table 2).

Table 2. Structure elements of the soybean yield, depending on the irrigation regime average for the period 2004 - 2006

index			x_i	1	2	3	4	5	6
plant height (cm)			x_1	65.6	79.3	80.3	71.1	71.2	72.2
height of the first follicle (cm)			x_2	13.6	12.4	12.8	12.6	13.1	12.0
Number of ramifications			x_3	2.2	3.2	3.1	3.1	2.6	3.2
number of internodes	total of the whole plant		x_4	25.6	39.6	38.1	33.0	29.7	35.5
	central stalk		x_5	14.2	17.0	16.9	15.7	15.0	15.9
	a branch / medium /		x_6	5.29	7.28	6.77	5.60	5.72	6.06
	total of all branches central stalk		x_7	11.4	22.7	21.2	17.3	14.7	19.5
average length of the internodes of the central stem (cm)			x_8	4.52	4.67	4.75	4.53	4.75	4.53
number of pods per plant	total		x_9	38.7	79.7	75.0	60.9	49.4	59.6
	central stalk		x_{10}	23.8	39.5	38.9	32.5	28.2	30.7
	by branches		x_{11}	14.9	40.2	36.1	28.4	21.2	28.9
number of beads in a bean (mean)			x_{12}	2.71	2.73	2.73	2.69	2.70	2.68
number of beans in one internode	average plant together		x_{13}	1.51	2.01	1.97	1.85	1.67	1.70
	central stalk		x_{14}	1.67	2.44	2.30	2.07	1.88	1.94
	by branches		x_{15}	1.30	1.77	1.70	1.64	1.44	1.50
mass of 1000 seeds (g)			x_{16}	146.5	147.7	144.6	144.5	142.3	147.7
grain yield (kg / da)			x_{17}	177.2	287.8	278.5	234.4	201.7	239.5

Table 3. Correlations between the studied parameters in soybean, variety Mira, 2004-2006 year

Xi	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}
x_1	1.00																
x_2	0.01	1.00															
x_3	0.41	-0.15	1.00														
x_4	0.75	-0.24	0.80	1.00													
x_5	0.73	-0.27	0.71	0.97^B	1												
x_6	0.81	-0.20	0.68	$0.97^{\mathbf{B}}$	0.97^B	1											
x_7	0.70	-0.32	0.45	0.80^A	0.77	0.77	1										
x_8	0.60	0.44	0.04	0.20	0.12	0.25	0.21	1									
x_9	0.71	-0.37	0.60	0.92^B	0.93^B	0.9^B	0.88^B	0.17	1								
x_{10}	0.65	-0.44	0.42	0.79	0.85^A	0.78	0.85^A	0.09	0.96^B	1							
x_{11}	0.71	-0.30	0.71	0.96^B	0.94^B	0.93^B	0.87^A	0.20	0.98^B	0.88^A	1						
x_{12}	0.35	0.01	-0.24	0.15	0.26	0.25	0.37	0.22	0.35	0.42	0.28	1					
x_{13}	0.52	-0.51	0.31	0.66	0.72	0.65	0.79	0.05	0.90^B	0.96^B	0.81^A	0.46	1				
x_{14}	0.56	-0.48	0.30	0.66	0.73	0.64	0.79	0.03	0.89^A	0.98^B	0.79	0.46	0.98^B	1			
x_{15}	0.51	-0.46	0.42	0.71	0.73	0.7	0.79	0.09	0.91^B	0.90^B	0.88^A	0.44	0.96^B	0.90^B	1		
x_{16}	0.16	-0.13	0.07	0.07	0.03	-0.01	0.34	0.17	0.11	0.15	0.08	-0.1	0.11	0.21	0.0	1	
x_{17}	0.81	-0.28	0.56	0.89^A	0.92^B	0.87^A	0.87^B	0.23	0.94^B	0.92^B	0.90^B	0.35	0.80^A	0.85^A	0.8	0.3	1

After the correlation analysis for each of the examined years, it was established that there is a very high correlation ($r > 0.9$) between the following parameters: number of internodes (x_4) and number of pods per plant (x_9), number of internodes (x_4) and grain yield (x_{17}) , number of internodes of the central shaft (x_5) and number of pods per plant (x_9), number of internodes of the central shaft (x_5) and grain yield (x_{17}), number of pods on the central shaft (x_{10}) and number of pods on the branches (x_{11}), number of pods on a central stem (x_{10}) and grain yield (x_{17}), number of beans in one central stem internode (x_{13}) and number of beans in one internode branches (x_{15}). Regardless of the irrigation mode and the climate characteristics of the years, in which the experiment was conducted, there is a tendency for a strong correlation between the total number of internodes, number of internodes on one node, the number of pods per plant and an internode. With these biometric indicators the correlation is most expressed. It makes an impression that the height of the first follicle, that is more important for reducing of yield loss in mechanized harvesting, is not correlated with any of the other indicators (Table 3). As it can be seen from the table, there is a large number of values of "r", which are in the range from 0.6 to 0.9, particularly in terms of yield (x_{17}) and the other structural elements ($x_{1,\ 3,\ 4,\ 5,\ 6,\ 7,\ 9,\ 10,\ 11,\ 13,\ 14,\ 15}$), i.e. from 16 includes structural members, the yield depends mathematically shown by 12, and in relative terms this represents the significant 75%. There is a lack of correlation between the extraction and the height of the first bean setting, and also between the yield and the length of the internodes. The poor correlation between it and the weight of 1000 seeds in this case is due to the relatively favorable climatic conditions during the experimental years. As a result, the absolute mass of the seeds in various embodiments of the assay varied in narrow limits (Table 2).

CONCLUSIONS

There is a high statistical proven correlation ($r > 0.9$) between the indicators: production - total number of internodes, yield - the number of pods per plant, number of internodes of the central stem and number of pods per plant, number of beans in one internode (central stalk) and the number of beans one internode in the branches.

The yield of grain is bound mathematically proved with 12 from total 16 structural indicators, which in relative terms represents 75%.

The correlation analysis is used to determine the strength of the relationship in the assessment of the complex impact of irrigation regime upon the biometric characteristics of soybeans. The results of the correlation analysis are consistent with the conclusions made in the analysis of applied irrigation regimes and their impact on plants from a biological perspective.

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