

RESPONSE OF NEW COTTON VARIETIES TO FERTILIZING LEVELS IN THE CONDITIONS OF SOUTHERN BULGARIA

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According to some authors the cotton varieties manifest specific fertilization requirements, while according to others the differences in the level of mineral nutrition of genotypes with close origin are insignificant.



Objective

- To trace the response of some new Bulgarian cotton varieties grown on Eutric Vertisols soils in the region of Central South Bulgaria to the different fertilizing rates of N, P₂O₅ and K₂O on the cotton yield, earliness, and fiber length in order to optimize their nutrition.



MATERIAL AND METHODS



The experiment was conducted on the testing field of the Cotton and Durum Wheat Research Institute, Chirpan, situated in a major cotton-growing region of Bulgaria.



- The cotton was grown in double crop-rotation with durum wheat (Tr. durum Desf.) under non-irrigated conditions.



- The experimental design was a randomized split-plot method with four replications. The trial plot size was 50 m² (6.00 x 8.34 m) and the individual net plots consisted of six 5.56 m rows spaced 0.60 m apart with a net plot size of 20 m².



- The fertilization design was $5N \times 5P + 2K = 27$ variants.
- This study included a selected number of variants.
- Single and full combination of nitrogen and phosphorus fertilization in rates of 0, 80, 160 and 240 kg/ha was tested.
- Two variants with potassium fertilization were included – K_{80} and $N_{120}P_{120}K_{80}$.



Genotypes

The experiment included the following new Bulgarian cotton varieties:

Chirpan-539

Created by intraspecific hybridization

Chirpan-539 without fertilization was accepted as a standard.



Perla

Created by interspecific hybridization
G. hirsutum x
G. barbadense)



Trakia

Created by experimental mutagenesis (irradiating seeds of the intraspecific hybrid Ogosta x 76223 with gamma rays (100 Gy).



Agronomic Practices

The applied agrotechnical practices are complied with the technology established for the region:

- Cotton seeds were sown within 20-30 April every year.
- The seeding rate in the experiment was an average of 16 seeds.m².
- Weeds were controlled by preplant and preemergence herbicides, interrow cultivation and hand chipping.
- Defoliants were not applied.
- There were two harvests made by hand.
- Analysis of variance (ANOVA) was performed to evaluate the yield differences as influenced by the genotypes, fertilization and years.



Soil

Leached Smolnitza (Eutric Vertisols by FAO)

The soil type at the IPTP region was defined by:

- the sandy-clay composition;
- with high humidity capacity and small water-permeability;
- has a high-powered humus horizon (70-110 cm),
- a compact zone of the profile (united horizon).



Soil

Soil analysis of the experimental field indicated:

- bulk weight of the plough soil layer – 1.0-1.2 g/cm³;
- specific gravity – 2.6-2.7,
- the cation exchange capacity (T8.2) was 41.0-46.1 meq/100 g soil



Soil

- total acidity (exchangeable H8.2) - 3.6 meq/100 g soil;
- no damage soil acidity;
- exchangeable aluminum were not established;
- degree of the bases saturation was very high - 93.4-98.8 %.



Properties of the soil, IPTP - Chirpan

Parameters	Depth, cm	
	0-30	30-60
pH _{KCl}	6.7	6.2
Humus, %	2.70	2.45
Total N, %	0.100	0.090
N-NH ₄ ⁺ , kg / ha	50	53
N-NO ₃ ⁻ , kg / ha	47	30
Total N _{min} , kg / ha	97	83
Available P ₂ O ₅ , mg/kg	51	39
Exchangable K ₂ O, mg/kg	230	160

The soil was with neutral soil reaction in the 0-60 cm soil layer, medium supplied with organic matter, with a poor to middle nitrogen supply, with low content of phosphates and well provided with available potassium.

Meteorological conditions

Year	Temperature sum, °C	Rainfall, mm	Water-temperature coefficient (WTC)	Relative humidity, %
2003	3702	339.3	0.92	71
2004	3464	390.0	1.13	75
2005	3450	469.1	1.38	74
2003-2005	3539	399.5	1.14	73.3
1928-2005	3551	296.2	0.83	65.8

The studied years were of diverse meteorological conditions during the cotton vegetation period (May-October):

2003 was very warm and moderately wet, particularly favourable for cotton growing;

2004 - moderately warm and wet, favourable for cotton growing;

2005 - cool and wet.

Studied parameters:

- The dates of beginning of the growth stages – emergence, bud formation, flowering and boll opening were determined, as well as their duration;
- September and total seed cotton yield (kg/ha);
- Elements of yield (bolls per plant and boll mass);
- Height of plants in maturity;
- Lint percentage (%);
- Modal length by "butterfly" method (mm);
- The earliness was determined as percentage of September yield to total yield;
- The agronomic N, P, K use efficiency in kg seed cotton was calculated in kg.kg⁻¹ as ratio (YF – YC)/FR, where YF – obtained yield with fertilization; YC – obtained yield without fertilization; FR – fertilizing rate (N, P₂O₅, K₂O).

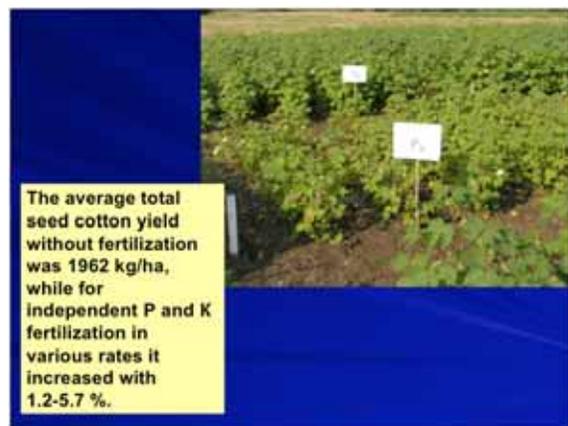
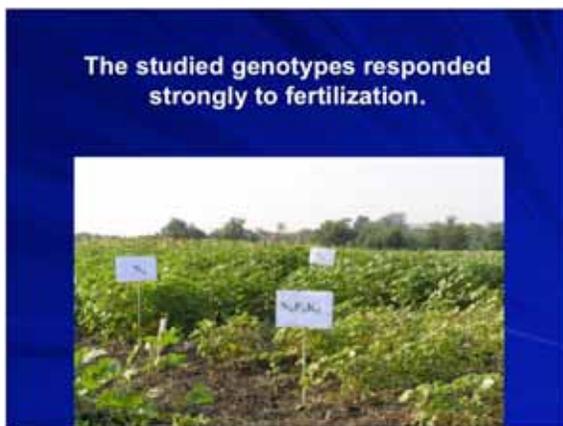


RESULTS AND DISCUSSION

Analysis of variance for total seed cotton yield

Source of variation	d.f.	Sum of squares SQ	Sum of squares SQ, %	Mean squares MS	Fisher's-tests
Total	98	333 907.5	100.00	-	-
E - Years	2	188 969.0	56.59	94 484.5 ***	165.0
Variants	32	108 285.5	32.43	3 383.9 ***	5.9
A-Genotype	2	21 587.0	6.46	10 793.5 ***	18.8
B-Fertilization	10	85 876.5	25.72	8 587.6 ***	15.0
A x B	20	822.0	0.25	41.1	0.07
Error	64	36 653.0	10.98	572.7	-

- The total yield was significantly influenced by the environmental conditions of the year (E), genotypes (A), type of fertilizer and fertilization level (B).
- The uncontrolled year conditions had greatest share in the total variation of the factors – 56.6 %.
- The fertilization level led to big differences – 25.7 %, and the genotype exerted weaker (6.5 %) but also significant influence.
- No significant differences in the cotton yield were occurred as a function of the interaction between cotton variety and N-fertilizing rate.
- The variance of factors for the September yield was similar.

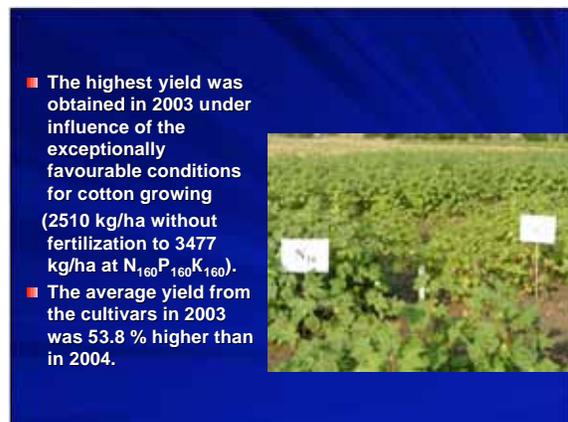


Effect of fertilization on total cotton yield, average for the genotypes

Treatment kg/ha	2003	2004	2005	Average	
				Yield kg/ha	Yield increase kg/ha %
N ₀ P ₀ K ₀	2510	1670	1707	1962	-
N ₀	2067	1512	2270	2423	461
N ₁₆₀	3396	2108	2434	2647	685
P ₁₆₀	2676	1754	1719	2048	86
P ₃₂₀	2893	1784	1745	2074	112
K ₁₆₀	2537	1697	1720	1986	24
N ₈₀ P ₁₆₀	3082	1981	2309	2474	512
N ₈₀ P ₃₂₀	3130	2046	2379	2518	556
N ₈₀ P ₁₆₀ K ₁₆₀	3424	2204	2530	2722	760
N ₈₀ P ₃₂₀ K ₁₆₀	3417	2244	2650	2737	776
N ₁₆₀ P ₁₆₀ K ₁₆₀	3477	2295	2565	2779	817

GD 5 %: 1 %; 0.1 % = 390.4; 518.8; 674.0

The productivity increased with the N fertilization and for N80 it was with more than 23.5 % as compared with the unfertilized, while for N160 – with 34.9 % more. The combined NP and NPK fertilization showed the best effect. Average for the three cultivars at medium soil supply the total yield was effective at N160P80-160 – 2722-2737 kg/ha, 38.7-41.6 % more than the control.



- The cotton yield increase at applied fertilization resulted from the bigger number of bolls kept on one plant (0.2-31.1 % more than the control) and the bigger boll mass - 0.7-25.0 % more.
- The greatest values were manifested at $N_{160}P_{160}K_{160}$.



N, P, K use efficiency, kg seed cotton

Element	Treatment				
	N_{80}	N_{160}	P_{80}	P_{160}	K_{80}
N	5.76	4.28	-	-	-
P_2O_5	-	-	1.08	0.70	-
K_2O	-	-	-	-	0.30

Significantly higher was the N use efficiency – 4.28 (N_{160}) to 5.76 kg seed cotton (N_{80}) as compared to phosphorus – 0.70 (P_{160}) to 1.08 kg (P_{80}) and potassium – 0.30 (K_{80}). The effect decreased with increasing of the nutrition level.



Total yield of cotton varieties, kg/ha

Genotype	Year			Average	
	2003	2004	2005	kg/ha	%
Chirpan-539	3180	1965	2226	2457	100.0
Perla	2724	1980	2049	2251	91.6
Trakia	3207	1976	2266	2483	101.0
Average	3037	1974	2180	2397	-

The response of the tested varieties to the fertilization level was close which was confirmed by the insignificant interaction genotype x fertilization. The year conditions were a decisive factor for the obtained yield. At all fertilization levels the varieties Trakia and Chirpan-539 did appear more productive. The results showed that at optimal fertilization and favourable meteorological conditions the cotton varieties realize their potential of high productivity.

September seed cotton yield, average for 2003-2005

Fertilization	Variety			Average	
	Chirpan 539	Perla	Trakia	kg/ha	%
$N_0P_0K_0$	1182	982	1121	1092	100.0
N_{80}	1498	1180	1314	1324	119.2
N_{160}	1496	1282	1305	1361	124.6
P_{80}	1234	1018	1145	1132	103.7
P_{160}	1255	1049	1185	1163	106.5
K_{80}	1285	1017	1148	1132	102.9
N_0P_{80}	1452	1246	1417	1372	125.6
N_0P_{160}	1467	1324	1437	1409	129.0
$N_{160}P_{80}$	1534	1345	1384	1421	130.1
$N_{160}P_{160}$	1578	1384	1466	1473	134.9
$N_{160}P_{160}K_{160}$	1613	1392	1495	1500	137.4
Average	1485	1262	1311	1366	-

GD (fertilization) 5%; 1%: 0.1% = 76; 148; 185
 GD (variety) 5%; 1%: 0.1% = 52; 104; 142
 GD (variety x fertiliz.) 5%; 1%: 0.1% = 140; 198; 278

The first picking (September yield) increased to greater extent with NP and NPK fertilization – 25.6-37.4 % more than the control, significant at $P=0.1\%$. Average for the Perla variety it was 1202 kg/ha, and for Trakia was 9.1 % higher, while for Chirpan-539 it was 16.6 % more.



Fertilization	Earliness, %
$N_0P_0K_0$	55.5
N_{80}	53.6
N_{160}	51.2
P_{80}	55.2
P_{160}	55.9
K_{80}	56.4
$N_{80}P_{80}$	55.4
$N_{80}P_{160}$	56.2
$N_{160}P_{80}$	52.2
$N_{160}P_{160}$	53.7
$N_{160}P_{160}K_{160}$	53.9
Average	54.4

- The index of earliness average for the period without fertilization was 55.5 %, it increased maximum at K_{80} - 56.4 %, and the share of September yield being lowest at N_{160} - 51.2 %.
- In 2003 and 2005 the earliness was higher - 70.1–77.8 %, but the tendency of influencing the nutrient elements was unidirectional.

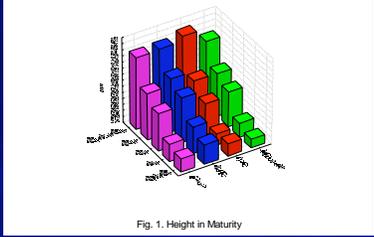


Fig. 1. Height in Maturity

- The rate of growth was most intensive in bud formation and flowering when the average height growth was 0.55-0.76 cm/day and dry matter per day was 57-69 kg/ha. N fertilization influenced positively the height and dry matter of the plants.
- The plants height increased under the influence of all tested fertilizing rates and at the end of the vegetation period was 2.6-38.0 % more than the unfertilized with the high average value of 69.6 cm at $N_{160}P_{160}K_{160}$.
- The plants of the Trakia variety were with 4.7 % higher than Perla and with 6.0 % higher than Chirpan-539.



Fig. 2. Lint Percentage

- The meteorological conditions and specific characteristics of the varieties exerted greater effect on the lint percentage in comparison with the fertilization.
- A tendency was observed for reduction of the lint percentage for all cultivars with increase of the fertilization level.
- During the years were created conditions for good seed nutrition, for amassing nutrient reserves and for that reason the average lint percentage was lower – 35.3 to 36.4 %.
- The lint percentage was lowest for the Perla variety - 35.0-35.4 %.

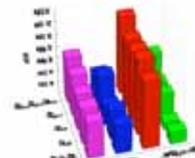


Fig. 3. Fiber Mean Length

- The meteorological conditions and specific characteristics of the varieties exerted greater effect on the fiber length in comparison with the fertilization.
- Other authors also point that the increase in fertilization rate does not lead to changes in the fiber length.
- Perla variety forms very fine and longest fiber – 28.3-28.7 mm.

CONCLUSIONS

- Under the conditions of Southern Bulgaria on soil type Eutric Vertisols the fertilization is an effective agrotechnical practice when applied in rates up to N180P80-160 where the total seed-cotton yield increased with 38.7-41.6 % as compared with the unfertilized.
- The N use efficiency expressed in kg seed cotton was significantly higher – 4.28-5.76 kg than phosphorus – 0.70-1.08 kg and potassium.
- The studied cotton cultivars realized a total yield of 1962 kg/ha (N0P0K0) – 2779 kg/ha (N180P160K160) and had similar demand to the N rates. At the applied fertilization variety Chirpan-539 manifested as the earliest and most productive. Trakia had very good productivity, and Perla – very high fiber quality. The lint percentage was lower for Perla but this variety formed the longest and very fine fiber.

