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ORIGINAL PAPER

Influence of mineral fertilization on cotton productivity

Stefka Stefanova-Dobreva[1] • Angelina Muhova[1] • Bogdan Bonchev[2]

[1] Field Crops Institute, 2 Georgi Dimitrov Blvd, 6200 Chirpan, Bulgaria
[2] Institute of plant genetic resources "K. Malkov", 2 Drujba str., 4122 Sadovo, Bulgaria

Corresponding Author: Stefka Stefanova-Dobreva,
E-mail: stefanovadobreva@gmail.com

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Abstract

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The aim of the study was to determine the effect of increasing rates of the main nutrients N and P under cotton productivity. In 1966, at the Field Crops Institute-Chirpan, a stationary fertilizer experiment was set up in a two-field crop rotation - cotton-durum wheat. The data represent the period 2014-2018. The Darmi variety was tested under non-irrigated conditions. In the study were tasted 40, 80, 120 and 160 kg N ha, and 40 and 80 kg P ha. For control was adopted N_0P_0. Fertilization with $N_{120}P_{80}$ had the strongest effect on the height of cotton plants (47.0% above control). The highest boll weight was reported under the influence of the $N_{80}P_{80}$ rate (28.34% above the control). Yield and number harvested bolls per plant were increased the most by the high fertilizer combination $N_{160}P_{80}$ (152.2% and 55.42% above the control, respectively). The strongest and most significant correlation was observed between plant height and boll weight (0.693 ***).

Key words: Cotton, Nitrogen, Phosphorus, Fertilization

Introduction

Cotton is a natural perennial plant that is now commercially grown as an annual plant in many parts of the world. Cotton is the most consumed natural fibre (Esteve-Turrillas and Guardia, 2017). The cotton bud is the most used part of the plant and is a raw material for a wide range of products, such as textiles, edible oil, paper,

animal feed and medicinal products (Ezuruike et al., 2014).

Bulgaria is located on the northernmost border of cotton growing (Stoilova et al., 2016). Mineral nutrients play a critical role to wishstand plant the adverse environmental conditions (Hawakesford et al., 2012). According to Khan et al. (2017) the nitrogen has more impact on yield, maturity, and lint quality of cotton crop than other primary plant nutrients. Insufficient N fertilizer application causes premature senescence, while excessive application causes late ripening and increases environmental pollution (Chen et al., 2020). On the other hand, Iqbal et al. (2019) emphasize that phosphorus deficiency in cotton causes slow shoot development and reduces the absorption of nitrogen and magnesium. An appropriate diet determines the receipt of high and stable yields.

The aim of the study was to determine the effect of increasing rates of essential nutrients N and P under cotton productivity.

Materials and methods

In 1966, at the Field Crops Institute-Chirpan, a stationary fertilizer experiment was set up in a two-field crop rotation – cotton-durum wheat. The data represent the period 2014/2018. Randomized block design was in four replications. The Darmi variety was tested under non-irrigated conditions. The size of the experimental plot was 10 m^2. Phosphorus was pmported as an autumn feed in the form of triple superphosphate. Nitrogen was incorporated with the last cultivation before sowing, as ammonium nitrate. In the study were tasted 40, 80, 120 and 160 kg N ha, and 40 and 80 kg P ha. For control was adopted N_0P_0.

The following traits were examined: yield per 1 plant (lint+seed) (Y1P), g; plant height (PH), cm; boll weight (BW), g; harvest of bolls per plant (HBP), number.

Differences between variants were found by analysis of variance (ANOVA) at P 5%, 1% and 0.1%. Correlation analysis was performed with the software product Statistics 13.0 software (TIBCO, Software, 2018).

Results and discussions

Table 1 presents the plant height (PH) on average for the test period. Without fertilization, the cotton plants reached a height of 34.5 cm. When applying the mineral fertilizer, the highest result was reported from the rate $N_{120}P_{40}$ – 50.7 cm or by 47.0% above the control. Similar values were obtained from variants $N_{160}P_{40}$ and $N_{160}P_{80}$, respectively by 39.1% and 38.6% more than the non-fertilized plot. The analysis of the dispersion showed statistical significance of the values at P = 0.1% for the indicated doses of mineral fertilizers. As in our study, Al-Assaf (2020) reports that the height of plants increases to a certain rate of nitrogen, with increasing fertilizer, the values decrease. On the other hand, the results of the study

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by Panhwar et al. (2018) indicate that with increasing fertilizer rate, plant height also increases.

Tabe 1. Plant height (cm) of cotton average for test period (2014/2018)

Fertilization		cm	% of control
N_0P_0		34.5	100.0
$N_{40}P_{40}$		43.3*	125.5
$N_{40}P_{80}$		42.3*	122.6
$N_{80}P_{40}$		46.6**	135.1
$N_{80}P_{80}$		44.8**	129.9
$N_{120}P_{40}$		**50.7*** **	**147.0**
$N_{120}P_{80}$		43.3**	125.5
$N_{160}P_{40}$		48.0***	139.1
$N_{160}P_{80}$		47.8***	138.6
LSD	*5%*	*6.9*	*20.0*
	1%	*9.2*	*26.7*
	0.1%	*12.2*	*35.4*

NS – no significant; *, **, *** significant at P=5%, P=1% and P=0.1%

Table 2 presents the data on yield of raw cotton from 1 plant, the weight of 1 boll and the number of bolls per plant for the period 2014/2018.

The lowest yield (lint+seed) per plant was obtained in the unfertilized control (4.6 g). The analysis of the dispersion revealed a proven increase in the values for all studied fertilization rates. Yield was least affected by $N_{40}P_{40}$ fertilization. In this variant, an increase of 56.5% over the control and the lowest degree of reliability was reported (P=5%). The combination of 160 kg N ha and 80 kg P ha had the strongest impact. Under the influence of this rate the values exceeded the control by 152.2%. The strong effect of N fertilization was confirmed by Luo et al. (2018). A number of authors confirm the positive effect of nitrogen fertilization on cotton yield (Yang et al., 2018; Luo et al., 2018).

Without fertilizer applied, 3.07 g per 1 boll was reported. Mineral fertilization had a positive and proven effect on the values of the indicator. The only option that was beyond statistical reliability was fertilizing with $N_{40}P_{80}$. The combination of $N_{80}P_{80}$ had the greatest effect on the boll weight, increasing the values by 28.34% compared to the control. It has been observed that as the fertilization rate increases, the values decrease. The results obtained by us confirm the findings of Niu et al. (2021). The authors report that as the N rate increases, so does the boll weight, however, when the nitrogen application exceeded the threshold, the boll weight would not continue to increase.

Table 2. Yield per 1 plant (g) and structural elements of cotton average for test period (2014/2018)

fertilization		Yield per 1 plant, g	% of control	Boll weight, g	% of control	Harvested bolls per plant, number	% of control
N_0P_0		4.6	100.0	3.07	100.00	1.66	100.00
$N_{40}P_{40}$		7.2*	156.5	3.65*	118.89	1.97^{NS}	118.68
$N_{40}P_{80}$		8.2***	178.3	3.56^{NS}	115.96	2.31***	139.16
$N_{80}P_{40}$		7.8**	169.6	3.72*	121.17	2.14**	128.92
$N_{80}P_{80}$		8.2***	178.3	**3.94****	**128.34**	2.04*	122.89
$N_{120}P_{40}$		7.3**	158.7	3.71*	120.85	2.05*	123.49
$N_{120}P_{80}$		8.7***	189.1	3.80**	123.78	2.26***	136.15
$N_{160}P_{40}$		9.1***	197.8	3.72*	121.17	2.30***	138.55
$N_{160}P_{80}$		**11.6*****	**252.2**	3.74*	121.82	**2.58*****	**155.42**
LSD	*5%*	*2.0*	*43.5*	*0.51*	*16.61*	*0.34*	*20.48*
	1%	*2.7*	*58.7*	*0.69*	*22.48*	*0.45*	*27.11*
	0.1%	*3.6*	*78.3*	*0.91*	*29.64*	*0.59*	*35.54*

NS – no significant; *, **, *** significant at P=5%, P=1% and P=0.1%

With the smallest number of bolls, it was expected to be the non-fertilized variant. When mineral fertilization was included, all studied rates had a reliable statistical effect. The highest values were observed under the action of 160 kg N ha in combination with 160 kg P ha. This variant exceeded the control by 55.42%. The study by Ahmad et al. (2021) confirms the results obtained by us.

The correlation analysis revealed a strong and proven relationship between the studied traits (table 3). The plants height and the boll weight (0.693 ***) were most strongly correlated. The weakest but proven correlation was observed between plant height and yield per plant (0.291 *). Khalid et al. (2018) reported the same positive correlation between plant height and boll weight and the number of bolls per plant.

Table 3. Correlation coefficients between the studied traits

	Y1P	*PH*	*BW*	*HBP*
Y1P	1			
PH	0.291*	1		
BW	0.394***	**0.693*****	1	
HBP	0.577***	0.602***	0.574***	1

n=43; *** 0.01%; **0.05%; *0.1%;

Conclusions

The following conclusions can be drawn from the obtained results: fertilization with $N_{120}P_{80}$ had the strongest effect on the height of cotton plants (47.0% above control). The highest boll weight was reported under the influence of the $N_{80}P_{80}$ rate (28.34% above the control). Yield per 1 plant and number of bolls per plant were increased the most by the high fertilizer combination $N_{160}P_{80}$ (152.2% and 55.42% above the control, respectively). The strongest and most significant correlation was observed between plant height and boll weight (0.693 ***).

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