RESPONSE OF COTTON (GOSSYPIUM HIRSUTUM L.) TO INORGANIC NITROGEN, LEGUME INCORPORATION AND FYM – A REVIEW

K.Mahavishnan and *K.Bhanu Rekha

ITC, R & D Centre, Hyderabad - 500034, India.

ABSTRACT

Cotton (Gossypium hirsutum L.) is the king of fibre crops, a crop of prosperity, and is an industrial commodity of worldwide importance. Amongst the cotton growing countries, India occupies the foremost position in acreage, but production is only 9 per cent of the total output. Excessive vegetative growth, boll shedding, imbalanced use of organic and inorganic fertilizers and poor agronomic practices largely attribute low productivity of cotton in India. The possible ways to increase the productivity is through the introduction of high yielding varieties and formulating better production technology including nutrient management practices.

Historically N fertilization of the crop in the tropical and sub tropical regions has been considered a risky investment because of unpredictability of weather (Wani et al., 1995). Furthermore, soil nitrate can be left unused in the soil in the absence of rainfall, or be lost through leaching by excessive rains at the time of planting season (Singh and Brar 2000). Soil N and rainfall complexities give rise to highly variable yields as well as variable efficiencies of soil and applied N (Ramanjaneyulu and Bucchi reddy 2002). A judicious combination of manures and fertilizers depending upon the availability, the type of soil and crops to be grown would not only maximize the crop production and improve the quality of the agricultural products but would also maintain the fertility, productivity and overall health of the soil for prosperity (Chadage et al., 2005). The use of organic manures such as FYM and legume incorporation have been proved to be viable components of integrated nutrient management for cotton across the globe (Blaise and Singh, 2004). The literature available on the above aspects are presented under different heads.

Effect of Nitrogen

Growth parameters: Plant height, an important parameter of growth has been found to increase with N fertilization by several researchers and the linear increase in plant height with applied N was observed up to 60 ( Mane et al., 1998), 80 (Ravishankar et al., 2005), 90 (Prasad and Prasad, 1998) and 120 (Manjappa et al., 1997) kg N ha⁻¹, respectively. This increase in plant height due to nitrogen application was mainly attributed to internodal elongation (Kalyankumar et al., 2004). An increase in IAI due to N fertilization up to 80 and 100 kg N ha⁻¹, respectively was observed by Deshmukh et al. (1996) and Tomar et al. (1994). The increased IAI with N application was due to increased leaf number and leaf area that ultimately resulted in increased photosynthetic activities of plant (Chhabra and Bishnoi, 1993). Several researchers across different agro climatic situation reported a significant increase in dry matter production with increase in the level of nitrogen. An increase in total dry matter production with each successive increase in the dose of N up to 80 kg (Krishnasamy et al., 1995), and up to 100 kg N ha⁻¹ (Ravankar and Deshmukh 1994) was observed. Khippal and Nehra (1995) observed 59, 77 and 82 per cent increase in dry matter production with the application of 80, 120 and 160 kg N ha⁻¹ over no nitrogen. It was attributed to the fact that N increased the meristematic activities and thus growth of the plant.

Yield attributes: Venugopalan and Blaise (2001) observed that there was a significant increase in the number of fruiting branches with
application of nitrogen. Bondada et al. (1996) found that number of main-stem node increased with increase in pre-plant fertilizer N. They also observed that cotton plants grown with 110 kg N ha\(^{-1}\) matured later than lower rates of N. Significant increase in bolls plant\(^{-1}\) with the application of N was reported by several researchers. Chand et al. (1997) found that bolls plant\(^{-1}\), increased with increase in N levels up to 80 kg ha\(^{-1}\). Increased boll size and bolls per plant with increasing N doses up to 60 kg N ha\(^{-1}\) was recorded by Jackson and Gerik (1990). They also observed that boll size in plants which received 0 mmol N was less than 80% of those which received 114 mmol N.

**Seed cotton yield** : Application of fertilizers had a positive and significant influence on seed cotton yield. Increase in the seed cotton yield with increase in N fertilizer levels was reported by a number of researchers across different soil and climatic conditions. Singh and Chauhan (1993) found that boll shedding intensity reduced with successive increment of N dose. They also revealed that N application resulted an adequate availability of N in soil solution, this might have increased the root growth, thereby increasing accumulation of photosynthates, thus overall improvement in yield attributing characters and ultimately higher yield. An increase in seed cotton yield due to N fertilization was observed up to 40 kg N ha\(^{-1}\) (Sawaji et al., 1994), 60 kg N ha\(^{-1}\), 75 kg N ha\(^{-1}\) (Singh and Brar, 1998), 80 kg N ha\(^{-1}\) (Muralidharan and Solaimalai, 2005), 100 kg N ha\(^{-1}\) (Ramesh et al., 2004). Prasad (2000) showed that bolls plant\(^{-1}\) and seed cotton yield increased with the application of N up to 60 kg ha\(^{-1}\), a further increase did not show any significant improvement in yield.

LH 886 cotton responded up to 60 kg N ha\(^{-1}\) with higher number of bolls per plant (22.8), boll weight (1.9 g) and seed cotton yield (24.3 q ha\(^{-1}\)) (Prasad et al., 2005).

Katkar et al. (2000) found a significantly superior seed cotton yield with 80 kg N ha\(^{-1}\) over 60 and 40 kg N ha\(^{-1}\). Bhaskar et al. (1993) reported that hybrid cotton H-4 recorded maximum seed cotton yield (4.89 q ha\(^{-1}\)) when it was fertilized with N\(_{60}\) + P\(_{40}\). Singh et al. (1999) showed that application of N fertilizer @ 90 kg ha\(^{-1}\) increased seed cotton yield by 1.7 and 2.3 times over control.

Bhar et al. (1996) showed that the application of 40, 80 and 120 kg N ha\(^{-1}\) recorded 12.8, 20.0 and 22.1 per cent higher yield than control. Kiran kumar et al. (2003) observed maximum kapas yield (8.63 q ha\(^{-1}\)) with N\(_{60}\) + P\(_{40}\) which was 88 per cent and 64 per cent more over N\(_{0}\) and N\(_{10}\) respectively.

**Fibre quality** : Velayudam et al. (2002) found that nitrogen application influenced staple length and strength of fibre significantly up to 90 kg ha\(^{-1}\). However, Malaiwal (1999) reported significant increase in staple length up to 60 kg N ha\(^{-1}\) only. Ramanjaneyulu and Buchareddy (2002) found that nitrogen application increased the lint index and seed index. Marimuthu et al., (2004) found that nitrogen treatments influenced the number and weight of seeds rather than the weight of lint per seed. While, Mukerji and Verma (1994) reported that fibre length, fibre weight, maturity coefficient and bundle strength were not influenced by nitrogen application. Krishnan and Lourduraj (1997) found that lint percent decreased with higher nitrogen rates, whereas fibre strength and its fineness remain unaffected.

Shahage et al. (2005) reported that halo-length and ginning percentage were remained unaffected by nitrogen levels and its source. Mane et al., (1998) noticed that uniformity ratio, ginning percentage, lint index and maturity coefficient were not improved with the application of N. However, seed index and span length were increased significantly up to 80 and 120 kg N ha\(^{-1}\), respectively. They also observed a declining trend in fibre strength and fibre fineness due to increase in N levels.

**Nutrient uptake** : Prasad and Prasad (1993) and Srinivasan and Venkatessa (2002) found
that application of N significantly increased the uptake of N at both squaring and flowering stage. Cotton fertilized with higher N rates recorded more petiole NO₃-N content and uptake of N (McConnel et al., 1992). Muthuchamy and Subramanian (2004) observed that increase in N level resulted in increased N uptake due to increased seed cotton yield. Srinivasan et al., (2002) recorded highest uptake of N with the application of 90 kg N ha⁻¹. Bharathi et al., (2003) observed that plants received 120 kg N ha⁻¹, contained 150 kg N ha⁻¹ in above ground parts at maturity compared with only 86 kg N ha⁻¹ in the control. Ravankar and Laharia (1994) recorded a linear increase in N uptake (24.27 to 54.09 kg ha⁻¹) with the increase in N application from 0 to 90 kg ha⁻¹.

**Effect of legume incorporation**: Cotton generally grown with wider inter spacing had initial slow growth for about 2-2½ months that offers great scope for growing a short duration leguminous crop as an intercrop and incorporation of the same at 45 DAS (Chandrasekharan, 2004)). Numerous experiments have been conducted in both rainfed and irrigated agriculture with cotton based intercropping systems. It is a conventional practice to include pulses in the crop mixtures and crop rotations for enriching the soil besides meeting the grain and fodder requirements, legumes benefit the associated and succeeding non-legumes. Instances of legume offers current benefit to the associated non-legume and residual effects to a subsequent crop (Solaiappan, 2002).

**Growth parameters**: Basavannappa and Biradar (2003) recorded highest dry matter of cotton in cotton + greengram combination followed by cotton + blackgram over pure stand of cotton.

**Yield attributes and yield**: Prabhakaran and James (2003) recorded an increased sympodia and boll number plant⁻¹ in cotton + greengram intercropping system, which ultimately resulted in increased yields. Balasubramaniyan et al., (1994) recorded more fruiting points and number of bolls plant⁻¹ in pure cotton, whereas boll size was higher in cotton + greengram intercropping system. Nalayini and Kandasamy (2003) obtained highest seed cotton yield when greengram was grown as an intercrop with cotton. Ramamurthy et al., (1994) recorded 95 per cent of sole cotton yield in cotton + greengram intercropping whereas it was only 52 per cent with cotton + cowpea. Blaise and Rao (2004) recorded highest seed cotton yield from with cotton preceded by sunnhemp incorporation. (Gidnavar et al., 1992) tried horsegram and sunnhemp as intercrop and incorporated on 45 DAS in cotton and found that seed cotton yield was highest with horsegram incorporation. Subramaniyan et al. (1995) reported that growing sunnhemp as intercrop and its incorporation at 40 DAS recorded higher seed cotton yield (18.9 q ha⁻¹) over control (17.13 q ha⁻¹). Prabhakaran (1996) reported that sunnhemp incorporation significantly increased the seed cotton yield (15 per cent) over non-green manured plot.

**Fibre quality**: Several workers reported that the fibre quality characters viz., ginning percentage, seed index, lint index, fibre fineness, maturity coefficient and fibre strength were remained unaffected by intercrops (Prasad and Prasad, 1996 and Charjan and Gaikwad, 2005). Ramesh babu (1998) reported that there was no significant difference in ancillary characters and technological qualities of cotton due to intercropping with blackgram, greengram, clusterbean, cowpea and moth bean.

**Nutrient uptake**: Rampakash and Prasad (2000) reported that cotton intercropped with blackgram recorded a higher N content of cotton over cotton with onion or bhendi, owing to better N fixation by legumes. However, P and K content of the plants were not influenced by intercrops. However, when cotton intercropped with blackgram an increase in nitrogen uptake by cotton was noticed. Sagarka et al., (2002)
observed a reduction in N, P and K uptake in cotton when onion was intercropped over sole cotton. Increased potassium uptake with FYM treated plots might be due to the priming effect, such that organics on decomposition releases organic acids which solubilize native i.e. fixed and non exchangeable form of K and change the soil solution with K ions at later stages of crop growth (Suresh et al., 2005).

**Soil fertility:** In the classical new permanent manural (NPM) experiments at Coimbatore, higher values of pore space percentage, maximum water holding capacity and hygroscopic coefficient were recorded by combined use of FYM and fertilizers (Krishnaswamy and Ramaswamy, 1984). FYM and compost act as a slow releasing N fertilizer through initial immobilization of applied N and its subsequent mineralization at later stages and favourably influences the soil physical, chemical and biological properties of soil (Sharma and Tomar, 1995). Mathur, (1997) reported that incorporation of full dose of recommended nutrients through FYM recorded significantly higher organic carbon and available N, P & K status over partial substitution. Brar and Brar, (2004) and Nayak et al., (1997) reported that higher availability of N in soil particularly with use of organic sources may be due to the direct addition of N through FYM to the available pool of the soil. It could also be attributed to the greater multiplication of soil microbes which could convert organically bound N to inorganic form. The increase in available P might be due to decomposition of organic matter and the increase in available K might be ascribed to direct addition of K to available pool of the soil besides the reduction in K fixing and release of K due to the interaction of organic matter with clay.

**CONCLUSION**

Intensive cultivation of land is becoming increasingly important for continuous agricultural growth in most of the tropical and sub-tropical countries. Under intensive cultivation, maintenance of soil health deserves special attention to sustain high agricultural production. So there is a need to develop economically viable and environmentally safe nutrient management strategies to achieve higher crop production at minimum economic and environment costs. Use of an appropriate combination of inorganic fertilizers and organic manures could conserve nutrients otherwise lost from fertilizer application. Several researchers across different soil and climatic conditions reported an increase in yield and soil quality parameters with application of organic manures along with inorganic fertilizers in cotton. As organic sources play a key role in enhancing efficient utilization of the native as well as applied nutrients through matching nutrient availability with crop demand to exhibit crop's productive capacity. Under normal rainfall year considerable amount of recommended dose of inorganic fertilizers to cotton could be substituted through addition of organic sources viz., legume incorporation and / or FYM without reduction in potential yield.

**REFERENCES**

La Mare, P.H. (1972). Exp. Agric. 8:299-310.