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CORRELATION DEPENDENCE BETWEEN BIOMETRIC INDICATORS AND PRODUCTIVITY IN THREE COTTON VARIETIES

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Abstract

The purpose of the study is to evaluate, by means of correlation analysis, the correlation between the main biometric indicators for three cotton varieties. The study was conducted in the field of experience of the Department of Crop Production, Faculty of Agriculture at the University of Trakia, Stara Zagora during the period 2018-2019. The field experience is derived by the method of fractional plots. The influence of both factors (fertilization and irrigation) on the development and productivity of the three varieties of cotton was studied. The relationships between the mass of one boll, the number of bolls per plant, the biomass by phase, the total yield per plant and the total yield of cotton per hectare were studied. Correlation dependencies were found, with a high degree of Helius correlation between the structural elements: mass of one boll and bud-formation (r = 0.989), mass of one boll and number of bolls per plant (r = 0.988) under irrigation conditions. Darmi is distinguished by a high degree of correlation between flowering and the number of bolls in a plant (r = 0.996). Colored naturally of Isabell is characterized by a high degree of correlation between positive depending of bud-formation and ripening (r = 0.967) and between the number of bolls in a plant and a total yield (r = 0.958). For irrigation are established correlations between bud-formation and flowering (r = 0.983) and between ripening and number of bolls in one plant (r = 0.979) in Helius. With a high degree of correlation feature dependencies between bud-formation and ripening (r = 0.963), and bud-formation number of bolls in a plant (r = 0.994) in Darmi. Strong positive correlation is drawn between bud-formation and flowering (r = 0.964) and between flowering and ripening (r = 0.956).

Key words: *cotton, irrigation, fertilization, yield, correlations.*

INTRODUCTION

In a market economy, efficient use of water is related to the optimization of mineral nutrition. Dosing of the required amount of mineral fertilizer supplied and distributed evenly over the area, optimizes resources for irrigation water, fertilizers, labor and energy.

The reduction of water resources is forcing researchers to focus on improving the efficiency of water use through introduction of new cotton varieties resistant to drought, or management of irrigation water. In an economic viewpoint, 25.0% saving in irrigation water (T75) resulted in 34.0% reduction in the net income. However, the net income of the T100 treatment is found to be reasonable in areas with no water shortage (Dağdelen et al., 2009).

The application of water-saving technologies has been a priority in the agricultural engineering of crops in recent years. The impact of regulated water scarcity has been the subject of research by many researchers. The cotton response rate was determined by reducing the irrigation rate. Polynomial equations establish the nature of dependencies between vegetative growth, the laying of the generative organs, productivity and irrigation rates (Wanjura et al., 2002; Ibragimov et al., 2007; Wang et al., 2011; Yang et al., 2015).

Study of the technology allowing a regulated water supply at a specific topographical and soil conditions was conducted in Southeast Anatolia (GAP) of Turkey establishes yields of cotton were respectively 4380, 3630 and 3380 kg/ha of a drop, furrow, sprinkler irrigation. Drip irrigation produces 21% more cotton seeds by the method of the furrow and 30% more than the method of spraying. The efficiency of use of water (WUE) proved to be respectively 4.87, 3.87 and 2.36 kg/ha/mm dropping groove and the sprinkler (Cetin and Bilgel, 2002).

Increase of boll number per plant under water stress condition showed that cotton had high ability for adapting water stress conditions. The highest yield was obtained in the I100

treatment. A second degree polynomial relation could adequately describe the cotton seed yield response to the irrigation water amount. The team of scientists found that under I25 (irrigation 25 %), I50 and I75 treatment conditions, evapotranspiration, total cotton seed yield, boll weight, lint percentage, number of sympodial branches and leaf area index decreased while some boll parameters such as boll weights and opened boll numbers increased (Onder et al., 2009).
Cotton grown in different soil-climatic regions manifests itself in different ways their productive potential. Impact on structural elements yields have predecessors, the rate of fertilization, seeding density and variety, the degree of weeding and soil preparation. Each element of agrotechnics is the object of study of a number of researchers (Koleva and Petrova, 2014; Barakova et al., 2018; Barakova et al., 2019)
Balanced diets and optimizing the moisture in the soil affords higher yields. Examining the influence of fertigiraneto with drip irrigation on the efficiency and productivity of cotton Jayakumar et al. (2015) establish a positive influence of a drop fertigirane on the potential of culture and soil fertility. Increasing the efficiency of nitrogen nutrition in drip irrigation was established by Aujla et al. (2005). Agronomic efficiency of nitrogen is increased from 21.65 to 28.59 kg of seed cotton per kg N, applied when applying the same amount of water and N by drip irrigation in comparison to the control pool. The nitrogen is nutrient element influencing the greatest extent on the growth and yield of cotton (Hou et al., 2007; Shah, 2008). The results suggest that once fertilization of the first stage of flowering reduces labor costs without reducing yield and thus can be a practical alternative for fertilization of cotton. Yang et al. (2012) found that fertilization has a higher rate of accumulation of biomass during the rapid accumulation. Single fertilization is a practical alternative to cotton fertilization.
Have been used an interesting approach to manage and comparing data in Bulgaria on some basic food products. It were calculated correlation coefficients and analyzed for all indicators of the products concerned (Dimova, 2018).
The main objective of the development is to evaluate, by means of correlation analysis, the nature of the relationship between certain bio-metric indicators and the productivity in cotton varieties, against the background of different levels of mineral nutrition and moisture supply.

MATERIALS AND METHODS

Establishing ecological plasticity and the impact of mineral nutrition on growth, development, productivity and quality of three varieties of cotton was set field experience in the experimental field of the Department of Plant Agriculture Faculty at Trakia University, Stara Zagora, Bulgaria. During the 2018-2019, three cotton varieties were subject to field research: Helius, Darmi and Isabel. The field study was conducted on soil type typically meadow-cinnamon soil in a fertilizer experiment under irrigation and non irrigation conditions. Based on the method of the small plots in 4 repetitions, with the size of a harvest plot of 15 m^2 (1.80 x 8.34 m), over a two-year period three types of cotton were tested.
The factors of the field experiment are varieties of cotton, the levels of nitrogen fertilization ($N_{0,8,16,24}$), humidity of the soil layer and the influence of climatic elements of the year. A basic fertilization with triple superphosphate norm P_8 in the autumn before sowing of cotton. Nitrogen fertilizer (NH_4NO_3) is imported sowing. Crop density is 12-16 thousand plants per hectare in a depth of seeds 3-5 cm. Irrigation is performed with a drip irrigation system. During the first year they were made two irrigations, and in the second were four irrigations to maintain 75% FC in the soil layer 0–0.50 m. For establishing the timing and duration of phenophase postemergence 40 plants are marked of the embodiment. Beginning of the phase is assumed as 10% of the plants enter the corresponding phase, and when 50% is reported mass occurring. During the growing season, double digging and pesticide treatment were carried out. The first harvest begins in September, after 50-60% of the boxes are burst.
The Bulgarian selection varieties have been studied and they were characterized by medium-sized to large boxes, a high yield of raw cotton and the yield of the fiber. Variety Izabell is

representative of a variety of naturally colored fiber with high ecological and economic effect. Inferior to the length of the fiber with the standards, but the extraction of raw cotton and precocity not inferior to standard varieties.

Assessing the impact of mineral fertilization, irrigation, and development of plants in three varieties of cotton is made based on the following biometric indicators: mass of one boll (x_1); bud-formation (x_2); flowering (x_3); ripening (x_4); number of bolls per plant (x_5); total yield (x_6).

Performed a correlation analysis, by means of which it is established and evaluated the relationship between the indicators examined, expressed by the correlation coefficient r. Correlations are the product of mathematical and statistical processing of the output data on Genchev et al. (1975). Are calculated correlation coefficients (r) statistical program SPSS.

RESULTS AND DISCUSSIONS

Since the two years of study in conducted field, the course of major phenophases has been record onset of the phenological observations. Sowing was conducted in optimal time. With regard to the dynamics of the dry biomass of cotton plants under irrigation and irrigation registered higher values under irrigation. Terms of the year, represented mainly by the different security temperatures and rainfall, are affecting plant development.

Values of dry biomass through phenophase budding vary on average depending on soil moisture in all three varieties. Helios variety is characterized by higher biomass values under irrigation and non irrigation conditions. For non-irrigation, biomass values are lower by 4.6% for Darmi and 5.1% for Isabel, compared to Helius.

In terms of irrigation, Darmi yields only 1.2% to Helius, while at Isabel 8.2% for all fertilizer levels is lower for biomass. A tendency for an increase in dry biomass has been reported in the three varieties. Helius under irrigation conditions has an increase rate of 46.1% at N_{24}. Under irrigation conditions, the rate is less than 13.8%. This can be explained by the better natural moisture supply in 2018. During the first year, a higher amount of registered rainfall at the beginning of the growing season provides enough moisture for the normal development of the plants. In Darmi, irrigation provides a growth rate of 28.9%, and without irrigation again the dry biomass is 43.5% higher with the high fertilizer background. Isabell recorded a higher rate of increase in dry biomass under irrigation conditions under the influence of mineral nutrition (35.4%). Under irrigation conditions, the increase in biomass was reported at 14.9%.

The results of flowering phenophase are similar. With the highest dry biomass, Helius stands out with a high fertilizer background (N_{24}) under irrigation and irrigation conditions. Helius exceeds the standards and the Macedonian variety shows a study by Spasov (2010) on productivity and yield of fiber. The results help to define the variety as environmentally friendly. For the other two varieties, irrigation has a greater influence on the formation of plant boss. Darmi by 11.1% is more responsive to irrigation. The naturally colored Isabell variety 9.7% exceeds the biomass formed during irrigation through phenophase flowering.

Cotton varieties have higher values of biomass, under the influence of irrigation and during the ripening phase. In terms of mineral fertilization levels, an increase in dry biomass has been reported for each variety. Under irrigation conditions, Helius produces more biomass, averaging 27.5% over non-irrigation options. From 52.1% to 60.8%, the increase in biomass growth in Darmi. Isabell responds to irrigation, but the growth of biomass during phenophase ripening is narrow in irrigation and non-irrigation range (52.5-55.1%).

Has been reported that with increasing in fertilizer rate, the Helius variety an increase in the generative growth. The results show that the average for irrigation levels under irrigation conditions and without irrigation, the average number of boxes is in the range of 4.56-4.66. The total yield of one plant, first and second harvest averages 20.80 g for non-irrigation variants and 22.38 g for irrigated variants. Optimization of the moisture factor forms a higher yield. The trend observed in the number of boxes at Darmi under the influence of different fertilization levels is similar. Other researchers have come to the same conclusions. According to Shah (2008), nitrogen (N) is the most essential nutrient of a plant, the most important growth limiting factor among all nutrients. Nitrogen is considered to be a major factor in cotton production, according to Bondada and Oosterhuis (2001) and Hou et al. (2007).

Darmi does not show much responsiveness to irrigation. The formed total yield of a single plant in Isabel under irrigation conditions is averages 18.33 g, while under irrigation conditions the variety forms 21.70 g. Under the influence of optimal moisture supply, Isabell forms a total yield of 18.4% per plant. The results show that the higher number of boxes placed, in irrigation conditions, is able to feed and burst in a timely manner.

After correlation analysis, correlation dependencies were found for each cotton variety with a high degree of correlation. The results for the Helius variety show a very high correlation dependence under non-irrigation conditions between the following indicators: mass per boll and bud-formation (r = 0.989); flowering (r = 0.963), number of bolls per plant (r = 0.988).

Table 1. Correlation dependencies of Helius variety under non-irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1.00	0.989*	0.963*	0.909	0.988*	0.691
x_2		1.00	0.965*	0.943	0.959*	0.604
x_3			1.00	0.976*	0.966*	0.495
x_4				1.00	0.891	0.326
x_5					1.00	0.699
x_6						1.00

Also between the indicators bud-formation (x_2) and flowering (x_3); number of bolls per plant (x_5). A positive correlation also was recorded between the indices: flowering (x_3) and ripening (x_4), number of bolls per plant (x_5) (Table 1). The correlation between the indicators is high and positive: mass of one boll (x_1) and bud-formation (x_2), as well as between bud-formation (x_2) and flowering (x_3). The high correlation coefficients reflect the linear relationship between the indicators considered.

For irrigation variants, a high degree of correlation was found between ripening (x_4) and the number of bolls per plant (x_5), with a correlation coefficient r = 0.979 (Table 2). The correlation coefficient between bud-formation and flowering is also high (r = 0.979). This indicates that there are conditions for the buttons that appear to develop and blossom. The lower coefficients between the number of bolls per plant (x_5); total yield (x_6) is an indicator that not all bolls of the laid boxes are guarded, there are dropped boxes and as a result the yield is lower.

Table 2. Correlation dependencies of Helius variety under irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1.00	0.955*	0.939	0.835	0.907	0.269
x_2		1.00	0.983*	0.850	0.870	0.081
x_3			1.00	0.932	0.933	0.219
x_4				1.00	0.979*	0.513
x_5					1.00	0.555
x_6						1.00

When analyzing the indicators of the Darmi variety, recorded under the conditions of natural moisture supply, the correlation between flowering (x_3) is most pronounced; and the number of bolls per plant (x_5) (r = 0.996), and the mass of one boll (x_1) less pronounced between the indicators; and flowering (x_3); ripening (x_4); number of bolls per plant (x_5) (r = 0.955÷0.973) (Table 3). The dependencies establish a strong relationship between the number of bolls filled and the blooms under non-irrigation conditions. The correlation between the number of bolls and the yield is with the coefficient r = 0.884, which is an indicator that the boxes placed under natural moisture supply are able to guarantee a stable yield. Generative growth is weaker, but the organs provided provide good productivity even with unsustainable soil moisture.

Table 3. Correlation dependencies of Darmi variety under non-irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1	0.901	0.963*	0.973*	0.955*	0.769
x_2		1	0.950*	0.970*	0.920	0.946
x_3			1	0.963*	0.996**	0.902
x_4				1	0.938	0.853
x_5					1	0.884
x_6						1

The data in Table 4 shows that a correlation was found with a positive coefficient between the indicators: bud-formation (x_2) and flowering (x_3); ripening (x_4); number of bolls per plant (x_5), with the strongest between bud-formation (x_2) and number of bolls per plant (x_5) (r = 0.994). The analyzes were made on the basis of the results of biometric indicators under irrigation conditions.

Table 4. Correlation dependencies of Darmi variety under irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1	0.850	0.915	0.734	0.833	0.100
x_2		1	0.952*	0.963*	0.994**	0.580
x_3			1	0.935	0.916	0.327
x_4				1	0.937	0.608
x_5					1	0.629
x_6						1

From the attached Tables 5 and 6, a less pronounced correlation between the parameters considered in the naturally colored Isabell variety is established. In it, without irrigation, the dependencies between bud-formation (x_2) and ripening (x_4) (r = 0.967) are derived.

Comparison with the previous varieties considered here with the Isabell variety has a high correlation between the indices: number of bolls per plant (x_5) and total yield (x_6) under non-irrigation conditions. The high number of bolls and the total yield were also characterized by a high ratio (r = 0.958).

When optimizing the irrigation conditions, strongly correlated correlations were found between bud-formation (x_2) and flowering (x_3) with a correlation coefficient (r = 0.964), respectively. The correlation between flowering (x_3) and ripening (x_4) with coefficient r = 0.956 is also highly correlated.

Table 5. Correlation dependencies of Izabell variety under non-irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1	0.769	-0.077	0.904	0.726	0.768
x_2		1	-0.190	0.967*	0.943	0.834
x_3			1	-0.201	0.146	0.365
x_4				1	0.898	0.834
x_5					1	0.958*
x_6						1

Table 6. Correlation dependencies of Izabell variety under irrigation conditions

x	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1	0.670	0.473	0.298	-0.256	-0.159
x_2		1	0.964*	0.855	0.538	-0.022
x_3			1	0.956*	0.730	0.147
x_4				1	0.820	0.410
x_5					1	0.292
x_6						1

As a result of the correlation analysis, correlation dependences between the studied parameters for the three cotton varieties were deduced. The strongest positive correlation is found for the variety Darmi between the number of bolls per plant and bud-formation and flowering. The highest correlation between the indicators is found in the Helius variety under irrigation conditions.

Mathematically unproven are correlations between yield and other parameters considered variety Helius Darmi as well as in a variety Isabell for irrigation regime.

CONCLUSIONS

The results show that when mineral nutrition increases, the vegetative and generative growth increase as well.

Correlation dependencies were found, with a high degree of Helius correlation between the structural elements: mass of one boll and bud-formation (r = 0.989), mass of one boll and number of bolls per plant (r = 0.988) under irrigation conditions. Darmi has a high correlation coefficient between flowering and the number of bolls per plant (r = 0.996). Naturally dyed Isabell is characterized by a high degree of positive relationship between bud-formation and ripening (r = 0.967) and between the number of bolls per plant and total yield (r = 0.958).

Irrigation correlations were found between bud-formation and flowering (r = 0.983) and between ripening and number of bolls per plant (r = 0.979) in Helius. The high correlation coefficient distinguishes between bud-formation and ripening (r = 0.963), bud-formation, and the number of bolls per plant (r = 0.994) in Darmi. A strong positive correlation was found between bud-formation and flowering (r = 0.964) and between flowering and ripening (r = 0.956).

The analysis which has been made, can serve that to predict the productivity of each variety and the advantages of each one of them.

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