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***RESEARCH PAPER***

# Simulated and observed yield of cotton based on boll dropping as influence by soil and foliar application nutrients

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**Abstract :** In cotton, flowering is a continuous process and 40 to 50 per cent set flowers (square) and bolls will shed due to nutritional deficiency or excesses of nutrient in soil or moisture stress. Dropping of the young bolls (Square drying) is one of the production constraints which is mainly due to imbalance and inadequate nutrition, to overcome this various soil nutrients where imposed along with foliar spray of potassium and boron. The field experiment was conducted with twelve treatments comprised of four fertility levels and three poly feed treatments at peak flowering and boll formation stage. Application of recommended dose of N, $P_2O_5$, $K_2O$ and foliar application of murite of potash @ 5 kg/ha has recorded significantly higher seed cotton yield (2501.8 kg/ha) as compared to other treatment combinations. Similarly application of Multi-k as foliar spray (Poly feed of 45:0:13 kg/ha N, $P_2O_5$, $K_2O$) had recorded higher seed cotton yield (2486.5 kg/ha) as compared to poly feed (19:19:19 kg/ha N, $P_2O_5$, $K_2O$) and water spray treatments and physical optimum yield loss of cotton was estimated based on linear and quadratic equations. The equation was fitted using leaf area with number of boll dropped at different stages of crop growth. The application of recommended dose of nitrogen alone treatment, physical yield loss was 2835.2 kg/ha and 1240.4 kg/ha with the application of recommended dose of nitrogen and phosphorus and application of recommended dose of all three elements, the estimated physical yield losses was 219.5 kg/ha in comparison with recommended dose of nitrogen, phosphorus, potassium and foliar application of potassium @5 kg/ha at early and peak flowering.

**Key Words :** Boll dropping, Cotton, Foliar nutrient of potassium, Predicated yield, Nutrients

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## INTRODUCTION

Cotton (*Gossypium* spp.) is one of the most important fiber crops of the world which plays a key role in the economic activity. It is the oldest among the commercial crops and is regarded as white gold. The cotton boll shedding may be an important natural process by which the plant adjusted its fruit load to match the demand and supply of the nutrients. In cotton, flowering is a continuous process and 40 to 50 per cent set flowers (square) and bolls will shed due to nutritional deficiency or excesses of nutrient in soil or moisture stress (Oosterhuis, 2001). Dropping of the young bolls (Square drying) is one of the production constraints which is mainly due to imbalance and inadequate nutrition due to introduction of exhaustive high yielding varieties and hybrids devoid of micronutrients and inadequate supply of organic manures resulted in wide spread of micronutrient deficiency. Cotton is a heavy feeder and removes large quantity of nutrients from soil. Therefore, crop nutrition form a crucial component of cotton production. Though cotton crop is of more than 150 days duration, the major uptake of nutrients is confined to only about 30-40 days, especially from flowering to boll formation. Nitrogen and phosphorus fertilizer (Diammonium phosphate) is a more emphatically used by the farmers leading to imbalanced nutrient supply. Moreover, potassium status in some areas has depleted from high to medium. Cotton crop is early and semi determination in growth habit, the rate of growth and rejuvenation capacity of the plant after first flush of flower is slow. It needs to supply requirement

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nutrient addition through soil should be provided along with foliar. Soil and foliar application of potassium was found more number of bolls per plant is due potassium play vital role by producing quality and quantity of bolls in cotton is well documented (Sharma and Singh, 2007). Foliar feeding is one of the most efficient way of supplying essential nutrients to a growing crop plant. It provides a method of delivering fundamental nutrients at key growth stages when the plant is at peak nutrient requirement and could not be made available through normal stream of root system from soil. Poly feed is a mechanism which contains all major nutrients of N, P and K in addition to micronutrients in balanced form which will improve vegetative growth and square formation in a rapid and efficient manner. Foliar nutrition may be a useful option particularly for the areas where soil application of fertilizers often leading to locking or loss of nutrients .With these techniques, nutrients can reach to the site of food synthesis directly, leaving no wastage. Further Kaur *et al*. (2007) reported that rapid maturing and short duration cotton cultivars demand for plant available nutrients especially during the fruit maturity stage. Therefore, foliar application of poly feeds was highly beneficial as the crop gets benefited from foliar application of nutrients when the roots are unable to meet the nutrient requirement of the crop at its critical growth stage resulting in higher square retention and higher cotton yield as reported by Tewolde *et al.* (2010). Keeping in view of the above points, the present study was conducted to investigate the effect of nutrient levels and poly feeds on square drying and yield of cotton from 2007 to 2008 at Zonal Agriculture Research station, Hiriyur, Karnataka.

**Table A : Mechanical and chemical analysis of soil-experimental site**

| | |
|---|---|
| **Physical properties** | |
| **Mechanical analysis** | |
| 1. Sand | 26 % |
| 2. Silt | 20 % |
| 3. Clay | 54 % |
| Bulk density | 1.43Mg/$m^3$ |
| Percent porosity | 46.24 |
| Infiltration rate | 1.30 m/hr |
| Water holding capacity | 52 % |
| **Chemical properties** | |
| pH | 8.75 |
| EC | 0.314 d S/m |
| CEC | 34.71 c.mol(p+) $kg^{-1}$ |
| Organic carbon | 5.90 g/kg |
| Nitrogen | 201.16 kg/ha |
| Phosphorous | 4.37 kg/ha |
| Potassium | 104.46g/ha |
| Boron | 0.98 ppm |

## MATERIAL AND METHODS

The field experiment was conducted at Zonal Agricultural Research Station, Babbur farm, Hiriyur, during the *Kharif* season of 2007 and 2008 in irrigated condition. The site is located in the central dry zone (zone-4) of Karnataka, India, between 13º57’32N Latitude and 70º37’38E longitude at an altitude of 606.1m above mean sea level with medium to deep black soil. The soil of experimental plot has pH 8.75, available nitrogen, phosphorus and potassium content of the soil was 201.1, 4.37 and 104 .46 kg/ha, respectively. The spacing adopted was 90 cm between rows and 60 cm between plants. Twelve treatments comprised of four fertility levels (Rec. dose of Nitrogen for soil application, Rec. dose of N and $P_2O_5$ for soil application, Rec. dose of N , $P_2O_5$ and K2O for soil application and Rec. dose of N $P_2O_5$ and $K_2O$ soil application and foliar application of potassium @ 5 kg/ha) and three poly feed treatments (Water spray, poly feed (19:19:19 N $P_2$O5 and $K_2O$ @ 20 g/l of water and poly feed (13:0:45 N $P_2O_5$ and $K_2O$ @ 20 g/l of water and boron 1 g/l of water at peak flowering and boll formation stage). These treatments were laid out with the plot size of 5.4 x 3.6cm in Factorial Randomized Block Design with three replications. The American cotton hybrid DCH-32 was sown in the second fortnight of June in a well prepared seedbed after giving pre-sowing irrigation. The crop was sown by dibbling method. Whole of the recommended dose of phosphorus, potassium and half of the recommended dose of nitrogen was applied at the time of sowing for all the treatment and remaining 50 per cent of nitrogen was applied at the time of flowering initiation. In case of foliar application, 5 per cent $K_2O$ was applied at initiation of flowering and peak boll formation stage by using knap sack sprayer with the spray solution of 700 litres as per the treatments. The net plot size harvested each year was 3.6x2.4 m (8.64 $m^{-2}$). Other cultural practices and plant protection measures were given as per the recommendation of the University of Agricultural sciences, Karnataka, India schedules. At time of maturity five plants per plot were selected for recording the observation on bolls per plant, yield per plant, and other ancillary characters. Yield estimation was worked out by using parameters like number of square dropping as against leaf area of plant at different stages. The linear and quadratic type of equation $Y=a + bX$ and $Y=a + bX^2$ were fitted using least square technique as given in Snedecor and Cochran (1967). The yield of plant was derived by differentiating the above function with respect to X and equating to zero.

For example $Y=a + bX+cX^2$

$$dy/dx=b+2cX$$

$$X=-b/2c$$

## RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

### Yield and its attributes:

Results revealed that application of recommended dose of N,$P_2O_5$, $K_2O$ and foliar application of murite of potash @ 5 kg/ha has recorded significantly higher seed cotton yield (2501.8 kg/ha) as compared to other treatment combinations (Table 1 and Fig. 1). The increase in seed cotton yield was attributed to yield parameters such as seed cotton yield per boll, seed cotton yield per plant, number of bolls per plant and numbers of sympodial branches as cotton bolls are major sink for K. Additional application of potassium increased cotton yield by 9 per cent (Pettigrew, 2003). Additional application of potassium as foliar spray contributed to boll number increase and enlargement of bolls as there is a tremendous translocation demand for potassium (K) in the leaves adjacent to each boll. Recommended dose of N, $P_2O_5$, and $K_2O$ or only N or $P_2O_5$, and $K_2O$ treatments showed significantly lower seed cotton yield (1973.1kg/ha) (Table 1 and Fig.1) which was mainly due to non availability of potassium during boll development stage leading to plant showing deficiency of potassium as applied potassium might have fixed in the soil as documented by Pervez *et al*. (2008). Potassium deficiency can limit the accumulation of crop biomass, due to reduction in partitioning of assimilate to the formation of leaf area and a decrease in the efficient use of intercepted radiation for the production of above ground biomass (Colomb *et al*., 1995). Pettigrew (1995) stated that part of the overall effect of K deficiency was reducing the amount of photosynthate available for reproductive sink, which produced change in lint yield and fibre quality.

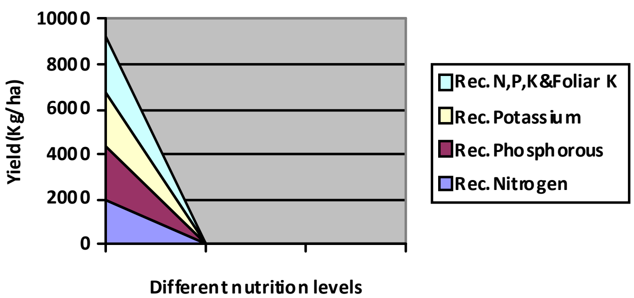


**Fig. 1 : Seed yield (kg/ha) as influence by different nutrients levels**

Application of multi-k (Poly feed of 45:0:13 Kg/ha N, $P_2O_5$, $K_2O$) recorded higher seed cotton yield (2486.5 kg/ha) (Table 2 and Fig.2) as compared to poly feed ( 19:19:19 kg/ha N,$P_2O_5$, $K_2O$) and water spray treatments. Application of multi-k yielded 6.7 per cent which was mainly due to cotton bolls are major sink for potassium with supplementary application of foliar spray. About 70 per cent of potassium uptake is during early boll set period causing more number of bolls and boll enlargement by meeting translocation demand on potassium in leaves adjacent to each boll, as documented by Kaur *et al.* (2007).

**Table 1 : Yield and yield parameter of cotton as influence by different nutrient levels and poly feed spray**

| Treatments | No. of bolls /plant | Seed cotton yield (kg /ha) | Seed cotton /plant (g) | Total no. boll drop during crop growth period |
|---|---|---|---|---|
| **Fertility levels (A)** | | | | |
| Rec. nitrogen | 36.3 | 1973.1 | 105.3 | 55.2 |
| Rec. N and P2O5 | 41.0 | 2345.3 | 124.9 | 34.3 |
| Rec. N , $P_2O_5$ and $K_2O$ | 42.7 | 2447.8 | 132.4 | 21.8 |
| Rec. N , $P_2O_5$, $K_2O$ and foliar spray of MOP at 5 kg/ha at early and peak flowering stages | 43.5 | 2501.8 | 134.9 | 15.0 |
| S.E.$\pm$ | 3.27 | 182.7 | 4.06 | 3.33 |
| C.D. (P=0.05) | NS | 632.2 | 14.04 | 11.52 |
| **Poly feeds** | | | | |
| Water spray | 38.9 | 2145.8 | 114.8 | 36.3 |
| Poly feed (19;19:19N, $P_2O_5$, $K_2O$ at 20g/l) at early and peak flowering stages | 41.0 | 2318.8 | 124.9 | 31.7 |
| Poly feed (13:0:45N, $P_2O_5$ ,$K_2O$ at 20g/l) and boron (1g/l) at early and peak flowering stages | 42.6 | 2486.5 | 133.5 | 26.7 |
| S.E.$\pm$ | 1.65 | 158.2 | 2.82 | 2.29 |
| C.D. (P=0.05) | NS | NS | 9.19 | 6.86 |
| Interaction | | | | |
| A x B S.E.$\pm$ | 3.27 | 165.0 | 5.65 | 4.59 |
| C.D. (P=0.05) | NS | NS | NS | NS |

NS=Non-significant

## Boll dropping:

Application of recommended dose of $N,P_2O_5$, $K_2O$ and foliar application of murite of potassium @ 5 kg/ha has recorded significantly lower square dropping (15 of boll / plant ) as compared to other treatment combination (Table 2 and Fig. 2). The application of potassium increases the per cent fruit retention by stimulating cotton crop in lengthening sympodial branches and retaining more fruits on the first three positions and also at the bottom of the plant during the early reproductive phase (Tewolde *et al.*, 2010).

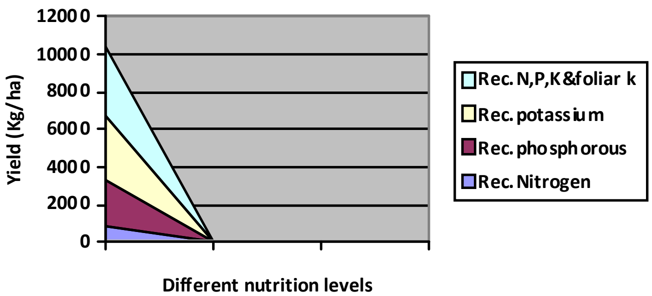


**Fig. 2 :** **Simulated seed cotton yield (Kg/ha) as influence by different nutrients levels**

Whereas foliar application multi-K (Poly feed of 45:0:13 kg/ha $N,P_2O_5$, $K_2O$+ boron 1 g/l of water at peak flowering and boll formation stage) recorded lower boll dropping (26.7 of bolls /plant) as compared to water spray (36.3) (Fig. 3). In accordance with Dettigrew (1999) potassium is a key element for transfer of photosynthates from source to sink. Boron is important in pollen germination and pollen tube growth, deficiency results in reduced boll retention, lower yield and poor fibre quality. Boron deficiency in cotton is characteristically manifested as deformed flowers, stunted growth, fruit shedding and decreased yield. Physiologically, deficiency of B results in decreased stomatal conductance and net photosynthetic rate, and depressed plant growth and dry matter accumulation, resulting in increased fruit abscission and a change in dry matter partitioning to the developing bolls after squaring (Oosterhuisl, 2001).

## Yield simulation:

The physical optimum yield loss of cotton was

**Table 2: Simulated yield of cotton under different nutrient levels**

| Sr. No. | Functions | $r^2$ | S.E | Estimated yield /plant | Estimated yield (kg/ha) | Yield loss over control (kg/ha) |
|---|---|---|---|---|---|---|
| **Fertility levels** | | | | | | |
| Rec. nitrogen | | | | | | |
| | Linear Y=20.569-0.02627 | 0.98 | 0.87 | - | | |
| | Quadratic Y=17.63430+0.005408-5.90158e-5 | 0.99 | 0.34 | 45.83 | 848.70 | 2835.2 |
| Rec. nitrogen and phosphorus | | | | | | |
| | Linear Y=13.2466-0.016522 | 0.98 | 0.71 | | | |
| | Quadratic Y=10.163489+0.0137231-5.202347e-5 | 0.99 | 0.07 | 131.95 | 2443.5 | 1240.4 |
| Rec. nitrogen, phosphorus and potassium | | | | | | |
| | Linear Y=8.83494-0.0108678 | 0.96 | 0.66 | | | |
| | Quadratic Y=5.7344074+0.016781-4.48635e-5 | 0.99 | 0.24 | 187.08 | 3464.4 | 219.5 |
| Rec. nitrogen, phosphorus, potassium and foliar spray of muriate potassium 5 kg/ha at early and peak flowering stages | | | | | | |
| | Linear Y=6.413485-0.0079433 | 0.96 | 0.48 | | | |
| | Quadratic Y=4.22377+0.01017275-2.808259e-5 | 0.99 | 0.28 | 189.21 | 3683.9 | - |

**Table 3 : Simulated yield of cotton under different foliar spray of nutrients**

| Sr. No. | Functions | $r^2$ | S.E | Estimated yield /plant | Estimated yield (kg/ha) | Yield loss over control (kg/ha) |
|---|---|---|---|---|---|---|
| Water spray at early and peak flowering stages | | | | | | |
| | Linear Y=14.157834-0.0192803 | 0.96 | 0.48 | | | |
| | Quadratic Y=11.29347+0.1149861-6.237161e-5 | 0.95 | 1.64 | 92.21 | 1707.5 | 1788.6 |
| Poly feed spray (19:19:19$N,P_2O_5$ and $K_2O$) at early and peak flowering stages | | | | | | |
| | Linear Y=12.511701-0.1531603 | 0.97 | 0.71 | | | |
| | Quadratic Y=9.684198+0.10705181-4.297555e-5 | 0.99 | 0.20 | 124.62 | 2307.7 | 1188.4 |
| Poly feed spray (13:0:45$N,P_2O_5$ and $K_2O$)and Boron (1g/l) at early and peak flowering stages | | | | | | |
| | Linear Y=10.469726-0.011582688 | 0.98 | 0.47 | | | |
| | Quadratic Y=8.9744968+0.01112286-2.94977e-5 | 0.99 | 0.28 | 188.79 | 3496.1 | - |

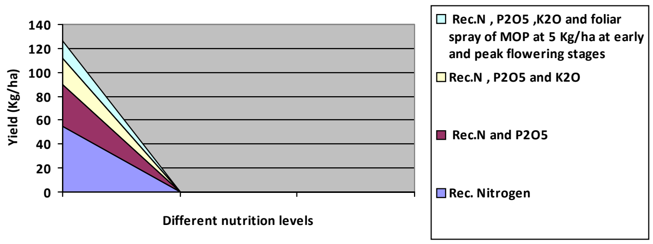


**Fig. 3 : Effect of different nutrients levels on Boll dropping (numbers / plant) in cotton**

estimated based on linear and quadratic equations. The equation was fitted using leaf area with number of boll dropped at different stages of crop growth. The application of Recommended dose of nitrogen alone treatment, physical yield loss was 2835.2 kg/ha with the coefficient predictability was as higher 98 to 99 per cent (Table 2 and 3). The application of nitrogen leads to heavy boll and flower senesces as observed by Mullins and Burmester (1990 ) and as per Silvertooth (1990) application of nitrogen alone without phosphorus and potassium in cotton can enhance the vegetative and reproductive growth and induce premature senescence of bolls leading to potential yield loss. Similarly physical yield loss was 1240.4 kg/ha with the application of recommended dose of nitrogen and phosphorus with the co-efficient predictability was 98 to 99 per cent. The combination of phosphorus with nitrogen as recommended dose helps to reduce the yield losses by 1594.8 kg/ha. The contribution of phosphorus to yield was 1594.8 kg/ha and in application of recommended dose of all elements, the estimated physical yield losses was 219.5 kg/ha in comparison with recommended dose of nitrogen, phosphorus, potassium and foliar application of potassium @5 kg/ha at early and peak flowering. The combined application of all three nutrients in addition to application potassium as foliar nutrient in cotton was found best for increasing carbohydrate flow to the developing boll load and reduced shedding young boll (Oosterhuis ,1995)

## Conclusion:

According to these studies, seed cotton yield response to soil and foliar application of nutrients was provided to current university recommendation. Furthermore, this research suggested that farmers are applying only nitrogen or applying only recommended nitrogen phosphorus or only recommended nitrogen phosphorus and potassium to cotton crop without foliar nutrition. With this view the application of recommended dose of $N, P_2O_5$, $K_2O$ and foliar application of murite of potash @ 5 kg/ha additional application of potassium increased cotton yield by 9 per cent of seed cotton yield was better understand in this study (2501.8 kg/ha) over control (only recommended nitrogen or only recommended nitrogen phosphorus or only recommended nitrogen and potassium) and similarly by using leaf area with number of boll dropped the extend yield loss was predicated on various nutrient levels and predictability was 98 to 99 and yield variation with respective nutrient application was found best solution for the farming community. This information would assist researchers in establishing suitable strategies for nutrient management in cotton and further leaf analysis based foliar nutrition spray needs addition research in cotton. Individual nutrient, soil applied nutrient and foliar potassium nutrients on cotton yield needs further study.

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