ROLE OF MAJOR NUTRIENTS IN COTTON - A CRITICAL REVIEW

K. Kalaichelvi, C. Chinnusamy1 and A. Arul Swaminathan2

Department of Agronomy,
Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu, India

ABSTRACT

Cotton, the "King of fibres" is often quoted as 'White gold' because of its higher commercial value. Our country ranks first in cotton acreage but the productivity is less. One of the major constraints in cotton is nutrient management. Cotton is a deep-rooted crop and voracious feeder of nutrients, responds well for nutrients. When the nutrients are supplied at sub optimal level, the diversion of nutrients to the reproductive sympodial branches gets disrupted leading to boll shedding and poor yield. On the other hand, excess application of fertilizer has its own limitation in promoting vegetative growth. The optimal dose of nutrients builds up a favourable condition in increasing cotton productivity. Response of nutrients in cotton varies among varieties and region and therefore, the recommendation of nutrients are to be made with region specific doses for increasing the productivity.

Cotton has retained its unique fame and name as the "King of fibres" and "White gold" because of its higher economical value among cultivable crops for quite a long period. It was the superiority of Indian cotton fabrics famed as "webs of woven mind" which attracted European countries to seek new trade routes to India. Indian economy continued to receive great support from the cotton industry, earned Rs. 55,000 crores in foreign exchange during 2000-01 by export of cotton fibre, yarn and textiles (AICCIP, 2002).Cotton cultivation impregnates its mark on the lives of 60 million people, offering 200 man-days/ha of employment through its cultivation practice, trade and processing (Mayee et al., 2002). Cotton statistics (Area, production and productivity)

At Global level, the area under cotton showed increasing trend from 31.95 to 33.98 m ha from 2000 to 2002, production from 19.27 to 21.09 mt and productivity from 603 to 621 kg/ha. Cotton area and production are estimated to be around 85.6 lakh hectares and 156 lakh bales, respectively during 2002 in India. Our National productivity is 309 kg/ha against the World productivity of 621 kg/ha. On contrary, India stands first in cotton acreage. Cotton possesses a very high production potential but the productivity stagnates over years. Major constraints, which decide the continuance of cotton cultivation, are agroclimatic conditions prevailed during cropping, improper use of fertilizers, indeterminate nature of growth, weeds, improper water management and severe pest and disease infestation.

Response of cotton to the applied nutrients

Cotton is a deep-rooted crop and voracious feeder of nutrients, responds well for nutrients. As it is a long duration crop, it requires constant supply of nutrients; the response is more during flowering and boll development phases. Diversion of nutrients to the reproductive sympodial branches gets disrupted leading to boll shedding and poor yield and compel the crop to exploit soil reserves for other nutrients. The optimal dose of nutrients builds up a favourable condition in increasing cotton productivity and improves the quality. The yield potential of the crop can be exploited to the maximum only when the nutrient requirements are fully met with. On the other hand, excess application of fertilizer

1 ARS, Bhavanisagar - 638 301, Tamil Nadu, India.
2 Horticulture College and Research Institute, Coimbatore - 641 003, Tamil Nadu, India.
has its own limitation in promoting vegetative growth. Response of nutrients in cotton varies among varieties and region and therefore, the recommendation of nutrients are to be done with region specific doses.

**Nutrient requirement of cotton**

The nutrient requirement of cotton to produce a quintal of kapas yield is estimated as 4.30, 0.20 and 4.52 kg N, P and K respectively. For cotton, the nutrient contribution from soil is accounted as 28.90, 26.40 and 10.60 %, through fertilizers 32.23, 34.40 and 70.30 % and from organics 18.80, 12.36 and 21.88 % of N, P and K, respectively (Selvakumari et al., 2000). So adequate supply of nutrients is necessary to attain higher productivity.

**Effect of applied nutrients on the growth and yield attributes of cotton**

Investigations on fertilizer use have conclusively proved that the efficiency of nitrogen in improving cotton yield and response of cotton to incremental nitrogen to certain level is well known fact. Hunsigi et al. (1972) inferred that 80% variation in seed cotton yield could be attributed to effect of nitrogen. In contrary, Venkatakrishnan (1994) opined that nutrient management practices did not show any influence on growth, yield attributes, yield and quality characters in cotton. Significant increase in plant height, number of monopodial and sympodial branches, dry matter production, bolls/plant and boll weight were recorded with incremental dose of N up to 80 kg/ha (Mool Chand et al., 1997). Increase in N levels from 0 to 120 kg/ha, significantly increased the plant height, biomass production, mainstem nodes, leaves per plant, leaf area and leaf area index in cotton (Perumal, 1999). Hussain et al. (2000) recorded increased plant height by applying 100 kg N/ha in irrigated cotton. Dry matter production of cotton increased with increasing levels of P to the extent of 50 kg/ha (More and Agale, 1993). Whereas, Swaji et al. (1994) reported that application of 20 or 30 kg P₂O₅ and 60 kg N/ha significantly increased the plant height, leaf area and growth rate of cotton. Srinivasan et al. (2002) observed that phosphorus levels did not influence plant height, number of monopodial and sympodial branches, but recorded more number of bolls and boll weight at 100 percent phosphorus level of 30 kg/ha over 75% and 50% recommended doses. However Manoharan (1978) reported that dry matter production, net assimilation rate and crop growth rate were unaffected by increased application of potassium.

**Effect of different levels of nutrient on its uptake by cotton**

The rate of uptake of nutrients, maximum between flowering and first picking, indicates the most critical phase reflecting on the seed cotton yield. Total N, P and K uptake increased with age of the crop and higher in 60 : 30 : 30 kg N P K/ha (Velu and Balasundaram, 1980). Khizdiranazarav (1984) reported that cotton accumulated more N from soil rather than applied N. Anandachowdary and Hanumantha Rao (1987) observed that concentration of N and K was maximum at early stage and reduced to minimum at maturity and also reported that N, P and K uptake increased as the growth stages advanced. Nitrogen uptake by cotton greatly increased with increasing N doses from 0 to 100 kg N/ha (Ravanker and Deshmukh, 1994; Ibrahim et al., 1997). Krishnappa and Lourdraj (1997) reported that application of 80 kg N/ha recorded maximum uptake of N, P and K in cotton at harvest stage. The petiole nitrate nitrogen declined steadily with crop ontogeny irrespective of N levels applied and showed significant increase in 75 and 100 kg N/ha than 50 kg N/ha and control (Venugopalan and Blaise, 2001) Nalayini et al. (2001) reported that N use efficiency in cotton decreased with increasing levels of N.
Rampakash et al. (2001) observed the highest N uptake with 100 kg N/ha over control. Khawale Vijayakumar Shriram and Prasad (2001) quantified nitrogen uptake of 119.5 kg/ha by the application of 80 kg N/ha. Sagarkar et al. (2002) quoted that higher nutrient uptake resulted in conversion of photosynthates to numerous metabolites needed for increasing yield attributes. There, was no increase in the uptake at the higher level of K application (Chandrasekaran, 1977). In contrary, Manoharan (1978) reported that when N was added to the soil the plant not only absorbed the N but also with higher potassic fertilizer application. Weir et al. (1988) found out that potassium fertilizer increased potassium uptake but levels dropped at critical points when maximum boll load occurred. Concentration of K in leaves varied at levels of potassium fertilizer and positively correlated with concentration of K in matured fibre (Cassman et al., 1990). According to Liu et al. (1992) the percentage of total N, P and K absorbed by cotton were 6, 12 and 12 per cent, respectively, at emergence to square stage, 36, 31 and 31 per cent at squaring to flowering stages, 43, 51 and 53 per cent at flowering to boll bursting stages and 3.6 and 5 per cent at boll opening to harvest. Rajeev Gopal et al. (2001) observed a most pronounced concentration of potassium in leaves than flowers and fruits and was in decreasing rate in other vegetative parts.

Effect of applied nutrients on the yield of cotton

The magnitude of increase in yield was to the tune of 29, 58 and 79% at 50, 100 and 150 kg N/ha respectively (Jain et al., 1983). Jaganathan et al. (1994) reported that response to the levels of fertilizers differed among varieties of cotton. Jaganathan and Venkitaswamy (1996) optimized the fertilizer level of 80:40:40 kg N P and K/ha in increasing the seed cotton yield over higher and lower doses. In contrary, Sasthri et al. (2001) recorded 48% increase in seed cotton yield by higher fertilizer dose of 200:150:100 kg NPK/ha than recommended dose. Whereas Srinivasan et al. (2001) reported that formulated moderate dose of 60:30:30 kg NPK/ha produced higher seed cotton yield with the highest B: C ratio with 80:40:40 kg NPK/ha which promoted more vegetative growth. Venugopalan and Blaise (2001) recorded 39% yield increase over control by applying recommended dose (80: 40: 40 kg NPK/ha) of fertilizers. Wankhade et al. (2001) recorded 32.2% and 14.7% increased seed cotton yield by applying recommended dose of fertilizers over no fertilizer and 50% of the recommended fertilizer application respectively. According to Ougunwole et al. (2003) seed cotton yield could be increased with increase in fertility rate when moisture is not a limiting factor. Phosphorus deficiency reduced the lint yield but did not affect open boll percentages and reproductive efficiency. Whereas, nitrogen deficiency enhanced the maturity and reduced lint yield by 26% (Tewoide et al., 1994). Tomar and Dhyani (1995) recorded 27, 34.6 and 65.6% respectively seed cotton yield increase with 30, 90 and 120 kg N/ha, respectively against no nitrogen application. The seed cotton yield increase was 17.6 and 19.5%, respectively, with 40 and 60 kg P/ha as compared to no P application and there was no significant yield response with potassium in cotton. Phosphorus and potassium did not influence the growth and yield attributes as well as yield and quality characters of cotton (Mool Chand et al., 1997). Whereas, Tomar et al. (2000) observed a very good impact on seed cotton yield with various levels of fertility and applied nutrients.

Targeted yield approach in cotton

There was a significant variation in seed cotton yield due to fertilizer treatments. Farmers' intention is to get the maximum yield
with limited resources. Targeted yield concept provides a profitable net income. Selvakumari et al. (1998) test verified the soil test crop response correlations and fertilizer adjustment equation in farmers holding for cotton on typic ustochrept and recorded higher response ratio and benefit cost ratio indicating the efficient and economic utilization of added fertilizer nutrients. Since the available nutrient status of soil as well as crop requirement are taken into account for formulating the fertilizer prescription equations, there is an assured and balanced supply of nutrients facilitating increased nutrient use efficiency and maintenance of soil fertility by prescription procedure. Khandare et al. (2002) validated fertilizer prescription equation formulated under Parbhani conditions and concluded that targeted yield of cotton was in close agreement with the actual yield and monetary returns were higher in 20 q targeted yield as compared to blanket recommended dose of fertilizers.

**Effect of nutrients on the fibre quality of cotton**

Chandrasekaran (1977) stated that K had no influence on ginning percentage, lint index and seed index in cotton. Cassman et al. (1990) reported that greater lint percentage was recorded due to increased fibre length and secondary wall thickness with the application of K fertilizer. Fibre percentage, fibre length, uniformity ratio, micronaire index and fibre strength were not affected by P levels (Malik et al., 1992). Split application of N improved the bundle strength of fibre and the maturity coefficient (Mukund Joshi et al., 1999). However, according to Hussain et al. (2000), application of 100 kg N/ha did not have significant influence on ginning percentage of cotton. Prasad, (2000) reported that application of phosphorus along with sulphur significantly increased the bundle strength. He further added that fibre strength, elongation percentage, fibre length and uniformity ratio were positively related with K fertilizers.

**CONCLUSION**

The optimal dose of nutrients builds up a favourable condition in increasing cotton productivity. Excess application of fertilizer has its own limitation in promoting vegetative growth. Nitrogen deficiency enhanced the maturity and reduced lint yield by 26% Phosphorus deficiency reduced the lint yield but did not affect open boll percentage and reproductive efficiency. Fibre strength, elongation percentage, fibre length and uniformity ratio were positively related with K fertilizers. Response of nutrients in cotton varies among varieties and region and therefore, the recommendation of nutrients are to be made with region specific doses. Thus more attention should be provided for increasing the efficiency of the applied nutrients by different approaches like split application, slow releasing fertilizers, need based fertilizer application, foliar spraying of the nutrients, drip fertigation, location specific researches on nutrient management, including the organic sources in the nutrient schedules along with inorganic fertilizers, giving more emphasis on the green manuring and intercropping in the cotton for the effective supply of the nutrients.

**REFERENCES**

Selvakumari, G. et al. (1998). *Department of Soil science and Agricultural chemistry, Tamil Nadu Agricultural University, Coimbatore.*
Selvakumari, G. et al. (1999). *Department of Soil science and Agricultural chemistry, Tamil Nadu Agricultural University, Coimbatore.*