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Raheel Atif HAMEED and Hakoomat ALI [1]

QUANTITATIVE PHYSIOLOGICAL, VEGETATIVE, AND REPRODUCTIVE ANALYSIS IN *Gossypium hirsutum* UNDER INFLUENCE OF CULTIVARS AND NITROGEN

SUMMARY

A two year field study was carried out to know the impact of cultivars selection and nitrogen on growth and development of cotton (*Gosssypium hirsutum*) plant under semi arid conditions of Punjab, Pakistan. Nitrogen and cultivar selection plays an important role in determination of plant yield under various environmental circumstances. It is the basic constituent of plant green material and in nature. Various treatments of nitrogen were Zero, 60, 110 and 160 kg ha-1 applied in splits to the soil along with high yielding cotton cultivars (CIM-496, CIM-506, and CIM-534). The highest significant vegetative quality traits of cotton i.e. plants main stem height, nodes per plant were produced by the cultivar CIM-534 during 2007 and 2008. However, physiological parameters like leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR), reproductive parameters such as total dry biomass (TDM), cotton bolls count m-2 and seed cotton yield were produced significantly the maximum by CIM-496 cultivar. Vegetative, reproductive and physiological traits were directly proportional to the increasing N rates ha-1. For better yield and yield components, nitrogen given at the rate of 160 kg ha-1 proved to be the optimum under semi arid conditions.

Keywords: Cultivars, *Gossypium hirsutum*, Growth, Nitrogen, Yield and Yield components.

INTRODUCTION

To minimize a big gap between potential and farm, fertilizer, soil and crop management practices are the most important factors. To feed the increasing population day by day, there is a big need to overcome this difference. In reduction of financial crises, unemployment and poverty, cotton played an important role. It enhanced industrial development, raw material for national and international spindles and oil expelling units, industries all over the world [2]. The scientists conducted comprehensive research work to prove that growth and development activities plays an important role to regulate plant growth, plant vegetative, reproductive and cotton boll load that resulted in increased yield per unit area. Judicious fertilizer use, improved agronomic techniques increased crop yield significantly [34]. Cultivar selection and nitrogen given to soil at various

[1] Raheel Atif Hameed (corresponding author: rahb100@yahoo.com) and Hakoomat Ali Department of Agronomy, University College of Agriculture, Bahauddin Zakariya University, Multan, Pakistan.

critical growth stages is essential to meet the yield requirements of the crop through out the growth period [29], [36]. Deficient supply of the nitrogen may reduce or even cease all development process of the crop plant that may leads to significant yield loss [20]. Excessive vegetative growth attracts sucking insect pests, diseases attack that resulted in delayed crop and fruit maturity that reduce yield [23]. However, a field study was designed to measure the individual and interactive affects of cultivars and nitrogen on growth, and yield and yield components of cotton.

MATERIAL AND METHODS

Experiments were conducted at the farm area of The Central Cotton Research Institute (CCRI), Multan, Pakistan. Four various nitrogen application rates (i.e. Zero, 60, 110 and 160 kg ha-1) were applied with CIM-496, CIM-506, and CIM-534 cotton cultivars during the two growing seasons (2007 and 2008) on a sandy loam soil. Field experiment was laid out in R.C.B.D. (randomized complete block design) design with split plot arrangements. All the cultivars were grown in the main plots while nitrogen was kept in the sub plots. 9 m x 3.3 m was the net plot size during both the years with 75 cm bed and furrows apart and plant to plant distance was maintained to 23 cm. A good quality seed bed was properly shaped with a bed shaper. Before the field experiment soil analysis was done that is given in Table 1.

Table 1. Soil analysis

Characteristics	**I**		**II**	
Chemical analysis	**15 cm**	**30 cm**	**15 cm**	**30 cm**
O. M (%)	0.66	0.60	0.63	0.62
SAR	2.45	1.72	2.53	1.79
Soil pH	8.08	8.16	8.10	8.14
EC_e (dS m^{-1})	2.29	1.70	2.32	1.80
P (ppm)	7	4	8	7
K (ppm)	100	90	102	91
Physical analysis	**15 cm**	**30 cm**	**15 cm**	**30 cm**
Sand (%)	15	16	15	16
Silt (%)	60	59	58	60
Clay (%)	26	24	25	26
Textural class	**Silt loam**			

Dibbling method for seed sowing was done while, thinning was done after three weeks of seed sowing to maintain the required number and distance between the plants. All the P2O5 (i.e. 50 kg ha-1) in the form of Triple Super

Phosphate (TSP) was applied at the seed sowing. Five free from insect pest attack, healthy, disease free plants were selected to calculate the data from all the plots of each treatment. Agronomic practices were kept the same for all the treatments through out the crop growth and development period. After 150 days of crop sowing, seed cotton was picked in two pickings while the second picking was done 180 days after sowing. Leaf, stem, flower and boll samples were oven dried at 80^{o}C taken from 1m2 for measurement of leaf area index, plant biomass, relative growth rate, crop growth rate, and net assimilation rate by [30] methods. From 1m2 number of bolls while, seed cotton was picked from each plot to convert on hectare basis. 100 gram seed cotton sample was taken, air dried and ginned for GOT percentage calculation. Field results were analyzed by using "MSTAT" statistical techniques and at 5% probability level, a least significant difference (LSD) test was applied to check the significance of treatment means [39].

RESULTS AND DISCUSSION

Plant height (cm)

In cotton main stem height is the main vegetative growth parameter that directly represents the fertilizer effect. Various nitrogen rates affected plant height significantly. Nitrogen applied at various crop growth stages showed direct relationship to the plant height (Fig.1). At various application rates Fertilizer applied through soil significantly influenced the plant height of cotton cultivars. Respectively in the two years, against untreated control, nitrogen given at the rate of 160 kg ha-1 produced 54% and 49% taller plants. All the cotton cultivars showed their significant effect on plant height at crop final harvest. CIM-534 produced significantly the tallest plants among all the cultivars while, the smallest plants achieved by CIM-506 [14], [19].

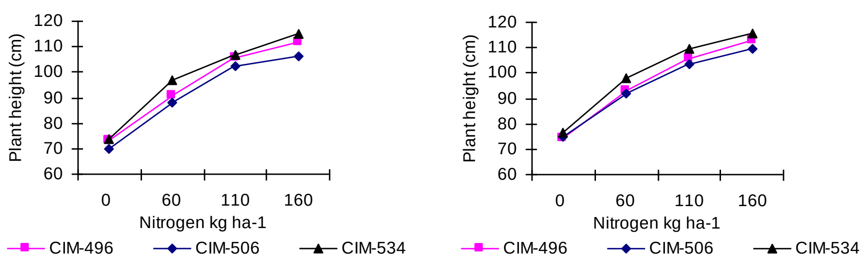

Figure 1. Effect of nitrogen and cultivars on plant height during I & II year

Number of nodes plant-1

Results indicated that as plant heights increased number of nodes increased and increase in number of plant nodes is directly proportional to the plant height. Number of nodes increased significantly as rate on nitrogen applied to soil increased. It was shown by the results that a significant interaction existed between nitrogen and cultivars. During both the years, CIM-534 cultivar produced the highest significant nodes count as compared to the other two cultivars while, CIM-506 produced the lowest number of nodes. These results are in line with those of [20].

Leaf area index (LAI)

Nitrogen applied to cotton cultivars at different application rates catalysed significantly many physiological processes. Both nitrogen and cultivars significantly affected the leaf area index during the two years of field crop research. Treatment 160 kg nitrogen ha-1 produced significantly the highest LAI through out the plant growth against untreated control.

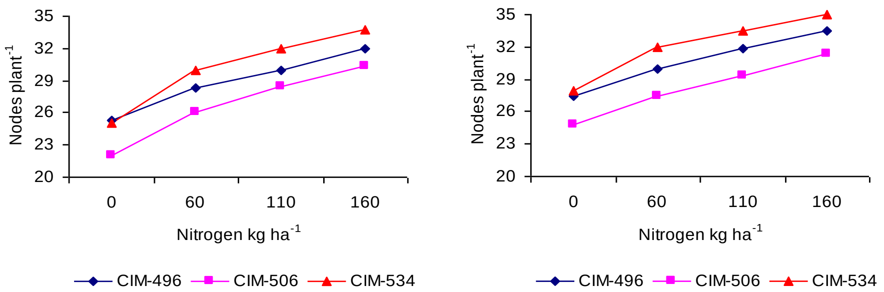

Figure 2. Effect of nitrogen and cultivars on nodes plant^{-1} during I & II year

Among all the cultivars, CIM-496 produced the highest significant LAI. From the fig-3, it is obvious that leaf area index increased up to 90 days after crop sowing. LAI started to decrease as crop reproductive growth stage converted to crop maturity. Thus, after 90 DAS all the cultivars achieved their maximum canopy. Similar results were reported by other scientists [35], [38].

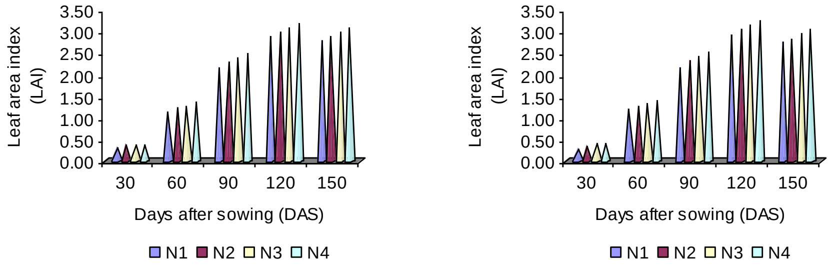

Figure 3. Effect of DAS and nitrogen rates on LAI during I & II year

Crop growth rate (gm^{-2}d^{-1})

All the cultivars and various nitrogen doses increased crop growth rate (CGR) significantly. CGR was enhanced significantly with each increment in nitrogen application rate i.e. from zero to 160 kg ha^{-1} from crop sowing to the crop harvest. However, the highest CGR was obtained by the treatment (160 kg nitrogen ha^{-1}) against control. Similarly, cultivar CIM-496 achieved the top position in production of the highest crop growth rate during both the seasons. It was also observed that crop growth rate was the maximum after 120 days of sowing and then decreased upto crop maturity [6], [28].

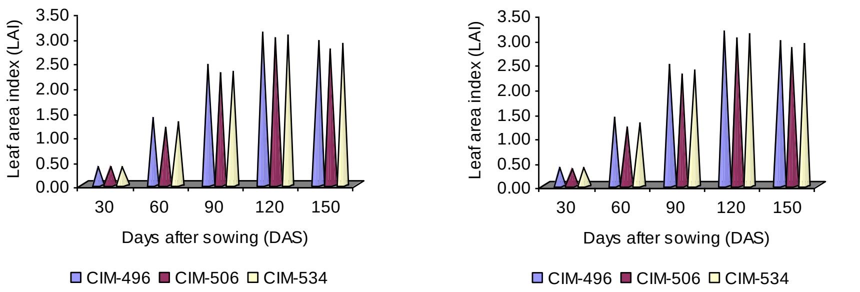

Figure 4. Effect of DAS and cotton cultivars on LAI during I & II year

Relative growth rate (g g^{-1} d^{-1})

Relative growth rate (RGR) was altered significantly by the cultivars and nitrogen fertilizer through out the crop growth. 160 kg nitrogen ha^{-1} treatment produced significantly the maximum RGR against control treatment from seedling emergence to the crop final harvest while, the RGR was highest after 90 DAS during both the years and then continuously decreased till crop harvest. As compared to CIM-506 and CIM-534, cultivar CIM-496 appeared with the maximum value of RGR through out the growing period. Similar findings were produced by [23].

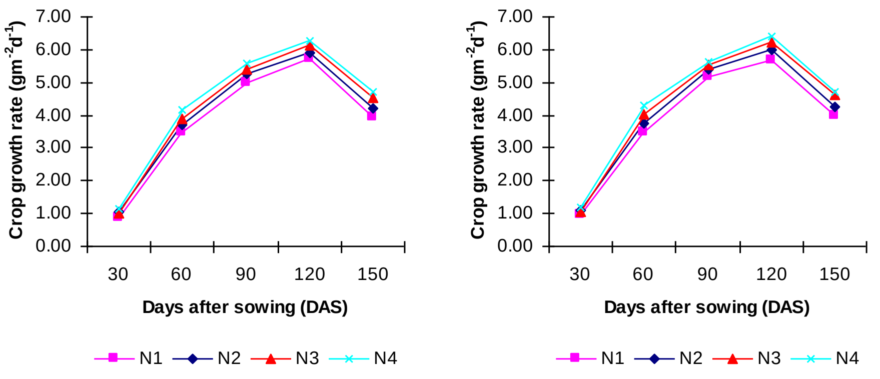

Figure 5. Effect of DAS and nitrogen rates on CGR during I & II year

Net assimilation rate (mg dm^{-2} d^{-1})

Cultivars and fertilizer nitrogen affected significantly cotton crop net assimilation rate (NAR) from 30 to 150 DAS. The maximum amount of nitrogen given to crop produced the highest significant NAR. However, it was observed that cotton net assimilation rate was the highest during early crop growth stages then after it started to decrease as crop matured.

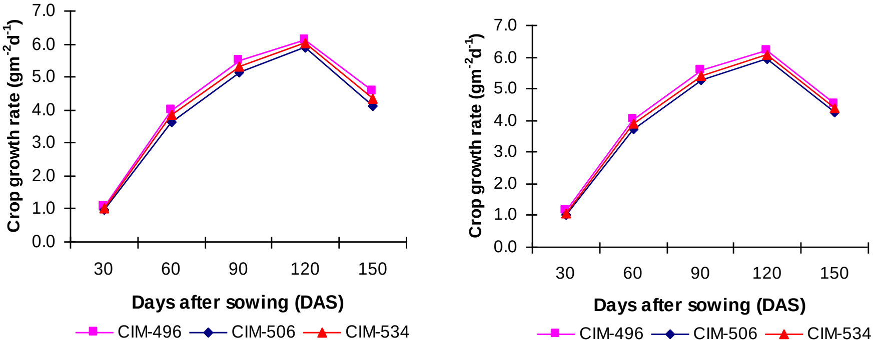

Figure 6. Effect of DAS and cotton cultivars on CGR during I & II year

Similarly, NAR of all the cultivars was the maximum during vegetative crop growth stages and then as fruit load increase it continuously decreased till crop final harvest. Again the cultivar CIM-496 produced the highest value of NAR against CIM-506 during the whole crop growing season [15], [32].

Total dry matter (gm^{-2})

Analyzed results indicated that total dry biomass (TDM) significantly influenced both by the cultivars and nitrogen fertilizer. Each nitrogen application treatment produced significant TDM accumulation against control. However, the highest total dry plant biomass was produced by 160 kg N ha^{-1} treatment at crop harvest against zero nitrogen treatment respectively in two different seasons. As concerned with the cultivars, CIM-506 produced the highest significant weight of dry biomass as compared to the other cultivars [17], [35].

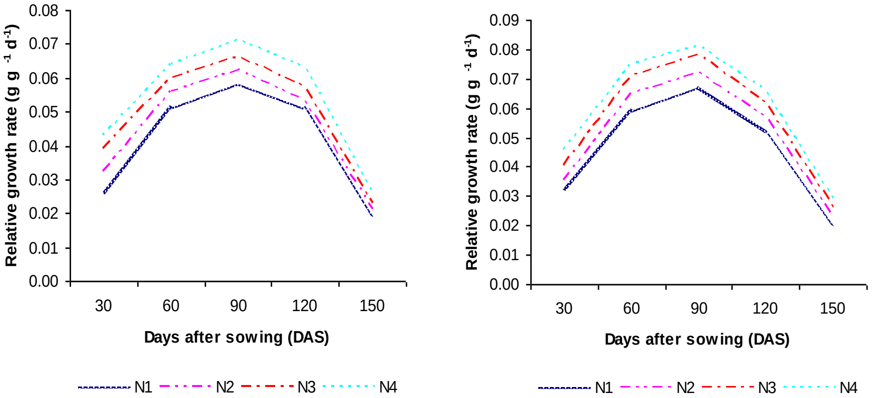

Figure 7. Effect of DAS and nitrogen rates on RGR during I & II year

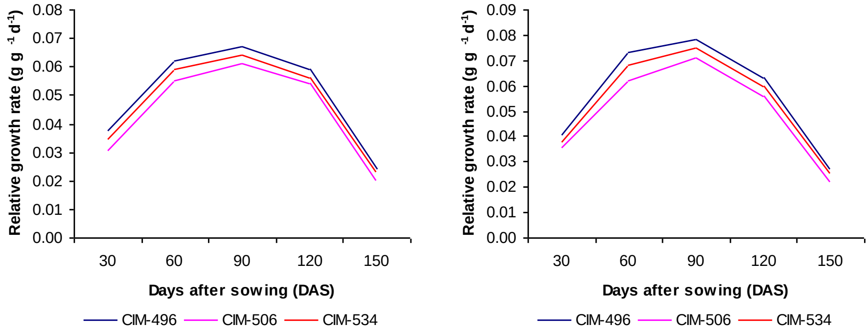

Figure 8. Effect of DAS and cotton cultivars on RGR during I & II year

Cotton bolls (m^{-2})

Cotton fruit production is directly associated with the availability of the balanced soil nutrients and cultivar selection. With increase in rate of nitrogen given to soil influenced the boll load significantly. As nitrogen rate increased fruit retention increased significantly and vice versa. Field research regarding bolls count showed that treatment i.e. 160 kg N ha^{-1} produced the highest significant results i.e. 55% and 53% more m^{-2} against control treatment in the two years. The maximum number of cotton fruits i.e.120.3 and 122.7 m^{-2} were produced by the cultivars CIM-496 in both the years respectively while CIM-506 appeared with the lowest numbers of bolls. Other researchers [9], [27] reported the similar results.

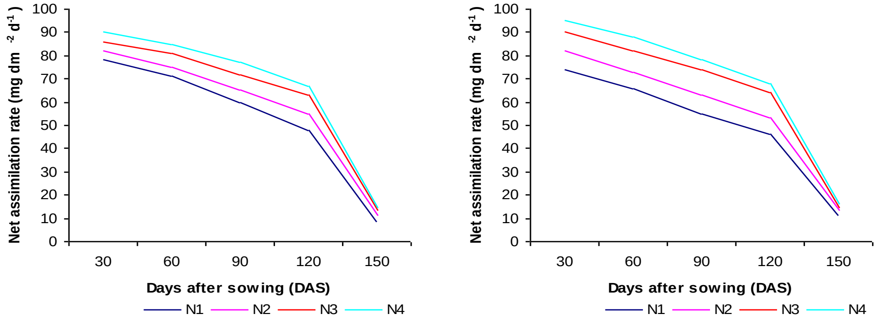

Figure 9. Effect of DAS and nitrogen rates on NAR during I & II year

Seed cotton yield (kg ha^{-1})

Judicious and timely application of nutrients to the soil has significant effect on seed cotton yield. In scarcity or absence of the plant nutrients, a visible reduction in yield had been noticed by many researches. However, there is no substitute of it only by the application of that specific nutrient yield reduction can be recovered. Results of field yields during the two years trails showed that increasing rates of nitrogen increased significantly seed cotton Significantly the highest seed cotton yield (i.e. 3445.7 and 3536.4 kg ha^{-1}) was obtained in both the crop growth seasons by the application of 160 kg nitrogen ha^{-1} against control treatment that was 63% and 64% more. However, various cultivars showed their maximum potential in producing the yield. Cotton cultivar CIM-496 produced the highest significant seed cotton yield (3124.6 and 3227.3 kg ha^{-1}) while, CIM-506 produced the lowest yield during both the years. Similar results were reported by [34], [36].

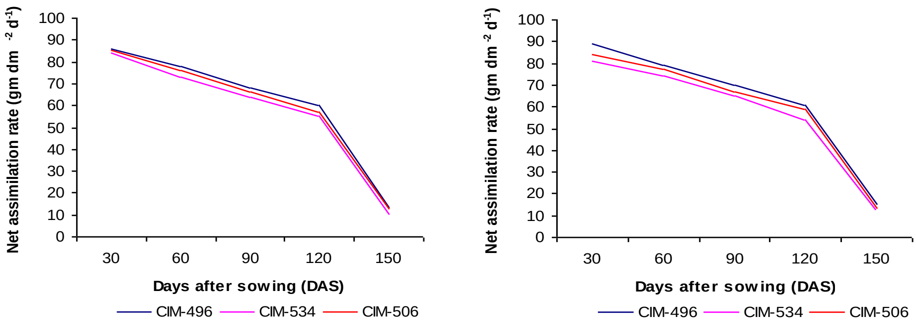

Figure 10. Effect of DAS and cotton cultivars on NAR during I & II year

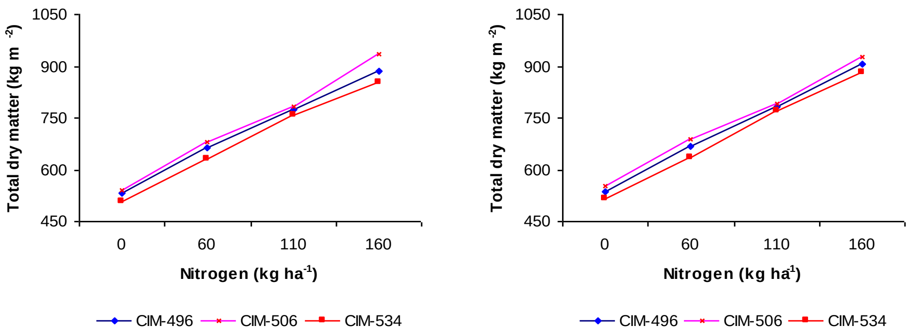

Figure 11. Effect of nitrogen rates and cotton cultivars on TDM during I&II year

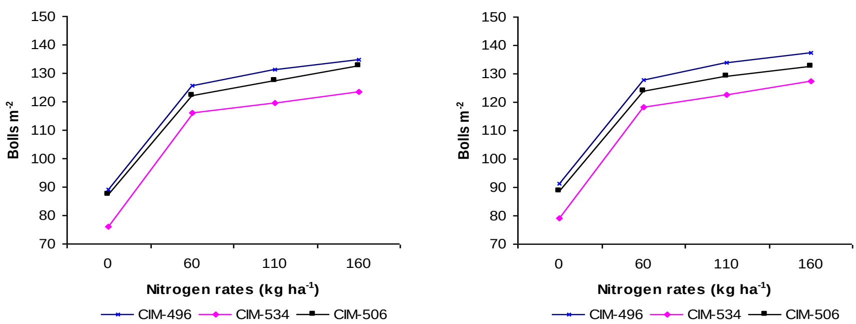

Figure 12. Effect of nitrogen rates and cotton cultivars on bolls during I & II year

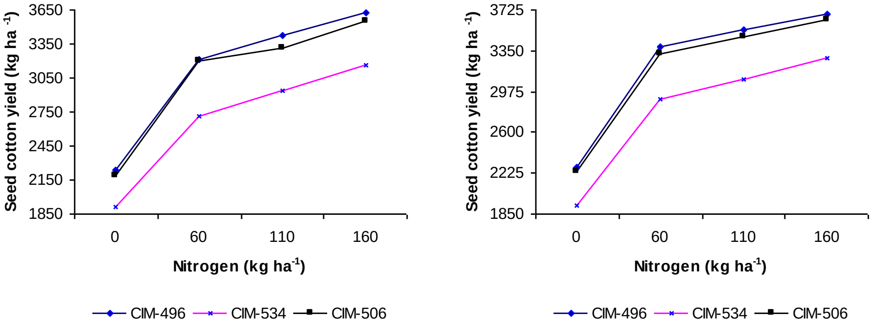

Figure 13. Effect of nitrogen rates and cotton cultivars on seed cotton yield during I & II year.

CONCLUSIONS

It may be concluded from the results that vegetative, reproductive and physiological processes in cotton may be significantly increased by the judicious use of nitrogen and cultivar selection.

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Raheel Atif Hameed i Hakoomat Ali

KVANTITATIVNA FIZIOLOŠKA, VEGETATIVNA I REPRODUKTIVNA ANALIZA *Gossypium hirsutum* NA OSNOVU UTICAJA SORTI I AZOTA

SAŽETAK

Obavljeno je dvogodišnje istraživanje u cilju utvrđivanja uticaja odabira sorti i azota na razvoj i rast biljke pamuka (*Gosssypium hirsutum*) u polu-sušnim uslovima Punjabe, Pakistan. Azot i odabir sorte imaju značajnu ulogu u utvrđivanju prinosa biljke pod različitim ekološkim uslovima. To je osnovni konstituent zelene materije biljke, kao i prirode. Primjenjeni su različiti tretmani azotom, od nula, 60, 110 i 160 kg ha^{-1} putem split aplikacije u zemljište, zajedno sa visokorodnim sortama pamuka (CIM-496, CIM-506 i CIM-534). Najznačajniji vegetativni kvalitet pamuka, tj. visina glavne stabljike biljke, kolenca po biljci, je ostvarila sorta CIM-534 tokom 2007. i 2008. godine. Međutim, fiziološki parametri, kao što su indeks površine lista (LAI), stopa rasta usjeva (CGR), stopa relativnog rasta (RGR) i stopa neto asimilacije (NAR), te reproduktivni parametri, kao što su ukupna suva biomasa (TDM), broj čaura pamuka po m^{-2} i prinos sjemena pamuka, su ostavreni do maksimalnih vrijednosti od strane sorte CIM-496. Vegetativne, reproduktivne i fiziološke osobine su direktno proporcionalne sa povećanjem stope N po ha^{-1}. Za bolji prinos i komponenete prinosa, optimalna je stopa azota od 160 kg ha^{-1}u polusušnim uslovima.

Ključne riječi: sorte, *Gossypium hirsutum*, rast, azot, prinos i komponente prinosa