Research Journal of Agriculture and Biological Sciences, 4(2): 154-158, 2008


# Effect of Sources of Nitrogen and Intercropping on Weed Control, Growth and Yield of Cotton

M. Jayakumar, K. Ponnuswamy and M. Mohamed Amanullah

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

**Abstract:** Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, India during winter (August - January) seasons of 2002 - 03 and 2003 - 04 in cotton to evaluate the effect of intercropping systems and sources of nitrogen involving organic and inorganic sources of nutrients. The experiment was laid out in a split plot design with three replications. Five intercropping systems viz., sole cotton, cotton + onion, cotton + blackgram, cotton + greengram and cotton + lucerne were included in the main plot. The subplot consisted of different nitrogen sources involving combinations of inorganic and organic manures namely, 100% recommended inorganic N, 75% inorganic N + 25% N through poultry manure, 75% inorganic N + 25% N through sunnhemp, 75% inorganic N + 25% N through farm wastes and 75% inorganic N + 25% N through weed compost. The results revealed that cotton + blackgram intercropping and 75% inorganic N + 25% N through poultry manure recorded significantly lower weed density, higher growth attributes, seed cotton yield and cotton equivalent yield in both the years of study.

**Key words:** Cotton, intercropping, organic, inorganic, growth, weeds and yield

## INTRODUCTION

Cotton is grown in about 80 countries in the world with 33 million ha in Asia contributing about 44 per cent of world's cotton production. In India, cotton is cultivated in 9 million ha with a production of 155 lakh bales and productivity of 529 kg lint $ha^{-1}$ [15], which is low compared to the world average of 590 kg lint $ha^{-1}$[11]. In Tamil Nadu, cotton occupies a total area of 2.3 lakh ha of which 65 per cent area comes under rainfed condition with a production of 4 lakh bales with productivity of 324 kg lint $ha^{-1}$. Despite the recent setbacks in production due to drought, cotton continues to remain the backbone of the rural economy particularly in the dry land areas.

Cotton, being a long duration and widely spaced crop having slow growth rate in the initial stages, intercropping is an option for income augmentation. This gives ample scope for growing short duration intercrops, which will make use of the potential resources of the environment, with an advantage of additional income per unit area. Intercropping also provides an efficient canopy cover over the inter row spaces of the main crop resulting in suppression of weed and conservation of soil moisture. Weeds compete for nutrients, moisture, sunlight and space *etc,* resulting in poor cotton yield. Weeds remove about 30-50 per cent of applied fertilizer and 20-40 per cent moisture, besides reducing the yield and quality of the produce[19].

Enhancement of cotton yield is also possible by intercropping with a short duration legume and other leguminous forage crops due to their complementary effect of fixing atmospheric nitrogen. The competition should be the least between the associate mixture of legume and non-legume cotton crop therefore, cropping should also be in a proper ratio to have the least smothering effect. Intercropping in cotton may also have adverse effect on the main crop, but could be adequately compensated by the extra yield from intercrops. Application of organic manures along with inorganic fertilizers helps to rejuvenate the degraded soils and ensure sustainability in crop production.

Suitable management practices like intercropping and judicious combination of organic and inorganic manures are considered as ecologically viable, economically feasible and avoid environmental pollution[18]. In addition, combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plants[4,12]. Hence with these ideas in view, this study was undertaken to evaluate the combined application of organic and inorganic sources of N in cotton based intercropping systems on the growth attributes, weed density and yield of cotton.

**Corresponding Author:** M. Jayakumar, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India.

## MATERIALS AND METHODS

Field experiments were conducted during winter (August - January) of 2002-03 and 2003-04 at Tamil Nadu Agricultural University, Coimbatore, on sandy clay loam soil with pH of 8.0. The experiment was laid out in a split plot design replicated thrice. The treatments in the main plot consisted of sole cotton ($M_1$), cotton + onion ($M^2$), cotton + blackgram ($M_3$), cotton + greengram ($M_4$) and cotton + lucerne ($M_5$). The subplot consisted of combinations of inorganic and organic manures namely, 100% recommended inorganic N ($S_1$), 75% inorganic N + 25% N through poultry manure ($S_2$), 75% inorganic N + 25% N through sunnhemp ($S_3$), 75% inorganic N + 25% N through farm wastes ($S_4$) and 75% inorganic N + 25% N with weed compost ($S_5$). The experimental soil was low in available N (229.8 kg $ha^{-1}$), low in available P (10.8 kg $ha^{-1}$) and high in available K (429.0 kg $ha^{-1}$). Cotton Cv. MCU 12 (150-155 days duration) was raised for the study.

The recommended dose of fertilizers (80: 40: 40 N, $P_2O_5$ and $K_2O$ kg $ha^{-1}$) were applied as urea, single super phosphate and muriate of potash. The seeds of cotton were sown at a spacing of 75 X 30 cm with two seeds per hill. The intercrops were sown between the cotton rows at recommended spacing. Other cultivation practices normally recommended for the cotton crop were followed. Fertilizer nitrogen was applied in the form of prilled urea (46% N) in two splits at seedling (20-25 DAS) and vegetative stage (40-45 DAS) as per the treatment schedule. The entire phosphorus fertilizer was applied as basal in the form of single super phosphate (16% $P_2O_5$). The potassium fertilizer was applied in the form of muriate of potash (60% $K_2O$) in two splits at seedling and vegetative stage.

Different sources of organic manures *viz.,* poultry manure, sunnhemp, weed compost and farm wastes were applied as per the treatments to meet the recommended 25 per cent 'N' level. Poultry manure was applied as well decomposed deep litter manure. Sunnhemp was grown as intercrop in cotton up to preflowering stage and then incorporated into the field. Weeds and farm wastes were collected from farm and the surrounding field, composted by pit method and then applied. Well decomposed manures were analyzed for the nutrient content. The nutrient content and the quantity of manures applied are given in Table 1.

Plant height was measured from the surface of the soil to the tip of the topmost leaf at harvest. LAI was estimated at 120 DAS using the formula suggested by Ashley *et al.*[1]. Dry matter production was recorded at 120 DAS. Weed density was recorded at 40 DAS[6].

Seed cotton from each picking was shade dried and weighed for each treatment separately and sum of all pickings was pooled. The data on weeds were subjected to log x + 2 transformation before statistical analysis as suggested by Bartlett[3].

## RESULTS AND DISCUSSIONS

**Growth Parameters:** Both intercropping and nutrient management practices significantly influenced the growth parameters, namely plant height, leaf area index (LAI) and dry matter production (DMP) (Table 2). Plant height at harvest was higher (138.0 cm) in sole crop of cotton ($M_1$) than cotton in the intercropping systems during both the years. The decrease in plant height under intercropping was due to the early, vigorous growth and smothering effect of the intercrops. The LAI (4.97) and DMP (4726 kg $ha^{-1}$) were also higher in sole cotton ($M_1$). The increase in LAI of sole cotton might have been due to the increased growth in terms of plant height. Due to intercropping, there was a decline in DMP of cotton. The reduction in DMP was obviously due to the reduction in the plant height and leaf area index (LAI). This is in agreement with the findings of Balasubramanian[2], Krishnasamy[13] and Velayutham[20]. Among the intercropping systems, the least reduction in cotton growth was seen with blackgram ($M_3$) and the highest reduction with lucerne ($M_5$).

Application of 75% N through inorganic and 25% N through poultry manure ($S_2$) proved better with respect to plant height, DMP and LAI. The increase in growth characters under this treatment was probably due to steady and slow release of N from organic manure by the enhanced activity of beneficial microbes like $N_2$ fixers and colonization of mycorrhizal fungi, through additional benefits of atmospheric N and P mobilization and also additional supply of P and K contributed from organics as reported by Madhavi *et al.*[14] and Cooperband *et al.*[8].

**Weed Density:** Weed density in cotton was significantly influenced by both intercropping systems and nutrient management practices (Table 3). Cotton + blackgram intercropping resulted in the least density of grasses (13.86 number $m^2$), sedges (11.26 number $m^2$) and broad leaved weeds (33.98 number $m^2$) during both the years. This might be due to the quick establishment of blackgram on land surface and the resultant quick smothering of the weeds. When it was ploughed in situ, the crop added nitrogen to the soil to the tune of 40-50 kg $ha^{-1}$ and blackgram showed a greater promise for weed smothering ability. The intercrops, which grew vigorously during the early stages and covered the soil with their canopy, resulted in reduced weed growth under intercropped situations. Similar findings were reported by Rajagopal *et al.,*[17].

**Table 1:** Nutrient content and quantity of organic manures applied in both the years

| Sl. No. | Organic manures | Nutrient content (%) on dry weight basis | | | | | | Quantity applied (kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2002-03 | 2003-04 | 2002-03 | 2003-04 | 2002- 03 | 2003-04 | 2002-03 | 2003-04 |
| | | N | | $P_2O_5$ | | $K_2O$ | | | |
| 1. | Poultry manure | 2.85 | 2.70 | 1.41 | 1.22 | 1.54 | 1.34 | 720 | 741 |
| 2. | Sunnhemp | 2.38 | 2.30 | 0.59 | 0.50 | 1.88 | 1.80 | 840 | 870 |
| 3. | Weed compost | 0.40 | 0.44 | 0.48 | 0.50 | 0.48 | 0.53 | 5000 | 4546 |
| 4. | Farm waste | 0.63 | 0.85 | 0.53 | 0.40 | 0.66 | 0.68 | 3175 | 2353 |

**Table 2:** Effect of intercropping systems and nitrogen sources on plant height, DMP and LAI of cotton (Mean of two years)

| Treatments | Plant height at harvest (cm) | Dry matter production at 120 DAS (kg ha$^{-1}$) | LAI at 120 DAS |
|---|---|---|---|
| | Intercropping systems | | |
| $M_1$ - Cotton alone | 138.0 | 4726 | 4.97 |
| $M_2$ - Cotton + onion | 122.2 | 4180 | 4.44 |
| $M_3$ - Cotton + blackgram | 130.1 | 4301 | 4.72 |
| $M_4$ - Cotton + greengram | 119.5 | 4069 | 4.39 |
| $M_5$ - Cotton + lucerne | 115.8 | 3883 | 4.33 |
| SEd | 2.9 | 92 | 0.26 |
| CD (P=0.05) | 6.8 | 212 | 0.54 |
| | Nitrogen sources | | |
| $S_1$- 100% recommended inorganic N | 121.5 | 4098 | 4.47 |
| $S_2$- 75% inorganic N + 25% N through poultry manure | 132.7 | 4531 | 4.86 |
| $S_3$- 75% inorganic N + 25% N through sunnhemp | 124.6 | 4216 | 4.41 |
| $S_4$- 75% inorganic N + 25% N through farm waste | 123.8 | 4163 | 4.50 |
| $S_5$- 75% inorganic N + 25% N through weed compost | 123.0 | 4126 | 4.49 |
| SEd | 3.2 | 91 | 0.26 |
| CD (P=0.05) | 6.6 | 185 | 0.52 |
| Interaction | NS | NS | NS |

Among the nutrient management practices, the least weed population was recorded in 100% recommended dose of N. The higher weed population recorded under the combined application of organic and inorganic source of N might be due to the better physical conditions provided by the organic manures which could have helped for the better germination of weed seeds present in the soil as reported by Mohamed Amanullah[16].

**Seed Cotton Yield:** Yield of seed cotton was significantly influenced by the intercropping systems and nutrient management practices (Table 4). Sole crop of cotton recorded higher seed cotton yield (1977 Kg ha$^{-1}$) than intercropped cotton. Enhanced growth without intercrop competition resulted in better development of yield attributes such as sympodial branches, fruiting points and number of bolls ultimately leading to increased seed cotton yield. Further uptake of NPK was also significantly higher in sole cropping of cotton at all stages, which might have also contributed to higher production efficiency. Similar findings were reported by Balasubramanian[2] and Deshpande *et al*[9]. Intercropping led to reduction in yield of cotton by 6.9 to 22.2 per cent depending on intercrop species. Yield reduction was higher with lucerne (20.0-22.2%) followed by green gram (14.8-17.3), onion (10.3-12.5%) and blackgram (5.4-6.9%) in that order.

The seed cotton yield was greatly influenced by the nutrient management practices. Substitution of 25% N through organic sources resulted in increased yield (3.6-24.6%) over application of entire N through inorganic sources. Largest increase in yield (23.7 to 24.6%) was achieved with integration of poultry manure to substitute 25% N. It was followed by the

**Table 3:** Effect of intercropping systems and nitrogen sources on weed population at 40 DAS in cotton (Mean of two years)

| Treatments | Grasses (No./m$^2$) | Sedges (No./m$^2$) | Broad leaved weeds (No./m$^2$) | Total weeds (No./m$^2$) |
|---|---|---|---|---|
| | | Intercropping systems | | |
| $M_1$ - Cotton alone | 4.62* (20.98) | 4.08 (16.10) | 6.69 (44.59) | 9.06 (82.06) |
| $M_2$ - Cotton + onion | 4.18 (17.02) | 3.78 (13.84) | 6.38 (39.70) | 8.42 (70.60) |
| $M_3$ - Cotton + blackgram | 3.78 (13.86) | 3.42 (11.26) | 5.86 (33.98) | 7.57 (57.10) |
| $M_4$ - Cotton + greengram | 3.93 (14.98) | 3.55 (12.14) | 6.06 (36.38) | 7.59 (57.50) |
| $M_5$ - Cotton + lucerne | 4.05 (15.92) | 3.68 (13.08) | 6.26 (38.78) | 7.98 (63.66) |
| SEd | 0.037 | 0.029 | 0.045 | 0.039 |
| CD (P=0.05) | 0.084 | 0.068 | 0.104 | 0.090 |
| | | Nitrogen sources | | |
| $S_1$ - 100% recommended inorganic N | 4.04 (15.96) | 3.62 (12.72) | 6.17 (37.80) | 8.03 (66.48) |
| $S_2$ - 75% inorganic N + 25% N through poultry manure | 4.09 (16.38) | 3.69 (13.22) | 6.22 (38.42) | 8.24 (68.02) |
| $S_3$ - 75% inorganic N + 25% N through sunnhemp | 4.11 (16.52) | 3.71 (13.34) | 6.24 (38.60) | 8.15 (68.46) |
| $S_4$ - 75% inorganic N + 25% N through farm waste | 4.13 (16.66) | 3.72 (13.46) | 6.25 (38.76) | 8.04 (68.88) |
| $S_5$ - 75% inorganic N + 25% N through weed compost | 4.19 (17.24) | 3.76 (13.77) | 6.33 (39.89) | 8.18 (70.90) |
| SEd | 0.033 | 0.030 | 0.041 | 0.008 |
| CD (P=0.05) | 0.075 | 0.060 | 0.083 | 0.015 |
| Interaction | NS | NS | NS | NS |

Figures in parenthesis indicate original values * log transformed values

**Table 4:** Effect of intercropping systems and nitrogen sources on seed cotton yield (kg ha$^{-1}$)

| Nitrogen Sources | Intercropping systems | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 - 2003 | | | | | | 2003 - 2004 | | | | | |
| | $M_1$ - Cotton alone | $M_2$ - Cotton + onion | $M_3$ - Cotton + black gram | $M_4$ - Cotton + greengram | $M_5$ - Cotton + lucerne | Mean | $M_1$- Cotton alone | $M_2$ - Cotton + onion | $M_3$ - Cotton + black gram | $M_4$ - Cotton + greengram | $M_5$ - Cotton + lucerne | Mean |
| $S_1$- 100% recommended inorganic N | 1800 | 1650 | 1745 | 1560 | 1450 | 1641 | 1710 | 1590 | 1665 | 1500 | 1410 | 1575 |
| $S_2$- 75% inorganic N+ 25% N through poultry manure | 2553 | 1970 | 2100 | 1850 | 1750 | 2045 | 2377 | 1880 | 2020 | 1782 | 1680 | 1948 |
| $S_3$- 75% inorganic N+ 25% N through sunnhemp | 2020 | 1840 | 1965 | 1740 | 1635 | 1840 | 1900 | 1765 | 1860 | 1690 | 1580 | 1759 |
| $S_4$- 75% inorganic N+ 25% N through farm waste | 1950 | 1770 | 1890 | 1680 | 1580 | 1774 | 1820 | 1700 | 1790 | 1618 | 1517 | 1689 |
| $S_5$- 75% inorganic N+ 25% N through weed compost | 1875 | 1710 | 1800 | 1605 | 1515 | 1701 | 1765 | 1650 | 1715 | 1560 | 1470 | 1632 |
| Mean | 2040 | 1783 | 1900 | 1687 | 1586 | | 1914 | 1717 | 1810 | 1630 | 1531 | |
| | | SEd | | CD (P=0.05) | | | | SEd | | CD (P=0.05) | | |
| M | | 39.6 | | 91.2 | | | | 37.5 | | 86.4 | | |
| S | | 33.9 | | 68.7 | | | | 34.4 | | 69.6 | | |
| M at S | | 78.6 | | 164.6 | | | | 78.4 | | 163.5 | | |
| S at M | | 76.0 | | 153.6 | | | | 76.9 | | 155.5 | | |

incorporation of sunnhemp to supply 25% N (11.7-12.1%). The increased yield achieved with poultry manure might be due its high N content and narrow C: N ratio, which accelerated the release of nitrogen. Similar findings were reported by Bishnoi and Bajwa[5]. Ghosh *et al.*[10] also reported that poultry manure as a rich source of nitrogen and phosphorus had positive influence on seed cotton yield.

Among the treatment combinations, sole cotton applied with 75 per cent inorganic N through poultry manure resulted in higher seed cotton yield in both the years of study. This was followed by cotton + blackgram with 75 per cent inorganic N + 25 per cent N through poultry manure

**Conclusion:** From the results of the experiments conducted, It can be concluded that cotton + blackgram intercropping with 75% inorganic N + 25% N through poultry manure recorded significantly lower weed density, higher growth attributes and seed cotton yield in both the years of study.

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