Effect of Water-Soluble fertilizers through fertigation on growth, yield component and yield of Bt cotton

Jayashri Gawali, Anil Dhamak and Suresh Waikar

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Abstract
Field experiment was conducted during kharif season of 2013-14 to study the effect of water soluble fertilizers through fertigation on growth, yield component and yield of Bt cotton at research farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was carried out in randomized block design with five treatments and four replications. The treatment consists of T1: Recommended dose of fertilizers through soil application, T2: Recommended dose of fertilizers through fertigation (conventional), T3: 100% RDF through soluble fertilizers by fertigation, T4: 80% RDF through soluble fertilizers by fertigation and T5: 60% RDF through soluble fertilizers by fertigation. The growth and yield component like plant height, number of leaves, leaf area, number of bolls, seed and stalk yield of cotton significantly improved with application of 100 per cent RDF through soluble fertilizers by fertigation into six splits followed by 80 per cent RDF through soluble fertilizers.

Keywords: Soluble fertilizers, fertigation, yield, Bt cotton

Introduction
Cotton ‘king of apparel fiber’ is an important cash crop and it supplies a major share of raw material for the textile industry. Cotton plays a key role in the national economy in terms of both employment generation and foreign exchange earnings. It contributes more than 14 per cent of annual value addition of industrial production and more than 30 per cent of total exports and 4 per cent of its Gross Domestic Product (GDP). India is the third largest producer of cotton in the world with 12.19 million hectares area, 242.5 bales of production with 467 kg ha⁻¹ productivity. India ranks first in area and productivity is far below the world average of over 600 kg ha⁻¹ (Anonymous, 2010) [1]. Maharashtra is one of the major cotton growing state having 39.32 lakh hectares with the production of 82 lakh bales. However, Productivity of cotton in Maharashtra is 335 kg lint per hectare which is very low as compared to Tamil Nadu (697 kg ha⁻¹), Andhra Pradesh (505 kg ha⁻¹) and Gujarat (665kg ha⁻¹). With the introduction of hybrid varieties, the use of chemical fertilizers is the “kingpin” in the present system of agriculture. Scientific use of fertilizers assumes vital importance for sustainable agriculture. Efficient use of fertilizers play back to the farmers more profit per unit investment. Fertilization is the most effective and convenient mean of maintaining optimum fertility levels and water supply according to specific needs of each crop and types of soil resulting in higher yields and better quality of crops. Fertilization offers advantages of saving in fertilizers as well as increase in fertilizer use efficiency (Nakayama and Bucks, 1986) [4]. Soluble fertilizer that dissolved easily in water and are immediately available for plant species. The water soluble nitrogen, phosphorus and potassium fertilizers play major role in growth and development of cotton. The paper deals with the study of the effect water soluble fertilizers through fertigation on growth, yield component and yield of Bt. cotton.

Material and Methods
A field experiment was conducted during kharif season of 2013-14 to study the effect of water soluble fertilizers through fertigation on growth, yield component and yield of Bt cotton at research farm, Department of Soil Science and Agricultural Chemistry.
The initial soil pH was 7.85, EC = 0.18 dS/m, organic carbon = 5.50 g kg⁻¹, calcium carbonate = 61.20 g kg⁻¹, available nitrogen = 156.00 kg ha⁻¹, phosphorus = 8.90 kg ha⁻¹, and potassium = 744.20 kg ha⁻¹. The soil was clayey in texture. The field experiment was carried out on Bt cotton crop (Variety Rashi-2) in kharif season during year 2013-14. The experiment was laid out in randomized block design with five treatments and four replications. The details of treatment are T₁: Recommended dose of fertilizers through soil application, T₂: Recommended dose of fertilizers through fertigation (conventional), T₃: 100% RDF through soluble fertilizers by fertigation, T₄: 80% RDF through soluble fertilizers by fertigation and T₅: 60% RDF through soluble fertilizers by fertigation.

Results and Discussion

Plant height

The data on plant height of Bt cotton at various growth stages influenced by water soluble fertilizer through fertigation are presented in Table 1. The application of soluble fertilizer through fertigation favourably influenced the height of cotton at various growth stages. Plant height varied in the range of 29.65 to 41.05 cms, 31.80 to 49.03 cms, 60.30 to 68.43 cms and 72.93 to 89.05 cms at square formation, flowering, boll bursting and harvest of Bt cotton, respectively. With the advancement of growth of cotton, increasing trend in plant height was observed. The treatment T₃ (100% RDF through soluble fertilizer) showed significantly more plant height at different stages of Bt cotton followed by T₄, T₂, T₅ and T₁ treatments, respectively. The application of soluble fertilizer through fertigation treatments recorded significantly higher plant height at all growth stages over soil application of fertilizers. The balanced application of fertilizer through fertigation into six splits resulted in increase in plant height. These results are in compliance with the finding of Rasker et al. (2001) [7] and Reddy and Aruna (2010) [8].

Number of leaves

The leaves count was taken at square formation, flowering and boll bursting stages of Bt cotton and the data are presented in Table 2. It was found that the number of leaves varied from 19.25 to 27.65 at square formation, 31.85 to 43.90 at flowering and 56.50 to 64.00 at boll bursting stage of Bt cotton. Maximum number of leaves per plant with T₁ treatment received 100 per cent RDF through soluble fertilizers through fertigation into six splits at all growth stages of Bt cotton. However, the treatment T₃ (100 per cent RDF through soluble fertilizers) are at par with T₄ (80 per cent RDF through soluble fertilizers).

The application of soluble fertilizers through fertigation into six splits proved significantly to increase number of leaves per plant over soil application of recommended dose of fertilizer. Reddy and Aruna (2010) [8] reported that maximum number of leaves per plant with more splits was the result of efficient utilization of applied nitrogen and potassium through fertigation than band placement. These results are in line with the findings of Nalayini et al. (2012) [5].

Leaf area

The result on leaf area as influenced by the application of soluble fertilizers through fertigation at various growth stages of Bt cotton are presented in Table 3. There was continuous build up of leaf area in Bt cotton with advancing growth stages. The results also indicated that the application of soluble fertilizers through fertigation into splits significantly influenced leaf area of Bt cotton at various growth stages over soil application of fertilizers. Leaf area varied from 872.20 to 244.30 cm², 1320.50 to 1740.72 cm² and 2585.00 to 3190.50 cm² at square formation, flowering, and boll bursting stage of Bt cotton. The highest leaf area was recorded with T₃ (100 per cent RDF through soluble fertilizers) followed by T₄ (80 per cent RDF through soluble fertilizers) at all stages of growth in Bt cotton during the year of experimentation. The increase in leaf area per plant with increasing age of the plant with soluble fertilizer through fertigation observed in the present study was in accordance with the findings reported by Veeraputhiran et al. (2005) [9].

Number of bolls

The number of bolls per plant is important yield parameters, as it gives a rough estimate of probable yield. The data on number of bolls per plant as influenced by different treatment during the year of experimentation are presented in Table 4. The number of bolls varied in the range of 66.96 to 85.11. The highest number of bolls plant⁻¹ (85.11) was observed in treatment T₁ (100% RDF through soluble fertilizers) while lowest number of bolls Plant⁻¹ (66.96) was noticed in T₅ treatment (100 per cent RDF through soil application). Shrinivasan (2003) registered the highest number of bolls per plant by application of recommended levels of fertilizers by skipping basal and applying all the nutrients in two splits. Cotton being an intermediate crop with long duration, application of fertilizers in later stages might have helped in inducing more number of bolls per plant. These results are in agreement with Bharambe et al. (1997) [2], Reddy and Aruna (2010) [8] and Nalayini et al. (2012) [5].

Seed cotton yield

The data on seed cotton yield (q ha⁻¹) as influenced by different treatment are synthesized in Table 5. The result revealed that the seed cotton yield varied in the range of 15.87 to 22.21 q ha⁻¹. The highest seed cotton yield (22.21 q ha⁻¹) was registered under T₃ treatment (100 per cent RDF through soluble fertilizers) followed by T₄ treatment (21.36 q ha⁻¹) which was statistically at par with T₃ treatment. The treatment T₅ (100% RDF through soil application) recorded lowest seed cotton yield (15.87 q ha⁻¹) of Bt cotton. The influence of different treatments on seed cotton yield followed the order T₃ > T₄ > T₅ > T₁. Thus, the result suggested that the application of soluble fertilizers through fertigation into six splits would be effective for obtaining maximum yield of cotton. Enhancement in yield in cotton crop due to scientific scheduling of fertilizer through drip over soil application of fertilizer has been reported by Nalayini et al. (2012) [5]. Hosamani et al. (2013) [3] reported that increased in seed cotton yield with 125 per cent RDF might be due to significantly higher number of good opened boll per plant, total number of boll harvested per plant, mean boll weight, amount of dry matter accumulation in reproductive parts and leaf area upto harvest. These results are in compliance with the finding of Bharambe et al. (1997) [2], and Patil et al. (2004) [5].

Cotton Stalk yield

The data on stalk yield of Bt cotton at harvest are presented in Table 5. The cotton stalk yield varied from 24.70 to 36.24 q ha⁻¹. The stalk yield was highest (36.24 q ha⁻¹) with the
treatment T3 (100 per cent RDF through soluble fertilizer). The lowest stalk yield (24.70 q ha⁻¹) was recorded in treatment T1 (100 per cent RDF through soil application). The influence of different treatments on cotton stalk yield followed the order: T3 > T4 > T2 > T5 > T1. The similar results were also reported by Bharambe et al. (1997) [2], Reddy and Aruna (2010) [10] and Nalayini et al. (2012) [5].

Table 1: Effect of soluble fertilizers through fertigation on plant height at various growth stages of Bt cotton (cm plant⁻¹).

| Treatment                                      | Square formation | Flowering | Boll bursting | At Harvest |
|------------------------------------------------|------------------|-----------|---------------|------------|
| T1- Recommended dose of fertilizers through soil application | 29.65            | 31.80     | 60.30        | 72.93      |
| T2- Recommended dose of fertilizers through fertigation (conventional) | 34.65            | 42.40     | 63.85        | 80.38      |
| T3- 100% RDF through soluble fertilizers by fertigation | 41.05            | 46.33     | 68.43        | 89.05      |
| T4- 80% RDF through soluble fertilizers by fertigation | 39.30            | 49.03     | 64.40        | 81.08      |
| T5- 60% RDF through soluble fertilizers by fertigation | 31.80            | 40.75     | 62.55        | 77.00      |
| SE±                                           | 1.30             | 1.62      | 1.29         | 0.50       |
| C.D. (P=0.05)                                 | 4.02             | 5.00      | 3.90         | 1.50       |
| Grand mean                                    | 35.29            | 42.06     | 63.90        | 80.0       |

Table 2: Effect of soluble fertilizers through fertigation on number of leaves plant⁻¹ at various growth stages of Bt cotton.

| Treatment                                      | Square formation | Flowering | Boll bursting |
|------------------------------------------------|------------------|-----------|--------------|
| T1- Recommended dose of fertilizers through soil application | 19.25            | 31.85     | 56.50        |
| T2- Recommended dose of fertilizers through fertigation (conventional) | 24.65            | 37.60     | 63.00        |
| T3- 100% RDF through soluble fertilizers by fertigation | 27.65            | 43.90     | 64.00        |
| T4- 80% RDF through soluble fertilizers by fertigation | 26.70            | 41.00     | 63.75        |
| T5- 60% RDF through soluble fertilizers by fertigation | 23.15            | 33.75     | 59.75        |
| SE±                                           | 1.29             | 2.11      | 1.21         |
| C.D. (P=0.05)                                 | 4.00             | 6.50      | 3.74         |
| Grand mean                                    | 24.28            | 37.62     | 61.40        |

Table 3: Effect of soluble fertilizers through fertigation on leaf area plant⁻¹ (cm²) at various growth stages of Bt cotton.

| Treatment                                      | Square formation | Flowering | Boll bursting |
|------------------------------------------------|------------------|-----------|--------------|
| T1- Recommended dose of fertilizers through soil application | 872.20           | 1320.50   | 2585.00      |
| T2- Recommended dose of fertilizers through fertigation (conventional) | 1096.63           | 1530.90   | 2744.28      |
| T3- 100% RDF through soluble fertilizers by fertigation | 1244.30           | 1740.72   | 3190.50      |
| T4- 80% RDF through soluble fertilizers by fertigation | 1190.30           | 1680.44   | 3080.30      |
| T5- 60% RDF through soluble fertilizers by fertigation | 985.80           | 1395.20   | 2683.20      |
| SE±                                           | 26.14            | 29.43     | 53.63        |
| C.D. (P=0.05)                                 | 80.55            | 90.71     | 165.27       |
| Grand mean                                    | 1077.84          | 1533.55   | 2876.65      |

Table 4: Effect of soluble fertilizers through fertigation of number of bolls per plant of Bt cotton

| Treatment                                      | No. bolls/plant |
|------------------------------------------------|-----------------|
| T1- Recommended dose of fertilizers through soil application | 66.96          |
| T2- Recommended dose of fertilizers through fertigation (conventional) | 47.35          |
| T3- 100% RDF through soluble fertilizers by fertigation | 85.11          |
| T4- 80% RDF through soluble fertilizers by fertigation | 77.85          |
| T5- 60% RDF through soluble fertilizers by fertigation | 70.92          |
| SE±                                           | 1.15            |
| C.D. (P=0.05)                                 | 3.56            |
| Grand mean                                    | 69.63           |

Table 5: Effect of soluble fertilizers through fertigation on seed cotton yield (q ha⁻¹) of Bt cotton

| Treatment                                      | Seed cotton yield (q ha⁻¹) | Stalk yield (q ha⁻¹) |
|------------------------------------------------|----------------------------|----------------------|
| T1- Recommended dose of fertilizers through soil application | 15.87                     | 24.70                |
| T2- Recommended dose of fertilizers through fertigation (conventional) | 19.62                     | 29.44                |
| T3- 100% RDF through soluble fertilizers by fertigation | 22.21                     | 36.24                |
| T4- 80% RDF through soluble fertilizers by fertigation | 21.36                     | 32.66                |
| T5- 60% RDF through soluble fertilizers by fertigation | 17.20                     | 27.28                |
| SE±                                           | 0.57                      | 1.29                 |
| C.D. (P=0.05)                                 | 1.78                      | 4.03                 |
| Grand mean                                    | 19.25                     | 30.06                |

**Conclusion**

The application of 100 per cent RDF through soluble fertilizers by fertigation into six splits significantly enhanced plant height, number of leaves, leaf area, number of bolls, seed and stalk yield of cotton followed by 80 per cent RDF through soluble fertilizers.
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