

Effect of Foliar Supplementation on Enhancing Seed Yield and Final Recovery of Processed Seeds in Cotton

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ABSTRACT: A field study to evaluate effect of foliar supplementation for enhancing seed yield was conducted at ICAR-CICR experimental farm (Nagpur, Maharashtra), during kharif season for two consecutive years (2018-19 and 2019-20). The study aimed to determine the seed yield of cotton seeds in ICAR-CICR released popular *G. hirsutum* cotton variety, Suraj after complete processing. The experiment consisted five treatments including control laid out in RBD with three replications. Treatment comprised of foliar application of nutrients viz. T1 (recommended practice consisting spray of NAA at 45 DAS; urea at 60 DAS and KNO₃ at 110 DAS); T2 (micronutrient mix), T3 (neem seed kernel extract) and T4 (fermented cow urine) each treatment applied thrice at 30 DAS, 45 DAS and 60 DAS in respective plots and T5 (water treated control). Foliar application of micronutrient mix during 2018 and neem kernel extract during 2019 proved significantly superior for the studied traits such as boll number, seed cotton yield, fuzzy seed yield and delinted, graded final clean seed yield. However, the seed recovery percentage for both the years was highest in treatment T1 (recommended) closely followed by T2 and T3. The pooled data also revealed foliar supplementation of both micro-nutrient mix and neem kernel extract as highly effective in enhancing the seed yield and, recommended practice as superior for enhanced seed recovery percentage.

Keywords: Cotton, Foliar, Seed yield, Seed recovery

Cotton is a major cash crop grown globally for its fibre, the primary product, constituting one-third of the crop harvest. The seed, though a by-product constitutes two third portion and is widely employed for extraction of edible oil and as a cattle feed. India occupies the topmost position among the cotton growing countries in the world with a cultivated area of 133.41 lakh ha and production of 356 lakh bales (www.caionline.in). The growth and productivity of cotton crop is significantly influenced by biotic as well as abiotic factors. Among the effective management strategies for abiotic stress tolerance, foliar feeding of major nutrients viz., N, and K as well as micronutrients (boron, magnesium, zinc and copper) alone or in combination is identified as an economically viable option in cotton due to quick absorption by the leaves and ensuring maximum yield potential along with fibre quality [1,2,3].

In spite of constituting a major portion of total harvest, the research on cotton seed per se either as a propagating material or as a by-product has received little attention [4]. The indeterminate growth habit of the cotton plant affects seed quality to a large extent since seeds are set and developed over an extended period of time.

It is mentioned that after ginning the fuzzy seeds obtained contains poorly filled, immature seeds largely varying in size which are indistinguishable unless delinted. High number of such seeds may contribute to fuzzy seed yield but cannot always guarantee high yield of clean seeds after processing. It is essential to obtain quality seeds with less wastage during delinting rather than total fuzzy seed yield alone. The available literature in cotton have reported the influence of various foliar management practices on total seed cotton yield, seed yield [5] and seed quality [6], but not specifically on the yield of seed after processing and cleaning. The effect of foliar supplementation widely followed for seed cotton yield needs improvisation and, has also not been well studied for its effect on cotton seed yield especially in the rainfed part of Vidarbha region. Moreover, with the rising urge for sustainable cultivation practices the researchers worldwide are investigating the ability of foliar supplementation with natural eco-friendly products, botanicals, etc. to control pests and enhance the crop yield and quality [7].

The present study was thus conducted to determine the influence of organic (neem kernel extract and fermented

cow urine) and micronutrient mix as foliar supplement on total seed cotton yield as well as yield of delinted clean seed in comparison with recommended practice and control.

MATERIAL AND METHODS

Field trials using a randomized complete block design with three replications were conducted during two consecutive years, 2018-19 and 2019-20 at ICAR-CICR, Nagpur experimental farm on loamy soil. The study aimed at determining effect of foliar supplementation on seed cotton yield and final graded quality seed yield in popular *G. hirsutum* cultivar, Suraj (non Bt) developed and released by ICAR-CICR. The sowing was done at recommended period in the month of June during both the years, in plots measuring 6.0 m X 3.6 m with 6 rows at an interrow distance of 60 cm and plant to plant distance of 60 cm for each treatment. Supplying growth hormone, NAA (Planofix) to prevent flower and boll drop; foliar spray of urea and KNO₃ are generally followed in cotton as recommended practice. Therefore, the 5 treatments included were recommended foliar practice consisting 40 ppm NAA@ at 45 DAS; 2% urea at 60 DAS and 2% KNO₃ at 110 DAS(T1); foliar application of micronutrient mix available in market with the trade name Mixol containing 2.5% Fe, 1% Mn, 3% Zn, 1% Cu, 0.1% Mo and 0.5% B (T2); extract prepared from neem kernel @ 750g soaked overnight in 5 litres water and then filtered extract diluted 3 times(T3); fermented cow urine prepared using fresh cow urine and jaggery fermented for 7 days and later diluted ten times (T4) and water treated control (T5). It was ensured that each plot maintained good plant stand and plant population and all the POP recommended by ICAR-CICR for cotton cultivation in Vidarbha was followed. One supplemental irrigation at boll maturity was

provided. The observations taken in each plot consisted boll number, seed cotton yield, yield of fuzzy seeds and yield of delinted, cleaned and graded seeds. After weighing the harvested seed cotton from each treatment, it was ginned and weight of fuzzy seed was determined. These fuzzy seeds were later acid delinted and washed to remove light, immature seeds. The delinted seeds were cleaned and graded in a gravity separator. The final clean seeds from each test plot were weighed separately and seed recovery percentage was calculated:

$$\frac{\text{Weight of graded clean seed recovered}}{\text{Weight of fuzzy seed obtained after ginning}} \times 100$$

RESULT AND DISCUSSION

A significant seasonal (year) effect was observed as indicated by higher values for the observed parameters in 2019-20 compared to 2018-19. The weather data of experimental location for both the years has been presented (Table 1). The total rainfall received, average RH as well as the total wet days were higher in 2019 and also the incidence of both sucking pests and boll worms were below ETL in 2019 compared to 2018 (CICR Annual Reports 2018 and 2019).

The observations of 2018-19 (Table 2) revealed that the foliar treatment of micronutrient mix (T2) recorded highest values for the traits such as boll number, seed cotton yield, fuzzy seed yield and delinted, graded seed yield. The treatment with neem kernel extract (T₃) was the second best for all the traits mentioned above except for delinted, graded seed yield. The treatment T2 was significantly superior to control for all the traits. The lint yield was highest for treatment T3 followed by T2. Both the treatments were also significantly superior to T1 (recommended foliar practice) for seed cotton yield and

Table 1. Weather Data at ICAR-CICR Nagpur farm during 2018-19 and 2019-20

| | 2018-19 | | | | 2019-20 | | | |
|-----------|-----------------------|-------------|--------------------|-------------------|-----------------------|-------------|--------------------|-------------------|
| | Mean temperature (°C) | Mean RH (%) | Mean rainfall (mm) | No: of rainy days | Mean temperature (°C) | Mean RH (%) | Mean rainfall (mm) | No: of rainy days |
| June | 30.84 | 63.68 | 217.00 | 10 | 33.47 | 43.84 | 132.4 | 8 |
| July | 27.26 | 81.76 | 480.00 | 11 | 27.53 | 71.56 | 398.4 | 20 |
| August | 27.28 | 77.29 | 171.00 | 8 | 26.55 | 83.45 | 343.4 | 20 |
| September | 27.14 | 70.88 | 74.00 | 3 | 26.3 | 85.35 | 275.0 | 19 |
| October | 26.61 | 62.43 | 0.00 | 0 | 25.35 | 70.95 | 77.0 | 4 |
| November | 23.42 | 62.37 | 0.00 | 0 | 21.9 | 61.6 | 0.0 | 0 |
| December | 18.75 | 64.94 | 0.00 | 0 | 18 | 60.6 | 14.6 | 3 |

Source: CICR Annual reports 2018 and 2019

Table 2. Effect of foliar treatments on seed cotton yield and seed yield in cotton Cv. Suraj

| Treatments | Boll No.(1000/ha) | | | SCY (kg/ha) | | | Lint Yield (kg/ha) | | | Fuzzy Seed (kg/ha) | | | Delinted Seed (kg/ha) | | |
|---------------------|-------------------|---------|--------|-------------|---------|---------|--------------------|---------|--------|--------------------|---------|---------|-----------------------|---------|--------|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| RPP | 359.0 | 594.8 | 476.9 | 1211.4 | 2040.1 | 1625.8 | 444.4 | 768.9 | 606.6 | 767.0 | 1271.3 | 1019.1 | 495.4 | 765.3 | 630.3 |
| Micro | 440.4 | 647.7 | 544.1 | 1419.8 | 2430.6 | 1925.2 | 520.1 | 890.1 | 705.1 | 899.7 | 1540.4 | 1220.1 | 507.7 | 910.2 | 709.0 |
| Neem | 381.2 | 706.2 | 543.7 | 1407.4 | 2500.0 | 1953.7 | 524.7 | 900.9 | 712.8 | 882.7 | 1599.1 | 1240.9 | 490.7 | 956.1 | 723.4 |
| Cow urine | 408.6 | 653.4 | 531.0 | 1345.7 | 2390.4 | 1868.1 | 496.9 | 834.9 | 665.9 | 848.8 | 1555.5 | 1202.1 | 456.8 | 797.8 | 627.3 |
| Control | 379.5 | 578.1 | 478.8 | 1196.0 | 2169.8 | 1682.9 | 450.6 | 792.7 | 621.7 | 745.4 | 1377.0 | 1061.2 | 381.2 | 613.7 | 497.5 |
| SEm± | 16.01 | 20.75 | 13.11 | 53.11 | 91.49 | 52.89 | 19.28 | 26.06 | 16.21 | 34.55 | 67.73 | 38.02 | 22.42 | 18.33 | 14.48 |
| CV (%) | 7.04 | 5.65 | 1.25 | 6.99 | 6.87 | 1.43 | 6.85 | 5.39 | 1.20 | 7.22 | 7.99 | 1.62 | 8.33 | 3.93 | 1.11 |
| CD (0.05) | 52.22 | 67.68 | 39.29 | 173.22 | 298.35 | 158.57 | 62.87 | 84.98 | 48.59 | 112.66 | 220.89 | 113.97 | 73.13 | 59.78 | 43.41 |
| Year (Y) | | | | | | | | | | | | | | | |
| Year 2018-19 | | | 393.73 | | | 1316.05 | | | 487.35 | | | 828.70 | | | 466.34 |
| Year 2019-20 | | | 636.02 | | | 2306.17 | | | 837.52 | | | 1468.66 | | | 808.63 |
| SEm | | | 8.29 | | | 33.45 | | | 10.25 | | | 24.04 | | | 9.16 |
| CD at 5% | | | 24.85 | | | 100.29 | | | 30.73 | | | 72.08 | | | 27.46 |
| Interaction (T x Y) | | | | | | | | | | | | | | | |
| SEm | | | 18.54 | | | 74.80 | | | 22.92 | | | 53.76 | | | 20.48 |
| CD at 5% | | | 55.57 | | | NS | | | NS | | | NS | | | 61.40 |

Table 3. Effect of foliar supplementation on parameters of seed cotton yield and seed yield in cotton, Cv. Suraj

| Treatments | Boll No.(1000/ha) | | | SCY (kg/ha) | | | Lint Yield (kg/ha) | | | Fuzzy Seed (kg/ha) | | | Delinted Seed (kg/ha) | | |
|---------------------|-------------------|---------|--------|-------------|---------|---------|--------------------|---------|--------|--------------------|---------|---------|-----------------------|---------|--------|
| | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled | 2018-19 | 2019-20 | Pooled |
| RPP | 359.0 | 594.8 | 476.9 | 1211.4 | 2040.1 | 1625.8 | 450.6 | 792.7 | 606.6 | 767.0 | 1271.3 | 1019.1 | 495.4 | 765.3 | 630.3 |
| Micro | 440.4 | 653.4 | 544.1 | 1419.8 | 2430.6 | 1925.2 | 520.1 | 890.1 | 705.1 | 899.7 | 1540.4 | 1220.1 | 507.7 | 910.2 | 709.0 |
| Neem | 408.6 | 706.2 | 557.4 | 1407.4 | 2500.0 | 1953.7 | 524.7 | 900.9 | 712.8 | 882.7 | 1599.1 | 1240.9 | 490.7 | 956.1 | 723.4 |
| Cow urine | 381.2 | 647.7 | 517.3 | 1345.7 | 2390.4 | 1868.1 | 496.9 | 834.9 | 665.9 | 848.8 | 1555.5 | 1202.1 | 456.8 | 797.8 | 627.3 |
| Control | 379.5 | 578.1 | 478.8 | 1196.0 | 2169.8 | 1682.9 | 444.4 | 768.7 | 621.7 | 745.4 | 1377.0 | 1061.2 | 381.2 | 613.7 | 497.5 |
| SEm± | 16.01 | 20.75 | 13.11 | 53.11 | 91.49 | 52.89 | 19.28 | 26.06 | 16.21 | 34.55 | 67.73 | 38.02 | 22.42 | 18.33 | 14.48 |
| CV (%) | 7.04 | 5.65 | 1.25 | 6.99 | 6.87 | 1.43 | 6.85 | 5.39 | 1.20 | 7.22 | 7.99 | 1.62 | 8.33 | 3.93 | 1.11 |
| CD (0.05) | 52.22 | 67.68 | 39.29 | 173.22 | 298.35 | 158.57 | 62.87 | 84.98 | 48.59 | 112.66 | 220.89 | 113.97 | 73.13 | 59.78 | 43.41 |
| Year (Y) | | | | | | | | | | | | | | | |
| Year 2018-19 | | | 393.73 | | | 1316.05 | | | 487.35 | | | 828.70 | | | 466.34 |
| Year 2019-20 | | | 636.02 | | | 2306.17 | | | 837.52 | | | 1468.66 | | | 808.63 |
| SEm | | | 8.29 | | | 33.45 | | | 10.25 | | | 24.04 | | | 9.16 |
| CD at 5% | | | 24.85 | | | 100.29 | | | 30.73 | | | 72.08 | | | 27.46 |
| Interaction (T x Y) | | | | | | | | | | | | | | | |
| SEm | | | 18.54 | | | 74.80 | | | 22.92 | | | 53.76 | | | 20.48 |
| CD at 5% | | | 55.57 | | | NS | | | NS | | | NS | | | 61.40 |

fuzzy seed yield. The highest value for the yield of delinted, graded, clean seeds, which is the major trait under study, was recorded for treatment T2 followed by treatment T1 and treatment T3 respectively. It is to be noted that the recommended practice (T1) in spite of the lower fuzzy seed yield, recorded higher delinted, graded seed yield compared to treatment T3. All the three treatments, T1, T2 and T3 were at par for the delinted and clean seed yield and were significantly higher than control (T5). The nutritional status of mother plants is reported to have a considerable impact on partitioning of carbohydrates and dry matter for the developing seeds [8,9]. The positive impact of foliar application of micronutrient mix on seed yield and its physiological/biochemical quality has been proved in cotton (5). Being eco-friendly and resulting in efficient absorption, foliar supplementation with nutrients is the most economical way to achieve higher produce with superior quality seeds in cotton [10]. They are known to act as a catalyst in the uptake of nutrients, positively influencing various physiological and biochemical processes in crop plants [11]. This results in better nutrient allocation to developing seeds [12] thus increasing the yield of completely mature, fully filled clean seeds with reduced seed loss. The role of balanced fertilization program with both macro and micro-nutrients in the production of high-quality cotton seeds has already been highlighted in cotton [13]. Compared to control, treatment T1 showed non-significant fuzzy seed yield, whereas, the difference was significantly higher for delinted, graded seed which can be attributed to the readily available foliar nutrients included in the treatment. The seed recovery percentage was significantly superior for T1 over control (Fig.1).

Though not significant, the treatments T2, T3 and T4 were also superior to control.

The data of 2019-20 revealed that the foliar treatment, T3 showed highest values for all the traits under study such as boll number, seed cotton yield, lint yield, fuzzy seed yield and delinted graded seed yield. The treatment T2 was the second best and both these treatments were significantly superior to control (T5) as well as recommended practice (T1) indicating their significant role in cotton seed production. Though neem kernel application is widely recommended for control of cotton pests, its role in increasing the seed yield in cotton could be due to its positive effect on photosynthetic and enzymatic activities [14]. There are reports on organic compounds having protective functions with positive influence on different physiological and biochemical activities of plants increasing their growth and yield [15]. The neem and its products are known as natural soil conditioner and are used in seed treatment, manurial application and increasing nutrient efficiency [16].

It is pertinent to mention that in 2019-20 season too, the recommended practice (T1) despite showing lower yield for fuzzy seeds compared to control, produced significantly higher yield of delinted, clean seeds reiterating the fact that it is not just the total seed yield per se but the yield of delinted and graded seed is more important in cotton. The seed recovery was significantly superior in T1 treatment very closely followed by T2 and T3 (Fig.1). The NAA and potassium nitrate present in the recommended practice has positively influenced higher retention of bolls and diversion of more photosynthates to developing bolls and seeds [17] reducing the proportion of damaged, partially filled/empty seeds.

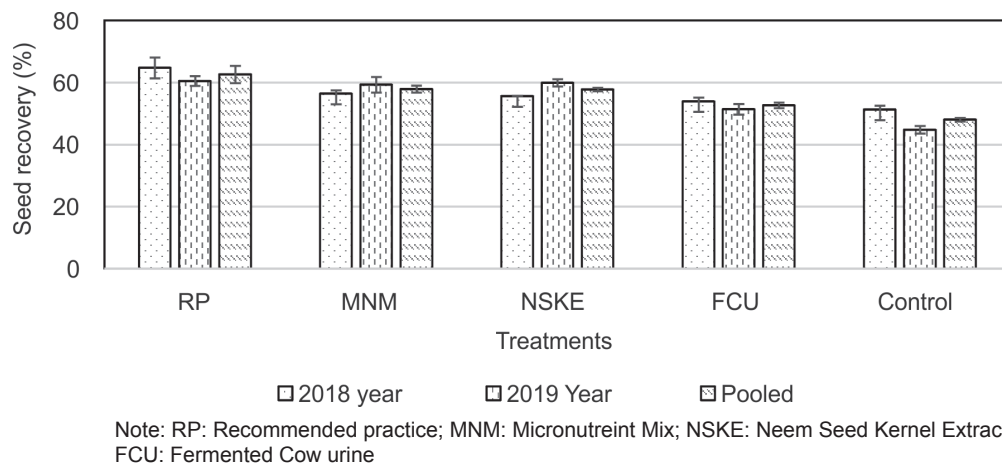


Figure 1. Comparison of seed recovery percentage among the foliar treatments for two years (Year wise and pooled)

The two year pooled data indicated that the treatments T2 and T3 were significantly superior to control as well as recommended practice (T1) for boll number, seed cotton yield, lint yield and seed yield (fuzzy and delinted, clean seed). Increase in the delinted, fully filled, viable seed yield in T3 was 45% and 14.7% higher than control and recommended practice (T1) respectively. Similarly, seed yield in T2 was 42.51% and 12.49% higher than control and T1 respectively. Foliar application of micronutrients during reproductive stages is equally critical and enhances the efficient utilization of nutrients resulting in higher seed cotton yield [18]. The pooled data revealed fermented cow urine (T4) was effective in significantly enhancing the boll number, seed cotton yield and fuzzy seed yield, but values were lower than those resulted by T2 and T3. Fermented Cow urine act as a good source of nutrients, mineral salts and hormones and is a widely adapted ITK for controlling sucking pests and increasing yield in cotton (www.cicr.org) and other crops [19]. Applying AmruthaJalam (fermented cow dung and cow urine) and botanical extractions from neem are important components in the recommended better management practices for cotton [20]. With regard to seed recovery percentage the treatment T1 remained significantly superior followed by treatments T2 and T3 respectively.

Although the treatment T3 (Neem kernel extract) was found numerically higher than micronutrient mix (T2) in increasing seed cotton yield and lint yield, both the treatments were at par with respect to enhancement in all the studied parameters except seed recovery. The treatment T1 which is the recommended practice was the best with regard to enhancing the seed recovery percentage. It is to be noted that irrespective of treatments and year of production, the seed recovery percentage remained 55.75% and the result of present study signifies the need to put in more research efforts on enhancing the clean seed recovery in addition to the total seed yield in cotton.

The interaction effects of season (year) and treatments showed significant contribution of all foliar interventions on traits such as boll numbers and seed yield (fuzzy and delinted, cleaned seeds) and seed recovery percentage whereas, the effect was non-significant with respect to seed cotton yield and lint yield.

CONCLUSION

All the four foliar interventions under study (recommended practice, micronutrient mix, neem kernel extract and

fermented cow urine) were effective in increasing the seed yield (both fuzzy and delinted) of cotton compared to untreated control. The most effective treatment for obtaining higher seed yield after delinting and cleaning was observed with foliar supplementation with micronutrient mix and neem kernel extract in 2018 and 2019, respectively. With regard to the seed recovery percentage, recommended practice proved superior during both the years. Our study emphasizes that there is 50% wastage of seeds in cotton which needs research attention.

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